National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

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NCHRP Manager: Crawford F. Jencks

Continuing Project to Synthesize Information on Highway Problems

A staff digest of the progress and status of NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," for which the Transportation Research Board is the agency conducting the research. Individual studies for the project are managed by Stephen F. Maher, P.E., Manager, Synthesis Studies, and Donna L. Vlasak, Senior Program Officer, serving under the Studies and Information Services Division of the Board, Stephen R. Godwin, Director.

INTRODUCTION

Administrators, practicing engineers, and researchers continually face highway problems on which much information already exists, either in documented form or in terms of undocumented experience and practice. Unfortunately, this information is often fragmented, scattered, and underevaluated. Often it is unknown to the person normally responsible for making decisions related to the topic. As a consequence, full knowledge of what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the ideas of practitioners faced with problems in their day-to-day work. Because there had been no systematic means for bringing such useful information together and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing study, NCHRP Project 20-5,

"Synthesis of Information Related to Highway Problems." This study is intended to search out and synthesize useful knowledge from all possible sources and to prepare documented reports on

Suggestions for synthesis topics may be sent to the NCHRP Manager at any time (see address on back). You can also submit your recommendation http://www4.nationalacademies.org/trb/ synthsis.nsf "SUGGEST an NCHRP or TCRP Synthesis Topic." Topics suggested must be accompanied by a brief scope statement including a discussion of the problem (a paragraph or two). A title (preferably 10 words or less) and the name and affiliation of the submitter are also necessary. Identification of information sources would be appreciated too. Suggestions for updates of published syntheses are also welcome. A committee meets once a year, usually in the late spring, to make the final selections. To be considered at the next spring meeting, all recommended topics should be posted by **January 31.** If a topic is not selected, the problem statement must be resubmitted the following year to be reconsidered.

Interested in writing a synthesis? For details, contact Stephen F. Maher, P.E. by e-mail at smaher@nas.edu, or by phone at 202-334-3245 or Donna L. Vlasak, by e-mail at dvlasak@nas.edu, or by phone at 202-334-2974.

current practices in the subject areas of concern. Reports from this endeavor constitute an NCHRP report series, Synthesis of Highway Practice, that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems.

THE SYNTHESIS PROGRAM

This synthesis series attempts to report on the various practices, making some recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which they are used in this fashion will be tempered by the breadth of the user's knowledge in the particular problem area.

To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, the Transportation Research Board analyzes available information assembled from numerous sources, including state departments of transportation. A panel of experts in the subject area is established to guide the researchers in organizing and evaluating the data collected on each topic and to review the synthesis report.

For each topic the project objectives are (1) to locate and assemble documented information; (2) to learn what practice has been used for solving or alleviating the problems; (3) to identify all ongoing research; (4) to learn what problems remain largely unsolved; (5) to organize, evaluate, and document the useful information that is acquired; and (6) to evaluate the effectiveness of the synthesis after it has been in the hands of its users for a period of time.

Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that which is now at hand; eventually the synthesis may need to be updated or redone. The readers and users of the syntheses are in the best position to know when this has occurred. Whenever you believe that a synthesis should be updated, it would be appreciated if you would contact TRB and let us know.

Studies in Progress and Planned for 2001

Work is currently under way on the topics listed in Table 1. Topics selected for the current program are listed in Table 2. Questions on these topics should be addressed to the project study managers, Stephen F. Maher, P.E. (202-334-3245) or Donna L. Vlasak (202-334-2974).

Selection of Topics

NCHRP Project Committee SP20-5 meets each year to select topics for study using funds from the upcoming fiscal year. The membership of this committee is given in Table 3. Current funding allows for initiation of about 12 syntheses per year. This number, plus some alternate topics, is selected by the committee at the annual project meeting.

The following factors are considered in the selection process for synthesis topics:

- The topic should address a problem that is widespread enough to generate broad interest in the synthesis.
- The topic should be timely and critical with respect to safety, economic, or social impact.
- The topic is appropriate if current practice is nonuniform or inconsistent from agency to agency, or if the validity of some practices appears to be questionable.
- The quality and quantity of useful available information should indicate a need to organize and compress that which has already been learned and written on the topic.
- The topic should not be one where ongoing research or other activities in progress might be expected to render the synthesis obsolete shortly after completion.

Each year many more topics are suggested for the committee's consideration than can be programmed for study in Project 20-5. Nevertheless, the continued success of this project depends on a constant supply of worthy synthesis topics. The interest of those who have recommended topics is sincerely appreciated, and they are urged to continue. Candidate topics are suggested by members of the committee and by a variety of other sources, including state department of transportation personnel; FHWA, AASHTO, and TRB committees; and other practioners and researchers.

Available Publications

The Syntheses of Highway Practice that have been completed under this project are listed in Table 4. Three Research Results Digests on topics studied under the project are also listed. In addition, two unpublished reports are available. The unpublished reports are for information only as they have not undergone the full review process of a published study. Copies of these Syntheses, Digests, and unpublished reports can be obtained from the Publications Office, Transportation Research Board, 2101 Constitution Avenue N.W., Washington, D.C. 20418; by calling (202) 334-3213; and through the Internet at http://nationalacademies.org/trb/bookstore/

Index of Topic Subjects

Table 5 is an index to published syntheses, unpublished studies, and digests and topics under study, as well as those expected to be started through 2001.

Conduct of the Studies

Throughout the year, following the project committee's selection of topics, studies are essentially

initiated in the order of priority assigned by the committee. A panel consisting of practitioners and researchers is formed for each topic. At its first meeting, this topic panel thoroughly discusses the topic, refines the scope, suggests sources of information, and identifies and discusses potential topic consultants.

Following this meeting, an agreement is made with a consultant to gather information on the topic, synthesize it, and draft a report. Typically, the agreement covers a period of 15 months. Information gathering and preparation of the first draft of the synthesis report takes about 8 months. This draft is reviewed by the topic panel with the consultant, often at the second panel meeting. A revised draft is then prepared by the consultant. Subsequent drafts and meetings are scheduled if needed, although this rarely occurs.

After the staff is substantially satisfied with the report, a final draft is sent to the members of NCHRP Project Committee SP20-5 for their approval. At the same time, members of the topic panel have their last chance to review the report, which is subsequently published as an NCHRP Synthesis of Highway Practice.

Table 1
TOPICS BEING STUDIED

No.	Title	No.	Title
30-01	Systems Engineering Processes for Developing Traffic Signal Systems	32-03	Impact of Red Light Camera Enforcement on Crash Experience
30-08	Bridge Deck Joint Performance	32-04	Significant Findings from Full-Scale/Accelerated
30-09	Quality Assurance of Structural Materials		Pavement Testing
31-01	Recent Geometric Design Research for Improved Safety	32-05	Driveway Regulation Practices
	and Operations	32-06	Public Benefits of Highway System Maintenance and
31-03	Assessment and Rehabilitation of Existing Culverts		Operations
31-04	Performance Measures for Research, Development, and Technology Programs	32-07	Performance Measures of Operational Effectiveness for Highway Segments and Systems
31-05	Collecting, Processing, and Integrating GPS Data into a	32-08	Cost-Effective Structures for Off-System Bridges
	GIS	32-09	Transportation Planning and Management for Special
31-06	Facilitating Partnerships in Transportation Research		Events
31-07	Long-Term Pavement Marking Practices	32-10	Compensation for Contractors Home Office Overhead
31-12	Ecological Mitigation	32-11	Interaction Between Wildlife Ecology and Roadways
32-01	Dealing with Truck Parking Demands	32-12	Owner Controlled Insurance Programs
32-02	Strategies for Managing Increasing Truck Traffic		Ç

Table 2 SYNTHESIS TOPICS SELECTED FOR THE FY 2001 PROGRAM

No.	Title	No.	Title
33-01	Design Exception Practices	33-11	Including Tourism and Recreation Travel in Metropolita
	Precast Structural Elements for Bridge Construction	33 11	and Statewide Transportation Plans
33-03	State Product Evaluation Programs	33-12	Integration of Freight Transportation with Intermodal
33-04	Management of Roadside Vegetation		Facilities
33-05	Quick Clearance of Traffic Incidents		
33-06	Roadway Safety Tools for Localities	Alterno	ate Topics
33-07	Safety Management Systems in Practice	33-13	Tools for Predicting Bicycle and Pedestrian Use
33-08	Strategies for Recruiting and Maintaining Individuals in	33-14	Institutional Frameworks for Statewide Transportation
	Transportation Related Jobs		Planning and Investment Decisions
33-09	Statewide Highway Letting Program Management	33-15	Alternative Fuels Evaluation Procedures and Selection
33-10	Steel Bridge Erection Practices		Systems

Table 3 NCHRP PROJECT COMMITTEE SP20-5

Chairman

C.	. Ian MacGillivray					
Iowa Department of Transportation						
Kenneth C. Afferton (Retired)	Wesley S.C. Lum					
New Jersey Department of Transportation	California Department of Transportation					
Susan Binder	Gary Taylor					
Federal Highway Administration	Michigan Department of Transportation					
Thomas R. Bohuslav	J. Richard Young, Jr., P.E. (Retired)					
Texas Department of Transportation	Mississippi Department of Transportation					
Nicholas J. Garber						
University of Virginia	Liaisons					
Dwight Horne	William Zaccagnino					
Federal Highway Administration	Federal Highway Administration					
Ysela Llort	Mark R. Norman					
Florida Department of Transportation	Transportation Research Board					

Table 4 COMPLETED SYNTHESES

No. Title, Pages, Price

- Traffic Control for Freeway Maintenance (1969) 47 pp., \$2.20
- Bridge Approach Design and Construction Practices (1969) 30 pp. 2. (microfiche)3
- Traffic-Safe and Hydraulically Efficient Drainage Practice (1969) 38 pp. (microfiche)*
- Concrete Bridge Deck Durability (1970) 28 pp. (microfiche)* (supplemented by Synthesis 57)
- Scour at Bridge Waterways (1970) 37 pp. (microfiche)*
- Principles of Project Scheduling and Monitoring (1970) 43 pp. (microfiche)*
- Motorist Aid Systems (1971) 28 pp., \$2.40
- Construction of Embankments (1971) 38 pp. (microfiche)* Pavement Rehabilitation—Materials and Techniques (1972) 41 pp. (out of 9.
- Recruiting, Training, and Retaining Maintenance and Equipment Personnel (1972) 35 pp. (microfiche)*
- Development of Management Capability (1972) 50 pp. (out of print)
- Telecommunications Systems for Highway Administration and Operations 12. (1972) 39 pp., \$2.80 (superseded by Synthesis 165)
- Radio Spectrum Frequency Management (1972) 32 pp., \$2.80
- Skid Resistance (1972) 66 pp. (microfiche)*
- Statewide Transportation Planning—Needs and Requirements (1973) 41 pp. (microfiche)* (superseded by Synthesis 95)
- Continuously Reinforced Concrete Pavement (1973) 23 pp., \$2.80
- Pavement Traffic Marking—Materials and Application Affecting Serviceability (1973) 44 pp., \$3.60 (superseded by Synthesis 138)
- Erosion Control on Highway Construction (1973) 52 pp. (microfiche)*
- Design, Construction, and Maintenance of PCC Pavement Joints (1973) 40 19. pp. (out of print)
- Rest Areas (1973) 38 pp., \$3.60
- Highway Location Reference Methods (1974) 30 pp., \$3.20
- Maintenance Management of Traffic Signal Equipment and Systems (1974) 41 pp. (microfiche)* (superseded by Synthesis 114)
- Getting Research Findings Into Practice (1974) 24 pp., \$3.20
- Minimizing Deicing Chemical Use (1974) 58 pp. (microfiche)*
- Reconditioning High-Volume Freeways in Urban Areas (1974) 56 pp., \$4.00
- Roadway Design in Seasonal Frost Areas (1975) 104 pp. (microfiche)* PCC Pavements for Low-Volume Roads and City Streets (1975) 31 pp. (microfiche)*
- Partial-Lane Pavement Widening (1975) 30 pp., \$3.20
- Treatment of Soft Foundations for Embankments (1975) 25 pp., \$3.20 (supplemented by Synthesis 147)
- Bituminous Emulsions for Highway Pavements (1975) 76 pp. (microfiche)* Highway Tunnel Operations (1975) 29 pp., \$3.20
- Effects of Studded Tires (1975) 46 pp., \$4.00
- Acquisition and Use of Geotechnical Information (1976) 40 pp., \$4.00
- Policies for Accommodation of Utilities on Highway Rights of Way (1976) 22 pp. (microfiche)*
- Design and Control of Freeway Off-Ramp Terminals (1976) 61 pp., \$4.40 35. Instrumentation and Equipment for Testing Highway Materials, Products, 36.
- and Performance (1976) 70 pp., \$4.80
- Lime-Fly Ash-Stabilized Bases and Subbases (1976) 66 pp. (microfiche)*
- Statistically Oriented End-Result Specifications (1976) 40 pp., \$4.00
- Transportation Requirements for the Handicapped, Elderly, and Economi-39 cally Disadvantaged (1976) 54 pp. (out of print)
- Staffing and Management for Social, Economic, and Environmental Impact Assessments (1977) 43 pp., \$4.00
- Bridge Bearings (1977) 62 pp. (microfiche)* Design of Pile Foundations (1977) 68 pp., \$4.80 42.
- Energy Effects, Efficiencies, and Prospects for Various Modes of 43. Transportation (1977) 57 pp., \$4.80 (supplemented by Synthesis 121)
- Consolidation of Concrete for Pavements, Bridge Decks, and Overlays (1977) 61 pp., \$4.80
- Rapid-Setting Materials for Patching of Concrete (1977) 13 pp. (out of print) Recording and Reporting Methods for Highway Maintenance Expenditures
- (1977) 35 pp., \$3.60
- Effect of Weather on Highway Construction (1978) 29 pp., \$3.20
- Priority Programming and Project Selection (1978) 31 pp. (out of print)
- Open-Graded Friction Courses for Highways (1978) 50 pp., \$4.00 Durability of Drainage Pipe (1978) 37 pp. (microfiche)*
 Construction Contract Staffing (1978) 62 pp., \$6.00
- Management and Selection Systems for Highway Maintenance Equipment (1978) 17 pp., \$4.40

No. Title, Pages, Price

- 53. Precast Concrete Elements for Transportation Facilities (1978) 48 pp., \$5.60
- Recycling Materials for Highways (1978) 53 pp. (microfiche)*
- Storage and Retrieval Systems for Highway and Transportation Data (1978) 30 pp., \$4.80
- JointRelated Distress in PCC Pavement—Cause, Prevention, and Rehabilitation (1979) 36 pp., \$5.20 Durability of Concrete Bridge Decks (1979) 61 pp. (microfiche)*
- (supplements Synthesis 4)
- Consequences of Deferred Maintenance (1979) 24 pp., \$4.40
- Relationship of Asphalt Cement Properties to Pavement Durability (1979) 43
- pp., \$5.60 Failure and Repair of Continuously Reinforced Concrete Pavement (1979) 42 pp., \$5.60
- Changeable Message Signs (1979) 37 pp., \$5.60
- Potential State Resources for Financing Transportation Programs (1979) 34 pp., \$5.20
- Design and Use of Highway Shoulders (1979) 26 pp., \$4.80
- Bituminous Patching Mixtures (1979) 26 pp., \$4.80
- Quality Assurance (1979) 42 pp., \$5.60

- Glare Screen Guidelines (1979) 17 pp., \$4.40 Bridge Drainage Systems (1979) 44 pp., \$5.60 Motor Vehicle Size and Weight Regulation, Enforcement, and Permit 68. Operations (1980) 45 pp., \$6.00
- Bus Route and Schedule Planning Guidelines (1980) 99 pp., \$8.00
- Design of Sedimentation Basins (1980) 53 pp., \$6.80
- Direction Finding from Arterials to Destinations (1980) 50 pp., \$6.40
- Transportation Needs Studies and Financial Constraints (1980) 54 pp., \$6.40 72. Alternative Work Schedules: Impacts on Transportation (1980) 54 pp., \$6.80 73.
- State Transit-Management Assistance to Local Communities (1980) 34 pp., 74.
- \$6.00
- 75 Transit Boards—Composition, Roles, and Procedures (1981) 24 pp., \$6.20
- 76 Collection and Use of Pavement Condition Data (1981) 74 pp., \$8.00
- Evaluation of Pavement Maintenance Strategies (1981) 56 pp., \$7.40 Value Engineering in Preconstruction and Construction (1981) 23 pp., \$6.40
- Contract Time Determination (1981) 45 pp., \$7.20
- Formulating and Justifying Highway Maintenance Budgets (1981) 49 pp., \$7.20
- 81.
- Experiences in Transportation System Management (1981) 88 pp., \$8.40 Criteria for Evaluation of Truck Weight Enforcement Programs (1981) 74
- Bus Transit Accessibility for the Handicapped in Urban Areas (1981) 73 pp., \$7.60
- 84. Evaluation Criteria and Priority Setting for State Highway Programs (1981) 32 pp., \$6,40
- Energy Involved in Construction Materials and Procedures (1981) 34 pp., \$6.40
- 86. Effects of Traffic-Induced Vibrations on Bridge Deck Repairs (1981) 40 pp., \$6.80
- Highway Noise Barriers (1981) 81 pp., \$7.20
- Underwater Inspection and Repair of Bridge Substructures (1981) 77 pp., \$7.60
- 89 Geotechnical Instrumentation for Monitoring Field Performance (1982) 46
- pp., \$6.80 NewProduct Evaluation Procedures (1982) 34 pp., \$6.80
- Highway Accident Analysis Systems (1982) 69 pp., \$7.60
- Minimizing Reflection Cracking of Pavement Overlays (1982) 38 pp., \$6.80
- Coordination of Transportation System Management and Land Use Management (1982) 38 pp., \$6.80
- Photologging (1982) 38 pp., \$6.80
- Statewide Transportation Planning (1982) 54 pp., \$7.20 (supersedes Synthesis 15)
- Pavement Subsurface Drainage Systems (1982) 38 pp., \$6.80
- Transit Ownership/Operation Options for Small Urban and Rural Areas (1982) 28 pp., \$6.40
- 98. Resealing Joints and Cracks in Rigid and Flexible Pavements (1982) 62 pp.,
- 99 Resurfacing with Portland Cement Concrete (1982) 90 pp., \$8.40
- 100
- Managing State Highway Finance (1982) 23 pp., \$6.40 Historic Bridges—Criteria for Decision Making (1983) 77 pp., \$8.00
- Material Certification and Material-Certification Effectiveness (1983) 17 pp.,

Table 4 (continued)

No. Title, Pages, Price No. Title, Pages, Price 103. Risk Assessment Processes for Hazardous Materials Transportation (1983) Recycling Portland Cement Concrete Pavements (1989) 46 pp., \$8.00 26 pp., \$6.40 Freeway Guide Sign Replacement: Policies and Criteria (1991) 37 pp., \$8.00 104. Criteria for Use of Asphalt Friction Surfaces (1983) 41 pp., \$6.80 Freeway Incident Management (1990) 23 pp., \$7.00 Maintenance Management of Street and Highway Signs (1990) 134 pp., Construction Contract Claims: Causes and Methods of Settlement (1983) 58 105 \$12.00 pp., \$7.20 Practical Guidelines for Minimizing Tort Liability (1983) 40 pp., \$6.80 Shallow Foundations for Highway Structures (1983) 38 pp., \$6.80 Wet-Pavement Safety Programs (1990) 54 pp., \$8.00 158. 106. Design and Construction of Bridge Approaches (1990) 45 pp., \$8.00 Bridge Weight-Limit Posting Practices (1984) 30 pp., \$6.40 Cold-Recycled Bituminous Concrete Using Bituminous Materials (1990) 105 160. pp., \$11.00 Highway Uses of Epoxy with Concrete (1984) 68 pp., \$8.80 110. Maintenance Management Systems (1984) 49 pp., \$8.00 161 Computer-Aided Design and Drafting Systems (1990) 24 pp., \$7.00 Distribution of Wheel Loads on Highway Bridges (1984) 22 pp., \$7.20 Signing Policies, Procedures, Practices, and Fees for Logo and Tourist-111. Cost Effectiveness of Hot-Dip Galvanizing for Exposed Steel (1984) 28 pp., Oriented Directional Signing (1990) 41 pp., \$8.00 112. Innovative Strategies for Upgrading Personnel in State Transportation 113. Administration of Research, Development, and Implementation Activities in Departments (1990) 35 pp., \$7.00 Highway Agencies (1984) 49 pp., \$8.00 Measures to Curtail State Fuel Tax Evasion (1990) 14 pp., \$7.00 Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 Transportation Telecommunications (1990) 92 pp., \$10.00 (supersedes (supersedes Synthesis 22) Synthesis 12) Reducing Construction Conflicts between Highways and Utilities (1984) 73 Traffic Signal Control Equipment: State of the Art (1990) 43 pp., \$8.00 pp., \$8.80 Measurements, Specifications, and Achievement of Smoothness for Pavement Construction (1990) 34 pp., \$8.00 116 Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40 Aspirat Overlay Besign Frocculines (1794) 09 pp., \$6.40 Toll Highway Financing (1984) 29 pp., \$7.20 Detecting Defects and Deterioration in Highway Structures (1985) 52 pp., Contract Management Systems (1990) 74 pp., \$10.00 168. 117. Removing Concrete from Bridges (1991) 42 pp., \$8.00 118. Managing Urban Freeway Maintenance (1990) 32 pp., \$7.00 Prefabricated Bridge Elements and Systems (1985) 75 pp., \$8.80 119. Fabrics in Asphalt Overlays and Pavement Maintenance (1991) 72 pp., \$9.00 Professional Resource Management and Forecasting (1985) 15 pp., \$6.80 120 172 Signal Timing Improvement Practices (1992) 88 pp., \$11.00 Energy Conservation in Transportation (1985) 25 pp., \$7.20 (supplements Short-Term Responsive Maintenance Systems (1991) 43 pp., \$9.00 121. 173. Stormwater Management for Transportation Facilities (1993) 81 pp., \$9.00 Synthesis 43) Life-Cycle Cost Analysis of Pavements (1985) 136 pp., \$10.80 Moisture Damage in Asphalt Concrete (1991) 91 pp., \$10.00 Bridge Designs to Reduce and Facilitate Maintenance and Repair (1985) 65 Bridge Paint: Removal, Containment, and Disposal (1992) 60 pp., \$9.00 123. pp., \$8.40 Freeway Corridor Management (1992) 64 pp., \$9.00 Truck Escape Ramps (1992) 56 pp., \$9.00 177. 124. Use of Weigh-in-Motion Systems for Data Collection and Enforcement 178. (1986) 34 pp., \$7.60 Latex-Modified Concretes and Mortars (1992) 58 pp., \$9.00 Maintenance Activities Accomplished by Contract (1986) 42 pp., \$8.00 Performance Characteristics of Open-Graded Friction Courses (1992) 44 pp., Equipment for Obtaining Pavement Condition and Traffic Loading Data \$8.00 (supplements Synthesis 49) In-Service Experience with Traffic Noise Barriers (1992) 61 pp., \$9.00 (1986) 118 pp., \$11.20 Use of Fly Ash in Concrete (1986) 66 pp., \$8.40 Methods for Identifying Hazardous Highway Elements (1986) 80 pp. 127. Performance and Operational Experience of Truck-Mounted Attenuators (1992) 54 pp., \$9.00 128. (microfiche)3 Knowledge Based Expert Systems in Transportation (1992) 52 pp., \$9.00 Freezing and Thawing Resistance of High-Strength Concrete (1986) 31 pp., 129. Disposal of Roadside Litter Mixtures (1993) 52 pp., \$12.00 \$7.60 185. Preferential Lane Treatments for High-Occupancy Vehicles (1993) 80 pp., 130. 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Negotiating and Contracting for Professional Engineering Services (1988) 75 192 Accident Data Quality (1993) 53 pp., \$12.00 Hot In-Place Recycling of Asphalt Concrete (1994) 69 pp., \$16.00 pp., \$9.60 138. Pavement Markings: Materials and Application for Extended Service Life Electronic Toll and Traffic Management (ETTM) Systems (1993) 64 pp., (1988) 45 pp., \$8.00 (supersedes Synthesis 17) Pedestrians and Traffic Control Measures (1988) 75 pp., \$9.00 Use of Warranties in Road Construction (1994) 60 pp., \$15.00 140. Durability of Prestressed Concrete Highway Structures (1988) 65 pp., \$9.00 Highway Maintenance Procedures Dealing with Hazardous Materials 196. Incidents (1994) 60 pp., \$15.00 Corridor Preservation (1994) 43 pp., \$11.00 141. Bridge Deck Joints (1989) 66 pp., \$9.00 Methods of Cost-Effectiveness Analysis for Highway Projects (1988) 22 pp., 142. Uses of Recycled Rubber Tires in Highways (1994) 162 pp., \$23.00 Recycling and Use of Waste Materials and By-Products in Highway Uniformity Efforts in Oversize/Overweight Permits (1988) 79 pp., \$10.00 Breaking/Cracking and Seating Concrete Pavements (1989) 39 pp., \$8.00 Construction (1994) 84 pp., \$20.00 Underwater Bridge Maintenance and Repair (1994) 54 pp., \$16.00 Multimodal Evaluation in Passenger Transportation (1994) 84 pp., \$19.00 145 Staffing Considerations in Construction Engineering Management (1989) 42 200 pp., \$8.00 201. Use of Consultants for Construction Engineering and Inspection (1989) 64 Severity Indices for Roadside Features (1994) 54 pp., \$12.00 146. pp., \$9.00 Current Practices in Determining Pavement Condition (1994) 57 pp., \$16.00 147. Treatment of Problem Foundations for Highway Embankments (1989) 72 Portland Cement Concrete Resurfacing (1994) 67 pp., \$15.00 pp., \$9.00 Performance and Operational Experience of Crash Cushions (1994) 87 pp., Indicators of Quality in Maintenance (1989) 114 pp., \$11.00 148 \$20.00 Highway Tort Liability Management Programs (1994) 40 pp., \$11.00 Partnerships for Innovation: Private Sector Contributions to Innovation in the 206 Highway Industry (1989) 45 pp., \$8.00 Managing Roadway Snow and Ice Control Operations (1994) 56 pp., \$15.00 150. Technology Transfer in Selected Highway Agencies (1989) 38 pp., \$8.00 Development and Implementation of Traffic Control Plans for Highway

Work Zones (1994) 37 pp., \$11.00

Practice (1994) 77 pp., \$19.00

209.

Sealers for Portland Cement Concrete Highway Facilities (1994) 85 pp.

Road Pricing for Congestion Management: A Survey of International

Process for Recapitalizing Highway Transportation Systems (1989) 43 pp.,

Evolution and Benefits of Preventive Maintenance Strategies (1989) 69 pp.,

Compaction of Asphalt Pavement (1989) 42 pp., \$8.00

151.

152.

153.

\$8.00

^{*}These syntheses are available from TRB in microfiche form only at a cost of \$10.00 each.

No. Title, Pages, Price

- Design, Construction, and Maintenance of PCC Pavement Joints (1995) 211. 50 pp., \$12.00
- Performance-Related Specifications for Highway Construction and Rehabilitation (1995) 48 pp., \$14.00
- 213. Effective Use of Park-and-Ride Facilities (1995) 45 pp., \$11.00
- Resolution of Disputes to Avoid Construction Claims (1995) 39 pp., \$13.00
- 215. Determination of Contract Time for Highway Construction Projects (1995) 43 pp., \$11.00
- 216. Implementation of Technology From Abroad (1995) 44 pp., \$11.00
- 217. Consideration of the 15 Factors in the Metropolitan Planning Process (1995) 55 pp., \$14.00
- Mitigation of Nighttime Construction Noise, Vibrations, and Other Nuisances (1999) 93 pp., \$30.00
- Photographic Enforcement of Traffic Laws (1995) 67 pp., \$18.00 219.
- Waterproofing Membranes for Concrete Bridge Decks (1995) 76 pp., \$21.00
- 221. Effects of Highway Widening Improvements on Urban and Suburban Areas (1996) 43 pp., \$13.00
- 222. Pavement Management Methodologies to Select Projects and Recommend Preservation Treatments (1995) 96 pp., \$22.00
- 223. Cost-Effective Preventive Maintenance of Pavements (1996) 103 pp., \$22.00
- Longitudinal Occupancy of Controlled Access Right-of-Way by Utilities 224. (1996) 30 pp., \$13.00
- Left-Turn Treatments at Intersections (1996) 87 pp., \$22.00 225.
- Remediation of Petroleum-Contaminated Soils (1996) 88 pp., \$22.00
- Collecting and Managing Cost Data for Bridge Management Systems (1996) 227 49 pp., \$15.00
- Reduced Visibility on the Highway (1996) 51 pp., \$15.00
- Applications of 3D and 4D Visualization Technology in Transportation 229. (1996) 73 pp., \$19.00
- 230. Freight Transportation Planning Practices in the Public Sector (1996) 47 pp., \$15.00
- Managing Contract Research Programs (1996) 92 pp., \$23.00
- Variability in Highway Pavement Construction (1996) 38 pp., \$14.00
- Land Development Regulations that Promote Access Management (1996) 45 233. pp., \$14.00
- Settlement of Bridge Approaches (The Bump at the End of the Bridge) 234. (1997) 75 pp., \$24.00
- 235. Application of Full-Scale Accelerated Pavement Testing (1997) 110 pp.,
- Methods for Household Travel Surveys (1997) 57 pp., \$15.00
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