

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: Harry A. Smith

## 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 Thomas L. Copas and Herbert A. Pennock, serving under the Special Projects 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 undervalued. 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.

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 page 8) 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. A check or money order must accompany orders totaling \$20.00 or less.

Work is currently under way on the topics listed in Table 2. Questions on these topics should be addressed to the project investigators, Thomas L. Copas and Herbert A. Pennock, who can be reached at (202) 334-3242.

#### Submission and Selection of Topics

One part of 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 11 or 12 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:

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

o 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.

o 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. State highway and transportation department personnel may submit suggestions for synthesis topics directly to the NCHRP Program Director or, if desired, through their state TRB Representative. Topics suggested must be accompanied by a brief scope statement or discussion of the problem.

#### 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 30 to 40 work-days 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 contains an index to published syntheses and topics now under study, as well as those expected to be started through 1987.

Table 1  
COMPLETED SYNTHESSES

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

\*These syntheses are available from TRB in microfiche form only at a cost of \$5.95 each.

more

Table 1 (continued)

No.	Title, Pages, Price	No.	Title, Pages, Price
84.	Evaluation Criteria and Priority Setting for State Highway Programs (1981) 32 pp., \$6.40	108.	Bridge Weight-Limit Posting Practices (1984) 30 pp., \$6.40
85.	Energy Involved in Construction Materials and Procedures (1981) 34 pp., \$6.40	109.	Highway Uses of Epoxy with Concrete (1984) 68 pp. \$8.80
86.	Effects of Traffic-Induced Vibrations on Bridge Deck Repairs (1981) 40 pp., \$6.80	110.	Maintenance Management Systems (1984) 49 pp., \$8.00
87.	Highway Noise Barriers (1981) 81 pp., \$7.20	111.	Distribution of Wheel Loads on Highway Bridges (1984) 22 pp., \$7.20
88.	Underwater Inspection and Repair of Bridge Substructures (1981) 77 pp., \$7.60	112.	Cost-Effectiveness of Hot-Dip Galvanizing for Exposed Steel (1984) 28 pp., \$7.20
89.	Geotechnical Instrumentation for Monitoring Field Performance (1982) 46 pp., \$6.80	113.	Administration of Research, Development, and Implementation Activities in Highway Agencies (1984) 49 pp., \$8.00
90.	New-Product Evaluation Procedures (1982) 34 pp., \$6.80	114.	Management of Traffic Signal Maintenance (1984) 134 pp., \$10.80 (supersedes Synthesis 22)
91.	Highway Accident Analysis Systems (1982) 69 pp., \$7.60	115.	Reducing Construction Conflicts between Highways and Utilities (1984) 73 pp., \$8.80
92.	Minimizing Reflection Cracking of Pavement Overlays (1982) 38 pp., \$6.80	116.	Asphalt Overlay Design Procedures (1984) 66 pp., \$8.40
93.	Coordination of Transportation System Management and Land Use Management (1982) 38 pp., \$6.80	117.	Toll Highway Financing (1984) 29 pp., \$7.20
94.	Photologging (1982) 38 pp., \$6.80	118.	Detecting Defects and Deterioration in Highway Structures (1985) 52 pp., \$8.00
95.	Statewide Transportation Planning (1982) 54 pp., \$7.20 (supersedes Synthesis 15)	119.	Prefabricated Bridge Elements and Systems (1985) 75 pp., \$8.80
96.	Pavement Subsurface Drainage Systems (1982) 38 pp., \$6.80	120.	Professional Resource Management and Forecasting (1985) 15 pp., \$6.80
97.	Transit Ownership/Operation Options for Small Urban and Rural Areas (1982) 28 pp., \$6.40	121.	Energy Conservation in Transportation (1985) 25 pp., \$7.20 (supplements Synthesis 43)
98.	Resealing Joints and Cracks in Rigid and Flexible Pavements (1982) 62 pp., \$7.20	122.	Life-Cycle Cost Analysis of Pavements (1985) 136 pp., \$10.80
99.	Resurfacing with Portland Cement Concrete (1982) 90 pp., \$8.40	123.	Bridge Designs to Reduce and Facilitate Maintenance and Repair (1985) 65 pp., \$8.40
100.	Managing State Highway Finance (1982) 23 pp., \$6.40	124.	Use of Weigh-in-Motion Systems for Data Collection and Enforcement (1986) 34 pp., \$7.60
101.	Historic Bridges-Criteria for Decision Making (1983) 77 pp., \$8.00	125.	Maintenance Activities Accomplished by Contract (1986) 42 pp., \$8.00
102.	Material Certification and Material-Certification Effectiveness (1983) 17 pp., \$6.00	126.	Equipment for Obtaining Pavement Condition and Traffic Loading Data (1986) 118 pp., \$11.20
103.	Risk Assessment Processes for Hazardous Materials Transportation (1983) 26 pp., \$6.40	127.	Use of Fly Ash in Concrete (1986) 66 pp., \$8.40
104.	Criteria for Use of Asphalt Friction Surfaces (1983) 41 pp., \$6.80	128.	Methods for Identifying Hazardous Highway Elements (1986) 80 pp., \$10.00
105.	Construction Contract Claims: Causes and Methods of Settlement (1983) 58 pp., \$7.20	129.	Freezing and Thawing Resistance of High-Strength Concrete (1986) (in press)
106.	Practical Guidelines for Minimizing Tort Liability (1983) 40 pp., \$6.80	130.	Traffic Data Collection and Analysis: Methods and Procedures (1986) (in press)
107.	Shallow Foundations for Highway Structures (1983) 38 pp., \$6.80		
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<u>Research Results Digests</u>			
100.	Safe Conduct of Traffic Through Highway Construction and Maintenance Zones (1978) 5 pp., \$1.00	106.	Use of Waste Materials in Highway Construction and Maintenance (1979) 2 pp., \$1.00

Table 2  
TOPICS BEING STUDIED

No.	Title	No.	Title
13-02	Methods of Cost-Effectiveness Analysis for Highway Projects	17-10	Pavement Management Practices
13-07	Storm Water Management for Transportation Facilities	17-11	Pedestrians and Traffic Control Measures
15-02	Durability of Prestressed Concrete Highway Structures	17-13	Staffing Considerations in Construction Engineering Management
15-05	Effects of Permit and Illegal Overloads on Pavements	18-01	Use of Consultants for Construction Engineering and Inspection
15-09	Protective Coatings for Bridge Steel	18-02	Innovative Techniques for Upgrading of Personnel by State Transportation Departments
16-01	Bridge Inspection Practices - Equipment, Staffing, and Safety	18-03	Bridge Approach Design and Construction Practices
16-03	Maintenance Management of Street and Highway Signs	18-04	Treatment of Problem Foundations for Highway Embankments
16-06	Wet-Pavement Safety Programs	18-05	Negotiating and Contracting for Professional Engineering Services
16-09	Managing Urban Freeway Maintenance	18-06	Pavement Markings: Materials and Application for Extended Service Life
16-10	Bridge Expansion Devices	18-07	Freeway Corridor Management
17-01	System-Wide Safety Improvements	18-08	Freeway Incident Management
17-02	Integrated Highway Information Systems	18-09	Durability of Cold-Recycled Bituminous Concrete Using Bituminous Materials
17-04	Effectiveness of Quality Assurance Procedures for Highway Construction and Materials	18-10	Contract Management Systems
17-05	Design, Construction, and Maintenance of PCC Pavement Joints	18-11	Evolution and Benefits of Preventive Maintenance Strategies
17-06	Recycling of Portland Cement Concrete Pavement	18-12	Indicators of Quality in Maintenance
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17-08	D-Cracking of Concrete Pavements		
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Table 3  
NCHRP PROJECT COMMITTEE SP20-5

Chairman Verdi Adam Louisiana Dept. of Transp. and Dev.	
Robert N. Bothman Oregon Dept. of Transportation	Thomas H. May Pennsylvania Dept. of Transportation
Jack Freidenrich New Jersey Dept. of Transportation	Edward A. Mueller Morales and Shumer Engineers
David Gedney Harland Bartholomew and Associates	Earl Shirley California Dept. of Transportation
Ronald E. Heinz Federal Highway Administration	Jon Underwood Texas Dept. of Highways and Public Transp.
John J. Henry Pennsylvania Transportation Institute	Robert J. Betsold (Liaison) Federal Highway Administration
Bryant Mather USAE Waterways Experiment Station	K. B. Johns (Liaison) Transportation Research Board

Table 4  
SYNTHESIS TOPICS SELECTED FOR THE FY 1986 PROGRAM

No.	Title	No.	Title
19-01	Computer-Aided Design and Drafting Systems	19-11	Operational Experience with Traffic Detectors
19-02	Nonuniformity in Oversize/Overweight Permits	19-12	Pavement Smoothness Measurement Systems and Specifications
19-03	Signal Timing and Optimization Procedures	19-13	Highway Surveying
19-04	Compaction of Asphalt Pavement	19-14	Noise Barrier Durability and Effectiveness
19-05	Hot Mix Asphalt Concrete Recycling	19-15	Concrete Bridge-Deck Removal Procedures
19-06	State Practices for Capital Improvement Selection	19-16	Contracting Procedures for Bridge Painting
19-07	Sign Replacement Programs: Policies and Criteria	19-17	Maintenance Management Strategies for Low-Volume Highways
19-08	Technology Transfer for New Highway Products to Maintenance and Operations	19-18	Surface Preparation for Concrete Repairs
19-09	Moisture Damage in Asphalt Concrete	19-19	Disposal of Wastes from Highway Materials Testing Laboratories
19-10	Transportation Telecommunications	19-20	Repair and Replacement of Highway Culverts
		19-21	Building Constituencies for Traffic Management Improvements

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

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