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Guidelines for the simplified design of structural reinforced concrete for buildings

Lignes directrices pour la conception simplifiée du béton armé pour les structures de bâtiments

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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).

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 (see 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.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 15673:2005), which has been technically revised with the following changes.

— recent research available in concrete frame and wall buildings as a result of poor structural behaviour observed during recent earthquakes have changed the design and detailing requirements for these type of buildings in seismic prone areas;

— concrete structural design criteria has been unified in almost all countries in order to use similar, if not identical load combinations with the same load factors, as well as strength reduction factors; this is a substantial change and has been changing in recent years in order to simplify and unify design criteria for different construction materials such as timber, steel, masonry and lastly concrete;

— concrete cover requirement have been updated to most recent international building code standards.

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Introduction

This document is developed for countries that do not have existing national standards. This document should not be used in place of a national standard unless specifically considered and accepted by the national standard body or other appropriate regulartory organization. The design rules are based in simplified worldwide-accepted strength models. This document is self-contained; therefore, actions (loads) and simplified analysis procedures are included, as well as minimum acceptable construction practice guidelines.

The minimum dimensional guidelines contained in this document 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 fact that numerous underdeveloped regions of the world lay in earthquake prone areas. The earthquake resistance 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 document 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 document and provide foolproof procedures. Notwithstanding, the economic implications of the conservatism inherent in approximate procedures as a substitution to sound and experienced engineering is to be a matter of concern to the designer that employs this document, and to the owner that hires him/her.

The purpose of these guidelines is to provide a registered civil engineer or architect with sufficient information to perform the design of the structural reinforced concrete that comprises the structural framing of a low-rise building that complies with the limitations established in 6.1. The rules of design as set forth in the present document are simplifications of the more elaborate requirements.

Although the guidelines contained in this document were drawn to produce, when properly employed, a reinforced concrete structure with an appropriate margin of safety, these guidelines are not a replacement of sound and experienced engineering judgement. In order for the resulting structure to attain the intended margin of safety, this document should be used as a whole, and alternative procedures should be employed only when explicitly permitted by the guidelines. The minimum dimensioning guides provided replace, in most cases, more elaborate procedures as those prescribed in the National Building Code, and the eventual economic impact is compensated by the simplicity of the procedures prescribed in this document.

The professional performing the structural design under these guidelines should meet the legal requirements for structural designers in the country of adoption possess a minimum appropriate knowledge of structural mechanics, statics, strength of materials, structural analysis, and reinforced concrete design and construction.

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Guidelines for the simplified design of structural reinforced concrete for buildings

1 Scope

This document provides guidelines for the design and construction of low-rise concrete building structures of small area to be built in the less developed areas of the world.

This document is applicable to the planning, design and construction of structural reinforced concrete structures to be used in new low-rise buildings of restricted occupancy, number of stories, and area.

This document can be used as an alternative to the development of a National Concrete Building Code, or equivalent document in countries where no national design codes are available by themselves, or as an alternative to the National Concrete Building Code in countries where specifically considered and accepted by the national standard body or other appropriate regulatory organization.

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

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

ISO 2103, *Loads due to use and occupancy in residential and public buildings*

ISO 2633, *Determination of imposed floor loads in production buildings and warehouses*

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 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 reinforcement*

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 10144, *Certification scheme for steel bars and wires for the reinforcement of concrete — Welded-wire reinforcement*

ISO 29581–1, *Cement — Test methods — Part 1: Analysis by wet chemistry*

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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:

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

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

3.1
acceleration of gravity
g
acceleration produced by gravity at the surface of the Earth

Note 1 to entry: For the application of these guidelines, its value can be approximated to *g* approximately [10] m/s^2.

3.2
admixture
material other than water, *aggregate* (3.3), or hydraulic cement, used as an ingredient of *concrete* (3.20) and added to concrete before or during its mixing to modify its properties

3.3
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* (3.20) or mortar

3.4
anchorage
device used to anchor a non-structural element to the structural framing

3.5
bar diameter
<nominal> approximate diameter of a steel reinforcing bar, often used as a class designation

Note 1 to entry: For deformed bars, it is common practice to use the diameter of a plain bar having the same area.

3.6
base of structure
level at which earthquake motions are assumed to be imparted to a building

Note 1 to entry: This level does not necessarily coincide with the ground level.

3.7
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

3.8
bearing capacity of the soil
maximum permissible stress on the *foundation* (3.51) soil that provides adequate safety against bearing failure of the soil, or *settlement* (3.90) of the foundation of such magnitude as to impair the structure

Note 1 to entry: Its value is defined at the *working stress* (3.122) level.

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

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3.10
boundary elements
portions along wall edges strengthened by longitudinal and *transverse reinforcement* (3.117)

Note 1 to entry: Boundary elements do not necessarily require an increase in thickness of the wall.

3.11
buildings
structures, usually enclosed by walls and a roof, constructed to provide support or shelter for an intended *occupancy* (3.76)

3.12
caisson
foundation pile of large diameter, built partly or totally above ground and sunk below ground usually by digging out the soil inside

3.13
cement
material which, when mixed with water, has hardening properties, used either in *concrete* (3.20) or by itself

3.14
center of mass
geometric place where all the *mass* (3.68) of the floor would be located in plan (assuming the floor diaphragm as an infinite rigid body in its own plane)

3.15
center of rigidity
geometric place located in plan and established assuming that the floor diaphragm is an infinite rigid body in its own plane, where applying an horizontal force, in any direction, no diaphragm rotation is presented around a vertical axis

3.16
column
vertical member used primarily to support axial compressive *loads* (3.66)

3.17
collector elements
elements that serve to transmit the inertia forces within the diaphragm to members of the *lateral-force resisting system* (3.60)

3.18
combined footing
footing (3.49) that transmits the load carried by several *columns* (3.16) or *structural concrete walls* (3.110) to the supporting soil

3.19
compression reinforcement
reinforcement (3.85) provided to resist compression stresses induced by *bending moments* (3.9) acting on the member section

3.20
concrete
mixture of portland cement or any other hydraulic cement, fine aggregate, coarse aggregate, and water, with or without *admixtures* (3.2)

3.21
concrete mix design
choice and proportioning of the ingredients of *concrete* (3.20)

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3.22
concrete, specified compressive strength of
f'_c
compressive cylinder strength of *concrete* (3.20) used in design

Note 1 to entry: It is expressed in megapascals (MPa).

Note 2 to entry: Whenever the quantity f'_c is under a radical sign $\left(\sqrt{f'_c}\right)$, the positive square root of numerical value only is intended and result has units of megapascals (MPa).

3.23
confinement hook
hook (3.56) on a *stirrup* (3.105), *hoop* (3.57), or *crosstie* (3.28) having a bend not less than 135° with a six-diameter (but not less than 75 mm) extension that engages the *longitudinal reinforcement* (3.67) and projects into the interior of the stirrup or hoop

3.24
confinement stirrup or tie
closed *stirrup* (3.105), *tie* (3.115) or continuously wound spiral

Note 1 to entry: A closed stirrup or tie can be made up of several *reinforcement* (3.85) elements each having *confinement hooks* (3.23) at both ends. A continuously wound spiral should have a confinement hook at both ends.

3.25
contraction joint
formed, sawed, or tooled groove in a concrete structure to create a weakened plane and regulate the location of cracking resulting from the dimensional change of different parts of the structure

3.26
corrosion
gradual degradation or weakening of metal from its surface that requires the presence of humidity and oxygen, and is helped by the presence of other materials

3.27
cover
<concrete> thickness of *concrete* (3.20) between the surface of any reinforcing bar and the nearest face of the concrete member

3.28
crosstie
continuous reinforcing bar having a 135° *hook* (3.56) at one end and a hook not less than 90° at least a six-diameter extension at the other end

Note 1 to entry: The hooks should engage peripheral longitudinal bars. The 90° hooks of two successive crossties engaging the same longitudinal bars should be alternated end by end.

3.29
curing
process of keeping the *concrete* (3.20) damp for a period of time, usually several days, starting from the moment it is cast, in order for the *cement* (3.13) to be provided with enough water to harden and attain the intended strength

Note 1 to entry: 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.

3.30
curtain wall
walls that are part of the façade or enclosure of the building

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3.31
deformed reinforcement
steel *reinforcement* (3.85) that has deformations in its surface to increase its bond to the *concrete* (3.20)

Note 1 to entry: The following steel reinforcement should be considered deformed reinforcement under these guidelines: deformed reinforcing bars, deformed *wire* (3.121), welded plain wire reinforcement, and welded deformed wire reinforcement conforming to the appropriate ISO standards.

3.32
depth of member
h
vertical size of a cross section of a horizontal structural element

3.33
design load combinations
combinations of factored *loads* (3.66) and forces

3.34
design strength
product of the *nominal strength* (3.74) multiplied by a *strength reduction factor, ϕ* (3.107)

3.35
development length
length of embedded reinforcement required to develop the *design strength* (3.34) of *reinforcement* (3.85) at a critical section

3.36
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* (3.56)

3.37
differential settlement
when the *foundation* (3.51) of different parts of a structure settle different amounts

3.38
drift
difference between the horizontal displacements of two consecutive levels

3.39
durability
characteristic of a structure to resist gradual degradation of its serviceability in a given environment for the design service life

3.40
effective depth of section
d
distance measured from the extreme compression fibre to the centroid of tension *reinforcement* (3.85)

3.41
embedment length
length of embedded *reinforcement* (3.85) provided beyond a critical section

3.42
essential facilities
buildings and other structures that are intended to remain operational in the event of extreme environmental loading from wind, snow, or earthquakes

3.43
factored loads and forces
specified nominal *loads* (3.66) and forces multiplied by the load factors

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3.44
fire protection of reinforcement
amount of concrete cover necessary for protection of the *reinforcement* (3.85) against the effects of the high temperatures produced by fire

Note 1 to entry: The concrete cover is a function of the number of hours of exposure to the fire.

3.45
flange
top or bottom part of an I-shaped or T-shaped section separated by the *web* (3.119)

3.46
flexural
pertaining to the flexure *bending moment* (3.9)

3.47
flexural reinforcement
reinforcement (3.85) provided to resist the tensile stresses induced by flexural moments acting on the member section

3.48
floor system
structural elements that comprise the floor of a story in a building

Note 1 to entry: It includes the *beams* (3.7) and *girders* (3.54), the *joists* (3.58) (if employed), and the *slab* (3.95) that spans between them.

3.49
footing
portion of the *foundation* (3.51) which transmits *loads* (3.66) directly to the soil

Note 1 to entry: May be the widening part of a *column* (3.16), a *structural concrete wall* (3.110) or several columns, in a *combined footing* (3.18).

3.50
formwork
temporary construction to contain *concrete* (3.20) in a plastic state while casting and setting take place, 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* (3.66) to the underlying soil, or to contain it

3.52
foundation beam
beam (3.7) that rests on the *foundation* (3.51) soil and spans between *footings* (3.49), used either to support walls or to limit *differential settlement* (3.37) of the foundation

3.53
foundation mat
continuous *slab* (3.95) laid over the ground as part of the *foundation* (3.51) and that transmits to the underlying soil the *loads* (3.66) from the structure

3.54
girder
main horizontal support *beam* (3.7), usually supporting other beams

3.55
gravity loads
loads (3.66) that act downward and are caused by the *acceleration of gravity*, *g*, (3.1) acting on the *mass* (3.68) of the elements that cause the dead and *live loads* (3.63)

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3.56
hook
bend at the end of a reinforcing bar

Note 1 to entry: They are defined by the angle that the bend forms with the bar as either 90°, 180° or 135° hooks.

3.57
hoop
closed *stirrup* (3.105), *tie* (3.115), or continuosly wound spiral

Note 1 to entry: A closed stirrup or tie can be made up of several *reinforcement* (3.85) elements, each having seismic *hooks* (3.56) at both ends. A continuously wound spiral shall have a seismic hook at both ends

3.58
joist
T-shaped or I-shaped *beam* (3.7) used in parallel series directly supporting floor and ceiling *loads* (3.66), and supported in turn by larger *girders* (3.54), beams, or bearing *structural concrete walls* (3.110)

3.59
lap splice
splice between two reinforcing bars obtained by overlapping them for a specified length

3.60
lateral-force resisting system
portion of the structure composed of members proportioned to resist forces related to earthquake effects

3.61
lightweight aggregate concrete
concrete (3.20) made with coarse granular material that weighs less than the granular material used in normal weight concrete

Note 1 to entry: This type of concrete is not covered by these guidelines.

3.62
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)

3.63
live load
loads (3.66) produced by the use and *occupancy* (3.76) of the building and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load, or dead load, without *load factors* (3.65)

3.64
load effects
forces and internal deformations produced in structural members by the applied *loads* (3.66)

3.65
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

3.66
loads
forces or other actions that result from the *weight* (3.120) of all building materials, occupants and their possessions, environmental effects, differential movement, and restrained dimensional changes

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3.67
longitudinal reinforcement
reinforcement (3.85) that is laid parallel to the longitudinal axis of the element, generally to account for flexural effects

3.68
mass
quantity of matter in a body

3.69
mesh wire
welded-wire *reinforcement* (3.85)

3.70
modulus of elasticity
ratio of normal stress to corresponding strain for tensile or compressive stresses below the proportional limit of the material

3.71
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* (3.47) in the upper part of the element section

3.72
negative reinforcement
in horizontal or nearly horizontal elements, the *flexural reinforcement* (3.47) required for *negative moment* (3.71) and that is placed in the upper part of the section of the element

3.73
nominal loads
magnitudes of the *loads* (3.66) (dead, live, soil, wind, snow, rain, flood, and earthquake), without *load factors* (3.65)

3.74
nominal strength
capacity of a structure or member to resist the effects of *loads* (3.66), as determined by theoretical computations using specified material strengths and dimensions, which in turn 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

3.75
non-structural elements
correspond to architectural, mechanical, and electrical components and systems permanently attached to the building

3.76
occupancy
purpose for which a building or other structure, or part thereof, is used or intended to be used

3.77
partitions
non-structural walls that are employed to divide spaces

Note 1 to entry: They do not support other parts of the building except themselves. When they are built in the exterior, sometimes they are referred to as *curtain walls* (3.30).

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

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3.79
permanent loads
loads (3.66) in which variations over time are rare or of small magnitude

Note 1 to entry: All other loads are variable loads; see also *nominal loads* (3.73).

3.80
pile
slender timber, *concrete* (3.20) or structural steel element embedded in the ground to support *loads* (3.66)

3.81
plain reinforcement
smooth surfaced steel *reinforcement* (3.85), or reinforcement that does not conform to the definition of *deformed reinforcement* (3.31)

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* (3.47) in the lower part of the element section

3.83
positive reinforcement
in horizontal or nearly horizontal elements, the *flexural reinforcement* (3.47) required for *positive moment* (3.82) and that is placed in the lower part of the section of the element

3.84
reaction
resistance to a force or load, or upward resistance of a *support* (3.112) such as a *structural concrete wall* (3.110) or *column* (3.16) against the downward pressure of a loaded member such as a beam

3.85
reinforcement
steel bars, *wire* (3.121), or *mesh wire* (3.69), used for reinforcing the *concrete* (3.20) where tensile stresses are expected, due either to the applied *loads* (3.66), *differential settlement* (3.37) or to environmental effects such as variation of temperature

3.86
required factored strength
strength of a member or cross section required to resist factored *loads* (3.66) or related internal moments and forces

3.87
retaining wall
wall built to hold back earth

3.88
selfweight
weight (3.120) of the structural element, caused by the material that composes the element

3.89
service load
load (3.66), without *load factors* (3.65)

3.90
settlement
downward movement of the supporting soil due to construction *loads* (3.66)

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3.91
shear
internal force acting tangential to the plane where it acts or perpendicular to the elements longitudinal axis

Note 1 to entry: Also called diagonal tension.

3.92
shear reinforcement
reinforcement (3.85) designed to resist *shear* (3.91)

3.93
shores
vertical or inclined *support* (3.112) members designed to carry the *weight* (3.120) of the *formwork* (3.50), *concrete* (3.20), and construction *loads* (3.66) above

3.94
shrinkage and temperature reinforcement
reinforcement (3.85) normal to *flexural reinforcement* (3.47) provided for shrinkage and temperature stresses in structural *solid slabs* (3.97) and *footings* (3.49) where flexural reinforcement extends in one direction only

3.95
slab
upper flat part of a reinforced *concrete* (3.20) floor carried by supporting *joists* (3.58), *beams* (3.7), walls or *columns* (3.16)

3.96
slab on grade
slab (3.95) set directly on the ground that serves either as a internal traffic surface or as part of the *foundation* (3.51)

3.97
solid slab
slab (3.95) of uniform thickness that does not have voids to make it lighter

3.98
span length
horizontal distance between *supports* (3.112) of a horizontal structural element, such as for a *slab* (3.95), *joist* (3.58), *beam* (3.7), or *girder* (3.54)

3.99
specifications
written document describing in detail the scope of work, materials to be used, method of installation, and quality of workmanship

3.100
specified lateral earthquake forces
lateral forces corresponding to the appropriate distribution of the design base *shear* (3.91) force for earthquake-resistant design

3.101
specified wind forces
nominal pressure of wind to be used in design

3.102
spiral reinforcement
continuously wound *reinforcement* (3.85) in the form of a cylindrical helix

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3.103
spread footing
isolated *footing* (3.49) that transmits the load carried by a single *column* (3.16) to the supporting soil

3.104
stairway
flight of steps leading from one level to another

3.105
stirrup
reinforcement (3.85) used to resist *shear* (3.91) and torsion stresses in a structural member

Note 1 to entry: Typically bars, *wires* (3.121), or welded wire reinforcement (plain or deformed) either single leg or bent into L, U, or rectangular shapes and located perpendicular to or at an angle to *longitudinal reinforcement* (3.67). The term "stirrups" is usually applied to lateral reinforcement in *girders* (3.54), *beams* (3.7), and *joists* (3.58). The term "ties" apply to those in *columns* (3.16) and walls. See also *tie* (3.115).

3.106
story height
vertical distance between the upper part of the *slab* (3.95) of a story and the upper part of the slab of the floor below

3.107
strength reduction factor
ϕ
coefficient that accounts for deviations of the actual strength from the *nominal strength* (3.74), according to the manner and consequences of failure

Note 1 to entry: Including the probability of understrength members due to variations in material strengths and dimensions, approximations in the design equations, to reflect the degree of ductility and required reliability on the member under the *load effects* (3.64) being considered, and to reflect the importance of the element in the structure.

3.108
stress
intensity of force per unit area

3.109
structural concrete
all *concrete* (3.20) used for structural purposes including plain and reinforced concrete and prestressed concrete

3.110
structural concrete walls
walls proportioned to resist combinations of *shear* (3.91), moments, and axial forces

Note 1 to entry: A "shearwall" is a "structural wall."

3.111
structural diaphragms
structural members, such as floor and roof *slabs* (3.95) which transmit inertial forces induced by earthquake motions

3.112
support
structural element that provides support to another structural element

3.113
tank
container for the storage of water or other fluids

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3.114
temporary facilities
buildings or other structures that are to be in service for a limited time and have a limited exposure period for environmental loadings

3.115
tie
loop of reinforcing bar or *wire* (3.121) enclosing *longitudinal reinforcement* (3.67)

Note 1 to entry: A continuously wound bar or wire in the form of a circle, rectangle, or other polygon shape without re-entrant corners is acceptable.

3.116
tie elements
elements which serve to transmit inertia forces and prevent separation of such building components as *footings* (3.49) and *walls* (3.118)

3.117
transverse reinforcement
reinforcement (3.85) located perpendicular to the longitudinal axis of the element, comprising *stirrups* (3.105), *ties* (3.115), *spiral reinforcement* (3.102), among others

3.118
wall
member, usually vertical, used to enclose or separate spaces

3.119
web
thin vertical portion of an I-shaped or T-shaped section that connects the *flanges* (3.45)

3.120
weight
vertical downward force exerted by a *mass* (3.68), when subjected to the *acceleration of gravity* (3.1)

Note 1 to entry: The weight is equal to the value of the mass multiplied by the acceleration of gravity, g.

3.121
wire
reinforcing bar of small diameter

3.122
working stress
allowable *stress* (3.108) to be used with unfactored *loads* (3.66)

3.123
yield strength
f_y
specified minimum yield strength or yield point of *reinforcement* (3.85)

Note 1 to entry: The yield strength is expressed in units of megapascals, MPa.

Note 2 to entry: Applicable International Standards specify that the yield strength or yield point be determined in tension.

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