

# Limit States Design in Structural Steel

by

G.L. Kulak, P.Eng.  
Professor Emeritus

and

G.Y. Grondin, P.Eng.  
Professor

Department of Civil and  
Environmental Engineering  
University of Alberta  
Edmonton, Alberta



**CANADIAN INSTITUTE OF STEEL CONSTRUCTION  
INSTITUT CANADIEN DE LA CONSTRUCTION EN ACIER  
3760 14<sup>TH</sup> AVENUE, SUITE 200  
MARKHAM, ONTARIO L3R 3T7**

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# PREFACE

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## Preface to Ninth Edition

The Ninth Edition of this text introduces the changes to the 2009 edition of CSA-S16 standard. The changes in CSA-S16 that have affected the content of this edition consist of: the addition of a new equivalent moment factor for the lateral torsional buckling capacity of beams with non-linear moment distributions; new block shear provisions; changes to the design of column base plates; changes to the design of steel-concrete composite beams; and various changes in connection design, related to the bearing resistance of bolts, the resistance of welded joints with welds in more than one orientation within the same shear plane.

The first two chapters of the book deal with the interrelationship of design and analysis, various aspects of steel construction, the structural steels and sections available, the International System of Units, and the philosophy of the limit states design approach. With the 2005 edition of the National Building Code, the factored loads in the limit states design approach have been redefined, with the implementation of a companion load approach. The design of tension members, presented in Chapter 3, reflects changes to S16-09 with respect to failure by block shear in gusset plates and in coped beams. (This mode of failure was called tension and shear block failure in the earlier edition of the Standard.) The changes are meant to provide a more uniform approach for tension members of different shapes.

The design of columns presented in Chapter 4 has remained essentially the same as in the previous edition of the standard. A change in the designation of flange width for local buckling consideration was introduced for clarity and the design of column base plates now requires a minimum of four anchor rods. S16-09 has introduced a number of changes to the design of steel beams. Chapter 5 introduces the new definition of the equivalent moment factor for non-linear moment distribution. Chapters 6 and 7 go on to describe the design processes needed for particular kinds of beams—composite beams and plate girders. Changes to the magnitude of the compression stress block in the concrete portion of composite beams have been introduced in S16-09 for consistency with the reinforced concrete design standard, CSA-A23.3-04. The stability of members and frames has always been a difficult area for instructors to teach and for students to understand. Chapter 8 underwent significant changes in the Seventh and Eighth editions to integrate the analysis and design topics and to illustrate

these concepts for both single storey and multi-storey buildings. Clarifications have been introduced in this edition to distinguish between braced and unbraced frames, a concept that influences significantly the analysis and design process of beam-columns. Changes have been made in Chapter 9 to reflect changes in S16–09 with the bearing resistance of bolts and the strength calculation of welded joints where weld segments in different orientation are introduced in the same shear plane. The example design of framed building presented in Chapter 10 has been updated to reflect the changes in S16–09. Finally, Chapter 11 deals with fatigue. Although it is likely that most instructors will not be able to include it in the undergraduate teaching program, it should be useful as students begin their professional career and to practicing engineers who need to know more about this topic.

The intent of the authors still remains to provide a reference document for the training of those who will be responsible in the future for the design of steel structures. The book is intended primarily for a one or two term course in the subject at the undergraduate level. Consequently, some changes that were introduced in S16–09 that are related to topics usually covered at the graduate level (e.g. lateral torsional buckling of monosymmetric beams or of beams loaded at a point other than the shear centre) have not been presented in this book.

The authors acknowledge the contributions of the co-authors of previous editions of this book. These are Peter Adams, the principal co-author of technical material in editions through the Fifth, and Michael Gilmore and Hugh Krentz, responsible for industry-related material and who acted as Publishers through the Sixth Edition. Their contributions and influence continue in this edition.

The authors are indebted to friends and colleagues who have suggested improvements in wording and have identified errors in the earlier printing of this text. In particular, continuing support from Dr. Dominique Bauer from École de technologie supérieure and Mr. Charles Albert from CISC is gratefully acknowledged.

*October, 2011*

*G.L. Kulak  
G.Y. Grondin*

# TABLE OF CONTENTS

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## *Chapter 1*

## *INTRODUCTION*

1.1	The Design Process . . . . .	1
1.2	Codes, Specifications and Standards . . . . .	2
1.3	Loads on Structures . . . . .	4
1.4	Structural Systems . . . . .	7
1.5	Analysis and Design . . . . .	9
1.6	Limit States Design . . . . .	10
1.7	The International System of Units . . . . .	16
1.8	Construction Contracts . . . . .	17
1.9	The Construction Process . . . . .	19
1.10	The Role of the Structural Designer . . . . .	22

## *Chapter 2*

## *STRUCTURAL STEEL*

2.1	Composition and Manufacture . . . . .	27
2.2	Strength and Ductility . . . . .	30
2.3	Cross-Section Properties . . . . .	32
2.4	Other Properties . . . . .	33
2.5	Types of Structural Steel . . . . .	35
2.6	Structural Steel Material Standards . . . . .	36
2.7	Structural Steel Products . . . . .	37

## *Chapter 3*

## *TENSION MEMBERS*

3.1	Introduction . . . . .	41
3.2	Tension Member Resistance . . . . .	43
3.3	Shear Lag . . . . .	45
3.4	Block Shear Failure . . . . .	48
3.5	Design Requirements . . . . .	49
3.6	Calculation of Effective Area of Tension Members . . . . .	51
3.7	Design Examples . . . . .	55
3.8	Eyebars and Cables . . . . .	62

## **Chapter 4**

## **COMPRESSION MEMBERS**

4.1	Introduction . . . . .	67
4.2	Strength of Steel Columns . . . . .	69
4.3	Behaviour of Cross-Section . . . . .	70
4.4	Behaviour of Columns . . . . .	72
4.5	Behaviour of Actual Columns . . . . .	80
4.6	Design of Columns . . . . .	82
4.7	Resistance Factor for Columns . . . . .	83
4.8	Design Examples . . . . .	84
4.9	Effective Length Concept . . . . .	95
4.10	Effect of Rotational Restraint on Column Strength . . . . .	96
4.11	Design Examples. . . . .	102
4.12	Summary: Effective Length Concept . . . . .	106

## **Chapter 5**

## **BEAMS**

5.1	Introduction . . . . .	109
5.2	Moment vs. Curvature Relationships for Beams . . . . .	110
5.3	Load vs. Deflection Relationships for Beams . . . . .	112
5.4	Flange Local Buckling and its Consequences . . . . .	113
5.5	Web Buckling and Slenderness Limits . . . . .	117
5.6	Resistance Factor – Laterally Supported Members . . . . .	118
5.7	Design Examples . . . . .	119
5.8	The Effect of Shear on Beam Strength . . . . .	123
5.9	Limitations on Deflection . . . . .	124
5.10	Laterally Unbraced Beams . . . . .	127
5.11	Resistance Factor – Laterally Unsupported Beams . . . . .	133
5.12	Concentrated Loads and Reactions . . . . .	140
5.13	Beams Subjected to Combined Bending and Torsion. . . . .	142
5.14	Special Topics in Beam Design . . . . .	151
5.15	Beams in Plastically Designed Structures . . . . .	152

## **Chapter 6**

## **COMPOSITE DESIGN**

6.1	Introduction . . . . .	155
6.2	Effective Area of Concrete . . . . .	156
6.3	Influence of Construction Method . . . . .	157
6.4	Strength Calculations . . . . .	158

6.5	Shear Connectors . . . . .	164
6.6	Partial Shear Connection . . . . .	170
6.7	Use of Formed Metal Deck . . . . .	174
6.8	Behaviour Under Negative Moment . . . . .	175
6.9	Deflections. . . . .	176
6.10	Shear Strength of Longitudinal Planes . . . . .	182
6.11	Other Composite Floor Members . . . . .	184

**Chapter 7**

**PLATE GIRDERS**

7.1	Introduction . . . . .	189
7.2	Preliminary Proportioning . . . . .	190
7.3	Design of Cross-Section for Bending . . . . .	192
7.4	Design of Cross-Section for Shear. . . . .	197
7.5	Stiffener Requirements . . . . .	203
7.6	Combined Shear and Moment. . . . .	207
7.7	Application of Concentrated Loads . . . . .	209
7.8	Design Example . . . . .	210

**Chapter 8**

**BEAM-COLUMNS**

8.1	Introduction . . . . .	221
8.2	Stability of Members and Frames . . . . .	222
8.3	Methods of Frame Analysis . . . . .	228
8.4	Design of Beam-Columns . . . . .	247
8.5	Summary: Axial Compression and Bending . . . . .	284
8.6	Axial Tension and Bending . . . . .	284

**Chapter 9**

**CONNECTIONS**

9.1	Introduction . . . . .	287
9.2	Rivets . . . . .	287
9.3	Bolts . . . . .	287
9.4	Welds . . . . .	292
9.5	Load Transfer Mechanisms . . . . .	299
9.6	Use of Pretensioned Bolts . . . . .	304
9.7	Fastener Resistance — Bolts . . . . .	304
9.8	Fastener Resistance — Welds . . . . .	308
9.9	Analysis and Design of Simple Connections . . . . .	309

9.10	Eccentrically Loaded Connections . . . . .	319
9.11	Connections Carrying Shear, Thrust, and Moment . . . . .	321
9.12	Beam Bearing Plates, Column Base Plates . . . . .	333

**Chapter 10**

**BUILDING DESIGN**

10.1	Introduction . . . . .	340
10.2	Loads . . . . .	344
10.3	Design of Roof System . . . . .	347
10.4	Design of Interior Columns . . . . .	351
10.5	Design of Wall System . . . . .	354
10.6	Design of Exterior Columns. . . . .	357
10.7	Roof Diaphragm Considerations . . . . .	362
10.8	Frame Stability Considerations . . . . .	366
10.9	Summary. . . . .	370

**Chapter 11**

**FATIGUE**

11.1	Introduction . . . . .	373
11.2	Sources of Flaws in Fabricated Steel Structures . . . . .	374
11.3	Basis for Design Rules. . . . .	375
11.4	Design Rules Given by Standards . . . . .	376
11.5	Fatigue Assessment for Variable Stress Ranges . . . . .	381
11.6	Fatigue Crack Growth Under Combined Stresses . . . . .	387
11.7	Fatigue Cracking from Out-of-Plane Effects . . . . .	388

<b>Appendix A</b> . . . . .	395
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<b>Index</b> . . . . .	399
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## FOREWORD

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For many years the CISC has supported the educational efforts of Canadian universities and other educational institutions by providing research grants, scholarships, films, slides, video tapes, computer programs, Handbooks, and other literature. As part of this continuing interest in education, the CISC is pleased to publish this textbook.

The Canadian Institute of Steel Construction does not assume responsibility for the contents of this book, nor for errors or oversights resulting from use of the information contained herein. All suggestions for improvement of this book will be forwarded to the authors for their consideration for future printings.

CISC is located at 3760 14th Avenue, Suite 200, Markham, Ontario, L3R 3T7. Contact can also be made as follows; telephone 905-946-0864, facsimile 905-946-8574, electronic mail *info@cisc-icca.ca*. A web site is also available: *www.cisc-icca.ca*.



Recommendations for the Plastic Design of Steel Structures. • Limit-state design: Recommendations for Limit State Design of Steel Structures. Recommendations that address a structural type. • Recommended Provisions for. First, design requirements are specified for limit states. Limit states are conditions beyond which functionality of the structural system or member cannot be maintained or fundamental assumptions are invalid. Second, design loads and member strengths are determined based on a probabilistic approach. There are two fundamental limit states: the "strength limit state" which addresses structural safety under extreme loading conditions; and "serviceability limit state" which address-

1 Steel Construction Today & Tomorrow December 2017.