New method for uniform corrosion measurement on reinforced concrete structure

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Corrosion is one of the major deterioration in reinforced concrete structure. It is responsible for considerable financial losses due to maintenance and repair needs. Steel rebars embedded on reinforced concrete structure are initially protected by a passive film on steel concrete interface. However, the pH of concrete can decrease due to carbonation front propagation which causes protective film destruction and uniform corrosion initiation.

Several corrosion detection methods exist: concrete resistivity, half-cell potential or linear polarization resistance (LPR) measurement. LPR method offers the advantage to provide the corrosion rate while other techniques only give a corrosion risk. The LPR value can be linked to the corrosion rate thanks the Stern-Geary equation if few hypotheses are made. Some commercial devices use LPR method but corrosion rate results differ widely. These devices use a guard ring to canalize the current on specific steel rebar area and assume that the steel rebar is uniformly polarized. However, recent works reveal that the top part of the steel rebar, right under the counter electrode, is the most polarized point. The particular point is referred as the point of interest (POI).

This works belongs to the DIAMOND project which aims to produce a new corrosion rate measurement device. It consists on a more simple geometry (no guard ring) and is based on corrosion rate measurement on a single point, the POI. To address this problem, the current density at the POI must be known. However, it depends on several parameters: injected current, concrete cover and resistivity and steel rebar diameter.

Previous worked by Mitzithra were conducted on Comsol® software to take into account the three dimensional aspect of the problem. It leads to the creation of the first abacuses that link the injected current density on the counter electrode to the current density at the POI depending on concrete cover and resistivity. On site, concrete cover and resistivity and steel rebar diameter are evaluated using other techniques.

Comsol® software was used to model the influence of concrete cover and resistivity and injected current on the current density at the POI. Moreover, a significant influence of the steel rebars diameter was also demonstrated. Large rebars tend to spread the current and the current density at the POI is smaller. This phenomenon was accentuated if the concrete cover is small.

Some abacus, linking the ratio between the current density at the POI and the density of injected current to concrete cover and steel rebar diameter, are built.

The Stern-Geary equation can now be used at the POI without usinga false approximation of a uniformly polarized rebar. The current density at the POI is known thanks the utilization of the build abacus. The corrosion state of reinforced concrete structure can be controlled more precisely.