

# Design of steel structures



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# ***Technical Committee on Steel Structures for Buildings***

<b>R.B. Vincent</b>	Vinmar Surface Coatings Inc, Westmount, Québec <i>Representing General Interest</i>	<i>Chair</i>
<b>M.I. Gilmor</b>	Cast Connex Corporation, Toronto, Ontario <i>Representing Producer Interest</i>	<i>Vice-Chair</i>
<b>P.C. Birkemoe</b>	University of Toronto, Toronto, Ontario <i>Representing General Interest</i>	
<b>R. Bjorhovde</b>	The Bjorhovde Group, Tucson, Arizona, USA	<i>Associate</i>
<b>S. Boulanger</b>	Supermétal, Saint-Laurent, Québec <i>Representing Producer Interest</i>	
<b>M. Bruneau</b>	University at Buffalo, Buffalo, New York, USA <i>Representing General Interest</i>	
<b>L. Callele</b>	Waiward Engineering, Edmonton, Alberta <i>Representing Producer Interest</i>	
<b>B.D. Charnish</b>	Entuitive Corporation, Toronto, Ontario <i>Representing User Interest</i>	
<b>C. Christopoulos</b>	University of Toronto, Toronto, Ontario	<i>Associate</i>
<b>D. Clapp</b>	Frazier Industrial Co., Long Valley, New Jersey, USA	<i>Associate</i>
<b>M.P. Comeau</b>	Campbell Comeau Engineering Limited, Halifax, Nova Scotia <i>Representing User Interest</i>	

---

<b>R.G. Driver</b>	University of Alberta, Edmonton, Alberta <i>Representing General Interest</i>	
<b>J. Ferrari</b>	Konstant Inc, Oakville, Ontario	<i>Associate</i>
<b>R.B. Fletcher</b>	Atlas Tube, Chicago, Illinois, USA <i>Representing Producer Interest</i>	
<b>G. Frater</b>	Canadian Steel Construction Council, Markham, Ontario	<i>Associate</i>
<b>G. Grondin</b>	AECOM, Edmonton, Alberta <i>Representing User Interest</i>	
<b>C. Hanson-Carbonneau</b>	ADF Group Inc, Terrebonne, Québec <i>Representing Producer Interest</i>	
<b>P.S. Higgins</b>	Peter S. Higgins & Associates, Malibu, California, USA	<i>Associate</i>
<b>M. Hrabok</b>	University of Saskatchewan, Saskatoon, Saskatchewan <i>Representing General Interest</i>	
<b>M. Lasby</b>	Fluor Canada Ltd, Calgary, Alberta <i>Representing User Interest</i>	
<b>F. Legeron</b>	Université de Sherbrooke, Sherbrooke, Québec	<i>Associate</i>
<b>E.S. Lévesque</b>	Structal Ponts, Québec, Québec	<i>Associate</i>
<b>D.H. MacKinnon</b>	Canadian Institute of Steel Construction, Markham, Ontario	<i>Associate</i>
<b>I. MacPhedran</b>	University of Saskatchewan, Saskatoon, Saskatchewan	<i>Associate</i>

<b>J.R. Mark</b>	Mississauga, Ontario <i>Representing General Interest</i>	
<b>J.C. Martin</b>	CWB Group, Milton, Ontario <i>Representing General Interest</i>	
<b>A.W. Metten</b>	Bush, Bohlman & Partners, Vancouver, British Columbia <i>Representing User Interest</i>	
<b>C.J. Montgomery</b>	DIALOG, Edmonton, Alberta <i>Representing User Interest</i>	
<b>T. Mulholland</b>	Rack-Net-Works, Mississauga, Ontario <i>Representing User Interest</i>	
<b>P.K. Ostrowski</b>	Ontario Power Generation Inc., Bowmanville, Ontario <i>Representing User Interest</i>	
<b>J.A. Packer</b>	University of Toronto, Toronto, Ontario	<i>Associate</i>
<b>C. Rogers</b>	McGill University, Montréal, Québec <i>Representing General Interest</i>	
<b>R.M. Schuster</b>	University of Waterloo, Waterloo, Ontario	<i>Associate</i>
<b>C.R. Taraschuk</b>	National Research Council Canada, Ottawa, Ontario <i>Representing Government and/or Regulatory Authority</i>	
<b>A. Tiruneh</b>	Alberta Municipal Affairs, Edmonton, Alberta <i>Representing Government and/or Regulatory Authority</i>	
<b>R. Tremblay</b>	Ecole Polytechnique de Montréal, Montréal, Québec <i>Representing General Interest</i>	

---

<b>T. Verhey</b>	Walters Incorporated, Hamilton, Ontario <i>Representing Producer Interest</i>	
<b>E.J. Whalen</b>	Canadian Institute of Steel Construction, Markham, Ontario	<i>Associate</i>
<b>A.F. Wong</b>	Canadian Institute of Steel Construction, Markham, Ontario <i>Representing Producer Interest</i>	
<b>P.R. Zinn</b>	Arpac Storage Systems Corporation, Delta, British Columbia	<i>Associate</i>
<b>M. Braiter</b>	CSA Group, Mississauga, Ontario	
<b>L. Julia Zadeh</b>	CSA Group, Mississauga, Ontario	

# ① ***Working Group on Design and Construction of Steel Storage Racks***

<b>J. Ferrari</b>	Konstant Inc, Oakville, Ontario	<i>Chair</i>
<b>D. Clapp</b>	Frazier Industrial Co., Long Valley, New Jersey, USA	
<b>P.S. Higgins</b>	Peter S. Higgins & Associates, Malibu, California, USA	
<b>J. Hirst</b>	North American Storage, Nisku, Alberta	
<b>E. Jacobsen</b>	Polytechnique Montréal, Montréal, Québec	
<b>A.W. Metten</b>	Bush, Bohlman & Partners, Vancouver, British Columbia	
<b>T. Mulholland</b>	Rack-Net-Works, Mississauga, Ontario	
<b>R. Tremblay</b>	Polytechnique Montréal, Montréal, Québec	
<b>L. Xu</b>	University of Waterloo, Waterloo, Ontario	
<b>P.R. Zinn</b>	Arpac Storage Systems Corporation, Delta, British Columbia	
<b>M. Braiter</b>	CSA Group, Toronto, Ontario	<i>Project Manager</i>

# ① Preface

This is the eighth edition of CSA S16, *Design of steel structures*. It supersedes the previous limit states editions published in 2009, 2001, 1994, 1989, 1984, 1978, and 1974. These limit states design editions were preceded by seven working stress design editions published in 1969, 1965, 1961, 1954, 1940, 1930, and 1924. The 1969 working stress design edition was withdrawn in 1984, from which point the design of steel structures in Canada has been carried out using limit states design principles.

This Standard is appropriate for the design of a broad range of structures. It sets out minimum requirements and is expected to be used only by engineers competent in the design of steel structures. The following is a list of some of the more important changes made in this edition:

- a) Clause 1.4 specifically prohibits the use of other standards for fabrication, erection and inspection.
- b) The definition of “snug-tightness” has been clarified.
- c) Information required on design documents has been augmented.
- d) ASTM grades A500/A500M, A1085 and A913/A913M have been added as permissible steel grades for design.
- e) The fire endurance design requirements have been restated to be in compliance with the NBCC.
- f) Requirements under impulse loading have been added.
- g) The initial misalignment of members at brace points has been clarified.
- h) A calculation for the net area of a slotted HSS member has been given.
- i) The minimum  $b/t$  for bearing stiffeners has been added.
- j) The clause permitting a joist manufacturer to determine the joist resistance by testing has been removed.
- k) Provisions for column stiffeners opposite a rigidly connected beam by bolting have been provided.
- l) Requirements for zinc-aluminum coated assemblies have been incorporated.
- m) The use of plate washers in lieu of hardened washers is permitted in oversize or slotted holes.
- n) The use of non-matching electrodes is permitted with reference to W59 for locations where this is permitted.
- o) Clause 24 that referred to joint surface conditions for field welding in the previous edition has been removed and is now covered in CSA W47.1.
- p) The factored resistance of anchor rods in bearing has been referred to CSA A23.3 to be consistent with other Canadian design standards.
- q) A clarification on fatigue calculations has been made to include bending moments due to joint eccentricities.
- r) An upper limit on the design force of single-storey buildings’ roof diaphragms has been provided.
- s) A minimum Charpy V-notch value has been specified for weld of primary members and connections.
- t) A maximum sulfur content for ASTM A913 used in seismic-resisting systems is specified.
- u) Additional criteria for joint connections have been added to ductile moment-resisting frames, limited ductility moment-resisting frames, and moderately ductile concentrically braced frames.
- v) The design of link beams for ductile eccentrically braced frames has been expanded.
- w) Detailing information for limited ductility plate walls has been given.
- x) Annex K Structural design for fire conditions has been updated.
- y) The clauses related to pin-connected members have been revised to clarify the net section and resistance requirements.

A commentary on this Standard, prepared by the Canadian Institute of Steel Construction with contributions from many members of the Technical Committee, comprises Part 2 of the Institute's *Handbook of Steel Construction*.

This Standard is intended to be used with the provisions of the 2015 edition of the *National Building Code of Canada (NBCC)*, specifically Clause 7, which references the NBCC for load factors, load combinations, and other loading provisions..

This Standard was prepared by the Technical Committee on Steel Structures for Buildings, under the jurisdiction of the Strategic Steering Committee for Construction and Civil Infrastructure, and has been formally approved by the Technical Committee. Annex N was prepared by the Working Group on Design and Construction of Steel Storage Racks.

This edition of the CSA S16 is dedicated to the memories of Laurie Kennedy, André Picard, and Richard Redwood, three distinguished designers, researchers, and devoted educators committed to the advancement of steel standards.

**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](http://standardsactivities.csa.ca).*
- 5) *This Standard is subject to review five years from the date of publication. 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.*

# S16-14

## *Design of steel structures*

### 1 Scope and application

#### 1.1 General

This Standard provides rules and requirements for the design, fabrication, and erection of steel structures. The design is based on limit states. The term “steel structures” refers to structural members and frames that consist primarily of structural steel components, including the detail parts, welds, bolts, or other fasteners required in fabrication and erection. This Standard also applies to structural steel components in structures framed in other materials. The clauses related to fabrication and erection serve to show that design is inextricably a part of the design-fabrication-erection sequence and cannot be considered in isolation. For matters concerning standard practice pertinent to the fabrication and erection of structural steel not covered in this Standard, see Annex A.

#### 1.2 Requirements

Requirements for steel structures such as bridges, antenna towers, offshore structures, and cold-formed steel structural members are given in other CSA Group Standards.

#### 1.3 Application

This Standard applies unconditionally to steel structures, except that supplementary rules or requirements might be necessary for

- a) unusual types of construction;
- b) mixed systems of construction;
- c) steel structures that
  - i) have great height or spans;
  - ii) are required to be movable or be readily dismantled;
  - iii) are exposed to severe environmental conditions;
  - iv) are exposed to severe loads such as those resulting from vehicle impact or explosion;
  - v) are required to satisfy aesthetic, architectural, or other requirements of a non-structural nature;
  - vi) employ materials or products not listed in Clause 5; or
  - vii) have other special features that could affect the design, fabrication, or erection;
- d) tanks, stacks, other platemwork structures, poles, and piling; and
- e) crane-supporting structures.

#### 1.4 Other standards

The use of other standards for the design, fabrication, erection, and/or inspection of members or parts of steel structures is neither warranted nor acceptable except where specifically directed in this Standard. The design formulas provided in this Standard may be supplemented by a rational design based on theory, analysis, and engineering practice acceptable to the regulatory authority, provided that nominal margins (or factors) of safety are at least equal to those intended in the provisions of this Standard. The substitution of other standards or criteria for fabrication, erection, and/or inspection is expressly prohibited unless specifically directed in this Standard.