

## 6 BOLTED END PLATE TO COLUMN MOMENT CONNECTION

### 6.5 Design capacity tables

The following Design Capacity Tables are provided, derived using DESIGN CHECK NOS 1 TO 9 inclusive

Column stiffening requirements must be separately assessed using DESIGN CHECK NOS 10 to 15 inclusive.

Design of column stiffeners can be carried out using DESIGN CHECK NOS 16 to 24 inclusive.

#### 6.6 Four bolt unstiffened end plate

Table 28 Design moment capacity of connection  $\phi M_{conn}$   
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

Table 29 Design moment capacity of connection  $\phi M_{conn}$   
Four bolt unstiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Unhaunched universal beam sections > 200 mm deep

Table 30 Design moment capacity of connection  $\phi M_{conn}$   
Four bolt unstiffened end plate—M24 bolts 8.8/TB category threads included in shear plane—Haunched universal beam sections > 300 mm deep

Table 31 Design moment capacity of connection  $\phi M_{conn}$   
Four bolt unstiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Haunched universal beam sections > 200 mm deep

#### 6.7 Four bolt stiffened end plate

Table 32 Design moment capacity of connection  $\phi M_{conn}$   
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

Table 33 Design moment capacity of connection  $\phi M_{conn}$   
Four bolt stiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Unhaunched universal beam sections > 200 mm deep

#### 6.8 Six bolt unstiffened end plate

Table 34 Design moment capacity of connection  $\phi M_{conn}$   
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

Table 35 Design moment capacity of connection  $\phi M_{conn}$   
Six bolt unstiffened end plate—M20 bolts 8.8/TB category threads included in shear plane—Unhaunched universal beam sections > 350 mm deep

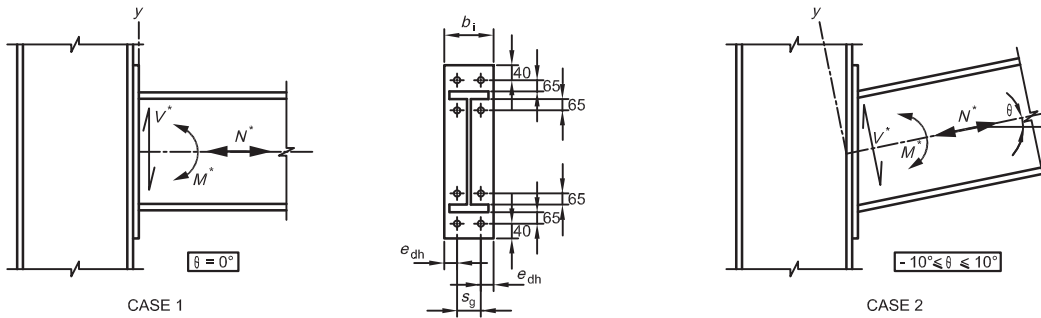
#### 6.9 Eight bolt stiffened end plate

Table 36 Design moment capacity of connection  $\phi M_{conn}$   
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



TABLE 28

**DESIGN MOMENT CAPACITY OF CONNECTION  $\phi M_{conn}$   
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  
(TABLE DEVELOPED USING THICK PLATE THEORY)**



Section, Grade 300	$\phi M_s$ kNm	Welds		Grade 250 plate			CASE 1		CASE 2 $\theta \neq 0, N^* \neq 0$		
		Flange	Web	Width $b_1$	Thickness $t_f$	Gauge $s_g$	Max $V^*$ (plus or minus) kN	$\theta=0, N^*=0$ $\phi M_{conn}$ kNm	Max $V^*$ (plus or minus) kN	Max $N^*$ (Tens or Comp) kN	$\phi M_{conn}$ Refer Note kNm
700WB130	1210	FPBW	8	270	28	170	532	636	165	224	557*
700WB115	1020	FPBW	8	270	28	170	532	632	165	197	563
610UB125	927	FPBW	8	250	28	170	399	554	177	201	492
610UB113	829	FPBW	8	250	28	170	343	551	165	182	495
610UB101	782	FPBW	8	250	28	170	222	549	165	175	495
530UB92.4	640	FPBW	10	230	28	150	531	484	140	159	441
530UB82.0	558	FPBW	10	230	28	150	525	481	131	142	444
460UB82.1	496	FPBW	10	220	28	140	472	415	118	141	383
460UB74.6	449	FPBW	10	220	28	140	431	414	108	128	385
460UB67.1	399	FPBW	8	220	28	140	400	399	100	116	386
410UB59.7	324	FPBW	8	220	28	140	328	324	328	103	324
410UB53.7	304	FPBW	8	220	28	140	317	304	317	99.0	304
360UB56.7	273	FPBW	8	220	28	140	297	273	297	98.0	273
360UB50.7	242	FPBW	8	220	25	140	269	242	269	87.5	242
360UB44.7	222	FPBW	8	220	25	140	251	222	252	82.5	222
310UB46.2	197	FPBW	6	220	25	140	213	197	213	80.0	197
310UB40.4	182	FPBW	6	220	25	140	191	182	192	75.0	182

NOTES:

$\phi M_s$  = design section moment capacity,  $\phi M_{conn}$  = design moment capacity of connection.

\* indicates  $\phi M_{conn}$  is less than recommended minimum of 0.5 ( $\phi M_s$ ).

Case 1 applies to straight flexural member splices (i.e.  $\theta=0$ ) with no axial force ( $N^*=0$ ).

Case 2 applies to connections where  $\theta$  is within the range  $-10$  to  $10$  degrees, and design axial force ( $N^*$ ) does not exceed the value tabulated (approx 5% of design section capacity). Axial/moment combination to be checked separately, for the beam section.

Minimum design shear force ( $V^*$ ) is the **MAXIMUM** of  $0.15\phi V_v$  (design shear capacity) and 40 kN.

Maximum  $V^*$  limited to  $0.6\phi V_v$  to ensure  $M^*, V^*$  combination is satisfied for the beam section.

Welds: E48XX/W50X electrodes assumed.

Fillet weld size given is minimum required, a larger size or FPBW may be used.

FPBW = full penetration butt weld. All welds Category SP.

Horizontal edge distance  $e_{dh} = (b_1 - s_g) / 2$ ; different for each section size but always  $\geq 36$  mm.



**Design capacity tables for structural steel**  
**Volume 4: Rigid connections—Open sections**

**by**

**T.J. Hogan**

**contributing author**

**N. van der Kreek**

**first edition—2009**



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

**Design capacity tables for structural steel**  
**Volume 4: Rigid connections—Open sections**

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 capacity tables for structural steel. Volume 4: Rigid connections—Open sections

1<sup>st</sup> ed.

Bibliography.

ISBN 978 1 921476 18 1 (pbk.).

ISBN 978 1 921476 19 8 (pdf.).

This publication originated as part of  
Design of structural connections

First edition 1978

Second edition 1981

Third edition 1988

Fourth edition 1994

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).

Also in this series:

Design Capacity Tables for Structural Steel Volume 3: Simple connections—Open sections

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

Design Guide 12: Bolted end plate to column moment connections

Design Guide 13: Splice 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	5.5 Design capacity tables	50
List of tables	v	5.6 Four bolt unstiffened end plate— Design capacity tables	51
Preface	vii	5.7 Four bolt stiffened end plate— Design capacity tables	53
About the author	viii	5.8 Six bolt unstiffened end plate— Design capacity tables	55
About the contributing author	viii	5.9 Eight bolt stiffened end plate— Design capacity tables	57
Acknowledgements	ix		
<b>1 CONCEPT OF DESIGN GUIDES.....</b>	<b>1</b>	<b>6 BOLTED END PLATE TO COLUMN MOMENT CONNECTION .....</b>	<b>58</b>
1.1 Background	1	6.1 Description of connection	58
1.2 Preliminary considerations	2	6.2 Typical detailing of connection	61
1.3 Included connections	3	6.3 Calculation of design actions	66
<b>2 GEOMETRICAL DETAILS.....</b>	<b>9</b>	6.4 Recommended design model— Summary of design checks	67
2.1 Standard parameters	9	6.5 Design capacity tables	68
2.2 Connection components— Bolted moment end plate	10	6.6 Four bolt unstiffened end plate	69
2.3 Connection components— Column stiffeners	12	6.7 Four bolt stiffened end plate	73
2.4 Bolt gauges to columns for bolted moment end plate connection	15	6.8 Six bolt unstiffened end plate	75
2.5 Flange cover plates for splices	16	6.9 Eight bolt stiffened end plate	77
2.6 Bolting layout to webs for bolted web splices	20	<b>7 BOLTED COVER PLATE SPLICE .....</b>	<b>78</b>
2.7 Web cover plate components for bolted splices	22	7.1 Description of connection	78
<b>3 DESIGN BASIS .....</b>	<b>23</b>	7.2 Typical detailing of connection	79
3.1 Design models	23	7.3 Calculation of design actions	82
3.2 Minimum design actions on connections	24	7.4 Recommended design model— Summary of design checks	83
<b>4 WELDED BEAM TO COLUMN MOMENT CONNECTION .....</b>	<b>28</b>	7.5 Design capacity tables	84
4.1 Description of connection	28	<b>8 BOLTED/WELDED COVER PLATE SPLICE .....</b>	<b>90</b>
4.2 Typical detailing of connection	31	8.1 Description of connection	90
4.3 Calculation of design actions	33	8.2 Typical detailing of connection	91
4.4 Recommended Design Model— Summary of design checks	34	8.3 Calculation of design actions	94
4.5 Design capacity tables	35	8.4 Recommended design model— Summary of design checks	95
4.6 Configuration A—Full penetration butt welds to flanges and webs	36	8.5 Design capacity tables	96
4.7 Configuration B—Fillet welds required to develop section moment capacity	38	<b>9 FULLY WELDED SPLICE .....</b>	<b>102</b>
4.8 Configuration C—Fillet welds to flanges and web	40	9.1 Description of connection	102
<b>5 BOLTED MOMENT END PLATE BEAM SPLICE CONNECTION.....</b>	<b>42</b>	9.2 Typical detailing of connection	103
5.1 Description of connection	42	9.3 Calculation of design actions	105
5.2 Typical detailing of connection	44	9.4 Recommended design model— Summary of design checks	106
5.3 Calculation of design actions	48	9.5 Design capacity tables	107
5.4 Recommended design model— Summary of design checks	49	<b>10 REFERENCES.....</b>	<b>110</b>
		<b>APPENDIX</b>	
		A Rigid connections DCTs, V4 comment form	111



## LIST OF FIGURES

	<i>Page</i>		<i>Page</i>		
Figure 1	Typical detailing for unstiffened variations of extended bolted moment end plate.....	4	Figure 25	Shims used between end plates....	46
Figure 2	Typical welded beam to column moment connection .....	4	Figure 26	Clearance required for tensioning bolts .....	47
Figure 3	Typical detailing for 4 bolt unstiffened bolted end plate to column connection.....	5	Figure 27	Design actions at connection.....	48
Figure 4	Typical detailing of bolted cover plate splice.....	6	Figure 28	Bolted end plate to column moment connections .....	58
Figure 5	Typical detailing of bolted/welded cover plate splice.....	7	Figure 29	Forms of extended end plate connection.....	59
Figure 6	Typical detailing of welded splice ...	8	Figure 30	Possible configurations of the bolted moment end plate beam to column connection.....	60
Figure 7	Bolting layouts for M24 bolts in bolted moment endplate .....	11	Figure 31	Typical detailing for 4 bolt unstiffened bolted end plate to column connection .....	61
Figure 8	Bolting layouts for M20 bolts in bolted moment endplate .....	11	Figure 32	Typical detailing for haunched rafter to column bolted end plate connection .....	62
Figure 9	Transverse stiffener arrangement .....	12	Figure 33	Removal of column flange with thicker plate inserted .....	62
Figure 10	Geometry of flange splice plates ..	16	Figure 34	Column doubler plate types.....	63
Figure 11	Web splice bolting layout M20 bolts.....	20	Figure 35	Shims used between end plate and column flange .....	64
Figure 12	Web splice bolting layout M24 bolts.....	21	Figure 36	Clearance required for tensioning bolts .....	65
Figure 13	Web cover plate components .....	22	Figure 37	Design actions on beam at column.....	66
Figure 14	Typical welded beam to column moment connection .....	28	Figure 38	Bolted cover plate splice .....	78
Figure 15	Alternative arrangements for welded beam to column connections .....	29	Figure 39	Typical detailing in flexural member .....	79
Figure 16	Arrangement with shop welded beams and column splices .....	29	Figure 40	Typical detailing in column/beam-column.....	80
Figure 17	Possible configurations of the welded moment beam to column connection.....	30	Figure 41	Typical detailing in tension member .....	80
Figure 18	Stub girder connection, fully shop welded beam stub, beam spliced on site.....	31	Figure 42	Design actions at splice.....	82
Figure 19	Field welded moment connection—including erection cleat.....	31	Figure 43	Bolted/welded cover plate splice .....	90
Figure 20	Design actions on beam at column.....	33	Figure 44	Typical detailing in flexural member .....	91
Figure 21	Bolted moment end plate beam splice connection .....	42	Figure 45	Typical detailing in column/beam column.....	92
Figure 22	Forms of extended bolted end plate connection .....	43	Figure 46	Typical detailing in tension member .....	92
Figure 23	Typical detailing for unstiffened variations of extended bolted moment end plate.....	44	Figure 47	Design actions at splice.....	94
Figure 24	Typical detailing for stiffened variations of extended bolted moment end plate.....	45	Figure 48	Fully welded splice .....	102
			Figure 49	Typical detailing of welded splice .....	103
			Figure 50	Use of backing strips .....	104
			Figure 51	Preferred splice location in column.....	104
			Figure 52	Design actions at splice.....	105



## LIST OF TABLES

		<i>Page</i>			<i>Page</i>
Table 1	Connection components bolted moment end plate .....	10	Table 20	Universal beams grade 300 design moment capacity of welded connection with flange welds and web welds.....	41
Table 2	Stiffener material design strengths.....	12	Table 21	Design moment capacity of connection $\phi M_{\text{conn}}$ four bolt unstiffened end plate M24 bolts welded beam/universal beam sections > 300 mm deep .....	51
Table 3	Flat bar components as stiffeners.....	13	Table 22	Design moment capacity of connection $\phi M_{\text{conn}}$ four bolt unstiffened end plate M20 bolts universal beam sections > 200 mm deep .....	52
Table 4	Flat bar width/column combinations suited to stiffening...	14	Table 23	Design moment capacity of connection $\phi M_{\text{conn}}$ four bolt stiffened end plate M24 bolts welded beam/universal beam sections > 300 mm deep .....	53
Table 5	Plate width/column combinations suited to stiffening .....	14	Table 24	Design moment capacity of connection $\phi M_{\text{conn}}$ four bolt stiffened end plate M20 bolts universal beam sections > 200 mm deep .....	54
Table 6	Suitable bolt gauges for column section flanges .....	15	Table 25	Design moment capacity of connection $\phi M_{\text{conn}}$ six bolt unstiffened end plate M24 bolts welded beam/universal beam sections > 450 mm deep .....	55
Table 7	Flange cover plate width/thickness combinations for one plate bolted cover plate splice .....	17	Table 26	Design moment capacity of connection $\phi M_{\text{conn}}$ six bolt unstiffened end plate M20 bolts universal beam sections > 350 mm deep .....	56
Table 8	Flange cover plate width/thickness combinations for one plate bolted/welded cover plate splice.....	17	Table 27	Design moment capacity of connection $\phi M_{\text{conn}}$ eight bolt stiffened end plate M24 bolts 8.8/TB category threads excluded from shear plane welded beam and universal beam sections > 520 mm deep .....	57
Table 9	Flange cover plate width/thickness combinations for three plate bolted cover plate splice .....	18	Table 28	Design moment capacity of connection $\phi M_{\text{conn}}$ four bolt unstiffened end plate M24 bolts unhaunched welded beam/universal beam sections > 300 mm deep .....	69
Table 10	Flange cover plate width/thickness combinations for three plate bolted/welded cover plate splice.....	19	Table 29	Design moment capacity of connection $\phi M_{\text{conn}}$ four bolt unstiffened end plate M20 bolts unhaunched universal beam sections > 200 mm deep .....	70
Table 11	Values of $n_{\text{max}}$ in web splice .....	20			
Table 12	Values of $n_{\text{max}}$ in web splice.....	21			
Table 13	Universal beams, Grade 300 design section moment and web capacities .....	26			
Table 14	Welded beams, Grade 300 design section moment and web capacities .....	27			
Table 15	Universal beams Grade 300 design section moment and web capacities .....	36			
Table 16	Welded beams Grade 300 design section moment and web capacities .....	37			
Table 17	Universal beams Grade 300 weld configurations to achieve design section moment capacity $\phi M_s$ .....	38			
Table 18	Welded beams Grade 300 weld configurations to achieve design section moment capacity $\phi M_s$ .....	39			
Table 19	Universal beams Grade 300 design moment capacity of welded connection with flange welds and web welds.....	40			



	<i>Page</i>		<i>Page</i>
Table 30		Table 40	
Design moment capacity of connection $\phi M_{conn}$ four bolt unstiffened end plate M24 bolts haunched universal beam sections > 300 mm deep .....	71	Design moment capacity of bolted three cover plate splice 700WB/800WB welded beam sections M24 bolts.....	88
Table 31		Table 41	
Design moment capacity of connection $\phi M_{conn}$ four bolt unstiffened end plate M20 bolts haunched universal beam sections > 200 mm deep .....	72	Design moment capacity of bolted three cover plate splice 900WB/1000WB welded beam sections M24 bolts.....	89
Table 32		Table 42	
Design moment capacity of connection $\phi M_{conn}$ four bolt stiffened end plate M24 bolts unhaunched welded beam/universal beam sections > 300 mm deep.....	73	Design moment capacity of bolted/welded single cover plate splice universal beam sections < 400 deep M20 bolts, 6 fillets to flange plates, 5 fillets to web plates.....	97
Table 33		Table 43	
Design moment capacity of connection $\phi M_{conn}$ four bolt stiffened end plate M20 bolts unhaunched universal beam sections > 200 mm deep .....	74	Design moment capacity of bolted/welded single cover plate splice universal beam sections > 400 deep M24 bolts, 8 or 6 fillets to flange plates, 5 fillets to web plates .....	98
Table 34		Table 44	
Design moment capacity of connection $\phi M_{conn}$ six bolt unstiffened end plate M24 bolts unhaunched welded beam/universal beam sections > 450 mm deep .....	75	Design moment capacity of bolted/welded three cover plate splice universal column sections M24 bolts, 6/8 fillets to flange plates and web plates and 6 fillets to web plates .....	99
Table 35		Table 45	
Design moment capacity of connection $\phi M_{conn}$ six bolt unstiffened end plate M20 bolts unhaunched universal beam sections > 350 mm deep .....	76	Design moment capacity of bolted three cover plate splice 700WB/800WB welded beam sections M24 bolts, 6/8 fillets to flange plates and 5 fillets to web plates .....	100
Table 36		Table 46	
Design moment capacity of connection $\phi M_{conn}$ eight bolt stiffened end plate M24 bolts unhaunched welded beam and universal beam sections > 520 mm deep .....	77	Design moment capacity of bolted/welded three cover plate splice 900WB/1000WB welded beam sections M24 bolts, 8 or 6 fillets to flange plates and 6 fillets to web plates..	101
Table 37		Table 47	
Design moment capacity of bolted single cover plate splice universal beam sections < 400 deep M20 bolts .....	85	Universal beams Grade 300 design section moment and shear capacities .....	107
Table 38		Table 48	
Design moment capacity of bolted single cover plate splice universal beam sections > 400 deep M24 bolts .....	86	Welded beams Grade 300 design section moment and shear capacities .....	108
Table 39		Table 49	
Design moment capacity of bolted three cover plate splice universal column sections > 240 deep M24 bolts .....	87	Universal columns/welded columns grade 300 design section moment and shear capacities .....	109

