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Standard Practice

Inspection Methods for Corrosion Evaluation of Conventionally Reinforced Concrete Structures

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Foreword

This NACE International standard practice provides testing procedures and investigative techniques for the evaluation of conventionally reinforced concrete structures. The investigation and evaluation techniques described in this standard focus on degradation resulting from corrosion of the reinforcing steel. When distress of a structure is evident, it is important to determine the nature of the degradation to select the best restoration strategy. Although this standard does not specifically address restoration options, additional information on repairs and corrosion mitigation techniques can be found in other NACE International standard practices, test methods, and state-of-the-art reports, and other publications.¹⁻¹⁷

This standard is intended for use by corrosion specialists, civil engineers, and structural engineers involved with evaluating corrosion of reinforcing steel in concrete. It also may be useful to owners of reinforced concrete structures whose service life may be affected by reinforcing steel corrosion.

NACE Task Group (TG) 055 prepared this standard. The TG is composed of manufacturers, users, consulting engineers, and other interested parties, and this standard represents a consensus of those members. This standard is not intended to be all encompassing. However, it provides information that allows the user to perform testing and evaluation of atmospherically exposed reinforced concrete structures that are believed damaged from corrosion of the reinforcing steel. Note that the information gathered during this investigation may require subsequent investigation and evaluation by qualified structural engineering personnel, depending on the nature and extent of degradation.

This standard was prepared in 2008 by NACE TG 055, a component of Specific Technology Group (STG) 01—Reinforced Concrete, and is also sponsored by STG 62—Corrosion Monitoring and Measurement: Science and Engineering Applications. It is published under the auspices of STG 01.

In NACE standards, the terms *shall*, *must*, *should*, and *may* are used in accordance with the definitions of these terms in the *NACE Publications Style Manual*. The terms *shall* and *must* are used to state a requirement, and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

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Contents

1. General.....	1
2. Definitions.....	1
3. Technique Selection.....	1
4. Corrosion Survey.....	2
5. Evaluation and Report.....	16
References.....	16

Section 1: General

1.1 Inspecting and monitoring the condition of reinforced concrete involves the use of a number of evaluation techniques, ranging from simple visual inspections that identify rust staining, cracks, and delamination, to physical and chemical inspection methods, which use hammer rebound, ultrasonic testing, electrical resistance, chemical analyses, or electrochemical potential and corrosion rate measurements. A number of relevant standards and overview technical papers that discuss issues germane to corrosion inspection of reinforced concrete structures are available.¹⁸⁻³² In 1993, a manual related to this topic was published.³³

1.2 The purpose of this standard is to provide the corrosion specialist, engineer, or owner a framework for evaluating the corrosion condition of a reinforced concrete structure

beyond simple visual inspection and basic sounding techniques. Evaluation techniques that identify general and localized corrosion of conventional reinforcement are provided. Although this standard specifically addresses conventionally reinforced structures, many of the techniques also apply to prestressed and post-tensioned reinforcement. Commentary is included for screening corrosion control methods that might be considered as part of recommendations for restoration of the reinforced concrete structure being evaluated. However, it is beyond the scope of this standard to fully address all factors associated with the design, criteria, and implementation of such corrosion control measures.

Section 2: Definitions

Electrode Potential: The potential of an electrode in an electrolyte as measured against a reference electrode. (The electrode potential does not include any resistance losses in potential in either the electrolyte or the external circuit. It represents the reversible work to move a unit of charge from the electrode surface through the electrolyte to the reference electrode.)

Electrometer: A highly sensitive electronic voltmeter whose input impedance is so high that the current flowing into it can be considered, for practical purposes, to be zero. To obtain accurate potential measurements in high-resistivity concrete, the required impedance may exceed $10^9 \Omega$.

Fickian Behavior: A process that follows Fick's laws of diffusion.

Laitance: A milky white deposit of fine particles on the surface of cement or concrete.

Pozzolan: A material that, when combined with water and calcium hydroxide or alkali oxides, exhibits cementitious properties.

Section 3: Technique Selection

3.1 The selection and application of specific techniques depends on the particular structure and the purpose of the survey. A detailed program of inspection for one structure is not necessarily directly applicable to a different structure.

3.2 Basic surveys, carried out at regular intervals, e.g., every one or two years, normally rely on relatively simple inspection methods. However, if corrosion or premature deterioration is suspected, or has occurred, a detailed survey involving additional techniques is required to ascertain the extent and degree of damage. In some cases, this may require sophisticated techniques to identify the nature and cause of the deterioration, highlight areas of particular damage or concern, and estimate the remaining life expectancy.

3.3 Procedures for inspecting concrete structures on site include:

- (a) Visual inspection techniques;
- (b) Crack inspection;
- (c) Delamination survey;
- (d) Cover thickness survey and reinforcement location;
- (e) Assessment of concrete strength and condition;
- (f) Corrosion potential measurements;
- (g) Corrosion rate measurement;