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Guidelines for simplified seismic assessment and rehabilitation of concrete buildings

Lignes directrices pour l'évaluation sismique simplifiée et 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. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 5, *Simplified design standard for concrete structures*.

Introduction

The aim of this International Standard is to provide rules for the earthquake resistant assessment and rehabilitation design and execution for existing structural concrete buildings for which simplified procedures may be applied instead of more sophisticated and thorough analyses, in light of the simplicity, symmetry, and other characteristics of the structure under study. This International Standard is developed for countries that do not have existing national standards on this subject and to offer, to local regulatory authorities anywhere, an alternative for the study of relatively small and simple buildings that abound in both rural and urban environments. The analysis and design rules are based in simplified worldwide-accepted strength models. This International Standard is self-contained; therefore actions (loads), simplified analysis procedures and design specifications are included, as well as minimum acceptable construction practice guidelines.

The minimum dimensional guidelines contained in this International Standard are intended to account for undesirable side effects that will otherwise require more sophisticated analysis and design procedures. Material and construction guidelines are aimed at site-mixed concrete as well as ready-mixed concrete, and steel of the minimum available strength grades.

The earthquake resistance guidelines are included for rehabilitation of concrete buildings in the numerous regions of the world which lie in earthquake prone areas. The earthquake resistance of rehabilitated buildings is based upon the employment of structural concrete walls (shear walls) that limit the lateral deformations of the structure and provide for its lateral strength.

This International Standard contains guidelines that can be modified by the national standards body due to local design and construction requirements and practices. These guidelines that can be modified are included using ["boxed values"]. The authorities in each member country are expected to review the "boxed values" and may substitute alternative definitive values for these elements for use in the national application of this International Standard. Changes to boxed values shall not be made without thorough analyses and sound supporting studies.

A great effort was made to include self-explanatory tables, graphics, and design aids to simplify the use of this International Standard and provide foolproof procedures. Notwithstanding, the economic implications of the conservatism inherent in approximate procedures as a substitute for sound and experienced engineering should be a matter of concern to the designer that employs the document, and to the owner that hires him.

Guidelines for simplified seismic assessment and rehabilitation of concrete buildings

1 Scope

This International Standard can be used as an alternative to the development of a building code, or equivalent document in countries where no national design codes are available by themselves, or as an alternative to the building code in countries where specifically considered and accepted by the national standards body or other appropriate regulatory organization, and applies to the assessment of earthquake resistance capability and to the seismic rehabilitation design and construction for existing structural concrete buildings.

The purpose of these guidelines is to provide sufficient information to perform the seismic assessment and rehabilitation of the structural concrete building that complies with the limitations established in Clause 5, for both undamaged structures that are deemed not to comply with the required characteristics for an adequate response at a specified performance level, and for structures that have undergone damage under seismic loadings. The rules of design as set forth in this International Standard are simplifications of more elaborate requirements.

Although the guidelines contained in this International Standard were drawn to produce, when properly employed, a reasonable assessment of the seismic vulnerability of an undamaged structure, a reasonable assessment of a structure damaged by a seismic event and a structural rehabilitation of the assessed concrete structure with an appropriate margin of safety, these guidelines are not a replacement for sound and experienced engineering. In order to attain the intended results on assessment and rehabilitation design, this International Standard must be used as a whole, and alternative procedures should be employed only when explicitly permitted by the guidelines. The minimum dimensioning guides as prescribed in this International Standard replace, in most cases, more elaborate procedures such as those prescribed in the national code or, if no national code exists, in internationally recognized full fledged codes, and the possible economic impact is compensated for by the simplicity of the procedures prescribed here.

The professional applying the procedures set forth by these guidelines should meet the legal requirements for structural designers in the country of adoption and have training and a minimum appropriate knowledge of structural mechanics, statics, strength of materials, structural analysis, and reinforced concrete design and construction.

While buildings rehabilitated in accordance with these guidelines are expected to perform within the selected performance levels for the applicable design earthquakes, compliance with these guidelines is necessary but may not guarantee the sought for performance, as current knowledge of structural behavior under seismic loads, and of the loads themselves, is still incomplete.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15673:2005, *Guidelines for the simplified design of structural reinforced concrete for buildings*

3 Terms and definitions

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

3.1
acceleration of gravity, g
acceleration produced by gravity at the surface of the earth

NOTE For the application of these guidelines its value can be approximated to 10 m/s^2.

3.2
adherence
force acting on the interface of two solid materials

3.3
admixture
material other than water, aggregate, or hydraulic cement, added to concrete before or during its mixing to modify its properties

3.4
aggregate
granular material, such as sand, gravel, crushed stone, and iron blast-furnace slag, used in conjunction with cementitious materials to form a hydraulic cement concrete or mortar

3.5
anchorage
devices used to anchor a non-structural element to the structural framing

3.6
bar diameter, nominal
approximate diameter of a steel reinforcing bar, often used as a class designation

NOTE For deformed bars, it is common practice to use the diameter of a plain bar having the same area.

3.7
beam
structural member for which ratio of axial load to axial gross capacity is equal to or less than 0,1.

3.8
bearing capacity of the soil
maximum permissible stress on the foundation soil that provides adequate safety against bearing failure of the soil

NOTE Its value is defined at the working stress level.

3.9
bending moment
product of a force and the distance to a particular axis, producing bending effects in a structural element

3.10
boundary elements
structural elements embedded at the ends of structural walls strengthened by transverse reinforcement to confine the longitudinal reinforcement

NOTE Boundary elements may require an increase in thickness of the wall.

3.11
caisson
foundation pile of large diameter, built partly or totally above ground and sunk below ground usually by digging out the soil inside

3.12
carbonation
process of conversion of calcium hydroxide in hardened cementitious material into calcium carbonate due to reaction with carbon dioxide diffused into the cement paste from the atmosphere

3.13
cement
material as specified in the corresponding referenced ISO standards, which, when mixed with water, has hardening properties

3.14
center of mass
geometric plan location of the resultant force due to the action of gravity on the mass of the floor is located, supposing the floor diaphragm as an infinite rigid body in its own plane

3.15
center of rigidity
geometric plan location of the resultant of the resistance forces due to structural vertical elements stiffness, calculated, supposing that the floor diaphragm is an infinite rigid body in its own plane in such a way that when applying a horizontal force in any direction, rotation of the diaphragm takes place with no distortion of the original shape of the floor

3.16
corrosion
process of disintegration of the reinforcing steel bars due to chemical or electromechanical change caused in presence of moisture

3.17
column
structural member in which the ratio of axial compressive loads to axial gross capacity is more than 0,1

3.18
collector elements
structural elements that carry the forces within a horizontal diaphragm to the lateral-force resisting system

3.19
combined footing
footing that transmits to the supporting soil the load carried by several columns or structural concrete walls

3.20
compression reinforcement
reinforcement provided to resist compression stresses in the member section

3.21
concrete
mixture of cementitious materials with fine aggregate, coarse aggregate, and water, with or without admixtures, to form a hardened material with specific strength properties

3.22
concrete mix design
choice and proportioning of the ingredients of concrete