
Contents

Foreword	ix
Philippe GUILLERMAIN† and François SCHLOSSER	
Entrepreneur’s Tribune: Geotechnics is at the Heart of Our Projects	xi
Pascal LEMOINE and Eric DURAND	
Preface	xiii
Acknowledgments	xix
Symbols and Notations	xxi
Introduction	lv
Chapter 1. Soil: Definition, Identification and Classification	1
1.1. Definition of a soil.	1
1.1.1. Characteristic sizes	1
1.2. Soil types	6
1.2.1. Granular soils	7
1.2.2. Fine soils	7
1.3. Laboratory identification tests.	9
1.3.1. Parameters and standards	9
1.3.2. Definition of parameters.	10

1.4. Examples of soil identification and applications	13
1.4.1. Particle size analysis	13
1.4.2. Characterization of soil plasticity	14
1.4.3. Organic material content research	14
1.4.4. Liquefaction risk analysis	15
1.4.5. Characterization of clay soils with respect to swelling and shrinkage	16
1.4.6. Soil treatment for platforms and technical backfills.	17
1.5. Soil classification	22
1.6. Illustrative samples	24
1.7. Roads and carriageways fact sheet	26
1.8. Railway platforms fact sheet.	28
1.9. Appendix 1.1: Classification of soft soil and rock	30
1.10. References.	40
Chapter 2. Stresses, Deformations and Behavioral Laws of Soils	41
2.1. Basic concepts of mechanics of continuous media.	41
2.1.1. Concept of stress	41
2.1.2. Concept of deformation	42
2.1.3. Generalization of the state of stresses	44
2.1.4. Generalization of the deformation state.	51
2.1.5. Deformation–displacement relations	51
2.1.6. Deformation rate	53
2.1.7. Acceleration	54
2.2. Behavioral laws	54
2.2.1. Elastic behavior model.	55
2.2.2. Elasto-plastic behavioral models.	64
2.2.3. Viscoelastic behavior models.	77
2.2.4. Dynamic behavior of soils.	78
2.3. Soil creep phenomenon.	82
2.3.1. Creep mechanism.	82
2.3.2. Creep stresses and deformations	82
2.4. Mechanics of continuous media applied to soils	83
2.4.1. Terzaghi’s fundamental relation	83
2.4.2. Concepts of short term and long term	84
2.4.3. Equilibrium equations	85
2.4.4. Experimental determination of elastic parameters of soil	90
2.4.5. Order of magnitude of soil parameters	93

2.5. Practical applications to construction projects	96
2.5.1. Calculation of vertical stresses in a homogeneous soil	96
2.5.2. Steps to solving finite element calculations: simple cases	98
2.5.3. Project 1: Modeling and calculation of settlement of a road embankment.	109
2.5.4. Project 2: Study of the displacements of a retaining slurry trench wall.	112
2.5.5. Project 3: Modeling of rafts on vertical stiff inclusions	118
2.5.6. Some lessons to be learned from deformation calculations	119
2.6. References	121

Chapter 3. Determination of the In-situ Geotechnical Parameters of Soils 125

3.1. Introduction.	125
3.1.1. The purpose of testing in geotechnical projects	125
3.1.2. On-site and laboratory tests: which to choose?	126
3.2. General methodology of geotechnical studies	127
3.2.1. Phases and types of standard geotechnical studies	127
3.2.2. Standard geotechnical missions	128
3.2.3. Blueprint of a geotechnical study	135
3.3. Inventory of field tests in France	137
3.3.1. Soil identification and classification tests.	137
3.3.2. Laboratory compression tests.	138
3.3.3. Laboratory shear tests	138
3.3.4. Legend for parameters measured in the laboratory	138
3.3.5. Tests to determine the mechanical properties of soils on site	139
3.3.6. Legend for parameters measured on site	139
3.3.7. Tests for the measurement of soil permeability	140
3.3.8. Tests to measure the dynamic soil parameters	140
3.3.9. Specific tests.	140
3.4. On-site parameter determination tests	141
3.4.1. Vane test	141
3.4.2. Cone penetration test (CPT).	151
3.4.3. Dynamic penetrometer test (PDA and PDB).	166
3.4.4. Standard penetration test (SPT)	172
3.4.5. Ménard pressuremeter test (MPT)	179
3.4.6. Phicometer shear test.	198
3.4.7. Plate-bearing test	205

3.5. French conventional soil classification.	214
3.5.1. Classification according to Fascicle 62, Part V	214
3.5.2. Soil classification according to Eurocode 7	214
3.5.3. Classification according to PS92 rules	216
3.5.4. Classification according to Eurocode 8	218
3.6. Correlations between parameters	219
3.6.1. Correlations between mechanical parameters measured on site	219
3.6.2. Correlations between other parameters	221
3.7. Practical analysis of typical tests	224
3.7.1. Practical example of monotonic pressuremeter tests	224
3.7.2. Practical example of pressuremeter tests with cycles	230
3.7.3. Control procedures for pressuremeter tests.	232
3.7.4. Practical example of cone penetration tests.	239
3.7.5. Variations and correlations between parameters measured on site	243
3.7.6. Photos of worksites and on-site survey equipment	247
3.8. Scope of application of on-site testing	254
3.9. Test results in typical soils	256
3.9.1. Pressuremeter tests (Baud diagram)	256
3.9.2. Pressuremeter tests in backfills treated with lime	257
3.9.3. Cone penetration tests	257
3.9.4. Common diagram for geotechnical investigations	258
3.10. Wise conclusion	262
3.11. Appendix 3.1: Correlations between net creep pressures and net limit pressures.	262
3.12. References.	263
French, European and ISO Standards in the Field of Geotechnics	271
Index	303
Summaries of Other Volumes.	307