

# RESEARCH RESULTS DIGEST

September 1999—Number 245

IDAHO TRANSPORTATION DEPARTMENT  
RESEARCH LIBRARY

Responsible Senior Program Officer: 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 Program Director 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, the problem statement must be resubmitted the following year to be reconsidered.

Interested in writing a synthesis? For details, contact Stephen F. Maher, P.E. by e-mail at [smaher@nas.edu](mailto:smaher@nas.edu), or by phone at 202-334-3245 or Donna L. Vlasak, by e-mail at [dvlasak@nas.edu](mailto: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 1999

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) 334-3214; and through the Internet at <http://www2.nas.edu/trbbooks/NCHRPSyn.html>

## 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 1999.

## 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
29-01	Robust Research Programs	30-03	Corridor Management
29-02	Roadway Incident Diversion Practices	30-04	Innovative Practices to Reduce Delivery Time for Right-of-Way in Project Development
29-03	Performance Survey on Open-Graded Friction Course Mixes	30-05	Procedures for Assessing Economic Development Impacts from Transportation Investments
29-04	DOT Project Management Systems	30-06	Sleep Deprivation Countermeasures for Motorist Safety
29-05	Impact of Narrow Median Widths on Commercial Vehicles	30-07	Data Sharing and Data Partnerships for Highways
29-07	Management and Selection Systems for Highway Maintenance Equipment	30-08	Bridge Deck Joint Performance
29-08	Measuring In-situ Mechanical Properties of Pavement Subgrade Soils	30-09	Quality Assurance of Structural Materials
30-01	Systems Engineering Processes for Developing Traffic Signal Systems	30-10	Maintenance of Highway Edgedrains
30-02	Multimodal Aspects of Statewide Transportation Planning	30-11	Design and Testing of Pavement Friction Characteristics
		30-12	Techniques Used to Minimize Lane Occupancy During Construction and Maintenance

Table 2  
SYNTHESIS TOPICS SELECTED FOR THE FY 1999 PROGRAM

No.	Title	No.	Title
31-01	Recent Geometric Design Research for Improved Safety and Operations	31-09	Truck Trip Generation Guide
31-02	Statistical Methods in Highway Safety Analysis	31-10	Traffic Control System Configuration Management Plans and Implementation Strategies
31-03	Assessment and Rehabilitation of Existing Culverts	31-11	Building Effective Relationships Between Central Cities, States, and the Federal Government
31-04	Performance Measures for Research, Development and Technology Programs	31-12	Validation of Wetland and Biohabitat Mitigation Measures
31-05	GPS to GIS: Turning Data into Information		<i>Alternate Topics</i>
31-06	Facilitation Partnerships in Funding Transportation Research	31-13	Public Benefits of Proper Maintenance and Operations
31-07	Review of Temporary and Long-Term Pavement Marking Practices	31-14	Institutional Frameworks for Statewide Transportation Planning and Investment Decisions
31-08	Impact of New Information/Communications Technology on Transportation Agencies	31-15	Project Financing

Table 3  
NCHRP PROJECT COMMITTEE SP20-5

Chairman C. Ian MacGillivray Iowa Department of Transportation	
Kenneth C. Afferton New Jersey Department of Transportation (Retired)	Henry H. Rentz Federal Highway Administration
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. Mississippi Department of Transportation (Retired)
Gloria J. Jeff Federal Highway Administration	<i>Liaisons</i>
Ysela Llort Florida Department of Transportation	Charles Niessner Federal Highway Administration
Wesley S.C. Lum California Department of Transportation	Robert E. Spicher Transportation Research Board

Table 4  
COMPLETED SYNTHESSES

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.	CostEffectiveness 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.	LifeCycle 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.



Table 5  
**INDEX TO SYNTHESSES AND STUDIES\***

- Accelerated pavement testing 235  
 Access management 233  
 Accident data 91, 192  
 Accident location 21, 91, 128, 202  
 Advance warnings 186  
 Aid to motorists 7  
 Artificial intelligence 183  
 Asphalt  
   - cement 59  
   - compaction 152  
   - emulsions 30, UR24-10  
   - friction courses 49, 104, 180, 29-03  
   - moisture damage 175  
   - overlays 116, UR24-10  
   - patching 64  
   - pavements 30, 49, 59, 104, 152, 171, 175, 180, 260  
   - recycling 54, 160, 193  
   - rut resistant 274  
   - surface treatments 223  
 Attenuators 182  
 Automatic vehicle identification (AVI) 194  
  
 Bases 37  
 Bearings for bridges 41  
 Bidding  
   - qualifications 190  
   - electronic 256  
 Bituminous  
   - emulsions 30  
   - patching 64  
   - pavements (see Asphalt)  
 Bridges  
   - approaches 2, 159, 234  
   - bearings 41  
   - below-water inspection 88  
   - below-water maintenance 200  
   - below-water repair 88, 200  
   - concrete decks 4, 57, 86, 209, 220  
   - construction 44, 53  
   - corrosion protection 257  
   - deck joints 141, 30-08  
   - deck removal 169  
   - deck sealers 209  
   - design for maintenance 123  
   - drainage 67  
   - durability 4, 57, 86, 118, 140  
   - dynamic impact factors 266  
   - expansion devices 141, 30-08  
   - foundations 42, 107, 253  
   - galvanizing 112, 257  
   - historic 101, 275  
   - increasing live loads, existing 249  
   - inspection 88, 118  
   - maintenance 227, 257  
   - management systems 227  
   - membranes 220  
   - paint removal 176, 251  
   - painting 136  
   - patching 45  
   - posting practices 108  
   - precast concrete 53, 119  
   - prefabricated 53, 119  
   - prestressed, durability 140  
   - scour 5, 200  
   - substructure repair 88, 200  
   - wheel load distribution 111  
 Bus transit planning 69  
 Bypasses, impacts of RRD 210  
  
 Capital programming 243  
 Changeable message signs 61, 237  
  
 Communications 7, 12, 13, 71, 165, 31-08  
 Computeraided design 161  
 Computers 55  
 Concrete  
   - admixtures 127, 129  
   - bridge decks 4, 57, 86, 169  
   - consolidation 44  
   - dry-cast 129  
   - durability 4, 57, 129, 140  
   - epoxies 109  
   - fly ash in 127, 199  
   - freezing and thawing 129  
   - latex-modified 179  
   - overlays 99, 204  
   - patching 45  
   - pavement recycling 54, 154  
   - pavements 16, 19, 27, 45, 56, 60, 98, 99, 134, 144, 204, 211  
   - precast 53  
   - rapid test methods 187  
   - repair preparation 169  
   - resurfacing 204  
   - sealers 209  
   - water reducers 129  
 Conduits  
   - trenchless installation 242  
 Consolidation of concrete 44  
 Construction  
   - acceptance 263  
   - bases and subbases 37  
   - bidding qualifications 190  
   - bituminous pavements 30  
   - bridge approaches 2, 159, 234  
   - bridge decks 4, 44, 57, 86  
   - concrete pavements 16, 19, 27, 44, 144, 204, 211  
   - consultants 146  
   - contract claims 105, 214  
   - contract time 79, 215  
   - embankments 8  
   - energy factors 85  
   - engineering 145, 146  
   - erosion control 18  
   - lane occupancy 3012  
   - management 51, 145  
   - material certification 102, 263  
   - pavements 16, 19, 27, 30, 44, 144, 211, 152, 167, 204, 211  
   - quality assurance 38, 65, 212, 232, 263  
   - recycling 54, 154, 193  
   - specifications 38, 212, 263  
   - staffing 51, 145  
   - subgrades 247  
   - techniques 30-12  
   - testing 36, 65, 187  
   - traffic control 208, RRD 100  
   - trenchless, conduits 242  
   - utilities 115, 224  
   - value engineering 78  
   - variability 232  
   - warranties 195  
   - weather 47  
 Consultants  
   - construction engineering 146  
   - DOT design 277  
   - negotiating for services 137  
 Contaminated Soils 226  
 Continuously reinforced pavements 16, 60, 204, 211  
 Contract  
   - bidding qualifications 190  
   - claims 105, 214  
   - maintenance 125, 246  
   - management 168  
   - research 231  
   - time determination 79, 215  
 Corridor management plans 30-03  
 Corridor preservation 197  
 Cost-effectiveness analysis 142, 223  
 Costs  
   - assessment and rehabilitation, 31-03  
   - life-cycle 122, 222, 269  
   - user & mitigation, 269  
 Crash cushions 182, 205  
 Culverts  
   - assessment and rehabilitation 31-03  
   - durability 50, 254  
   - inlets 3  
  
 Data  
   - collection 124, 126, 130  
   - partnerships 30-07  
   - sharing 30-07  
   - systems 55  
 D-cracking 134  
 Deferred maintenance 58, 223  
 Deicing chemical use 24, 207  
 Design  
   - bituminous pavements 30, 116, 260  
   - bridge approaches 2, 159, 234  
   - bridge bearings 41  
   - computer-aided 161  
   - concrete pavements 16, 19, 27, 189, 211  
   - for bridge maintenance 123  
   - frost 26  
   - geometric research 31-01  
   - pavement overlays 99, 116, 204  
   - pavements 16, 19, 26, 27, 30, 189, 211, 260, 30-11  
   - pile foundations 42, 253  
   - roadways 26, 247  
   - shoulders 63  
   - toll plaza 240  
   - use of consultants 277  
   - value engineering 78  
 Direction finding 71  
 Disadvantaged, transportation for 39  
 Drainage  
   - bridge 67  
   - pavement 96, 174, 239  
   - sedimentation basins 70  
   - pipe durability 50, 254  
   - structures 3, 174  
  
 Economic benefits 30-05  
 Edgedrains, maintenance 30-10  
 Elderly, maintenance 30-10  
 Elderly, transportation for 39, 83  
 Electronic bids 256  
 Electronic toll & traffic management systems 194  
 Embankments 8, 234  
 Employees (see Personnel)  
 Emulsions 30  
 Endresult specifications 38, 212  
 Energy  
   - bituminous emulsions 30  
   - construction 85  
   - transportation use 43, 121  
 Environmental issues, highway maintenance 272  
 Epoxies 109  
 Equipment  
   - for pavement data 126  
   - for testing 36  
   - for traffic control 166, 270  
   - management of 52, 245, 29-07  
   - procurement of 52  
   - selection of 52, 29-07  
 Expansion devices for bridges 141, 30-08  
 Expert systems 183  
  
 Fabrics for pavements 171  
 Field testing equipment 36, 126  
 Finance/budgets 62, 72, 80, 100, 117, 151, 243  
 Fly ash 37, 127  
 Fog 228  
 Foundations  
   - embankments 8, 29, 147, 234  
   - pile 42, 253  
   - shallow 107  
   - soft strata 29, 147  
 Freeways  
   - corridor management 177  
   - incident management 156  
   - maintenance 1, 25, 170  
   - off-ramps 35  
   - reconstruction 273  
   - project development 273  
   - repair 25  
 Freight planning 230  
 Friction courses 49, 104, 180, 29-03  
 Frost susceptibility 26  
 Fuel taxes 62, 164  
 Funding Research 31-06  
  
 Galvanizing 112, 257  
 Geotechnical  
   - data 33  
   - exploration 33  
   - instrumentation 89, 253  
   - In-situ strength measurement 29-08  
   - load and resistance factor design 276  
   - pile foundation vibrations 253  
 Glare screen 66  
 Grade crossings 250, 271  
 GPS satellite positioning 258  
 GPS to GIS 31-05  
 Ground penetrating radar 255  
 Guaranty of construction 195  
 Guardrails 244  
  
 Handicapped, transportation for 39, 83  
 Hazardous materials transportation  
   - impacts on maintenance 196  
   - risk assessment 103  
   - routing criteria 261  
 High occupancy vehicles (HOV) 185  
 Highway-railroad grade crossings 250, 271  
 Historic bridges 101, 275  
  
 Ice control operations 207  
 Incident management on freeways 156, 270  
 Information for motorists 7, 71, 162, 237  
 Information systems 133, 31-08  
 Innovation by private industry 149, 265  
 Inspection by consultants 146, 263  
 Inspection of bridges 88  
 Instrumentation 36, 235  
 Instrumentation, geotechnical 89, 253  
 ISTE  
   - 15 factors 217  
   - small MPOs 252



Table 5 (continued)

<ul style="list-style-type: none"> <li> <ul style="list-style-type: none"> <li>Joints, bridge deck 141, 30-08</li> <li>Joints, concrete pavement 19, 56, 98, 134, 211</li> <li>Joints and cracks, sealing 98</li> <li>Land development 233</li> <li>Laboratory testing equipment 36</li> <li>Land use 93, 233</li> <li>Latex-modified concrete 179</li> <li>Left-turn treatments 225</li> <li>Legal liability 106, 206</li> <li>Life-cycle costs 122, 269</li> <li>Lime-fly ash 37</li> <li>Litter disposal 184</li> <li>Load and resistance factor design (geotechnical) 276</li> <li>Location reference methods 21, 91</li> <li>Low-volume pavements 27, 260</li> </ul> </li> <li>Maintenance           <ul style="list-style-type: none"> <li>- bituminous pavements 30, 64, 98</li> <li>- bridges 88, 123, 200, 227, 257</li> <li>- budgets 80</li> <li>- concrete pavements 19, 45, 56, 60, 98, 204, 211</li> <li>- contract 125</li> <li>- costs 58, 98, 223</li> <li>- deferred 58, 223</li> <li>- edge drains 30-10</li> <li>- equipment 52, 29-07</li> <li>- freeways 1, 25, 170</li> <li>- hazardous materials impacts 196</li> <li>- litter disposal 184</li> <li>- management 10, 22, 46, 52, 58, 80, 110, 157, 173, 29-07</li> <li>- management systems 110, 173</li> <li>- pavement costs 77, 98</li> <li>- pavement joints 19, 56, 98, 134, 211</li> <li>- pavements 9, 19, 25, 30, 45, 56, 60, 64, 98, 134</li> <li>- personnel 10</li> <li>- preventive, value of 153, 223</li> <li>- quality assurance 148</li> <li>- records 46</li> <li>- recycling 54, 193</li> <li>- reporting 46</li> <li>- rest areas 20, 246</li> <li>- scheduling 170</li> <li>- signs 157, 155</li> <li>- snow and ice 24, 207</li> <li>- traffic control 1, 25, RRD 100, 208</li> <li>- traffic signals 22, 114, 245</li> <li>- training 10</li> <li>- tunnels 31</li> <li>- winter 24, 207</li> </ul> </li> <li>Management           <ul style="list-style-type: none"> <li>- construction 51, 145</li> <li>- contract 168</li> <li>- corridor plans 30-03</li> <li>- data 55</li> <li>- freeway corridor 177</li> <li>- freeway incidents 156</li> <li>- maintenance 10, 22, 46, 52, 58, 80, 110, 170, 173, 245</li> <li>- maintenance, environmental issues 272</li> <li>- maintenance, equipment 29-07</li> <li>- personnel 11, 120</li> <li>- project, systems 29-04</li> <li>- research 113, 231</li> <li>- risk, R-O-W 30-04</li> <li>- roadway information 133</li> <li>- snow and ice control operations 207</li> <li>- S.E.E. assessments 40</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li> <ul style="list-style-type: none"> <li>- training 11, 188</li> </ul> </li> <li>Materials           <ul style="list-style-type: none"> <li>- acceptance 263</li> <li>- assurances, structural 30-09</li> <li>- certification 102, 263</li> <li>- testing equipment 36, 263</li> </ul> </li> <li>Median           <ul style="list-style-type: none"> <li>- barriers 244</li> <li>- glare screen 66</li> <li>- narrow, widths 29-05</li> </ul> </li> <li>Metropolitan planning organizations (MPOs) 217, 252</li> <li>Mileposts 21</li> <li>Modeling, 3D and 4D 229</li> <li>Monitoring of projects 6, 263, 29-04</li> <li>Motorist aid systems 7</li> <li>Motorist information 71, 162, 237</li> <li>Multimodal transportation 201, 30-02</li> <li>Needs studies 72, 151</li> <li>New-product evaluation 90, 150, 265</li> <li>Noise barriers 87, 181</li> <li>Noise characteristics of pavements 268</li> <li>Off-ramps 35</li> <li>Open-graded surfaces 49, 104, 180, 29-03</li> <li>Outsourcing services 246</li> <li>Overlays 9, 49, 92, 99, 104, 116, 144, 204</li> <li>Overload effects 131</li> <li>Paint removal 176, 251</li> <li>Painting steel bridges 136</li> <li>Park-and-ride facilities 213</li> <li>Patching 9, 45, 64</li> <li>Pavements           <ul style="list-style-type: none"> <li>- asphalt 30, 49, 59, 116, 152, 160, 171, 175, 180, 260, 29-03</li> <li>- bases 37</li> <li>- concrete 16, 19, 27, 44, 56, 60, 99, 144, 204, 211</li> <li>- condition data 76, 126, 203</li> <li>- construction 16, 19, 27, 30, 44, 211</li> <li>- CRCP 16, 60</li> <li>- design 189, 260, 30-11</li> <li>- distress 9</li> <li>- drainage 96, 239</li> <li>- durability 59, 160, 274</li> <li>- effects of overloads 131</li> <li>- evaluation 76, 126, 203</li> <li>- fabrics 171</li> <li>- friction 14, 158, 30-11</li> <li>- friction courses 49, 104, 180, 29-03</li> <li>- frost design 26</li> <li>- joints 19, 56, 98, 134, 211</li> <li>- life-cycle costs 122, 269</li> <li>- light duty 260</li> <li>- low-volume 27, 260</li> <li>- maintenance 9, 19, 25, 30, 45, 56, 60, 64, 98, 134, 211, 223</li> <li>- maintenance costs 77, 98, 223</li> <li>- management 135, 222</li> <li>- markings 17, 138, UR24-07, 31-07</li> <li>- moisture damage 175</li> <li>- noise characteristics 268</li> <li>- overlays 9, 92, 99, 116, 144, 204</li> <li>- patching 9, 45, 64</li> <li>- recycling 54, 154, 160, 193</li> <li>- rehabilitation 9, 25, 92, 134, 222</li> <li>- rut resistant (asphalt) 274</li> <li>- Safety Analysis 31-02</li> <li>- sealers 209</li> <li>- skid resistance 14, 158</li> </ul> </li> <li>- smoothness 167</li> <li>- striping 17, 138, 218</li> <li>- studded tires 32</li> <li>- subgrade stabilization 247</li> <li>- surface texture 268</li> <li>- testing 235, 30-11</li> <li>- widening 28, 221</li> <li>Pedestrian traffic control 139</li> <li>Performance measures 238, 31-04</li> <li>Performance-related specifications 212</li> <li>Permit operations 68, 143           <ul style="list-style-type: none"> <li>- effects on pavements 131</li> </ul> </li> <li>Personnel           <ul style="list-style-type: none"> <li>- bridge inspection 141</li> <li>- construction engineering 51, 145</li> <li>- maintenance 10</li> <li>- planning for 120</li> <li>- S.E.E. assessment 40</li> <li>- training 10, 11, 163, 188, 248</li> </ul> </li> <li>Photographic traffic law enforcement 219</li> <li>Photologging 94</li> <li>Pile foundations 42, 253</li> <li>Pipe durability 50, 254</li> <li>Planning           <ul style="list-style-type: none"> <li>- freight 230</li> <li>- MPOs 217, 252</li> <li>- multimodal evaluation 201</li> <li>- personnel 120</li> <li>- statewide transportation 15, 95, 30-02</li> <li>- transit 69, 73</li> <li>- transportation 73, 201</li> </ul> </li> <li>Poor, transportation for 39</li> <li>Posting of bridges 108</li> <li>Pothole repair 45, 64</li> <li>Pozzolans 37, 127, 199</li> <li>Precast concrete 53, 119</li> <li>Prefabricated structural systems 119</li> <li>Preferential lane treatments 185</li> <li>Preservation, historic bridges 275</li> <li>Prestressed concrete durability 140</li> <li>Preventive maintenance 153, 223</li> <li>Priority programming 48, 84, 222</li> <li>Private sector involvement 149, 246, 265</li> <li>Professional engineering services           <ul style="list-style-type: none"> <li>- construction 146</li> <li>- design 277</li> <li>- negotiating 137</li> </ul> </li> <li>Programming 48, 72, 84, 151, 243</li> <li>Project development 273</li> <li>Project scheduling 6, 215, 243, 29-04</li> <li>Quality assurance 38, 65, 148, 212, 232, 263, 30-09</li> <li>Radio communications 12, 13, 165</li> <li>Radio frequency management 13</li> <li>Railroad grade crossings 252, 271</li> <li>Rapid test methods 187</li> <li>Reconstruction 247, 273</li> <li>Recycling highway materials 54, 154, 160, 193, 198, 199</li> <li>Reduced visibility 228</li> <li>Reference methods 21</li> <li>Reference posts 21, 91</li> <li>Reflection cracking 9, 92</li> <li>Rehabilitation           <ul style="list-style-type: none"> <li>- culverts 31-03</li> <li>- freeways 25</li> <li>- pavements 9, 56, 92, 99, 134, 204, 222</li> <li>- subgrades, stabilization 247</li> </ul> </li> <li>Research           <ul style="list-style-type: none"> <li>- contract 231</li> <li>- funding 31-06</li> </ul> </li> <li>- implementation 23, 150</li> <li>- management 113</li> <li>- robust programs 29-01</li> <li>Resurfacing portland cement concrete 204</li> <li>Rest areas 20</li> <li>Right of way           <ul style="list-style-type: none"> <li>- clearance 30-04</li> <li>- utilities 34, 224</li> </ul> </li> <li>Risk assessment, haz. materials 103</li> <li>Road pricing 210, 269</li> <li>Roadside hazard severity 202</li> <li>Roadway           <ul style="list-style-type: none"> <li>- information systems 133</li> <li>- incident diversion practices 29-02</li> </ul> </li> <li>Routing, haz. materials 261</li> <li>Rubber tire uses 198, 199</li> <li>Rumble strips 191</li> <li>Safety 1, 3, 7, 14, 32, 49, 66, 91, 128, 132, 156, 158, 182, 186, 191, 192, 202, 205, RRD 100, 244, 30-06, 31-01</li> <li>Safety Analysis 31-02</li> <li>Scheduling of projects 6, 222, 243, 29-04</li> <li>Scour 5, 200</li> <li>Sealers for PCC highway facilities 209</li> <li>Sedimentation basins 18, 70</li> <li>Severity indices 202</li> <li>Shoulders 63</li> <li>Signs           <ul style="list-style-type: none"> <li>- advance warning 186</li> <li>- changeable message 61, 237</li> <li>- maintenance 155, 157</li> <li>- motorist information 71, 162</li> </ul> </li> <li>Size regulation and enforcement 68, 143</li> <li>Skid resistance 14, 158, 30-11</li> <li>Sleep deprivation 30-06</li> <li>Smoothness, pavements 167</li> <li>Snow and ice control 24, 207</li> <li>Soft foundations 29, 147</li> <li>Soils           <ul style="list-style-type: none"> <li>- erosion 18</li> <li>- measuring, in situ 29-08</li> <li>- remediation of contaminated 226</li> </ul> </li> <li>Specifications 38, 65, 212</li> <li>Spectrum management 13</li> <li>Stabilization           <ul style="list-style-type: none"> <li>- bases 37</li> <li>- subbases 247</li> </ul> </li> <li>Staffing           <ul style="list-style-type: none"> <li>- construction 51, 145, 263</li> <li>- maintenance 10</li> <li>- planning for 120</li> <li>- S.E.E. assessments 40</li> </ul> </li> <li>Standards, travel survey 236           <ul style="list-style-type: none"> <li>- historic bridges 275</li> </ul> </li> <li>Statewide transportation planning 15, 95, 267, 30-02</li> <li>Statistical specifications 38, 65, 212, 232</li> <li>Statistical Methods 31-02</li> <li>Storm water management 174</li> <li>Stream scour 5, 200</li> <li>Striping 17, 138, 218</li> <li>Structures (see bridges)</li> <li>Studded tires 32</li> <li>Subbases 37</li> <li>Subgrades, stabilization 247</li> <li>Subsurface information 33, 255</li> <li>Superplasticizers for concrete 129</li> <li>Surface courses 49, 104, 180, UR24-07</li> <li>Surveying, GPS satellite 258</li> <li>Systems, maintenance 29-07</li> <li>Systems, traffic control 30-01</li> </ul>
---	--

Table 5 (continued)

---

Taxes, fuel 62, 164	- management plans 31-10	- elderly/handicapped 39, 83	Utilities 34, 115, 242
Technology transfer 23, 150, 216, 231, 29-01	- pedestrian 139	- management assistance 74	Value engineering 78
Telecommunications 12, 165	- plans 208	- ownership 97	Variable message signs 61, 237
Telephones 12, 165	- priority lanes 185	- planning 69, 73	Vehicle attenuators 182
Testing	- ramps 35	Transportation	Vibration from piles 253
- construction 36, 65, 263	- signal systems maintenance management 245	- development process 267	Vibration of concrete 44
- rapid 187	- systems development 30-01, 31-10	- economic benefits 30-05	Video traffic law enforcement 219
- soils (in-situ) 29-08	- work zones 1, RRD 100, 208	- investment 30-05	Visibility 228
- equipment 36, 187	Traffic data collection 130	- planning 15, 72, 73, 95, 151, 201, 230, 252	Visualization 3D and 4D 229
- pavements 30-11	Traffic law enforcement 219	- management centers 270	Warranties in construction 195
Toll	Traffic markings 17, 138, 218	- system management 81, 93, 259	Waste materials 199, RRD 106
- collection 194	Traffic paint 17, 138, 218	Travel surveys 236	Waterproofing membranes for bridge decks 220
- financing 117	Traffic safety 1, 3, 32, 35, 66, RRD 100, 202, 205, 244	Truck	Weather 47
- plaza design 240	Traffic signals	- Truck escape ramps 178	Weigh-in-motion 124
- practices 262	- equipment 166	- Truck operating characteristics 241	Weight regulation and enforcement 68, 82, 124, 143
Tort liability 106, 206, 265	- left turns 225	- Trip generation 31-09	Wetland Mitigation 31-12
Traffic control	- maintenance 22, 114, 245	- Truck weights and sizes 68, 82, 124, 143	Widening of pavements 28, 221
- circles 264	- preemption (rail) 271	Tunnels, maintenance and operation 31	Winter maintenance 24, 207
- construction 208, RRD 100	- timing 172	Underwater bridge inspection 88	Work schedules 73
- devices 61, 166, 186, 237	Training of personnel 10, 11, 163, 188, 248	Underwater bridge repair 88, 200	Work zone traffic 1, RRD 100, 208
- equipment 166	Transit	Urban freeways 25, 273	
- left-turn treatments 225	- boards 75		
- maintenance 1, 208, RRD 100, 245			
- management centers 270			

---

These **Digests** are issued in order to increase awareness of research results emanating from projects in the CRP. Persons wanting to pursue the project subject matter in greater depth should contact the Cooperative Research Programs Staff, Transportation Research Board, 2101 Constitution Ave., NW, Washington, DC 20418.

**TRANSPORTATION RESEARCH BOARD**

National Research Council  
2101 Constitution Avenue, NW  
Washington, DC 20418

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

MR ROBERT M SMITH  
RESEARCH & ASST MATLS ENGR  
IDAHO TRANSPORTATION DEPT  
P O BOX 7129  
3311 W STATE ST  
BOISE ID 83703-5879

S6 P10  
(000021-05)

