

# Contents

<b>1</b>	<b>Reappraisal of Concepts Underlying Reinforced-Concrete Design . . .</b>	<b>1</b>
1.1	Introduction . . . . .	1
1.2	Truss Analogy. . . . .	2
1.2.1	Background . . . . .	2
1.2.2	Auxiliary Mechanisms of Shear Resistance. . . . .	2
1.2.3	Inclined Strut . . . . .	8
1.3	Flexural Capacity . . . . .	9
1.4	Critical Regions . . . . .	14
1.5	Points of Contraflexure. . . . .	15
1.6	Effects on Structural Behaviour . . . . .	17
1.7	Alternative Design Methods. . . . .	18
1.8	Concluding Remarks . . . . .	19
	References. . . . .	19
<b>2</b>	<b>The Concept of the Compressive-Force Path . . . . .</b>	<b>23</b>
2.1	Introduction . . . . .	23
2.2	Proposed Function of Simply-Supported Beams . . . . .	23
2.2.1	Physical State of Beam. . . . .	23
2.2.2	Load Transfer to Supports . . . . .	25
2.2.3	Effect of Cracking on Internal Actions. . . . .	27
2.2.4	Contribution of Uncracked and Cracked Concrete to the Beam's Load-Carrying Capacity . . . . .	30
2.2.5	Causes of Failure . . . . .	30
2.3	Validity of Proposed Structural Functioning of Simply-Supported Beams. . . . .	34
2.4	Conclusions . . . . .	39
	References. . . . .	39
<b>3</b>	<b>Modelling of Simply-Supported Beams . . . . .</b>	<b>41</b>
3.1	Introduction . . . . .	41
3.2	Physical Model . . . . .	41
3.3	Failure Criteria . . . . .	43
3.3.1	Type I Behaviour . . . . .	43

3.3.2	Type II Behaviour. ....	47
3.3.3	Type III Behaviour. ....	55
3.3.4	Type IV Behaviour. ....	56
3.4	Comparison of Predictions of Proposed and Code Adopted Criteria . . . . .	59
3.5	Concluding Remarks . . . . .	65
	References . . . . .	65
<b>4</b>	<b>Design of Simply Supported Beams. ....</b>	<b>67</b>
4.1	Introduction . . . . .	67
4.2	Assessment of Longitudinal Reinforcement . . . . .	67
4.3	Assessment of Transverse Reinforcement . . . . .	69
4.3.1	Type II Behaviour. ....	69
4.3.2	Type III Behaviour . . . . .	71
4.4	Design Procedure . . . . .	71
4.5	Design Examples . . . . .	73
4.5.1	Beam Under Uniformly-Distributed Loading . . . . .	73
4.5.2	Beam Under Two-Point Loading with $a_v/d = 4$ . . . . .	75
4.5.3	Beam Under Two-Point Loading with $a_v/d = 3$ . . . . .	76
4.5.4	Beam Under Two-Point Loading Exhibiting Type III Behaviour . . . . .	78
4.5.5	Beam of Type IV Behaviour. ....	79
<b>5</b>	<b>Design for Punching of Flat Slabs . . . . .</b>	<b>83</b>
5.1	Background . . . . .	83
5.2	Criteria for Punching . . . . .	84
5.2.1	Punching Due to Bond Failure. ....	84
5.2.2	Punching Initiation at the Location of Change in the CFP Direction. ....	86
5.2.3	Punching Capacity . . . . .	86
5.2.4	Verification of Proposed Criteria for Punching . . . . .	87
5.3	Transverse Reinforcement for Punching . . . . .	92
5.4	Verification of Design Method . . . . .	94
5.4.1	Slabs Investigated. ....	94
5.4.2	NLFEA Program Used for Verification . . . . .	97
5.4.3	Results of Analysis and Discussion . . . . .	99
5.5	Concluding Remarks . . . . .	105
	References . . . . .	107
<b>6</b>	<b>Design of Structures Comprising Beam-Like Elements . . . . .</b>	<b>109</b>
6.1	Introduction . . . . .	109
6.2	Structural Members Other than Simply-Supported Beams . . . . .	109
6.2.1	Physical Models . . . . .	109
6.2.2	Verification . . . . .	112

6.2.3	Typical Design Examples. . . . .	116
6.3	Structural Configurations Comprising Beam-Like Elements. . . . .	117
6.4	Beam-Column Joints . . . . .	120
6.4.1	Mechanisms of Load Transfer . . . . .	120
6.4.2	Design Models . . . . .	121
6.4.3	Application of CFP Model . . . . .	124
6.4.4	Proposed Design Procedure . . . . .	124
6.4.5	Verification of Design Method for Beam-Column Joints. . . . .	126
6.5	Concluding Remarks . . . . .	136
	References . . . . .	138
<b>7</b>	<b>Earthquake-Resistant Design. . . . .</b>	<b>141</b>
7.1	Introduction . . . . .	141
7.2	Beam-Column Elements . . . . .	141
7.2.1	Experimental Details . . . . .	142
7.2.2	Specimen Design . . . . .	143
7.2.3	Results of Tests . . . . .	145
7.2.4	Discussion of the Results . . . . .	147
7.2.5	Concluding Remarks . . . . .	149
7.3	Structural Walls . . . . .	150
7.3.1	Experimental Details . . . . .	151
7.3.2	Design. . . . .	153
7.3.3	Results . . . . .	154
7.3.4	Discussion of Results . . . . .	156
7.3.5	Concluding Remarks . . . . .	157
7.4	Beam-Column Joints . . . . .	158
7.4.1	Experimental Details . . . . .	158
7.4.2	Results . . . . .	162
7.4.3	Discussion of Results . . . . .	166
7.4.4	Concluding Remarks . . . . .	168
7.5	Points of Contraflexure. . . . .	169
7.5.1	Experimental Details . . . . .	170
7.5.2	Results of Tests . . . . .	172
7.5.3	Discussion of Results . . . . .	174
7.5.4	Concluding Remarks . . . . .	176
7.6	Conclusions . . . . .	177
	References . . . . .	179
<b>8</b>	<b>Design Applications . . . . .</b>	<b>181</b>
8.1	Introduction . . . . .	181
8.2	Column Exhibiting Type II Behaviour. . . . .	181
8.2.1	CFP Design . . . . .	182
8.2.2	EC2/EC8 Design . . . . .	186
8.3	Column Exhibiting Types of Behaviour II and III . . . . .	187
8.3.1	CFP Design . . . . .	187

8.3.2	EC2/EC8 Design . . . . .	191
8.4	Coupling Beam of Type II Behaviour . . . . .	192
8.4.1	CFP Design . . . . .	193
8.4.2	EC2/EC8 Design . . . . .	195
8.5	Coupling Beam of Type III Behaviour. . . . .	196
8.5.1	CFP Design . . . . .	197
8.5.2	EC2/EC8 Design . . . . .	199
8.6	External Beam-Column Joint. . . . .	199
8.7	Structural Wall . . . . .	201
8.7.1	CFP Design . . . . .	201
8.7.2	EC2/EC8 Design . . . . .	204
8.8	Flat Slab Punching . . . . .	206
8.8.1	CFP Design . . . . .	206
8.8.2	EC2 Design . . . . .	211
8.9	Prestressed Concrete Beam . . . . .	212
8.10	Square Footing . . . . .	214
	Reference. . . . .	217
	<b>Index. . . . .</b>	<b>219</b>

<http://www.springer.com/978-3-319-00487-7>

Compressive Force-Path Method  
Unified Ultimate Limit-State Design of Concrete  
Structures

Kotsovos, M.D.

2014, XVI, 221 p. 191 illus., Hardcover

ISBN: 978-3-319-00487-7