

Contents

<i>Preface</i>	v
1. INTRODUCTION	1
1.1 Titular Definitions	1
1.2 Historical Development	1
1.3 Origin of Soil	3
1.4 Residual Soils	3
1.5 Transport Soils	4
1.6 Organic Soils	5
1.7 Volcanic Soils	5
2. SOIL PARTICLES AND STRUCTURE	6
2.1 Particle Nature	6
2.2 Clay Minerals	7
2.3 Clay Water	9
2.4 Granular Soil Structure	10
2.5 Clay Soil Structure	11
2.6 Composite Soil Structure	12
2.7 Mass Structure	13
2.8 Cohesive and Cohesionless Soils	13
3. PHASE SYSTEM CONSTITUENTS	14
3.1 Soil Phase System and Definitions	14
3.2 Inter-relations	16
3.3 Densities and Unit Weights	17
3.4 Supplementary Useful Inter-relations	18
3.5 Density Index	19
3.6 Moisture Content Determination	24
3.7 Specific Gravity Determination	27
3.8 Particle Size Determination	28
3.9 Sedimentation Analysis	28
3.10 Grading Curve	34
4. CONSISTENCY, PLASTICITY AND SENSITIVITY	37
4.1 Consistency Limits	37
4.2 Liquid and Plastic Limits Determination	38

x Contents

4.3	Shrinkage Limit Determination	42
4.4	Consistency of Undisturbed Soil	44
4.5	Activity	44
4.6	Sensitivity	45
4.7	Swell Index Potential	45
5.	CLASSIFICATION AND IDENTIFICATION	48
5.1	Size-based Classification	48
5.2	Indian Standard Classification	49
5.3	Field Identification and Classification of Coarse-grained Soils	52
5.4	Field Identification and Classification of Fine Grained Soils	55
5.5	Black Cotton Soils	56
5.6	ASTM—Unified Soil Classification	56
6.	PERMEABILITY, CAPILLARITY AND EFFECTIVE STRESS	63
6.1	Head and Gradient	63
6.2	Permeability and Darcy Law	64
6.3	Validity of Darcy Law	65
6.4	Factors Affecting Permeability	66
6.5	Average Permeability of Layered Deposit	67
6.6	Laboratory Determination of Permeability	69
6.7	Field Determination of Permeability	71
6.8	Capillarity	80
6.9	Effective Stress	83
6.10	Quick Condition, Uplift and Liquefaction	86
7.	SEEPAGE, FLOWNET AND DRAINAGE	94
7.1	Laplace Equation	94
7.2	Properties of Flow Net	96
7.3	Construction of Flow Net	97
7.4	Graphical Method	97
7.5	Electrical Analogy Method	99
7.6	Anisotropic Soil	100
7.7	Effect of Interface of Dissimilar Soils	102
7.8	Uses of Flow Net	103
7.9	Piping and Heaving	103
7.10	Protective Filters	105
7.11	Flow in Earth Dams	111
7.12	Drainage	114
7.13	Drainage and Separation by Geotextiles	116

8.	STRESS DISTRIBUTION	118
8.1	Approximate Solutions	118
8.2	Elastic Solutions	119
8.3	Uniformly Distributed Load	120
8.4	Pressure Bulb	124
8.5	Line load	125
8.6	Point Load and Finite Layer	126
8.7	Contact Pressure	126
9.	SHEAR STRENGTH	131
9.1	Mohr Circle of Stress	131
9.2	Shear Strength (Mohr-Coulomb theory)	132
9.3	Failure Plane and Stress Relations	134
9.4	Shear Strength Tests—Triaxial Test	135
9.5	Unconfined Compression Test	137
9.6	Direct Shear Test	139
9.7	Vane Shear Test	140
9.8	Shear Behaviour of Cohesionless Soils—Sands	147
9.9	Shear Behaviour of Cohesive Soils—Clays	149
9.10	Stress Path— K_f Line	155
9.11	Pore Pressure Parameters	156
9.12	Elastic Properties of Soils	157
10.	SLOPE STABILITY	164
10.1	Slope Failure and Basic Assumptions	164
10.2	Plane Failure	164
10.3	Rotational Failure—Swedish Method	166
10.4	Taylor Friction Circle and Stability Number Method	173
10.5	Stability of Earth Dam	177
10.6	Bishop Method of Slices	180
10.7	Safety Factor by Stability Coefficients	181
11.	EARTH PRESSURE AND RETAINING STRUCTURES	186
11.1	Earth Pressure —Definitions	186
11.2	At-rest Earth Pressure	186
11.3	Earth pressure Theories—Rankine Theory	187
11.4	Rankine Active Pressure—Cohesionless Soil	187
11.5	Active Pressure—Cohesive Soil	191
11.6	Rankine Passive Pressure	193
11.7	Failure Zones and Required Deformation	194

11.8	Coulomb Theory	200
11.9	Coulomb Solution—Cohesionless Soil	201
11.10	Rebhann (Poncelet) Construction	207
11.11	Culmann Construction	209
11.12	Stability of Retaining Wall	211
11.13	Cantilever Sheet Pile Wall	216
11.14	Anchored Sheet Pile Wall (Bulkhead)	218
11.15	Braced Excavation	221
12.	CONSOLIDATION	223
12.1	Definition of Consolidation	223
12.2	Consolidation Test	224
12.3	Preconsolidation Pressure	227
12.4	Terzaghi Theory of Consolidation	228
12.5	Determination of Coefficient of Consolidation	231
12.6	Determination of Permeability	234
12.7	Comparative Settlement Rate	238
12.8	Field Consolidation	240
12.9	Final Settlement	241
12.10	Equivalent Layer Method	242
12.11	Settlement under Time-Dependent Loading	246
12.12	Secondary Consolidation	247
13.	BEARING CAPACITY AND SHALLOW FOUNDATIONS	249
13.1	Bearing Capacity Terms	249
13.2	Shallow and Deep Foundations	250
13.3	Shear Failure Patterns	250
13.4	Terzaghi Theory of Bearing Capacity	251
13.5	Skempton Value of N_c	253
13.6	Indian Code Recommendations	253
13.7	Bearing Capacity of Layered Soils	256
13.8	Plate Load Test	260
13.9	Standard Penetration Test	263
13.10	Static Cone Penetration Test	265
13.11	Dynamic Cone Test	266
13.12	Footing Settlement	266
14.	PILE FOUNDATIONS	270
14.1	Definitions	270
14.2	Load Capacity	270
14.3	Pile Capacity in Sand	271

14.4	Pile Capacity in Clay	273
14.5	Dynamic Analysis	274
14.6	Pile Load Tests	277
14.7	Group Action	284
14.8	Settlement of Piles in Sand	286
14.9	Settlement of Piles in Clay	287
15.	WELL FOUNDATIONS	292
15.1	Well and its Components	292
15.2	Shape and Size	293
15.3	Depth of Well	294
15.4	Bearing Capacity of Well	296
15.5	Settlement of Well	296
15.6	Sinking of Well	297
16.	FOUNDATIONS ON SWELLING SOILS	304
16.1	Swelling Soils	304
16.2	Methods of Construction	304
16.3	Under-reamed Pile Foundation	306
16.4	Remedial Measures	307
17.	MACHINE FOUNDATIONS	309
17.1	Foundation Vibration	309
17.2	Design Considerations	313
17.3	Design Methods	314
17.4	Lumped Parameter Method	314
17.5	Design for Horizontal Vibration	316
17.6	Bearing Capacity and Settlement	317
17.7	Vibration and Shock Isolation	319
18.	COMPACTION AND PAVEMENT DESIGN	329
18.1	Compaction and its Objectives	329
18.2	Theory of Compaction	329
18.3	Laboratory Compaction Tests	332
18.4	Properties of Compacted Soil	335
18.5	Field Measurement of Compaction	336
18.6	Field Compaction Equipment	338
18.7	Compaction Control	340
18.8	Pavements	342
18.9	California Bearing Ratio	343
18.10	Flexible Pavement Design	345

19. SOIL STABILIZATION AND IMPROVEMENT	347
19.1 Methods Applicable to Surface and Shallow Deposits	347
19.2 Methods Applicable to Deeper Thick Deposits	348
20. SITE INVESTIGATION AND SAMPLING	352
20.1 Objectives and Methods	352
20.2 Excavation and Boring Methods	352
20.3 Extent and Depth of Exploration	354
20.4 Requirement of Samplers	356
20.5 Type of Samplers	357
20.6 Methods of Sampling	359
20.7 Handling and Transport of Samples	360
20.8 Geophysical Methods	360
21. SOIL TESTING	364
Ex.: 1 Moisture Content Determination	364
Ex.: 2 Specific Gravity Determination	367
Ex.: 3 Particle Size Determination	371
Ex.: 4 Consistency Limits Determination	384
Ex.: 5 Permeability Determination	392
Ex.: 6 Consolidation Test	404
Ex.: 7 Compaction Tests	412
Ex.: 8 Field Density and Voids Ratio Determination	420
Ex.: 9 Shear Strength Determination	427
Ex.: 10 California Bearing Ratio Determination	438
Ex.: 11 North Dakota Cone Test	445
Ex.: 12 Swelling Pressure Determination	447
22. OBJECTIVE TESTING	451
22.1 Multiple-choice Questions	451
22.2 Fill-up-the blanks Type Questions	458
22.3 True-false Type Questions	464
<i>Index</i>	467