Contents

Part I: Chapter 1 – Chapter 4

Chap	oter 1: Ship Structure Configurations and Main Characteristics	3
1	Introduction	3
2	Ship Types and Main Characteristics	
	2.1 Bulk Carriers	3
	2.2 Double Sides Bulk Carriers	6
	2.3 Bottom Structure of Bulk Carriers	7
	2.4 Types and Categories of Bulk Carriers	7
	2.5 Main Structural Components of Single Skin Bulk Carriers	8
3	General Cargo Ships	
4	Container Ships	14
5	RoRo Ships	17
	5.1 Ramps Types and Arrangements in Ro-Ro Ships	18
6	Tankers	19
	6.1 Single Hull Tankers (Conventional Construction)	19
	6.2 Design Features of Double Hull Tankers	21
	6.3 Structural System of Double Hull Structure	
	6.4 Double Bottom and Double Side Construction of Oil Tankers	23
Chap	pter 2: Configurations and Characteristics of Ship Structural	
	Assemblies	
1	Introduction	
2	Ship Structural Assemblies	
3		25
	Bottom Structure	25 25
	3.1 Single Bottom Structure	25 25 25
	3.1 Single Bottom Structure3.2 Double-Bottom Structure	25 25 25
	 3.1 Single Bottom Structure 3.2 Double-Bottom Structure 3.3 Transversely Framed Double Bottom 	25 25 25 26 27
	 3.1 Single Bottom Structure 3.2 Double-Bottom Structure 3.3 Transversely Framed Double Bottom 3.4 Longitudinally Framed Double Bottom 	25 25 25 26 27 28
4	3.1 Single Bottom Structure 3.2 Double-Bottom Structure 3.3 Transversely Framed Double Bottom 3.4 Longitudinally Framed Double Bottom Side Shell Structure	25 25 25 26 27 28
4	3.1 Single Bottom Structure	25 25 26 27 28 29
4	3.1 Single Bottom Structure	25 25 25 26 27 28 29 30 31
4	3.1 Single Bottom Structure	25 25 26 27 28 29 30 31
·	3.1 Single Bottom Structure 3.2 Double-Bottom Structure 3.3 Transversely Framed Double Bottom 3.4 Longitudinally Framed Double Bottom Side Shell Structure 4.1 Transversely Framed Side Shell Structure Assemblies 4.2 Longitudinally Framed Side Shell Structure Deck Structure 5.1 Deck Plating	25 25 26 27 28 29 30 31 31
·	3.1 Single Bottom Structure	25 25 26 27 28 29 30 31 31 32 33

6	Transverse Bulkheads	34
7	Scantlings of Ship Structural Members	
8	Ship Structural Connections and Details	38
	8.1 Frame Brackets	38
	8.2 Beam Brackets	39
	8.3 Tripping Brackets	41
	8.4 Connection between Bottom Longitudinals and Bottom	
	Transverses	42
Char	oter 3: Configurations and Geometrical Properties of Ship Structure	
•	Members	45
1	Introduction	. 45
2	Structural Units of a Ship	. 45
	2.1 Stiffened Panels	. 45
	2.2 Frameworks	. 47
	2.3 Hull Fittings	. 48
3	Configurations and Geometrical Properties of Ship Structure Members	
	3.1 Standard Rolled Sections with Attached Plating	
	3.2 Fabricated Sections	. 49
	3.3 Geometrical Properties of Fabricated Symmetrical Sections	
	with Attached Plating	. 50
	3.3.1 Flat-Bar	. 51
	3.3.2 Standard Angle Sections	. 52
	3.3.3 Offset Bulb	
4	Flexural Properties of Fabricated Sections with Attached Plating	. 55
5	Equivalent Section Modulus	. 56
6	Effect of Variation in Thickness of Attached Plating on the Section	
	Modulus and Second Moment of Area	. 59
7	Geometrical and Flexural Properties of Curved Plates	. 59
8	Rational Selection of Equivalent Rolled and Fabricated Sections	
	of Ship Strength Members	. 60
9		. 61
10	O Rational Shapes of Cross-Sections of Beams	. 62
1		. 63
1	2 Design of Girders Having Fabricated T-Sections	. 64
1.	3 Determination of Optimum Depth of I-Section Girders	. 65
Cha	pter 4: Bending of Beams and Girders	
1		71
2	Subdivision of Ship Structure into Members and Assemblies	71
3	· · · · · · · · · · · · · · · · · · ·	
4		
	4.1 Forces and Moments on a Beam Element	
	4.2 Modeling of Ship Structural Members	73
	4.3 Boundary Conditions of Idealized Beam Elements	74
	4.4 Modeling 2D Frame Structures Using Beam Elements	

4.5 Modeling 2D Grillage Structure	. 75
4.6 Modeling 2D Deck Structure	. 75
4.7 Modeling 2D Bottom Structure	
4.8 Modeling 2D Side Structure	. 76
4.9 Modeling 2D Transverse Bulkhead	
4.10 Modeling 3D Space Frame Structures Using Beam Elements	. 77
5 Modeling by Using Plate Elements	
5.1 FEM Idealization Using Plate Elements	. 78
6 Boundary Conditions of Beams and Columns	. 80
7 Effective Span of a Beam	. 80
8 Determination of the Optimum Span Length and Size of Bracket	. 82
9 Simple Beam Theory	. 83
9.1 Beam Loading and Response	. 83
9.2 Beam Deflections	. 87
10 The Influence of the Type of End Support on the Magnitude and	
Distribution of the Bending Moment	. 89
10.1 Effect of Degree of Constraint at the End Support on the	
Magnitude and Distribution of the Bending Moment	. 90
10.2 General Case of Uniform Loading and Constrained	
End Supports	
11 Beam Stresses	
11.1 Beam under Normal (Axial) Loading	
11.2 Beams Subjected to Bending Stresses	
11.2.1 Bending of Symmetrical Sections	
11.2.2 Bending of Sections with One Axis of Symmetry	
11.3 Bending of Asymmetrical Sections	
12 Bending Stresses in Beams Constructed with High Tensile Steel	
13 Equivalent Stress	
14 Flexural Stresses in Fabricated Asymmetrical Sections	
14.1 A Simple Procedure for Calculating Flexural Warping Stresses	. 99
14.2 Main Parameters Affecting the Magnitude and Distribution	
of Flexural Warping Stresses	
15 Effective Breadth Concept	
15.1 Effective Breadth of Uniform Symmetrical Sections	
15.2 Effective Flexural Properties of Sections	
15.3 Effective Breadth of Asymmetrical Face Plates	
15.4 Effective Breadth of Curved Face Plates	
15.4.1 Symmetrical Face Plates	
15.4.2 Asymmetrical Face Plate	113
Part II: Chapter 5 – Chapter 9	
Tart II. Chapter 3 - Chapter 7	
Chapter 5: Hull Girder Loading	
1 Introduction	
2 The Nature of Hull Girder Loads	
3 Classification of Hull Girder Loads	118

4	4	Hull Girder Longitudinal Vertical Bending Moments	118
		4.1 Stillwater Shear Force and Bending Moment	
		4.2 Wave-Induced Component	120
	5	Effect of Hull Girder Vertical Deflection on the Distribution	
		of Shear Force and Bending Moment along Ship Length	120
		5.1 Shear Force and Bending Moment Correction due to	
		Ship Deflection	123
	6	Hydrodynamic Loads	
		6.1 Dynamic Loadings due to Shipping Green Seas	
	7	Hull Girder Dynamic Shear Force and Bending Moment	
	8	Hull Girder Design Vertical Bending Moment	128
		8.1 Standard Still Water Bending Moments	
		8.2 Vertical Wave Bending Moment	129
		8.3 An Approximate Estimate of the Maximum Value of the	
		Wave Induced Bending Moment M _w	130
	9	Horizontal Bending Moment	
	10	Hull Girder Shearing Forces	131
		10.1 Total Vertical Shearing Force F _V	131
		10.2 Stillwater Shear Force Component F _S	
		10.3 The Distribution of the Vertical Wave-Induced Shearing Force	
		10.4 Approximate Value of the Maximum Vertical Shear Force	
	11		134
	12		
		12.1 Short Term Prediction of Loading	
		12.2 Long Term Predictions	
		12.3 Extreme Value Distributions	
Ch	ap	oter 6: Hull Girder Bending Stresses	141
	1	Introduction	141
	2	Hull Girder Bending Stress Components	141
		2.1 Hull Girder Primary Stresses Induced by Longitudinal Vertical	
		Bending Moments	142
	3	Geometrical and Flexural Properties of Ship Sections	145
		3.1 Flexural Properties of Longitudinally Framed Deck and	
		Bottom Structures	147
	4	Hull Girder Stresses When the Ship Is In the Inclined Condition	
	5	Hull Girder Stresses due to Horizontal Bending Moment	150
	6	Hull Girder Shear Stresses	151
Ch	ıap	oter 7: Secondary Loading and Stresses	153
	1	Introduction	153
	2	Strength Members of Ship Bottom Assemblies Sustaining	
		Secondary Loadings	
		2.1 Secondary Loading and Stresses in Bottom Assemblies	154
		2.2 Secondary Loading and Stresses in Transversely Stiffened	
		Bottom Assemblies	154

Contents XXIII

		2.2.1	Secondary Loading and Stresses in Bottom Girders	155
		2.2.2		156
		2.2.3	Secondary Stresses in Tank Top Plating	157
	2.3	Second	dary Stresses in Longitudinally Stiffened Double	
		Bottor	n Structure	157
		2.3.1	Secondary Stresses in Bottom Girders	158
		2.3.2	Secondary Stresses in Bottom Longitudinals	159
		2.3.3	Secondary Stresses in Bottom Plating	160
		2.3.4	Secondary Stresses in Tank Top Longitudinals	161
		2.3.5		
3	Seco	ndary I	Loading and Stresses in Deck Structure Assemblies	162
	3.1	Secon	dary Stresses in Transversely Stiffened Deck Structure	
		3.1.1	Secondary Stresses in Deck Girders	
		3.1.2	Secondary Stresses in Deck Plating	163
	3.2	Secon	dary Stresses in Longitudinally Stiffened Deck Structure	163
			Secondary Stresses in Deck Girders	
			Secondary Stresses in Deck Longitudinals	
4	Seco	ndary S	Stresses in Bottom Structure Assemblies of Oil Tankers	165
	4.1	Secon	dary Stresses in Bottom Girders	165
	4.2	Secon	dary Stresses in Bottom Longitudinals	166
	4.3	Secon	dary Stresses in Bottom Plating	168
5	Grill	lage Str	ucture	169
 _				
hap	ter 8	: Terti	ary Loading and Stresses in Strength Members	171
	т.,	of Sh	ips	1/1 171
1	Intro	duction	1	171
2			ing in Transversely Stiffened Bottom Plating	
			ses in Transversely Stiffened Bottom Plating	172
4	Tert	iary Lo	ading and Stresses in the Strength Members	174
		ongituc	linally Stiffened Bottom Structure	174
	4.1	Tertia	ry Loading on Bottom Longitudinals	174 176
	4.2	Tertia	ary Stress in Bottom Longitudinals	170 170
	4.3	Tertia	ry Loading on Tank Top Longitudinals	170
	4.4		ary Loading on Bottom Plating	
	4.5		ry Stress in Bottom Plating	
	4.6	Local	Stresses in Bottom Platingmum Required Thickness of Bottom Plating	102 19 <i>1</i>
	4.7	Wilnii T	mum Required Trickness of Bottom Platting	10 4
_	4.8	Tertia	ry Loading and Stresses in Tank Top Longitudinals pading and Stresses in Longitudinally Stiffened Deck	103
5				196
		cture	w. Looding on Dook Longitudingle	100
	5.1	Tertia	ry Loading on Deck Longitudinals	100 197
_	5.2	1 erus	ary Stresses in Deck Longitudinalsling and Stresses in Side Longitudinals	107 190
b	LOC	ai Loac	and Stresses in Side Longitudinals	109

XXIV Contents

Chap	oter 9: Compounding of Stresses in Ship Strength Members	
1	Introduction	
2	Various Stresses in Strength Members of Ship Structure	
	2.1 Total Stress Induced in Ship Structural Members	
3	Compounding of Stresses in Ship Strength Members	193
	3.1 Compounding of Stresses in Strength Members of Transversely	
	Stiffened Double Bottom Assembly	
	3.1.1 Locations of Compounding of Stresses	194
	3.1.2 Compounding of Stresses in Bottom Girders	
	of Transversely Stiffened Double Bottom Structure	195
	3.1.3 Compounding of Stresses in Bottom Plating	199
4	Compounding of Stresses in Tank Top Plating	202
5	Compounding of Stresses in the Strength Members of Longitudinally	
	Stiffened Double Bottom Structure	204
	5.1 Locations of Compounding of Stresses for Longitudinally	
	Stiffened Bottom Structure	205
	5.2 Compounding of Stresses in a Bottom Girder	206
	5.3 Compounding Stresses in Bottom Longitudinals	208
	5.4 Compounding of Stresses in the Bottom Plating	
	5.5 Compounding of Stresses in the Tank Top Longitudinals	215
	5.6 Compounding of Stresses in the Tank Top Plating	
6	Compounding of Stresses in Longitudinally Stiffened Deck Structure	
	6.1 Compounding of Stresses in Deck Girders	
	6.2 Compounding of Stresses in Deck Longitudinals	
	6.3 Compounding of Stresses in Deck Plating	
7	Compounding of Stresses for Oil Tankers	
	7.1 Compounding of Stresses in the Bottom Girder	
	7.2 Compounding of Stresses in Bottom Longitudinals	
	7.3 Compound Stress in Bottom Plating of an Oil Tanker	
	Subjected to Sagging Moment	230
	. 66 6	
Part	III: Chapter 10 - Chapter 14	
Char	oter 10: Columns and Beam Columns	237
1	Introduction	237
2	Structural Members Subjected to Compressive Loadings	237
3	Classes of Perturbations	238
4	The Problem of Stability	240
	4.1 Critical Force and Critical Stress	
	4.2 Effect of Eccentric Loading	
5	Beam Columns	
	5.1 Load-Deflection Relationship of Beam Columns	
6	Stresses in Beam Columns	254

Contents XXV

Chap	oter 1	1: Buckling of Stiffened Panels	. 267
1		oduction	
2	Basi	c Configurations of Stiffened Panels	. 267
3	Mod	les of Deformation of Transversely Stiffened Plate Panels	. 268
	3.1	Modes of Buckling Deformation of Stiffeners	. 269
	3.2	Global Mode of Deformation of Stiffened Panels	
4	Asse	essment of Buckling Strength of Plating	. 273
	4.1	Commonly Used Idealized Plate Boundary Support Conditions	. 274
	4.2	General In-Plane Loading Conditions	. 275
		4.2.1 Single Loading Conditions	
		4.2.2 Combined Loading Conditions	. 276
	4.3	Modes of Buckling Deformation	. 278
		4.3.1 Mode of Buckling Deformation of a Long Plate	
		for the following Conditions	. 278
		4.3.2 Mode of Buckling Deformation of a Plate Fixed	
		at the Long Edges is as Shown in Fig. (11,28)	. 279
		4.3.3 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading Conditions	
		is shown in Fig. (11.29):	. 279
		4.3.4 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading Conditions	
		is shown in Fig. (11.30):	. 279
		4.3.5 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading Conditions	
		is Shown in Fig. (11.32):	. 280
		4.3.6 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading Conditions	
		is Shown in Fig. (11.33)	. 280
		4.3.7 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading	
		conditions is Shown in Fig. (11.34)	. 281
		4.3.8 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading Conditions	
		is Shown in Fig. (11.35)	. 281
		4.3.9 Mode of Buckling Deformation of a Long Plate	
		for the following Edge Supports and Loading conditions	
		is Shown in Fig. (11.37)	. 282
5		ic Equations of Plate Buckling for Various Boundary Conditions	
	and	Different Loading Combinations	. 282
	5.1		
		Stresses over the Short Edges	. 282
	5.2	Plate Simply Supported at All Edges and Subjected to In-Plane	
		Compressive Stresses over the Long Edges	283
	5.3	Plate Has One Long Edge Free and All Other Edges Simply	
		Supported	284

		5.4 Plate has One Long Edge Free and the Other Long Edge	
		Clamped	. 285
	6	Buckling of Simply Supported Plate under Various in Plane Loading	
		Conditions	. 285
		6.1 Plate Subjected to Pure Bending Stresses	. 285
		6.2 Plate Subjected to Pure Shear Stresses	
	7	In-Elastic Bucking	
		7.1 Inelastic Buckling due Shear Loading	
	8	Assessment of Buckling Strength of Plating Subjected to Combined	
		Loading	288
		8.1 Combined Shear and Compressive Stresses on the Short Edges	289
		8.2 Combined Shear and In-Plane Bending on the Short Edge	290
		8.3 Combined In-Plane Bending and Compression	
		8.4 In Plane Compression in Two Orthogonal Directions	292
		8.5 Combined Shear, In-Plane Bending and Compression	293
	9	Critical Buckling Stress of Plating of Stiffened Panels	
		9.1 Longitudinally Stiffened Panels	
		9.2 Transversely Stiffened Panels	295
	10	Post-buckling Strength of Plating	298
		10.1 Ultimate Stress of Simply Supported Plate Panels	300
		10.1.1 Long Edges Loaded	
		10.1.2 Short Edges Loaded	
	11	•	
		11.1 Uncertainty Modeling of Buckling Safety Margin	303
C	hap	ter 12: Assessment of Buckling of Ship Structure	305
	- 1	Introduction	
			305
	2	Ship Strength Members Sustaining Compressive Forces	305
		Ship Strength Members Sustaining Compressive Forces	305 305
	2	Ship Strength Members Sustaining Compressive Forces	305 305 307
	2	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression 3.1 Idealization of the In-Plane Compressive Loadings	305 305 307 307
	2	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression 3.1 Idealization of the In-Plane Compressive Loadings 3.2 Critical Buckling Stress	305 305 307 307
	2	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression 3.1 Idealization of the In-Plane Compressive Loadings 3.2 Critical Buckling Stress 3.3 Boundary Conditions	305 305 307 307 309
	2	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309
	2	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309
	2	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 310
	2 3	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression 3.1 Idealization of the In-Plane Compressive Loadings 3.2 Critical Buckling Stress 3.3 Boundary Conditions 3.3.1 Boundary Conditions of Girders 3.3.2 Boundary Conditions of Plating Modes of Buckling 4.1 General Modes of Buckling of Girders	305 305 307 309 309 310 312
	2 3	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression 3.1 Idealization of the In-Plane Compressive Loadings 3.2 Critical Buckling Stress 3.3 Boundary Conditions 3.3.1 Boundary Conditions of Girders 3.3.2 Boundary Conditions of Plating Modes of Buckling 4.1 General Modes of Buckling of Girders 4.2 Modes of Buckling of Face Plates	305 305 307 307 309 309 312 312
	2 3	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression 3.1 Idealization of the In-Plane Compressive Loadings 3.2 Critical Buckling Stress 3.3 Boundary Conditions 3.3.1 Boundary Conditions of Girders 3.3.2 Boundary Conditions of Plating Modes of Buckling 4.1 General Modes of Buckling of Girders 4.2 Modes of Buckling of Face Plates 4.3 Modes of Buckling of the Web Plate	305 305 307 307 309 309 312 312 312
	2 3	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314
	2 3 4	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314 314
	2 3 4	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314 314 315
	2 3 4 5 6	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314 314 316
	2 3 4 5 6	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314 314 316 316
	2 3 4 5 6	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314 314 316 316
	2 3 4 5 6 7	Ship Strength Members Sustaining Compressive Forces Basic Equations of Buckling of Plate Panels Subjected to Non-uniform In-Plane Compression	305 305 307 307 309 309 312 312 314 316 316 318

Contents XXVII

9 Assessment of Buckling of Longitudinals	322
10 Assessment of Buckling of Plating	326
10.1 Buckling of Bottom Plating	326
10.2 Buckling of Deck Plating	328
10.3 Buckling of Side Shell Plating	332
10.3.1 Configurations of Side Shell Plate Panels	332
10.3.2 Induced Stresses in the Side Shell Plating	
10.3.3 Compounding of Stresses in Side Shell Plate Panels	334
10.3.4 Assessment of Buckling of Side Shell Plating	335
Chapter 13: Control of Buckling Failure of Ship Structure	
1 Introduction	
2 Reliability Basis of Ship Structural Safety	
3 Deterioration of Structural Capability with Time	
4 Responsible Authorities for Ensuring Structural Safety	
5 Main Causes of Buckling Failure	
6 Control of Ship Structure Failure by Improving Design	
6.1 Improving Design of Plate and Tripping Brackets	
6.2 Using Symmetrical Face Plates of Girders	
6.3 Improving Design of Curved Part of Web Frame Brackets	347
6.4 Improving Design of Plate Panels Loaded by Compressive	
Forces	
6.5 Improving Design of Plate Panels Loaded by Shear Forces	
6.6 Improving Design of Local Structural Connections	349
6.7 Improving Design of the Connection between the Web Plate	
Stiffeners and Longitudinals	
6.8 Improving Design of Web Plating of Top Wing Tanks	
6.9 Improving Design of the Ends of Side Girders in Oil Tankers	
6.10 Improving Design of Web Plating of Deep Girders	351
7 Owners Approach for Improving Ship Structure Operational Life	
and Safety	
7.1 Impact of Corrosion on Strength of Ship Structure Members	352
8 Control of ship Structure Failure by Improving Quality of Ship	
Fabrication Processes	356
8.1 Control of the Out-of Straightness of Stiffeners/Girders	
and Plate Panels	
8.2 Control of Fabrication Deformations of Ship Structure Members	
8.2.1 Out-of-Straightness	
8.2.2 Warping of the Whole Section of the Strength Member	
8.2.3 Warping of Face Plate	358
8.2.4 Lateral Deviations between Centerline of the Web and	
Centerline of the Flange	358
8.2.5 Inclination of the Web Plate of Section with Respect	
to the Attached Plating	
8.2.6 Deformations and Deviations of Face Plates or Flanges	
8.2.7 Gap Between Beam and Frame, see fig. (13.40)	. 360

	8.3 Cont	rol of Welding Distortions	360
		Avoiding Over-Welding	
		Placing Welds near the Neutral Axis or the Center	
		of the Part	360
	8.3.3	Balancing Welds Around the Neutral Axis	360
		Control of Alignment of Butt and Fillet Welds	
9	Improving	g Control of Corrosion	361
Chap	oter 14: Pro	oblems	363
References			
Inde	γ		381