

Contents

<i>Preface</i>	viii
<i>Notation Index</i>	x
1 Classification and Identification Properties of Soil	1
1.1 Agricultural and engineering soil	1
1.2 Engineering definitions	2
1.3 Clays	4
1.4 Soil classification	6
1.5 Common types of soil	15
1.6 Soil classification and description	16
1.7 Soil properties	23
1.8 Soil physical relations	33
Exercises	34
2 Soil Water, Permeability and Flow	37
2.1 Subsurface water	37
2.2 Flow of water through soils	39
2.3 Darcy's law of saturated flow	40
2.4 Coefficient of permeability (k)	40
2.5 Determination of k in the laboratory	41
2.6 Determination of k in the field	45
2.7 Approximation of k	48
2.8 General differential equation of flow	48
2.9 Potential and stream functions	50
2.10 Flow nets	52
2.11 Hydraulic gradient	52
2.12 Calculation of seepage quantities from a flow net	54
2.13 Drawing a flow net	55
2.14 Critical hydraulic gradient, i_c	57
2.15 Seepage forces	58
2.16 Alleviation of piping	58
2.17 Design of filters	59
2.18 Total and effective stress	63
2.19 Capillarity	64
2.20 Earth dams	67
2.21 The problem of stratification	73
2.22 Calculation of seepage quantities in an anisotropic soil	75
2.23 Permeability of sedimentary deposits	78

2.24	Seepage through soils of different permeability	81
2.25	Refraction of flow lines at interfaces	82
	Exercises	84
3	Shear Strength of Soils	87
3.1	Friction	87
3.2	Complex stress	88
3.3	The Mohr circle diagram	89
3.4	Cohesion	93
3.5	Coulomb's law of soil shear strength	94
3.6	Modified Coulomb's law	95
3.7	The Mohr–Coulomb yield theory	96
3.8	Determination of the shear strength parameters	97
3.9	Determination of the total stress parameters ϕ_u and c_u	105
3.10	Determination of the effective stress parameters ϕ' and c'	107
3.11	The pore pressure coefficients A and B	111
3.12	The triaxial extension test	116
3.13	Behaviour of soils under shear	120
3.14	Variation of the pore pressure coefficient A	124
3.15	Operative strengths of soils	125
3.16	Space diagonal and octahedral plane	127
3.17	Sensitivity of clays	132
3.18	Activity of a clay	133
3.19	Residual strength of soil	135
	Exercises	138
4	Elements of Stress Analysis	143
4.1	Stress–strain relationships	143
4.2	The state of stress at a point within a soil mass	144
4.3	Stresses induced by the self-weight of the soil	145
4.4	Stresses induced by applied loads	146
4.5	Influence charts for vertical stress increments	151
4.6	Bulbs of pressure	152
4.7	Shear stresses	153
4.8	Contact pressure	155
	Exercises	157
5	Stability of Slopes	159
5.1	Granular materials	159
5.2	Soils with two strength components	162
5.3	Methods of investigating slope stability	163
5.4	Total stress analysis	163
5.5	Effective stress analysis	176
5.6	Planar failure surfaces	192
5.7	Slope stability analysis to Eurocode 7	196
	Exercises	200

6	Lateral Earth Pressure	211
6.1	Introduction	211
6.2	Active and passive earth pressure	211
6.3	Active pressure in cohesionless soils	213
6.4	Surcharges	220
6.5	The effect of cohesion on active pressure	227
6.6	Choice of method for prediction of active pressure	236
6.7	Design parameters for different soil types	237
6.8	The choice of backfill material	239
6.9	Earth pressure at rest	245
6.10	Influence of wall yield on design	246
6.11	Strutted excavations	247
6.12	Passive pressure in cohesionless soils	248
6.13	The effect of cohesion on passive pressure	251
6.14	Operative values for ϕ and c for passive pressure	253
	Exercises	255
7	Earth Retaining Structures	257
7.1	Main types of earth retaining structures	257
7.2	Gravity walls	257
7.3	Embedded walls	260
7.4	Design of earth retaining structures	262
	7.4.1 Design to BS 8002: 1994	262
	7.4.2 Geotechnical design to Eurocode 7	263
7.5	Design of gravity walls	269
7.6	Design of sheet pile walls	282
7.7	Reinforced soil	297
7.8	Soil nailing	299
	Exercises	300
8	Bearing Capacity of Soils	303
8.1	Bearing capacity terms	303
8.2	Types of foundation	303
8.3	Analytical methods for the determination of the ultimate bearing capacity of a foundation	304
8.4	Determination of the safe bearing capacity	313
8.5	The effect of groundwater on bearing capacity	314
8.6	Developments in bearing capacity equations	314
8.7	Designing spread foundations to Eurocode 7	320
8.8	Non-homogeneous soil conditions	327
8.9	<i>In situ</i> testing for ultimate bearing capacity	330
8.10	Pile foundations	337
8.11	Designing pile foundations to Eurocode 7	350
8.12	Pile groups	356
	Exercises	358

9	Foundation Settlement and Soil Compression	361
9.1	Settlement of a foundation	361
9.2	Immediate settlement	362
9.3	Consolidation settlement	373
9.4	Two-dimensional stress paths	394
	Exercises	401
10	Rate of Foundation Settlement	403
10.1	Analogy of consolidation settlement	403
10.2	Distribution of the initial excess pore pressure, u_i	403
10.3	Terzaghi's theory of consolidation	404
10.4	Average degree of consolidation	408
10.5	Drainage path length	409
10.6	Determination of the coefficient of consolidation, c_v , from the consolidation test	410
10.7	Determination of the permeability coefficient from the consolidation test	412
10.8	Determination of the consolidation coefficient from the triaxial test	412
10.9	The model law of consolidation	414
10.10	Consolidation during construction	416
10.11	Consolidation by drainage in two and three dimensions	419
10.12	Numerical determination of consolidation rates	420
10.13	Construction pore pressures in an earth dam	426
10.14	Numerical solutions for two- and three-dimensional consolidation	428
10.15	Sand drains	431
	Exercises	437
11	Compaction and Soil Mechanics Aspects of Highway Design	439
11.1	Laboratory compaction of soils	439
11.2	Main types of compaction plant	447
11.3	Moisture content value for <i>in situ</i> compaction	449
11.4	Specification of the field compacted density	450
11.5	<i>In situ</i> tests carried out during earthwork construction	452
11.6	Highway design	455
	Exercises	470
12	Unsaturated Soils	473
12.1	Unsaturated soils	473
12.2	Measurement of soil suction	475
12.3	Soil structure changes with water content	477
12.4	Stress states in unsaturated soils	479
13	Critical State Theory	483
13.1	Critical state theory	483
13.2	Symbols	483

13.3	Critical state	484
13.4	Isotropic consolidation	485
13.5	Stress paths in three-dimensional stress space	487
13.6	The critical state line	489
13.7	Representation of triaxial tests in $p'-q-v$ space	492
13.8	The Roscoe surface	495
13.9	The overall state boundary	498
13.10	Equation of the Hvorslev surface	499
13.11	Residual and critical strength states	501
14	Site Investigation and Ground Improvement	503
14.1	Desk study	503
14.2	Site reconnaissance	504
14.3	Ground investigation	505
14.4	Site investigation reports	513
14.5	Ground improvement	516
14.6	Environmental geotechnics	520
	<i>References</i>	521
	<i>Index</i>	531