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# Guidelines for the simplified design of reinforced concrete bridges

*Lignes directrices pour la conception simplifiée des ponts en béton armé*

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# Contents

Page

# 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 design and construction of relatively short span concrete bridges. This International Standard is developed for countries that do not have existing national standards on this subject and to offer to local regulatory authorities an alternative for the design of relatively small bridges that abound in urban overpasses and over creeks and rivers everywhere. This International Standard shall not be used in place of a national standard unless specifically considered and accepted by the national standards body or other appropriate regulatory organization. The design rules are based in simplified worldwide-accepted strength models. This International Standard is self-contained; therefore, 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 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 to account for the numerous regions of the world which lie in earthquake prone areas. The earthquake resistance for zones with high seismic hazard 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, in place of piers or frames that can be used in zones with intermediate, low or no significant earthquake hazard.

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 the document.

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 the simplified design of reinforced concrete bridges

## 1 Scope

This International Standard can be used as an alternative to the development of a National Concrete Bridge Design and Construction Code, or equivalent document in countries where no national design codes are available by themselves, or as an alternative to the National Concrete Bridge Design and Construction Code in countries where specifically considered and accepted by the national standards body or other appropriate regulatory organization, and applies to the planning, design and construction of structural concrete bridges to be used in new bridges of restricted span length, height of piers, and type.

The purpose of these guidelines is to provide sufficient information to perform the design of the structural concrete bridge that complies with the limitations established in 6.1. 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 structural concrete structure with an appropriate margin of safety, these guidelines are not a replacement for sound and experienced engineering. In order for the resulting structure designed employing these guidelines to attain the intended margin of safety, 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, and the possible economic impact is compensated for by the simplicity of the procedures prescribed here.

The professional performing the structural design under 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.

Designs and details for new bridges should address structural integrity by considering the following:

- the use of continuity and redundancy to provide one or more alternate paths;

- structural members and bearing seat widths that are resistant to damage or instability;

- external protection systems to minimize the effects of reasonably conceived severe loads.

## 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 679, *Cement — Test methods — Determination of strength*

ISO 863, *Cement — Test methods — Pozzolanicity test for pozzolanic cements*

ISO 3010, *Basis for design of structures — Seismic actions on structures*

ISO 4354, *Wind actions on structures*

ISO 6274, *Concrete — Sieve analysis of aggregates*

ISO 6782, *Aggregates for concrete — Determination of bulk density*

ISO 6783, *Coarse aggregates for concrete — Determination of particle density and water absorption — Hydrostatic balance method*

ISO 6934-1, *Steel for the prestressing of concrete — Part 1: General requirements*

ISO 6934-3, *Steel for the prestressing of concrete — Part 3: Quenched and tempered wire*

ISO 6934-4, *Steel for the prestressing of concrete — Part 4: Strand*

ISO 6934-5, *Steel for the prestressing of concrete — Part 5: Hot-rolled steel bars with or without subsequent processing*

ISO 6935-1, *Steel for the reinforcement of concrete — Part 1: Plain bars*

ISO 6935-2, *Steel for the reinforcement of concrete — Part 2: Ribbed bars*

ISO 6935-3, *Steel for the reinforcement of concrete — Part 3: Welded fabric*

ISO 7033, *Fine and coarse aggregates for concrete — Determination of the particle mass-per-volume and water absorption — Pycnometer method*

ISO 9194, *Bases for design of structures — Actions due to the self-weight of structures, non-structural elements and stored materials — Density*

ISO 9597, *Cement — Test methods — Determination of setting time and soundness*

ISO 10144, *Certification scheme for steel bars and wires for the reinforcement of concrete structures*

ISO 3766:2003, *Construction drawings — Simplified representation of concrete reinforcement*

## 3 Terms and definitions

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

**3.1**
**abutment**
end support of a bridge superstructure

NOTE Abutments are used to transmit the reaction of superstructure to the foundations, to retain the earth filling and to connect the superstructure to the approach roads.

**3.2**
**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 $g \approx [10]$ m/s$^2$.

**3.3**
**admixture**
material other than water, aggregate, or hydraulic cement, used as an ingredient of concrete and 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 a cementing medium to form a hydraulic cement concrete or mortar

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

**3.6**
**backfill**
material used for refilling any hole that has been excavated

**3.7**
**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.

**3.8**
**beam**
horizontal, or nearly horizontal, structural member supported at one (such as a cantilever) or more points, but not throughout its length, transversely supporting a load, and subjected primarily to flexure

**3.9**
**bearing capacity of the soil**
maximum permissible stress on the foundation soil that provides adequate safety against bearing failure of the soil, or settlement of the foundation of such magnitude as to impair the structure

NOTE Its value is defined at the working stress level.

**3.10**
**bearing – elastomeric**
device constructed partially or wholly from elastomer to transmit loads and accommodate movements between a bridge and its supporting structure

**3.11**
**bending moment**
product of a force and the distance to a particular axis, producing bending effects in a structural element

**3.12**
**boundary elements**
portions along wall edges strengthened by longitudinal and transverse reinforcement

NOTE Boundary elements do not necessarily require an increase in thickness of the wall.

**3.13**
**bridge**
structure carrying a road, path or railway over an obstacle

**3.14**
**caisson**
foundation pile of large diameter, built partly or totally above ground and sunk below ground usually by digging out the soil inside

**3.15**
**cantilever**
element that extends beyond its support and is supported on one end only

**3.16**
**cement**
material as specified in the corresponding referenced ISO standards, which, when mixed with water, has hardening properties

NOTE Used either in concrete or by itself.

**3.17**
**clearance**
distance by which one thing clears another; the space between them

**3.18**
**column**
vertical member used primarily to support axial compressive loads

**3.19**
**collector elements**
elements that serve to transmit the inertia forces within the diaphragm to members of the lateral-force resisting system

**3.20**
**combined footing**
footing that transmits to the supporting soil the load carried by several columns or structural concrete walls

**3.21**
**compression reinforcement**
reinforcement provided to resist compression stresses induced by flexural moments acting on the member section

**3.22**
**concrete**
mixture of portland cement and any other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without admixtures

**3.23**
**concrete mix design**
choice and proportioning of the ingredients of concrete

**3.24**
**concrete specified compressive strength,** $f_c^{'}$
compressive cylinder strength of concrete used in design and evaluated in accordance with the appropriate ISO standard, expressed in megapascals (MPa)

NOTE Whenever the quantity $f_c^{'}$ is under a radical sign ($\sqrt{f_c^{'}}$), the positive square root of numerical value only is intended, and the result has units of megapascals (MPa).

**3.25**
**confinement hook**
hook on a stirrup, hoop, or crosstie having a bend not less than 135° with a six-diameter (but not less than 75 mm) extension that engages the longitudinal reinforcement and projects into the interior of the stirrup or hoop

**3.26**
**confinement stirrup or tie**
closed stirrup, tie or continuously wound spiral

NOTE A closed stirrup or tie can be made up of several reinforcement elements each having confinement hooks at both ends. A continuously wound spiral should have a confinement hook at both ends.