

8 RECOMMENDED DESIGN MODEL—SUMMARY OF DESIGN CHECKS

Summary of checks—End plate, welds, bolts

- 9.1 DESIGN CHECK NO. 1 — Detailing requirements
- 9.2 DESIGN CHECK NO. 2 — Design capacity of flange welds to beam
- 9.3 DESIGN CHECK NO. 3 — Design capacity of web welds to beam
- 9.4 DESIGN CHECK NO. 4 — Design capacity of bolts at tension flange
- 9.5 DESIGN CHECK NO. 5 — Design capacity of bolts in shear
- 9.6 DESIGN CHECK NO. 6 — Design capacity of end plate at tension flange
- 9.7 DESIGN CHECK NO. 7 — Design capacity of end plate in shear
- 9.8 DESIGN CHECK NO. 8 — Design requirements for stiffener to end plate
- 9.9 DESIGN CHECK NO. 9 — Design capacity of stiffener welds to end plate

Summary of checks—Unstiffened column

- 10.1 DESIGN CHECK NO. 10 — Local bending of column flange at beam tension flange
- 10.2 DESIGN CHECK NO. 11 — Local yielding of column web at beam tension flange
- 10.3 DESIGN CHECK NO. 12 — Local yielding of column web at beam compression flange
- 10.4 DESIGN CHECK NO. 13 — Column web crippling at beam compression flange
- 10.5 DESIGN CHECK NO. 14 — Column web compression buckling
- 10.6 DESIGN CHECK NO. 15 — Column web panel in shear

Summary of checks—Columns with doubler plates

- 11.1 DESIGN CHECK NO. 16 — Local bending of column flange with flange doubler plates at beam tension flange
- 11.2 DESIGN CHECK NO. 17 — Local yielding of column web with doubler plates at beam tension flange
- 11.3 DESIGN CHECK NO. 18 — Local yielding of column web with doubler plates at beam compression flange
- 11.4 DESIGN CHECK NO. 19 — Crippling of column web with doubler plates at beam compression flange
- 11.5 DESIGN CHECK NO. 20 — Compression buckling of column web with doubler plates
- 11.6 DESIGN CHECK NO. 21 — Column web panel with doubler plates in shear

Summary of checks—Columns with transverse stiffeners

- 12.1 DESIGN CHECK NO. 22 — Column with transverse stiffeners at tension flange
- 12.2 DESIGN CHECK NO. 23 — Column with transverse stiffeners at compression flange
- 12.3 DESIGN CHECK NO. 24 — Column with transverse diagonal shear stiffeners



Design Guide 12
Bolted end plate to column moment connections

by

T.J. Hogan

contributing author

N. van der Kreek

first edition—2009



AUSTRALIAN STEEL INSTITUTE
(ABN)/ACN (94) 000 973 839

Design Guide 12
Bolted end plate to column moment connections

Copyright © 2009 by AUSTRALIAN STEEL INSTITUTE

Published by: AUSTRALIAN STEEL INSTITUTE

All rights reserved. This book or any part thereof must not be reproduced in any form without the written permission of Australian Steel Institute.

Note to commercial software developers: Copyright of the information contained within this publication is held by Australian Steel Institute (ASI). Written permission must be obtained from ASI for the use of any information contained herein which is subsequently used in any commercially available software package.

FIRST EDITION 2009 (LIMIT STATES)

National Library of Australia Cataloguing-in-Publication entry:

Hogan, T.J.

Design Guide 12: Bolted end plate to column moment connections

1st ed.

Bibliography.

ISBN 978 1 921476 14 3 (pbk.).

ISBN 978 1 921476 15 0 (pdf.).

1. Steel, Structural—Standards—Australia.
2. Steel, Structural—Specifications—Australia.
3. Joints, (Engineering)—Design and construction.
 - I. van der Kreek, N.
 - II. Australian Steel Institute.
 - III. Title

(Series: Structural steel connection series).

This publication originated as part of
Design of structural connections
First edition 1978
Second edition 1981
Third edition 1988
Fourth edition 1994

Also in this series:

Handbook 1: Design of structural steel connections

Design Guide 1: Bolting in structural steel connections

Design Guide 2: Welding in structural steel connections

Design Guide 3: Web side plate connections

Design Guide 4: Flexible end plate connections

Design Guide 5: Angle cleat connections

Design Guide 6: Seated connections

Design Guide 10: Bolted end plate beam splice connections

Design Guide 11: Welded beam to column moment connections

Disclaimer: The information presented by the Australian Steel Institute in this publication has been prepared for general information only and does not in any way constitute recommendations or professional advice. While every effort has been made and all reasonable care taken to ensure the accuracy of the information contained in this publication, this information should not be used or relied upon for any specific application without investigation and verification as to its accuracy, suitability and applicability by a competent professional person in this regard. The Australian Steel Institute, its officers and employees and the authors of this publication do not give any warranties or make any representations in relation to the information provided herein and to the extent permitted by law (a) will not be held liable or responsible in any way; and (b) expressly disclaim any liability or responsibility for any loss or damage costs or expenses incurred in connection with this publication by any person, whether that person is the purchaser of this publication or not. Without limitation, this includes loss, damage, costs and expenses incurred as a result of the negligence of the authors or publishers.

The information in this publication should not be relied upon as a substitute for independent due diligence, professional or legal advice and in this regards the services of a competent professional person or persons should be sought.



CONTENTS

	<i>Page</i>		<i>Page</i>
List of figures	iv	10.5 DESIGN CHECK NO. 14—Column web compression buckling	49
List of tables	vi	10.6 DESIGN CHECK NO. 15—Column web panel in shear	50
Preface	vii	11 RECOMMENDED DESIGN MODEL—COLUMNS WITH DOUBLER PLATES.....	51
About the author	viii	11.1 DESIGN CHECK NO. 16—Local bending of column flange with flange doubler plates at beam tension flange	51
About the contributing author	viii	11.2 DESIGN CHECK NO. 17—Local yielding of column web with doubler plate(s) at beam tension flange	52
Acknowledgements	ix	11.3 DESIGN CHECK NO. 18—Local yielding of column web with doubler plate(s) at beam compression flange	54
1 CONCEPT OF DESIGN GUIDES.....	1	11.4 DESIGN CHECK NO. 19—Crippling of column web with doubler plate(s) at beam compression flange	55
1.1 Background	1	11.5 DESIGN CHECK NO. 20—Compression buckling of column web with doubler plate(s)	57
2 DESCRIPTION OF CONNECTION	2	11.6 DESIGN CHECK NO. 21—Column web panel with doubler plate(s) in shear	59
3 TYPICAL DETAILING OF CONNECTION ..	5	12 RECOMMENDED DESIGN MODEL—COLUMNS WITH TRANSVERSE STIFFENERS.....	61
4 DETAILING CONSIDERATIONS.....	9	12.1 DESIGN CHECK NO. 22—Column with transverse stiffeners at tension flange	61
5 AS 4100 REQUIREMENTS	12	12.2 DESIGN CHECK NO. 23—Column with transverse stiffeners at compression flange	65
6 BASIS OF DESIGN MODEL.....	13	12.3 DESIGN CHECK NO. 24—Column with transverse diagonal shear stiffeners	67
7 CALCULATION OF DESIGN ACTIONS ...	15	13 ADDITIONAL CONSIDERATIONS	69
8 RECOMMENDED DESIGN MODEL—SUMMARY OF DESIGN CHECKS.....	21	14 ECONOMICAL CONSIDERATIONS	70
9 RECOMMENDED DESIGN MODEL.....	26	15 DESIGN EXAMPLE.....	71
9.1 DESIGN CHECK NO. 1—Detailing requirements	26	15.1 Design example—Four bolt unstiffened end plate to column connection	71
9.2 DESIGN CHECK NO. 2—Design capacity of flange welds to beam	28	16 REFERENCES.....	79
9.3 DESIGN CHECK NO. 3—Design capacity of web welds to beam	29	17 DESIGN CAPACITY TABLES	80
9.4 DESIGN CHECK NO. 4—Design capacity of bolts at tension flange	31	17.1 Four bolt unstiffened end plate	81
9.5 DESIGN CHECK NO. 5—Design capacity of bolts in shear	33	17.2 Four bolt stiffened end plate	85
9.6 DESIGN CHECK NO. 6—Design capacity of end plate at tension flange	34	17.3 Six bolt unstiffened end plate	87
9.7 DESIGN CHECK NO. 7—Design capacity of end plate in shear	38	17.4 Eight bolt stiffened end plate	89
9.8 DESIGN CHECK NO. 8—Design requirements for stiffener to end plate	39	APPENDICES	
9.9 DESIGN CHECK NO. 9—Design capacity of stiffener welds to end plate	40	A Thick and thin end plate behaviour	90
10 RECOMMENDED DESIGN MODEL—UNSTIFFENED COLUMN	41	B Limcon software	92
10.1 DESIGN CHECK NO. 10—Local bending of column flange at beam tension flange	41	C ASI Design Guide 12 comment form	97
10.2 DESIGN CHECK NO. 11—Local yielding of column web at beam tension flange	44		
10.3 DESIGN CHECK NO. 12—Local yielding of column web at beam compression flange	45		
10.4 DESIGN CHECK NO. 13—Column web crippling at beam compression flange	47		



LIST OF FIGURES

	<i>Page</i>	<i>Page</i>	
Figure 1	Bolted end plate to column moment connections 2	Figure 24	Clearance dimensions a_f and s_{po} ...27
Figure 2	Forms of extended end plate connection 3	Figure 25	End plate stiffener detailing27
Figure 3	Possible configurations of the bolted moment end plate beam to column connection..... 4	Figure 26	Flange weld design actions28
Figure 4A	Typical detailing for 4 bolt unstiffened bolted end plate to column connection..... 5	Figure 27	Web weld design actions.....30
Figure 4B	Typical detailing for haunched rafter to column bolted end plate connection 6	Figure 28	Yield line pattern 4 bolt (2/2) unstiffened end plate34
Figure 5	Removal of column flange with thicker plate inserted 6	Figure 29	Yield line pattern 4 bolt (2/2) stiffened end plate35
Figure 6	Column doubler plate types 7	Figure 30	Yield line pattern 6 bolt (2/4) unstiffened end plate36
Figure 7	Column transverse stiffener types .. 8	Figure 31	Yield line pattern 8 bolt (2/6) unstiffened end plate36
Figure 8	Shims used between end plate and column flange 9	Figure 32	Yield line pattern 8 bolt (4/4) stiffened end plate37
Figure 9	Stiffener detailing..... 10	Figure 33	Yield line pattern 4 bolt (2/2) end plate to unstiffened column flange41
Figure 10	Clearance required for tensioning bolts 11	Figure 34	Yield line pattern 2/4(6) bolt end plate to unstiffened column flange42
Figure 11	Design actions on beam at column..... 15	Figure 35	Yield line pattern 2/6(8) bolt end plate to unstiffened column flange42
Figure 12	Calculation of flange forces due to bending moment and axial force—horizontal beam..... 16	Figure 36	Yield line pattern 4/4(8) bolt end plate to unstiffened column flange43
Figure 13	Calculation of force components where beam is inclined to column in upwards direction..... 17	Figure 37	Flange removed with new plate inserted43
Figure 14	Calculation of force components where beam is inclined to column in downwards direction 18	Figure 38	Application of c_t term—Column web yielding at beam tension flange44
Figure 15	Alternative stress distributions in beam..... 19	Figure 39	Application of c_t term—Column web yielding at beam compression flange45
Figure 16	Notation used for 4 bolt (2/2) unstiffened end plate 22	Figure 40	Angle of dispersion used in DESIGN CHECK NO. 1246
Figure 17	Notation used for 4 bolt (2/2) stiffened end plate 22	Figure 41	Dispersion arrangement used in DESIGN CHECK NO. 1446
Figure 18	Notation used for 8 bolt (4/4) stiffened end plate 22	Figure 42	Case I arrangement.....47
Figure 19	Notation used for 6 bolt (2/4) unstiffened end plate 23	Figure 43	Case II and case III arrangement ..47
Figure 20	Notation used for 8 bolt (2/6) unstiffened end plate 23	Figure 44	Examples of web panel shear conditions50
Figure 21	Summary of design check locations on column..... 24	Figure 45	Column flange doubler plate details at beam tension flange.....51
Figure 22	Column and beam dimensions used in design model..... 25	Figure 46	Column web doubler plate details at beam tension flange.....53
Figure 23	Stiff bearing dimension b_{sc} used in design model 25	Figure 47	Column web doubler plate details at beam compression flange53
		Figure 48	Web doubler plate—Welds to column flange53
		Figure 49	Case I arrangement.....55



	<i>Page</i>		<i>Page</i>
Figure 50	55	Figure 60	68
Figure 51	56	Figure 61	69
Figure 52	58	Figure 62	71
Figure 53	59	Figure 63	72
Figure 54	62	Figure 64	77
Figure 55	63	Figure 65	77
Figure 56	63	Figure 66	78
Figure 57	64	Figure 67	90
Figure 58	64		
Figure 59	65		



LIST OF TABLES

		<i>Page</i>			<i>Page</i>
Table 1	Range of tested parameters	14	Table 11	Design moment capacity of connection ϕM_{conn} —Four bolt stiffened end plate—M24 bolts 8.8/TB category threads included in shear plane—Unhaunched welded beam/universal beam sections > 300 mm deep	85
Table 2	Equations to be applied for different configurations and connection elements.....	20	Table 12	Design moment capacity of connection ϕM_{conn} —Four bolt stiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Unhaunched universal beam sections > 200 mm deep	86
Table 3	Recommended limits on parameters	26	Table 13	Design moment capacity of connection ϕM_{conn} —Six bolt unstiffened end plate—M24 bolts 8.8/TB category threads included in shear plane—Unhaunched welded beam/universal beam sections > 450 mm deep	87
Table 4	Strength of plate to AS 3678—Grade 250	35	Table 14	Design moment capacity of connection ϕM_{conn} —Six bolt unstiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Unhaunched universal beam sections > 350 mm deep	88
Table 5	Strength of flat bars to AS 3679.1—Grade 300	39	Table 15	Design moment capacity of connection ϕM_{conn} —Eight bolt stiffened end plate—M24 bolts 8.8/TB Category threads included in shear plane—Unhaunched welded beam and universal beam sections > 520 mm deep	89
Table 6	Stiffener material strengths.....	62			
Table 7	Design moment capacity of connection ϕM_{conn} —Four bolt unstiffened end plate—M24 bolts 8.8/TB category threads included in shear plane—Unhaunched welded beam/universal beam sections > 300 mm deep	81			
Table 8	Design moment capacity of connection ϕM_{conn} —Four bolt unstiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Unhaunched universal beam sections > 200 mm deep	82			
Table 9	Design moment capacity of connection ϕM_{conn} —Four bolt unstiffened end plate—M24 bolts 8.8/TB category threads included in shear plane—Haunched universal beam sections > 300 mm deep	83			
Table 10	Design moment capacity of connection ϕM_{conn} —Four bolt unstiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Haunched universal beam sections > 200 mm deep	84			

