Reinforced Concrete Structures

Rebar Corrosion and Integrity Inspections and Monitoring Cathodic Protection

Rebar corrosion

Steel reinforcements of concrete structures are naturally protected by the alkalinity of cement which allows to establish and maintain passive conditions. However, there are a number of specific but recurrent situations where passivity can be destroyed and corrosion can initiate and propagate (Fig. 1). These are:

- Penetration of chloride ions
- Carbonation
- Stray currents.

In all cases, corrosion starts after an initiation period where corrosion rate is negligible, and then propagates at a rate which can be quite high depending on local concrete conditions and macrocell establishment (Fig. 2).

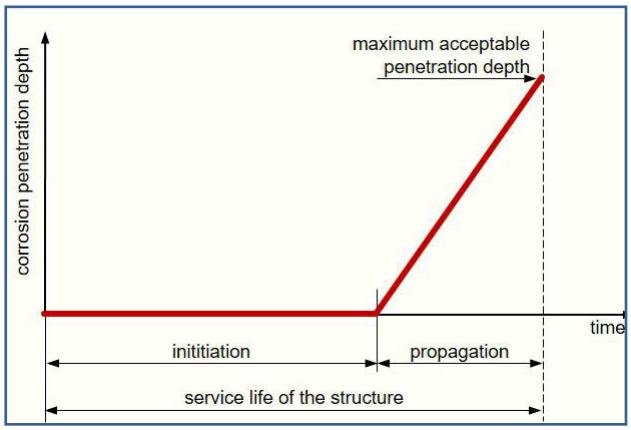


Fig. 1 - Initiation and propagation of localized corrosion

Fig. 2 - Example of corrosion attack on a rebar

Durability and Integrity of Reinforced Concrete Structures

Durability and structural integrity of reinforced concrete structures is determined by rebar corrosion. Corrosion rate of passive steel in concrete is very low, but not nil: in non-carbonated and non-chloride contaminated concrete corrosion rate is in the order of 0.1 µm/year, but can increase of orders of magnitude if these prerequisites are not met. CESCOR provides expert assessment for reinforced concrete infrastructures where long-term durability are requested (i.e. 50 years or more) and when an existing structure shall be requalified and operating life extended.

Corrosion in concrete Inspection Methods

CESCOR performs inspection on reinforced concrete structures for the assessment of rebar corrosion. Applied techniques include:

- Potential measurements and mapping
- Carbonation penetration tests (Fig. 3)
- Linear Polarization Resistance measurements (LPR) (Fig. 4)
- Core drillings for chloride penetration analysis (Fig. 5)
- Interference measurements
- Concrete resistivity measurement (Fig. 6)

Fig. 3 - Carbonation test of concrete with phenolphthalein

Fig. 4 - Linear Polarization Measurements

Fig. 5 - Core drilling

Fig. 6 - Concrete resistivity measurements

Potential Mapping

The technique is applied to concrete structures exposed to atmosphere. The inspection is performed by measuring the rebar free corrosion potential by an array of portable reference electrodes connected to an acquisition system. The measured potential value provides a probabilistic indication on the corrosion condition of rebar in correspondence of the position where the reading was taken. The potential values are then processed in form of maps of the inspected structural element, allowing to identify macrocells, i.e. anodic (corrosion) and cathodic areas.

Fig. 6 - Concrete resistivity

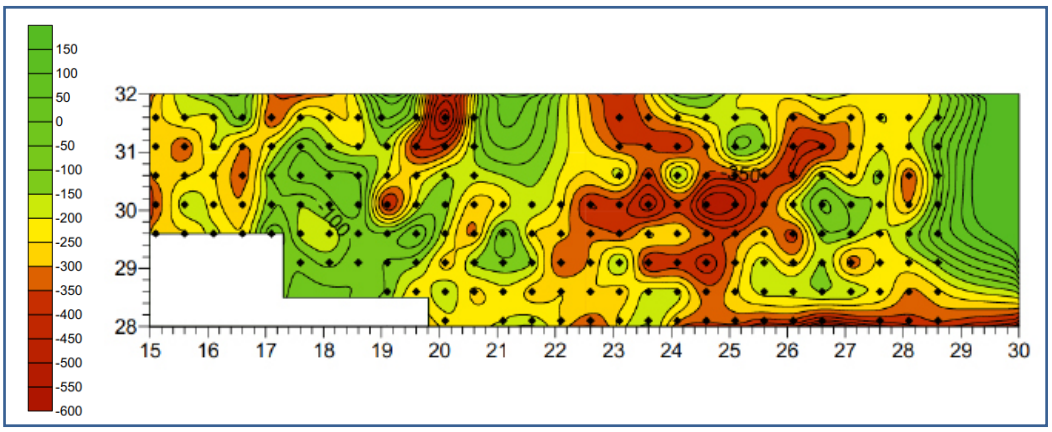
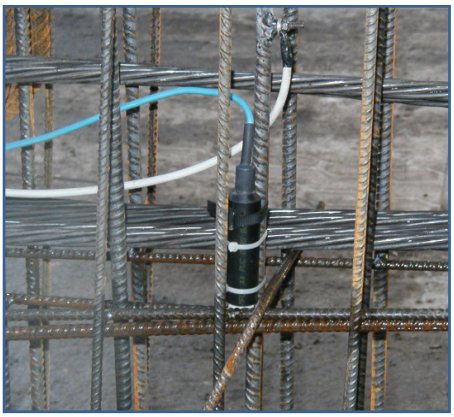
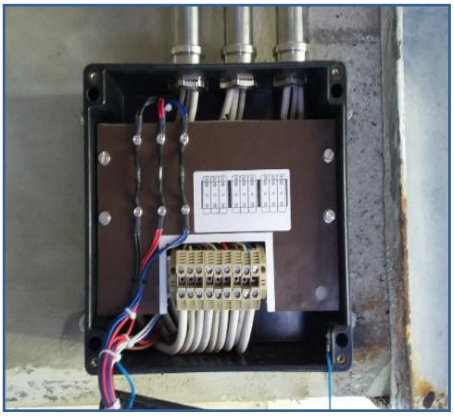


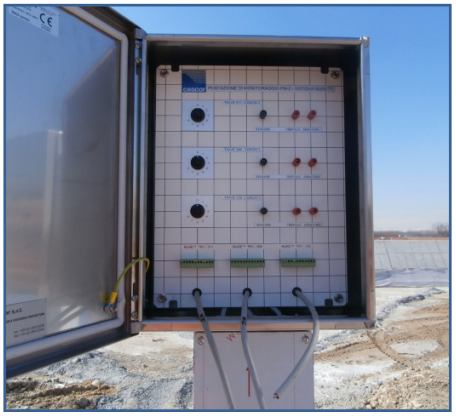
Fig. 6 - Concrete resistivity measurements

Corrosion monitoring

Some examples of corrosion monitoring devices and monitoring junction boxes.







Cathodic Protection

Zinc galvanic anodes for rebar cathodic protection

Ti-MMO mesh anode applied on a concrete pile

Feeding and Control Units for CP in concrete

Bridge architraves protected by an ICCP system

Services

For reinforced concrete structures, CESCOR provides:

- Durability and integrity assessment studies
- Site inspection surveys
- Permanent corrosion monitoring systems
- Cathodic protection systems – galvanic anodes and impressed current type.

Applications

- Viaducts and bridges - decks, pylons.
- Galleries and tunnels - on roads and railways
- Piers and harbor facilities
- Subways
- Car parking

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