



**International
Standard**

ISO 16311-3

**Maintenance and repair of concrete
structures —**

**Part 3:
Design of repairs**

Entretien et réparation des structures en béton —

Partie 3: Conception des réparations

**Second edition
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 7, *Maintenance and repair of concrete structures*.

This second edition cancels and replaces the first edition (ISO 16311-3:2014) which has been technically revised.

The main changes are as follows:

- the definitions of “repair” has been updated.

A list of all parts in the ISO 16311 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The repair of defects and deterioration in concrete structures requires complex design work. This document defines the design principles, strategies, remedies and methods for the repair of concrete structures that have suffered or can suffer damage or deterioration. It gives guidance on the choice of repair design principles, strategies, remedies, methods and selection of products and systems which are appropriate for the intended use.

This document identifies key stages in the repair process:

- the need for assessment of the condition of the structure;
- the need for identification of the causes of deterioration;
- evaluating the options for repair and decision-making;
- the selection of the appropriate remedies for repair;
- the selection of methods;
- the definition of properties of products and systems;
- the specification of maintenance requirements following repair.

This document does not deal with matters related to structural design and the verification of structural performance in both deteriorated and repaired condition. The information related to the deteriorated condition is presented in ISO 16311-2.

This document contains [Annex A](#) which provides guidance and background information.

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Maintenance and repair of concrete structures —

Part 3: Design of repairs

1 Scope

This document defines basic considerations and decision-making for the specification of repair remedies, and management strategies for reinforced and unreinforced concrete structures. This document covers only atmospherically exposed structures, and buried or submerged structures, if they can be accessed.

This document specifies repair design principles, and strategies for defects and on-going deterioration including, but not limited to:

- a) mechanical actions, e.g. impact, overloading, movement caused by settlement, blast, vibration and seismic actions;
- b) chemical and biological actions from environments, e.g. sulfate attack, alkali-aggregate reaction;
- c) physical actions, e.g. freeze–thaw, thermal cracking, moisture movement, salt crystallization, fire, and erosion;
- d) reinforcement corrosion;
- e) original construction defects that remained unaddressed from the time of construction.

The execution of maintenance and repairs is covered in ISO 16311-4.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16311-1, *Maintenance and repair of concrete structures — Part 1: General principles*

ISO 16311-2, *Maintenance and repair of concrete structures — Part 2: Assessment of existing concrete structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16311-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 defect

fault or deviation from the intended level of performance of a structure or its parts

[SOURCE: ISO 15686-1:2011]

3.2

maintenance

set of activities undertaken to check, evaluate the performance of a structure and preserve/restore it so as to satisfy its performance requirements in service

[SOURCE: ISO 13823:2008, 3.15]

3.3

passivity

state in which steel in concrete is protected by a thin film and the corrosion rate is minimized

Note 1 to entry: This film is destabilized or lost when concrete carbonates to the level of the reinforcing steel, when aggressive salts concentrate and attack the steel, or atypically, when all oxygen is depleted at the surface of the steel (i.e. submerged concrete members after many years).

3.4

protection

measure that is intended to prevent or reduce the development of defects in the structure

3.5

repair

restoration of a structure or its components to an acceptable condition by the renewal or replacement of worn, damaged, or deteriorated components including prevention and protection

[SOURCE: ISO 13823:2008, 3.20, modified — "including prevention and protection" has been added.]

4 Minimum considerations before repair design

4.1 General

This clause outlines procedures that shall be undertaken to assess the current condition of a concrete structure prior to designing repair programs.

General guidance is given in [Annex A](#).

4.2 Initial risk assessment

The risks to health and safety from falling debris or localized structural failure due to removing deteriorated materials, and the effect of deterioration upon the mechanical stability of the concrete structure shall be assessed as a pre-repair work, as well as the anticipated loads and forces during repair work.

Where the concrete structure or a portion thereof is considered unsafe, appropriate actions and sequences shall be specified to make it safe before other repair work is undertaken and while underway, taking into account any additional risks that can arise from the repair work itself. Such action can include local repairs, the installation of support or other temporary stabilization measures, or partial or even complete demolition.

4.3 Assessment of defects and their causes

An assessment shall be made of the defects in the concrete structure, their causes, and of the ability of the concrete structure to perform its function per the detailed guidance provided in ISO 16311-2. This information is briefly summarized in the subsequent paragraphs.

The process of assessment of the structure shall include, but not be limited to, the following.

- a) Documentation of the materials and systems comprising the structure.
- b) The visible condition of the existing concrete structure.
- c) Testing to determine the condition of the concrete and reinforcing steel.

- d) The original design approach and potential design deficiencies.
- e) The environment, including exposure to deleterious species.
- f) The history of the concrete structure, including environmental exposure, and previous maintenance and repair programs.
- g) The conditions of use (e.g. loading or other actions).
- h) Requirements for future use.

The nature and causes of defects and deficiencies, including combinations of causes, shall be identified and recorded (see [Figure 1](#)).

The approximate extent and likely rate of increase of defects shall then be assessed. An estimate shall be made of when the concrete member or structure would no longer perform as intended, with no repair measures (other than maintenance of existing systems) applied.

The results of the completed assessment shall be valid at the time that the repairs are designed and carried out. If, as a result of passage of time or for any other reason, there are doubts about the validity of the assessment, a new assessment shall be made.

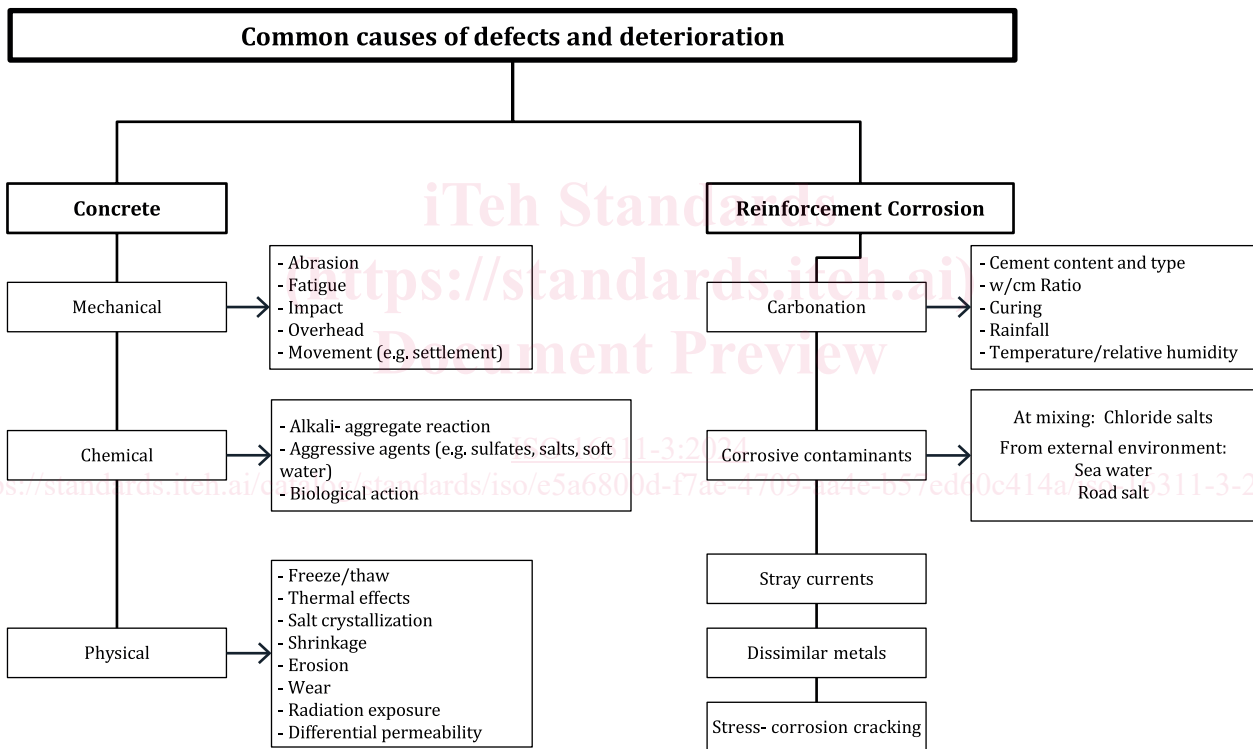


Figure 1 — Common causes of defects and deterioration

5 Strategies for maintenance and repair

5.1 General

This clause identifies options and factors to be considered when choosing a strategy for the management of the structure.

5.2 Options

In accordance with ISO 16311-1, the following options shall be taken into account in deciding the appropriate action to meet the future requirements for the life of the structure.

- a) Do nothing for a certain time while monitoring the structure.
- b) Re-analyse the structural capacity, possibly leading to a downgrade in function.
- c) Prevent or reduce further deterioration.
- d) Strengthen or repair all or part of the concrete structure.
- e) Reconstruct all or part of the concrete structure.
- f) Demolish all or part of the concrete structure.

5.3 Factors

The factors that shall be considered when choosing a management strategy include, but are not limited to the following categories.

5.3.1 General

- a) The intended use and remaining service life of the structure.
- b) The required performance of the structure.
NOTE This can include, for example, fire resistance and watertightness.
- c) The likely service life of the repair work.
- d) The required availability of the structure, permissible interruption to its use and opportunities for additional repair and monitoring work.
- e) The acceptable number and cost of repair cycles during the design life of the concrete structure.
- f) The comparative whole life cost of the alternative management strategies, including future inspection and maintenance or further repair cycles.
- g) Properties and possible methods of preparation of the existing substrate.
- h) The appearance of the repaired structure.

5.3.2 Structural

- a) The actions including during and after implementation of the strategy.
- b) The response mechanism against the actions, including during and after implementation of the strategy.

5.3.3 Risk assessment

- a) The consequences of structural failure.
- b) Health and safety requirements.
- c) The effect on occupiers or users of the structure and on adjacent structures and the general public.

5.3.4 Environmental

- a) The exposure environment of the structure, member, part and whether it can be changed locally.