

## CONTENTS

	<i>Page</i>		<i>Page</i>
List of figures	iv	4.9 Weld group loaded by general set of design actions	67
List of tables	v	4.10 Properties of common fillet weld groups	69
Preface	vi	4.11 Practical fillet weld groups	71
About the author	vii	4.12 Design example No. 4— Design of fillet weld group loaded in-plane	75
About the contributing author and editor	vii	4.13 Design example No. 5— Design of fillet weld group loaded out-of-plane	76
Acknowledgements	viii	5 CONNECTION COMPONENTS.....	77
1 CONCEPT OF DESIGN GUIDES.....	1	5.1 Angle components	77
1.1 Background	1	5.2 Flat bar components	79
2 BACKGROUND DISCUSSION.....	2	5.3 Plate components	80
2.1 General considerations	2	5.4 Design capacities	81
2.2 Forms of construction	3	6 SUPPORTED MEMBERS.....	86
2.3 Connection design models	6	6.1 General	86
2.4 Connection characteristics	7	6.2 Uncoped sections	87
3 BOLTS AND BOLT GROUPS .....	10	6.3 Design example No. 6— UB unholed and holed moment and shear capacity	93
3.1 Bolt types and bolting categories	10	6.4 Single web coped sections	95
3.2 Bolt dimensions	11	6.5 Design example No. 7— UB single web coped moment and shear capacity	101
3.3 Dimensions of wrenches for installing bolts	12	6.6 Double web coped sections	102
3.4 Bolt mechanical properties	14	6.7 Design example No. 8— UB double web coped moment and shear capacity	105
3.5 Design requirements for bolts	15	6.8 Lateral torsional buckling	106
3.6 AS 4100 Design requirements— Strength limit state	17	6.9 Block shear failure of coped sections	107
3.7 AS 4100 design requirements— Serviceability limit state	23	6.10 Web reinforcement of coped supported members	109
3.8 Geometric requirements of AS 4100 for bolted connections	26	7 SUPPORTING MEMBERS.....	110
3.9 Bolt group loaded in-plane	28	7.1 Rationalised dimensions	110
3.10 Design example No. 1— Design of bolts in lap splice connection	39	7.2 Gauge lines	113
3.11 Design example No. 2— Design of bolt group loaded in-plane	41	8 MINIMUM DESIGN ACTIONS ON CONNECTIONS.....	116
3.12 Bolt group loaded out-of-plane	44	8.1 AS 4100 Requirements	116
3.13 Prying action	46	9 REFERENCES.....	118
3.14 Design example No. 3— Design of bolt group loaded out-of-plane	50	APPENDICES	
4 WELDS AND WELD GROUPS.....	52	A Limcon software	120
4.1 Weld types	52	B ASI Handbook 1 comment form	125
4.2 Standard weld symbols	53		
4.3 Selection of prequalified welding consumables	54		
4.4 Weld categories	55		
4.5 Design of butt welds— Strength limit state	56		
4.6 Design of fillet welds— Strength limit state	58		
4.7 Weld group loaded in-plane	62		
4.8 Weld group loaded out-of-plane	66		



## LIST OF FIGURES

		<i>Page</i>			<i>Page</i>
Figure 1	Rigid connections .....	4	Figure 33	Design forces per unit length parallel to weld group axes $x, y, z$ .	61
Figure 2	Simple connections .....	5	Figure 34	Fillet weld subject to longitudinal and transverse shear forces .....	61
Figure 3	Moment rotation characteristics of typical connections .....	7	Figure 35	General fillet weld group.....	63
Figure 4	End plate tear-out failure edge distances .....	16	Figure 36	Horizontal and vertical weld component forces at a point in a weld group .....	65
Figure 5	End plate tear-out failure force components .....	16	Figure 37	Fillet weld group loaded out-of-plane .....	66
Figure 6	End plate tear-out, simple case ....	16	Figure 38	General fillet weld group.....	67
Figure 7	Lap joint and brace/gusset connection .....	21	Figure 39	Possible critical points in particular fillet weld group.....	71
Figure 8	Bolt group subject to in-plane moment .....	28	Figure 40	Fillet weld group loaded in- and out-of-plane .....	72
Figure 9	Bolt group subject to shear forces at centroid .....	29	Figure 41	Two parallel vertical welds loaded out-of-plane .....	72
Figure 10	Bolt group subject to a general load set.....	29	Figure 42	Two parallel horizontal welds loaded out-of-plane .....	74
Figure 11	Graphical relationship—Bolt force to component displacement.....	30	Figure 43	Fillet weld group loaded in-plane...	75
Figure 12	Horizontal and vertical bolt forces at an extreme bolt .....	31	Figure 44	Fillet weld group loaded out-of-plane .....	76
Figure 13	Single bolt column loaded in-plane.....	32	Figure 45	Rectangular connection component geometry.....	81
Figure 14	Single bolt column—Forces and edge distances for end plate tear-out or bearing failure .....	33	Figure 46	Rectangular component design moment capacity—Major axis.....	82
Figure 15	Double bolt column loaded in-plane.....	35	Figure 47	Rectangular component design moment capacity—Minor axis.....	82
Figure 16	Double bolt column—Forces and edge distances for end plate tear-out or bearing failure .....	36	Figure 48	Rectangular component design capacity in axial tension .....	83
Figure 17	Bolted plate splice .....	39	Figure 49	Examples of block shear failure in components .....	84
Figure 18	Bolt group loaded in-plane.....	41	Figure 50	Block shear area in components ...	85
Figure 19	Bolt group loaded out-of-plane— Design actions.....	44	Figure 51	Section with holes in both flanges .	88
Figure 20	Double bolt column geometry .....	45	Figure 52	Section with holes in one flange ....	88
Figure 21	Prying mechanism in T-stub connection .....	46	Figure 53	Section with holes in one flange ....	89
Figure 22	Graphical relationship—Bolt load/applied load for a stiff T-stub flange .....	47	Figure 54	Single web coped (SWC) sections	95
Figure 23	Graphical relationship—Bolt load/applied load for a flexible T-stub flange .....	47	Figure 55	SWC universal beam (UB) .....	95
Figure 24	T-stub critical dimensions and design actions .....	48	Figure 56	T-Section of SWC UB showing elastic neutral axis.....	96
Figure 25	T-stub parameters .....	48	Figure 57	SWC UB T-section with plastic neutral axis in web.....	96
Figure 26	Bolt group loaded out-of-plane ....	50	Figure 58	SWC UB T-section with plastic neutral axis in the flange .....	97
Figure 27	T-stub geometry .....	51	Figure 59	SWC universal beam example ....	101
Figure 28	Weld types.....	52	Figure 60	Double web coped (DWC) sections .....	102
Figure 29	Symbols for welds on drawings ....	53	Figure 61	Elastic neutral axis in DWC section .....	103
Figure 30	Design throat thickness of incomplete penetration butt weld ..	57	Figure 62	DWC universal beam example ....	105
Figure 31	Design throat thickness of fillet welds.....	58	Figure 63	Block shear failure in DWC members .....	107
Figure 32	Design actions on a fillet weld .....	60	Figure 64	Block shear area in SWC and DWC members.....	108
			Figure 65	Web reinforcement of coped supported members.....	109



## LIST OF TABLES

		<i>Page</i>			<i>Page</i>
Table 1	Bolt category identification system.....	10	Table 28	Gauge lines for angles .....	78
Table 2	Dimensions of commercial bolts and nuts .....	11	Table 29	Strengths of angles to AS/NZS 3679.1 Grade 300.....	78
Table 3	Dimensions of high strength structural bolts and nuts .....	11	Table 30	Flats .....	79
Table 4	Dimensions of wrenches for determining erection clearances .....	12,13	Table 31	Strength of plate to AS/NZS 3678 Grade 250 .....	80
Table 5	Metric hexagon commercial bolts .	14	Table 32A	Universal beams, Grade 300—Design section moment and web capacities.....	91
Table 6	High strength structural bolts.....	14	Table 32B	Parallel flange channels, Grade 300—Design section moment and web capacities .....	91
Table 7	AS 4100 Clause 9.3.2 provisions, strength limit state, static loads.....	17	Table 32C	Welded beams, Grade 300—Design section moment and web capacities.....	92
Table 8	Design areas of bolts .....	18	Table 33A	Single web coped universal beams, Grade 300—Design section moment and shear capacities .....	99
Table 9	Strength limit state commercial bolts 4.6/S bolting category .....	19	Table 33B	Single web coped parallel flange channels, Grade 300—Design section moment and shear capacities .....	100
Table 10	Strength limit state high strength structural bolts 8.8/S, 8.8/TB, 8.8/TF bolting categories .....	20	Table 34A	Double web coped universal beams, Grade 300—Design section moment and shear capacities .....	104
Table 11	Reduction factor for lap connections .....	22	Table 34B	Double web coped parallel flange channels, Grade 300—Design section moment and shear capacities .....	104
Table 12	AS 4100 Clause 9.3.3 provisions serviceability limit state—Static loads .....	24	Table 35	Universal beams rationalised dimensions for detailing.....	110
Table 13	Serviceability limit state high strength structural bolts 8.8/TF bolting category .....	25	Table 36	Universal columns rationalised dimensions for detailing.....	110
Table 14	Minimum edge distances .....	26	Table 37	Welded beams rationalised dimensions for detailing.....	111
Table 15	AS 4100 provisions for slotted and oversize holes.....	27	Table 38	Welded columns rationalised dimensions for detailing.....	111
Table 16	Single bolt column .....	32	Table 39	Parallel flange channels rationalised dimensions for detailing.....	112
Table 17	Bolt group design factors for single column of bolts .....	34	Table 40	Gauge lines for universal sections .....	113
Table 18	Double bolt column .....	35	Table 41	Gauge lines for welded section flanges.....	114
Table 19	Bolt group factors for double column of bolts .....	37	Table 42	Gauge lines for welded section webs .....	114
Table 20	Bolt group factors for double column of bolts .....	38	Table 43	Gauge lines for parallel flange channels .....	115
Table 21	Prequalified welding consumables .....	54			
Table 22	Strength of weld metal.....	54			
Table 23	Design capacities of equal leg fillet welds per unit length Category SP .....	59			
Table 24	Design capacities of equal leg fillet welds per unit length Category GP.....	59			
Table 25	Properties of common fillet weld groups treated as line elements....	69			
Table 26	Equal angles—Rationalised dimensions for detailing.....	77			
Table 27	Unequal angles—Rationalised dimensions for detailing.....	77			

