Introduction

1. Materials **1**

1.1 Concrete mix design 1

1.2 Steel fibre reinforced concrete (SFRC).

1.3 The behaviour of hardened concrete 6

1.4 High-strength concrete 7

1.4-1 Components of cement-based matrices 9

2. Limit states **10**

2.1 Strain Diagrams in the Ultimate Limit State 10

2.2 Stress - strain Diagram for Concrete 13

2.3 Stress-strain Diagram for Reinforcing Steel 14

2.4 Basic Values for the Design Resistance to Moments and Axial Forces 16

2.5 Verification at the Serviceability Limit States 17

Example 2.1 17

Example 2.2 20

Example 2.3 The determination of actual and statistical properties of concrete and steel 21

Example 2.4 The beam has a theoretical span 2.50 m, perform load test of reinforced concrete beam. 23

2.6 Shrinkage 29

2.7 Creep 30

2.7-1 The investigation of the effects of shrinkage of a composite concrete structure 30

3. Structural system **37**

3.1 Reinforced Concrete Beams 37

Example 3.1-1 39

3.1-1 Continuous beams 41

Example 3.1-2 Determine the required tension reinforcement to the section 46

Example 3.1-3 Determine the required tension reinforcement to the section 48

Example 3.1-4 Determine the required tension reinforcement to the section 49

Example 3.1-5 Determine the required tension reinforcement to the section 50

Example 3.1-6 Determine the required tension reinforcement to the section 52

Example 3.1-7 Determine the required tension reinforcement to the section 53

Example 3.1-8 Determine the required tension reinforcement to the section 55

Example 3.1-9 Determine the required tension reinforcement to the section. 57

Example 3.1-10 Determine the required tension reinforcement to the section 59

3.2 Reinforced Concrete Slabs 68

3.2.1 Flat Slabs 69

3.2.1-1 Analysis and Design of Flat Plate 71

Example: 3.2-1 Design and calculation of Flat Plate 72

Example 3.2-2 Assessment of the punching according to EC 2 80

Example 3.2-3 Assessment of the punching according to EC 2 84

Example 3.2-4 The calculation of the maximum bending moment of reinforced concrete rectangular slab 88

Table D 3 Coefficients for calculating bending moments over between the supports 88

Table E3 Calculation of deflection and moments circular plates depending the method of support and load 90

3.3 Staircases 93

Example 3.3-1 Design a straight flight staircase in a residential building 96

Example 3.3-2 Circular-staircase 98

3.4 Reinforced concrete column 100

Example 3.4-1 Design reinforced concrete columns rectangular cross section 110

Example 3.4-2 Determine the carrying capacity of a rectangular column 111

Example 3.4.3 Determine the carrying capacity of circular columns 112
3.5 Mode of failure of reinforced concrete members subjected to torsion 113
Example 3.5-1 Failure due to torsion 118
Example 3.5-2 The Assessment of the cross section for the interaction of torsion moment and shear force 121
Example 3.5-3 Spreading of box girders beams 122
Example 3.5-4 Dual-chamber section or 2 box girder cross-section 125
3.6 Shear walls 128
Example 3.6-1: Reinforced concrete wall subjected to horizontal load 132
Example 3.6-2: Solution of reinforcing concrete walls with openings subjected to vertical load 134
3.7 Pre-tensioned Prestress Concrete Beam 139
3.7.1 Pre-tensioning 139
3.7.2 Pre-tensioning 139
3.7.3 Partial prestressing 141
3.7.4 In post-tensioned 141
Example 3.7-1: Pre-tensioned Prestress Reinforce Concrete I Beam 142
3.7.5 Loss of Prestress Due to Creep and Shrinkage 148
3.7.6 Ultimate limit state of failure due to bending moment 152
3.7.7 Limit state stress limitation 154
3.7.8 Cracking limit state 155
3.7.9 Deflection 157
Example 3.7-2 Determination of required tension reinforcement to the cross-section 157
Example 3.7-3 Partial prestressed beams 160
Example 3.7-4 Determination of required tension reinforcement to the section. 163
Example 3.7-5 Determination of the tension reinforcement to the section 164
Example 3.7-6 Determination of the tension reinforcement of reinforced concrete rectangular column 165
Example 3.7-7 Determination of the tension reinforcement of reinforced concrete rectangular column 166
Example 3.7-8 Determination of the tension reinforcement of reinforced concrete rectangular column 167
Example 3.7-9 Ultimate limit state of the cross-section 169
Example 3.7-10 Determination of the ultimate bending moment and stresses at the upper and lower of cross-section 169
Example 3.7-11 Determine the ultimate bending moment and concrete stresses. 171
Example 3.7-12 Determine the ultimate bending moment and concrete stresses 173
3.8 Calculation of stiffness of concrete members 175
Example 3.8-1 Calculation of bending and shear stiffness 175
Example 3.8-2 Calculation of bending and shear stiffness 177
Example 3.8-3 Cross section with cracks 181
Example 3.8-4 Calculation of initial bending and axial stiffness 189
Example 3.8-5: Calculation of curvature of rectangular cross-section 198
3.9 Concrete Foundations 203
3.9.1 Shallow Foundations 205
3.9.2 Strap Footing 206
3.9.3 Combined Footing 207
3.9.4 Strip/continuous footings 207
3.9.5 Mat or Raft footings 208
3.9.6 Pile foundations 208
Example 3.9-1 Assessment of slab foundation to punching 211
Example 3.9-2 Determination of the design bearing capacity of the soil at depth 213
Example 3.9-3 Endless beam 213
Example 3.9-4 Design of reinforcement in footing 217
Example 3.9-5 Static calculation of extreme square isolated footings 223

Realization Projects **227**
References **257**