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Requirements for seismic assessment and retrofit of concrete structures

Exigences relatives à l'évaluation sismique et à la réhabilitation des structures en béton

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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 documents 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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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 16711:2015), which has been technically revised.

The main change compared to the previous edition is the addition of a new paragraph in 5.3.

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.

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Introduction

Earthquakes bringing damage to structures have occurred frequently in many areas of the world. Heavy damage caused by earthquakes are concentrated on vulnerable structures. Due to these damaging earthquakes, human lives are likely to be lost. Confusion in everyday life and stagnation of economic activities also occur.

As the result of the direct action of earthquakes, structures can collapse or overturn in earthquake-prone areas. However, given a main shock occurs, it is expected that through seismic assessment and retrofit of concrete structures, human life losses, economical losses and structural collapses can be mitigated and/or prevented and quick recovery can be attained.

In some countries, such as Japan and the USA, the framework for the identification of vulnerable structures before and after an earthquake, seismic retrofit decision-making and construction exists. In addition, the standards for seismic assessment technology and for seismic retrofit technology have already been established in these countries. Furthermore, technical manuals have been established in order to apply the standards to practical work. Therefore, based on these standards, the social system is built where a country, a district and a local administrative agency (authorities), the owner of the structure, a user, a retrofit designer, a retrofit work supervisor, a retrofit work supplier and other people concerned by this matter share a purpose of the seismic retrofit and the information about the effect of seismic retrofit. Also, the owner of the structure can judge the necessity of appropriate retrofit and a seismic retrofit execution is carried out smoothly.

However, it is not so frequent that a huge earthquake disaster occurs in a specific country or an area. These conditions disturb conducting seismic assessment, seismic retrofit work and smooth social decision making to conduct seismic retrofit. As a result, it is feared that the earthquake disaster expands and the recovery from the disaster is delayed when a large earthquake disaster happens once.

Therefore, it is necessary to establish a principle of the seismic assessment, decision making of the seismic retrofit, the framework of the procedure for screening the vulnerable structures, seismic retrofit execution. This document provides the requirements of standards for comprehensive evaluation of the seismic damage/expected damage of existing reinforced concrete structures and repair/retrofit. In other words, this document provides the standard work items related to seismic assessment and retrofit and standard procedures in each stage. It clarifies the contents and the scope of each duty.

In this document, the seismic performance of an existing reinforced concrete structure is expressed in terms of the intensity of earthquake motions that lead the structures to the safety limit state[1)] in principle. As the result, whether the existing reinforced concrete (referred to as RC, hereafter) structures fulfil the provisions of the design standard in the specific country or area does not matter. That is the feature of this document.

The retrofit can be also conducted based on seismic performance, not on whether the seismic retrofit meets an existing standard. Because this document sets such rational performance requirements, the vulnerable parts which should be reinforced are clearly identified.

National and regional standards are generally more prescriptive in nature than International Standards and vary somewhat from region to region.

1) Ultimate limit state is mainly considered. However, other limit states can be considered such as seismic damage control limit state when time history analysis is used.

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Requirements for seismic assessment and retrofit of concrete structures

1 Scope

This document provides requirements for seismic assessment and retrofit of concrete structures.

It can be used to reduce the risk of seismic damage by structural collapse or turnover during a seismic event.

This document provides the framework and principles of methods of detailed seismic assessment and the judgment, seismic retrofit plan and design, seismic retrofit execution of existing reinforced concrete structures before the occurrence of a severe earthquake and of the structures struck by an earthquake.

It is an umbrella-type document with general provisions intended to provide wide latitude of choice in terms of comprehensive principle on the evaluation of the seismic damage/expected damage of existing reinforced concrete structures and repair/retrofit. Therefore, it is intended to be used in conjunction with sound engineering judgment.

This document is applicable to reinforced concrete structures and pre-stressed concrete structures that have been designed on the basis of the structural design criteria set in a specific country or region.

It is not applicable to unreinforced concrete and masonry structures.

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 1920-4:2020, *Testing of concrete — Part 4: Strength of hardened concrete*

ISO 15630-1:2019, *Steel for the reinforcement and prestressing of concrete — Test methods — Part 1: Reinforcing bars, rods and wire*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
assessment
set of activities performed in order to verify the reliability of an existing structure for future use

[SOURCE: ISO 13822:2010, 3.1]

3.2
design document
document resulting from structural calculation and design drawings

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3.3
inspection
conformity evaluation by observation and judgment accompanied as appropriate by measurement, testing or gauging.

Note 1 to entry: For structures, this evaluation consists of actions collecting information on the current state of a structure through observation and simplified non-destructive or destructive testing supplemented with materials and structural testing, as required.

[SOURCE: ISO 16311-2:2014, 3.15]

3.4
investigation
collection of information through *inspection* (3.3), document search, load testing and other testing

[SOURCE: ISO 16311-1:2014, 3.7]

3.5
limit state
critical state specified using a performance index, beyond which the structure no longer satisfies a design performance requirement

[SOURCE: ISO 19338:2014, 3.9]

3.6
maintenance
set of activities taken to check, evaluate the performance of a structure, and preserve/restore it so as to satisfy performance requirements in service

[SOURCE: ISO 16311-1:2014, 3.8]

3.7
seismic capacity
force or displacement defined for the *limit states* (3.5)

Note 1 to entry: Multiple limit states can be selected besides the life safety limit state, such as acceptable economic loss limit state, reparability limit state, immediate occupancy limit state or functionality limit state.

3.8
performance objective
required performance level (e.g. life safety) for a given earthquake hazard level (e.g. an earthquake with a 10 % probability of exceedance in 50 years)

3.9
seismic damage
physical evidence of inelastic deformation, cracks or spalling of a structural component caused by an earthquake

3.10
seismic retrofit
restoring or improving the seismic performance of a pre- or post-earthquake existing structure to meet the seismic *performance objective* (3.8), including “structural repair” and “strengthening”

Note 1 to entry: Repair is adopted to restore structural performance and to mitigate safety risks up to the initially required design level and to achieve the intended service life.

Note 2 to entry: Strengthening relates to the measures taken to improve structural performance relating to load bearing capacity and deformation of an existing structure and/or its members.

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