Preface xiii

Chapte	Chapter 1. Introduction	
1.1	Definition of a Forensic Engineer	1
1.2	Types of Damage	3
1.3	Typical Clients	4
1.4	Legal Process	5
	1.4.1 Civil Litigation	5
	1.4.2 Important Legal Terms	6
	1.4.3 Discovery	8
	1.4.4 Alternative Dispute Resolution	9
	1.4.5 Trial	10
1.5	Examples	11
1.6	Outline of Chapters	17
Part ⁻	Assignment and Investigation	
Chapter 2. The Assignment		27
2.1	Preliminary Information	27
2.2	Accepting the Assignment	28
	2.2.1 Curriculum Vitae	28
	2.2.2 Compensation	30
	2.2.3 Forensic Engineer's Agreement with the Client	30
	2.2.4 Confidentiality	30
Chapt	er 3. The Investigation	33
3.1	Planning the Investigation	33
3.2	Site Investigation	35
	3.2.1 Initial Site Visit	35
	3.2.2 Nondestructive Testing	36
	3.2.3 Destructive Testing	37
	3.2.4 Monitoring	44
	3.2.5 Laboratory Testing	49

3 3	Document Search	53
3.3	3.3.1 Project Reports and Plans	53
	3.3.2 Building Codes	55
	3.3.3 Technical Documents	55
3.1	Analysis and Conclusions	55
3.4	3.4.1 Case Study	56
2 5	Report Preparation	59
3.5	neport Preparation	33
Part 2	2 Forensic Geotechnical and Foundation Investigations	
Chapte	er 4. Settlement of Structures	65
4.1	Introduction	66
4.2	Allowable Settlement	66
	4.2.1 Different Types of Foundations and Buildings	69
4.3	Classification of Cracking Damage	70
4.4	Component of Lateral Movement	72
4.5	Collapsible Soil	76
4.6	Backfill Settlement	79
4.7	Other Causes of Settlement	80
•••	4.7.1 Limestone Cavities or Sinkholes	80
	4.7.2 Consolidation of Soft and/or Organic Soil	82
	4.7.3 Collapse of Underground Mines and Tunnels	83
	4.7.4 Ground Subsidence due to Extraction of Oil or Groundwater	86
	4.7.5 Settlement of Landfills and Decomposition of Organic Matter	87
4.8	Change in Properties with Time	90
	4.8.1 Example of Change in Properties with Time	91
4.9	Case Studies	92
Chapt	er 5. Expansive Soil	103
5.1	Introduction	103
	5.1.1 Expansive Soil Factors	104
	5.1.2 Laboratory Testing	105
	5.1.3 Surcharge Pressure	106
5.2	Swelling of Desiccated Clay	106
	5.2.1 Identification of Desiccated Clay	107
	5.2.2 Hydraulic Conductivity and Rate of Swell	109
5.3	Types of Expansive Soil Movement	112
	5.3.1 Lateral Movement	112 113
	5.3.2 Vertical Movement	114
5.4	Foundation Design for Expansive Soil 5.4.1 Conventional Slab-on-Grade Foundation	114
	5.4.2 Posttensioned Slab-on-Grade	115
	5.4.3 Pier and Grade Beam Support	119
	5.4.4 Other Treatment Alternatives	119
5.5		120
5.5	5.5.1 Flexible Pavements	120
	5.5.2 Concrete Pavements	125
5.6	Flatwork	126
	E 6 1 Unward Movement	126

	5.6.2 Walking of Flatwork	129
5.7	7 Case Study	131
Chan	oter 6. Lateral Movement	137
Citap	ter o. Lateral movement	107
6.1	1 Typical Causes of Lateral Movement	137
6.2	2 Allowable Lateral Movement of Buildings	140
6.3	Rock Fall	142
	6.3.1 Case Studies	144
6.4	Surficial Slope Failures	154
	6.4.1 Stability Analysis	155
	6.4.2 Surficial Failures	156
6.5	5 Gross Slope Failures	160
	6.5.1 Case Study	162
6.6	6 Landslides	171
	6.6.1 Case Study	174
6.7	7 Debris Flow 6.7.1 Case Study	187 189
	B Slope Softening and Creep	192
0.0	6.8.1 Case Study	192
6.0	9 Trench Cave-Ins	203
0.3	6.9.1 Case Study	203
6 1	10 Dam Failures	208
0.	6.10.1 Large Dams	208
	6.10.2 Small Dams	212
	6.10.3 Landslide Dams	213
Chan	oter 7. Other Geotechnical and Foundation Problems	215
Onap	Activity of the decicle of the decic	2.0
	1 Introduction	215
7.2	2 Earthquakes	216
	7.2.1 Surface Faulting and Ground Rupture	217
	7.2.2 Liquefaction	220 221
	7.2.3 Slope Movement and Settlement 7.2.4 Translation and Rotation	221
	7.2.5 Foundation Behavior	222
7 9	3 Erosion	225
,.,	7.3.1 Sea Cliffs	227
	7.3.2 Badlands	234
7.4	4 Deterioration	234
• • •	7.4.1 Sulfate Attack	234
	7.4.2 Pavement Deterioration	244
	7.4.3 Frost	245
7.5	5 Tree Roots	247
7.6	6 Bearing Capacity Failures	249
	7.6.1 Buildings	249
	7.6.2 Roads	251
	7.6.3 Pumping of Clay	251
7.7		252
	7.7.1 Case Study	256
7.8		260
	7.8.1 Case Study	266

7.9	Retaining Walls 7.9.1 Case Study	285 290
7 10	Shrinkage Cracking of Concrete Foundations	294
	Timber Decay of Foundations	302
	Soluble Soil Particles	305
7.12	Soluble Soil Particles	303
Chapt	er 8. Groundwater and Moisture Problems	309
8.1	Groundwater	309
	8.1.1 Pavements	310
	8.1.2 Slopes	312
8.2	Moisture Migration through Floor Slabs	315
	8.2.1 Moisture Dome Test and Vapor Flow Rate 8.2.2 Acceptable Vapor Flow Rates	318 320
	8.2.3 Structural Design and Construction Details	320
	8.2.4 Flat Slab Ceilings	321
8.3	Moisture Migration through Basement Walls	323
0.0	8.3.1 Damage due to Moisture Migration through Basement Walls	323
	8.3.2 Structural Design and Construction Details	326
	8.3.3 Case Study	327
8.4	Pipe Breaks and Clogs	330
8.5	Surface Drainage	334
	3 Repairs and Crack Diagnosis	044
Chapt	er 9. Repairs	341
9.1	Development of Repair Recommendations	341
	9.1.1 Projects Involving Civil Litigation	342
9.2	Repair of Slab-on-Grade Foundations	343
	9.2.1 Reinforced Mat 9.2.2 Reinforced Mat with Piers	343 346
	9.2.3 Partial Removal and/or Strengthening of the Foundation	348
	9.2.4 Concrete Crack Repairs	351
9.3	Other Foundation Repair Alternatives	354
	Repair of Surficial Slope Failures	355
	9.4.1 Rebuild the Failure Area	356
	9.4.2 Geogrid Repair	356
	9.4.3 Soil-Cement Repair	359
	9.4.4 Pipe Piles and Wood Lagging	360
	9.4.5 Suitability of Repair Method	362
	9.4.6 Summary	363
9.5	Repair of Gross Slope Failures and Landslides 9.5.1 Pier Walls	363 364
	3.3.1 Fici Walls	30-
Chapt	er 10. Crack Diagnosis	377
10.		
	1 Introduction	377
10.:	1 Introduction 2 Pavements Cracks	377 377
10.: 10.:	2 Pavements Cracks	

10.5	Ground Cracks and Fissures	401
10.6	Damage due to Earthquakes	419
10.7	Cracking to Repaired Structures	430
Part 4	Reducing Potential Liability	
Chapte	11. Concluding Chapter	435
11.1	Future Outlook for Forensic Engineering	435
11.2	Reducing Potential Liability	435
11.3	Preparation of Reports and File Management	437
	11.3.1 Report Preparation	437
	11.3.2 Daily Field Reports	438
	11.3.3 File Management	438
	11.3.4 Examples of Poor File Management	439
11.4	Engineering Jargon, Superlatives, and Technical Words	440
	11.4.1 Engineering Jargon	440
	11.4.2 Superlatives	441
	11.4.3 Technical Words	443
11.5	Strategies to Avoid Civil Liability	443
	11.5.1 Assessing Risk	444
	11.5.2 Insurance	444
	11.5.3 Limitation of Liability Clauses	445
bpend	ix A. Recommended Practices for Design Professionals	
	Engaged as Experts in the Resolution of	
	Construction Industry Disputes (ASFE)	447
ppend	ix B. Case Management Order	453
opend	ix C. References	475
		7/3