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Performance and assessment requirements for design standards on structural concrete

Exigences de performance et d'évaluation pour la conception des normes relatives au béton structurel

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19338 was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 4, *Performance requirements for structural concrete*.

Introduction

Concrete is the most popular material used in the construction market. Presently, about one-third of a ton of concrete is produced each year for every human being in the world (some 2 billion tons per year).

International Standards on concrete technology can play a significant role for improving the global trade climate. International Standards in the field of concrete and its use in civil infrastructure are ever more needed as the economic development of the world continues.

ISO/TC 71/SC 4 was established to develop standards for performance requirements for structural concrete. This International Standard gives the performance and assessment requirements for concrete structures. It is an umbrella type document with general provisions and guidelines and lists the regional consensus standards that are deemed to satisfy this International Standard. The regional standards are generally more prescriptive in nature and vary somewhat from region to region.

This International Standard is intended to provide wide latitude in choice in terms of general requirements for performance and assessment of concrete structures. It should be used, therefore, in conjunction with sound engineering judgment.

Performance and assessment requirements for design standards on structural concrete

1 Scope

This International Standard provides performance and assessment requirements for design standards for structural concrete. It can be used for international harmonization of design and construction requirements.

This International Standard includes

a) requirements, which define the required structural concrete performance,

b) criteria, which give means for expressing the requirements, and

c) assessment clauses, which give acceptable methods of verifying the specific criteria.

2 Normative references

The following referenced documents are indispensable for the application 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 2394, *General principles on reliability for structures*

ISO 6241, *Performance standards in building — Principles for their preparation and factors to be considered*

ISO 7162, *Performance standards in building — Contents and format of standards for evaluation of performance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
accidental load
actions whose chance of occurrence is very small but intensity is very large compared with variable actions

3.2
action
assembly of concentrated or distributed mechanical forces acting on/in a structure (direct actions), deformations imposed on the structure or contained within it (indirect actions), or environmental actions

3.3
analysis (assessment)
acceptable methods of evaluating the performance index or verifying the compliance of specific criteria

3.4
criteria
means of expressing the performance requirements for structural concrete by specific technical values and appropriate limits

3.5
design service life
period for which the structure or structural element is to be used for its intended purpose with anticipated maintenance but without substantial repair being necessary

3.6
durability
ability of a structure or structural element to assure no deterioration that is harmful to required performance in the relevant environment

3.7
environmental actions
assembly of physical, chemical or biological influences which may cause restraint effects or deterioration to the materials making up the structure, which in turn may adversely affect its serviceability, restorability and safety

3.8
experimental analysis
use of physical models to determine load-carrying capacity and serviceability of prototype design

3.9
limit state
critical state specified using a performance index, beyond which the structure no longer satisfies the design performance requirement

3.10
limit states design
design procedure where actions under factored loads are used to determine structural response and where resistance at limit state conditions is made equal to or greater than the response

3.11
load factors
multiplier(s) applied to load

3.12
maintenance
total set of activities performed during the design service life of the structure to enable it to fulfil the performance requirements

3.13
models
simplified mathematical descriptions of actions simulating experimental setup, material properties, the behaviour of a structure, etc.

3.14
partial safety factors for materials
devisors applied to the material characteristic strength in general conformance with reliability-based design requirements

NOTE See also resistance factor (3.21).

3.15
performance evaluation
procedure where actions at service load are used to determine structural response and limits are placed on response at service loads

3.16
performance requirement
definition of the required structural performance in designed concrete structures

3.17
permanent load
self-weights of structures including permanent attachments

3.18
reliability
ability of a structure or structural element to fulfil the specified requirements during design service life of the structure

3.19
representative value of action
value of action used for the verification of criteria

3.20
resistance
ability of a member to bear loads or section forces

NOTE The resistance is also used to control response values, such as permissible crack width and deflection.

3.21
resistance factor
multiplier applied to resistance in general conformance with reliability-based design requirements

NOTE When applied to materials, these multipliers may also be called material factors. See partial safety factors for materials (3.14).

3.22
robustness
ability of a structure not to be damaged by events like fire, explosions, impact or consequences of human errors, to an extent disproportionate to the original cause

3.23
restorability
ability of a structure or structural element to be repaired physically and economically when damaged under the effects of considered actions

3.24
safety
ability of structure or structural element to assure no casualty to users of, and people around, the structure, within the limits of acceptable probability

3.25
serviceability
ability of a structure or structural elements to provide appropriate behaviour or functionality in use under the effects of considered actions at serviceability limit state

3.26
structural integrity
ability of a structure to avoid widespread collapse when localized damage occurs

3.27
variable load
weights of moving objects on structures as well as any other loads whose intensity is variable, including traffic loads, wave loads, wind loads, water pressures, earth pressures, and loads induced by temperature

4 General requirements

4.1 Overall structural concept

The overall quality of a structure shall be implemented through strict quality control and care by a knowledgeable qualified design professional. In conceiving a structural system, load-carrying behaviour under maximum and frequent loads, materials and their combinations, constructibility, costs, and environmental aspects and aesthetics shall be considered. See ISO 2394, ISO 6241 and ISO 7162.

4.2 Structural integrity

Design of concrete structures shall provide general structural integrity, directly or implicitly. Localized damage or deterioration in a structure shall not impair general structural integrity.

4.3 Design approach

A design standard for structural concrete shall be based on quantitative performance evaluation at the limit states. Design shall consider safety, serviceability, restorability, structural integrity, robustness, environmental adequacy and durability. Where applicable, limit states caused by fatigue, fire, explosion, impact, and rare accidental actions or other extreme loadings or actions shall be considered.

4.4 Design service life

Design service life shall be defined in consideration of the structural role, the social importance of the structures concerned, and the economically justified service life. Structural requirements shall be satisfied throughout the defined design life.

4.5 Workmanship, materials and quality assurance

In order that the properties of the completed structure be consistent with the requirements and the assumptions made during the planning and design, quality assurance and execution expectations for construction shall be considered and adequate quality control measures shall be taken.

5 Performance requirements

5.1 General

For ultimate limit states, the design standard shall specify sets of action combinations and a reliability-based design concept that can be analytically demonstrated to give an adequate performance level during the design life of the structure.

5.2 Structural safety and ultimate limit states

The safety level shall be selected considering the consequences of failure, function of the facility, ductility of the expected modes of failure, redundancy of the structure, and ability to inspect and maintain the finished structure during service. Compressive stresses in concrete under sustained loads shall not cause crushing of the concrete.

5.3 Serviceability limit states

5.3.1 General

Service load deflections, vibrations and cracking shall be limited so that they do not impair the use of the structure.

5.3.2 Deflection and cracking limit states

Deflections and cracking shall be considered using factored loads and load combinations in which the load factors correspond to an acceptable probability of occurrence of the serviceability limit state being checked.

5.3.3 Vibration limit state

Dynamic response and/or periods of vibration of a structure shall be considered and limited to avoid discomfort to occupants, impairing use of the structure, and/or avoid the risk of resonance. Dynamic analyses shall be used where required.

5.4 Durability limit state

The structure shall be designed such that deterioration does not cause it to reach an ultimate limit state or a serviceability limit state during its design life. Alternatively, regular maintenance shall be prescribed and considered in determining the design service life of a structure.

5.5 Fire resistance limit state

When exposure to fire during the life of a structure is possible, the structural concrete shall provide adequate fire resistance with regard to life safety and residual structural capacity during and after a fire.

5.6 Fatigue limit state

For structures or parts of structures where fatigue may be a limiting design consideration, the fatigue limit state shall be considered. Where fatigue is considered, performance requirements under fatigue loading shall be specified.

6 Loadings and actions

6.1 General

Loads due to use and occupancy and environmental actions shall be defined considering excess probability or recurrence interval based on statistically surveyed data.

6.2 Load factors

Load factors in general conformance with reliability-based design concept shall differentiate between the different variabilities of permanent loads, frequent variable loads due to use and occupancy, frequent environmental actions and rare loads. Load factors shall also differentiate between stabilizing and unstabilizing loads.

6.3 Action combinations

Action combinations used shall recognize the reduced probability of the simultaneous occurrence of variable loads.

6.4 Permanent loads

Permanent loads, including self weight and the weight of permanently attached items, shall be included.

6.5 Variable loads

Variable loads that result from use of the structure shall be included.