Guide for Conducting a Visual Inspection of Concrete in Service

Reported by ACI Committee 201
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This guide provides terminology to perform and report on the visual condition of concrete in service. It includes a checklist of the many details that may be considered in making a report and descriptions for various concrete conditions associated with the durability of concrete.

Keywords: chemical attack; concrete durability; corrosion; cracking; deterioration; discoloration; environments; joints; oxidation; popouts; scaling; serviceability; spalling; staining; surface defects; surface imperfections.

CONTENTS
Chapter 1—Introduction, p. 2
  1.1—Scope
  1.2—Introduction
  1.3—References

Chapter 2—Descriptions of distress, p. 2
  2.1—Cracking
  2.2—Distress
  2.3—Textural features and phenomena relative to their development

Chapter 3—Visual inspection report and checklist, p. 12

Appendix, p. 14

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CHAPTER 1—INTRODUCTION

1.1—Scope
This is a guide for a visual inspection of concrete in service. A visual inspection is an examination of concrete to identify and define many of the various conditions concrete may exhibit during its service life. The visual inspection is typically limited to the surfaces of the concrete structure that are visually accessible.

1.2—Introduction
By completing a visual inspection of the concrete immediately after construction, and through repetition at intervals during the concrete’s service life, the visual inspection provides important historical information on performance and durability. The inspection results also aid in early detection of distress and deterioration, enabling repair or rehabilitation before replacement is necessary.

It is important that the inspector properly document any observations related to environmental and loading conditions. Inspections are often supplemented with nondestructive tests, destructive tests, and other investigations, especially when distress and deterioration is observed and information regarding the internal condition of the concrete is needed.

While a visual inspection is most often used in connection with the condition survey of concrete that is showing defects or some degree of distress, its application is recommended for all concrete structures. It is important that the inspector properly document any observations related to environmental exposure (effects from physical loads, deformations, defects, imperfections, and distress), durability, and performance. Concrete material records and construction practices should be collected and reviewed.

The checklist includes items that might have a bearing on the durability and performance of the concrete. Individuals making the survey should not limit their investigation to the items listed, but should review any other contributing factors. Following the guide does not eliminate the need for intelligent observations and the use of sound judgment.

Individuals performing the inspection should be experienced and competent in concrete condition surveys. In addition to written descriptions, sketches of relevant features are valuable and encouraged. Photographs, including a scale to indicate dimensions, are of great value in showing the condition of concrete. Video coverage should be considered for documentation as it provides an enhanced visual dimension that may exceed that of still photography.

The descriptions and photographs provided in Chapter 2 illustrate typical observations encountered during inspections and aid in the preparation of a condition survey report by identifying the characteristics of potential problems and describing their condition. The checklist in Chapter 3 is provided to assist the user to identify the characteristics of potential condition survey findings and their description.

1.3—References
This guide should be used in conjunction with ACI Concrete Terminology and the following American Concrete Institute documents.

201.2R Guide to Durable Concrete
207.3R Practices for Evaluation of Concrete in Existing Massive Structures for Service Conditions
224.1R Causes, Evaluation, and Repair of Cracks in Concrete Structures
228.1R In-Place Methods to Estimate Concrete Strength
228.2R Nondestructive Test Methods for Evaluation of Concrete in Structures
311.1R ACI Manual of Concrete Inspection (SP-2)
349.3R Evaluation of Existing Nuclear Safety-Related Concrete Structures
350.1 Tightness Testing of Environmental Engineering Concrete Structures
364.1R Guide for Evaluation of Concrete Structures Before Rehabilitation
437R Strength Evaluation of Existing Concrete Buildings

This guide should also be used in conjunction with the following documents for condition assessment of structures:


CHAPTER 2—DESCRIPTIONS OF DISTRESS
Imperfections and distresses have been categorized and illustrated by photographs, and their severity and extent of occurrence have been quantified where possible. The purpose of the photographs is to standardize the reporting of the condition of the concrete in a structure. Those performing the survey should be thoroughly familiar with the terminology of various types of imperfections and distresses. Figures are provided to illustrate the various types of defects and distresses, along with the cause of deterioration when known.
2.1—Cracking

Crack—a complete or incomplete separation, of either concrete or masonry, into two or more parts produced by breaking or fracturing.

Cracking of concrete should be reported based on crack widths and the type of crack.

2.1.1 Crack widths—Examples of cracks of varying widths are shown in Fig. 2.1.1(a) and (b).

2.1.2 Crack patterns

2.1.2.1 Checking—development of shallow cracks at closely spaced but irregular intervals on the surface of plaster, cement paste, mortar, or concrete. (See also cracks and crazing.)

2.1.2.2 Craze cracks—fine random cracks or fissures in a surface of plaster, cement paste, mortar, or concrete (Fig. 2.1.2.2(a) and (b)).

2.1.2.2.1 Crazing—the development of craze cracks; the pattern of craze cracks existing in a surface. (See also checking and cracks.)

2.1.2.3 D-cracks—a series of cracks in concrete near and roughly parallel to joints and edges (Fig. 2.1.2.3(a) and (b)).

2.1.2.4 Diagonal crack—in a flexural member, an inclined crack, caused by shear stress, usually at approximately 45 degrees to the axis; or a crack in a slab, not parallel to either the lateral or longitudinal directions (Fig. 2.1.2.4(a) and (b)).

2.1.2.5 Hairline cracks—cracks in an exposed-to-view concrete surface having widths so small as to be barely perceptible.

2.1.2.6 Longitudinal cracks—a crack that develops parallel to the length of the member.

2.1.2.7 Map cracking—1) intersecting cracks that extend below the surface of hardened concrete; caused by shrinkage of the drying surface concrete that is restrained by concrete at greater depths where either little or no shrinkage occurs; vary in width from fine and barely visible to open and well-defined; or 2) the chief symptom of a chemical reaction between alkalis in cement and mineral constituents in aggregate within hardened concrete; due to differential
rate of volume change in different members of the concrete; cracking is usually random and on a fairly large scale and, in severe instances, the cracks may reach a width of 12.7 mm (0.50 in.) (Fig. 2.1.2.7(a) and (b)). (See also checking and crazing; also known as pattern cracking.)

2.1.2.8 Pattern cracking—cracking on concrete surfaces in the form of a repeated sequence; resulting from a decrease in volume of the material near the surface, or an increase in volume of the material below the surface, or both. (See map cracking.)

2.1.2.9 Plastic shrinkage cracking—cracking that occurs in the surface of fresh concrete soon after it is placed and while it is still plastic (Fig. 2.1.2.9(a) and (b)).

2.1.2.10 Random cracks—uncontrolled cracks that develop at various directions away from the control joints.

2.1.2.11 Shrinkage cracking—cracking of a structure or member due to failure in tension caused by external or internal restraints as reduction in moisture content develops, carbonation occurs, or both (Fig. 2.1.2.11).

2.1.2.12 Temperature cracking—cracking due to tensile failure, caused by temperature drop in members subjected to external restraints or by a temperature differential in members subjected to internal restraints (Fig. 2.1.2.12).