



## Continuing Project to Synthesize Information on Highway Problems: 2014

### DETAILS

21 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-27108-0 | DOI 10.17226/22450

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## NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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# Research Results Digest 386

## CONTINUING PROJECT TO SYNTHESIZE INFORMATION ON HIGHWAY PROBLEMS

A staff digest of the progress and status of NCHRP Project 20-05, "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 M. Williams, Program Director, Synthesis Studies, Donna L. Vlasak, Senior Program Officer, Gail R. Staba, Senior Program Officer, Jo Allen Gause, Senior Program Officer, and Tanya M. Zwahlen, 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 Program—authorized the Transportation Research Board to undertake a continuing

You can submit your recommendation at: <http://www.trb.org/SynthesisPrograms/Suggest.aspx> "Synthesis Topic Submittals." 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 cycle, all submissions should be received by February 2014. If a topic is not selected, it may be resubmitted the following year to be considered.

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

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study. This study, NCHRP Project 20-05, “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 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 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 2014

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 M. 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; Gail R. Staba, by e-mail at [gstaba@nas.edu](mailto:gstaba@nas.edu), or by phone at 202-334-2442; Jo Allen Gause, by e-mail at [jgause@nas.edu](mailto:jgause@nas.edu), or by phone at 202-334-3826; or Tanya M. Zwahlen, by e-mail at [tzwahlen@nas.edu](mailto:tzwahlen@nas.edu) or by phone at 585-315-1834.

**Table 1** TOPICS BEING STUDIED

No.	Title	No.	Title
41-06	Accelerating Implementation of Transportation Research Results	44-09	Alternative Technical Concepts for Contract Delivery Methods
44-01	FEMA and FHWA Emergency Relief Funds Reimbursement to DOTs	44-10	Non-Nuclear Methods for Compaction Control of Unbound Materials
44-02	Using the Economic Value Created by Transportation to Fund Transportation	44-11	Managing Longitudinal Utility Installations on Controlled Access Highway Right-of-Way
44-03	Outsourcing Winter Maintenance	44-12	Training and Exercising for All-Hazards Emergency Planning, Preparation, and Responses for Maintenance and Operations Field Personnel
44-04	Pavement Patching Practices	44-13	Operational Data Sharing Among Agencies
44-05	Roadway Safety Data Interoperability Between Local and State Agencies	44-14	Permanent Signs Mounted on Median Barriers
44-06	Implementation of AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG) and Software	44-15	State Bridge Load Posting Processes and Practices
44-07	Thin Asphalt Concrete Overlays		
44-08	Response to Extreme Weather Impacts on Transportation Systems		

**Table 2** SYNTHESIS TOPICS SELECTED FOR THE FY 2013 PROGRAM

No.	Title	No.	Title
45-01	Service Life of Culverts	45-10	The Impacts of Energy Developments on U.S. Roads and Bridges
45-02	Practices for Developing Transparent Best Value Selection Procedures	45-11	Economic and Development Implications of Transportation Disinvestment
45-03	Current Practices to Set and Monitor DBE Goals on Design Build Projects and Other Alternative Project Delivery Methods	45-12	Methods and Practice on Reduction and Elimination of Asphalt Mix Segregation
45-05	Current Practices for Design and Load Testing of Large Diameter Open-End Driven Pipe Piles	45-13	Maintenance Quality Assurance Field Inspection Practices
45-06	Active and Passive Speed Management Methods in Work Zones: Technology and Procedures	45-14	Practices for Permitting Superheavy Load Movements on Highway Pavements
45-07	Forecasting Major Revenue Sources and Use of Non-Gas Tax Revenue Sources for Surface Transportation Infrastructure	45-15	Fiber Additives in Asphalt Mixtures
45-09	Indefinite Delivery/Indefinite Quantity Contracting Practices	45-16	Alliance Contracting—Evolving Alternative Project Delivery
		45-17	Visualization of Geotechnical Data for Disaster Mitigation and Response

### Selection of Topics

NCHRP Synthesis Oversight Panel 20-05 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 13 syntheses per year. 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.

**Table 3** NCHRP SYNTHESIS OVERSIGHT PANEL SP20-05

Chairman Catherine Nelson Oregon Department of Transportation	
Kathleen S. Ames Michael Baker, Jr., Inc., Springfield, Illinois	Roger C. Olson Minnesota Department of Transportation
Stuart D. Anderson Texas A&M University	Robert L. Sack New York State Department of Transportation
Brian A. Blanchard Florida Department of Transportation	Francine Shaw-Whitson Federal Highway Administration
Cynthia J. Burbank Parsons Brinckerhoff, Inc., Warrenton, Virginia	Larry Velasquez JAVEL Engineering, LLC, Santa Fe, New Mexico
Lisa Freese Scott County (MN) Community Services Division	<i>Liaisons</i>
Malcolm T. Kerley Virginia Department of Transportation (retired)	Jack Jernigan Federal Highway Administration
Richard D. Land California Department of Transportation	Mary Lynn Tischer Federal Highway Administration
John M. Mason, Jr. Auburn University	Stephen F. Maher Transportation Research Board

- 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 Oversight Panel's consideration than can be programmed for study in Project 20-05. 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. Nine 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://www.trb.org/bookstore>. Please send check orders to: TRB, PO Box 741494,

Atlanta, GA 30374-1494, or fax to: 202/334-2519. All reports from No. 295 on (and some selected others) are available as online publications [<http://www.trb.org/Publications/PubsNCHRPSynthesisReports.aspx> "National Cooperative Highway Research Program (NCHRP) Synthesis Reports"].

### Index of Topic Subjects

Table 5 is an index to published syntheses, unpublished studies, and digests and topics in production.

### Conduct of the Studies

Following the Oversight Panel's selection of topics, studies are initiated in the order of priority assigned by the Panel. A Topic 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 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, at the second Topic Panel meeting. A revised draft is then prepared by the consultant.

After the staff is substantially satisfied with the report, a final draft is sent to members of the Topic Panel, along with two members of the Oversight Panel, for their final review, and a ballot on whether to publish the report. With this 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	6.	Principles of Project Scheduling and Monitoring (1970) 43 pp. (microfiche)*
2.	Bridge Approach Design and Construction Practices (1969) 30 pp. (microfiche)*	7.	Motorist Aid Systems (1971) 28 pp., \$2.40
3.	Traffic-Safe and Hydraulically Efficient Drainage Practice (1969) 38 pp. (microfiche)*	8.	Construction of Embankments (1971) 38 pp. (microfiche)*
4.	Concrete Bridge Deck Durability (1970) 28 pp. (microfiche)* (supplemented by Synthesis 57)	9.	Pavement Rehabilitation—Materials and Techniques (1972) 41 pp. (out of print)
5.	Scour at Bridge Waterways (1970) 37 pp. (microfiche)*	10.	Recruiting, Training, and Retaining Maintenance and Equipment Personnel (1972) 35 pp. (microfiche)*



**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
11.	Development of Management Capability (1972) 50 pp. (out of print)	36.	Instrumentation and Equipment for Testing Highway Materials, Products, and Performance (1976) 70 pp., \$4.80
12.	Telecommunications Systems for Highway Administration and Operations (1972) 39 pp., \$2.80 (superseded by Synthesis 165)	37.	Lime-Fly Ash-Stabilized Bases and Subbases (1976) 66 pp. (microfiche)*
13.	Radio Spectrum Frequency Management (1972) 32 pp., \$2.80	38.	Statistically Oriented End-Result Specifications (1976) 40 pp., \$4.00
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		

**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
60.	Failure and Repair of Continuously Reinforced Concrete Pavement (1979) 42 pp., \$5.60	88.	Underwater Inspection and Repair of Bridge Substructures (1981) 77 pp., \$7.60
61.	Changeable Message Signs (1979) 37 pp., \$5.60	89.	Geotechnical Instrumentation for Monitoring Field Performance (1982) 46 pp., \$6.80
62.	Potential State Resources for Financing Transportation Programs (1979) 34 pp., \$5.20	90.	New Product Evaluation Procedures (1982) 34 pp., \$6.80
63.	Design and Use of Highway Shoulders (1979) 26 pp., \$4.80	91.	Highway Accident Analysis Systems (1982) 69 pp., \$7.60
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		
87.	Highway Noise Barriers (1981) 81 pp., \$7.20		

**Table 4** (Continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
114.	Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 (supersedes Synthesis 22)	140.	Durability of Prestressed Concrete Highway Structures (1988) 65 pp., \$9.00
115.	Reducing Construction Conflicts between Highways and Utilities (1984) 73 pp., \$8.00	141.	Bridge Deck Joints (1989) 66 pp., \$9.00
116.	Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40	142.	Methods of Cost-Effectiveness Analysis for Highway Projects (1988) 22 pp., \$7.00
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 Seating 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		



**Table 4** (Continued)

<b>No.</b>	<b>Title, Pages, Price</b>	<b>No.</b>	<b>Title, Pages, Price</b>
165.	Transportation Telecommunications (1990) 92 pp., \$10.00 (supersedes Synthesis 12)	190.	Criteria for Qualifying Contractors for Bidding Purposes (1994) 40 pp., \$11.00
166.	Traffic Signal Control Equipment: State of the Art (1990) 43 pp., \$8.00	191.	Use of Rumble Strips to Enhance Safety (1993) 74 pp., \$19.00
167.	Measurements, Specifications, and Achieve- ment 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 Transpor- tation (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
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