

Contents

About the contributors	xi
Acknowledgments	xv
Introduction: A historical overview of the development of the road	1
<i>C.A. O'Flaherty</i>	
1 Road location	6
<i>C.A. O'Flaherty</i>	
1.1 Complexity of the location process	6
1.2 Overview of the location process	7
1.3 Location surveys in non-built-up locales	8
1.4 Road location in built-up areas	21
1.5 Locating water crossings	23
1.6 Aerial photography	25
1.7 Other remote sensing techniques	30
1.8 References	32
2 Subsurface investigations	34
<i>C.A. O'Flaherty</i>	
2.1 Investigation aims	34
2.2 Sequencing of the investigation	35
2.3 Subsurface exploration methods	43
2.4 Preparing the main report	51
2.5 References	52
3 Plans, specifications and contracts	53
<i>A. Boyle</i>	
3.1 Classical steps in preparing a programme for a major road: an overview	53
3.2 Documentation of a major road improvement project	58
3.3 The European dimension	64
3.4 References	65
4 Soils for roadworks	66
<i>C.A. O'Flaherty</i>	
4.1 Soil formation and types of soil	66
4.2 Soil profiles	70
4.3 Soil particles	72

4.4	Soil water	77
4.5	Soil phase relationships	80
4.6	Frost action in soils	83
4.7	Identification and description of soils in the field	89
4.8	Soil classification	93
4.9	Basic soil tests	99
4.10	Soil testing: a comment on the European dimension	115
4.11	References	116
5 Materials used in road pavements		118
<i>M.J. Brennan and C.A. O'Flaherty</i>		
5.1	Penetration-grade refinery bitumens	118
5.2	Natural asphalts	127
5.3	Cutback bitumens	127
5.4	Bitumen emulsions	128
5.5	Road tars and tar-bitumens	130
5.6	Modified bitumens	132
5.7	Cements	136
5.8	Limes	138
5.9	Conventional aggregates	139
5.10	Secondary aggregates	153
5.11	References	159
6 Soil-stabilized pavements		163
<i>C.A. O'Flaherty</i>		
6.1	Why stabilize soils?	163
6.2	Mechanical stabilization	163
6.3	Cement stabilization	170
6.4	Lime stabilization	175
6.5	Construction of cement- and lime-treated courses in pavements	179
6.6	Bituminous stabilization	182
6.7	References	184
7 Surface drainage for roads		185
<i>C.A. O'Flaherty</i>		
7.1	Importance of surface drainage	185
7.2	Types and uses of surface drains	186
7.3	Estimating the surface run-off	191
7.4	Draining the carriageway	206
7.5	References	208
8 Subsurface moisture control for road pavements		210
<i>C.A. O'Flaherty</i>		
8.1	Why subsurface moisture control is so important	210
8.2	Protecting the road pavement and foundation	211

8.3	Designing and laying conventional longitudinal subdrains	218
8.4	French drains	222
8.5	Geotextiles in drains	222
8.6	References	223
9	Introduction to pavement design	225
	<i>C.A. O'Flaherty</i>	
9.1	Evolution of the road pavement	225
9.2	The component layers of a road pavement: types and functions	229
9.3	Some basic considerations affecting pavement design	234
9.4	Flexible pavement design methods	255
9.5	Rigid pavement design considerations	259
9.6	References	264
10	Earthworks and unbound bases for pavements	267
	<i>C.A. O'Flaherty</i>	
10.1	Establishing the horizontal and vertical alignments	267
10.2	Earthworks quantities	268
10.3	Balancing earthworks quantities	271
10.4	Excavation and earthmoving equipment	276
10.5	Compaction specifications	278
10.6	Compaction equipment for earthworks	279
10.7	Constructing embankments on soft soils	286
10.8	Materials used in embankments	294
10.9	Preparing the subgrade	295
10.10	Unbound capping and subbase layers	298
10.11	Unbound roadbases	299
10.12	References	301
11	Premixed bituminous-bound courses: standard materials	303
	<i>M.J. Brennan and C.A. O'Flaherty</i>	
11.1	Advantages and disadvantages of standard 'recipe-type' specifications	303
11.2	Harmonization of European standards	304
11.3	Mechanisms by which asphalts and coated macadams distribute traffic stresses	305
11.4	Standard 'recipe-type' specifications currently used in the UK	306
11.5	Possible future standard wearing course materials	322
11.6	References	323
12	Design and construction of hot-mix bituminous surfacings and roadbases	325
	<i>S.E. Zoorob</i>	
12.1	Why design bituminous paving mixtures?	325
12.2	Standard 'recipe' approach	325

12.3	Engineering design approach	326
12.4	Outline of procedure for analysing a compacted paving mixture	327
12.5	Terms used in bituminous mix design	327
12.6	Marshall method of mix design	332
12.7	Advanced mix design methods	340
12.8	Construction methods for hot-mix hot-laid bituminous materials	353
12.9	References	359

13 Concrete pavement construction **362**

C.A. O'Flaherty

13.1	Steps in the construction process	362
13.2	Preparing the foundation	362
13.3	Placing the forms for conventional paving trains	364
13.4	Joint assemblies and reinforcement	365
13.5	Preparing the concrete	366
13.6	Placing and finishing the concrete	367
13.7	Texturing of running surfaces	372
13.8	Curing the concrete	373
13.9	Other pavements with concrete	373
13.10	References	375

14 Current British thickness design practice in relation to new bituminous and concrete pavements **377**

C.A. O'Flaherty

14.1	Introduction	377
14.2	Foundation design	378
14.3	Traffic assessment	381
14.4	Thickness design of pavements	385
14.5	References	393

15 Analytical design of flexible pavements **395**

J. McElvaney and M.S. Snaith

15.1	Introduction	395
15.2	Pavement design period and design loading	397
15.3	Structural analysis of layered elastic systems	402
15.4	Design criteria used in analytical methods	403
15.5	Pavement material and subgrade properties required for structural analysis	405
15.6	Layer characterization for purposes of structural analysis	411
15.7	Damage computations and performance models	415
15.8	Concluding comments	419
15.9	References	419

16 Analysis of stresses in rigid concrete slabs and an introduction to concrete block paving	424
<i>J. Knapton</i>	
16.1 Introduction	424
16.2 Subgrade	424
16.3 Subbase	425
16.4 Modulus of subgrade reaction	425
16.5 Plate bearing and CBR testing	427
16.6 Fibre-reinforced pavement quality concrete	427
16.7 Thermal and moisture-related stresses in concrete slabs	428
16.8 Crack control methods	434
16.9 Spacing of joints	436
16.10 Mechanistic rigid pavement design	436
16.11 Some research results	443
16.12 Design of concrete block paving	447
16.13 References	451
17 Basic road maintenance operations	452
<i>J.E. Oliver</i>	
17.1 Importance of maintenance	452
17.2 Scope of road maintenance	454
17.3 Maintenance management systems	456
17.4 Maintenance rating systems for bituminous roads	460
17.5 Maintenance rating systems for concrete roads	463
17.6 Maintenance of bituminous pavements	464
17.7 Maintenance of concrete pavements	467
17.8 Maintenance of unsurfaced soil–aggregate pavements	468
17.9 Maintenance of other roadway features	469
17.10 Winter maintenance operations	473
17.11 External influences on maintenance operations	475
17.12 Future directions of road maintenance	477
17.13 References	477
18 Wet skid resistance	479
<i>A.R. Woodside and W.D.H. Woodward</i>	
18.1 Introduction	479
18.2 What is wet skid resistance?	479
18.3 Why should the highway engineer consider wet skid resistance?	480
18.4 Development of methods to measure wet skid resistance	483
18.5 What is a wet road surface?	484
18.6 The mechanics of wet skidding	484
18.7 The measurement and prediction of wet skid resistance	489
18.8 A critical evaluation of the PSV test method	494
18.9 The contact patch: understanding what happens	495
18.10 Conclusions	497
18.11 References	498

19 Design and use of surface treatments	500
<i>H.A. Khalid</i>	
19.1 Surface treatment types and purposes	500
19.2 Surface dressings recommended in Road Note 39	501
19.3 Factors affecting the use of surface dressing systems	504
19.4 Theory underlying the design of surface dressing	505
19.5 Applying surface dressing and avoiding failure	509
19.6 Slurry seals	511
19.7 Thin surface treatments	511
19.8 References	513
20 Structural maintenance of road pavements	516
<i>D. McMullen and M.S. Snaith</i>	
20.1 Introduction	516
20.2 Concept of pavement strengthening	516
20.3 Structural assessment procedure	517
20.4 Use of deflection measurements	521
20.5 Use of deflection–life relationships	524
20.6 Overlay design methods for flexible pavements	529
20.7 Overlay design methods for concrete pavements	537
20.8 References	544
Index	547