

**MECHANICS** & DESIGN

FIFTH EDITION

James K. Wight James G. MacGregor

## Contents

PREFACE	xi
ABOUT THE AUTHORS	
INTRODUCTION	
<ul> <li>1-1 Reinforced Concrete Structures 1</li> <li>1-2 Mechanics of Reinforced Concrete 1</li> <li>1-3 Reinforced Concrete Members 3</li> <li>1-4 Factors Affecting Choice of Reinforced Concrete for a Structure 4</li> <li>1-5 Historical Development of Concrete and Reinforced Concrete as Structural Materials 8</li> <li>1-6 Building Codes and the ACI Code 10 References 11</li> </ul>	
<ul> <li>THE DESIGN PROCESS</li> <li>2-1 Objectives of Design 12</li> <li>2-2 The Design Process 12</li> <li>2-3 Limit States and the Design of Reinforced Concrete 13</li> <li>2-4 Structural Safety 17</li> <li>2-5 Probabilistic Calculation of Safety Factors 19</li> <li>2-6 Design Procedures Specified in the ACI Building Code 20</li> <li>2-7 Load Factors and Load Combinations in the 2008 ACI Code 22</li> <li>2-8 Loadings and Actions 27</li> </ul>	12
	<ul> <li>ABOUT THE AUTHORS</li> <li>INTRODUCTION</li> <li>1-1 Reinforced Concrete Structures 1</li> <li>1-2 Mechanics of Reinforced Concrete 1</li> <li>1-3 Reinforced Concrete Members 3</li> <li>1-4 Factors Affecting Choice of Reinforced Concrete for a Structure 4</li> <li>1-5 Historical Development of Concrete and Reinforced Concrete as Structural Materials 8</li> <li>1-6 Building Codes and the ACI Code 10 References 11</li> <li>THE DESIGN PROCESS</li> <li>2-1 Objectives of Design 12</li> <li>2-2 The Design Process 12</li> <li>2-3 Limit States and the Design of Reinforced Concrete 13</li> <li>2-4 Structural Safety 17</li> <li>2-5 Probabilistic Calculation of Safety Factors 19</li> <li>2-6 Design Procedures Specified in the ACI Building Code 20</li> <li>2-7 Load Factors and Load Combinations in the 2008 ACI Code 22</li> </ul>

	8-6	Design for Anchorage 375	
	8-7	Bar Cutoffs and Development of Bars in Flexural Members 380	
	8-8	Reinforcement Continuity and Structural Integrity Requirements 390	
	8-9	Splices 406	
		References 410	
CHAPTER 9	SERV	/ICEABILITY	412
	9-1	Introduction 412	
	9-2	Elastic Analysis of Stresses in Beam Sections 413	
	9-3	Cracking 418	
	9-4	Deflections of Concrete Beams 428	
	9-5	Consideration of Deflections in Design 436	
	9-6	Frame Deflections 446	
	9-7	Vibrations 446	
	9-8	Fatigue 448	
		References 450	
CHAPTER 10	CONTINUOUS BEAMS AND ONE-WAY SLABS		452
	10-1	Introduction 452	
	10-2	Continuity in Reinforced Concrete Structures 452	
	10-3	Continuous Beams 456	
	10-4	Design of Girders 475	
	10-5	Joist Floors 476	
	10-6	Moment Redistribution 478	
		References 479	
CHAPTER 11	COLU	JMNS: COMBINED AXIAL LOAD AND BENDING	481
	11-1	Introduction 481	
	11-2	Tied and Spiral Columns 483	
	11-3	Interaction Diagrams 488	
	11-4	Interaction Diagrams for Reinforced Concrete Columns 490	
	11-5	Design of Short Columns 509	
	11-6	Contributions of Steel and Concrete to Column Strength 525	
	11-7	Biaxially Loaded Columns 527	
		References 539	
CHAPTER 12	SLENDER COLUMNS		540
	12-1	Introduction 540	
	12-2	Behavior and Analysis of Pin-Ended Columns 545	
	12-3	Behavior of Restrained Columns in Nonsway Frames 563	

		Frames 578	
	12-6	Calculation of Moments in Sway Frames Using Second-Order Analyses 580	
	12-7	Design of Columns in Sway Frames 585	
	12-8	General Analysis of Slenderness Effects 602	
	12-9	Torsional Critical Load 602	
		References 605	
CHAPTER 13	TWO-	WAY SLABS: BEHAVIOR, ANALYSIS, AND DESIGN	606
	13-1	Introduction 606	
	13-2	History of Two-Way Slabs 608	
	13-3	Behavior of Slabs Loaded to Failure in Flexure 608	
	13-4	Analysis of Moments in Two-Way Slabs 611	
	13-5	Distribution of Moments in Slabs 615	
	13-6	Design of Slabs 621	
	13-7	The Direct-Design Method 626	
	13-8	Equivalent-Frame Methods 641	
	13-9	Use of Computers for an Equivalent-Frame Analysis 662	
	13-10	Shear Strength of Two-Way Slabs 668	
	13-11	Combined Shear and Moment Transfer in Two-Way Slabs 687	
	13-12	Details and Reinforcement Requirements 703	
	13-13	Design of Slabs Without Beams 709	
	13-14	Design of Slabs with Beams in Two Directions 731	
	13-15	Construction Loads on Slabs 742	
	13-16	Deflections in Two-Way Slab Systems 742	
		Use of Post-Tensioning 746	
		References 750	
CHAPTER 14	TWO-	WAY SLABS: ELASTIC AND YIELD-LINE ANALYSES	753
	14-1	Review of Elastic Analysis of Slabs 753	
	14-2	Design Moments from a Finite-Element Analysis 755	
	14-3	Yield-Line Analysis of Slabs: Introduction 757	
	14-4	Yield-Line Analysis: Applications for Two-Way Slab Panels 764	
	14-5	Yield-Line Patterns at Discontinuous Corners 773	
	14-6	Yield-Line Patterns at Columns or at Concentrated Loads 775	
		References 778	

Design of Columns in Nonsway Frames 568

Behavior of Restrained Columns in Sway

12-4

12-5

CHAPTER 15	FOOTINGS		780
	15-1	Introduction 780	
	15-2	Soil Pressure Under Footings 780	
	15-3	Structural Action of Strip and Spread Footings 789	
	15-4	Strip or Wall Footings 795	
	15-5	Spread Footings 799	
	15-6	Combined Footings 806	
	15-7	Mat Foundations 815	
•	15-8	Pile Caps 816	
		References 818	
CHAPTER 16	SHEAR FRICTION, HORIZONTAL SHEAR TRANSFER, AND COMPOSITE CONCRETE BEAMS		820
	16-1	Introduction 820	
	16-2	Shear Friction 820	
	16-3	Composite Concrete Beams 831	
		References 839	
CHAPTER 17	DISCONTINUITY REGIONS AND STRUT-AND-TIE MODELS		841
	17-1	Introduction 841	
	17-2	Design Equation and Method of Solution 844	
	17-3	Struts 844	
	17-4	Ties 850	
	17-5	Nodes and Nodal Zones 851	
	17-6	Common Strut-and-Tie Models 863	
	17-7	Layout of Strut-and-Tie Models 866	
	17-8	Deep Beams 870	
	17-9	Continuous Deep Beams 883	
	17-10	Brackets and Corbels 894	
	17-11	Dapped Ends 905	
	17-12	Beam–Column Joints 910	
	17-13	Bearing Strength 922	
	17-14	T-Beam Flanges 924	
		References 927	
CHAPTER 18	WALLS AND SHEAR WALLS		930
	18-1	Introduction 930	
	18-2	Bearing Walls 933	
	18-3	Retaining Walls 936	
	18-4	Tilt-Up Walls 937	
	18-5	Shear Walls 937	
	18-6	Lateral Load-Resisting Systems for Buildings 938	
	18-7	Shear Wall–Frame Interaction 939	

	18-8	Coupled Shear Walls 941	
	18-9	Design of Structural Walls—General 945	
	18-10	Flexural Strength of Shear Walls 955	•
	18-11	Shear Strength of Shear Walls 962	
	18-12	Critical Loads for Axially Loaded Walls 972	
		References 980	
CHAPTER 19	DESIG	ON FOR EARTHQUAKE RESISTANCE	982
	19-1	Introduction 982	
	19-2	Seismic Response Spectra 983	
	19-3	Seismic Design Requirements 988	
	19-4	Seismic Forces on Structures 992	
	19-5	Ductility of Reinforced Concrete Members 995	
	19-6	General ACI Code Provisions for Seismic Design 997	
	19-7	Flexural Members in Special Moment Frames 1000	
	19-8	Columns in Special Moment Frames 1012	
	19-9	Joints of Special Moment Frames 1020	
	19-10	Structural Diaphragms 1022	
	19-11	Structural Walls 1024	
	19-12	Frame Members not Proportioned to Resist Forces Induced by Earthquake Motions 1030	
	19-13	Special Precast Structures 1030	
	19-14	Foundations 1031	
		References 1031	
APPENDIX A	1033		
APPENDIX B	1083		

INDEX 1091