INTERNATIONAL STANDARD

ISO 28842

First edition
2013-06-15

Guidelines for the simplified design of reinforced concrete bridges

Lignes directrices pour la conception simplifiée des ponts en béton armé

Reference number
ISO 28842:2013(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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.

3.27
corrosion
gradual removal or weakening of metal from its surface that requires the presence of humidity and oxygen, and is helped by the presence of other materials

3.28
cover, concrete
thickness of concrete between surface of any reinforcing bar and the nearest face of the concrete member

3.29
crosstie
continuous reinforcing bar having a 135° hook at one end and a hook not less than 90° at least a six-diameter extension at the other end

NOTE The hooks should engage peripheral longitudinal bars. The 90° hooks of two successive crossties engaging the same longitudinal bars should be alternated end for end.

3.30
crown
highest point of a convex structure, such as an arch or a vault

3.31
curb
edge where a raised pavement/sidewalk/footpath, road median, or road shoulder meets an unraised street or other roadway

3.32
curing
keeping the concrete damp for a period of time, usually several days, starting from the moment it is cast, in order for the cement to be provided with enough water to harden and attain the intended strength

NOTE Appropriate curing will greatly reduce shrinkage, increase strength of concrete, and should reduce surface cracking. Curing time will depend on temperature and relative humidity of surrounding air, the amount of wind, the direct sunlight exposure, the type of concrete mix employed, and other factors.

3.33
deformed reinforcement
steel reinforcement that has deformations in its surface to increase its bond to the concrete.

NOTE The following steel reinforcement should be considered deformed reinforcement under these guidelines: deformed reinforcing bars, deformed wire, welded plain wire fabric, and welded deformed wire fabric conforming to the appropriate ISO standards.

3.34
depth of member, h
vertical size of a cross section of a horizontal structural element

3.35
design load combinations
combinations of factored loads and forces as specified in these guidelines

3.36
design strength
product of the nominal strength multiplied by a strength reduction factor

3.37
development length
length of embedded reinforcement required to develop the design strength of reinforcement at a critical section

3.38
development length for a bar with a standard hook
shortest distance between the critical section (where the strength of the bar is to be developed) and a tangent to the outer edge of the 90° or 180° hook

3.39
differential settlement
when the foundation of different parts of a structure settle different amounts

3.40
drainage
natural or artificial removal of surface and sub-surface water from a given area

NOTE Drainage is a system that carries water or sewage away from a place.

3.41
durability
characteristic of a structure to resist gradual degradation of its serviceability in a given environment for the design service life

3.42
effective depth of section, d
distance measured from extreme compression fiber to centroid of tension reinforcement

3.43
embedment length
length of embedded reinforcement provided beyond a critical section

3.44
factored loads and forces
specified nominal loads and forces multiplied by the load factors prescribed in these guidelines

3.45
fire protection of reinforcement
amount of concrete cover necessary for protection of the reinforcement against the effects of the high temperatures produced by fire

NOTE The concrete cover is a function of the number of hours of exposure to the fire.

3.46
flange
top or bottom part of an I or T shaped section separated by the web

3.47
flexural
pertaining to the flexure bending moment

3.48
flexural reinforcement
reinforcement provided to resist the tensile stresses induced by flexural moments acting on the member section

3.49
footing
that portion of the foundation which transmits loads directly to the soil

NOTE May be the widening part of a column, a structural concrete wall or several columns, in a combined footing.

3.50
formwork
temporary construction to contain concrete in a plastic state while it is cast and setting, and that forms the final shape of the element as the concrete hardens

3.51
foundation
any part of the structure that serves to transmit loads to the underlying soil, or to contain it

3.52
foundation beam
beam that rests on the foundation soil and spans between footings, used either to support walls or to limit differential settlement of the foundation

3.53
foundation mat
continuous slab laid over the ground as part of the foundation and that transmits to the underlying soil the loads from the structure

3.54
girder
main horizontal support beam, usually supporting other beams

3.55
gravity loads
loads that act downward and are caused by the acceleration of gravity, *g*, acting on the mass of the elements that cause the dead and live loads

3.56
hydrostatic pressure
pressure at a specific elevation exerted by a body of water at rest or, in the case of groundwater, the pressure at a specific elevation due to the weight of water at higher levels in the same zone of saturation

NOTE Hydrostatic pressure increases linearly with depth.

3.57
hydrodynamic pressure
pressure at a specific elevation exerted by a body of water at rest or, in the case of groundwater, during an earthquake and that results from the dynamic response of the water itself

3.58
hook
bend at the end of a reinforcing bar

NOTE They are defined by the angle that the bend forms with the bar as either 90°, 180° or 135° hooks.

3.59
Interface Friction Angle
angle of friction at the interface (or the skin friction) between cohesionless soil and another material

3.60
Internal Friction Angle
angle measured between the normal force and resultant force that is attained when failure just occurs in response to a shearing stress

NOTE 1 It is a measure of the ability of a unit of rock or soil to withstand a shear stress.

NOTE 2 Its value is determined experimentally.

3.61
joist
T-shaped beam used in parallel series directly supporting deck loads, and supported in turn by larger girders, beams, or bearing structural concrete walls

3.62
lap splice
splice between two reinforcing bars obtained by overlapping them for a specified length

3.63
lateral-force resisting system
portion of the structure composed of members proportioned to resist forces related to earthquake effects

3.64
lightweight aggregate concrete
concrete made with coarse granular material that weighs less than the granular material used in normal weight concrete

NOTE This type of concrete is not covered by these guidelines.

3.65
limit state
condition beyond which a structure or member becomes unfit for service and is judged either to be no longer useful for its intended function (serviceability limit state) or to be unsafe (strength limit state)

3.66
live loads
static and dynamic effects, in terms of forces applied on the structure, produced by the use of the bridge by pedestrians and/or vehicles and and not including construction or environmental loads

3.67
load effects
forces and deformations produced in structural members by the applied loads

3.68
load factor
factor that accounts for deviations of the actual load from the nominal load, for uncertainties in the analysis that transforms the load into a load effect, and for the probability that more than one extreme load will occur simultaneously

3.69
loads
forces or other actions that result from the weight of all bridge materials, pedestrians, vehicles, environmental effects, differential movement, and restrained dimensional changes

3.70
longitudinal reinforcement
reinforcement that is laid parallel to the longitudinal axis of the element, generally to account for flexural effects

3.71
mass
quantity of matter in a body

3.72
mesh wire
welded-wire fabric reinforcement

3.73
modulus of elasticity
ratio of normal stress to corresponding strain for tensile or compressive stresses below proportional limit of material

3.74
negative moment
flexural moment that produces tension stresses at the upper part of the section of a horizontal or nearly horizontal element, and that requires placing negative flexural reinforcement in the upper part of the element section

3.75
negative reinforcement
in horizontal or nearly horizontal elements, the flexural reinforcement required for negative moment and that is placed in the upper part of the section of the element

3.76
nominal loads
magnitudes of the loads specified in these guidelines (dead, live, soil, wind, snow, rain, flood, and earthquake)

3.77
nominal strength
capacity of a structure or member to resist the effects of loads, as determined by computations using specified material strengths and dimensions and the formulas set forth by these guidelines

NOTE Specified material strengths are derived from accepted principles of structural mechanics or by field tests or laboratory tests of scaled models, allowing for modelling effects and differences between laboratory and field conditions.

3.78
pedestal
upright compression member with a ratio of unsupported height to average least lateral dimension of less than 3

3.79
permanent loads
loads in which variations over time are rare or of small magnitude

NOTE All other loads are variable loads (see also nominal loads).

3.80
pile
slender timber, concrete or structural steel element embedded in the ground to support loads

3.81
plain reinforcement
smooth surfaced steel reinforcement, or reinforcement that does not conform to the definition of deformed reinforcement

3.82
positive moment
flexural moment that produces tension stresses at the lower part of the section of a horizontal or nearly horizontal element, and that requires placing positive flexural reinforcement in the lower part of the element section

3.83
positive reinforcement
in horizontal or nearly horizontal elements, the flexural reinforcement required for positive moment and that is placed in the lower part of the section of the element