

Public Roads

A JOURNAL OF HIGHWAY RESEARCH



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

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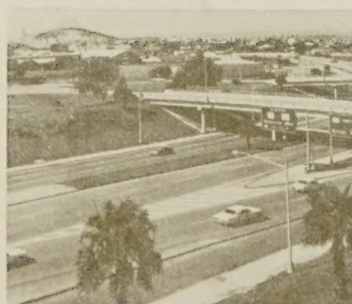
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COVER

A major trunk route from the Gulf Coast to the Texas interior, Interstate Highway 37 also carries local traffic in Corpus Christi. The Corpus Christi Harbor Bridge can be seen in the background. (Photo courtesy Texas Highway Department)

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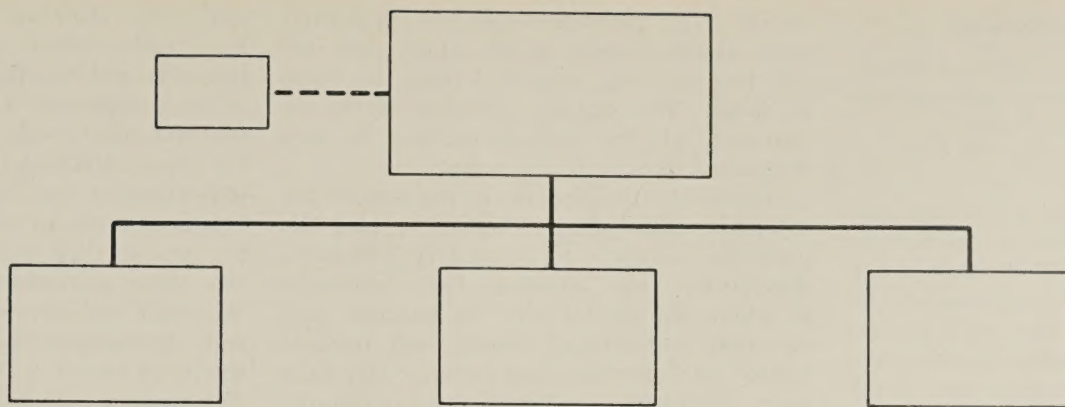
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State Highway Department Management

Part 1.—Organization

Reported by ¹ PRISCILLA FAMOUS,
 Management Analyst
 Economics and Requirements Division

BY THE OFFICE OF
 RESEARCH AND DEVELOPMENT
 BUREAU OF PUBLIC ROADS

Introduction

A PUBLIC Roads program adopted early in 1963 enabled State highway departments to use a part of their Federally allocated highway planning and research (HP&R) funds to investigate the administration and management practices of their highway organizations. Research investigations were to be formulated by the States to yield results that had general, rather than specific, application. The findings and recommendations for improvement were to be documented for each project in written reports, from which the Bureau of Public Roads planned to prepare a final generalized report. In response to the program, research projects were approved for a number of States.

Because the final reports from these projects originated from 11 different sources, each with its peculiarities and specific problems, preparation of generalized summaries for all areas of the research was impractical, and it was concluded that instead of a single document, the Public Roads report would consist of several parts, each dealing with a particular segment, or area, of highway-department management. The first part, which deals only with those findings and recommendations that concerned organization, or structure, of the highway departments surveyed, is presented here. In addition to the information from the State reports, (1-11)² information on *types of organization* was obtained, from the Highway Research Board (12) and

Beginning with this issue, the Public Roads research staff will report on management studies that were conducted in several States to upgrade the quality of highway administration. The findings that related to the organization, or structure, of the highway departments surveyed in the studies are reported in this part. Findings on other aspects of highway-department management will be presented in future issues.

It is hoped that all State highway departments will be motivated to modify and adapt those findings that may be suitable for specific application.

from other sources. When later information was available, the original information obtained from the State reports was updated prior to publication, and when administrative or legal actions were taken at the State level to carry out the recommendations of the State reports, they were noted if the author was aware of them.

The principal purpose of any formalized organization, or structure, is to provide a framework to make decisions and to execute them. The authority to make decisions and execute them must be delegated, and in the laws of each State, the authority to administer roads and highways is delegated to a single executive, to a highway board or commission, or to a combination of the two. The State law also may provide for the appointment of the chief engineer, treasurer, and other staff personnel, and may designate the functional divisions through which highway operations are carried out, but the internal organization of the department, generally, is left to the discretion of the single executive, board, commission, or director.

In most States, it is a legal requirement that the State's attorney general be the highway department's legal representative.

Thus the highway department's legal division is an extension of the attorney general's office, and the department's legal officer, if not appointed by the attorney general, must receive his approval. Other legal restrictions on many of the highway department's responsibilities for the highway system are in the areas of personnel, purchasing, and administration of budgeted funds. Negotiations with other State agencies often involve unraveling complexities that result from out-moded procedures, which cause delays in placing needed personnel in operations and in programing. It was the opinion of one consultant that, to counteract such impedances, the other State agencies should establish policies that would allow the highway department, as well as other State departments, to act independently in its execution.

With respect to highway department organization, the Federal law states that before Federal aid for highway purposes will be approved, the department "shall have adequate powers, and be suitably equipped and organized to discharge to the satisfaction of the Secretary the duties" that the law requires, and specifically provides that the organization include a secondary road unit. (USC Title 23, sec. 302.)

¹ Prepared for publication by David Summerville following the death of Miss Famous.

² Italic numbers in parentheses identify the references listed on page 287.

Types of Organization

Included here is a review of the generally recognized types of highway organizations that are used in many of the States.

Single executive

Under the single executive type of organization, highway administration is directed by one person; no boards or commissions of any kind are included in the organization. In some States the statutes contain a general grant of authority that permits the executive to exercise all the powers and perform all the duties of the department; those powers and duties that are specifically enumerated are then vested in the department. In other States specific powers are granted directly to the executive, as in Alabama where the State law reads, "The chief executive officer of the highway department shall be known as the highway director . . . all the powers, authority, and duties in the highway department shall be exercised by the highway director." (Code of Ala., Title 23, sec. 1.) Almost all the specific powers granted in subsequent sections are vested in the department, which, of course, is an indirect way of vesting them in the director.

Single executive with advisory board or commission

In several States, direction is provided by a single executive and a multimember advisory board or commission whose purpose is to advise the executive in carrying out his responsibilities as the directing head of the highway organization. Sometimes, the advisory bodies are assigned specific duties. They may make surveys to determine the conditions and needs of highways in their respective areas of the State, may give advice on the establishment of broad policies, or may perform many other necessary functions, as directed. In effect, the board or commission has no administrative authority, as may be stated by the statutes. One State in this category is West Virginia where, under the laws of this State, the State road commissioner is the chief executive officer of the commission and has direct and complete control of the entire State road program and system. The State road commission is designated an advisory body to the commissioner. (W. Va. Code, Ch. 17, secs. 16-2A-1, 17-2-1.)

Single executive and commission in coordinate capacities

In other States, the law concerning highway administrative direction divides the authority between a single executive and a commission, each acting in a coordinate capacity to the other. The commission is a part-time body, and the single executive is a full-time official who is designated commission chairman and chief administrative officer of the highway department and who is charged with the duty of executing all orders and decisions of the commission. The powers and duties vested in the commission are fixed by statute. The laws of Maryland can be interpreted as having this form of organization. They provide for a seven-member State roads commission con-

sisting of six part-time members, appointed from specified areas of the State, and one full-time member, appointed from the State at large. The at-large member serves as chairman of the commission and is also designated director of highways.

Generally, the director is responsible for Interstate and primary highways, and the part-time members for secondary highways. Specifically, the director has "exclusive direction and control over the location, construction, geometrics, design, and maintenance" of Interstate and primary highways and "complete jurisdiction and authority over the engineering and right-of-way departments of the commission and the entire administrative organization of the commission itself." (Annotated Code of Md., Article 89B, sec. 1-7B.) The part-time members of the commission conduct a continuing survey of the State secondary highways in their respective areas, and the full commission formulates policies relating to location, type, design, construction, and maintenance of the secondary system. The commission also determines the extent that consulting engineers will be employed on the entire State highway system, but the director has the sole authority to select all consulting engineers employed.

Limited-control commission

Under the limited-control commission form of highway administration, the statutes provide for a part-time commission and for the appointment, usually by the commission, of an executive administrative officer. The law may require that the commissions limit their duties to the determination of policy and policy-related activities. Thus the executive officers, although subordinate to the commissions, are left free to administer the departments.

Arizona's law provides that control of the highway department be vested in a highway commission, but it further states that the commission shall "in general exercise powers and duties which relate to adopting and carrying out policies of the department and control of its financial affairs." Another section of the Arizona law reads as follows: "The director shall be the chief executive and administrative officer of the department and shall have charge of the administration of all highway affairs authorized by the commission." (Ariz. Rev. Stat. Annotated secs. 18-106, 18-109.) In general, then, the Arizona law limits the commission's functions to policy determination and related duties and gives the director authority to perform administrative functions.

Administrative commission

Commissions that exercise considerable administrative control, as distinguished from those that are restricted to policy determination or perform only limited administrative duties, are administrative commissions. The members of these commissions usually serve full time. Highway operations in Maine are organized under an administrative commission, a three-member State highway commission, in which only the chairman devotes full time to commission duties. According to the

law, "The chairman shall be the chief administrative officer, having general charge of the office and records, but all policy decisions of the commission must be by a majority of its total membership." (Rev. Stat. of Maine, Ch. 23, sec. 3.) On the basis of the salaries paid, it is assumed that the other members of the commission are expected to devote considerable time to their duties. On the other hand, the three administrative commissioners in Wisconsin each devote full time to their duties, and the administrative and executive authority is vested in the chairman. (Wis. Stat. Annotated sec. 84.01.)

In all the States, except Georgia, Mississippi, Nevada, and South Carolina, statutes pertaining to highway department organization provide for the governor to appoint commission members and single executives and, generally, for one or both bodies of the States' general assemblies to confirm the appointments. In Georgia and South Carolina, highway commission members are elected by the respective general assemblies. In Mississippi, the citizens of the State's three supreme court districts elect, by popular vote, a commissioner for their district. In Nevada the board of highway directors consists of the governor, attorney general, and State controller, all elected officials.

Departments of Transportation

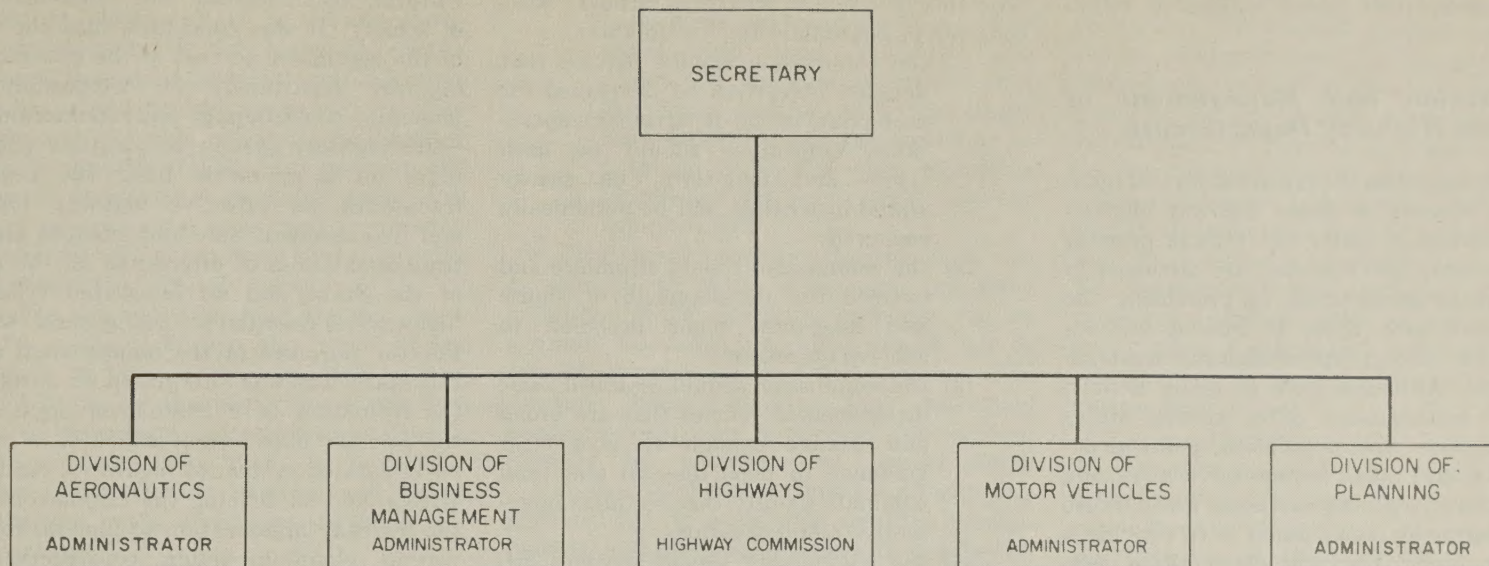
One of the newest forms of organization for highways is to include the highway department in a State department of transportation. Hawaii, the pioneer of this type of organization, introduced a department of transportation as a State agency when Hawaii was admitted to statehood and reorganized its government. Following is a brief description of the department of transportation in Hawaii and of those in the other States that have since established them:

Hawaii

The first legislative assembly in 1959, by enactment, provided for a department of transportation to be headed by a single executive titled director. The new agency incorporated all the functions, duties, and powers, of the former aeronautics, harbor, highway, and public-works commissions. The director of transportation is appointed by the governor. The law provides for the establishment, within the department, of a commission on transportation "which shall sit in an advisory capacity to the director of transportation on matters within the jurisdiction of the department of transportation." (Session laws of Hawaii, First State Legislature, Second Special Session, Act 1, 1959.)

California

In 1961, California established what is now titled the Business and Transportation Agency; the original title was Highway Transportation Agency, but the statute was amended in 1965 to remove the word "highway" from the title. The Agency includes the former departments of motor vehicles; highway patrol and public works, which includes the division of highways; aeronautics, contracts, and rights-of-



Organization of the Wisconsin Department of Transportation.

way; and bay toll crossings. The law provides that the transportation agency be headed by an administrator who is appointed by the governor and is designated chairman of the State highway commission; however, legislation approved in 1967 removes the administrator from the highway commission and provides for selection of a chairman by majority vote of the commission. (West's Annotated Calif. Code, Government Code, sec. 13975; and session laws 1967, S46.)

New Jersey

The department of transportation in New Jersey was established in 1966 as a principal department in the executive branch of the State government. It provides for the appointment by the governor of an administrator titled commissioner of transportation. All the functions, powers, and duties of the State highway department and State highway commissioner, of the division of railroad transportation, and of the department of conservation and economic development and its commissioner were transferred and vested in the department of transportation. (N.J. Laws of 1966, sec. 413.)

Another unit of the new department is the commuter operating agency, which is charged with unraveling problems of dwindling commuter rail passenger service and with studying the possibility of changing the routes, services, and fares of the commuter lines that have been limiting their services for some time.

New York

The legislative enactment establishing a department of transportation for New York became effective September 1, 1967. The head of the new department, designated commissioner of transportation, is appointed by the governor for a term that is concurrent with the governor's term.

The department is charged with the formulation of a long-range, comprehensive, state-

wide transportation plan for the balanced development and coordination of adequate, safe, and efficient commuter and general-transportation facilities and services in the State at reasonable costs to the people. These transportation facilities include highways, rapid transit, railroad, omnibus, marine (inland waterways), and other transportation facilities and services, as well as aviation and airport facilities and services, whether publicly or privately owned, developed, operated, or maintained. The new law abolished the former department of public works. Except for the functions of flood control, shoreline and beach erosion control, and the construction of public buildings, which were transferred to the office of general services, and to the conservation department, all the functions powers, and obligations of the public works department were transferred to the department of transportation. (McKinney's Session Law News, No. 5, May 25, 1967, and Regular Session of 1967, Ch. 717, titles 5-8).

Wisconsin

Statutes enacted by the 1967 Wisconsin legislature provide for reorganization of the executive branch of the State government. As a part of this reorganization, a department of transportation was created. The agency known as the State highway commission was renamed the division of highways and transferred intact and attached to the department of transportation. The head of the new department is a secretary of transportation who is appointed by the governor. The law provides that any agency attached to a department shall exercise its powers, duties, and functions prescribed by law, but that budgeting, program coordination, and related management functions shall be performed under the direction and supervision of the head of the department. (Laws of Wis. 1967, Ch. 75, effective August 1, 1967).

Florida

The Florida law, or House Bill No. 685, passed by the 1967 legislature, established a transportation commission, a department of transportation, and a transportation authority. The chairman of the State road board is an ex officio member of the three-member transportation authority. The authority is an advisory board to the transportation commission whose chairman is the governor. The responsibility of the authority, other than being an advisory unit, is to coordinate the functions of the public service commission, State road department, and the department of transportation. No change was made in the authority of the State road board, or in its organizational status in the State government.

Delaware

Although the organization in Delaware is listed frequently in publications as a department of transportation, the term has been applied to what is generally considered mass transit and the State highway department is not involved.

Other States

During the 1967 sessions of the general assemblies in several States, bills to create transportation departments were introduced. The West Virginia bill came to vote but failed passage. Six States passed bills that authorized studies prior to establishing departments. During the 1969 sessions, Colorado, Connecticut, Maine, New Hampshire, Oregon, and Washington introduced bills to establish transportation departments, and other States gave consideration to such bills.

Six States have highway departments that were established by constitutional enactment rather than by legislative enactment. These States are Arkansas, Georgia, Louisiana, Michigan, Missouri, and New Mexico. Usually, highway department organizational changes

are more difficult to make under constitutional establishment than under legislative establishment.

Organization and Management of State Highway Departments

The findings from the organization and management surveys of State highway departments conducted under the HP&R projects by consultants in 11 States, are discussed in the following paragraphs. In presenting the information, each State is treated individually, as no uniform type of highway organization exists. Although alike in many details, highway organizations differ among States largely because size, population, political development and other factors have a bearing on the type of organizations used. The purpose of a department organization is to provide a form, or order, through which those concerned with management can operate. In general terms, highway management operations can be classified as top, divisional or staff, and field, and each is discussed as reported in the individual project reports.

Top Administrative Organization

Commissions and directors as top administrators and the legal bases for organization were discussed under the heading *Types of Organization*. In addition to commissioners and directors, chief engineers also may be considered top administrators. The recommendations concerning top administrative organization, as they apply to specific States follow:

Indiana

In Indiana, it was recommended that both the role of the highway commission, as the policymaking body, and that of the highway director, as the chief executive officer of policy with authority and responsibility for the internal affairs of the department and highway program, be clarified and established in the law to prevent members of the commission, either individually or as a group, from becoming involved in operational matters. It also was recommended that as the commission, by law is responsible for all highway matters, it should be empowered, rather than the governor, to appoint the executive director to serve at its pleasure. It was further recommended that written guides, describing the functions, responsibilities, authority, and relationships with other organization units, be prepared for all top management positions so that personnel filling the positions will know the duties and activities for which they are responsible and accountable.

Washington

As for Indiana, it was recommended that the roles of the highway commission and the highway director in the State of Washington be clarified in the law to restrict operational matters solely to the director. Other suggestions and recommendations for the top administrative level in the State of Washington were:

- That the highway commission give its time and attention to what was termed "basic concepts of boardmanship," as follows:

- (1) the commission should require that detailed objectives be developed for each phase of the department's operations. Objectives should be both short- and long-term, be clearly stated in writing, and be periodically reviewed;
- (2) the commission should stimulate and oversee the development of short- and long-term plans designed to achieve objectives;
- (3) the commission should establish basic departmental policies that are broad and flexible enough to give clear guidance to departmental staff and eliminate rigidity that restrains imaginative administration;
- (4) the commission should develop criteria against which the performances of the department and highway director can be evaluated; and
- (5) the commission, together with the director, should be responsible for developing a program of outside relations with the legislature, with other State and Federal agencies, and with the public.

- That the executive officer be formally authorized, either by law or policy, to delegate to subordinates, as he considers necessary, his duties, responsibilities, and authority.

- That a monthly meeting of the commission, governor, and director be scheduled to improve relations between the highway department and the governor, who it was observed was not kept informed of highway operations, and whose views on matters of policy were not always considered. At this meeting, the activities of the department could be discussed and the views of the governor on policy matters ascertained.

- That the director, as chief executive officer and ex officio member of the commission, develop and keep current a comprehensive policy manual; that he develop a new agenda format to conduct commission meetings more effectively; and to relieve him of administrative detail and allow him more time for highway matters, that he eliminate interdepartmental correspondence, document signing, etc., being routed through his office.

- That a management staff, consisting of the assistant director and the heads of the major operational functions, be formed to meet regularly with the director to discuss problems and report on program and project status.

Nebraska

Reportedly, one purpose of the survey in Nebraska was the development of a program "to effectively plan and manage the State's overall highway program on a coordinated statewide basis." Accordingly, both State and local highway legislation, organization, staffing, and operations were analyzed. Recommendations were made to correct weaknesses or problems found in these areas, many of which were believed caused by retention of an organizational concept that was inadequate

and incompatible with today's advance in cultural, technological, and economic facets of society. It was concluded that the intent of the legislature to vest in the governor and highway department the responsibility for planning, constructing, and maintaining the State highway system is adequate and provides on a statewide basis the necessary framework for effective highway planning and management. Safe and efficient highway transportation is of interest to all the people of the State, and an integrated system of highways is essential to the general welfare. For the purposes of the management study, this statement was interpreted as authorizing the formation of a State-level organization the primary objective of which is to provide an integrated system of highways, roads, and streets, and as defining the responsibilities of the highway organization to include administration, planning, design, construction, and maintenance of such a system. It was the opinion of the consultant, that "implicit in the objectives," as contained in the legislative intent, "is the responsibility for the Department of Roads to provide leadership, guidance, and control recommendations to all levels including county, city, and local governmental units," concerned with highway operations, but that the "attitude of the Department of Roads appears to be that it does and should confine its concern to matters affecting the specific system defined as the State highway system."

To effect the development of an integrated system of highways, and also to determine what functions should be performed at the several levels of government, the consultants believed that all laws, policies, and procedures should be designed to force authority and responsibility to the lowest level possible, consistent with good management and efficient operation. Thus, the local political units should assume responsibility for performing, with a minimum of control, the day-to-day activities associated with highway planning, design, construction, maintenance, and financing of their highways, roads, and streets; if these local units will not accept it, the responsibility should be transferred to the next higher level. Final or central authority must be vested in the State highway department and include the power to prevent or discourage local units from using funds and pursuing policies that are hostile to overall development of the integrated highway system. Such authority, it was pointed out, can be exercised by withholding funds, by selecting and dismissing personnel, and by granting incentives for the attainment of objectives. Highway-user allocations and local tax levies for the road system should be considered State funds rather than local funds, and, as such, should be used to develop a system of highways, roads, and streets to benefit all citizens of the State.

For the highway department to exercise its authority and assume responsibility for an integrated highway system, it would be necessary, particularly where local governments are concerned, to enact additional legislation or modify existing legislation as follows:

• Revise the section of the law termed *legislative intent* to mean that the department through its director is to formulate short- and long-range needs for highways, roads, and streets to provide for an integrated system of roadways and bridges, to provide administrative and technical assistance on highway matters to counties and cities, to promote and coordinate cooperative planning and effort between governmental units, and to organize and staff a department at State level to provide for an integrated highway system.

• Define the statewide road system, incorporating in the definition the intent of the legislature to provide an integrated system, and assigning to the department administration of the system and responsibility for it.

• Require the department to develop a functional classification system, and assign all highways, roads, and streets to one of the classifications.

• Assign to counties and municipalities the administrative responsibility for highways that are classified *local*. No responsibility should be assigned to a unit below the county level. Encourage municipalities to contract with counties or vice versa to provide highway services when the good of residents can be served through integrated, economic operations.

• Assign specific planning, design, construction, maintenance, and financing responsibilities to each highway classification. Assignment should specify the services, such as maintenance, that the local government is to finance through local tax revenue only.

• Assign to the department responsibility to develop, document, and provide means for implementation, standards of design, construction, and maintenance, to guide local units in the discharge of duties assigned. Provision for monitoring use of standards by the department should be included.

• Require the department to develop and implement a plan to identify and update biennially long-range needs of all highways, roads, and streets, and to use the resultant value of needs as a guide for distribution of State-aid to local government units.

• Require the appointment in each county and municipality of an individual with qualifications approved by the department, and assign to him the following duties:

- (1) Develop and submit to local units long-range plans, updated annually, based on needs; annual programs for design, construction, and maintenance; and annual budgets based on programmed projects and activities. Submit, after local approval, plans, programs, and budgets to the department.
- (2) Direct operations of State-approved activities; certify upon completion of projects that State-established standards have been complied with, and recommend that work done by contract be accepted and the contractor paid.
- (3) According to the system and schedules developed for the purpose, prepare and submit annually to the State

auditor and to the department a report showing actual receipts, disbursements and accomplishments compared with those budgeted and programmed. Include provisions that the State auditor and department have authority and responsibility to withhold State aid when standards established for such report are not complied with.

• Incorporate provisions to encourage two or more local units to appoint the same individual when operating economy can be assured. The term individual should include consulting engineers and firms on less than full-time basis. Require that registered engineers certify and approve all construction projects for counties and municipalities.

• Assign to the department authority and responsibility to work with counties, municipalities, and other subdivisions to develop an integrated road system; the department must have final authority should differences of opinion occur. Also, assign authority and responsibility to establish safety codes, sign structure, driving rules, etc., on the road system.

• Develop incentives for counties and municipalities to adopt centralized organizations and to consolidate them when economically feasible. Paying part of the salary of an engineer to supervise road and street operations was one incentive suggested.

• Establish a permanent transportation committee consisting of legislative members to evaluate highway needs, to determine effectiveness of highway programs, and to consider future legislation.

• Eliminate all duties, now assigned to the head of the department, that are not directly related to the activities of the department.

• Abolish the State highway commission and establish, as the intent of the legislature, that the governor and department head shall have full authority and responsibility for the conduct of the department. The consultants concluded that the commission lacked authority to do anything but give advice to the head of the department and to the governor—and only at their request—and be listener to complaints against the road system and department. To meet the need for group thinking at the policy-forming level, the consultants recommended the formation—as an integral part of the department—of a management committee made up of six department members and three public advisors. Members would be the department head; the directors of administration, planning, design, and field operations; and the public relations manager. The department head would be the chairman, and the public relations manager the secretary. Selection of the public advisors would be the responsibility of the department head; the advisors would serve at the department head's discretion, and be outstanding, knowledgeable individuals—one each from the financial, managerial, and promotional areas of commerce and industry. Suitable fees and expense allowance should be provided the public advisors, and monthly meetings of the management committee should be considered.

Existing law provides for a department head, but does not give him a title although giving him "full control, management, supervision, administration, and direction of the department, and all powers and duties conferred on the department are exercised under his direction."³ There is no statute authorizing any one individual or group as the policy-making authority. It is implied that the head should set policy as well as administer and that final authority is with the governor. The legislature, it was concluded, lacked the necessary technical skills to make highway policy and, furthermore, did not convene often enough to be responsive to the department's needs.

The consultant's analysis of the highway department's organizational structure establishes the head of the department as the administrator. Staff functions reporting directly to the administrator are audits, personnel, program and planning, information, and, to some extent, legal. The administrator is also responsible for adopting and enforcing the rules and regulations pertaining to the duties of the State's safety patrol and for maintaining an office for law enforcement and public safety. The technical and engineering services and the field divisions report to the administrator through a deputy administrator. All of the staff groups, whether reporting to the administrator or to his deputy, have been delegated authority and responsibility in their respective areas for direct supervision of field offices on matters concerning their staff functions. The administrator's or deputy's contacts with the district offices are usually to resolve disagreements between staff heads and district engineers rather than to exercise management leadership. This supervisory arrangement organizationally isolates the district from the department.

According to the analysis other obstacles to effective organization and management are as follows:

• Either there is an apparent lack of well-defined policies, which restricts decisionmaking and leads to inconsistencies, or decisionmaking was so consistent that initiative and new ideas were being destroyed.

• Management is involved in details that are more appropriately delegated to subordinates. Long accepted practices are difficult to change or modify; no one wants to risk changing what is accepted.

Alabama

The general criticism of the Alabama highway organization, as reported by the consultants, was that functional sections were expanded in the organization without giving sufficient care to their placement, and also that legal and political considerations left management little discretion for placing functions and positions.

Organized under the single executive type of management structure, the director, as well as being the policy maker and designated

³ Following the recommendations the department head was given the title director-State engineer to increase his responsibility.

chief executive officer, had four functional units reporting to him in addition to the chief engineer and the executive assistant. In a reorganization plan that was developed, only the director's staff—executive assistant, legal services, and chief engineer—were placed under his direct supervision.

In the opinion of the consultants, the position and responsibilities of the executive assistant needed clarification. This official, it appeared, had direct lines of contact to all personnel in the department, shunned established lines of responsibility and communication, thus staff levels of management were not always fully aware of the activities in their subordinate organization.

For the more effective handling of its legal matters, it was suggested that the department have its own legal staff. Although the legal staff would be legally responsible to the attorney general, it would report to him through the highway director. In addition to providing better legal facilities, this arrangement would reduce legal expenses through Federal participation in many legal costs.

It is apropos to note here that the plan proposed for reorganization was used as a basis for a management structure adopted in November 1963, and recommendations for the improvement of legal activities later were enacted into law. The law creates a legal division for the department, to be headed by a chief counsel appointed by the highway director with approval of the attorney general. The director was also authorized to appoint, with the attorney general's approval, and subject to the State's merit system, assistant counsel as necessary to transact the department's legal business; appointees were to be full time and paid from highway revenue.

Minnesota

The survey of the Minnesota State Highway Department, outlined these criticisms of the organizational plan: Lack of flexibility in meeting changing work requirements; inappropriate balance between engineering and management skills; some programs over-emphasized at the expense of others of equal importance; related activities dispersed; and an inappropriate division of functions and responsibilities between the districts and the maintenance areas. It was recommended that a plan for organization be structured around the department's objectives and the nature and character of work required to achieve them.

In this State, the overall leadership is vested in a State highway commissioner who is authorized, by law, to organize the department, employ personnel, and delegate to subordinates the responsibilities that he considers, in each instance, necessary to carry out the department's duties and functions. In addition to the commissioner's staff, as provided by the heads of the several functional divisions, it was proposed that the commissioner appoint a public advisory council of 12 to 15 members to keep him informed as to whether his policies and programs are meeting the expectations of the people in different sections of the State.

The State has implemented most of the consultant's recommendations, but benefits are difficult to measure. The department has been restructured under six major divisions, and as a result, the organization is flexible enough to meet future needs, has a more manageable span of control, has clear cut lines of authority and responsibility, and makes provisions for increased delegation of authority to field districts.

The top management group has been redefined to include the commissioner, deputy commissioner, one deputy commissioner for operations, and five assistant commissioners, and their roles in program formulation and execution have been specified.

Benefits from the recommended reorganization of external relations has been marked. Progress has been made in the areas of data processing, field maintenance, drivers license, and equipment maintenance, with resulting cost savings.

More effective approaches to government and community relations have been adopted to provide improved relations with the legislature and help to untangle red tape with the State department of administration.

Missouri

In Missouri, the authority for highways is placed in a part-time policymaking commission. The chief administrative officer is the chief engineer whose time must be divided between meetings with the public and highway department activities. Often, he is not present when decisions that cannot be made at a lower level of management are required. The assistant chief engineer is responsible for certain divisions and can only investigate and pass on to the chief engineer the problems of other divisions. At the next lower level are two assistants to the chief engineer who have not been delegated adequate authority to correspond with their areas of responsibility. Each must await the return of the chief engineer and vie for his time when a decision is needed or a controversial problem is encountered. It was pointed out in the study that some realignment of the highway department's top management organization or structure appeared necessary to segregate and place responsibility for decisionmaking, planning, execution, followup, and control.

Since the recommendation was made, the commission announced that it will appoint an administrator to serve under the direction of the commission. The administrator will have general charge of the department and will perform such duties and have such authority as the commission may designate.

Virginia

In Virginia, the law provides that the highway department be administered under a part-time commission with a full-time chairman designated highway commissioner. He is charged with the execution of all orders and decisions of the commission and is vested with plenary powers for constructing and maintaining the State highway systems. The statutes define the powers and duties of the highway commission, but the authority and

responsibility for setting policies and objectives of the department is not included among them. To overcome this deficiency and to induce commission members to take a broader-than-district view of objectives, it was recommended:

- That members continue to be appointed from the construction districts into which the State is divided, but that they be directed by statute to represent only the broad interest of the State as a whole and not be guided by the interest of their home districts. This recommendation was enacted into law and became effective June 1964.

- That the highway commission be given authority and responsibility to approve and censure the administrative management of the department. This recommendation also was enacted into law and became effective June 1964.

- That the term of office for highway commission members be increased from 4 to 6 years, and that the members organize themselves into several subcommittees. The proposed committees were administration and public relations—to consist of three members with the director of administration serving as secretary; planning and finance—to consist of three members with the director of programming and planning serving as secretary; and policy—to consist of two members with the director of operations serving as secretary.

A reorganization plan formulated to overcome other weaknesses observed in the management of the department recommended:

- That the State highway commissioner be designated chief executive officer for administration, and that the chief engineer be designated chief executive officer for operations, to relieve the commissioners of operations details.

- That a new echelon of management—four directors—be created to relieve the concentration of responsibility in the top managers. This would add two more top executives and enable the grouping of related divisions. The new officials and the divisions under their supervision are: Director of programming and planning—to include right-of-way, research, traffic and planning, programming, and scheduling; director of engineering—to include bridge, location and design, materials, secondary roads, and urban; director of operations—to include construction, equipment, maintenance, landscape, and field districts; and director of administration—to include fiscal and accounting, personnel and organization, purchases and stores, toll facilities, and public information. The director of administration is to report to the highway commissioner, and other directors to the chief engineer—deputy commissioner. This recommended management plan was used as the basis to reorganize the highway department in 1965. It reduces the number of divisions heads reporting directly to the highway commissioner, and gives him the opportunity to devote his time to the executive responsibilities of his position. It also establishes formal channels of communications between the several divisions and the field offices.

In discussing State highway organizations generally, it was stated that the legislatures in all States provided for the administration of highways and, in some States, set up in law a skeleton organization. The skeleton organization action is not always considered to be advantageous, as most law makers are not experienced or knowledgeable in administration and management. Under such conditions the administrator must organize the functions, employ the personnel, and issue the orders, always mindful of the powers and restraints imposed by legislative enactment and sometimes by the constitution.

Mississippi

The law in Mississippi provides for a popularly elected highway commission. The terms of the members are concurrent with that of the governor. The statutes also provide what may be termed organizational restrictions, as follows:

- The amount of salaries and maximum expenses allowed the commission are set.

- The commission must employ a director who is designated the chief administrative officer with the authority, under the commission and in conformity with its orders, to approve bids; sign all vouchers, requisitions, contracts and agreements; and order all supplies and materials. The director must employ, subject to the approval of the commission, a chief engineer, an engineer of construction, an engineer of maintenance, and a bridge engineer, and such other department heads as may be advisable and necessary.

- The chief engineer is legally responsible, subject to the approval of the director, to appoint and remove the district engineers and other assistants or employees of the department other than the engineers appointed by the director.

- The State-aid division, established "within the State highway department," is headed by an engineer appointed by the governor. He is authorized to employ and remove at any time assistant State-aid engineers and other engineers, assistants, and employees as necessary to carry out the purposes of the division.

- The heads of the several staff divisions and of the districts are required to be engineers.

Otherwise the commission and director may organize the department, establish pay schedules, employ personnel, and do whatever is necessary to construct and maintain the State highway system.

Another legal requirement that, in the opinion of the consultants, caused many of the highway department's management problems is the allocation of highway construction funds equally among the districts from which the highway commissioners are elected, which gives rise to a concept that there are as many State highway departments as there are commissioner districts. From the management point of view, this arrangement serves to force programming of construction activities within the districts, as opposed to programming of construction for the State as a whole, and tends to prevent management from developing effective and efficient programs for the entire State's highway needs.

Maintenance funds, also affected by this concept, are apportioned on the basis of mileage under maintenance, and the commissioner district that has the minimum construction cost per mile will increase its improved maintained mileage at the fastest rate, which results in increased maintenance fund apportionments for that district. Also, districts tend to treat machinery and equipment purchased with their maintenance apportionment as exclusively their own, rather than as assets of the highway department. Thus there are wide variances in standards of maintenance and in utilization of equipment and personnel, as well as imbalanced inventories and nonuniform reporting and control procedures.

The three-highway-department concept is also a problem in accounting for the construction funds. To comply with the statutes, the department must establish separate funds for each commissioner district, and, as an operating procedure, separate funds also are established for each construction district within the commissioner district. Such accounting procedures add to the costs of department administration. Furthermore, the economy of the whole State is affected, for it can best be served if highways are built where and when users demand them—not as construction fund apportionments restrict them. The principal organizational deficiencies found by the consultants are as follows:

- No provision was made for anyone to act in the director's absence, or for an interim administrative authority should prolonged illness or other incapacity remove the director from duty. Nor was there a provision for delegation of authority and responsibility to lower levels of employment. It was pointed out that the cause probably was the interpretation placed on the statutes, as nothing was found in the law to prevent the delegation of many of the director's duties to proper subordinate units.

- No provision was made for well-coordinated work programs between the several related staff functions. All the divisions and districts independently reported directly to the chief engineer and the director. There was no intermediate administrative-executive level to coordinate the work of related functions.

- Central office divisions and personnel were housed in quarters that were inadequate and at several different locations. Some functions were not assigned to the division that had primary operating responsibility, partly because of the lack of housing facilities, and partly because of personality and capability conflicts that could exist in any organization.

A pattern for reorganization of the highway department to eliminate these deficiencies was recommended. Although it was realized that the plan might never be fully achieved, it was believed that technical changes in construction and maintenance methods, improvement in administrative techniques, and the capabilities and personalities of employees will work against the highway organization's ever becoming static. The plan offers the following recommended goals:

- Establish the chief engineer as deputy highway director to act for the director during

his absence, but only on the written authorization of the director and with the formal approval of the commission.

- Reassign functions under the most logical and most appropriate staff divisions. Establish separate divisions to administer personnel, procurement, office services, and equipment-management functions.

- Establish separate offices for systems and procedures and internal auditing, and make them staff functions of the director. These offices, working together, are to be responsible for designing and maintaining all policy and procedures manuals, designing and controlling all forms and reports, designing and installing all data collection and analysis systems, making all internal audits, and insuring compliance with department policies by the divisions and districts.

Two changes that would require legislation are: (1) Place the statewide division, which is now required by law and which is primarily concerned with the secondary road system, completely under the highway commission, and amend the law accordingly, and (2) amend the legislation requiring the chiefs of all functional divisions and the districts to be engineers. Where engineering knowledge is not required, the best interests of the department could be served if persons with other professional qualifications acted as division chiefs. However, it was pointed out, that there is no reason why an individual trained in the engineering sciences cannot, through experience, develop adequate capabilities in administration and management. Some functions or divisions that would not require administrators with engineering knowledge are personnel and merit system, financial control, right-of-way, office services, equipment, and procurement; appointments should be left to the discretion of the commission and director.

After examining alternative methods to establish proper administrative controls, the consultants included in a new State operating procedures manual those methods that appeared most practical for the department and submitted the manual to the highway commission for approval. This manual replaced the administrative memorandum series and the administrative procedures developed through interoffice letters, or independently, by each responsible division or district. The manual appeared to be written to correct misunderstandings rather than to prevent them.

The principal recommendations that did not require legislative action became effective in Mississippi as of July 1965. A manual containing policy statements, established areas of responsibility and authority, organization charts, flow charts, and exact copies of forms and instructions was compiled, and a systems and procedures section was established to keep the manual current. The chief engineer now acts during the director's absence. Internal auditing and public relations, formerly staff functions of the director, are now operating sections.

One recommendation, the construction of a highway department central office building,

has not been implemented as the legislature has not authorized the expenditure. No changes in Mississippi law have been reported.

South Carolina

The laws of South Carolina provide the basic organizational structure for the highway department, and require the appointment of a State highway commission and the selection and appointment by the commission of three officers—a chief highway commissioner, as administrative and executive head of the department; a State highway engineer; and a secretary-treasurer. The law also provides that the department be divided into such divisions as the commission or the chief highway commissioner may prescribe, but states that it shall consist of at least these principal divisions: Engineering, motor vehicle, and law enforcement. The latter two may be combined under one director.

Legislative declaration or statement of policy is one feature of modern highway law, and such a statement should be given consideration for inclusion in South Carolina's existing statutes. The declaration should be clear, concise, and written to inspire the administrative body and to encourage maximum use of technical and management skills and resources to achieve the stated objectives and policies.

It was suggested that the head of each division be designated director, and that some standard designations be adopted for the subdivisions. Standardization of unit designations would aid organizational control and position classification, and prevent unofficial acquisition of status and title.

Indiana

The highway affairs of Indiana are vested in a State highway commission, which is a policymaking body having four members appointed by the governor for a term of 4 years. The law provides that the members serve at the pleasure of the governor who also is authorized by law to appoint an executive director of highways—not a member of the commission—who is designated the chief executive and administrative officer and who not only serves at the governor's pleasure but also is subject to the orders, direction, control, and supervision of the commission members. It was found that, to a certain degree, members of the commission were involved in operational matters.

The consultant concluded that two features of the law governing highway administration should be changed: (1) Appointment terms for members of the commission should be staggered to carry over experienced members from year to year, and (2) as the commission, by law, is responsible for all matters, it, rather than the governor, should be empowered to appoint the executive director to serve at the commission's pleasure.

Although the commission is charged with the responsibility of building and maintaining the State highway system, other governmental agencies have some authority over highway affairs. The State department of administration is responsible for providing direction to

other State agencies in matters concerning personnel, purchasing, and the administration of budget funds. Such control, by causing delays in giving necessary approvals and requiring cumbersome administrative procedures, has an adverse influence on the operation of the highway commission. It was the opinion of the consultant that the State department of administration should establish personnel and purchasing policy, but the execution of the policy should be the responsibility of the highway commission.

Staff or Division Organization

The term *staff*, as used in this report, applies to that level of highway organization below the chief executive, or administrator, and sometimes, the chief engineer. The different staff units are called divisions, although many State organizations use other titles such as department, bureau, group, or office for this level of management. The term *section* refers to units of management within a division.

The reasons for differences in State organizations are many; however, there is little difference among States in the basic highway functions—planning, engineering, and administration. The type and size of the management structure depends on the number and categories of personnel required to do the work, and on the expense of the highway systems.

The findings presented and discussed here do not apply to the headquarters of every State, and the recommendations for improvement in management and organization cannot be presented in an overall or general form. However, basic to each survey is a recommendation for a reorganization of the management plan not only to make it more efficient and more economical but also to meet the needs of the State being investigated.

Alabama

Principal recommendations made for reorganization in Alabama are as follows:

- Reduce the number of persons—15—reporting directly to the chief engineer.
- Centralize all accounting operations in the headquarters office.
- Expand and formalize the fiscal management, planning, and control functions.
- Establish independent audit and management systems analysis functions.

By realigning and consolidating functions and organizing headquarters operations in four functional units—engineering, operations, administration, and plans and programs—the number of units reporting to the chief engineer could be reduced to six. It was recommended that each of these be headed by an assistant chief engineer—a new position and title in the management structure. This reorganization would improve coordination between staff functions; improve continuity in long-range planning and programing; relieve the highway director and chief engineer of routine administration and decisionmaking; and increase opportunities to develop top management experience and abilities.

In addition to the four coordinating units, it was suggested that two independent units—

audit office and management systems analysis office—be established as staff functions of the chief engineer. The audit office's responsibilities would include independent evaluation, both financial and nonfinancial, of the degree of compliance with the department's established policies and procedures; analysis of instances of noncompliance; and special audits, as requested. Benefits resulting from such investigations would include improved compliance with policies and procedures; increased awareness of management's fiscal problems; increased reliance on financial records by other State agencies and Public Roads; and greater flexibility in adjusting to changes in operating and fiscal conditions.

The management systems analysis office would keep the department's administrative, accounting, and communications systems responsive to management needs and in conformity with management policies and statutory requirements. Benefits expected from this unit include current maintenance of all policy, administrative procedures, and procedures manuals; continual surveillance of data communications systems to keep them responsive to needs and technical advances; minimization of investment in forms; and coordination for reporting all fiscal and operational data.

To improve the fiscal and accounting function, a fiscal division as a responsibility of the assistant chief engineer, office of administration was proposed. The detailed accounting and financial recordkeeping being performed in other divisions and in field or district offices would be consolidated in an accounting section of this unit. Such an accounting and fiscal arrangement should increase the reliability of accounting records; increase the timeliness and accuracy of fiscal reports; reduce paperwork in both the headquarters divisions and in the districts; and increase the efficiency of auditing, billing, and accounting. Also proposed for the fiscal division was a financial control section to be responsible for compiling the annual operating budget, processing changes in budgets and allotments during a fiscal year, and preparing management and financial reports generated by the accounting section. Benefits expected from creation of this section are improved control over allotment of funds, improved control of district and staff functions through enforced budgeting procedures, greater flexibility in evaluating project requests for additional funds, increased knowledge of unit costs of different functions and projects, and improved reliability in long range planning and programing.

An offices services section to consolidate headquarters offices and divisions was proposed for the office of administration. Responsibilities of this section would include office engineer services, processing construction bids, operation of a central supply room for paper stock and clerical needs, handling of all insurance and compensation claims, and operation of a centralized printing and reproduction shop. The offices services section should minimize investment in paper stocks and clerical supplies inventory, increase

efficiency in procurement and field inventory operations, reduce routine forms and printing costs, and eliminate the use of unnecessary forms and records.

Georgia

In Georgia, the consultants were of the opinion that the headquarters management plan was "not arranged in a logical and functional manner." Practically all functional activities were under the direction of the chief engineer, although the statutes provide for the appointment of a director of highways and specify that he be the department's chief administrative officer. Adjustments had been made in the organization to accommodate individuals rather than functions, resulting in a sprawling structure, fragmentation of functions, and combination of unrelated activities. A plan for reorganization was submitted to limit the responsibility of the chief engineer to engineering and engineering related duties, eliminate inconsistencies, and result in more efficient highway operations.

The reorganization plan proposed organization of the department under five units or offices and included a public information office, all reporting to the director of highways. The divisions and their functions are:

Engineering—The plan specifically proposed that engineering be headed by the chief engineer and his assistants, and that it consist of seven units or divisions: Road design, bridge, construction, materials, maintenance, traffic services, and right-of-way. This arrangement is more compact and, with proper assignment of responsibility and commensurate delegation of authority, should free the State highway engineer of much unnecessary detail. Overlapping jurisdictions and responsibilities would be eliminated and the means provided for achieving better control and coordination of several units with more effective use of personnel.

Administration—It was proposed that administration be responsible for personnel, organization planning, management audits, data processing, reproduction services, files, space management, communications, and custodial services. For the data processing activities, which were being carried out at three computer installations, the consultants recommended the establishment of an adequately equipped and staffed data processing center, where the data processing services would be consolidated in one unit. The department was advised also that provisions should be made for systematic management audits of the organization and performance; that management audits should be a regular part of organization management and control; and that this activity should be placed in the administration division.

The problem of storage and retrieval of records needed attention, as record storage occupied needed working space, and necessitated an ever growing investment in filing equipment, materials, and personnel. Guidelines and suggestions were set up to systematically approach the problem. To be successful, a records management program must have the backing of top administrators,

and its goals must be established, responsibility placed, and procedures outlined in a written policy statement. Responsibility for coordinating the program should be assigned to a high-ranking member of the administration division staff. The most effective way to insure compliance with a records disposal policy, the consultants advised, is to control the issuance of filing cabinets.

Finance—Units proposed for finance were financial planning, budgeting, accounting, auditing, fiscal affairs, and payroll.

Planning—The planning function had not achieved the status of a key operation within the department. It was pointed out that planning is the responsibility of the highway administrator and that a well organized and staffed planning unit to advise and assist the administrator was a necessity. It was recommended that the proposed planning division at least consist of these sections; planning—including long-range improvement plans with separate rural and urban units; programming—with separate units for implementation of cooperative projects under Federal-aid secondary and urban programs, and for developing programs in cooperation with cities and counties; and economic studies and research—including all studies and investigations, and the research needed as a basis for planning decisions.

Equipment and Supply—In the proposed management plan, the equipment and supply division would be responsible for procurement of all supplies and equipment, warehousing, supply and equipment depots and services, and radio installation and maintenance, as well as for the development and administration of an equipment rental system, self-supporting supply system, motor vehicle control, and motor pool operations. It would also be responsible for development of a training program and manual for mechanics, shopmen, and equipment operators.

Public Information Office—Proposed activities connected with public information include all relations and information services; publicity; reporting; meeting with the press, radio, and television media; annual or regular department reports and publications; and related promotion and information services. Particular emphasis was given to the publication of the annual reports and other documents, which should inform the public of the programs and goals of the department. Presentation of information in concise and simple language, it was believed, would lay the foundation for public understanding and support.

Another recommendation to insure better organization and control of the department's activities was the establishment of a standard system of organization unit designations. The use of approved titles precludes the assumption of unofficial titles and improper organization status by personnel.

The latest organization chart, indicates that the Georgia highway department has been reorganized according to some of the recommendations. The divisions of planning and personnel, and the public information office

have been removed from control of the State highway engineer and made a part of the director's immediate staff. A separate utility division has been established, construction controls have been placed under the construction unit, and an internal audit section has been set up to include internal audit and systems and procedures units. Some right-of-way changes have been incorporated, and part of the reorganization of the engineering division has been adopted. Others are being studied and are expected to be adopted soon. Finance and audits was placed under the secretary and treasurer. Programming of work has been moved from the Federal-aid engineer's office to a division of planning under control of the State highway director. Few maintenance recommendations have been implemented.

Indiana

In the Indiana survey, the recommended plan, on approval of the highway commission, was implemented whenever legal enactment was not required. Implementation was at the expense of the commission.

Several operational areas of the Indiana organization were considered for improvement. There were separate units for road construction and bridge construction, each performing location, design, and other functions, and this separation was carried into the field units. Much of the design work was done by consultants, material testing facilities were limited, and traffic responsibilities overlapped other engineering functions. Some of the commission members were involved in operational activities, especially in the acquisition of land. Not only were training programs needed, but the personnel situation was critical throughout the organization, and patronage employment often was the usual procedure.

The following improvements were suggested for highway management:

- Establish an organization with definite organizational responsibilities that provide for a logical delegation of authority and group related functions under a common management.

- Develop a system to publish policies for the guidance of all supervisors in the execution of their delegated responsibilities.

- Coordinate effectively commission goals and objectives with other agencies involved in highway matters. Define commission objectives for overall plans and programs and specific objectives for each organizational unit.

- Project workloads sufficiently into the future to allow management to plan for the financing, manpower, equipment, and facilities to accomplish planned objectives. Provide managers at all levels with the information necessary to coordinate and control the operations under their supervision, and to interpret and apply policies and standards uniformly in all districts.

One of the principal objectives of the Indiana survey was to develop an organization structure and operating relationships to achieve basic goals and implement the policies of the commission. From an analysis made of the commission's responsibilities, it was recommended that highway operations be

organized under five principal functional groupings, or departments, which together with their primary responsibilities are as follows:

Highway Development—Identification and design of needed highway improvements, including long-range planning, program planning, design, and related activities required to accomplish these functions at both the headquarters and district levels.

Land Acquisition—Acquisition of right-of-way to accommodate designed improvements, including abstracting, appraising, property management, and related engineering and administrative activities necessary to support land-acquisition functions.

Highway Operations—Construction and maintenance of State highways, including construction supervision, materials testing, maintenance, and traffic engineering, as well as statewide coordination, control, and execution of responsibility in the field or districts.

Technical Services—All support services used by the highway development, land acquisition, and highway operations units, including research, scheduling, computer services, photogrammetry, and office supply and maintenance.

It was recommended that the above four groups be under the direction and management of the chief engineer. The fifth group:

Staff Functions—which include personnel administration, accounting and fiscal control, management methods and procedures, and public information, was to be the responsibility of the director of highways.

Other useful tools suggested for management improvement, were guides and manuals, including:

- A position guide that defines the responsibilities of each managerial or supervisory position in the organization, and which provides a system for delegating authority to the proper levels of management.

- A management guide that contains organization charts, a position guide, and the general policies of the commission. This guide will provide a continuing means to define the functions, responsibilities, authority, and relations, of all managerial and supervisory positions.

- A functional budget that provides the manager of each major functional unit with current and accurate information regarding the financing of activities under his control, as well as a means for staffing, equipment, replacement, material requirements and other items involving the expenditure of funds.

Minnesota

In the survey of the Minnesota organization it was proposed that the State restructure its management plan around the highway department's defined objectives, and it was recommended that the organizational structure carry out the functions of the department under the following six major divisions: *Operations, planning and programing, engineering standards, management control, government and community relations, and safety.*

Operations—Under the supervision of a deputy commissioner, titled director of operations, this unit would have responsibility

for managing the field or district units and overseeing the headquarters functions of design, right-of-way, contract administration, central shop, and road information and permits. The civil defense program and special projects were recommended to be the province of the operations division in which assignments would be headed by staff assistants. To avoid the possibility of the deputy commissioner's being too occupied with headquarters activities at the expense of the field units, it was proposed that an assistant director of operations, reporting directly to the deputy commissioner, be given responsibility for supervising the headquarters offices.

Planning and Programing—The consultants pointed out construction planning is but one of many highway-building activities and suggested that the division be expanded to include planning and programing for all the highway system's needs under the supervision of an assistant commissioner. It was proposed that the work of this division be under two principal units, transportation system planning and programing, each headed by a director. The transportation system planning section would absorb the present construction planning responsibilities of the planning research section and would include the newly assigned non-construction responsibilities of community transportation planning services, road system data, construction planning, nonrecurring maintenance planning, facilities and equipment planning, and programing.

Engineering Standards—In the reorganization for this division, an assistant commissioner would be responsible for assuring management that the technical operations of the department are conducted in accordance with sound engineering practice. To cover the range of technical services required, it was proposed that this new division be organized in eight units: *Research coordination*—to monitor technical research projects; *State aid*—to check the plans and specifications prepared by county and municipal jurisdictions against professional engineering standards and oversee the contract award procedure; *materials*—to provide a quality control service by conducting tests to assure that prescribed materials standards are met; *traffic engineering*—to develop standards, and review specific traffic engineering plans to assure that prescribed standards have been applied; *design standards*—to assure that road and bridge design is performed in accordance with prescribed design standards; *construction*—to develop contract specification standards, review new construction techniques, and establish contractor prequalification standards; *maintenance*—to prescribe up-to-date maintenance techniques, and to assure their use by operating personnel; and *right-of-way*—to assure top management that operating units are performing in accordance with approved practices and procedures, and to develop uniform appraisal and acquisition standards and monitor their application.

Management Control—This division would be responsible for personnel, data-processing,

and accounting activities which were direct responsibilities of the State highway commissioner. In the reorganization plan, these functions would be supervised by an assistant commissioner who would be responsible for developing and using a system of management controls. The following subunits were proposed for this division: *Program control*—to monitor program progress against approved time schedules; *management services*—to provide in-house advice and guidance on organizational and management problems; *budgeting and financial planning*—to provide adequate budgeting services; *financial services*—to prescribe procedures and safeguards for the collection, receipt, custody, deposit, and disbursement of the department's moneys, to be responsible for all recordkeeping and manual processing of financial data, to maintain the appropriate cost accounting and control records, and to perform internal and external audits; *data processing*, to be responsible for systems and procedures improvements; and *administrative services*, to centralize the department's major housekeeping activities.

Safety—The safety function would be elevated to division status and supervision would be performed by an assistant commissioner of safety. Activities within the division would be organized under three-units, as follows: Traffic statistics analysis, highway patrol, and drivers licenses.

Government and Community Relations—This division, under the supervision of an assistant commissioner, would assume responsibility for developing a more aggressive and positive external relations effort. It was proposed that activities be administered through the following units: *Highway program information*—to prepare news releases and report on highway operations; *technical support services*—to provide specialized services in art and audiovisual techniques and to maintain the film library and publications service; and *public safety education*—to promote safety formerly in the safety unit.

Most of the consultants recommendations have been implemented in Minnesota. The department has been restructured under the six suggested major divisions, which provides the organizational flexibility to meet future needs; it has a more manageable span of control, clear cut lines of authority and responsibility, and increased delegation of authority to field districts.

The top management group has been redefined to include a commissioner, a deputy commissioner, a deputy commissioner of operations, and five assistant commissioners, and to specify their roles in program formulation and execution.

Many benefits have accrued from the external effort. Progress has been made in the areas of data processing, field maintenance, drivers license, and equipment maintenance, and has resulted in substantial cost savings. More effective approaches to government and community relations have been adopted to improve relations with the legislature and to help untangle redtape with the State department of administration.

Nebraska

The proposed reorganization for the highway department in Nebraska was formulated to facilitate adoption of the *management by objective* concept, to align major functions and activities not considered an integral part of highway-department objectives; and to recognize differences between staff and line responsibilities.

Functions not considered necessary to the department's operations were law enforcement and public safety, scale (weighing) operations, and the keeping of accident records. It was suggested that the accident record bureau, a unit of the traffic engineering section in the existing division of engineering services and field divisions, be transferred to the department of motor vehicles, and that formal provisions be made for this agency to furnish the highway department the statistics it requires. To provide a solution to the problem presented by the other extraneous functions, it was suggested that, although legislative action might be required, a new department of public safety be established under the governor using the existing law enforcement and public safety division of the department as a basis for the new State agency. The scale operations would become a responsibility of the new agency, but responsibility for recommending to the legislature freight and dimension standards to best protect the State's road investment would remain with the department of highways.

To further restructure the activities of the department toward an integrated system of highways, roads, and streets, it was recommended that the headquarters organization consist of four major units, or offices: Administration, planning, design, and field operations. Although administrative in nature, public relations and contracts would be units under the director-State engineer because of their relation to his office. For reporting purposes legal services, under the control of the attorney general also would remain an adjunct of the office of the director-State engineer.

The four major divisions, each headed by a director, would report to the director-State engineer. These divisions and their principal functional units are as follows:⁴

Administration—Personnel, property and equipment, management information services, and data processing operations, all headed by a manager. Fiscal management under a controller.

Planning—Program planning, maps and statistics, and projects scheduling, each under a manager. Planning and research programs, county and municipal programs, each headed by an administrator.

Design—Bridge design, roadway design, materials and tests, and right-of-way, all directed by an engineer manager.

Field Operations—Maintenance, construction, and districts, all directed by an engineer.

Missouri

A regrouping of functional divisions within the highway department was recommended in Missouri to combine duplicate sections or functions, to strengthen the decisionmaking process, and to economize on time and personnel. The reorganization plan proposed that the following officials head the groups or offices indicated:⁵

- Assistant to the chief engineer, planning and design—all divisions concerned with preliminary design and planning, including right-of-way.

- Assistant to the chief engineer, operations—the divisions of construction, and materials.

- Assistant to the chief engineer, maintenance—the divisions of road maintenance, and equipment.

- Chief of administrative services, titled controller—all functions, except public information, of a staff service nature including data processing, internal review and audit, personnel, accounting, and procurement.

It was proposed that the several assistants to the chief engineer and the controller report to the assistant chief engineer. The public information function, which is involved primarily with the public relations activities of the chief engineer, should be a staff function, reporting directly to the chief engineer.

Other recommended changes in management include the establishment of a right-of-way organization and an office of district coordinator. At the time of the study, the chief counsel, in addition to his legal duties also served as chief of the right-of-way division. Assistant chief counsels handled legal matters within their areas, but decisions were the responsibility of the chief counsel. Establishment of a separate right-of-way division, and the delegation of a decisionmaking authority to the assistant chief counsels, would relieve the chief counsel of detail and permit more effective use of his services by the highway commission. Another weakness concerning right-of-way activities, and one contrary to the principle of sound fiscal control reportedly was the combination in one unit of appraisal review and negotiation assistance. It was pointed out that the establishment of property values and the negotiation with property owners should be accomplished by separate units. As time is very important in right-of-way operations, it was suggested that formal training of personnel in areas of negotiation and field liaison would reduce time spans and could result in lower acquisition costs.

The office of assistant to the chief engineer of district operations, or district coordinator, if established at the division level, would give field operations greater uniformity and more immediate supervision, and also would relieve the chief engineer of decisionmaking responsibilities when controversial issues arise between the divisions and the districts. The establishment of this office should in no way interfere with the direct lines of communication necessary for control of routine matters

⁵ This recommendation, according to information from the Regional Office of the Bureau, is being given favorable consideration.

between these units and the management organization.

Before the recommended structural changes can be made, organizational relations and responsibilities must be defined, and specific descriptions for managerial positions prepared and approved. The assistants to the chief engineer and the controller, all recommended for appointment under the reorganized management plan, and given responsibility for coordination of the divisions assigned to them, must also be assigned adequate authority to administer the duties involved.

The following changes and suggestions were proposed for improvement of management within the highway department's headquarters divisions:

Bridge—There should be two assistant division chiefs in the bridge division—one for preliminary design, the other for final design. The maintenance section in the bridge division should be transferred to the maintenance division to make more effective use of personnel and allow the district engineer more control over the maintenance effort in his district.

Traffic—Because of overlapping functions with other divisions, the traffic division is eliminated from the revised organizational structure by transferring its responsibilities as follows: Signs and marking, to the maintenance division; sign contract, to the surveys and plans division; and traffic surveys, to the highway planning division.

Supplementary Roads—Although Public Roads regulations require that the supplementary or secondary road program be coordinated by a single unit, the level of the unit in the organization is not specified. In the consultant's opinion, the supplementary roads function could be performed and requirements adhered to if it were a section of the survey and plans division, which remove the function from division status and would not only save time, but also make more effective use of personnel and lower costs.

Personnel—The structure of the personnel division and the number of employees was considered inadequate to administer effectively the policies and programs of the highway department.

South Carolina

The management research study in South Carolina indicated that some regrouping of services and activities was necessary "in order to provide the chief executive officer with the specialized skills and knowledge needed for effective management and control over all operating divisions of the highway department."

The reorganization plan recommended that the department be organized into seven major divisions and a public relations unit. The recommended divisions are: Administration, planning and programing, supply and equipment, motor vehicle, law enforcement, engineering, and finance. It was suggested that the head of each division be called director and that some standard designations be adopted for the units of organization below

⁴ The recommended headquarters organization was implemented effective January 1968.

the division level. It was also suggested that standardization of unit designations would aid organization control and position classification, as well as prevent unofficial acquisition of status and title. Reorganization of the department as proposed, would result in a more efficient operation because of the combination of related activities and functions into logical components. The proposed structure eliminates overlapping jurisdictions and divisions of responsibility for given functions and reduces time consuming coordination and duplication of effort now required to administer some of the activities.

Administration Division—Activities recommended for inclusion in the administration division are personnel, organization planning, data processing duplication services, space management, custodial, and related house-keeping services. Because there appeared to be two independent computer operations, one engineering and the other financial, the establishment of a data processing center was recommended. When equipped with the recommended machinery and personnel, the center would provide data processing services for the entire highway department.

Planning and Programing Division—It was pointed out that planning is the key operation from which all other activities flow. The planning function, at the time of the study, was not yet developed as an organized and coordinated activity, and the responsibility for it was scattered. Planning is a primary responsibility of the chief executive, but to plan, he must have information. It is the duty of the planning division to provide this specialized assistance. It was recommended that the planning division report directly to the chief executive officer.

Supply and Equipment Division—Review of this division indicated the need for a well-defined policy on equipment replacement, or retirement, based on age, mileage, condition, and maintenance costs; proper cost records; a training program for mechanics, shopmen, and equipment operators, as well as a manual for their guidance; and the establishment of equipment operations as a self-sustaining activity with a revolving fund and proper cost-accounting and recordkeeping systems. Transfer of the purchasing function to the supply and equipment division was recommended to eliminate duplication of effort, and permit coordination of purchasing and supply and equipment management. As purchases are made by the State purchasing division, it would be the function of the supply and equipment division to supply the State purchasing division with recommendations and specifications for purchases.

Motor Vehicle Division—Inclusion of this division within the State highway department is a legal requirement. Its activities are those that deal with registration and titling of motor vehicles, revenue collection, safety and financial responsibility, and driver licensing and control.

Law Enforcement Division—This division is established by statute, and includes the enforcement of motor vehicle and traffic

laws and regulations, truck size and weight, and education enforcement programs.

Engineering Division—The consultants found the engineering division to be "not arranged in either a functional or logical way." Seven district engineers, and at least a dozen other individuals report directly to the State highway engineer. Assignments are not clear, overlapping of duties occurs, and informal arrangements are the rule—all of which are signs of inadequate administrative machinery. It was recommended that the engineering division consist of seven principal sections—right-of-way, bridge, design, construction, maintenance, materials, traffic—and that it be organized to permit greater output and a better product. With proper assignment of responsibility and commensurate delegation of authority, the State highway engineer could be freed of much unnecessary detail. The combination of related functions and activities into fewer components would eliminate overlapping jurisdictions and responsibility, and provide for better control and coordination of division functions.

Public Relations Office—As organized at the time of the study, public relations and safety education were in the same unit. This unit was charged also with the administration of the school-bus driver training programs, licensing of driver training schools, and qualification and approval of their instructors.

Finance Division—The statutes require the commission to appoint a secretary-treasurer, a fiscal officer, who acts as director of the finance division. The consultants suggest that the position of secretary and treasurer be separated. Also, as the chief executive officer is the administrative officer of the department, it was suggested that he, rather than the highway commission, should appoint the director of finance and that the legal provisions concerning this officer's appointment be revised accordingly. All accounting and related functions now being carried on in other divisions should be transferred to the finance division, as should the payroll and leave records being maintained in the personnel office.

Other criticisms and suggestions for improving the department's organization and management practices were as follows:

- Management guides should be prepared to set forth the functions, responsibilities, authority, and relations of all top management positions so that occupants will have a permanent source of instruction and guidance concerning their place and functions in the organization.

- The internal auditors of the finance division should not be responsible for management audits. Reports and performance schedules should be used to check organization and performance. To assure a neutral review and appraisal, audits should be made by a division or unit not directly concerned with the operations and activities being studied. It was recommended that such a unit be placed in the proposed administration division.

- A body of policy statements, approved by the chief executive, should be developed to guide the divisions and districts in carrying out the functions of the department. Where such statements do not exist, they should be prepared for review and approval.

Since the management study was completed in South Carolina, some of the recommendations have been implemented. Some of the results affect the entire department; others affect the different divisions. Certain changes have been made in the law, although enactment may not have been influenced completely by the management study. A data processing section, placing all data processing operations of the department into one unit, with new equipment, has been established under the secretary-treasurer. In lieu of forming a planning section to work closely with the chief highway commissioner in all planning for the department as recommended, a program engineer has been installed to work with all units of the organization in planning and coordinating the different stages of construction from programing and location to acceptance of completed as part of the improved highway system.

Schoolbus driver training has been removed from public relations and transferred to the State department of education. Traffic safety education, which was also under public relations, has been transferred to the motor vehicle division. Driver license examination has been transferred from the patrol division to the motor vehicle division, and the upgrading of the ranks of patrol personnel, as suggested to improve morale, had been successfully done without materially increasing costs of operation. According to the State highway engineer, the overall review of the highway department's operations generally has improved the organization and increased efficiency.

Texas

Criticism of the highway department's structure in Texas was that it was organized according to activity rather than to function, and the organization tended to be "people-oriented" with too many people reporting to top management. Responsibilities of the divisions were divided and often overlapped; for example, five divisions, in addition to the district where work was being considered, were involved in the processing and execution of contracts. It was pointed out that this division of responsibility and duplication of activity, resulted from patterning the organization of headquarters divisions after that of the districts. The basic function of the division should be to aid management at the headquarters and district levels. A secondary function is to support the field or district organization by providing service and technical skills not obtainable within the districts. It was concluded that too much emphasis had been placed on the secondary function, which promoted independence and self-sufficiency among the units at the division level. Reorganization at the headquarters, or division, level was suggested to eliminate duplication and overlapping of functions.

Other criticisms and suggestions for improvement of the organization and management practices in Texas were as follows:

- As each division approached outside agencies independently concerning its own operations, several divisions may be negotiating with the same agency, such as the Bureau of Public Roads, on different but related matters, which has an adverse effect on planning. Moreover, the action of one division could be contrary to the best interests of another. A division's authority should be classified and specific policies put in writing so that conflicts with outside agencies can be resolved by determining which division's authority is to prevail.

- Training programs are developed and carried out by different divisions and districts without regard for the need of the department as a whole, and personnel are recruited according to the needs of the several organization units. The consultants advised that recruitment and training are proper functions of the department's personnel division. They suggested that the personnel division expand its functions to include a coordinated state-wide employee training program on a continuing basis, and to develop an inventory of the skills of all personnel employed by the department. Better coordination of employment and recruitment also should be established.

Washington

In the Washington highway department, more than 20 unit heads reported directly to the director of highways. This situation was due primarily to the director's lack of authority to delegate to subordinates any of his responsibilities. Recommendations for improving and streamlining the highway department's management plan at the division level were as follows:

- Reorganize the headquarters office of the department under seven functional divisions—personnel services, management services, planning and research, engineering, construction, maintenance, and toll facilities. Such an arrangement simplifies and clarifies work flow; groups together and pinpoints authority, functional activities, and related programs; includes right-of-way and bridge design under engineering; and reduces the director's span of control.

- Redesignate or retitle major departmental positions. For the assistant director, who serves as a deputy, the title deputy director of highways could be used. The title assistant director for the heads of the proposed divisions would better depict their positions and responsibilities in the structure. Personnel director was suggested as the title for the head of personnel services. The title *assistant* applied to any position below the assistant director level should be eliminated.

- Facilitate communications between and among organizational units. The management plan, to be effective, should be flexible enough that anyone needing information can request it at the source. Subordinates should keep their superiors informed on matters affecting the operations of their units.

- Prepare functional job descriptions so that the responsibilities of each organizational unit will be generally understood. Duties and responsibilities should be set forth in writing.

- Prepare, revise, and keep operating manuals up to date.

- Establish an offices services section in the proposed management services division to provide additional office and clerical services to engineering and management personnel at all levels.

- Transfer the public information function to the office of the director of highways. In addition to duties related to public information, the public information officer should serve as the administrative assistant to the director, particularly when dealing with the public in such matters as public appearances of the director, of the members of the highway commission, and of other staff personnel.

- Strengthen the services of the legal office. Legal support is an extension of the attorney general's office. It was recommended that the legal office be headed by an assistant attorney general and that, rather than having division status in the organization, it be attached to the office of the director of highways for supervision, but report directly to the attorney general. It also was suggested that the legal staff be enlarged, and that one member of the staff be assigned to take care of legal matters in each of the district offices.

The State has two agencies concerned with toll facilities—toll bridge authority, and toll facilities division. In the opinion of the consultants, the toll bridge authority, a separate agency organized many years ago to plan and finance toll facilities, has outlived its usefulness, as most of its functions already have been transferred to the highway commission. The remaining responsibility also could be transferred without difficulty. The relationships of the toll facilities division to the other divisions of the highway department are unclear. Toll facilities are not a part of the highway department's programs and budgets, and it is difficult for them to get projects planned, designed, constructed, and maintained by the appropriate units of the department's organization. It was recommended that the toll facilities division be headed by an assistant director of highways for toll facilities who would have responsibility for coordinating, planning, and approving and monitoring design, construction, and maintenance operations performed by other highway divisions.

As of February 1968, the Washington Highway Commission had adopted and implemented, almost entirely, the recommendations of the consultants. A deputy director's position was created, and the director was delegated authority for the day-to-day management of the department. He was also given authority to subdelegate authority to subordinates. The headquarters divisions were organized into the recommended groups, and the executive heads were classified assistant directors, thus reducing the control span of the director. These changes have permitted the department to properly identify the needs for additional personnel and the

qualifications required to accomplish the type of work to be done by the department.

Mississippi

A criticism of the highway-department organization in Mississippi was that no intermediate administrative-executive level existed in the organization to coordinate the work of related functions, so that all the divisions and districts independently had to report directly to the chief engineer and director. The reorganization plan submitted for this department recommended the establishment of three new management-level positions—assistant director for administration, assistant chief engineer-operations, and assistant chief engineer-planning—placed in the organizational structure between the operating divisions and the deputy director-chief engineer. The assistant director for administration was to have responsibility for:

Financial Control—On a centralized basis, including the auditing function and accounting responsibilities formerly done by the districts, the office engineer, and the materials division.

Personnel and Merit System—To centralize all personnel functions as recommended and discussed in another report; and all staff training and safety programs carried on in the department.

Office Services—A new division to administer the various incidental department-wide services formerly performed in the several divisions, and to include central files, central office supplies, mail service, printing shop, computer center, and a building services center to provide all custodial, janitorial, and space management functions for the central office.

Procurement—A new division to assume complete control of all procurement, except construction contract administration, which remains the responsibility of the office engineer.

The establishment of this new division and units in the structure will bring together all administrative functions under the assistant director for administration. It will relieve the technical divisions of miscellaneous functions thus allowing them more time for their specialized responsibilities. The improved internal control will also promote more efficient utilization of the department's resources.

The positions of assistant chief engineer-operations and assistant chief engineer-planning and design—on the same organizational level as the assistant director for administration—will not require additional personnel. The reorganization required will place the assistant chief engineer-operations in charge of staff functions that have direct relations with the field or district operations. The assistant chief engineer-planning and design will be responsible for coordination and direction of the centralized highway and design activities, including right-of-way.

These proposed management recommendations made for the division level in Mississippi have been implemented. Related functions have been regrouped under three principal offices or departments titled administration, operations, and planning and design. An

assistant director heads administration, and an assistant chief engineer heads each of the other groups. Other benefits realized are improved efficiency resulting from common usage of centralized reproduction equipment; improved filing system; reduction in cost of office and clerical supplies through centralized procurement and issuing procedure; increased utilization of computer equipment in both fiscal and engineering fields, thus justifying acquisition of a more sophisticated system; and improved inventory control. Because the central offices are in five locations, the recommended services center has not been organized, but will be when new quarters become available. Also, an equipment division was established to facilitate joint use of maintenance equipment by the districts.

District Organization

Each State highway department has a field organization made up of units commonly known as districts. Highway districts are the extension of the State highway department's headquarters offices into several geographical areas of the State. It is through district organizations that highways are constructed and maintained. As there is diversity among the States in management plans at the head-

quarters level, there is also diversity in district organizations, and sometimes a variance within a State. Following are some of the recommendations made concerning district organization for several States.

Alabama

In the opinion of the consultants in Alabama, the existing diversity of district organization plans was deficient, primarily because of the decentralization of the department's overall organization plan. In effect, each district was a small, autonomous highway department. Differences among the districts—such as size, degree of urbanization, and topography—make differences in district responsibilities. But for overall highway operations—internal control, data flow, and general management—a basic uniform organization plan for the districts should be established. It was recommended that the operations of each district be carried out through seven major functional units—administration, right-of-way, county aid, materials and test, construction, equipment, and maintenance—all responsible to the district engineer. Benefits expected from this plan are improved management performance reporting, improved budgeting and planning, increased efficiency in administration procedures, simplification of communications and of accounting and data

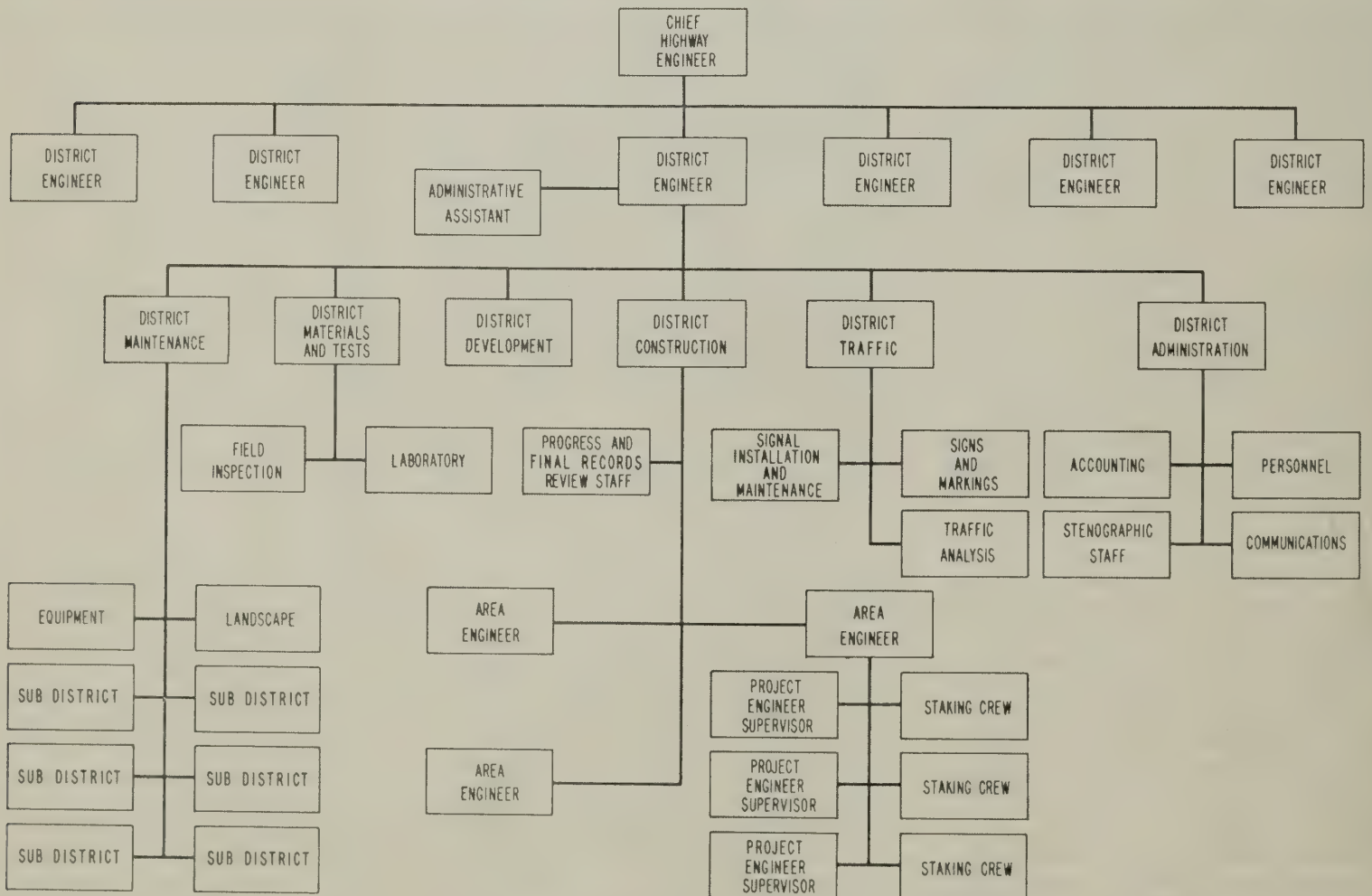
flow, clear lines of promotions, and improved personnel and training evaluation.

Georgia

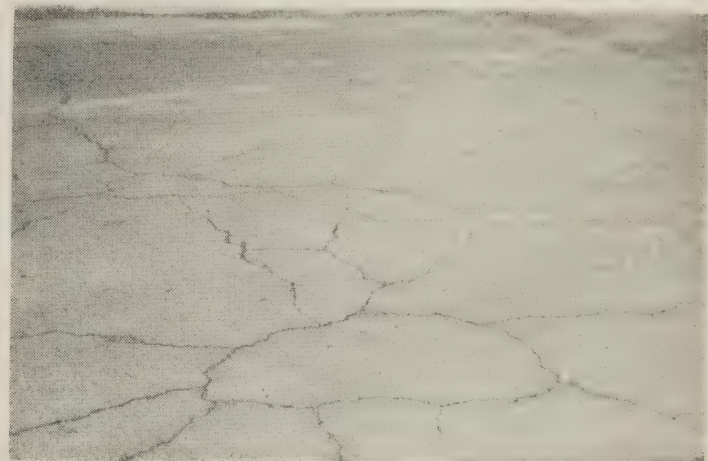
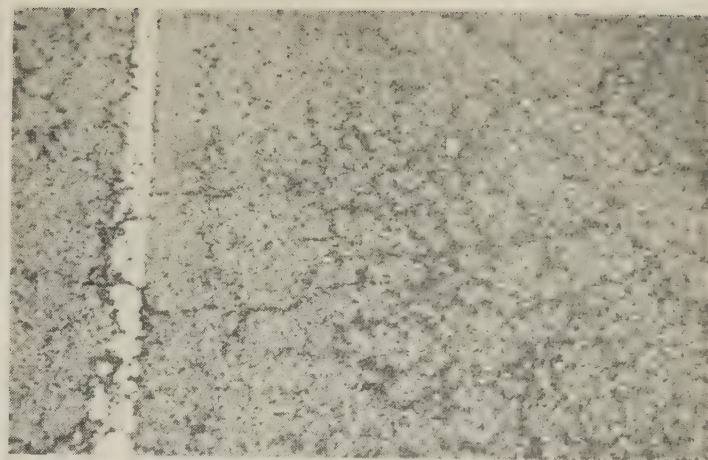
In Georgia, where many of the highway department's activities were the responsibility of the district and subdistrict organizations, some clarification of the relations between the central office and the districts was advised. It was recommended that activities be further decentralized as qualified personnel becomes available to assume the responsibilities. It was also suggested that subdistrict organizations be eventually eliminated. Because the State is involved in the development of an integrated highway network in urban areas, it was recommended that metropolitan districts, composed of the counties making up the metropolitan areas, be established.

Indiana

District operations in Indiana were supervised by field engineers traveling out of the central office. The highway department was advised to organize the districts following the pattern developed for the central office, and place each district under the supervision of a district engineer directly responsible to the chief engineer of the commission. The pattern provides for five functional groups—maintenance, construction, traffic, materials and tests, and administration.



District organization used by the Indiana State Highway Commission.



It is unwise to draw conclusions from limited data when considering the durability and hardening of bituminous materials.

Asphalt Hardening— Fact and Fallacy

Reported by ¹ J. YORK WELBORN,
Principal Research Engineer
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BY THE OFFICE OF
RESEARCH AND DEVELOPMENT
BUREAU OF PUBLIC ROADS

RESEARCH RELATED to durability and hardening of bituminous materials is documented in the literature by several hundred research reports (1, 2)². Most of the reported research, concerned with changes in asphalts, has been conducted in carefully controlled laboratory experiments, usually under accelerated aging conditions. Well designed field experiments also have been conducted to investigate under identical environmental conditions asphalts from different sources, although usually the sources have been limited to those that were readily available in a particular area. In other research, asphalts used in normal construction under differing service and environmental conditions have been studied. Again, these studies usually were limited relatively to few asphalt sources and pavement samples.

Recognizing the need for comprehensive and reliable information, the Public Roads research staff in 1967 began a comprehensive

Control of asphalt hardening during construction and service of highway pavements will provide longer pavement life and result in better economy. According to the results of a study of 11- to 13-year-old pavements, the mixture design and the mixing, spreading, and compaction of the mixture at the time of construction are probably the most important factors governing the hardening of asphalt.

study of asphalt-cement durability. The primary objective of this study was to determine the overall changes in the physical and chemical properties of asphalt cements during construction and service in pavements. Some of the more obvious findings concerned with the hardening characteristics of asphalt cements are reported here. The fallacy of drawing conclusions from limited data will be pointed out, and the quantitative relation between hardening and certain mixture characteristics will be shown. Some of these findings are not new but were anticipated, and it is hoped that they will serve as guidelines to evaluate asphalt durability in the continuing search for more durable pavements. The complete data are now undergoing additional analyses in preparation for a later, more thorough report.

A brief description of the test procedures used in the study is included in this report. These procedures have proved suitable for studying changes in properties of asphalt and paving mixtures from pavements, and if followed by other researchers, they should provide a basis to compare data from other sources.

The research reported here is a continuation of earlier studies of properties of asphalt cements produced during 1954-56 from all major sources in the United States (3, 4, 5, 6). When samples of these asphalt cements were collected, specific information on the corresponding paving projects was obtained. Of the 300 projects identified 210 were constructed with 85/100 penetration grade asphalt.

In a 1965-66 survey, Public Roads obtained further information on the status of the 210

¹ Presented at the 14th Annual Conference, Canadian Technical Asphalt Association, Edmonton, Alberta, November 3-5, 1969.

² Italic numbers in parentheses identify the references listed on page 285.

projects, including the general condition of the pavements and the extent of maintenance or reconstruction that had been carried out since construction. This survey revealed that 130 of the 210 pavements were still in service and that the remainder had been either surface treated, overlaid, or partly reconstructed.

Subsequently, the condition of the pavement surfacings were evaluated to develop qualitative and quantitative information on the types of distress observed. For this phase, the hypothesis was that the type and amount of distress may be correlated with the original or existing asphalt properties, or with the changes in the properties during service. A report on the procedures used for the pavement evaluation was presented at the 1969 meeting of the Association of Asphalt Paving Technologists and will be published in the Proceedings of AAPT, vol. 38, 1969.

Field Sampling Plan

To reduce the amount of work required to obtain and test samples from all the 210 paving projects, a representative group of pavements was selected for study. The selection was based on the information from the 1965-66 survey and on several other factors related to the asphalts—their physical and chemical properties, their sources, and the environments at the locations where they were used. Considering that overlaid or surface-treated pavements could indicate asphalts of poor quality, a number of *nonsurvivor* projects were included. Fifty-three projects in 19 States were finally selected for detailed study—38 were *survivors*, or in service as constructed, and 15 had been resurfaced. The projects represented asphalts from 29 different sources. Seventeen of the 29 asphalts had been used in more than one paving project and eight were represented by both survivor and nonsurvivor pavements. To provide data on one major source of asphalt, three projects were included that had been constructed with 60/70 penetration asphalt. The locations of the projects by States are shown in figure 1.

A random sampling plan was used for each of the paving projects. Initially the plan called for six samples per project, but as the field study progressed, the frequency of sampling was sometimes modified, primarily for projects that were less than 1 mile long. The minimum number of samples taken for any project was two; the total number of samples taken from the 53 projects was 313.

During the pavement-condition evaluation the survey team located each sample site and marked it with spray paint. The section of pavement 200 feet beyond the sample site was used for the condition evaluation.

Sample locations were in the outer wheel path of the travel lane, an important feature of the sampling plan. For a special study of transverse variability, two projects also were sampled between the wheel paths and in the passing lane. Confining the sample location to the outer wheel path tended not only to eliminate differences owing to construction compaction and traffic densification, but also to minimize the effect of oil drippings.

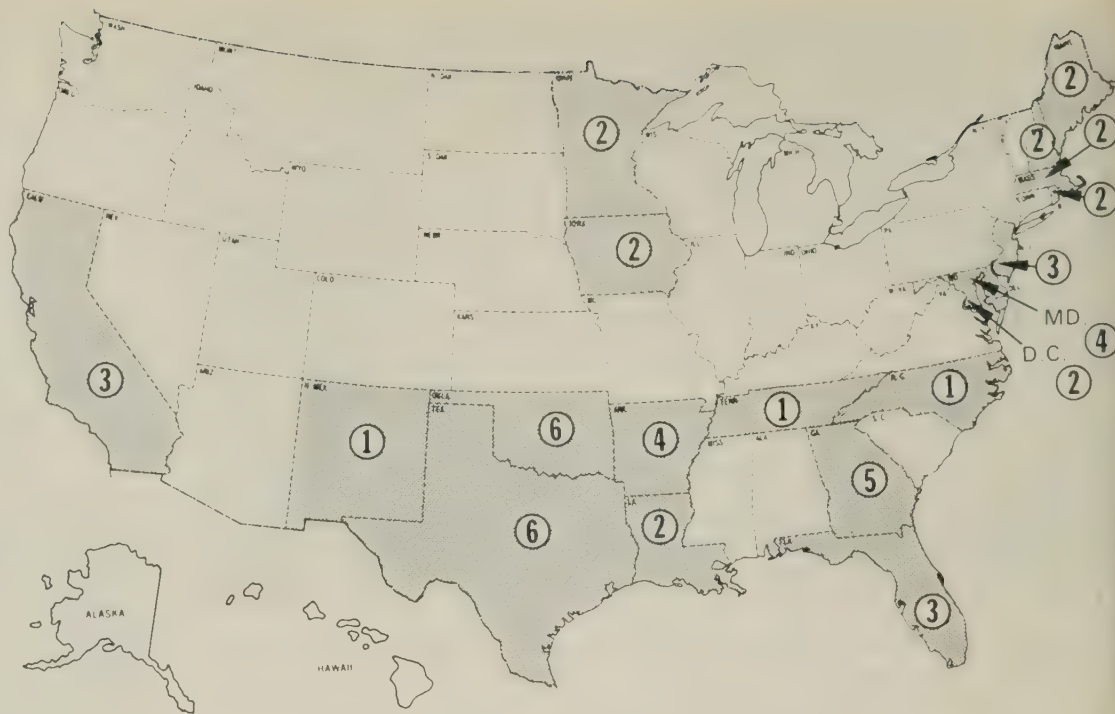


Figure 1.—States included in study.

Laboratory Analysis

All pavement samples from the 53 projects were processed and analyzed in the Public Roads research laboratories. Prior to the laboratory analysis, a preliminary study was conducted to determine the adequacy and precision of all the laboratory tests to be used. Four replicate tests were made on split samples from four pavement samples, and the variability of results determined. This preliminary study showed that all procedures, general descriptions of which are given later under *Laboratory Test Procedures*, were under satisfactory control.

In addition to the laboratory study of *physical* properties of the paving mixtures and asphalts, the *chemical* composition and changes in composition caused by aging were

investigated by a contractor who had previously studied the composition of the asphalts representative of those used in the pavements (5, 6).

As test data were accumulated, it became evident that there was a wide variability in results of samples from the same project. Examples of the variability are shown in table 1 for six pavements in which the same asphalt was used. The test properties tabulated for recovered asphalts are 77° F. penetration, and 140° F. viscosity; those for the paving mixtures are air void content and voids filled with asphalt. Variability values shown in the table for six samples are minimum, maximum, mean, and standard deviation. The largest standard deviations for these six projects were 17.6 decimillimeters for penetration, 104 kilopoises for viscosity,

Table 1.—Variability of test data for properties of pavement samples

Property	Project number	Variability			
		Minimum	Maximum	Mean	Standard deviation
Penetration, 77° F.	17	22	50	31.5	9.6
	18	31	70	47.6	14.4
	26	18	24	21.3	2.3
	27	23	74	46.7	17.6
	40	29	39	35.0	4.3
	41	17	38	23.8	7.3
Viscosity, 140° F. kilopoises	17	3.9	36.7	19.0	12.7
	18	2.5	17.0	9.1	5.6
	26	35.5	60.0	46.8	7.9
	27	2.1	32.0	11.6	11.2
	40	7.0	12.7	9.4	2.4
	41	13.4	315.2	119.0	104.0
Air void content. percent	17	0.1	4.9	2.5	1.5
	18	1.0	2.9	1.8	0.8
	26	4.4	7.2	5.7	0.9
	27	1.0	5.3	2.3	1.5
	40	2.1	2.9	2.4	0.4
	41	2.7	12.1	6.9	3.0
Voids filled with asphalt. percent	17	75.4	99.5	86.8	7.5
	18	84.1	94.0	89.4	4.3
	26	64.3	75.7	70.0	3.7
	27	73.4	93.3	87.4	6.8
	40	82.5	87.5	85.6	2.2
	41	47.2	85.0	67.5	12.1

3.0 percent for voids, and 12.1 percent for voids filled. Inspection of these data, as well as of data for individual samples, indicated that differences in the properties of recovered asphalts were due to differences in the properties of the mixtures, as will be shown.

Effect of Voids on Asphalt Hardening

The relation between void content and penetration of asphalt No. 7 after 12 years of service is shown in figure 2. The plotted points are for 30 individual samples of the six projects tabulated in table 1. Some scatter of results is evident, but there is a definite trend of lower penetrations with higher void contents, as might be expected.

The relation can be described by a least squares regression line of the form $\log \text{penetration}, Y = 1.783 - 0.599 \log \text{voids}, X$. Four other lines, parallel to the regression line, are also shown in figure 2. The two dashed lines show the limits of plus and minus one standard error of Y on X . The other two lines, shown by dash-dots, are the limits of plus and minus two standard errors of Y on X about the line of regression. Should asphalt No. 7 be sampled and tested under a similar program, 68 percent of the values for penetration and voids would be expected to fall within the one-standard-error band, and 95 percent within the two-standard-error band.

The relation of pavement-sample void content to asphalt hardening, as indicated by viscosity at 140° F., is shown in figure 3. The relation is similar to that shown in figure 2. It is apparent from these figures that several samples are necessary to reveal the range in the data when hardening of

asphalt in pavements is studied. Many reports on asphalt hardening during service have data based only on one sample location. Moreover, some reports compare the hardening of asphalts from different sources without recognizing the relation of mixture properties. For example, asphalt No. 7 as used in State C could be considered a nondurable asphalt, as the low penetration values, below 30, usually are associated with pavement distress, depending on the climatic environment. However, many of the penetration values for the same asphalt from projects in States A and B were above 30, and several were more than 50. The higher penetrations have been associated with good performance under the same environmental condition.

Accordingly, to judge asphalt durability from insufficient data is fallacious. If variability of the paving mixture throughout the pavement is not known, several random samples must be tested. Also, if significant variability is found, the properties of the recovered asphalt must be related to the mixture properties before the durability of the asphalt is judged.

Voids Filled With Asphalt and Hardening

Other mixture properties associated with performance of asphalt No. 7 are shown in figures 4 and 5. The relation of voids filled with asphalt to penetration of the recovered asphalt after about 12 years of service is shown in figure 4. As might be expected, the relation, an *eye-ball* curve, indicates a definite trend of less hardening for higher percentages of voids filled. For this particular

asphalt, from the standpoint of hardening, a minimum of 85 percent voids filled probably would have provided relatively good performance for all projects.

The relation of voids filled to hardening, as measured by viscosity at 140° F., is shown in figure 5. This curve, based on a least squares computation, indicates that the relation is linear for this type of plot—log viscosity against voids filled. Also shown in figure 5 are the limits established by computations of one and two standard errors. The difference in the shapes of the curves in figures 4 and 5 could be due to the fact that consistency of hard asphalts can be measured better by viscosity at 140° F. than by penetration at 77° F. Also, it is possible that the complex flow, or shear susceptibility, of these asphalts at 77° F. interferes with the true measurement of consistency. However, regardless of the method of measurement, the important role that mixture design plays in the durability of the contained asphalt is illustrated by figures 2-5.

The discussion heretofore was based on the analysis of only one of the 29 asphalt sources studied. Within-project data from other asphalt sources show similar relations between mixture properties and asphalt durability. The extent of within-project variability varied from project to project but is not included in this report. The relations of void content and voids filled with asphalt of the mixtures with penetration and viscosity of the asphalts recovered from all the pavements are shown in figures 6, 7, and 8.

The relation of void content to penetration of recovered asphalt is shown in figure 6. Plotted points are average values for each of the 53 projects. Although the plot points are

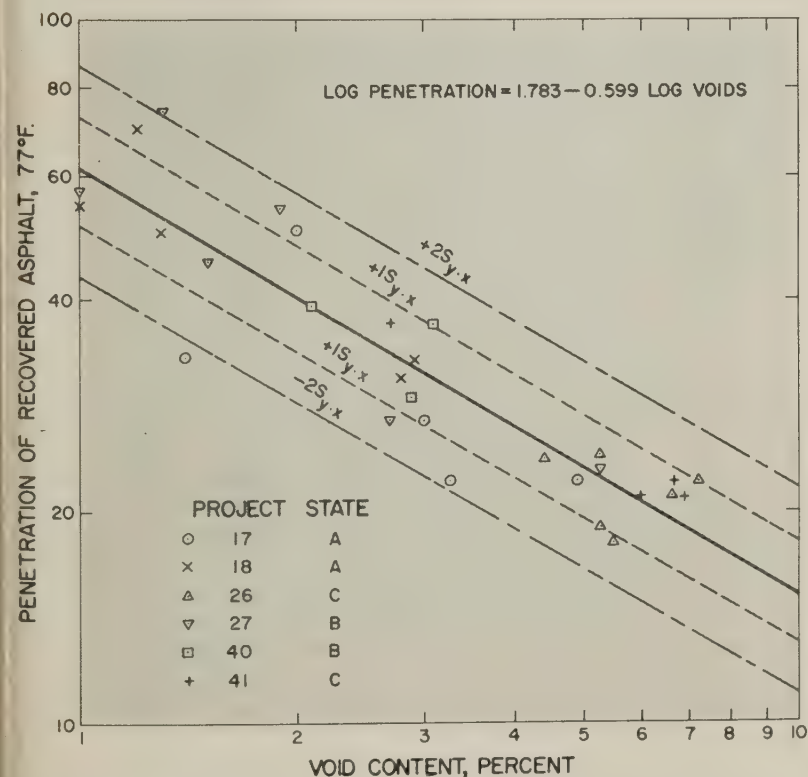


Figure 2.—Effect of void content on penetration of recovered asphalt—AC-7.

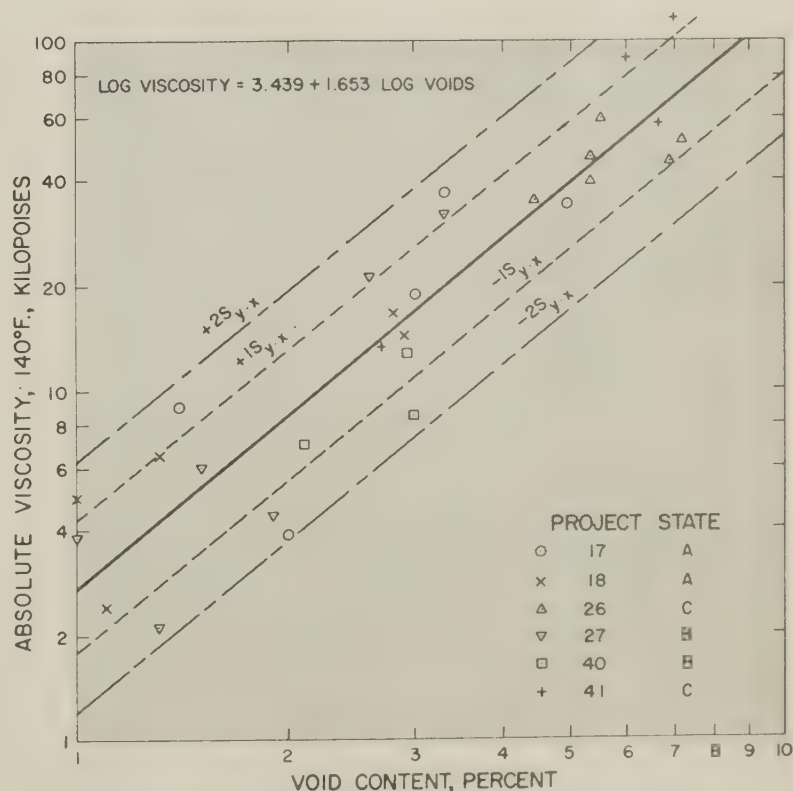


Figure 3.—Effect of void content on viscosity of recovered asphalt—AC-7.

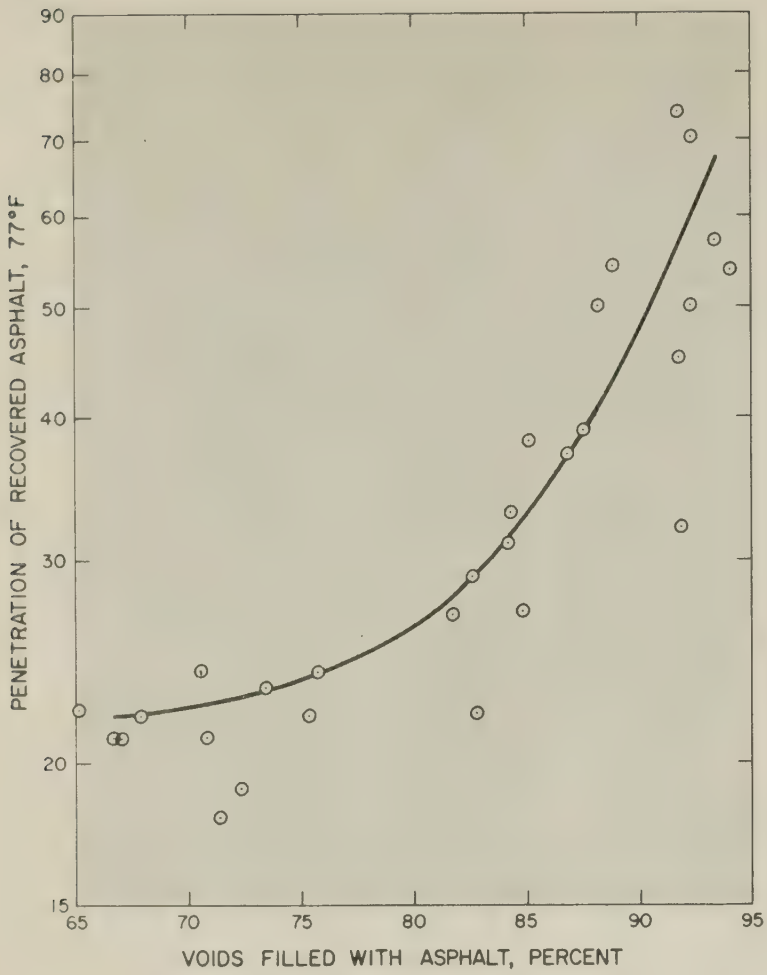


Figure 1.—Effect of voids filled with asphalt on penetration of recovered asphalt—AC-7.

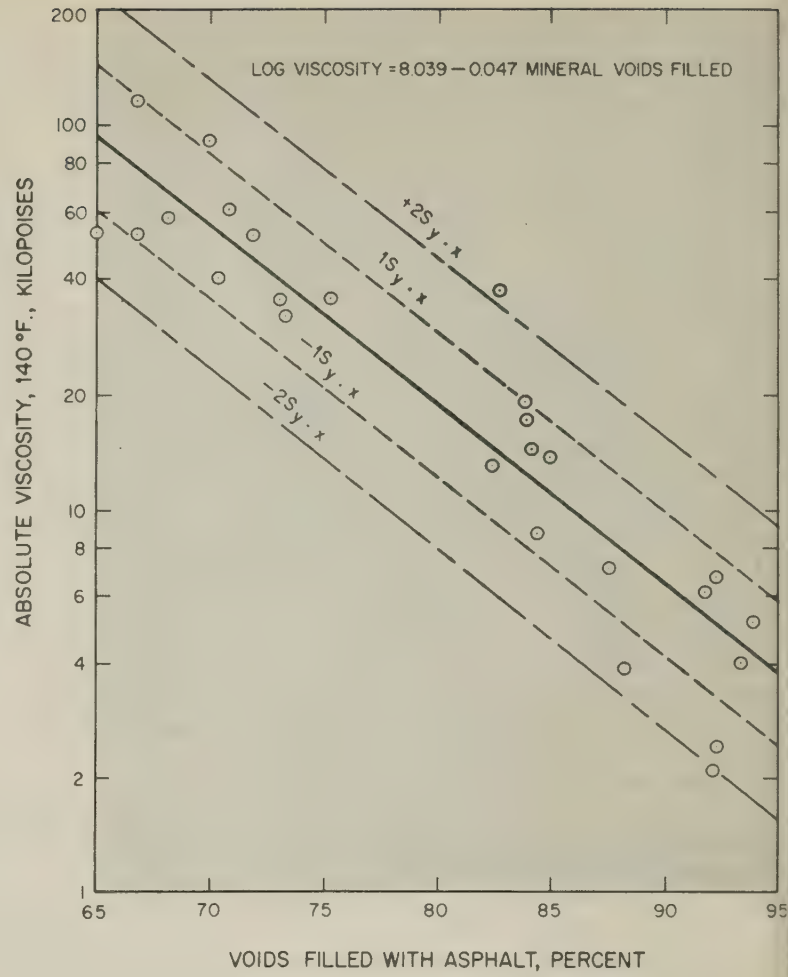


Figure 5.—Effect of voids filled with asphalt on viscosity of recovered asphalt—AC-7.

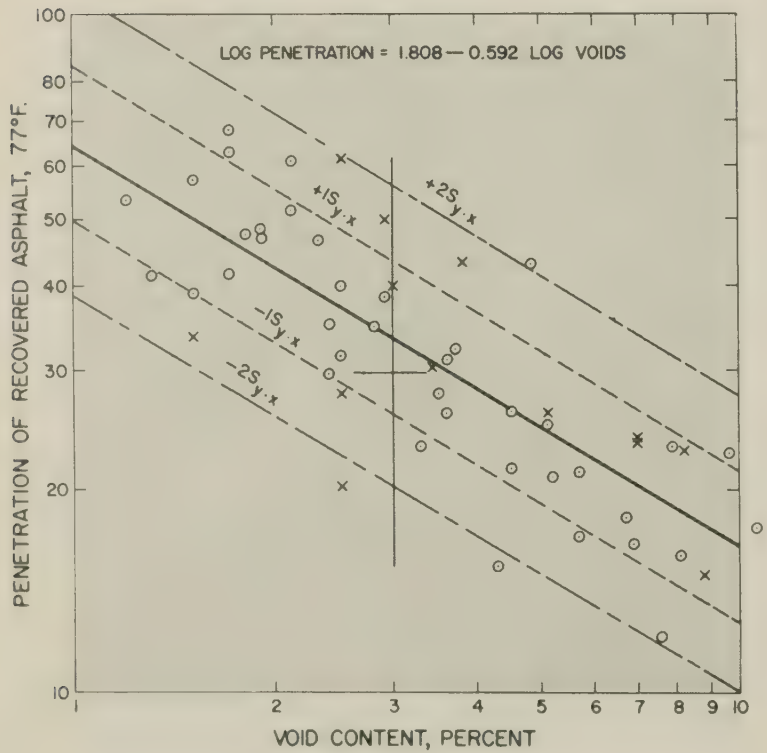


Figure 6.—Effect of void content on penetration of recovered asphalt—averages of projects.

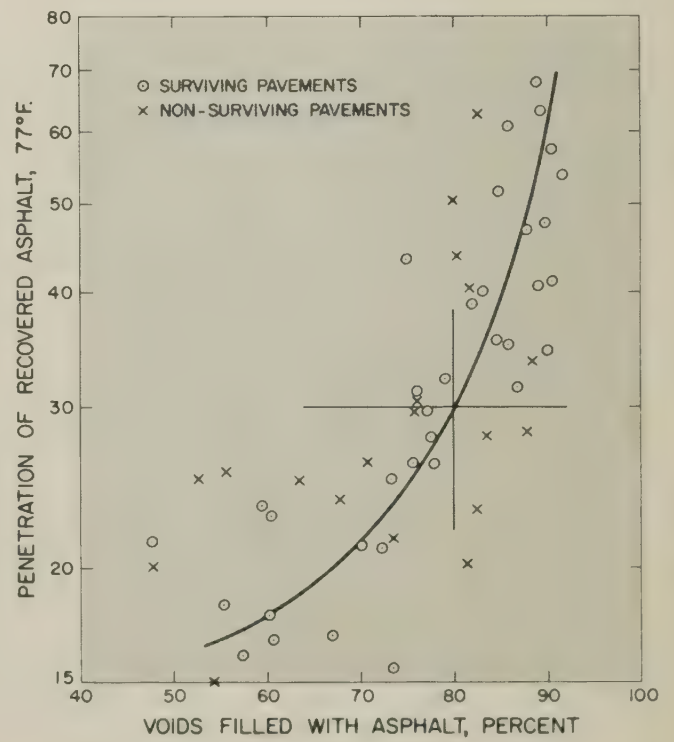


Figure 7.—Effect of voids filled with asphalt on penetration of recovered asphalt—averages of projects.

scattered appreciably, the plot indicates that pavements with no more than 3-percent voids have acceptable levels of hardening. Only three projects having voids of less than 3 percent had penetrations of less than 30. For five projects, the void contents were more than 3 percent and penetrations were above 30.

The relation of voids filled to penetration of recovered asphalt is shown in figure 7. Based on the trend shown by the arbitrarily drawn curve, only four projects with more than 80-percent voids filled had penetrations of less than 30.

The relation of voids filled to viscosity at 140° F. of the recovered asphalt is shown in figure 8. The asphalts from all but two of the projects had viscosities of less than 30 kilopoises when the voids filled were above 80 percent. Only four projects with 70 to 80 percent of the voids filled had asphalt viscosities of less than 30 kilopoises. Moreover, the spread in the results of figures 6, 7, and 8 indicate that factors other than void content and voids filled affected the hardening of the asphalt.

To determine the differences in the durability characteristics of the various asphalts, these data, together with data on such mixture properties as volume of asphalt, mineral voids, surface area, and type of aggregate should be analyzed to determine their contributions to changes in the physical and chemical properties of the asphalts.

Viscosity data were obtained at low temperatures. Eventually, these data also should be analyzed to obtain information on temperature and shear susceptibility of the recovered asphalts and on their changes during service. Such information should determine whether viscosity measurements over a range of temperature can be used more advantageously than conventional penetration, softening point, and ductility tests to analyze performance characteristics of asphalts.

As indicated previously, the following test procedures were included in this report because they have proved suitable for studying the properties of paving mixtures and recovered asphalts. They should provide a guide to other researchers considering similar studies.

Laboratory Test Procedures

Following is a description of the procedures used to determine the physical characteristics of pavement samples, bituminous mixtures, and recovered asphalts. Each test was assigned to the same operator throughout the testing program, thereby eliminating test-result differences caused by individual testing techniques.

Receipt of pavement samples

All samples received from the State highway departments were properly packed; no samples were distorted or broken. Samples were properly identified according to instructions given to the highway departments.

Samples received at the Public Roads research laboratory were logged in, the

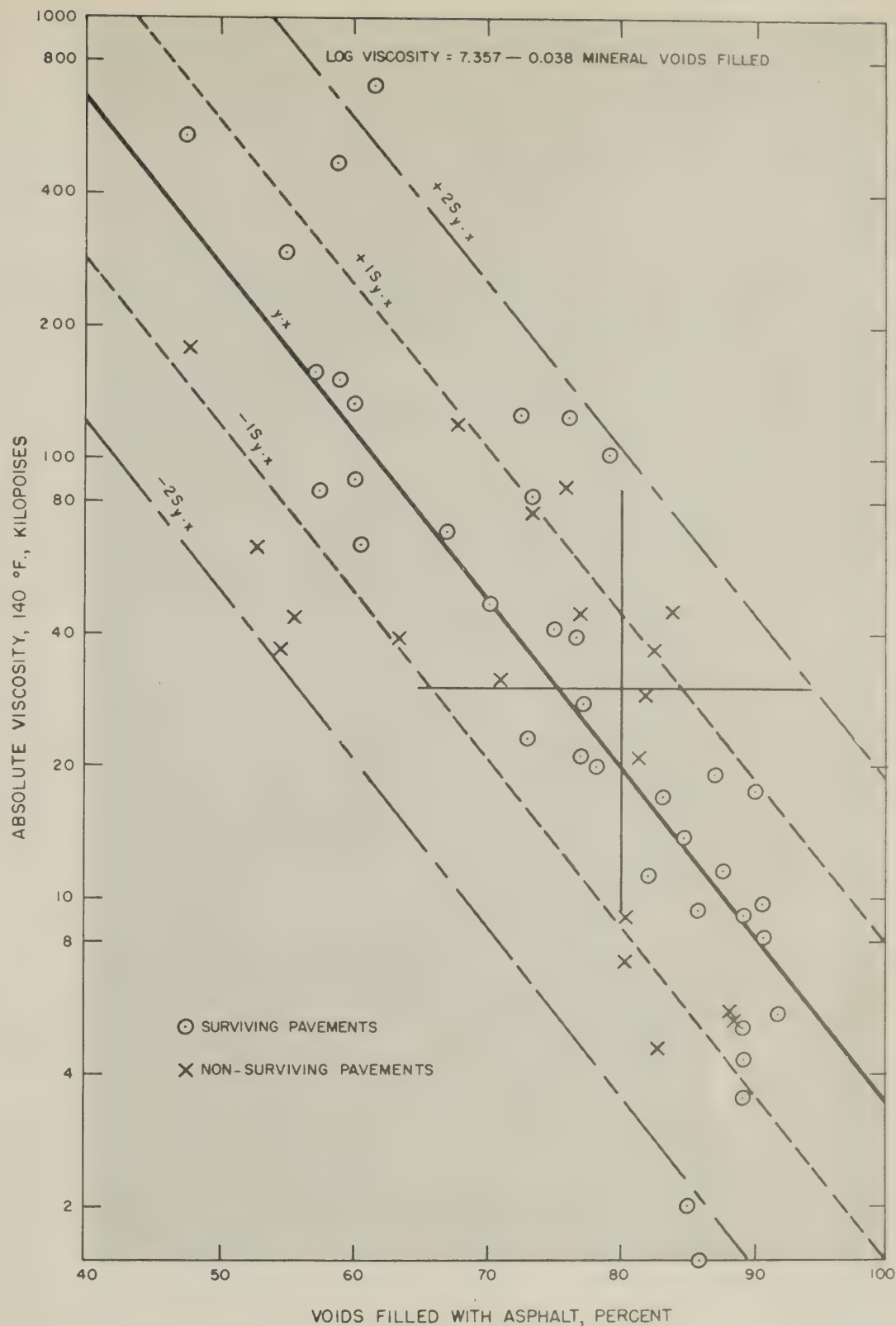


Figure 3.—Effect of voids filled with asphalt on viscosity—averages of projects.

various pavement layers measured, and Polaroid pictures taken to record the type of sample submitted. With few exceptions, the samples contained the underlying asphalt binder or base courses.

Sample preparation

To insure removal of surface contaminants, the top 1/4 inch was removed with a diamond saw. If the test layer had been resurfaced, the overlay plus 1/4 inch of the original surface was removed. With few exceptions, 1 inch of the original surface course from each core or slab was selected for test. The material above

and below the 1-inch layer were stored in the laboratory for future study. Usually, enough pavement samples were processed at one time to permit about four analyses during each working day.

Bulk specific gravity

On each test sample, bulk specific gravity was determined by the water immersion methods described in ASTM D 1075-54, (AASHTO T 165-55). The volume was determined as the difference between the saturated surface-dry weight and the weight of the test sample in water. After immersion in water,

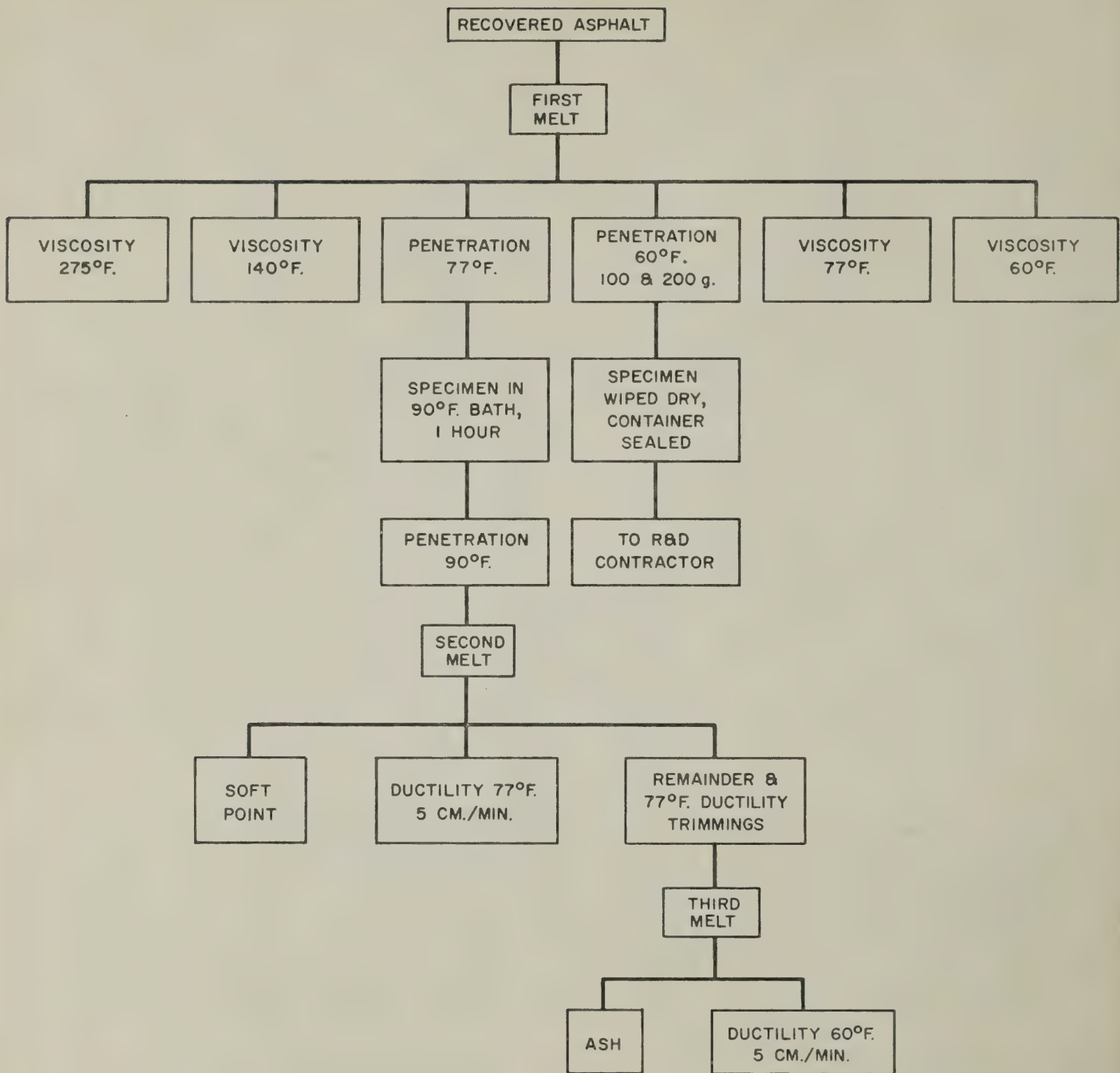


Figure 9.—Testing schedule for recovered asphalts.

the samples were dried for 3 hours in a vacuum oven at 29.8 in. Hg and 115°–120° F. This procedure insured a dry sample with no entrapped water and no additional hardening of asphalt. After cooling, the dry weight of the test sample was determined and the bulk specific gravity calculated.

Enough dried cores from each sample were randomly selected to provide 3,200–4,000 grams of mixture. The cores were placed in a pan and heated by three 250-watt infrared

lamps to a softness that permitted the particles to be separated. After hand mixing in the pan, the broken down samples were split by riffle sample splitter to obtain test samples of 2,000–3,300 grams for extraction and recovery and of about 1,200 grams for the maximum specific gravity test.

Maximum specific gravity

The maximum specific gravity of the mixture was determined by the vacuum saturation

procedure according to the method outlined in ASTM D 2041–64T, (AASHTO T 209–64). A wetting agent was used in the water to facilitate complete wetting of test specimens. Using maximum specific gravity, the average bulk specific gravity of the test specimens and the percentage of asphalt in the mixture were calculated for samples from each site—percentage of air voids, percentage of mineral voids (based on the effective specific gravity of the aggregate), and effective specific gravity of the aggregate.

Sieve analysis

Dried aggregate from the extraction operation was used for sieve analysis, AASHTO T 30-55. The aggregate sample, representing combined material from one site, was washed to loosen material adhering to the larger size aggregate and to remove most of the material passing the 200 sieve by decantation over a No. 200 sieve protected by a 40-mesh sieve. A wetting agent was used in the water. The aggregate sample was oven-dried and then separated on the 1-inch, $\frac{3}{4}$ -inch, $\frac{1}{2}$ -inch, and $\frac{3}{8}$ -inch sieves by handshaking, and on the No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200 sieves by mechanical shaking. The sieve analysis included the amount of fines removed by washing and the ash contained in the recovered asphalt. In addition to the sieve analysis, the surface area of the aggregate was determined using the following formula:

$$\text{Surface area (ft.}^2\text{/lb.)} = 2 + 0.02a + 0.04b + 0.08c + 0.14d + 0.30e + 0.60f + 1.60g$$

Where,

a, b, c, d, e, f, and *g* are percentages of total aggregate passing sieve sizes Nos. 4, 8, 16, 30, 50, 100, 200, respectively. The surface area (S.A.) was corrected to a common basis of specific gravity of aggregate (2.65):

$$\text{Correct S.A.} = \frac{\text{Effective Specific Gravity}}{2.65} \times \text{calculated S.A.}$$

Additional data

The following additional mixture characteristics were calculated from determined values:

- Bitumen index $\times 10^{-3}$ =
 $\frac{\% \text{ asphalt, (aggregate basis)}}{100 \times \text{corrected surface area}}$
- Voids-bitumen index ratio =
 $\frac{\% \text{ air voids}}{\text{bitumen index} \times 10^{-3}}$
- Dust/A.C. ratio =
 $\frac{\% \text{ minus No. 200 sieve}}{\% \text{ A. C., (aggregate basis)}}$
- Film thickness = bitumen index $\times 10^{-3}$
 $\times 4.870$

Where, 4.870 is a factor developed by Campen and others (7).

- Percent mineral voids.
- Hudson \bar{A} value.
- Ratio of aggregate passing No. 8 and No. 200 sieves.
- Ratio of aggregate passing No. 50 and No. 200 sieves.

A petrographic analysis of the coarse and fine fractions of the extracted aggregate was made to determine the classification and type of aggregate used on each project.

Extraction procedure

The test samples obtained as described above were extracted in single 2,000-3,000-gram-capacity centrifuge bowls in accordance with AASHTO T 164-65, Method A using A.C.S. grade benzene. Because the samples

had been vacuum-dried, water determinations were not made.

Immediately after the extraction was completed, 100-ml. aliquot was taken for an ash correction; the asphalt was recovered from the extract by the procedure that follows.

Recovery procedure

The extracts were clarified in a continuous-flow, super centrifuge at 48,000-50,000 r.p.m. and concentrated to about 200 ml. by vacuum distillation under 25-27 in. Hg of vacuum. Check tests of this procedure indicated that the maximum temperature of the residue in the distillation flask was about 180° F.

The concentrates were transferred to 250-ml. wide-mouth extraction flasks and the asphalts recovered in accordance with the procedure described in ASTM D 1856-65, (AASHTO T 170-65). After completing the final distillation, the recovered asphalts were poured into 6-ounce ointment-type cans for testing. Generally, the amount of asphalt obtained in each recovery test was of the order of 70-90 grams, depending on the composition of the mixtures. On the average, about 7 hours were required for four complete extraction and recovery tests.

Tests on recovered asphalts

When available, standard procedures were used for tests on the recovered asphalts. The sequence of the tests and the general handling of the test samples is shown in figure 9.

The following specific procedures were used for the tests:

Viscosity

275° F—ASTM D 2170-65T (AASHTO T 201-65) (Zeitfuchs).

140° F¹—ASTM D 2171-63T (AASHTO T 202-65) (Cannon Manning).

140° F²—ASTM 1968 Book of Standards, part 11, pp. 864-865, sections 6(a) and 6(b).

¹ (For viscosities up to 200 kilopoises).

² (For viscosities 200 kilopoises-1 megapoise).

77 and 60° F—ASTM 1968 Book of Standards, part 11, pp. 839-844, (Controlled Shear Rate Method).

Penetration

ASTM D 5-61 (AASHTO T 49-64):

60° F., 77° F., 90° F.,¹ 100g., 5 seconds.

60° F., 200g., 60 seconds.

¹ 90° F.—test made on 77° F. test specimen after 1 additional hour of conditioning in 90° F. bath.

Softening point

ASTM D 36-64T (AASHTO T 53-64), except that a four-specimen ring holder was used.

Ductility

ASTM D 113-44 (AASHTO T 51-67I), except that one test specimen was used and no adjustment of bath specific gravity was made.

Ash

AASHTO T 111-42, except that residue was not recarbonated, as ignition was controlled at 550-600° C.

Summary

Some of the more obvious findings of a comprehensive study of the durability of asphalt cements subjected to 11 to 13 years of service in pavements has been presented here. The data serve to illustrate the fallacy of judging durability of asphalts from limited pavement samples and without knowledge of mixture properties. The data also confirm or establish the following facts:

- Void contents of asphalt concrete paving mixtures are related to durability of the contained asphalts. Reducing voids to less than 3 percent assures improved asphalt durability during service. However, excessive reductions that promote instability and flushing under traffic should be avoided.

- Voids filled with asphalt have a definite relation to asphalt durability. At least 80-percent voids filled assures more durable asphalt. As for void content, excessive filling should be avoided.

- Factors other than void content and voids filled with asphalt contribute to the lack of asphalt durability.

REFERENCES

(1) *Indexes of vols. 1-26 and vols. 32-36, Proceedings of the Association of Asphalt Paving Technologists* vol. 26, February 1957 and vol. 36, February 1967.

(2) *Characteristics of Bituminous Materials, Highway Research Board Bibliography 35, 1963 and Supplement to Bibliography 35, Highway Research Board Bibliography 40, 1966.*

(3) *Properties of Highway Asphalts—Part I, 85-100 Penetration Grade*, by J. York Welborn and Woodrow J. Halstead, PUBLIC ROADS, A JOURNAL OF HIGHWAY RESEARCH, vol. 30, No. 9, August 1959, and also Proceedings of the Association of Asphalt Paving Technologists, vol. 28, January 1959.

(4) *Properties of Highway Asphalts—Part II, Various Penetration Grades*, by J. York Welborn and Woodrow J. Halstead, PUBLIC ROADS, A JOURNAL OF HIGHWAY RESEARCH, vol. 31, No. 4, October 1960, and also Proceedings of the Association of Asphalt Paving Technologists, vol. 29, January 1960.

(5) *Composition and Changes in Composition of Highway Asphalts, 85-100 Penetration Grade*, by Fritz S. Rostler and Richard M. White, Proceedings of the Association of Asphalt Paving Technologists, vol. 31, pp. 35-89, January 1962.

(6) *Properties of Highway Asphalts—Part III, Influence of Chemical Composition*, by Woodrow J. Halstead, Fritz S. Rostler, and Richard M. White, PUBLIC ROADS, A JOURNAL OF HIGHWAY RESEARCH, vol. 34, No. 2, June 1966.

(7) *The Relationships Between Voids; Surface Area, Film Thickness and Stability in Bituminous Paving Mixtures*, by W. H. Campen, J. R. Smith, L. G. Erickson, and L. R. Mertz, Proceedings of the Association of Asphalt Paving Technologists, vol. 28, pp. 149-178, January 1950.

Fatal Head-On Collisions on The Interstate System, 1968, Caused by Wrong-Way Drivers

Harold R. Hosea, Office of Traffic Operations, Bureau of Public Roads

In studies of fatal accidents on completed sections of the Interstate System in 1967 and 1968,¹ it was disclosed that approximately 5 percent of the crashes were head-on collisions caused by drivers operating their vehicles in the wrong direction. Although not a large proportion of the accidents that occur, these crashes are especially important for two reasons. First, in 1968 for example, they resulted in a higher fatality rate per accident than any other type of collision. The estimated economic loss in fatalities, personal injuries, and property damage for the 1968 wrong-way-driver collisions was \$9.5 million (computed as described on page 219 of the original article¹). Secondly, it was anticipated that the design of the Interstate System, with its fully controlled access and separated opposing lanes, would minimize head-on collisions.

Following an investigation of wrong-way movements on fully controlled access facilities in 1964, a circular memorandum from the Bureau of Public Roads to its regional and division engineers stated this conclusion:

¹ *Fatal Accidents on Completed Sections of the Interstate System, 1968*, PUBLIC ROADS, A JOURNAL OF HIGHWAY RESEARCH, vol. 35, No. 10, October 1969, pp. 217-224.

"... it was hoped that most of the wrong-way movements would tend to solve themselves with time, yet this has not proven to be the case." At the time that this investigation was conducted, 15 percent of the States reported that the problem of wrong-way movements was serious enough to warrant extensive studies to determine remedial steps, particularly with respect to signing.

As suggested in the 1968 study of fatal accidents,¹ the problem continues to be serious, despite improvements in signing and other engineering features. For example, in 1968, 35 States reported at least one fatal accident of the wrong-way type and two reported 16 each. The 1968 study also confirmed a conclusion based on the 1964 investigation that older drivers account for a disproportionate number of wrong-way movements. The median age of drivers responsible for the 1968 wrong-way fatal collisions was approximately 39, compared with a median age of 32 for all fatal accidents on the Interstate System. Drivers 65 years of age and older were responsible for 15.3 percent of the 1968 crashes caused by wrong-way driving; only 5.4 percent of the drivers responsible for all fatal accidents were in this age group.

At least two circumstances seem responsible for the preponderance of older drivers involved in wrong-way accidents. Presumably there tends to be a decrease in alertness with advancing age. More significantly perhaps many older drivers acquired their driving habits prior to the widespread development of freeways and, therefore, may be more prone to make U-turns on a divided highway if they find that they are traveling in the wrong direction or have missed the desired off-ramp. Such maneuvers contribute significantly to wrong-way accidents, although entering freeways by exit ramps is probably the more common violation.

An important factor not considered in the 1964 investigation is the drinking driver. In the 1968 study it was found that 32 percent of the drivers primarily responsible for all fatal accidents whose sobriety was reported had been drinking and that 9 percent were obviously intoxicated. The corresponding percentages for drivers responsible for wrong-way fatal accidents were 74 and 33 percent. The wrong-way drivers reported as drinking were also generally older than those involved in other types of fatal accidents.

State Highway Department Management

(Continued from p. 278)

nance, materials and tests, development, construction, and traffic.

Minnesota

It was recommended that each district engineer in Minnesota be designated chief executive responsible for implementing the highway program in his district. He should have complete freedom of action as long as he operates within the limits of the approved program plans given him for execution. Organization within a district should depend on the size of the district, permitting each supervisor a span of control to enable him to provide adequate supervision of his subordinates. Structuring the plan of organization for the district in accordance with the volume of their engineering and construction work has been done. Benefits are equalization of workloads, improved morale, improved performance in field decisions, increased expertise at district level due to specialization, and establishment of additional career ladders.

Missouri

Each district in Missouri is supervised by a district engineer who can be considered the field counterpart of the chief engineer of the

State highway department. Because the district engineer must devote his time and attention to the general public, as well as to internal operating problems, there should be an assistant district engineer in each district.

South Carolina

The system by which the districts are related to the highway department in South Carolina is described as decentralized administration with centralized controls. To strengthen this arrangement, and free the district engineers of routine matters, thus permitting them to give attention to the general planning, management, and public relations responsibilities, the following personnel assignments in the district organization were proposed: An office manager responsible for accounting, financial records, payrolls, time and attendance, purchasing, inventory and related office services; a traffic engineer, responsible for the normal traffic engineering activities, particularly in the urban districts; and a materials engineer, reporting to the district construction engineer, responsible for the district laboratory and for testing and checking materials.

Texas

The diversity of management plans within a State, even when workloads are of similar proportions, is shown by this finding. In Texas for example, the district laboratory in one district is under the district design engineer in another the assistant district engineer who also supervises accounting and warehousing, whereas the latter functions in the first district cited are assigned to the district maintenance engineer. Such organization patterns tend to emphasize differences between districts similar in other respects, and detract from the effective coordination of highway activities by the headquarters offices. It was suggested that appointments be made to fill given positions rather than shifting functions to fit the ability of the incumbent.

Washington

Relations between the districts in Washington and the headquarters divisions should be clarified. As the districts are not autonomous units, headquarters should establish standards for district operations and the district should be required to operate within the standard-

Conclusions

Highway management personnel will need to keep aware of changing State requirements and expectations of highway users. They must be prepared to manage a larger and ever-expanding program. Highway departments need to have a plan of organization matched to these rapidly changing and developing programs. The changing requirements and expectations must be kept under continuous review in order to provide goals that meet them, provide a source of directed action for the highway department, and provide a cohesive team approach on the part of all elements of geographically widespread departments.

Some States may not require all the organizational units recommended in the States surveyed—or perhaps cannot afford them. However, many of the problems arising in the larger highway organizations also arise in the smaller ones and the recommendations and findings reported may offer a solution when modified to the situation.

REFERENCES

(1) *Financial Management Study*, by Ernst & Ernst, prepared for the Texas Highway Department, Special Report, 1966.

(2) *Management Improvement Program*, conducted by Peat, Marwick, Mitchell & Co. for the State Highway Department of Alabama, February 1964.

(3) *Management Improvement Project*, by Roy Jorgensen & Associates for the Indiana State Highway Commission, 1962-1964.

(4) *Management Research Study*, by Ernst & Ernst for the State of Nebraska Department of Roads, 1967.

(5) *Management Research Study of the South Carolina State Highway Department*, by Highway Management Associates, 1964.

(6) *Management Research Study of the State Highway Department of Georgia*, by Highway Management Associates, 1965.

(7) *Management Study, Missouri State Highway Department*, by Peat, Marwick, Mitchell & Co., 1963.

(8) *Organization and Management Survey*, Department of Highways State of Minnesota, by Peat, Marwick, Mitchell & Co., 1966.

(9) *Report on Management Research Project*, by Booz, Allen & Hamilton, Inc., for Washington State Highway Commission, Department of Highways, 1965.

(10) *Research Study of Administrative Practices and Control Procedures*, by Worden and Risberg for the Virginia Department of Highways, 1965.

(11) *A Study to Improve Management Functions*, by Peat, Marwick, Mitchell & Co., for the Mississippi State Highway Department, 1966.

(12) *State Highway Administrative Organizations*, Highway Research Board Special Report 51, Washington, D.C., 1959.

New Publications

Five new publications by the Bureau of Public Roads may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, prepaid. The following paragraphs give a brief description of each publication and its purchase price.

Reference Guide Outline—Specifications for Aerial Surveys and Mapping by Photogrammetric Methods for Highways

Reference Guide Outline—Specifications for Aerial Surveys and Mapping by Photogrammetric Methods for Highways, revised 1968 (\$1.25 a copy), enables the purchaser and the producer of aerial photography, maps, and other survey data required for highway engineering to know what is needed and what can be furnished to effectively and economically obtain all essential data. This revised Outline incorporates many helpful suggestions from users of previous editions, including various highway engineering organizations and photogrammetric engineering firms.

The National System of Interstate and Defense Highways

The National System of Interstate and Defense Highways, 1969 (15 cents a copy), is a pamphlet with illustrations and a map about the 42,500-mile Interstate and Defense Highway System which, when completed, will connect and serve 90 percent of all cities of over 50,000 population, as well as many smaller cities and towns. The map shows highways open to traffic, major toll roads, and plans for roads not yet under construction.

Standard Plans for Highway Bridges, Vol. III, Timber Bridges

Standard Plans for Highway Bridges, Vol. III, Timber Bridges, May 1969 (75 cents a copy), is a revised edition of the 1962 publication. The plans are intended to serve as a useful guide to State, county, and local highway departments in the development of suitable and economical bridge designs, and to give sufficiently complete information so that they will approach contract drawings as nearly as practicable. For any given bridge location, however, the requirements imposed by site conditions will necessitate modification of the plans, which have been developed for level roadway grades and right-angle crossings only.

Presented in this volume are five series of standard plans for timber bridges as follows: Timber stringers—laminated deck, timber stringers—concrete deck, continuous longitudinal laminated deck, continuous timber-concrete—composite deck, and glued-laminated stringers—laminated deck.

Analysis and Modeling of Relationships Between Accidents and the Geometric and Traffic Characteristics of the Interstate System

Analysis and Modeling of Relationships Between Accidents and the Geometric and Traffic Characteristics of the Interstate System, August 1969 (\$1 a copy), presents the results of a research effort to relate the geometric and traffic characteristics of the Interstate System to the accident experience of the System. Mathematical models were developed for 13 individual unit types, such as outer connec-

tions, loops, and acceleration lanes, and six interchange types, such as diamond, cloverleaf, and trumpet. These models provide a measure of the relation between accidents on Interstate highways and the various geometric and traffic characteristics.

Geometric characteristics studied in this project had very little bearing on the frequency of accidents on the Interstate System. Although there was no warrant for any major changes in geometries, there was evidence that minor changes in geometries would effect some change in the accident rate.

Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects

Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, 1969 (\$3.50 a copy), is patterned largely after the AASHO Guide Specifications for Highway Construction to establish nationwide uniformity and consistency of specifications and contractual matters in highway construction. These specifications are designed to prevent early obsolescence of the specifications and controversy in the administration of contracts, and to encourage increased production and decreased costs consistent with high quality work.

This publication is issued primarily for use in the construction of roads and bridges on Federal highway projects under the direct supervision of the Bureau of Public Roads.

Although the specifications are for those items of work, materials, and construction methods that are generally applicable to direct Federal highway contracts, the information is adaptable for use by other highway agencies.

Highway Research and Development Reports Available From Clearinghouse for Federal Scientific and Technical Information

The following highway research and development reports are available from the Clearinghouse for Federal Scientific and Technical Information, Sills Building, 5285 Port Royal Road, Springfield, Va. 22151. Paper copies are priced at \$3 each and microfiche copies at 60 cents each. To order, send the stock number of each report desired and a check or money order to the Clearinghouse. Prepayment is required.

Highway research and development reports available from the Clearinghouse are also listed by subject in *Public Roads* annual publication Highway Research and Development Studies (see inside back cover) according to the goals and projects of the national program of highway research and development.

Stock No.		Stock No.		Stock No.	
PB 177746	Controlling Drifting Sand Dunes on Cape Cod.	PB 178223	The Determination of the Test Maximum Density with Nuclear Gages.	PB 178508	Effects of Chemical and Mineralogical Properties on the Engineering Characteristics of Arkansas Soils—Franklin County.
PB 177754	Mineral Wear in Relation to Pavement Slipperiness.	PB 178224	A Study of Misaligned Dowels in Concrete Pavements.	PB 178511	Relative Variable Moment of Inertia and Influence Lines for One-Shot Analysis of Three-Span Continuous Highway Bridge Steel Girders in Center-Span Range of 300 to 450 Feet.
PB 177758	Management Research Study of the Delaware State Highway Department.	PB 178226	Developing Traffic Indices for the Detection of High Accident Potential Highways in North Carolina.	PB 178520	Proceeding Program Review Meeting Research and Development of Traffic System.
PB 177759	Load-Carrying Capacity of Minnesota Secondary Flexible Pavements.	PB 178292	The Effect of Flashing Traffic Control Devices on Accident Occurrence.	PB 178537	Model Studies of Energy Dissipators for Large Culverts.
PB 177782	Traffic Systems Reviews and Abstracts—February Issue 1968.	PB 178293	Investigation of Resistance of Concrete to Cracking.	PB 178538	Weathering Test of Reinforced Concrete Slab With Various Depths of Steel—Bridge Deck Deterioration Study.
PB 177813	Ultimate Strength of Rectangular Prestressed Concrete Columns Under Concentric and Eccentric Loadings.	PB 178294	Study of Lime Treated Sections on Road 10-SJ-580, 132.	PB 178789	Report on the Influence of Asphalt Properties on the Behavior of Bituminous Concrete.
PB 177815	Finite Element Analysis of Skew Composite Girder Bridges.	PB 178295	Investigation of Dowel Bar Coatings.	PB 178807	Final Report to the State of New York Department of Public Works Flexible Base Course Performance Study.
PB 177823	Multi-Directional Slip Base for Break-Away Luminaire Supports.	PB 178298	Performance of Channel Changes.	PB 178825	Induced Dynamic Strains in Bridge Structures Due to Random Truck Loadings.
PB 177825	Long-Term Deformation in Clay.	PB 178299	A Study of Lightweight Aggregate Concrete for Prestressed Highway Bridge Girders—Phase III.	PB 178826	The Analytical and Experimental Study of a Simple Girder Slab Bridge.
PB 177831	An Analysis of Right-of-Way Appraisal Problems.	PB 178353	Insulation of Subgrade Third Year Summary.	PB 178848	Coal Hydrogenation Study: Volume I—Final Report.
PB 177838	Traffic Systems Reviews and Abstracts—March Issue 1968.	PB 178355	Analysis of Continuous Box Girder Bridges.	PB 178849	Volume II—Final Report.
PB 177875	Moisture Response of Soils.	PB 178356	Review of Literature on Air-Entrained Concrete.	PB 178850	Volume III—Final Report.
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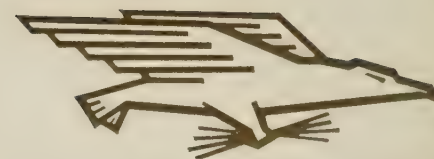
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