# Contents

**Preface** ix  
**1 Introduction** 1  
  1.1 Pavement Types 1  
  1.2 Pavement Infrastructure Overview 5  
  1.3 Significance of Pavement Infrastructure to the Nation's Economic Activity 6  
  1.4 Funding Pavements 7  
  1.5 Engineering Pavements 10  
  1.6 Book Organization 10  
  References 11  
  Problems 12  

**2 Pavement Traffic Loading** 13  
  2.1 Introduction 13  
  2.2 Traffic-Monitoring Technology 14  
  2.3 Summarizing Traffic Data for Pavement Design Input 24  
  2.4 Load Limits and Enforcement 34  
  References 37  
  Problems 39  

**3 Characterization of Pavement Subgrades and Bases** 41  
  3.1 Introduction 41  
  3.2 Mechanical Behavior 41  
  3.3 Resilient Response 43  
  3.4 Plastic Response 57  
  3.5 Other Aggregate Layer Indices 61  
  3.6 Aggregate and Soil Stabilization 65  
  References 68  
  Problems 71
4 Aggregates 73
  4.1 Introduction 73
  4.2 Aggregate Types and Classifications 74
  4.3 Aggregate Properties 76
References 102
Problems 104

5 Asphalt Materials 107
  5.1 Introduction 107
  5.2 Chemical Composition of Asphalt Binders 108
  5.3 Preliminaries on Rheology and Viscoelasticity 111
  5.4 Asphalt Binder Properties 121
  5.5 Asphalt Grades 129
  5.6 Binder Modification 141
  5.7 Asphalt Mixture Volumetric Analysis 144
  5.8 Asphalt Mixture Properties 148
References 158
Problems 160

6 Concrete Materials 163
  6.1 Introduction 163
  6.2 Cementitious Materials 163
  6.3 Hydration 164
  6.4 Chemical Admixtures 168
  6.5 Properties of Cement, Paste, and Mortar 168
  6.6 Properties of Concrete 171
References 180
Problems 180

7 Flexible Pavement Analysis 183
  7.1 Introduction 183
  7.2 Single-Layer Elastic Solutions 184
  7.3 Two-Layer Elastic Solutions 189
  7.4 Multilayer Linear Elastic Solutions 192
  7.5 Multilayer Nonlinear Elastic Solutions 194
  7.6 Viscoelastic Solutions 196
References 203
Problems 204

8 Rigid Pavement Analysis 207
  8.1 Introduction 207
  8.2 Overview of the Elastic Theory on Plates 210
  8.3 Environment-Induced Stresses 213
## Contents

8.4 Load-Induced Stresses 221  
8.5 Finite Element Method Solutions 232  
References 244  
Problems 246  

9 Pavement Evaluation 251  
9.1 Introduction 251  
9.2 Serviceability 252  
9.3 Structural Capacity 284  
9.4 Surface Distress 303  
9.5 Safety 316  
References 322  
Problems 326  

10 Environmental Effects on Pavements 331  
10.1 Introduction 331  
10.2 Water in Pavements 332  
10.3 Heat in Pavements 349  
References 358  
Problems 360  

11 Structural Design of Flexible Pavements 363  
11.1 Introduction 363  
11.2 AASHTO 1986/1993 Design Method 364  
11.3 Asphalt Institute Design Method 376  
11.4 NCHRP 1-37A Design Method 378  
References 391  
Problems 393  

12 Structural Design of Rigid Pavements 399  
12.1 Introduction 399  
12.2 AASHTO 1986/1993 Design Method 400  
12.3 PCA Design Method 412  
12.4 NCHRP 1-37A Design Method 418  
References 444  
Problems 446  

13 Pavement Rehabilitation 451  
13.1 Introduction 451  
13.3 Asphalt Institute Flexible Pavement Overlay Design Method 460  
13.4 AASHTO (1993) Rigid Pavement Overlay Design Method 460  
13.5 NCHRP 1-37A Overlay Design Method 465
Contents

References 470
Problems 471

14 Economic Analysis of Pavement Project Alternatives 473
14.1 Introduction 473
14.2 Overview of Time Value of Money Concepts 475
14.3 Methods for Economic Comparison of Alternatives 483
14.4 Cost Components in Pavement LCCA 492
References 526
Problems 532

Index 535