SI EDITION

Fourth Edition

TRAFFIC AND HIGHWAY ENGINEERING

NICHOLAS J. GARBER

LESTER A. HOEL

Contents

PART 1	■ INTRODUCTION 1	
1	The Profession of Transportation 3	
	Importance of Transportation 3 Transportation History 6 Transportation Employment 16 Summary 23 Problems 24 References 25	
2	Transportation Systems and Organizations Developing a Transportation System 27 Modes of Transportation 34 Transportation Organizations 47 Summary 51 Problems 52 References 54	2
PART 2	■ TRAFFIC OPERATIONS	55
3	Characteristics of the Driver, the Pedestrian, the Vehicle, and the Road 57 Driver Characteristics 58 Perception-Reaction Process 60 Older Drivers' Characteristics 61 Pedestrian Characteristics 62 Bicyclists and Bicycles Characteristics 62 Vehicle Characteristics 63 Road Characteristics 88	

	Problems 95 References 98
4	Traffic Engineering Studies 99 Spot Speed Studies 100 Volume Studies 115 Travel Time and Delay Studies 133 Parking Studies 139 Summary 146 Problems 147 References 150
5	Highway Safety 151 Issues Involved in Transportation Safety 152 Strategic Highway Safety Plans 154 Effectiveness of Safety Design Features 190 Summary 208 Problems 208 Rèferences 212
6	Fundamental Principles of Traffic Flow 213 Traffic Flow Elements 213 Flow-Density Relationships 218 Shock Waves in Traffic Streams 230 Gap and Gap Acceptance 243 Introduction to Queuing Theory 249 Summary 258 Problems 258
7	Intersection Design 265 Types of At-Grade Intersections 266 Design Principles for At-Grade Intersections 276 Design of Railroad Grade Crossings 314 Summary 320 Problems 322 References 325
8	Intersection Control 327 General Concepts of Traffic Control 327 Conflict Points at Intersections 331 Types of Intersection Control 332 Signal Timing for Different Color Indications 342 Freeway Ramps 373 Summary 378 Problems 378

Summary 93

References

380

9	Capacity and Level of Service for Highway Segments Two-Lane Highways 382 Freeways 406 Multilane Highways 424 Summary 430 Problems 431 References 434 Appendix: Tables 434	381
10	Capacity and Level of Service at Signalized Intersections Definitions of Some Common Terms 457 Level of Service at Signalized Intersections 460 Summary 528 Problems 528 References 533 Appendix: Tables 534	457
PART 3 ■	TRANSPORTATION PLANNING 549	
11	The Transportation Planning Process 551 Basic Elements of Transportation Planning 552 Transportation Planning Institutions 562 Urban Transportation Planning 566 Forecasting Travel 574 Summary 586 Problems 587 References 588	
12	Forecasting Travel Demand 591 Demand Forecasting Approaches 591 Trip Generation 593 Trip Distribution 603 Mode Choice 613 Traffic Assignment 625 Other Methods for Forecasting Demand 633 Estimating Freight Demand 637 Traffic Impact Studies 638 Summary 644 Problems 645 References 652	
13	Evaluating Transportation Alternatives 653 Basic Issues in Evaluation 653 Evaluation Based on Economic Criteria 657 Evaluation Based on Multiple Criteria 669 Summary 684 Problems 684 References 689	

PART 4	■ LOCATION, GEOMETRICS, AND DRAINAGE 691	
14	Highway Surveys and Location 693 Principles of Highway Location 693 Highway Survey Methods 701 Highway Earthwork and Final Plans 723 Summary 731 Problems 733 References 734	
15	Geometric Design of Highway Facilities 737 Factors Influencing Highway Design 738 Design of the Alignment 754 Special Facilities for Heavy Vehicles on Steep Grades Bicycle Facilities 791 Parking Facilities 796 Computer Use in Geometric Design 801 Summary 802 Problems 802 References 805	790
16	Highway Drainage 807 Surface Drainage 807 Highway Drainage Structures 809 Sediment and Erosion Control 811 Hydrologic Considerations 813 Unit Hydrographs 826 Hydraulic Design of Highway Drainage Structures Subsurface Drainage 870 Economic Analysis 889 Summary 889 Problems 889 References 891 Additional Readings 892	827
PART 5 17	MATERIALS AND PAVEMENTS Soil Engineering for Highway Design 895 Soil Characteristics 895 Basic Engineering Properties of Soils 899 Classification of Soils for Highway Use 907 Soil Surveys for Highway Construction 917	893
	Soil Compaction 922 Special Soil Tests for Pavement Design 932 Frost Action in Soils 936 Summary 937 Problems 937 References 941	

18	Bituminous Materials 943	
	Sources of Asphalt 943 Description and Uses of Bituminous Binders Properties of Asphalt Materials 949 Tests for Asphalt Materials 953 Asphalt Mixtures 969 Superpave Systems 992 Summary 1019 Problems 1019 References 1022	946
19	Design of Flexible Pavements 1025	
	Structural Components of a Flexible Pavement Soil Stabilization 1027	1025
	General Principles of Flexible Pavement Design Summary 1070 Problems 1070 References 1073	1032
20	Design of Rigid Pavements 1075 Materials Used in Rigid Pavements 1081 Joints in Concrete Pavements 1081 Types of Rigid Highway Pavements 1083 Pumping of Rigid Pavements 1084 Stresses in Rigid Pavements 1085 Thickness Design of Rigid Pavements 1093 Summary 1129 Problems 1129 References 1131	
21	Pavement Management 1133 Problems of Highway Rehabilitation 1133 Methods for Determining Roadway Condition Pavement Condition Prediction 1151 Pavement Rehabilitation 1160 Pavement Rehabilitation Programming 1162 GIS and Pavement Management 1172 Summary 1174 Problems 1174 References 1176 Appendixes 1177	1136
	Index 1206	