CSA Group

A23.3-14

Design of concrete structures

Legal Notice for Standards

Canadian Standards Association (operating as "CSA Group") develops standards through a consensus standards development process approved by the Standards Council of Canada. This process brings together volunteers representing varied viewpoints and interests to achieve consensus and develop a standard. Although CSA Group administers the process and establishes rules to promote fairness in achieving consensus, it does not independently test, evaluate, or verify the content of standards.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document's fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party's intellectual property rights. CSA Group does not warrant the accuracy, completeness, or currency of any of the information published in this document. CSA Group makes no representations or warranties regarding this document's compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL CSA GROUP, ITS VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF CSA GROUP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, CSA Group is not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and CSA Group accepts no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

CSA Group is a private not-for-profit company that publishes voluntary standards and related documents. CSA Group has no power, nor does it undertake, to enforce compliance with the contents of the standards or other documents it publishes.

Intellectual property rights and ownership

As between CSA Group and the users of this document (whether it be in printed or electronic form), CSA Group is the owner, or the authorized licensee, of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. Without limitation, the unauthorized use, modification, copying, or disclosure of this document may violate laws that protect CSA Group's and/or others' intellectual property and may give rise to a right in CSA Group and/or others to seek legal redress for such use, modification, copying, or disclosure. To the extent permitted by licence or by law, CSA Group reserves all intellectual property rights in this document.

Patent rights

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. CSA Group shall not be held responsible for identifying any or all such patent rights. Users of this standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.

Authorized use of this document

This document is being provided by CSA Group for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by CSA Group to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from CSA Group; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.

Standards Update Service

A23.3-14
June 2014

Title: *Design of concrete structures*

To register for e-mail notification about any updates to this publication
- go to **shop.csa.ca**
- click on **CSA Update Service**

The **List ID** that you will need to register for updates to this publication is **2422755**.

If you require assistance, please e-mail **techsupport@csagroup.org** or call 416-747-2233.

Visit CSA Group's policy on privacy at **csagroup.org/legal** to find out how we protect your personal information.

A23.3-14
Design of concrete structures

™A trade-mark of the Canadian Standards Association, operating as "CSA Group"

Published in June 2014 by CSA Group
A not-for-profit private sector organization
5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6

*To purchase standards and related publications, visit our Online Store at **shop.csa.ca***
or call toll-free 1-800-463-6727 or 416-747-4044.

ISBN 978-1-77139-390-4

Contents

Technical Committee on Reinforced Concrete Design

D. Mitchell	McGill University, Montréal, Québec *Representing General Interest*	*Chair*
R.J. McGrath	Cement Association of Canada (CAC), Ottawa, Ontario *Representing Producer Interest*	*Vice-Chair*
P. Paultre	Université de Sherbrooke, Sherbrooke, Québec *Representing General Interest*	*Technical Secretary*
P. Adebar	University of British Columbia, Vancouver, British Columbia *Representing General Interest*	
S.D. Alexander	Buckland & Taylor|COWI, Edmonton, Alberta *Representing User Interest*	
C.M. Allen	Adjeleian Allen Rubeli Limited, Ottawa, Ontario *Representing User Interest*	
F.M. Bartlett	Western University, London, Ontario *Representing General Interest*	
M.P. Collins	University of Toronto, Toronto, Ontario *Representing General Interest*	
M.P. Comeau	Campbell Comeau Engineering Limited, Halifax, Nova Scotia *Representing User Interest*	
R. Dozzi	Harris Rebar & Harris PT, Stoney Creek, Ontario *Representing Producer Interest*	

M. Ghabrial	HGS Limited Consulting Engineers, Windsor, Ontario *Representing Producer Interest*	
W. Kassian	Kassian Dyck & Associates, Calgary, Alberta *Representing Producer Interest*	
T. Kokai	Read Jones Christoffersen Consulting Engineers, Toronto, Ontario *Representing User Interest*	
K.L. Lemieux	Weiler Smith Bowers Consultants, Burnaby, British Columbia *Representing Producer Interest*	
R.E. Loov	Calgary, Alberta *Representing General Interest*	
J.G. Mutrie	Jones Kwong Kishi Consulting Engineers, North Vancouver, British Columbia *Representing User Interest*	
J.A. Patrick	Alberta Infrastructure, Edmonton, Alberta *Representing Government and/or Regulatory Authority*	
C.R. Taraschuk	National Research Council Canada, Ottawa, Ontario *Representing Government and/or Regulatory Authority*	
S. Vézina	Groupe SMi, Montréal, Québec *Representing User Interest*	
C.M. Wang	Grande Cache Coal, Calgary, Alberta *Representing User Interest*	
P. Gulletson	CSA Group, Mississauga, Ontario	*Project Manager*
L. Jula Zadeh	CSA Group, Mississauga, Ontario	*Project Manager*

In addition to the members of the Committee, the following individuals made significant contributions to the development of this Standard:

E.C. Bentz	University of Toronto, Toronto, Ontario
R.H. DeVall	Read Jones Christoffersen Consulting Engineers, Vancouver, British Columbia
K. Truderung	Tower Engineering Group, Winnipeg, Manitoba

In addition, the members of the Structural Engineers Association of BC Technical Committee on Concrete Design made contributions to the development of this Standard.

Preface

This is the sixth edition of CSA A23.3, *Design of concrete structures.* It supersedes the previous editions published in 2004, 1994, 1984, 1977 (metric), and 1973 (imperial), and 1959.

This Standard is intended for use in the design of concrete structures for buildings in conjunction with CSA A23.1/A23.2, *Concrete materials and methods of concrete construction/Methods of test and standard practices for concrete,* and CSA A23.4, *Precast concrete — Materials and construction*.

Changes in this edition include the following:

a) Clause 3.1 contains new definitions for conventional construction, moderately ductile wall systems, different types of tilt-up construction, and gravity-load resisting frames.

b) Clause 7.4.3.1 contains new requirements for the clear distance between pretensioning wires or strands at the ends of members. Clause 7.6.5 contains new requirements for additional column ties in column-slab connections over the slab depth where the slab is discontinuous. In Clause 7.6.4, the minimum diameter of spiral reinforced has been changed to 10 mm and the limit of one-sixth of the core diameter for the clear spacing between successive turns in a spiral has been removed. Clause 7.7.3 has new requirements for column ties in beam-column joints.

c) Clause 9.2.1.2 gives guidance on stiffnesses to be used in members of lateral load resisting systems for wind loading. Clause 9.8 provides cautionary notes on member minimum thickness requirements and accounting for construction stages and early loading in computing deflections.

d) Clause 10.9.4 contains a new requirement for the required ratio of spiral reinforcement. Clause 10.10.4 has increased the maximum factored axial load resistance of spirally reinforced columns and contains new provisions for the resistance of compression members as a function of wall thickness. Clause 10.16.3 provides a new factor for determining the amplitude of sway moments.

e) Changes to the shear design provisions in Clause 11 include the following: the need to account for cover spalling for members subjected to high shear stress; new requirement for sections near supports; definition of special member types; accounting for effect of bars terminated in the flexural tension zone; and increased spacing limit for transverse reinforcement for special cases. Changes to the strut-and-tie design provisions of Clause 11.4 include the following: introduction of refined strut-and-tie models; modelling of members subjected to uniform loads; revised strut dimensions for struts anchored by reinforcement and for struts in narrow part of fanning compression regions; simplified expression for limiting compressive stress in struts; new detailing requirements for anchorage of ties; and provisions accounting for confinement of bearing in nodal regions.

f) Clause 13 on two-way slab systems has been revised to include the following: the use of d_v in determining the one-way shear resistance; new details for bottom bars in column strips of slabs with drop panels (see Figure 13.1); and a change in the definition of V_{se} for the design of structural integrity reinforcement (see Clauses 13.10.6.1 and 3.2).

g) Clause 14 contains a new requirement to account for strong axis bending in bearing walls and new wall thickness requirements and slenderness requirements for flexural shear walls.

h) Clause 18.3.1 permits a higher compressive stress limit in the concrete at transfer at the ends of simply supported members.

i) Clause 21 on special provisions for seismic design has a number of significant changes. This Clause has been reorganized so that all the requirements for ductile frames are in Clause 21.3, while all the requirements for moderately ductile frames are in Clause 21.4. New dimensional limitations for moderately ductile moment-resisting frames have been added in Clause 21.4.2. The requirements

for moderately ductile shear walls have been spelled out in greater detail, and because of the significant overlap with the requirements for ductile shear walls, the requirements for moderately ductile and ductile shear walls are presented together in Clause 21.5. All shear wall design requirements that were redundant with Clause 14 have been removed from Clause 21. Thus, the designer of seismic shear walls must look to Clause 14 for important requirements such as dimensional limitations, transfer of forces across construction joints, and many other requirements. The requirements for strength and ductility over the height of shear walls in Clause 21.5.2 have been expanded. New requirements have been added for the design for bending moment and shear force below the plastic hinge at the base, and for the increased shear force in walls due to the inelastic effects of higher modes. New requirements have been added in Clause 21.5.5 for the anchorage of horizontal reinforcement at the ends of walls depending on the level of ductility. New requirements have been added in Clause 21.5.7 to ensure that walls have adequate ductility to tolerate some yielding near mid-height due to higher mode bending moments. The design requirements for two new types of reinforced concrete SFRS — moderately ductile coupled walls and moderately ductile partially coupled walls — have been added in Clause 21.5.8. The requirements for squat shear walls in Clause 21.5.10 have been relaxed where the walls are longer than needed. The requirements for conventional construction shear walls in Clause 21.6.3 have been expanded. New requirements for the design and detailing of tilt-up construction, including moderately ductile and limited ductility tilt-up walls and frames, are presented in Clause 21.7. New requirements for the design of foundations are presented in Clause 21.10, including the requirement to consider foundation movements. New requirements are presented in Clause 21.11 to ensure that all members not considered part of the seismic-force-resisting system have adequate displacement capacity.

j) Clause 23.2.9 provides revised design provisions for structural integrity of tilt-up construction. The effective area of reinforcement used to calculate the factored resisting moment has been modified.

k) Annex D on anchorage has been modified to include changes to the requirements specified in Appendix D of ACI 318M-11/318RM-11, *Building Code Requirements for Structural Concrete* and *Commentary*. Annex D provides new provisions for the bond strength of adhesive anchors in tension; installation of horizontal and upwardly inclined adhesive anchors; the bond strength of adhesive anchors in tension; the resistance of anchors for load cases involving earthquake effects; revised breakout resistance in shear for an anchor in cracked concrete; and new requirements for the installation of anchors.

This Standard was prepared by the Technical Committee on Reinforced Concrete Design, under the jurisdiction of the Strategic Steering Committee on Construction and Civil Infrastructure, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

3) *This Standard was developed by consensus, which is defined by CSA Policy governing standardization — Code of good practice for standardization as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*

4) *To submit a request for interpretation of this Standard, please send the following information to* ***inquiries@csagroup.org*** *and include "Request for interpretation" in the subject line:*

a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*

b) *provide an explanation of circumstances surrounding the actual field condition; and*

c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization and are available on the Current Standards Activities page at standardsactivities.csa.ca.

5) *This Standard is subject to review five years from the date of publication and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to* ***inquiries@csagroup.org*** *and include "Proposal for change" in the subject line:*

a) *Standard designation (number);*
b) *relevant clause, table, and/or figure number;*
c) *wording of the proposed change; and*
d) *rationale for the change.*

A23.3-14
Design of concrete structures

1 Scope

1.1 General

This Standard specifies requirements, in accordance with the *National Building Code of Canada,* for the design and strength evaluation of

a) structures of reinforced and prestressed concrete;
b) plain concrete elements; and
c) special structures such as parking structures, arches, tanks, reservoirs, bins and silos, towers, water towers, blast-resistant structures, and chimneys.

Note: *Special requirements for parking structures are specified in CSA S413.*

1.2 Fire resistance

This Standard requires designs to be carried out in accordance with the fire resistance requirements of the applicable building code (see Clause 8.1.2).

1.3 Alternative design procedures

Designs that use procedures that are not covered by this Standard but are carried out by a person qualified in the methods applied and provide a level of safety and performance equivalent to designs complying with this Standard are acceptable if carried out by one of the following methods:

a) analysis based on generally established theory;
b) evaluation of a full-scale structure or a prototype by a loading test; or
c) studies of model analogues.

1.4 Terminology

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.5 Units of measurement

Equations appearing in this Standard are compatible with the following units:

a) area: mm^2 (square millimetres);
b) force: N (newtons);
c) length: mm (millimetres);

