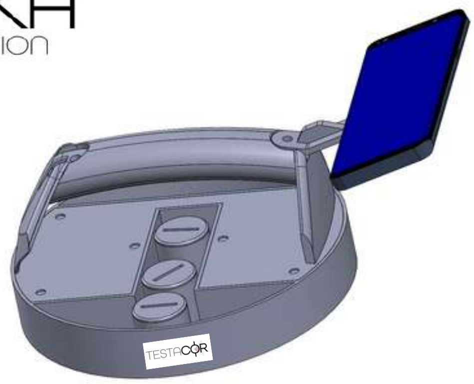
TESTACOR

DATA SHEET

TESTACOR

SENSORIKA
LAB INNOVATION



"ON-SITE EVALUATION EQUIPMENT FOR CORROSION RATE, CORROSION POTENTIAL, AND RESISTIVITY IN REINFORCED CONCRETE STRUCTURES"

GENERAL DESCRIPTION

TESTACOR, as an advanced integral corrosion meter, presents itself as a compact solution for evaluating corrosion in concrete structures, standing out for its advanced technology, simultaneous measurement of multiple parameters, and specialized support services.

Unlike other systems, with TESTACOR, all parameters are obtained simultaneously through a single easy-to-handle measuring probe. It highlights the innovative controlled polarization technique (see Fig.1), which not only ensures the reliability of the measurement but also ensures that the polarization (or electrochemical perturbation) induced in the steel is not harmful.

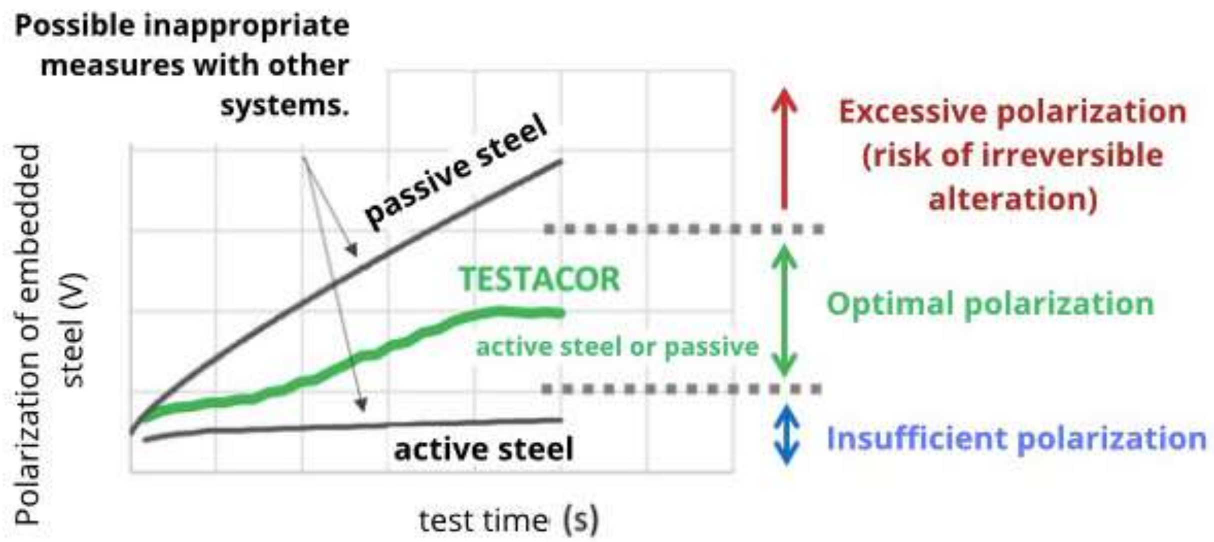


Fig.1 Optimal Polarization Achieved with Testacor During the Test Compared to Possible Undesirable Situations with Other Systems

The purpose of controlled polarization in TESTACOR is to obtain precise and reliable information about the kinetics of the electrochemical corrosion process of embedded steel, with the advantage that:

- Performs a Dynamic Adjustment of the Current for precise control of polarization. It prevents excessive and irreversible polarization of the reinforcements.
- In addition to on-site inspection of real structures, TESTACOR is designed to evaluate laboratory specimens, an application of special interest in the field of quality control and scientific research.

PROVIDED PARAMETERS

TESTACOR is an innovative device designed for the non-invasive assessment of the corrosion state in reinforced concrete structures. By measuring the key parameters: Corrosion Potential (E_{CORR}), Concrete Resistivity (ρ), and Corrosion Rate (I_{CORR}). These parameters allow determining the risk or level of corrosion of the structures according to the criteria of ranges and thresholds established in regulations (see Table 1).

Corrosion Potential, (E_{CORR})

The measurement of corrosion potential (E_{CORR}) consists of determining the electrical potential difference (V) between the steel reinforcement and a standard reference electrode placed in contact with the concrete surface. (E_{CORR}) is a qualitative parameter associated with the risk or probability of reinforcement corrosion.

In Testacor, ECORR is measured with respect to the saturated copper/copper sulfate reference electrode ($Cu/CuSO_4$sat.), also known as CSE electrode.

Resistivity (ρ)

The measurement of concrete resistivity helps interpret the value of corrosion rate (I_{CORR}), as it is closely related to the moisture content within the concrete pore network. The parameter measured with different techniques is the electrical resistance of the concrete (Re), typically measured in kΩ. Resistivity is calculated from Re taking into account the geometric factor of the measuring cell. Therefore, its units are kΩ·cm.

In Testacor, resistivity (ρ) is determined by applying the 'current interruption' technique between the embedded reinforcement and a disk placed in contact with the concrete surface over the reinforcement. The process involves recording the instantaneous voltage drop (also known as 'ohmic drop') when the electrical signal is imposed and then instantly cut off. The 'ohmic drop' (Re) is converted into resistivity, in kΩ·cm, by applying a cell factor. (cm^2)

Corrosion Rate (I_{CORR})

The corrosion rate is commonly determined in terms of current density, that is, in terms of corrosion current density (I_{CORR}). This is the only parameter that allows quantifying the kinetics of the corrosion process. Its usual units of measurement are µA/cm², so it is always necessary to know the metallic area (cm²) to which the measurement refers.

Applying Faraday's law, it is possible to translate the values of (I_{CORR}) measured to section losses of the reinforcement (corrosion rate in µm/year), so this type of measurement is very useful for estimating the remaining life of structures affected by corrosion.

$$1\mu A/cm^2 <> 11.6\ \mu m/año$$

In Testacor, the corrosion density (I_{CORR}) is obtained through a dynamically controlled galvanostatic pulse electrochemical polarization methodology based on the linear polarization resistance (LPR) technique. The polarization resistance (RP) obtained by this technique is related to (I_{CORR}) through the Stern and Geary formula:

$$i_{CORR} = \frac{B}{R_p \cdot steel\ area}$$

The parameter B can vary between 13 and 52 mV in most metal-medium systems, with a value of 26 mV typically assumed for reinforced concrete. The essential advantage of the controlled polarization method used in Testacor is that, unlike other systems, the polarization of the reinforcement is always performed within appropriate levels (between 10 and 30 mV) for the LPR method to be valid. That is, sufficient polarization to record a reliable response (>10mV) but without excessively polarizing the reinforcement (< 30 mV), thus avoiding the risk of producing irreversible polarization.

E_{CORR} vs CSE (UNE 112083) QUALITATIVE			Resistivity (RILEM TC-154) QUALITATIVE			i_{CORR} (UNE 112072) QUANTITATIVE		
(green)	> -200 mV	Low (< 10%)	(green)	> 100 kΩ·cm	Negligible	(green)	< 0,1 µA/cm²	Negligible
(orange)	-350 / -200 mV	Moderate (50%)	(yellow)	50 / 100 kΩ·cm	Low	(yellow)	0,1 / 0,5 µA/cm²	Low
			(orange)	10 / 50 kΩ·cm	Moderate	(orange)	0,5 / 1 µA/cm²	Moderate
(red)	< -350 mV	High (> 90%)	(red)	< 10 kΩ·cm	High	(red)	> 1 µA/cm²	High

Table 1. Reference criteria applied to determine the risk and level of corrosion in reinforced concrete according to the parameters of corrosion potential (E_{CORR}), resistivity (ρ), and corrosion density (I_{CORR})

MEASUREMENT METHOD

TESTACOR utilizes a non-destructive method based on the dynamically controlled galvanostatic pulse technique to evaluate the corrosion rate of embedded steel in reinforced concrete. Below are the key aspects of this method:

1 Galvanostatic Pulse with Sensorized Confinement:

The evaluated reinforcement area is controlled during the measurement by a sensorized guard ring system, which effectively confines the applied signal. This ensures the reliability of the corrosion rate measurement.

2 Dynamic Adjustment of Polarization Current:

A current pulse is applied with a dynamic adjustment of the applied polarization current to maintain it at appropriate levels. This dynamic adjustment ensures that the induced polarization does not cause irreversible damage to the embedded steel, maximizing the system's effectiveness.

3 Multiparameter Measurement Probe:

The measurement is carried out using a single probe that simultaneously records several critical parameters:

- Corrosion potential of the embedded steel (E_{CORR}), , in mV vs CSE).
- Corrosion rate of the embedded steel expressed in current density (I_{CORR}) , in μA/cm²) and section loss (V_{CORR}, in μm/year).
- Electrical resistivity of the concrete (ρ, in kΩ·cm).

4

Controlled Polarization for Measurement Reliability:

The controlled polarization technique ensures measurement reliability by avoiding harmful electrochemical disturbances.
Controlled polarization minimizes the risks of irreversible damage to the inspected metallic elements, allowing the same point to be evaluated as many times as desired within a short period of time.

5

Simultaneous Measurement of Parameters:

Unlike other systems, TESTACOR allows the simultaneous acquisition of all critical parameters through the easy-to-handle probe.

6

Versatile Applications:

Designed for on-site inspection of real structures and evaluation of laboratory specimens.
Applicable in quality control and scientific research in the field of reinforced concrete corrosion.

7

Multidisciplinary Development:

The patented technique and advanced protocol have been developed by a multidisciplinary team of researchers from the Eduardo Torroja Institute of Construction Sciences of the Spanish National Research Council (CSIC).

ADVANTAGES AND APPLICATIONS

1 Measurement Reliability:

A patented advanced measurement method is applied, ensuring dynamic control of induced polarization to maintain it at optimal levels, thus guaranteeing measurement reliability and avoiding any risk of irreversible damage to the embedded steel.

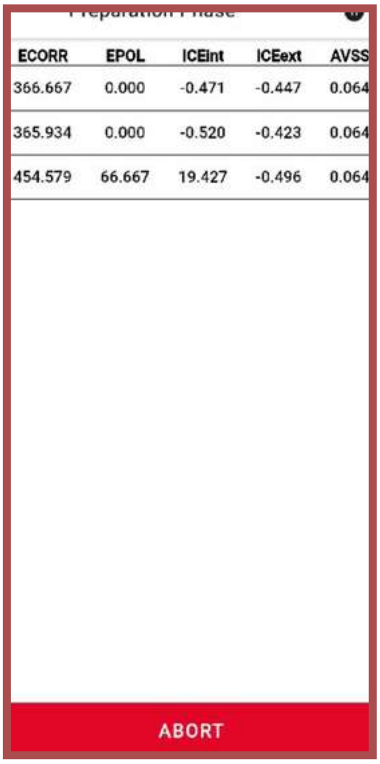
2 Application Versatility:

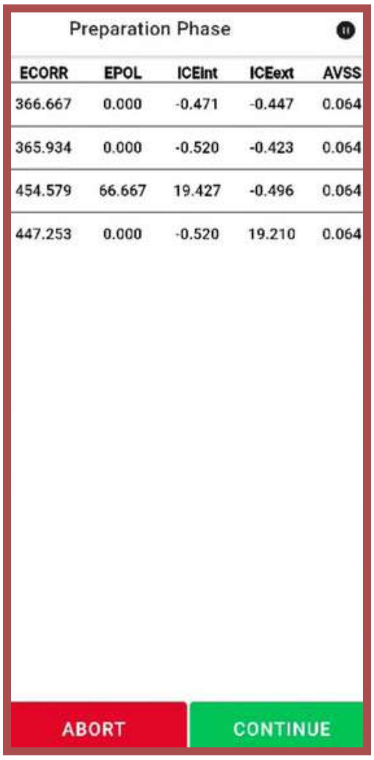
Designed for on-site inspection tasks of reinforced concrete structures, as well as for remote and continuous monitoring, reducing operational costs. Applicable in corrosion studies on laboratory specimens for scientific research.

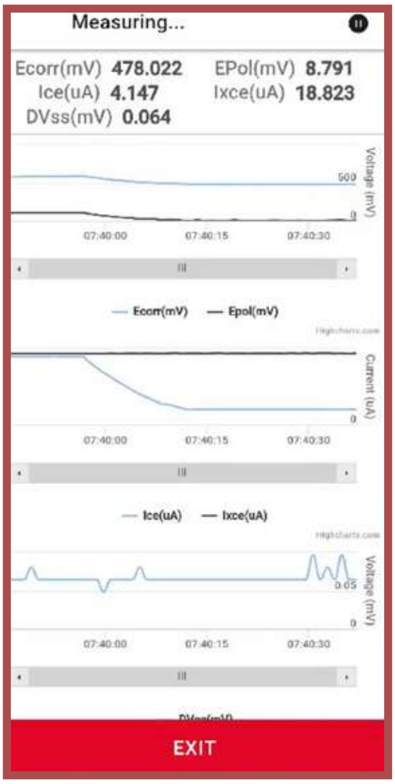
3 Reduction of Additional Equipment:

Eliminates the need for specific sensors for each corrosion parameter. All parameters are measured simultaneously using a multiparameter probe.

EXAMPLE OF USE: TESTACOR APP







SUPPORT

- Specialized training in equipment operation and result interpretation.
- Regular maintenance and inspection of electronic components and probes.
- Continuous software updates and technical training.

Specialized Support:

Provides services such as personnel training, regular inspection and maintenance, software updates, device repairs, and technical consultancy. Exclusive Access to New Devices: Priority and exclusive access to new devices under development, participation in workshops and validation campaigns on prototype structures, among other benefits.

HARDWARE

- **Enhanced Howland Current Source (EHCS) Implementation:** Generation of controlled currents for precise measurements.

- **Current Measurement:** Two channels for measuring currents generated in the inner and outer ring. Conversion of currents to voltage ranges for acquisition with ADC.

- **EHCS Validation:** Calibration with a resistive load of 1 kohm and preliminary tests. Repetition of the process for different resistive loads and Randles cells.

The software associated with a device like TESTACOR generally handles several essential functions:

1. **Device Control:** Allows configuration and control of the hardware from a graphical interface. This would include setting measurement parameters, calibration, and device activation.

2. **Real-Time Data Visualization:** Provides a real-time interface for visualizing data as it is being collected. This may include real-time graphs of measured parameters such as corrosion rate, corrosion potential, and concrete resistivity.

3. **Data Storage:** Measurement results are stored in a local or cloud-based database. This allows access to historical data and facilitates long-term analysis.
   Data Analysis: May include analysis tools to assess trends over time, identify patterns or correlations in the data, and generate reports.

4. **Cloud System Compatibility:** For internet-connected devices, the software typically facilitates uploading data to a cloud platform, where users can access data from any location and device.

5. **Firmware Updates:** Allows remote firmware updates for the device to ensure it is always using the latest software version.

6. **Corrosion Maps:** Mapping of the measured corrosion parameters clearly, visualizing critical areas with color diagrams in the face of corrosion.

7. **User-Friendly Interface:** An easy-to-use interface is crucial for operators to configure and use the device seamlessly.

CONTROLLED POLARIZATION TECHNIQUE

The purpose of controlled polarization in TESTACOR is to obtain precise and reliable information about the kinetics of the electrochemical corrosion process of embedded steel, with the advantage that:

- Performs a dynamic current adjustment for precise polarization control.
- Prevents excessive and irreversible polarization of the reinforcements.

TESTACOR performs a dynamic adjustment of the applied polarization current to the reinforcement.
This dynamic adjustment ensures that the polarization remains at appropriate levels to obtain precise measurements without causing irreversible damage to the embedded steel.

Importance in TESTACOR:

Reliability of Measurements: Controlled polarization in TESTACOR ensures the reliability of corrosion measurements by maintaining controlled conditions and avoiding undesired effects that could affect the results.

Low Polarization of Steel: By controlling polarization, embedded steel is protected from potential damage caused by excessive electrochemical disturbances.

Dynamic Adjustment for Different Scenarios: The dynamic adjustment capability allows adaptation to different corrosion scenarios, optimizing system performance for a wide range of conditions.

TESTACOR

REGULATION AND CONTROL PROTOCOL

It includes an advanced protocol for the regulation and control of the applied current.

The regulation and control protocol contributes to the maximum effectiveness of the TESTACOR system by maintaining polarization within optimal ranges.

MANUFACTURER INFORMATION

SENSORIKA
LAB INNOVATION

www.sensorikalab.com

witeklab@witeklab.ad

WITEKLAB

Sales

https://www.witeklab.com/en/