

# NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Sponsored by the American Association of State Highway and Transportation Officials and the Federal Highway Administration

Subject Areas: I Planning, Administration, and Environment; II Design; III Materials, Construction, and Maintenance; IV Operations and Safety; VI Public Transit; VIII Freight Transportation; IX Marine Transportation

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## Research Results Digest 325

### 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 Jon Williams, Manager, Synthesis Studies, Donna L. Vlasak, Senior Program Officer, and Gail Staba, Senior Program Officer, serving under the Studies and Special Programs Division of the Board, Stephen R. Godwin, Director.

### INTRODUCTION

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be 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 is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research

Suggestions for synthesis topics may be sent to the NCHRP Manager at any time by contacting the Cooperative Research Programs Staff, Transportation Research Board, 500 Fifth Street, NW, Washington, D.C., 20001. You can also submit your recommendation at: <http://www.trb.org/Studies/Synthesis/Syntheses.asp> "Suggest an ACRP, NCHRP, or TCRP Synthesis Topic." Topics suggested must be accompanied by a brief (one or two paragraphs) scope statement, including a discussion of the problem. A title (preferably 10 words or less) and the name and affiliation of the submitter are also necessary. Identification of information sources is appreciated. A committee meets once each year, usually in the late spring, to make the final selections. To be considered at the next annual meeting, all submissions should be received by February 2008. If a topic is not selected, it must be resubmitted the following year to be considered.

Interested in writing a synthesis? For details see the Synthesis homepage (address above) under "New Topics."

Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, “Synthesis of Information Related to Highway Problems,” searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, Synthesis of Highway Practice.

## THE SYNTHESIS PROJECT

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be most successful in resolving specific problems.

To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, TRB employs a consultant to gather and analyze available information from numerous sources, including state departments of transportation. A panel of experts in the subject area is established to guide the consultants 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 alle-

viating 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 disseminate the synthesis information to all who might benefit from it.

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. New knowledge can be expected to be added to that which is now at hand and 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 propose a synthesis update by contacting the NCHRP Manager, Transportation Research Board, 500 Fifth Street, NW, Washington, D.C. 20001.

## Studies in Progress and Planned for 2008

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, Jon Williams by e-mail at [jwilliams@nas.edu](mailto:jwilliams@nas.edu), or by phone at 202-334-3245, Donna L. Vlasak, by e-mail at [dvlasak@nas.edu](mailto:dvlasak@nas.edu), or by phone at 202-334-2974, or Gail Staba, by e-mail at [gstaba@nas.edu](mailto:gstaba@nas.edu), or by phone at 202-334-2116.

**Table 1** TOPICS BEING STUDIED

No.	Title	No.	Title
35-11	Links Between Transportation and Economic Development	38-06	Pre-Overlay Treatment of Existing Pavements
36-02	Monitoring Scour Critical Bridges	38-07	Forecasting Metropolitan Commercial and Freight Travel
37-07	Bridge Management Systems for Transportation Agency Decision Making	38-09	Estimating Resilient Modulus Values of Subgrades and Unbound Pavement Materials
37-09	Performance-Based Contracting for Maintenance	38-10	High-Speed Weigh-in-Motion System Calibration Practices
37-11	Debt Financing Practices	38-11	Dynamic Message Sign Displays During Non-Incident, Non-Roadwork Periods
38-01	Quality Assurance in Design-Build Projects	38-12	Alternative Contracting Methods to Facilitate Faster Construction and Reconstruction
38-02	Information Technology for Efficient Project Delivery	38-13	Illuminated, Active, In-Pavement Marker Systems
38-03	Compilation of Public Opinion Data on Tolls and Road Pricing	38-15	Falling Weight Deflectometer Usage
38-04	State Highway Cost Allocation Studies		
38-05	LED Traffic Signal Monitoring, Maintenance, and Replacement Issues		

**Table 2** SYNTHESIS TOPICS SELECTED FOR THE FY 2007 PROGRAM

No.	Title	No.	Title
39-01	Quality Management of Pavement Distress Data Collection	39-07	Reduce Trash on the Roadsides
39-02	Improving the Safety of Moving Lane Closures	39-08	Real-Time Traveler Information for the Public
39-03	Cathodic Protection for Life Extension of Existing Reinforced Concrete Bridge Elements	39-09	Design Flexibility Considerations for Cities
39-04	Performance-Based Construction Contractor Pre-Qualifications	39-10	Adjacent Pre-cast Box Girder Bridges: Connection Details
39-05	Emergency Evacuation and Repopulation	39-11	Long-Term Performance of Polymer Concrete and Best Practices
		39-12	Identify Promising Technologies for Environmental Surveys
		39-13	Pavement Marking Warranty Specifications

### 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. These, plus some alternate topics, are selected by the committee at its 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.

**Table 3** NCHRP PROJECT COMMITTEE SP20-5

Chairman Gary D. Taylor CTE Engineers	
Thomas R. Bohuslav Texas Department of Transportation	Catherine Nelson Oregon Department of Transportation
Dwight Horne Federal Highway Administration	Larry Velasquez New Mexico Department of Transportation
Ysela Llort Florida Department of Transportation	Paul T. Wells Consultant, Ballston Spa, New York
Wesley S. C. Lum California Department of Transportation	<i>Liaisons</i>
James W. March Federal Highway Administration	William Zaccagnino Federal Highway Administration
John M. Mason, Jr. Pennsylvania State University	Stephen F. Maher Transportation Research Board

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 practitioners and researchers.

### Available Publications

The Syntheses of Highway Practice that have been completed under this project are listed in Table 4. Four 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, 500 Fifth Street, NW, Washington D.C. 20001; by calling (202) 334-3213; and through the Internet at <http://trb.org/bookstore>. All reports from No. 295 on (and some selected others) are available as online publications ([http://www.trb.org/news/blurb\\_browse.asp?id=5](http://www.trb.org/news/blurb_browse.asp?id=5) "Cooperative Research Programs").

### 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 2007.

### Conduct of the Studies

Following the project committee's selection of topics, studies are 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, a consultant is hired to gather information on the topic, synthesize it, and draft a report. Typically, the agreement covers a period of 12–15 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 members of the topic panel for their last chance to review the report and then NCHRP Project Committee SP20-5 for final approval. The report is subsequently published as an NCHRP Synthesis of Highway Practice.

**Table 4** COMPLETED SYNTHESSES

No.	Title, Pages, Price	No.	Title, Pages, Price
1.	Traffic Control for Freeway Maintenance (1969) 47 pp., \$2.20	8.	Construction of Embankments (1971) 38 pp. (microfiche)*
2.	Bridge Approach Design and Construction Practices (1969) 30 pp. (microfiche)*	9.	Pavement Rehabilitation—Materials and Techniques (1972) 41 pp. (out of print)
3.	Traffic-Safe and Hydraulically Efficient Drainage Practice (1969) 38 pp. (microfiche)*	10.	Recruiting, Training, and Retaining Maintenance and Equipment Personnel (1972) 35 pp. (microfiche)*
4.	Concrete Bridge Deck Durability (1970) 28 pp. (microfiche)* (supplemented by Synthesis 57)	11.	Development of Management Capability (1972) 50 pp. (out of print)
5.	Scour at Bridge Waterways (1970) 37 pp. (microfiche)*	12.	Telecommunications Systems for Highway Administration and Operations (1972) 39 pp., \$2.80 (superseded by Synthesis 165)
6.	Principles of Project Scheduling and Monitoring (1970) 43 pp. (microfiche)*	13.	Radio Spectrum Frequency Management (1972) 32 pp., \$2.80
7.	Motorist Aid Systems (1971) 28 pp., \$2.40		

**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
14.	Skid Resistance (1972) 66 pp. (microfiche)*	39.	Transportation Requirements for the Handicapped, Elderly, and Economically Disadvantaged (1976) 54 pp. (out of print)
15.	Statewide Transportation Planning—Needs and Requirements (1973) 41 pp. (microfiche)* (superseded by Synthesis 95)	40.	Staffing and Management for Social, Economic, and Environmental Impact Assessments (1977) 43 pp., \$4.00
16.	Continuously Reinforced Concrete Pavement (1973) 23 pp., \$2.80	41.	Bridge Bearings (1977) 62 pp. (microfiche)*
17.	Pavement Traffic Marking—Materials and Application Affecting Serviceability (1973) 44 pp., \$3.60 (superseded by Synthesis 138)	42.	Design of Pile Foundations (1977) 68 pp., \$4.80
18.	Erosion Control on Highway Construction (1973) 52 pp. (microfiche)*	43.	Energy Effects, Efficiencies, and Prospects for Various Modes of Transportation (1977) 57 pp., \$4.80 (supplemented by Synthesis 121)
19.	Design, Construction, and Maintenance of PCC Pavement Joints (1973) 40 pp. (out of print)	44.	Consolidation of Concrete for Pavements, Bridge Decks, and Overlays (1977) 61 pp., \$4.80
20.	Rest Areas (1973) 38 pp., \$3.60	45.	Rapid-Setting Materials for Patching of Concrete (1977) 13 pp. (out of print)
21.	Highway Location Reference Methods (1974) 30 pp., \$3.20	46.	Recording and Reporting Methods for Highway Maintenance Expenditures (1977) 35 pp., \$3.60
22.	Maintenance Management of Traffic Signal Equipment and Systems (1974) 41 pp. (microfiche)* (superseded by Synthesis 114)	47.	Effect of Weather on Highway Construction (1978) 29 pp., \$3.20
23.	Getting Research Findings into Practice (1974) 24 pp., \$3.20	48.	Priority Programming and Project Selection (1978) 31 pp. (out of print)
24.	Minimizing Deicing Chemical Use (1974) 58 pp. (microfiche)*	49.	Open-Graded Friction Courses for Highways (1978) 50 pp., \$4.00
25.	Reconditioning High-Volume Freeways in Urban Areas (1974) 56 pp., \$4.00	50.	Durability of Drainage Pipe (1978) 37 pp. (microfiche)*
26.	Roadway Design in Seasonal Frost Areas (1975) 104 pp. (microfiche)*	51.	Construction Contract Staffing (1978) 62 pp., \$6.00
27.	PCC Pavements for Low-Volume Roads and City Streets (1975) 31 pp. (microfiche)*	52.	Management and Selection Systems for Highway Maintenance Equipment (1978) 17 pp., \$4.40
28.	Partial-Lane Pavement Widening (1975) 30 pp., \$3.20	53.	Precast Concrete Elements for Transportation Facilities (1978) 48 pp., \$5.60
29.	Treatment of Soft Foundations for Embankments (1975) 25 pp., \$3.20 (supplemented by Synthesis 147)	54.	Recycling Materials for Highways (1978) 53 pp. (microfiche)*
30.	Bituminous Emulsions for Highway Pavements (1975) 76 pp. (microfiche)*	55.	Storage and Retrieval Systems for Highway and Transportation Data (1978) 30 pp., \$4.80
31.	Highway Tunnel Operations (1975) 29 pp., \$3.20	56.	Joint Related Distress in PCC Pavement—Cause, Prevention, and Rehabilitation (1979) 36 pp., \$5.20
32.	Effects of Studded Tires (1975) 46 pp., \$4.00	57.	Durability of Concrete Bridge Decks (1979) 61 pp. (microfiche)* (supplements Synthesis 4)
33.	Acquisition and Use of Geotechnical Information (1976) 40 pp., \$4.00	58.	Consequences of Deferred Maintenance (1979) 24 pp., \$4.40
34.	Policies for Accommodation of Utilities on Highway Rights of Way (1976) 22 pp. (microfiche)*	59.	Relationship of Asphalt Cement Properties to Pavement Durability (1979) 43 pp., \$5.60
35.	Design and Control of Freeway Off-Ramp Terminals (1976) 61 pp., \$4.40	60.	Failure and Repair of Continuously Reinforced Concrete Pavement (1979) 42 pp., \$5.60
36.	Instrumentation and Equipment for Testing Highway Materials, Products, and Performance (1976) 70 pp., \$4.80	61.	Changeable Message Signs (1979) 37 pp., \$5.60
37.	Lime-Fly Ash-Stabilized Bases and Subbases (1976) 66 pp. (microfiche)*	62.	Potential State Resources for Financing Transportation Programs (1979) 34 pp., \$5.20
38.	Statistically Oriented End-Result Specifications (1976) 40 pp., \$4.00	63.	Design and Use of Highway Shoulders (1979) 26 pp., \$4.80

**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
64.	Bituminous Patching Mixtures (1979) 26 pp., \$4.80	92.	Minimizing Reflection Cracking of Pavement Overlays (1982) 38 pp., \$6.80
65.	Quality Assurance (1979) 42 pp., \$5.60	93.	Coordination of Transportation System Management and Land Use Management (1982) 38 pp., \$6.80
66.	Glare Screen Guidelines (1979) 17 pp., \$4.40	94.	Photologging (1982) 38 pp., \$6.80
67.	Bridge Drainage Systems (1979) 44 pp., \$5.60	95.	Statewide Transportation Planning (1982) 54 pp., \$7.20 (supersedes Synthesis 15)
68.	Motor Vehicle Size and Weight Regulation, Enforcement, and Permit Operations (1980) 45 pp., \$6.00	96.	Pavement Subsurface Drainage Systems (1982) 38 pp., \$6.80
69.	Bus Route and Schedule Planning Guidelines (1980) 99 pp., \$8.00	97.	Transit Ownership/Operation Options for Small Urban and Rural Areas (1982) 28 pp., \$6.40
70.	Design of Sedimentation Basins (1980) 53 pp., \$6.80	98.	Resealing Joints and Cracks in Rigid and Flexible Pavements (1982) 62 pp., \$7.20
71.	Direction Finding from Arterials to Destinations (1980) 50 pp., \$6.40	99.	Resurfacing with Portland Cement Concrete (1982) 90 pp., \$8.40
72.	Transportation Needs Studies and Financial Constraints (1980) 54 pp., \$6.40	100.	Managing State Highway Finance (1982) 23 pp., \$6.40
73.	Alternative Work Schedules: Impacts on Transportation (1980) 54 pp., \$6.80	101.	Historic Bridges—Criteria for Decision Making (1983) 77 pp., \$8.00
74.	State Transit-Management Assistance to Local Communities (1980) 34 pp., \$6.00	102.	Material Certification and Material-Certification Effectiveness (1983) 17 pp., \$6.00
75.	Transit Boards—Composition, Roles, and Procedures (1981) 24 pp., \$6.20	103.	Risk Assessment Processes for Hazardous Materials Transportation (1983) 26 pp., \$6.40
76.	Collection and Use of Pavement Condition Data (1981) 74 pp., \$8.00	104.	Criteria for Use of Asphalt Friction Surfaces (1983) 41 pp., \$6.80
77.	Evaluation of Pavement Maintenance Strategies (1981) 56 pp., \$7.40	105.	Construction Contract Claims: Causes and Methods of Settlement (1983) 58 pp., \$7.20
78.	Value Engineering in Preconstruction and Construction (1981) 23 pp., \$6.40	106.	Practical Guidelines for Minimizing Tort Liability (1983) 40 pp., \$6.80
79.	Contract Time Determination (1981) 45 pp., \$7.20	107.	Shallow Foundations for Highway Structures (1983) 38 pp., \$6.80
80.	Formulating and Justifying Highway Maintenance Budgets (1981) 49 pp., \$7.20	108.	Bridge Weight-Limit Posting Practices (1984) 30 pp., \$6.40
81.	Experiences in Transportation System Management (1981) 88 pp., \$8.40	109.	Highway Uses of Epoxy with Concrete (1984) 68 pp., \$8.80
82.	Criteria for Evaluation of Truck Weight Enforcement Programs (1981) 74 pp., \$7.20	110.	Maintenance Management Systems (1984) 49 pp., \$8.00
83.	Bus Transit Accessibility for the Handicapped in Urban Areas (1981) 73 pp., \$7.60	111.	Distribution of Wheel Loads on Highway Bridges (1984) 22 pp., \$7.20
84.	Evaluation Criteria and Priority Setting for State Highway Programs (1981) 32 pp., \$6.40	112.	Cost Effectiveness of Hot-Dip Galvanizing for Exposed Steel (1984) 28 pp., \$7.20
85.	Energy Involved in Construction Materials and Procedures (1981) 34 pp., \$6.40	113.	Administration of Research, Development, and Implementation Activities in Highway Agencies (1984) 49 pp., \$8.00
86.	Effects of Traffic-Induced Vibrations on Bridge Deck Repairs (1981) 40 pp., \$6.80	114.	Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 (supersedes Synthesis 22)
87.	Highway Noise Barriers (1981) 81 pp., \$7.20	115.	Reducing Construction Conflicts between Highways and Utilities (1984) 73 pp., \$8.80
88.	Underwater Inspection and Repair of Bridge Substructures (1981) 77 pp., \$7.60	116.	Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40
89.	Geotechnical Instrumentation for Monitoring Field Performance (1982) 46 pp., \$6.80		
90.	New Product Evaluation Procedures (1982) 34 pp., \$6.80		
91.	Highway Accident Analysis Systems (1982) 69 pp., \$7.60		

**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
117.	Toll Highway Financing (1984) 29 pp., \$7.20	143.	Uniformity Efforts in Oversize/Overweight Permits (1988) 79 pp., \$10.00
118.	Detecting Defects and Deterioration in Highway Structures (1985) 52 pp., \$8.00	144.	Breaking/Cracking and Sealing Concrete Pavements (1989) 39 pp., \$8.00
119.	Prefabricated Bridge Elements and Systems (1985) 75 pp., \$8.80	145.	Staffing Considerations in Construction Engineering Management (1989) 42 pp., \$8.00
120.	Professional Resource Management and Forecasting (1985) 15 pp., \$6.80	146.	Use of Consultants for Construction Engineering and Inspection (1989) 64 pp., \$9.00
121.	Energy Conservation in Transportation (1985) 25 pp., \$7.20 (supplements Synthesis 43)	147.	Treatment of Problem Foundations for Highway Embankments (1989) 72 pp., \$9.00
122.	Life-Cycle Cost Analysis of Pavements (1985) 136 pp., \$10.80	148.	Indicators of Quality in Maintenance (1989) 114 pp., \$11.00
123.	Bridge Designs to Reduce and Facilitate Maintenance and Repair (1985) 65 pp., \$8.40	149.	Partnerships for Innovation: Private Sector Contributions to Innovation in the Highway Industry (1989) 45 pp., \$8.00
124.	Use of Weigh-in-Motion Systems for Data Collection and Enforcement (1986) 34 pp., \$7.60	150.	Technology Transfer in Selected Highway Agencies (1989) 38 pp., \$8.00
125.	Maintenance Activities Accomplished by Contract (1986) 42 pp., \$8.00	151.	Process for Recapitalizing Highway Transportation Systems (1989) 43 pp., \$8.00
126.	Equipment for Obtaining Pavement Condition and Traffic Loading Data (1986) 118 pp., \$11.20	152.	Compaction of Asphalt Pavement (1989) 42 pp., \$8.00
127.	Use of Fly Ash in Concrete (1986) 66 pp., \$8.40	153.	Evolution and Benefits of Preventive Maintenance Strategies (1989) 69 pp., \$9.00
128.	Methods for Identifying Hazardous Highway Elements (1986) 80 pp. (microfiche)*	154.	Recycling Portland Cement Concrete Pavements (1989) 46 pp., \$8.00
129.	Freezing and Thawing Resistance of High-Strength Concrete (1986) 31 pp., \$7.60	155.	Freeway Guide Sign Replacement: Policies and Criteria (1991) 37 pp., \$8.00
130.	Traffic Data Collection and Analysis: Methods and Procedures (1986) 58 pp., \$8.40	156.	Freeway Incident Management (1990) 23 pp., \$7.00
131.	Effects of Permit and Illegal Overloads on Pavements (1987) 99 pp., \$10.40	157.	Maintenance Management of Street and Highway Signs (1990) 134 pp., \$12.00
132.	System-Wide Safety Improvements: An Approach to Safety Consistency (1987) 20 pp., \$6.80	158.	Wet-Pavement Safety Programs (1990) 54 pp., \$8.00
133.	Integrated Highway Information Systems (1987) 31 pp., \$7.60	159.	Design and Construction of Bridge Approaches (1990) 45 pp., \$8.00
134.	D-Cracking of Concrete Pavements (1987) 34 pp., \$7.60	160.	Cold-Recycled Bituminous Concrete Using Bituminous Materials (1990) 105 pp., \$11.00
135.	Pavement Management Practices (1987) 139 pp., \$12.40	161.	Computer-Aided Design and Drafting Systems (1990) 24 pp., \$7.00
136.	Protective Coatings for Bridge Steel (1987) 107 pp., \$11.00	162.	Signing Policies, Procedures, Practices, and Fees for Logo and Tourist-Oriented Directional Signing (1990) 41 pp., \$8.00
137.	Negotiating and Contracting for Professional Engineering Services (1988) 75 pp., \$9.60	163.	Innovative Strategies for Upgrading Personnel in State Transportation Departments (1990) 35 pp., \$7.00
138.	Pavement Markings: Materials and Application for Extended Service Life (1988) 45 pp., \$8.00 (supersedes Synthesis 17)	164.	Measures to Curtail State Fuel Tax Evasion (1990) 14 pp., \$7.00
139.	Pedestrians and Traffic Control Measures (1988) 75 pp., \$9.00	165.	Transportation Telecommunications (1990) 92 pp., \$10.00 (supersedes Synthesis 12)
140.	Durability of Prestressed Concrete Highway Structures (1988) 65 pp., \$9.00	166.	Traffic Signal Control Equipment: State of the Art (1990) 43 pp., \$8.00
141.	Bridge Deck Joints (1989) 66 pp., \$9.00		
142.	Methods of Cost-Effectiveness Analysis for Highway Projects (1988) 22 pp., \$7.00		

**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
167.	Measurements, Specifications, and Achievement of Smoothness for Pavement Construction (1990) 34 pp., \$8.00	192.	Accident Data Quality (1993) 53 pp., \$12.00
168.	Contract Management Systems (1990) 74 pp., \$10.00	193.	Hot In-Place Recycling of Asphalt Concrete (1994) 69 pp., \$16.00
169.	Removing Concrete from Bridges (1991) 42 pp., \$8.00	194.	Electronic Toll and Traffic Management (ETTM) Systems (1993) 64 pp., \$15.00
170.	Managing Urban Freeway Maintenance (1990) 32 pp., \$7.00	195.	Use of Warranties in Road Construction (1994) 60 pp., \$15.00
171.	Fabrics in Asphalt Overlays and Pavement Maintenance (1991) 72 pp., \$9.00	196.	Highway Maintenance Procedures Dealing with Hazardous Materials Incidents (1994) 60 pp., \$15.00
172.	Signal Timing Improvement Practices (1992) 88 pp., \$11.00	197.	Corridor Preservation (1994) 43 pp., \$11.00
173.	Short-Term Responsive Maintenance Systems (1991) 43 pp., \$9.00	198.	Uses of Recycled Rubber Tires in Highways (1994) 162 pp., \$23.00
174.	Stormwater Management for Transportation Facilities (1993) 81 pp., \$9.00	199.	Recycling and Use of Waste Materials and By-Products in Highway Construction (1994) 84 pp., \$20.00
175.	Moisture Damage in Asphalt Concrete (1991) 91 pp., \$10.00	200.	Underwater Bridge Maintenance and Repair (1994) 54 pp., \$16.00
176.	Bridge Paint: Removal, Containment, and Disposal (1992) 60 pp., \$9.00	201.	Multimodal Evaluation in Passenger Transportation (1994) 84 pp., \$19.00
177.	Freeway Corridor Management (1992) 64 pp., \$9.00	202.	Severity Indices for Roadside Features (1994) 54 pp., \$12.00
178.	Truck Escape Ramps (1992) 56 pp., \$9.00	203.	Current Practices in Determining Pavement Condition (1994) 57 pp., \$16.00
179.	Latex-Modified Concretes and Mortars (1992) 58 pp., \$9.00	204.	Portland Cement Concrete Resurfacing (1994) 67 pp., \$15.00
180.	Performance Characteristics of Open-Graded Friction Courses (1992) 44 pp., \$8.00 (supplements Synthesis 49)	205.	Performance and Operational Experience of Crash Cushions (1994) 87 pp., \$20.00
181.	In-Service Experience with Traffic Noise Barriers (1992) 61 pp., \$9.00	206.	Highway Tort Liability Management Programs (1994) 40 pp., \$11.00
182.	Performance and Operational Experience of Truck-Mounted Attenuators (1992) 54 pp., \$9.00	207.	Managing Roadway Snow and Ice Control Operations (1994) 56 pp., \$15.00
183.	Knowledge Based Expert Systems in Transportation (1992) 52 pp., \$9.00	208.	Development and Implementation of Traffic Control Plans for Highway Work Zones (1994) 37 pp., \$11.00
184.	Disposal of Roadside Litter Mixtures (1993) 52 pp., \$12.00	209.	Sealers for Portland Cement Concrete Highway Facilities (1994) 85 pp., \$19.00
185.	Preferential Lane Treatments for High-Occupancy Vehicles (1993) 80 pp., \$10.00	210.	Road Pricing for Congestion Management: A Survey of International Practice (1994) 77 pp., \$19.00
186.	Supplemental Advance Warnings (1993) 83 pp., \$19.00	211.	Design, Construction, and Maintenance of PCC Pavement Joints (1995) 50 pp., \$12.00
187.	Rapid Test Methods for Asphalt Concrete and Portland Cement Concrete (1993) 47 pp., \$10.00	212.	Performance-Related Specifications for Highway Construction and Rehabilitation (1995) 48 pp., \$14.00
188.	Management Training and Development Programs (1993) 56 pp., \$15.00	213.	Effective Use of Park-and-Ride Facilities (1995) 45 pp., \$11.00
189.	State Highway Pavement Design Practices (1993) 45 pp., \$11.00	214.	Resolution of Disputes to Avoid Construction Claims (1995) 39 pp., \$13.00
190.	Criteria for Qualifying Contractors for Bidding Purposes (1994) 40 pp., \$11.00	215.	Determination of Contract Time for Highway Construction Projects (1995) 43 pp., \$11.00
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