

National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

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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, and Donna L. Vlasak, Senior Program Officer, serving under the Studies and Information Services Division of the Board, Stephen R. Godwin, Director.

INTRODUCTION

Highway administrators, engineers, and researchers 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 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 is a storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it is from research and much from the work of practitioners faced with problems in their day-to-day work. There has been no 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 has, therefore, 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 searches out and synthesizes useful knowledge from all possible sources and prepares documented reports on specific topics. Reports from

this endeavor constitute an NCHRP report series, Synthesis of Highway Practice. Each report is a concise document pertaining to a specific highway topic.

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://www4.trb.org/trb/synthesis.nsf> **"SUGGEST an 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 would also be appreciated too. Suggestions for updates of published syntheses are also welcome. 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 **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, see the Synthesis homepage (address above) under "New Topics."

THE SYNTHESIS PROJECT

This synthesis series reports on current knowledge and practice, 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 most successful in resolving specific problems.

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 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 2002

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, 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.

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 non-uniform 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 practitioners 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, 500 Fifth Street, NW, Washington D.C. 20001; by calling (202) 334-3213; and through the Internet at <http://nationalacademies.org/trb/bookstore>. All reports from No. 295 on (and some selected others) are available as online publications (<http://www4.trb.org/trb/onlinepubs.nsf> "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 2002.

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 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	32-10	Compensation for Contractors Home Office Overhead
30-08	Bridge Deck Joint Performance	32-11	Interaction Between Wildlife Ecology and Roadways
30-09	Quality Assurance of Structural Materials	32-12	Owner Controlled Insurance Programs
31-06	Facilitating Partnerships in Transportation Research	33-01	Design Exception Practices
31-07	Long-Term Pavement Marking Practices	33-02	Precast Structural Elements for Bridge Construction
32-01	Dealing with Truck Parking Demands	33-03	State Product Evaluation Programs
32-02	Strategies for Managing Increasing Truck Traffic	33-04	Integrated Roadside Vegetation Management
32-03	Impact of Red Light Camera Enforcement on Crash Experience	33-05	Safe and Quick Clearance of Traffic Incidents
32-04	Significant Findings from Full-Scale/Accelerated Pavement Testing	33-06	Roadway Safety Tools for Local Agencies
32-05	Driveway Regulation Practices	33-07	Safety Management Systems in Practice
32-06	Public Benefits of Highway System Maintenance and Operations	33-08	Current Practice for Recruiting and Retaining Individuals in Transportation Agencies
32-07	Performance Measures of Operational Effectiveness for Highway Segments and Systems	33-09	Statewide Highway Letting Program Management
32-08	Cost-Effective Structures for Off-System Bridges	33-10	Steel Bridge Erection Practices
32-09	Transportation Planning and Management for Special Events	33-11	Including Tourism and Recreation Travel in Metropolitan and Statewide Transportation Planning and Decision Making
		33-12	Freight Transportation as a Good Neighbor

Table 2
SYNTHESIS TOPICS SELECTED FOR THE FY 2002 PROGRAM

No.	Title	No.	Title
34-01	Centerline Rumble Strip Practices on Rural Roads	34-09	Concrete Bridge Deck Performance
34-02	Road Safety Audits: The State of the Practice	34-10	Winter Highway Operations
34-03	Linking Strategic Planning to Resource and Implementation Issues	34-11	Geographic Information System Applications in Pavement Management
34-04	Automated Pavement Distress Collection Techniques	34-12	Access Location and Design on Crossroads in the Vicinity of Freeway Interchanges
34-05	Effective Construction Management of Disadvantaged Business Enterprise Issues		
34-06	Convertible Roadway Lane Practices		<i>Alternate Topics</i>
34-07	Cooperative Arrangements Between State and Local Agencies to Manage Arterial Corridors to Preserve Mobility and Safety	34-13	Use of Geophysics on Transportation Projects
34-08	Use of Ultra-Thin Whitetopping	34-14	TIPs, STIPs, and Innovative Finance: How Have New Tools Transformed the Programming Process and Determination of Fiscal Constraint

Table 3
NCHRP PROJECT COMMITTEE SP20-5

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

Table 4
COMPLETED SYNTHESES

No.	Title, Pages, Price	No.	Title, Pages, Price
1.	Traffic Control for Freeway Maintenance (1969) 47 pp., \$2.20	54.	Recycling Materials for Highways (1978) 53 pp. (microfiche)*
2.	Bridge Approach Design and Construction Practices (1969) 30 pp. (microfiche)*	55.	Storage and Retrieval Systems for Highway and Transportation Data (1978) 30 pp., \$4.80
3.	Traffic-Safe and Hydraulically Efficient Drainage Practice (1969) 38 pp. (microfiche)*	56.	JointRelated Distress in PCC Pavement—Cause, Prevention, and Rehabilitation (1979) 36 pp., \$5.20
4.	Concrete Bridge Deck Durability (1970) 28 pp. (microfiche)* (supplemented by Synthesis 57)	57.	Durability of Concrete Bridge Decks (1979) 61 pp. (microfiche)* (supplements Synthesis 4)
5.	Scour at Bridge Waterways (1970) 37 pp. (microfiche)*	58.	Consequences of Deferred Maintenance (1979) 24 pp., \$4.40
6.	Principles of Project Scheduling and Monitoring (1970) 43 pp. (microfiche)*	59.	Relationship of Asphalt Cement Properties to Pavement Durability (1979) 43 pp., \$5.60
7.	Motorist Aid Systems (1971) 28 pp., \$2.40	60.	Failure and Repair of Continuously Reinforced Concrete Pavement (1979) 42 pp., \$5.60
8.	Construction of Embankments (1971) 38 pp. (microfiche)*	61.	Changeable Message Signs (1979) 37 pp., \$5.60
9.	Pavement Rehabilitation—Materials and Techniques (1972) 41 pp. (out of print)	62.	Potential State Resources for Financing Transportation Programs (1979) 34 pp., \$5.20
10.	Recruiting, Training, and Retaining Maintenance and Equipment Personnel (1972) 35 pp. (microfiche)*	63.	Design and Use of Highway Shoulders (1979) 26 pp., \$4.80
11.	Development of Management Capability (1972) 50 pp. (out of print)	64.	Bituminous Patching Mixtures (1979) 26 pp., \$4.80
12.	Telecommunications Systems for Highway Administration and Operations (1972) 39 pp., \$2.80 (superseded by Synthesis 165)	65.	Quality Assurance (1979) 42 pp., \$5.60
13.	Radio Spectrum Frequency Management (1972) 32 pp., \$2.80	66.	Glare Screen Guidelines (1979) 17 pp., \$4.40
14.	Skid Resistance (1972) 66 pp. (microfiche)*	67.	Bridge Drainage Systems (1979) 44 pp., \$5.60
15.	Statewide Transportation Planning—Needs and Requirements (1973) 41 pp. (microfiche)* (superseded by Synthesis 95)	68.	Motor Vehicle Size and Weight Regulation, Enforcement, and Permit Operations (1980) 45 pp., \$6.00
16.	Continuously Reinforced Concrete Pavement (1973) 23 pp., \$2.80	69.	Bus Route and Schedule Planning Guidelines (1980) 99 pp., \$8.00
17.	Pavement Traffic Marking—Materials and Application Affecting Serviceability (1973) 44 pp., \$3.60 (superseded by Synthesis 138)	70.	Design of Sedimentation Basins (1980) 53 pp., \$6.80
18.	Erosion Control on Highway Construction (1973) 52 pp. (microfiche)*	71.	Direction Finding from Arterials to Destinations (1980) 50 pp., \$6.40
19.	Design, Construction, and Maintenance of PCC Pavement Joints (1973) 40 pp. (out of print)	72.	Transportation Needs Studies and Financial Constraints (1980) 54 pp., \$6.40
20.	Rest Areas (1973) 38 pp., \$3.60	73.	Alternative Work Schedules: Impacts on Transportation (1980) 54 pp., \$6.80
21.	Highway Location Reference Methods (1974) 30 pp., \$3.20	74.	State Transit-Management Assistance to Local Communities (1980) 34 pp., \$6.00
22.	Maintenance Management of Traffic Signal Equipment and Systems (1974) 41 pp. (microfiche)* (superseded by Synthesis 114)	75.	Transit Boards—Composition, Roles, and Procedures (1981) 24 pp., \$6.20
23.	Getting Research Findings Into Practice (1974) 24 pp., \$3.20	76.	Collection and Use of Pavement Condition Data (1981) 74 pp., \$8.00
24.	Minimizing Deicing Chemical Use (1974) 58 pp. (microfiche)*	77.	Evaluation of Pavement Maintenance Strategies (1981) 56 pp., \$7.40
25.	Reconditioning High-Volume Freeways in Urban Areas (1974) 56 pp., \$4.00	78.	Value Engineering in Preconstruction and Construction (1981) 23 pp., \$6.40
26.	Roadway Design in Seasonal Frost Areas (1975) 104 pp. (microfiche)*	79.	Contract Time Determination (1981) 45 pp., \$7.20
27.	PCC Pavements for Low-Volume Roads and City Streets (1975) 31 pp. (microfiche)*	80.	Formulating and Justifying Highway Maintenance Budgets (1981) 49 pp., \$7.20
28.	Partial-Lane Pavement Widening (1975) 30 pp., \$3.20	81.	Experiences in Transportation System Management (1981) 88 pp., \$8.40
29.	Treatment of Soft Foundations for Embankments (1975) 25 pp., \$3.20 (supplemented by Synthesis 147)	82.	Criteria for Evaluation of Truck Weight Enforcement Programs (1981) 74 pp., \$7.20
30.	Bituminous Emulsions for Highway Pavements (1975) 76 pp. (microfiche)*	83.	Bus Transit Accessibility for the Handicapped in Urban Areas (1981) 73 pp., \$7.60
31.	Highway Tunnel Operations (1975) 29 pp., \$3.20	84.	Evaluation Criteria and Priority Setting for State Highway Programs (1981) 32 pp., \$6.40
32.	Effects of Studded Tires (1975) 46 pp., \$4.00	85.	Energy Involved in Construction Materials and Procedures (1981) 34 pp., \$6.40
33.	Acquisition and Use of Geotechnical Information (1976) 40 pp., \$4.00	86.	Effects of Traffic-Induced Vibrations on Bridge Deck Repairs (1981) 40 pp., \$6.80
34.	Policies for Accommodation of Utilities on Highway Rights of Way (1976) 22 pp. (microfiche)*	87.	Highway Noise Barriers (1981) 81 pp., \$7.20
35.	Design and Control of Freeway Off-Ramp Terminals (1976) 61 pp., \$4.40	88.	Underwater Inspection and Repair of Bridge Substructures (1981) 77 pp., \$7.60
36.	Instrumentation and Equipment for Testing Highway Materials, Products, and Performance (1976) 70 pp., \$4.80	89.	Geotechnical Instrumentation for Monitoring Field Performance (1982) 46 pp., \$6.80
37.	Lime-Fly Ash-Stabilized Bases and Subbases (1976) 66 pp. (microfiche)*	90.	NewProduct Evaluation Procedures (1982) 34 pp., \$6.80
38.	Statistically Oriented End-Result Specifications (1976) 40 pp., \$4.00	91.	Highway Accident Analysis Systems (1982) 69 pp., \$7.60
39.	Transportation Requirements for the Handicapped, Elderly, and Economically Disadvantaged (1976) 54 pp. (out of print)	92.	Minimizing Reflection Cracking of Pavement Overlays (1982) 38 pp., \$6.80
40.	Staffing and Management for Social, Economic, and Environmental Impact Assessments (1977) 43 pp., \$4.00	93.	Coordination of Transportation System Management and Land Use Management (1982) 38 pp., \$6.80
41.	Bridge Bearings (1977) 62 pp. (microfiche)*	94.	Photologging (1982) 38 pp., \$6.80
42.	Design of Pile Foundations (1977) 68 pp., \$4.80	95.	Statewide Transportation Planning (1982) 54 pp., \$7.20 (supersedes Synthesis 15)
43.	Energy Effects, Efficiencies, and Prospects for Various Modes of Transportation (1977) 57 pp., \$4.80 (supplemented by Synthesis 121)	96.	Pavement Subsurface Drainage Systems (1982) 38 pp., \$6.80
44.	Consolidation of Concrete for Pavements, Bridge Decks, and Overlays (1977) 61 pp., \$4.80	97.	Transit Ownership/Operation Options for Small Urban and Rural Areas (1982) 28 pp., \$6.40
45.	Rapid-Setting Materials for Patching of Concrete (1977) 13 pp. (out of print)	98.	Resealing Joints and Cracks in Rigid and Flexible Pavements (1982) 62 pp., \$7.20
46.	Recording and Reporting Methods for Highway Maintenance Expenditures (1977) 35 pp., \$3.60	99.	Resurfacing with Portland Cement Concrete (1982) 90 pp., \$8.40
47.	Effect of Weather on Highway Construction (1978) 29 pp., \$3.20	100.	Managing State Highway Finance (1982) 23 pp., \$6.40
48.	Priority Programming and Project Selection (1978) 31 pp. (out of print)	101.	Historic Bridges—Criteria for Decision Making (1983) 77 pp., \$8.00
49.	Open-Graded Friction Courses for Highways (1978) 50 pp., \$4.00	102.	Material Certification and Material-Certification Effectiveness (1983) 17 pp., \$6.00
50.	Durability of Drainage Pipe (1978) 37 pp. (microfiche)*	103.	Risk Assessment Processes for Hazardous Materials Transportation (1983) 26 pp., \$6.40
51.	Construction Contract Staffing (1978) 62 pp., \$6.00	104.	Criteria for Use of Asphalt Friction Surfaces (1983) 41 pp., \$6.80
52.	Management and Selection Systems for Highway Maintenance Equipment (1978) 17 pp., \$4.40		
53.	Precast Concrete Elements for Transportation Facilities (1978) 48 pp., \$5.60		

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

Table 4 (continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
105.	Construction Contract Claims: Causes and Methods of Settlement (1983) 58 pp., \$7.20	158.	Wet-Pavement Safety Programs (1990) 54 pp., \$8.00
106.	Practical Guidelines for Minimizing Tort Liability (1983) 40 pp., \$6.80	159.	Design and Construction of Bridge Approaches (1990) 45 pp., \$8.00
107.	Shallow Foundations for Highway Structures (1983) 38 pp., \$6.80	160.	Cold-Recycled Bituminous Concrete Using Bituminous Materials (1990) 105 pp., \$11.00
108.	Bridge Weight-Limit Posting Practices (1984) 30 pp., \$6.40	161.	Computer-Aided Design and Drafting Systems (1990) 24 pp., \$7.00
109.	Highway Uses of Epoxy with Concrete (1984) 68 pp., \$8.80	162.	Signing Policies, Procedures, Practices, and Fees for Logo and Tourist-Oriented Directional Signing (1990) 41 pp., \$8.00
110.	Maintenance Management Systems (1984) 49 pp., \$8.00	163.	Innovative Strategies for Upgrading Personnel in State Transportation Departments (1990) 35 pp., \$7.00
111.	Distribution of Wheel Loads on Highway Bridges (1984) 22 pp., \$7.20	164.	Measures to Curtail State Fuel Tax Evasion (1990) 14 pp., \$7.00
112.	Cost Effectiveness of Hot-Dip Galvanizing for Exposed Steel (1984) 28 pp., \$7.20	165.	Transportation Telecommunications (1990) 92 pp., \$10.00 (supersedes Synthesis 12)
113.	Administration of Research, Development, and Implementation Activities in Highway Agencies (1984) 49 pp., \$8.00	166.	Traffic Signal Control Equipment: State of the Art (1990) 43 pp., \$8.00
114.	Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 (supersedes Synthesis 22)	167.	Measurements, Specifications, and Achievement of Smoothness for Pavement Construction (1990) 34 pp., \$8.00
115.	Reducing Construction Conflicts between Highways and Utilities (1984) 73 pp., \$8.80	168.	Contract Management Systems (1990) 74 pp., \$10.00
116.	Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40	169.	Removing Concrete from Bridges (1991) 42 pp., \$8.00
117.	Toll Highway Financing (1984) 29 pp., \$7.20	170.	Managing Urban Freeway Maintenance (1990) 32 pp., \$7.00
118.	Detecting Defects and Deterioration in Highway Structures (1985) 52 pp., \$8.00	171.	Fabrics in Asphalt Overlays and Pavement Maintenance (1991) 72 pp., \$9.00
119.	Prefabricated Bridge Elements and Systems (1985) 75 pp., \$8.80	172.	Signal Timing Improvement Practices (1992) 88 pp., \$11.00
120.	Professional Resource Management and Forecasting (1985) 15 pp., \$6.80	173.	Short-Term Responsive Maintenance Systems (1991) 43 pp., \$9.00
121.	Energy Conservation in Transportation (1985) 25 pp., \$7.20 (supplements Synthesis 43)	174.	Stormwater Management for Transportation Facilities (1993) 81 pp., \$9.00
122.	Life-Cycle Cost Analysis of Pavements (1985) 136 pp., \$10.80	175.	Moisture Damage in Asphalt Concrete (1991) 91 pp., \$10.00
123.	Bridge Designs to Reduce and Facilitate Maintenance and Repair (1985) 65 pp., \$8.40	176.	Bridge Paint: Removal, Containment, and Disposal (1992) 60 pp., \$9.00
124.	Use of Weigh-in-Motion Systems for Data Collection and Enforcement (1986) 34 pp., \$7.60	177.	Freeway Corridor Management (1992) 64 pp., \$9.00
125.	Maintenance Activities Accomplished by Contract (1986) 42 pp., \$8.00	178.	Truck Escape Ramps (1992) 56 pp., \$9.00
126.	Equipment for Obtaining Pavement Condition and Traffic Loading Data (1986) 118 pp., \$11.20	179.	Latex-Modified Concretes and Mortars (1992) 58 pp., \$9.00
127.	Use of Fly Ash in Concrete (1986) 66 pp., \$8.40	180.	Performance Characteristics of Open-Graded Friction Courses (1992) 44 pp., \$8.00 (supplements Synthesis 49)
128.	Methods for Identifying Hazardous Highway Elements (1986) 80 pp. (microfiche)*	181.	In-Service Experience with Traffic Noise Barriers (1992) 61 pp., \$9.00
129.	Freezing and Thawing Resistance of High-Strength Concrete (1986) 31 pp., \$7.60	182.	Performance and Operational Experience of Truck-Mounted Attenuators (1992) 54 pp., \$9.00
130.	Traffic Data Collection and Analysis: Methods and Procedures (1986) 58 pp., \$8.40	183.	Knowledge Based Expert Systems in Transportation (1992) 52 pp., \$9.00
131.	Effects of Permit and Illegal Overloads on Pavements (1987) 99 pp., \$10.40	184.	Disposal of Roadside Litter Mixtures (1993) 52 pp., \$12.00
132.	System-Wide Safety Improvements: An Approach to Safety Consistency (1987) 20 pp., \$6.80	185.	Preferential Lane Treatments for High-Occupancy Vehicles (1993) 80 pp., \$10.00
133.	Integrated Highway Information Systems (1987) 31 pp., \$7.60	186.	Supplemental Advance Warnings (1993) 83 pp., \$19.00
134.	D-Cracking of Concrete Pavements (1987) 34 pp., \$7.60	187.	Rapid Test Methods for Asphalt Concrete and Portland Cement Concrete (1993) 47 pp., \$10.00
135.	Pavement Management Practices (1987) 139 pp., \$12.40	188.	Management Training and Development Programs (1993) 56 pp., \$15.00
136.	Protective Coatings for Bridge Steel (1987) 107 pp., \$11.00	189.	State Highway Pavement Design Practices (1993) 45 pp., \$11.00
137.	Negotiating and Contracting for Professional Engineering Services (1988) 75 pp., \$9.60	190.	Criteria for Qualifying Contractors for Bidding Purposes (1994) 40 pp., \$11.00
138.	Pavement Markings: Materials and Application for Extended Service Life (1988) 45 pp., \$8.00 (supersedes Synthesis 17)	191.	Use of Rumble Strips to Enhance Safety (1993) 74 pp., \$19.00
139.	Pedestrians and Traffic Control Measures (1988) 75 pp., \$9.00	192.	Accident Data Quality (1993) 53 pp., \$12.00
140.	Durability of Prestressed Concrete Highway Structures (1988) 65 pp., \$9.00	193.	Hot In-Place Recycling of Asphalt Concrete (1994) 69 pp., \$16.00
141.	Bridge Deck Joints (1989) 66 pp., \$9.00	194.	Electronic Toll and Traffic Management (ETTM) Systems (1993) 64 pp., \$15.00
142.	Methods of Cost-Effectiveness Analysis for Highway Projects (1988) 22 pp., \$7.00	195.	Use of Warranties in Road Construction (1994) 60 pp., \$15.00
143.	Uniformity Efforts in Oversize/Overweight Permits (1988) 79 pp., \$10.00	196.	Highway Maintenance Procedures Dealing with Hazardous Materials Incidents (1994) 60 pp., \$15.00
144.	Breaking/Cracking and Sealing Concrete Pavements (1989) 39 pp., \$8.00	197.	Corridor Preservation (1994) 43 pp., \$11.00
145.	Staffing Considerations in Construction Engineering Management (1989) 42 pp., \$8.00	198.	Uses of Recycled Rubber Tires in Highways (1994) 162 pp., \$23.00
146.	Use of Consultants for Construction Engineering and Inspection (1989) 64 pp., \$9.00	199.	Recycling and Use of Waste Materials and By-Products in Highway Construction (1994) 84 pp., \$20.00
147.	Treatment of Problem Foundations for Highway Embankments (1989) 72 pp., \$9.00	200.	Underwater Bridge Maintenance and Repair (1994) 54 pp., \$16.00
148.	Indicators of Quality in Maintenance (1989) 114 pp., \$11.00	201.	Multimodal Evaluation in Passenger Transportation (1994) 84 pp., \$19.00
149.	Partnerships for Innovation: Private Sector Contributions to Innovation in the Highway Industry (1989) 45 pp., \$8.00	202.	Severity Indices for Roadside Features (1994) 54 pp., \$12.00
150.	Technology Transfer in Selected Highway Agencies (1989) 38 pp., \$8.00	203.	Current Practices in Determining Pavement Condition (1994) 57 pp., \$16.00
151.	Process for Recapitalizing Highway Transportation Systems (1989) 43 pp., \$8.00	204.	Portland Cement Concrete Resurfacing (1994) 67 pp., \$15.00
152.	Compaction of Asphalt Pavement (1989) 42 pp., \$8.00	205.	Performance and Operational Experience of Crash Cushions (1994) 87 pp., \$20.00
153.	Evolution and Benefits of Preventive Maintenance Strategies (1989) 69 pp., \$9.00	206.	Highway Tort Liability Management Programs (1994) 40 pp., \$11.00
154.	Recycling Portland Cement Concrete Pavements (1989) 46 pp., \$8.00	207.	Managing Roadway Snow and Ice Control Operations (1994) 56 pp., \$15.00
155.	Freeway Guide Sign Replacement: Policies and Criteria (1991) 37 pp., \$8.00	208.	Development and Implementation of Traffic Control Plans for Highway Work Zones (1994) 37 pp., \$11.00
156.	Freeway Incident Management (1990) 23 pp., \$7.00	209.	Sealers for Portland Cement Concrete Highway Facilities (1994) 85 pp., \$19.00
157.	Maintenance Management of Street and Highway Signs (1990) 134 pp., \$12.00	210.	Road Pricing for Congestion Management: A Survey of International Practice (1994) 77 pp., \$19.00
		211.	Design, Construction, and Maintenance of PCC Pavement Joints (1995) 50 pp., \$12.00
		212.	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
		214.	Resolution of Disputes to Avoid Construction Claims (1995) 39 pp., \$13.00

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

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