

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 under-evaluated. 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 at: <http://www4.national-academies.org/trb/synthesis.nsf> under "**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 also be appreciated. 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, it must be resubmitted the following year.

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 2000

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 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, 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 2000.

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 negotiated 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 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	31-05	Collecting, Processing, and Integrating GPS Data into GIS
30-08	Bridge Deck Joint Performance	31-06	Facilitating Partnerships in Transportation Research
30-09	Quality Assurance of Structural Materials	31-07	Long-Term Pavement Marking Practices
31-01	Recent Geometric Design Research for Improved Safety and Operations	31-08	Impact of New Information/Communications Technology on Transportation Agencies
31-02	Statistical Methods in Highway Safety Analysis	31-09	Truck Trip Generation Guide
31-03	Assessment and Rehabilitation of Existing Culverts	31-10	Traffic Control System Configuration Management
31-04	Performance Measures for Research, Development, and Technology Programs	31-11	Building Effective Relationships Between Central Cities, States, and the Federal Government
		31-12	Ecological Mitigation

Table 2
SYNTHESIS TOPICS SELECTED FOR THE FY 2000 PROGRAM

No.	Title	No.	Title
32-01	Dealing with Truck Parking Demands	32-10	Compensation for Contractors Home Office Overhead
32-02	Strategies for Managing Increasing Truck Traffic	32-11	Interaction Between Wildlife Ecology and Transportation Systems
32-03	Measured Benefits of "Red Light Cameras"	32-12	Owner Controlled Insurance Programs
32-04	Significant Findings from Full-Scale/Accelerated Pavement Testing		<i>Alternate Topics</i>
32-05	Driveway Regulation Practices	32-13	Institutional Frameworks for Statewide Transportation Planning and Investment Decisions
32-06	Public Benefits of Highway System Maintenance and Operations	32-14	Congestion Management in the Central Business District
32-07	Performance Measures of Operational Effectiveness for Highway Segments and Systems	32-15	Design Build for Transportation Projects
32-08	Cost Effective Structures for Off-System Bridges		
32-09	Transportation Planning and Management for Major Events		

Table 3
NCHRP PROJECT COMMITTEE SP20-5

Chairman C. Ian MacGillivray Iowa Department of Transportation	
Kenneth C. Afferton New Jersey Department of Transportation (Retired)	Wesley S.C. Lum California Department of Transportation
Susan Binder Federal Highway Administration	Gary Taylor Michigan Department of Transportation
Thomas R. Bohuslav Texas Department of Transportation	J. Richard Young, Jr., P.E. Mississippi Department of Transportation (Retired)
Nicholas J. Garber University of Virginia	
Dwight Horne Federal Highway Administration	<i>Liaisons</i> William Zaccagnino Federal Highway Administration
Ysela Llort Florida Department of Transportation	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	52.	Management and Selection Systems for Highway Maintenance Equipment (1978) 17 pp., \$4.40
2.	Bridge Approach Design and Construction Practices (1969) 30 pp. (microfiche)*	53.	Precast Concrete Elements for Transportation Facilities (1978) 48 pp., \$5.60
3.	Traffic-Safe and Hydraulically Efficient Drainage Practice (1969) 38 pp. (microfiche)*	54.	Recycling Materials for Highways (1978) 53 pp. (microfiche)*
4.	Concrete Bridge Deck Durability (1970) 28 pp. (microfiche)* (supplemented by Synthesis 57)	55.	Storage and Retrieval Systems for Highway and Transportation Data (1978) 30 pp., \$4.80
5.	Scour at Bridge Waterways (1970) 37 pp. (microfiche)*	56.	Joint-Related Distress in PCC Pavement—Cause, Prevention, and Rehabilitation (1979) 36 pp., \$5.20
6.	Principles of Project Scheduling and Monitoring (1970) 43 pp. (microfiche)*	57.	Durability of Concrete Bridge Decks (1979) 61 pp. (microfiche)* (supplements Synthesis 4)
7.	Motorist Aid Systems (1971) 28 pp., \$2.40	58.	Consequences of Deferred Maintenance (1979) 24 pp., \$4.40
8.	Construction of Embankments (1971) 38 pp. (microfiche)*	59.	Relationship of Asphalt Cement Properties to Pavement Durability (1979) 43 pp., \$5.60
9.	Pavement Rehabilitation—Materials and Techniques (1972) 41 pp. (out of print)	60.	Failure and Repair of Continuously Reinforced Concrete Pavement (1979) 42 pp., \$5.60
10.	Recruiting, Training, and Retaining Maintenance and Equipment Personnel (1972) 35 pp. (microfiche)*	61.	Changeable Message Signs (1979) 37 pp., \$5.60
11.	Development of Management Capability (1972) 50 pp. (out of print)	62.	Potential State Resources for Financing Transportation Programs (1979) 34 pp., \$5.20
12.	Telecommunications Systems for Highway Administration and Operations (1972) 39 pp., \$2.80 (superseded by Synthesis 165)	63.	Design and Use of Highway Shoulders (1979) 26 pp., \$4.80
13.	Radio Spectrum Frequency Management (1972) 32 pp., \$2.80	64.	Bituminous Patching Mixtures (1979) 26 pp., \$4.80
14.	Skid Resistance (1972) 66 pp. (microfiche)*	65.	Quality Assurance (1979) 42 pp., \$5.60
15.	Statewide Transportation Planning—Needs and Requirements (1973) 41 pp. (microfiche)* (superseded by Synthesis 95)	66.	Glare Screen Guidelines (1979) 17 pp., \$4.40
16.	Continuously Reinforced Concrete Pavement (1973) 23 pp., \$2.80	67.	Bridge Drainage Systems (1979) 44 pp., \$5.60
17.	Pavement Traffic Marking—Materials and Application Affecting Serviceability (1973) 44 pp., \$3.60 (superseded by Synthesis 138)	68.	Motor Vehicle Size and Weight Regulation, Enforcement, and Permit Operations (1980) 45 pp., \$6.00
18.	Erosion Control on Highway Construction (1973) 52 pp. (microfiche)*	69.	Bus Route and Schedule Planning Guidelines (1980) 99 pp., \$8.00
19.	Design, Construction, and Maintenance of PCC Pavement Joints (1973) 40 pp. (out of print)	70.	Design of Sedimentation Basins (1980) 53 pp., \$6.80
20.	Rest Areas (1973) 38 pp., \$3.60	71.	Direction Finding from Arterials to Destinations (1980) 50 pp., \$6.40
21.	Highway Location Reference Methods (1974) 30 pp., \$3.20	72.	Transportation Needs Studies and Financial Constraints (1980) 54 pp., \$6.40
22.	Maintenance Management of Traffic Signal Equipment and Systems (1974) 41 pp. (microfiche)* (superseded by Synthesis 114)	73.	Alternative Work Schedules: Impacts on Transportation (1980) 54 pp., \$6.80
23.	Getting Research Findings Into Practice (1974) 24 pp., \$3.20	74.	State Transit-Management Assistance to Local Communities (1980) 34 pp., \$6.00
24.	Minimizing Deicing Chemical Use (1974) 58 pp. (microfiche)*	75.	Transit Boards—Composition, Roles, and Procedures (1981) 24 pp., \$6.20
25.	Reconditioning High-Volume Freeways in Urban Areas (1974) 56 pp., \$4.00	76.	Collection and Use of Pavement Condition Data (1981) 74 pp., \$8.00
26.	Roadway Design in Seasonal Frost Areas (1975) 104 pp. (microfiche)*	77.	Evaluation of Pavement Maintenance Strategies (1981) 56 pp., \$7.40
27.	PCC Pavements for Low-Volume Roads and City Streets (1975) 31 pp. (microfiche)*	78.	Value Engineering in Preconstruction and Construction (1981) 23 pp., \$6.40
28.	Partial-Lane Pavement Widening (1975) 30 pp., \$3.20	79.	Contract Time Determination (1981) 45 pp., \$7.20
29.	Treatment of Soft Foundations for Embankments (1975) 25 pp., \$3.20 (supplemented by Synthesis 147)	80.	Formulating and Justifying Highway Maintenance Budgets (1981) 49 pp., \$7.20
30.	Bituminous Emulsions for Highway Pavements (1975) 76 pp. (microfiche)*	81.	Experiences in Transportation System Management (1981) 88 pp., \$8.40
31.	Highway Tunnel Operations (1975) 29 pp., \$3.20	82.	Criteria for Evaluation of Truck Weight Enforcement Programs (1981) 74 pp., \$7.20
32.	Effects of Studded Tires (1975) 46 pp., \$4.00	83.	Bus Transit Accessibility for the Handicapped in Urban Areas (1981) 73 pp., \$7.60
33.	Acquisition and Use of Geotechnical Information (1976) 40 pp., \$4.00	84.	Evaluation Criteria and Priority Setting for State Highway Programs (1981) 32 pp., \$6.40
34.	Policies for Accommodation of Utilities on Highway Rights of Way (1976) 22 pp. (microfiche)*	85.	Energy Involved in Construction Materials and Procedures (1981) 34 pp., \$6.40
35.	Design and Control of Freeway Off-Ramp Terminals (1976) 61 pp., \$4.40	86.	Effects of Traffic-Induced Vibrations on Bridge Deck Repairs (1981) 40 pp., \$6.80
36.	Instrumentation and Equipment for Testing Highway Materials, Products, and Performance (1976) 70 pp., \$4.80	87.	Highway Noise Barriers (1981) 81 pp., \$7.20
37.	Lime-Fly Ash-Stabilized Bases and Subbases (1976) 66 pp. (microfiche)*	88.	Underwater Inspection and Repair of Bridge Substructures (1981) 77 pp., \$7.60
38.	Statistically Oriented End-Result Specifications (1976) 40 pp., \$4.00	89.	Geotechnical Instrumentation for Monitoring Field Performance (1982) 46 pp., \$6.80
39.	Transportation Requirements for the Handicapped, Elderly, and Economically Disadvantaged (1976) 54 pp. (out of print)	90.	New Product Evaluation Procedures (1982) 34 pp., \$6.80
40.	Staffing and Management for Social, Economic, and Environmental Impact Assessments (1977) 43 pp., \$4.00	91.	Highway Accident Analysis Systems (1982) 69 pp., \$7.60
41.	Bridge Bearings (1977) 62 pp. (microfiche)*	92.	Minimizing Reflection Cracking of Pavement Overlays (1982) 38 pp., \$6.80
42.	Design of Pile Foundations (1977) 68 pp., \$4.80	93.	Coordination of Transportation System Management and Land Use Management (1982) 38 pp., \$6.80
43.	Energy Effects, Efficiencies, and Prospects for Various Modes of Transportation (1977) 57 pp., \$4.80 (supplemented by Synthesis 121)	94.	Photologging (1982) 38 pp., \$6.80
44.	Consolidation of Concrete for Pavements, Bridge Decks, and Overlays (1977) 61 pp., \$4.80	95.	Statewide Transportation Planning (1982) 54 pp., \$7.20 (supersedes Synthesis 15)
45.	Rapid-Setting Materials for Patching of Concrete (1977) 13 pp. (out of print)	96.	Pavement Subsurface Drainage Systems (1982) 38 pp., \$6.80
46.	Recording and Reporting Methods for Highway Maintenance Expenditures (1977) 35 pp., \$3.60	97.	Transit Ownership/Operation Options for Small Urban and Rural Areas (1982) 28 pp., \$6.40
47.	Effect of Weather on Highway Construction (1978) 29 pp., \$3.20	98.	Resealing Joints and Cracks in Rigid and Flexible Pavements (1982) 62 pp., \$7.20
48.	Priority Programming and Project Selection (1978) 31 pp. (out of print)	99.	Resurfacing with Portland Cement Concrete (1982) 90 pp., \$8.40
49.	Open-Graded Friction Courses for Highways (1978) 50 pp., \$4.00	100.	Managing State Highway Finance (1982) 23 pp., \$6.40
50.	Durability of Drainage Pipe (1978) 37 pp. (microfiche)*		
51.	Construction Contract Staffing (1978) 62 pp., \$6.00		

*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
101.	Historic Bridges—Criteria for Decision Making (1983) 77 pp., \$8.00	151.	Process for Recapitalizing Highway Transportation Systems (1989) 43 pp., \$8.00
102.	Material Certification and Material-Certification Effectiveness (1983) 17 pp., \$6.00	152.	Compaction of Asphalt Pavement (1989) 42 pp., \$8.00
103.	Risk Assessment Processes for Hazardous Materials Transportation (1983) 26 pp., \$6.40	153.	Evolution and Benefits of Preventive Maintenance Strategies (1989) 69 pp., \$9.00
104.	Criteria for Use of Asphalt Friction Surfaces (1983) 41 pp., \$6.80	154.	Recycling Portland Cement Concrete Pavements (1989) 46 pp., \$8.00
105.	Construction Contract Claims: Causes and Methods of Settlement (1983) 58 pp., \$7.20	155.	Freeway Guide Sign Replacement: Policies and Criteria (1991) 37 pp., \$8.00
106.	Practical Guidelines for Minimizing Tort Liability (1983) 40 pp., \$6.80	156.	Freeway Incident Management (1990) 23 pp., \$7.00
107.	Shallow Foundations for Highway Structures (1983) 38 pp., \$6.80	157.	Maintenance Management of Street and Highway Signs (1990) 134 pp., \$12.00
108.	Bridge Weight-Limit Posting Practices (1984) 30 pp., \$6.40	158.	Wet-Pavement Safety Programs (1990) 54 pp., \$8.00
109.	Highway Uses of Epoxy with Concrete (1984) 68 pp., \$8.80	159.	Design and Construction of Bridge Approaches (1990) 45 pp., \$8.00
110.	Maintenance Management Systems (1984) 49 pp., \$8.00	160.	Cold-Recycled Bituminous Concrete Using Bituminous Materials (1990) 105 pp., \$11.00
111.	Distribution of Wheel Loads on Highway Bridges (1984) 22 pp., \$7.20	161.	Computer-Aided Design and Drafting Systems (1990) 24 pp., \$7.00
112.	Cost Effectiveness of Hot-Dip Galvanizing for Exposed Steel (1984) 28 pp., \$7.20	162.	Signing Policies, Procedures, Practices, and Fees for Logo and Tourist-Oriented Directional Signing (1990) 41 pp., \$8.00
113.	Administration of Research, Development, and Implementation Activities in Highway Agencies (1984) 49 pp., \$8.00	163.	Innovative Strategies for Upgrading Personnel in State Transportation Departments (1990) 35 pp., \$7.00
114.	Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 (supersedes Synthesis 22)	164.	Measures to Curtail State Fuel Tax Evasion (1990) 14 pp., \$7.00
115.	Reducing Construction Conflicts between Highways and Utilities (1984) 73 pp., \$8.80	165.	Transportation Telecommunications (1990) 92 pp., \$10.00 (supersedes Synthesis 12)
116.	Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40	166.	Traffic Signal Control Equipment: State of the Art (1990) 43 pp., \$8.00
117.	Toll Highway Financing (1984) 29 pp., \$7.20	167.	Measurements, Specifications, and Achievement of Smoothness for Pavement Construction (1990) 34 pp., \$8.00
118.	Detecting Defects and Deterioration in Highway Structures (1985) 52 pp., \$8.00	168.	Contract Management Systems (1990) 74 pp., \$10.00
119.	Prefabricated Bridge Elements and Systems (1985) 75 pp., \$8.80	169.	Removing Concrete from Bridges (1991) 42 pp., \$8.00
120.	Professional Resource Management and Forecasting (1985) 15 pp., \$6.80	170.	Managing Urban Freeway Maintenance (1990) 32 pp., \$7.00
121.	Energy Conservation in Transportation (1985) 25 pp., \$7.20 (supplements Synthesis 43)	171.	Fabrics in Asphalt Overlays and Pavement Maintenance (1991) 72 pp., \$9.00
122.	Life-Cycle Cost Analysis of Pavements (1985) 136 pp., \$10.80	172.	Signal Timing Improvement Practices (1992) 88 pp., \$11.00
123.	Bridge Designs to Reduce and Facilitate Maintenance and Repair (1985) 65 pp., \$8.40	173.	Short-Term Responsive Maintenance Systems (1991) 43 pp., \$9.00
124.	Use of Weigh-in-Motion Systems for Data Collection and Enforcement (1986) 34 pp., \$7.60	174.	Stormwater Management for Transportation Facilities (1993) 81 pp., \$9.00
125.	Maintenance Activities Accomplished by Contract (1986) 42 pp., \$8.00	175.	Moisture Damage in Asphalt Concrete (1991) 91 pp., \$10.00
126.	Equipment for Obtaining Pavement Condition and Traffic Loading Data (1986) 118 pp., \$11.20	176.	Bridge Paint: Removal, Containment, and Disposal (1992) 60 pp., \$9.00
127.	Use of Fly Ash in Concrete (1986) 66 pp., \$8.40	177.	Freeway Corridor Management (1992) 64 pp., \$9.00
128.	Methods for Identifying Hazardous Highway Elements (1986) 80 pp. (microfiche)*	178.	Truck Escape Ramps (1992) 56 pp., \$9.00
129.	Freezing and Thawing Resistance of High-Strength Concrete (1986) 31 pp., \$7.60	179.	Latex-Modified Concretes and Mortars (1992) 58 pp., \$9.00
130.	Traffic Data Collection and Analysis: Methods and Procedures (1986) 58 pp., \$8.40	180.	Performance Characteristics of Open-Graded Friction Courses (1992) 44 pp., \$8.00 (supplements Synthesis 49)
131.	Effects of Permit and Illegal Overloads on Pavements (1987) 99 pp., \$10.40	181.	In-Service Experience with Traffic Noise Barriers (1992) 61 pp., \$9.00
132.	System-Wide Safety Improvements: An Approach to Safety Consistency (1987) 20 pp., \$6.80	182.	Performance and Operational Experience of Truck-Mounted Attenuators (1992) 54 pp., \$9.00
133.	Integrated Highway Information Systems (1987) 31 pp., \$7.60	183.	Knowledge Based Expert Systems in Transportation (1992) 52 pp., \$9.00
134.	D-Cracking of Concrete Pavements (1987) 34 pp., \$7.60	184.	Disposal of Roadside Litter Mixtures (1993) 52 pp., \$12.00
135.	Pavement Management Practices (1987) 139 pp., \$12.40	185.	Preferential Lane Treatments for High-Occupancy Vehicles (1993) 80 pp., \$10.00
136.	Protective Coatings for Bridge Steel (1987) 107 pp., \$11.00	186.	Supplemental Advance Warnings (1993) 83 pp., \$19.00
137.	Negotiating and Contracting for Professional Engineering Services (1988) 75 pp., \$9.60	187.	Rapid Test Methods for Asphalt Concrete and Portland Cement Concrete (1993) 47 pp., \$10.00
138.	Pavement Markings: Materials and Application for Extended Service Life (1988) 45 pp., \$8.00 (supersedes Synthesis 17)	188.	Management Training and Development Programs (1993) 56 pp., \$15.00
139.	Pedestrians and Traffic Control Measures (1988) 75 pp., \$9.00	189.	State Highway Pavement Design Practices (1993) 45 pp., \$11.00
140.	Durability of Prestressed Concrete Highway Structures (1988) 65 pp., \$9.00	190.	Criteria for Qualifying Contractors for Bidding Purposes (1994) 40 pp., \$11.00
141.	Bridge Deck Joints (1989) 66 pp., \$9.00	191.	Use of Rumble Strips to Enhance Safety (1993) 74 pp., \$19.00
142.	Methods of Cost-Effectiveness Analysis for Highway Projects (1988) 22 pp., \$7.00	192.	Accident Data Quality (1993) 53 pp., \$12.00
143.	Uniformity Efforts in Oversize/Overweight Permits (1988) 79 pp., \$10.00	193.	Hot In-Place Recycling of Asphalt Concrete (1994) 69 pp., \$16.00
144.	Breaking/Cracking and Seating Concrete Pavements (1989) 39 pp., \$8.00	194.	Electronic Toll and Traffic Management (ETTM) Systems (1993) 64 pp., \$15.00
145.	Staffing Considerations in Construction Engineering Management (1989) 42 pp., \$8.00	195.	Use of Warranties in Road Construction (1994) 60 pp., \$15.00
146.	Use of Consultants for Construction Engineering and Inspection (1989) 64 pp., \$9.00	196.	Highway Maintenance Procedures Dealing with Hazardous Materials Incidents (1994) 60 pp., \$15.00
147.	Treatment of Problem Foundations for Highway Embankments (1989) 72 pp., \$9.00	197.	Corridor Preservation (1994) 43 pp., \$11.00
148.	Indicators of Quality in Maintenance (1989) 114 pp., \$11.00	198.	Uses of Recycled Rubber Tires in Highways (1994) 162 pp., \$23.00
149.	Partnerships for Innovation: Private Sector Contributions to Innovation in the Highway Industry (1989) 45 pp., \$8.00	199.	Recycling and Use of Waste Materials and By-Products in Highway Construction (1994) 84 pp., \$20.00
150.	Technology Transfer in Selected Highway Agencies (1989) 38 pp., \$8.00	200.	Underwater Bridge Maintenance and Repair (1994) 54 pp., \$16.00
		201.	Multimodal Evaluation in Passenger Transportation (1994) 84 pp., \$19.00
		202.	Severity Indices for Roadside Features (1994) 54 pp., \$12.00
		203.	Current Practices in Determining Pavement Condition (1994) 57 pp., \$16.00
		204.	Portland Cement Concrete Resurfacing (1994) 67 pp., \$15.00
		205.	Performance and Operational Experience of Crash Cushions (1994) 87 pp., \$20.00
		206.	Highway Tort Liability Management Programs (1994) 40 pp., \$11.00

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

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