

**NCHRP**  
National Cooperative Highway Research Program

# RESEARCH RESULTS DIGEST

December 1992

Number 190

These **Digests** are issued in the interest of providing an early awareness of the research results emanating from projects in the NCHRP. By making these results known as they are developed, it is hoped that the potential users of the research findings will be encouraged toward their early implementation in operating practices. Persons wanting to pursue the project subject matter in greater depth may do so through contact with the Cooperative Research Programs Staff, Transportation Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

Responsible Staff Engineer: Daniel W. Dearasaugh

## 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. The Principal Investigators responsible for the project are Sally D. Liff and Scott A. Sabol, serving under the Studies and Information Services Division of the Board.*

### INTRODUCTION

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

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the ideas of practitioners faced with problems in their day-to-day work. Because there has 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 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 specific 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 utilized in this fashion will be tempered by the breadth of the user's knowledge in the particular problem area.

Suggestions for synthesis topics may be sent to the NCHRP Program Director at any time (see address on back). Topics suggested must be accompanied by a brief scope statement or discussion of the problem (a paragraph or two). Suggestions for updates of published syntheses are also welcome.

Interested in writing a synthesis? For details, contact Sally D. Liff or Scott A. Sabol at 202-334-3242.

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 highway and transportation departments. 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; (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 write to TRB (address on back) and let us know.

#### *Available Publications and Studies in Progress*

The Syntheses of Highway Practice that have been completed under this project are listed in Table 1. Two Research Results Digests on topics studied under the project are also listed. Copies of these Syntheses and Digests can be obtained from the Publications Office, Transportation Research Board, 2101 Constitution Avenue N.W., Washington, D.C. 20418.

Work is currently under way on the topics listed in Table 2. Questions on these topics should be addressed to the project investigators, Sally D. Liff and Scott A. Sabol, who can be reached at (202) 334-3242.

#### *Submission and Selection of Topics*

One part of the project procedures that is not widely understood is the process for submission and selection of topics. NCHRP Project Committee SP20-5 meets each Fall 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 to 14 syntheses per year. This number plus some alternative topics are selected by the committee at the Fall meeting. Topics selected for the current program are listed in Table 4. It is unlikely that those near the bottom of the list will be studied at this time.

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

- The problem should be widespread enough to generate broad interest in the synthesis.
- The problem should be timely and critical with respect to economic impact, safety, or social impact.

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

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

#### *Conduct of the Studies*

Throughout the year, 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, an agreement is negotiated with a consultant to gather information on the topic, synthesize it, and draft a report. Typically, the agreement covers about 50 workdays over a period of about one year. Information gathering and preparation of the first draft of the synthesis report usually take from 6 to 9 months. This draft is reviewed by the topic panel with the consultant at the second panel meeting. A revised draft is then prepared by the author and reviewed by the topic panel. Subsequent drafts and meetings are scheduled if needed, although this rarely occurs.

After the topic panel 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. Comments from these reviews are incorporated into the final report, which is usually published as an NCHRP Synthesis of Highway Practice.

#### *Index of Topic Subjects*

Table 5 is an index to published syntheses and topics under study, as well as those expected to be started through 1993.

Table 1  
COMPLETED SYNTHESSES

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

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

Table 1 (continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
97.	Transit Ownership/Operation Options for Small Urban and Rural Areas (1982) 28 pp., \$6.40	141.	Bridge Deck Joints (1989) 66 pp., \$9.00
98.	Resealing Joints and Cracks in Rigid and Flexible Pavements (1982) 62 pp., \$7.20	142.	Methods of Cost-Effectiveness Analysis for Highway Projects (1988) 22 pp., \$7.00
99.	Resurfacing with Portland Cement Concrete (1982) 90 pp., \$8.40	143.	Uniformity Efforts in Oversize/Overweight Permits (1988) 79 pp., \$10.00
100.	Managing State Highway Finance (1982) 23 pp., \$6.40	144.	Breaking/Cracking and Sealing Concrete Pavements (1989) 39 pp., \$8.00
101.	Historic Bridges — Criteria for Decision Making (1983) 77 pp., \$8.00	145.	Staffing Considerations in Construction Engineering Management (1989) 42 pp., \$8.00
102.	Material Certification and Material-Certification Effectiveness (1983) 17 pp., \$6.00	146.	Use of Consultants for Construction Engineering and Inspection (1989) 64 pp., \$9.00
103.	Risk Assessment Processes for Hazardous Materials Transportation (1983) 26 pp., \$6.40	147.	Treatment of Problem Foundations for Highway Embankments (1989) 72 pp., \$9.00
104.	Criteria for Use of Asphalt Friction Surfaces (1983) 41 pp., \$6.80	148.	Indicators of Quality in Maintenance (1989) 114 pp., \$11.00
105.	Construction Contract Claims: Causes and Methods of Settlement (1983) 58 pp., \$7.20	149.	Partnerships for Innovation: Private Sector Contributions to Innovation in the Highway Industry (1989) 45 pp., \$8.00
106.	Practical Guidelines for Minimizing Tort Liability (1983) 40 pp., \$6.80	150.	Technology Transfer in Selected Highway Agencies (1989) 38 pp., \$8.00
107.	Shallow Foundations for Highway Structures (1983) 38 pp., \$6.80	151.	Process for Recapitalizing Highway Transportation Systems (1989) 43 pp., \$8.00
108.	Bridge Weight-Limit Posting Practices (1984) 30 pp., \$6.40	152.	Compaction of Asphalt Pavement (1989) 42 pp., \$8.00
109.	Highway Uses of Epoxy with Concrete (1984) 68 pp., \$8.80	153.	Evolution and Benefits of Preventive Maintenance Strategies (1989) 69 pp., \$9.00
110.	Maintenance Management Systems (1984) 49 pp., \$8.00	154.	Recycling Portland Cement Concrete Pavements (1989) 46 pp., \$8.00
111.	Distribution of Wheel Loads on Highway Bridges (1984) 22 pp., \$7.20	155.	Freeway Guide Sign Replacement: Policies and Criteria (1991) 37 pp., \$8.00
112.	Cost-Effectiveness of Hot-Dip Galvanizing for Exposed Steel (1984) 28 pp., \$7.20	156.	Freeway Incident Management (1990) 23 pp., \$7.00
113.	Administration of Research, Development, and Implementation Activities in Highway Agencies (1984) 49 pp., \$8.00	157.	Maintenance Management of Street and Highway Signs (1990) 134 pp., \$12.00
114.	Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 (supersedes Synthesis 22)	158.	Wet-Pavement Safety Programs (1990) 54 pp., \$8.00
115.	Reducing Construction Conflicts between Highways and Utilities (1984) 73 pp., \$8.80	159.	Design and Construction of Bridge Approaches (1990) 45 pp., \$8.00
116.	Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40	160.	Cold-Recycled Bituminous Concrete Using Bituminous Materials (1990) 105 pp., \$11.00
117.	Toll Highway Financing (1984) 29 pp., \$7.20	161.	Computer-Aided Design and Drafting Systems (1990) 24 pp., \$7.00
118.	Detecting Defects and Deterioration in Highway Structures (1985) 52 pp., \$8.00	162.	Signing Policies, Procedures, Practices, and Fees for Logo and Tourist-Oriented Directional Signing (1990) 41 pp., \$8.00
119.	Prefabricated Bridge Elements and Systems (1985) 75 pp., \$8.80	163.	Innovative Strategies for Upgrading Personnel in State Transportation Departments (1990) 35 pp., \$7.00
120.	Professional Resource Management and Forecasting (1985) 15 pp., \$6.80	164.	Measures to Curtail State Fuel Tax Evasion (1990) 14 pp., \$7.00
121.	Energy Conservation in Transportation (1985) 25 pp., \$7.20 (supplements Synthesis 43)	165.	Transportation Telecommunications (1990) 92 pp., \$10.00 (supersedes Synthesis 12)
122.	Life-Cycle Cost Analysis of Pavements (1985) 136 pp., \$10.80	166.	Traffic Signal Control Equipment: State of the Art (1990) 43 pp., \$8.00
123.	Bridge Designs to Reduce and Facilitate Maintenance and Repair (1985) 65 pp., \$8.40	167.	Measurements, Specifications, and Achievement of Smoothness for Pavement Construction (1990) 34 pp., \$8.00
124.	Use of Weigh-in-Motion Systems for Data Collection and Enforcement (1986) 34 pp., \$7.60	168.	Contract Management Systems (1990) 74 pp., \$10.00
125.	Maintenance Activities Accomplished by Contract (1986) 42 pp., \$8.00	169.	Removing Concrete from Bridges (1991) 42 pp., \$8.00
126.	Equipment for Obtaining Pavement Condition and Traffic Loading Data (1986) 118 pp., \$11.20	170.	Managing Urban Freeway Maintenance (1990) 32 pp., \$7.00
127.	Use of Fly Ash in Concrete (1986) 66 pp., \$8.40	171.	Fabrics in Asphalt Overlays and Pavement Maintenance (1991) 72 pp., \$9.00
128.	Methods for Identifying Hazardous Highway Elements (1986) 80 pp. (microfiche)*	172.	Signal Timing Improvement Practices (1992) 88 pp., \$11.00
129.	Freezing and Thawing Resistance of High-Strength Concrete (1986) 31 pp., \$7.60	173.	Short-Term Responsive Maintenance Systems (1991) 43 pp., \$9.00
130.	Traffic Data Collection and Analysis: Methods and Procedures (1986) 58 pp., \$8.40	174.	Stormwater Management for Transportation Facilities (1993) (in press)
131.	Effects of Permit and Illegal Overloads on Pavements (1987) 99 pp., \$10.40	175.	Moisture Damage in Asphalt Concrete (1991) 91 pp., \$10.00
132.	System-Wide Safety Improvements: An Approach to Safety Consistency (1987) 20 pp., \$6.80	176.	Bridge Paint: Removal, Containment, and Disposal (1992) 60 pp., \$9.00
133.	Integrated Highway Information Systems (1987) 31 pp., \$7.60	177.	Freeway Corridor Management (1992) 64 pp., \$9.00
134.	D-Cracking of Concrete Pavements (1987) 34 pp., \$7.60	178.	Truck Escape Ramps (1992) 56 pp., \$9.00
135.	Pavement Management Practices (1987) 139 pp., \$12.40	179.	Latex-Modified Concretes and Mortars (1992) 58 pp., \$9.00
136.	Protective Coatings for Bridge Steel (1987) 107 pp., \$11.00	180.	Performance Characteristics of Open-Graded Friction Courses (1992) 44 pp., \$8.00 (supplements Synthesis 49)
137.	Negotiating and Contracting for Professional Engineering Services (1988) 75 pp., \$9.60	181.	In-Service Experience with Traffic Noise Barriers (1992) (in press)
138.	Pavement Markings: Materials and Application for Extended Service Life (1988) 45 pp., \$8.00 (supersedes Synthesis 17)	182.	Performance and Operational Experience of Truck-Mounted Attenuators (1993) (in press)
139.	Pedestrians and Traffic Control Measures (1988) 75 pp., \$9.00	183.	Knowledge Based Expert Systems in Transportation (1992) 52 pp., \$9.00
140.	Durability of Prestressed Concrete Highway Structures (1988) 65 pp., \$9.00	184.	Disposal of Roadside Litter Mixtures (1993) (in press)
		185.	Preferential Lane Treatments for High-Occupancy Vehicles (1993) (in press)
		186.	Supplemental Advance Warnings (1993) (in press)
		187.	Rapid Test Methods for Asphalt Concrete and Portland Cement Concrete (1993) (in press)
		106.	Use of Waste Materials in Highway Construction and Maintenance (1979) 2 pp., \$1.00
		22-13	Use of Rumble Strips to Enhance Safety

**Research Results Digests (RRD)**

100. Safe Conduct of Traffic Through Highway Construction and Maintenance Zones (1978) 5 pp., \$1.00

**Syntheses in Editorial and Publication Process**

21-03 Management Training and Development Programs

21-11 Impacts of Hazardous Materials on Highway Maintenance

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

Table 2  
TOPICS BEING STUDIED

No.	Title	No.	Title
17-05	Design, Construction, and Maintenance of PCC Pavement Joints	23-05	Relationship of Current Construction Specifications to Performance
17-07	Durability of Drainage Pipe	23-06	Corridor Preservation
19-22	Status and Application of GPS Satellite Positioning for Departments of Transportation	23-07	Use of Warranties in Road Construction
20-22	Highway Tort Liability Management Programs	23-09	Severity Indices for Roadside Features
21-06	Development of Professional Highway Maintenance Engineers	23-10	Portland Cement Concrete Resurfacing
21-08	Development and Implementation of Traffic Control Plans for Highway Work Zones	23-11	Changeable Message Signs
21-10	Hot In-Place Recycling of Asphalt Concrete	23-12	Reduced Visibility on the Highway
21-11	Impacts of Hazardous Materials on Highway Maintenance	23-13	Effective Use of Park-and-Ride Facilities
21-13	Highway Pavement Structural Design Practices	24-01	Resolution of Disputes to Avoid Construction Claims
21-14	Criteria for Qualifying Contractors for Bidding Purposes	24-02	International Survey of Roadway Pricing
22-02	Uses of Recycled Rubber Tires in Highways	24-03	Performance and Operational Experience of Permanent and Temporary Crash Cushions
22-04	Underwater Bridge Maintenance and Repair	24-04	Determination of Contract Time for Highway Construction Projects
22-07	Current Practices in Determining Pavement Condition	24-05	Pavement Management Methodologies to Select Projects and Recommend Preservation Treatments
22-10	Recycling and Use of Waste Materials and By-Products in Highway Construction	24-06	Electronic Toll and Traffic Management Systems
22-11	Photographic Enforcement of Traffic Laws	24-07	Pavement Markings
22-12	Truck Operating Characteristics	24-08	Longitudinal Occupancy of Limited/Controlled Access Right-of-Way by Utilities
22-14	Impacts of Highway Bypasses on Rural Communities and Small Urban Areas	24-10	Asphalt Surface Treatments and Thin Overlays
23-01	Accident Data Quality	24-11	Implementation of Technologies from Abroad
23-03	Managing Roadway Snow and Ice Control Operations	24-12	Sealers for Portland Cement Concrete Highway Facilities
23-04	Multimodal Evaluation in Passenger Transportation	24-13	Effects of Highway Widening Improvements on Urban and Suburban Areas

Table 3  
NCHRP PROJECT COMMITTEE SP20-5

Chairman	
Verdi Adam*	
Gulf Engineers & Consultants	
Kenneth C. Afferton	Edward A. Mueller*
New Jersey Dept. of Transportation	Morales and Shumer Engineers
Robert N. Bothman*	Earl C. Shirley
The HELP Program	California Dept. of Transportation
Jack Freidenrich*	Jon P. Underwood
The RBA Group	Texas Dept. of Transportation
John J. Henry	Thomas O. Willett
Pennsylvania Transportation Institute	Federal Highway Administration
Gloria J. Jeff	J. Richard Young, Jr.
Michigan Dept. of Transportation	Mississippi Dept. of Transportation
Bryant Mather*	Richard A. McComb (Liaison)
USAE Waterways Experiment Station	Federal Highway Administration
Thomas H. May*	Robert E. Spicher (Liaison)
Pennsylvania Dept. of Transportation	Transportation Research Board

\* — Term ended November 1992

Table 4  
SYNTHESIS TOPICS SELECTED FOR THE FY 1993 PROGRAM

No.	Title	No.	Title
25-01	Applications of 3D and 4D Highway Modeling	25-13	Procedures MPOs Use to Consider the 15 Factors in Developing Plans and Programs Under the ISTEA
25-02	Methodologies Associated with Freight Planning	25-14	Conducting Contract Research
25-03	Left Turn Treatments	25-15	Productivity Measurements within DOTs
25-04	Highway Guiderail and Median Barrier Crashworthiness	25-16	Dynamic Effects of Pile Installations on Adjacent Structures
25-05	Evaluating and Implementing Public-Private Partnership Options in Transportation	25-17	Requirements for Traffic Management System Applications of Highway Advisory Radio
25-06	Managing Bridge Maintenance	25-18	Cathodic Protection for Steel-Reinforced Concrete Bridge Elements
25-07	Pavement Subsurface Drainage Systems	25-19	Evaluation of Sign Legends to Improve Legibility, Conspicuity, and Visibility
25-08	Medium-Size Area Congestion Management Systems	25-20	Evolution and Timeliness of Transportation-Related Training in the Highway Community
25-09	Waterproofing Membranes for Bridge Decks		
25-10	Cost Effective Preventive Maintenance		
25-11	Toll Plaza Design		
25-12	Transportation Systems Management		

Table 5  
INDEX TO SYNTHESSES AND STUDIES\*

Accident data 91, 23-01	- pavements 16, 19, 27, 45, 56,	- roadways 26	Information systems 133
Accident location 21, 91, 128, 23-09	60, 98, 99, 134, 144, 17-05,	- shoulders 63	Innovation by private industry 149
Advance warnings 186	23-10	- toll plaza 25-11	Inspection by consultants 146
Aid to motorists 7	- precast 53	- value engineering 78	Inspection of bridges 88
Artificial intelligence 183	- repair preparation 169	Direction finding 71	Instrumentation 36
Asphalt	- sealers 24-12	Disadvantaged, transportation for 39	Instrumentation, geotechnical 89
- cement 59	- water reducers 129	Drainage	
- compaction 152	Congestion management 25-08	- bridge 67	Joints, bridge deck 141
- emulsions 30	Consolidation of concrete 44	- pavement 96, 174, 25-07	Joints, concrete pavement 19, 56, 98,
- friction courses 49, 104, 180	Construction	- sedimentation basins 70	134, 17-05
- moisture damage 175	- bases and subbases 37	Drainage durability 50, 17-07	Joints and cracks, sealing 98
- overlays 116	- bidding qualifications 21-14	Drainage structures 3	
- patching 64	- bituminous pavements 30		Laboratory testing equipment 36
- pavements 30, 49, 59, 104, 152,	- bridge approaches 2, 159	Elderly, transportation for 39, 83	Land use 93
171, 175, 180, 19-09, 24-10	- bridge decks 4, 44, 57, 86	Electronic toll & traffic management	Latex-modified concrete 179
- recycling 54, 160, 21-10	- concrete pavements 16, 19, 27,	systems 24-06	Left turn treatments 25-03
- surface treatments 24-10	44, 144, 17-05	Embankments 8	Legal liability 106, 20-22
Attenuators 182	- consultants 146	Employees (see Personnel)	Life-cycle costs 122
Automatic vehicle identification	- contract claims 105, 24-01	Emulsions 30	Lime-fly ash 37
(AVI) 24-06	- contract time 79, 24-04	End-result specifications 38	Litter disposal 184
Bases 37	- embankments 8	Energy	Location reference methods 21, 91
Bearings for bridges 41	- energy factors 85	- bituminous emulsions 30	Low-volume pavements 27
Bidding qualifications 21-14	- engineering 145, 146	- construction 85	
Bituminous emulsions 30	- erosion control 18	- transportation use 43, 121	Maintenance
Bituminous patching 64	- management 51, 145	Epoxies 109	- bituminous pavements 30, 64,
Bituminous pavements (see Asphalt)	- material certification 102	Equipment	98
Bridges	- pavements 16, 19, 27, 30, 44,	- for pavement data 126	- bridges 88, 123, 22-04, 25-06
- approaches 2, 159	144, 17-05, 152, 167	- for testing 36	- budgets 80
- bearings 41	- quality assurance 38, 65, 23-05	- for traffic control 166	- concrete pavements 19, 45, 56,
- below-water inspection 88	- recycling 54, 154, 21-10	- management of 52	60, 98, 17-05
- below-water repair 88, 22-04	- specifications 38, 23-05	- procurement of 52	- contract 125
- concrete decks 4, 57, 86	- staffing 51, 145	- selection of 52	- costs 58, 98
- construction 44, 53	- testing 36, 65, 187	Expansion devices for bridges 141	- deferred 58
- deck joints 141	- traffic control 21-08, RRD 100	Expert systems 183	- equipment 52
- deck removal 169	- utilities 115, 24-08		- freeways 1, 25, 170
- deck sealers 24-12	- value engineering 78	Fabrics for pavements 171	- hazardous materials impacts
- design for maintenance 123	- warranties 23-07	Field testing equipment 36, 126	21-11
- drainage 67	- weather 47	Finance/budgets 62, 72, 80, 100, 117,	- litter disposal 184
- durability 4, 57, 86, 118, 140	Consultants	151	- management 10, 22, 46, 52, 58,
- expansion devices 141	- construction engineering 146	Fly ash 37, 127	80, 110, 157, 173
- foundations 42, 107	- negotiating for services 137	Fog 23-12	- management systems 110,
- galvanizing 112	Continuously reinforced pavements	Foundations	20-05, 20-06
- historic 101	16, 60	- embankments 8, 29, 147	- pavement costs 77, 98
- inspection 88, 118	Contract bidding qualifications 21-14	- pile 42	- pavement joints 19, 56, 98,
- maintenance 25-06	Contract claims 105, 24-01	- shallow 107	134, 17-05
- membranes 25-09	Contract maintenance 125	- soft strata 29, 147	- pavements 9, 19, 25, 30, 45, 56,
- paint removal 176	Contract management 168	Freeways	60, 64, 98, 134, 17-05
- painting 136	Contract time determination 79,	- corridor management 177	- personnel 10
- patching 45	24-04	- incident management 156	- preventive, value of 153, 25-10
- posting practices 108	Corridor preservation 23-06	- maintenance 1, 25, 170	- quality assurance 148
- precast concrete 53, 119	Cost-effectiveness analysis 142	- off-ramps 35	- records 46
- prefabricated 53, 119	Costs, life-cycle 122	- repair 25	- recycling 54, 21-10
- prestressed, durability 140	Crash cushions 182, 24-03	Freight planning 25-02	- reporting 46
- scour 5	Culverts	Friction courses 49, 104, 180	- rest areas 20
- substructure repair 88, 22-04	- durability 50, 17-07	Frost susceptibility 26	- scheduling 170
- wheel load distribution 111	- inlets 3	Fuel taxes 62, 164	- signs 157, 155
Bus transit planning 69	Data collection 124, 126, 130	Galvanizing 112	- snow and ice 24, 23-03
Bypasses, impacts of 22-14	Data systems 55	Geotechnical data 33	- traffic control 1, 25, RRD 100,
Changeable message signs 61, 23-11	D-cracking 134	Geotechnical exploration 33	21-08
Communications 7, 12, 13, 71, 165	Deferred maintenance 58	Geotechnical instrumentation 89	- traffic signals 22, 114
Computer-aided design 161	Deicing chemical use 24, 23-03	Glare screen 66	- training 10, 21-06
Computers 55	Design	GPS satellite positioning 19-22	- tunnels 31
Concrete	- bituminous pavements 30, 116,	Guaranty of construction 23-07	- winter 24, 23-03
- admixtures 127, 129	21-13	Guidrails 25-04	Management
- bridge decks 4, 57, 86, 169	- bridge approaches 2, 159		- construction 51, 145
- consolidation 44	- bridge bearings 41	Handicapped, transportation for 39,	- contract 168
- dry-cast 129	- computer-aided 161	83	- data 55
- durability 4, 57, 129, 140	- concrete pavements 16, 19, 27,	High occupancy vehicles 185	- freeway corridor 177
- epoxies 109	17-05, 21-13	Hazardous materials transportation	- freeway incidents 156
- fly ash in 127	- for bridge maintenance 123	- impacts on maintenance 21-11	- maintenance 10, 22, 46, 52, 58,
- freezing and thawing 129	- frost 26	- risk assessment 103	80, 110, 170, 173
- latex-modified 179	- pavement overlays 99, 116,	Historic bridges 101	- personnel 11, 120
- overlays 99, 23-10	23-10	Incident management on freeways	- research 113
- patching 45	- pavements 16, 19, 26, 27, 30,	156	- roadway information 133
- pavement recycling 54, 154	17-05, 21-13	Information for motorists 7, 71, 162	- S.E.E. assessments 40
	- pile foundations 42		- training 11, 21-03

\*Simple numbers represent published syntheses; hyphenated numbers represent studies in progress.

Table 5 (continued)

Material certification 102	- striping 17, 138, 24-07	- management 113	Traffic control
Materials testing equipment 36	- studded tires 32	Rest areas 20	- construction 21-08, RRD 100
Median barriers 25-04	- surface treatments 24-10	Right of way	- devices 61, 166, 186, 23-11
Median glare screen 66	- widening 28, 24-13	- utilities 34, 24-08	- equipment 166
Metropolitan Planning Organizations (MPOs) 25-13	Pedestrian traffic control 139	Risk assessment, haz. materials 103	- left turn treatments 25-03
Mileposts 21	Permit operations 68, 143	Road pricing 24-02	- maintenance 1, 21-08, RRD 100
Modeling, 3D and 4D 25-01	- effects on pavements 131	Roadside hazard severity 23-09	- pedestrian 139
Monitoring of projects 6	Personnel	Roadway information systems 133	- plans 21-08
Motorist aid systems 7	- bridge inspection 141	Rubber tire uses 22-02, 22-10	- priority lanes 185
Motorist information 71, 162	- construction engineering 51, 145	Rumble strips 22-13	- ramps 35
Multimodal transportation 23-04	- maintenance 10, 21-06	Safety 1, 3, 7, 14, 32, 49, 66, 91, 128, 132, 156, 158, 21-08, 186, 182, 22-13, 23-01, 23-09, 24-03 RRD 100, 25-04	- work zones 1, RRD 100, 21-08
Needs studies 72, 151	- planning for 120	Scheduling of projects 6, 24-05	Traffic data collection 130
New-product evaluation 90, 150	- S.E.E. assessment 40	Scour 5, 22-04	Traffic law enforcement 22-11
Noise barriers 87, 181	- training 10, 11, 163, 21-03, 21-06	Sedimentation basins 18, 70	Traffic marking 17, 138, 24-07
Off-ramps 35	Photographic traffic law enforcement 22-11	Severity indices 23-09	Traffic paint 17, 138, 24-07
Open-graded surfaces 49, 104, 180	Photologging 94	Shoulders 63	Traffic safety 1, 3, 32, 35, 66, RRD 100, 23-09
Overlays 9, 49, 92, 99, 104, 116, 144, 23-10	Pile foundations 42	Signs	Traffic signals
Overload effects 131	Pipe durability 50, 17-07	- advance warning 186	- equipment 166
Paint removal 176	Planning	- changeable message 61, 23-11	- left turns 25-03
Painting steel bridges 136	- freight 25-02	- maintenance 157, 155	- maintenance 22, 114
Patching 9, 45, 64	- MPOs 25-13	- motorist information 71, 162	- timing 172
Pavements	- multimodal evaluation 23-04	Size regulation and enforcement 68, 143	Training of personnel 10, 11, 163, 21-03, 21-06
- asphalt 30, 49, 59, 116, 152, 160, 171, 175, 180	- personnel 120	Skid resistance 14, 158	Transit
- bases 37	- statewide transportation 15, 95	Smoothness, pavements 167	- boards 75
- concrete 16, 19, 27, 44, 56, 60, 99, 144, 17-05, 23-10	- transit 69, 73	Snow and ice control 24, 23-03	- elderly/handicapped 39, 83
- condition data 76, 126, 22-07	- transportation 73, 23-04	Soft foundations 29, 147	- management assistance 74
- construction 16, 19, 27, 30, 44, 17-05	Poor, transportation for 39	Soil erosion 18	- ownership 97
- CRCP 16, 60	Posting of bridges 108	Specifications 38, 65, 23-05	- planning 69, 73
- design 21-13	Pothole repair 45, 64	Spectrum management 13	Transportation planning 15, 72, 73, 95, 151, 23-04
- distress 9	Precast concrete 53, 119	Stabilization of bases 37	Transportation systems management 81, 93, 25-12
- drainage 96, 25-07	Prefabricated structural systems 119	Staffing	Truck escape ramps 178
- durability 59, 160	Prestressed concrete durability 140	- construction 51, 145	Truck operating characteristics 22-12
- effects of overloads 131	Preventive maintenance value 153	- maintenance 10	Truck weights and sizes 68, 82, 124, 143
- evaluation 76, 126, 22-07	Priority lane treatments 185	- planning for 120	Tunnels, maintenance & operation 31
- fabrics 171	Priority programming 48, 84, 24-05	- S.E.E. assessments 40	Underwater bridge inspection 88
- friction 14, 158	Private sector involvement 149, 25-05	Statewide transportation planning 15, 95	Underwater bridge repair 88, 22-04
- friction courses 49, 104, 180	Professional engineering services	Statistical specifications 38, 65	Urban freeway reconditioning 25
- frost design 26	- construction 146	Storm water management 174	Utilities 34, 115, 24-08
- joints 19, 56, 98, 134, 17-05	- negotiating 137	Stream scour 5	Value engineering 78
- life-cycle costs 122	Programming 48, 72, 84, 151	Striping 17, 138, 24-07	Variable message signs 61, 23-11
- low-volume 27	Public-private partnerships 25-05	Structures (see bridges)	Vehicle attenuators 182
- maintenance 9, 19, 25, 30, 45, 56, 60, 64, 98, 134, 17-05, 25-10	Quality assurance 38, 65, 148, 23-05, 24-09	Studded tires 32	Vibration of concrete 44
- maintenance costs 77, 98, 25-10	Radio communications 12, 13, 165	Subbases 37	Video traffic law enforcement 22-11
- management 135, 24-05	Radio frequency management 13	Subsurface information 33	Visibility 23-12
- marking 17, 138, 24-07	Rapid test methods 187	Superplasticizers for concrete 129	Warranties in construction 23-07
- moisture damage 175	Recycling highway materials 54, 154, 160, 21-10, 22-02, 22-10	Surface courses 49, 104, 180	Waste materials 22-10, RRD 106
- overlays 9, 92, 99, 116, 144, 23-10	Reference methods 21	Surveying, GPS satellite 19-22	Weather 47
- patching 9, 45, 64	Reference posts 21, 91	Taxes, fuel 62, 164	Weigh-in-motion 124
- recycling 54, 154, 160, 21-10	Reflection cracking 9, 92	Technology transfer 23, 150, 24-11	Weight regulation & enforcement 68, 82, 124, 143
- rehabilitation 9, 25, 92, 134, 24-05	Rehabilitation	Telecommunications 12, 165	Widening of pavements 28, 24-13
- sealers 24-12	- freeways 25	Telephones 12, 165	Winter maintenance 24, 23-03
- skid resistance 14, 158	- pavements 9, 56, 92, 99, 134, 23-10, 24-05	Testing, construction 36, 65	Work schedules 73
- smoothness 167	Research	Testing, rapid 187	Work zone traffic 1, RRD 100, 21-08
	- contract 25-14	Testing equipment 36, 187	
	- implementation 23, 150	Toll collection 24-06	
		Toll financing 117	
		Toll plaza design 25-11	
		Tort liability 106, 20-22	

\*Simple numbers represent published syntheses; hyphenated numbers represent studies in progress.

**TRANSPORTATION RESEARCH BOARD**

National Research Council  
2101 Constitution Avenue, N.W.  
Washington, D.C. 20418

NON-PROFIT ORG.  
U.S. POSTAGE  
PAID  
WASHINGTON, D.C.  
PERMIT NO. 8970

00002105 1A 1A 9512 001  
Robert M Smith  
Research & Asst Matls Supvr  
Idaho Transportation Dept  
P O Box 7129  
Boise ID 83707-1129