

Continuing Project to Synthesize Information on Highway Problems

Research

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 Technical Activities 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," which 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*, which 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.

Available Publications and Studies in Progress

The 73 published Syntheses of Highway Practice that have been prepared under this project to date 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 \$7.50 or less.

Work is currently under way on the 29 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) 389-6606.

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 alternate topics are selected by the committee at the Fall meeting. Topics selected for the FY '81 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. 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 man-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 1981.

The NCHRP Projects Engineer responsible for Project 20-5 is Robert J. Reilly, who can be reached at (202) 389-6741.

Table 1
COMPLETED TOPICS

(a) Syntheses

No.	Title, Pages, Price	No.	Title, Pages, Price
1.	Traffic Control for Freeway Maintenance (1969) 47 pp., \$2.20	37.	Lime-Fly Ash-Stabilized Bases and Subbases (1976) 66 pp., \$4.80
2.	Bridge Approach Design and Construction Practices (1969) 30 pp., \$2.00	38.	Statistically Oriented End-Result Specifications (1976) 40 pp., \$4.00
3.	Traffic-Safe and Hydraulically Efficient Drainage Practice (1969) 38 pp. (out of print)*	39.	Transportation Requirements for the Handicapped, Elderly, and Economically Disadvantaged (1976) 54 pp., \$4.40
4.	Concrete Bridge Deck Durability (1970) 28 pp. (out of print)*	40.	Staffing and Management for Social, Economic, and Environmental Impact Assessment (1977) 43 pp., \$4.00
5.	Scour at Bridge Waterways (1970) 37 pp. (out of print)*	41.	Bridge Bearings (1977) 62 pp., \$4.80
6.	Principles of Project Scheduling and Monitoring (1970) 43 pp., \$2.40	42.	Design of Pile Foundations (1977) 68 pp., \$4.80
7.	Motorist Aid Systems (1971) 28 pp., \$2.40	43.	Energy Effects, Efficiencies, and Prospects for Various Modes of Transportation (1977) 57 pp., \$4.80
8.	Construction of Embankments (1971) 38 pp. (out of print)*	44.	Consolidation of Concrete for Pavements, Bridge Decks, and Overlays (1977) 61 pp., \$4.80
9.	Pavement Rehabilitation - Materials and Techniques (1972) 41 pp., \$2.80	45.	Rapid-Setting Materials for Patching of Concrete (1977) 13 pp., \$2.40
10.	Recruiting, Training, and Retaining Maintenance and Equipment Personnel (1972) 35 pp., \$2.80	46.	Recording and Reporting Methods for Highway Maintenance Expenditures (1977) 35 pp., \$3.60
11.	Development of Management Capability (1972) 50 pp., \$3.20	47.	Effect of Weather on Highway Construction (1978) 29 pp., \$3.20
12.	Telecommunications Systems for Highway Administration and Operations (1972) 39 pp., \$2.80	48.	Priority Programming and Project Selection (1978) 31 pp., \$3.20
13.	Radio Spectrum Frequency Management (1972) 32 pp., \$2.80	49.	Open-Graded Friction Courses for Highways (1978) 50 pp., \$4.00
14.	Skid Resistance (1972) 66 pp., \$4.00	50.	Durability of Drainage Pipe (1978) 37 pp., \$3.60
15.	Statewide Transportation Planning - Needs and Requirements (1973) 41 pp. (out of print)*	51.	Construction Contract Staffing (1978) 62 pp., \$6.00
16.	Continuously Reinforced Concrete Pavement (1973) 23 pp., \$2.80	52.	Management and Selection Systems for Highway Maintenance Equipment (1978) 17 pp., \$4.40
17.	Pavement Traffic Marking - Materials and Application Affecting Serviceability (1973) 44 pp., \$3.60	53.	Precast Concrete Elements for Transportation Facilities (1978) 48 pp., \$5.60
18.	Erosion Control on Highway Construction (1973) 52 pp., \$4.00	54.	Recycling Materials for Highways (1978) 53 pp., \$5.60
19.	Design, Construction, and Maintenance of PCC Pavement Joints (1973) 40 pp., \$3.60	55.	State Highway and Transportation Data Storage and Retrieval Systems (1978) 30 pp., \$4.80
20.	Rest Areas (1973) 38 pp., \$3.60	56.	Joint-Related Distress in PCC Pavement—Cause, Prevention and Rehabilitation (1979) 36 pp., \$5.20
21.	Highway Location Reference Methods (1974) 30 pp., \$3.20	57.	Durability of Concrete Bridge Decks (1979) 61 pp., \$6.00
22.	Maintenance Management of Traffic Signal Equipment and Systems (1974) 41 pp. (out of print)*	58.	Consequences of Deferred Maintenance (1979) 24 pp., \$4.40
23.	Getting Research Findings Into Practice (1974) 24 pp., \$3.20	59.	Relationship of Asphalt Cement Properties to Pavement Durability (1979) 43 pp., \$5.60
24.	Minimizing Deicing Chemical Use (1974) 58 pp., \$4.00	60.	Failure and Repair of Continuously Reinforced Concrete Pavement (1979) 42 pp., \$5.60
25.	Reconditioning High-Volume Freeways in Urban Areas (1974) 56 pp., \$4.00	61.	Changeable Message Signs (1979) 37 pp., \$5.60
26.	Roadway Design in Seasonal Frost Areas (1975) 104 pp., \$6.00	62.	Potential State Resources for Financing Transportation Programs (1979) 34 pp., \$5.20
27.	PCC Pavements for Low-Volume Roads and City Streets (1975) 31 pp. (out of print)*	63.	Design and Use of Highway Shoulders (1979) 26 pp., \$4.80
28.	Partial-Lane Pavement Widening (1975) 30 pp., \$3.20	64.	Bituminous Patching Mixtures (1979) 26 pp., \$4.80
29.	Treatment of Soft Foundations for Embankments (1975) 25 pp., \$3.20	65.	Quality Assurance (1979) 42 pp., \$5.60
30.	Bituminous Emulsions for Highway Pavements (1975) 76 pp., \$4.80	66.	Glare Screen Guidelines (1979) 17 pp., \$4.40
31.	Highway Tunnel Operations (1975) 29 pp., \$3.20	67.	Bridge Drainage Systems (1979) 44 pp., \$5.60
32.	Effects of Studded Tires (1975) 46 pp., \$4.00	68.	Motor Vehicle Size and Weight Regulation, Enforcement, and Permit Operations (1980) 45 pp., \$6.00
33.	Acquisition and Use of Geotechnical Information (1976) 40 pp., \$4.00	69.	Bus Route and Schedule Planning Guidelines (1980) 99 pp., \$8.00
34.	Policies for Accommodation of Utilities on Highway Rights-of-Way (1976) 22 pp., \$3.20	70.	Design of Sedimentation Basins (1980) 53 pp., \$6.80
35.	Design and Control of Freeway Off-Ramp Terminals (1976) 61 pp., \$4.40	71.	Direction Finding from Arterials to Destinations (1980) 50 pp., \$6.40
36.	Instrumentation and Equipment for Testing Highway Materials, Products, and Performance (1976) 70 pp., \$4.80	72.	Transportation Needs Studies and Financial Constraints (in publication)
		73.	Alternative Work Schedules: Impacts on Transportation (in publication)

(b) Research Results Digests

- | | |
|------|---|
| 100. | Safe Conduct of Traffic Through Highway Construction and Maintenance Zones, 5 pp., \$1.00 |
| 106. | Use of Waste Materials in Highway Construction and Maintenance, 2 pp., \$1.00 |

*For information on obtaining copies of out-of-print syntheses, write to University Microfilms International, 300 North Zeeb Road, Ann Arbor, Michigan 48106.

Table 2

TOPICS BEING STUDIED

No.	Title	No.	Title
8-10	Photologging	11-09	Transit Board Roles, Procedures, and Composition
9-12	Welding and Inspection Practices in Bridge Fabrication	11-10	Contract Time Determination
9-13	Rapid Testing	11-13	Experiences with Removal of Barriers to Elderly and Handicapped Use of Bus Transit and Related Highway Services
9-14	Environmental Monitoring (Air, Water, Noise)	11-14	Experiences in Transportation System Management
10-03	Formulating and Justifying Highway Maintenance Budgets	12-01	Program Evaluation Criteria and Priority Setting
10-05	Collection and Use of Pavement Condition Data	12-02	Criteria for Evaluation of Truck Weight Enforcement
10-08	Below-the-Waterline Inspection and Repair of Bridge Substructures	12-03	Use of Data Processing and Accident Location Systems for Highway Accident Analysis
10-11	State Transit-Management Assistance to Local Communities	12-04	Resealing Joints and Cracks in Rigid and Flexible Pavements
11-02	Value Engineering in Preconstruction Activities	12-06	Shallow Foundations for Highway Structures
11-03	Value Engineering on Construction Contracts	12-07	Highway Noise Barriers
11-04	Techniques for Minimizing Reflection Cracking of Pavement Overlays	12-08	Coordinating TSM and Land-Use Planning and Implementation to Meet Development and Transportation Objectives
11-05	Utilization of Information Systems in Construction Engineering Management	12-09	Energy Involved in Construction Materials and Procedures
11-06	Geotechnical Instrumentation for Monitoring Field Performance	12-11	Bridge Designs to Reduce and Facilitate Maintenance and Repair
11-07	Pavement Subsurface Drainage Systems	12-12	New Products Evaluation Procedures
11-08	Evaluation of Pavement Maintenance Strategies		

Table 3

NCHRP PROJECT COMMITTEE SP20-5

Chairman Ray R. Biege, Jr. Kansas Department of Transportation	
Verdi Adam Louisiana Dept. of Transp. and Dev.	Thomas H. May Pennsylvania Dept. of Transportation
Robert N. Bothman Oregon Dept. of Transportation	Theodore F. Morf Consultant
Jack H. Dillard Virginia Highway & Transp. Research Council	Edward A. Mueller Reynolds, Smith and Hills
Jack Freidenrich New Jersey Dept. of Transportation	Milton P. Criswell Federal Highway Administration
David Gedney DeLeuw, Cather and Company	K. B. Johns Transportation Research Board
Bryant Mather USAE Waterways Experiment Station	

TABLE 4

SYNTHESIS TOPICS SELECTED FOR THE FY '81 PROGRAM

No.	Title	No.	Title
13-01	Contract Claims: Causes and Methods of Settlement	13-11	Evaluation of Criteria for Historic Bridge Decisions
13-02	Methods of Cost-Effectiveness Analysis for Highway Projects	13-12	Maintenance of Traffic Signals
13-03	State Transportation Financial Planning	13-13	Design Criteria for Use of Asphaltic Concrete Friction Courses
13-04	Portland Cement Concrete Overlays	13-14	Material Certification and Material-Certification Effectiveness
13-05	Statewide Transportation Plans: Their Function and Content	13-15	Recruiting, Training, and Retaining Engineering Technicians
13-06	Transit Ownership/Management Options for Small Urban and Rural Areas	13-16	Highway Bridge Fracture Studies
13-07	Storm Water Management for Highway Facilities	13-17	Asphalt Overlay Design Procedures
13-08	Bridge Posting Practices	13-18	Energy Conservation in Transportation
13-09	Highway Inventory Systems	13-19	Park and Ride Facilities
13-10	Methodology for Risk Assessment of Hazardous Materials Transportation	13-20	Planning, Design, and Construction of Bicycle Facilities

Table 5

INDEX TO SYNTHESSES AND STUDIES*

-
- Accident location 21, 12-03
 - Aid to motorists 7
 - Air quality monitoring 9-14
 - Asphalt
 - cement 59
 - emulsions 30
 - friction courses 49
 - patching 64
 - pavements 30, 49, 59
 - Bases 37
 - Bearings for bridges 41
 - Bituminous emulsions 30
 - Bituminous patching 64
 - Bituminous pavements 30, 49, 59
 - Bridges
 - approaches 2
 - bearings 41
 - below-water inspection 10-08
 - concrete decks 4, 57
 - construction 44, 53
 - design for maintenance 12-11
 - drainage 67
 - foundations 42, 12-06
 - historic 13-11
 - inspection 10-08
 - patching 45
 - posting practices 13-08
 - precast concrete 53
 - prefabricated 53
 - scour 5
 - substructure repair 10-08
 - welding 9-12
 - Bus transit planning 69
 - Changeable message signs 61
 - Communications 7, 12, 13, 71
 - Computers 55
 - Concrete
 - bridge decks 4, 57
 - consolidation 44
 - patching 45
 - pavements 16, 19, 27, 45, 56, 60, 12-04, 13-04
 - precast 53
 - Consolidation of concrete 44
 - Construction
 - bases and subbases 37
 - bituminous pavements 30
 - bridge approaches 2
 - bridge decks 4, 44, 57
 - concrete pavements 16, 19, 27, 44
 - contract claims 13-01
 - contract time 11-10
 - embankments 8
 - energy factors 12-09
 - erosion control 18
 - management 51, 11-05
 - pavements 16, 19, 27, 30, 44
 - recycling 54
 - specifications 38
 - staffing 51
 - testing 65
 - traffic control RRD 100
 - value engineering 11-03
 - weather 47
 - welding 9-12
 - Continuously reinforced pavements 16, 60
 - Contract claims 13-01
 - Contract time determination 11-10
 - Cost-effectiveness analysis 13-02
 - Culverts
 - durability 50
 - inlets 3
 - Data systems 55
 - Deicing chemical use 24
 - Deferred maintenance 58
 - Design
 - bituminous pavements 30
 - bridge approaches 2
 - bridge bearings 41
 - concrete pavements 16, 19, 27
 - frost 26
 - pavements 16, 19, 26, 27, 30
 - pile foundations 42
 - roadways 26
 - shoulders 63
 - value engineering 11-02
 - Disadvantaged, transportation for 39
 - Drainage
 - bridge 67
 - pavement 11-07
 - sedimentation basins 70
 - Drainage durability 50
 - Drainage structures 3
 - Elderly, transportation for 39, 11-13
 - Embankments 8
 - Emulsions 30
 - End-result specifications 38
 - Energy
 - bituminous emulsions 30
 - construction 12-09
 - transportation use 43
 - Environmental monitoring 9-14
 - Equipment
 - management 52
 - procurement 52
 - selection 52
 - Field testing equipment 36
 - Finance/budgets 62, 72, 10-03, 13-03
 - Fly ash 37
 - Foundations
 - embankments 8, 29
 - pile 42
 - shallow 12-06
 - soft strata 29
 - Freeways
 - maintenance 1, 25
 - off-ramps 35
 - repair 25
 - Friction courses 49
 - Frost susceptibility 26
 - Fuel taxes 62
 - Geotechnical data 33
 - Geotechnical exploration 33
 - Geotechnical instrumentation 11-06
 - Glare screen 66
 - Handicapped, transportation for 39, 11-13
-

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

Hazardous materials transportation <ul style="list-style-type: none">- risk assessment 13-10	Patching 9, 45, 59
Highway inventory systems 13-09	Pavements <ul style="list-style-type: none">- asphalt 30, 49, 59- bases 37- bituminous 30, 49, 59- concrete 16, 19, 27, 44, 56, 60, 13-04- condition data 10-05- construction 16, 19, 27, 30, 44- CRCP 16, 60- distress 9- drainage 11-07- durability 59- evaluation 10-05- friction courses 49- frost design 26- joints 19, 56, 12-04- low-volume 27- maintenance costs 11-08, 12-04- overlays 9, 11-04, 13-04- patching 9, 45, 64- rehabilitation 9, 25, 11-04- skid resistance 14- striping 17- studded tires 32- widening 28
Historic bridges 13-11	Permit operations 68
Information for motorists 7, 71	Personnel training 10, 11
Inspection of bridges 10-08	Photologging 8-10
Instrumentation, geotechnical 11-06	Pile foundations 42
Inventory systems for highways 13-09	Pipe durability 50
Joints, concrete pavement 19, 56, 12-04	Planning <ul style="list-style-type: none">- statewide transportation 15, 13-05- transit 69, 73- transportation 73
Joints and cracks, sealing 12-04	Poor, transportation for 39
Laboratory testing equipment 36	Posting of bridges 13-08
Land use 12-08	Pothole repair 64
Lime-fly ash 37	Pozzolans 37
Location reference methods 21	Precast concrete 53
Low-volume pavements 27	Priority programming 48, 12-01
Maintenance <ul style="list-style-type: none">- bituminous pavements 30, 64, 12-04- bridges 10-08, 12-11- budgets 10-03- concrete pavements 29, 45, 56, 60, 12-04- costs 58, 12-04- deferred 58- equipment 52- freeways 1, 25- management 10, 22, 46, 52, 58, 10-03- pavement costs 11-08, 12-04- pavements 9, 19, 25, 30, 45, 56, 60, 64, 12-04- personnel 10- records 46, 11-08- recycling 54- reporting 46- rest areas 20- traffic control 1, 25, RRD 100- traffic signals 22, 13-12- tunnels 31	Programming 48, 12-01
Management <ul style="list-style-type: none">- construction 51, 11-05- data 55- information systems 11-05- maintenance 10, 22, 46, 52, 58, 10-03- personnel 11- S.E.E. assessments 40- training 11	Project scheduling 6
Materials testing equipment 36, 9-13	Quality assurance 65
Median glare screen 66	Radio communications 12, 13
Mileposts 21	Radio frequency management 13
Monitoring of projects 6	Rapid testing 9-13
Motorist aid systems 7	Recycling highway materials 54
Motorist information 71	Reference methods 21
Needs studies 72	Reference posts 21
New product evaluation 12-12	Reflection cracking 9, 11-04
Noise barriers 12-07	Rehabilitation <ul style="list-style-type: none">- freeways 25- pavements 9, 56, 11-04
Noise monitoring 9-14	Research implementation 23
Off-ramps 35	Rest areas 20
Open-graded surfaces 49	Right-of-way <ul style="list-style-type: none">- utilities 34- value engineering 11-02
Overlays 9, 49, 11-04, 13-04	Risk assessment, hazardous materials 13-10

-
- Scheduling of projects 6
 - Scour 5
 - Sedimentation basins 18, 70
 - Shoulders 63
 - Signs, changeable message 61
 - Size regulation and enforcement 68
 - Skid resistance 14
 - Snow and ice control 24
 - Soft foundations 29
 - Soil erosion 18
 - Specifications 38, 65
 - Spectrum management 13
 - Stabilization of bases 37
 - Staffing
 - construction 51
 - maintenance 10
 - S.E.E. assessments 40
 - Statewide transportation planning 15, 13-05
 - Statistical specifications 38, 65
 - Storm water management 13-07
 - Stream scour 5
 - Striping 17
 - Structures (see bridges)
 - Structures, precast 53
 - Studded tires 32
 - Subbases 37
 - Subsurface information 33
 - Surface courses 49

 - Taxes, fuel 62
 - Telecommunications 12
 - Telephones 12
 - Testing, construction 65, 9-13
 - Testing equipment 36, 9-13

 - Traffic control
 - construction RRD 100
 - devices 61
 - maintenance 1, RRD 100
 - ramps 35
 - Traffic marking 17
 - Traffic paint 17
 - Traffic safety 1, 3, 32, 35, 66, RRD 100
 - Traffic signal maintenance 22, 13-11
 - Training of personnel 10, 11
 - Transit
 - barriers, elderly/handicapped 11-13
 - boards 11-09
 - management assistance 10-11
 - ownership 13-06
 - planning 69, 73
 - Transportation planning 15, 72, 73, 13-05
 - Transportation system management 11-14, 12-08
 - Truck weights and sizes 68, 12-02
 - Tunnels, maintenance & operation 31

 - Urban freeway reconditioning 25
 - Utilities 34

 - Variable message signs 61
 - Value engineering 11-02, 11-03
 - Vibration of concrete 44

 - Waste materials RRD 106
 - Water quality monitoring 9-14
 - Weather 47
 - Weight regulation & enforcement 68, 12-02
 - Welding 9-12
 - Widening of pavements 28
 - Work schedules 73
-

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. 42970

000015M023

~~CHIEF OF HIGHWAY DIV.~~

IDAHO TRANSPORTATION DEPT
P O BOX 7129
BOISE

ID 83707