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REPORT TO THE CONGRESS

Problems Resulting From
Deterioration Of Pavement' On
The Interstate Highway System
Federal Highway' Administration / *End title*
Department Of Transportation *here*
B-164497

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

~~715078~~ JUNE 30, 1970
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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D C 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on problems resulting from deterioration of pavement on the Interstate Highway System. The Federal Highway Administration, an agency of the Department of Transportation, is responsible for administering the interstate highway program.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Bureau of the Budget; the Secretary of Transportation; and the Administrator, Federal Highway Administration.

A handwritten signature in cursive script that reads "James B. Stacks".

Comptroller General
of the United States

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ABBREVIATIONS

AASHO American Association of State Highway Officials

FAI Federal-aid-interstate

FHWA Federal Highway Administration

GAO General Accounting Office

D I G E S T

WHY THE REVIEW WAS MADE

The Federal-Aid Highway Act of 1956 authorized construction of the Interstate Highway System and made Federal funds available to the States on a 90-10 participating basis (90 percent Federal) for construction of the system.

The 1956 act provided that highways be designed to carry the types and volumes of traffic forecast for the year 1975. A 1963 amendment to the act eliminated reference to the year 1975 and provided that highways be designed to carry the types and volumes of traffic forecast for 20 years from the date of approval.

In January 1967, the Federal Highway Administration directed that a re-evaluation be made of those sections of pavements authorized for construction prior to October 24, 1963 (the date of the 1963 amendment to the act), and authorized placement of an added layer of pavement (called overlay) where it was determined that the existing pavement, with normal maintenance, would not provide adequate performance for 20 years. The estimated costs of such overlays as of 1968 were \$200 million. (See p. 9.)

During a review of the 1968 estimate of the cost to complete the Interstate System, the General Accounting Office (GAO) noted that.

--A substantial number of such overlays had been programmed for placement.

--Overlays, although considered by the Federal Highway Administration to be new construction, appeared to relieve the States of some of their responsibility for maintaining the completed segments of the Interstate System.

GAO undertook this review to determine the nature and magnitude of the overlay program and the relationship between the overlay program and the statutory responsibility of the States to maintain, at their expense, completed segments of the Interstate System.

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FINDINGS AND CONCLUSIONS

As of January 1, 1970, about 70 percent of the 42,500-mile system was open to traffic, 11 percent was under construction, 15 percent was in the process of engineering and right-of-way activities, and 4 percent was in a preliminary status. About \$39 billion of Federal-aid funds have been obligated for interstate highway projects.

GAO's review of the overlay program in nine States showed that:

- The overlay program provided for extending the design period to 20 years for previously completed segments of the Interstate System that were initially designed to carry traffic for the year 1975. Since it is unclear whether the Congress intended that interstate highway funds be used to extend the design period of these segments, GAO concluded that the nature and magnitude of this program should be presented fully to the Congress. (See ch. 2.)
- The overlay program thus far had been applied only to certain segments of interstate highways authorized prior to October 24, 1963.
- There would be a continuing need for periodic overlays of the Interstate System, a need that would increase with the passage of time and with the expected increases in weights and volumes of traffic.
- The cost of overlays for the entire Interstate System would vastly exceed the 1968 cost estimate. (See ch. 2.)
- Although maintenance of the Interstate System was, by law, the responsibility of the States, overlays relieved States of their responsibility to maintain smooth and safe riding surfaces. (See p. 27.)
- There were significant differences among the States in (1) the methods used for evaluating the condition of the highway surface to determine whether an overlay was necessary and (2) the design procedures used to establish the amount of overlay needed. (See ch. 4.)
- There was a need for more precise procedures to ensure that overlays are placed at the proper times and at depths needed to provide necessary serviceability.

RECOMMENDATIONS OR SUGGESTIONS

The Secretary of Transportation should require the Federal Highway Administration to:

- Establish maintenance standards that define a State's maintenance responsibility and recognize (1) that overlays are required from time to time to provide a safe and efficient riding surface and

(2) such overlays represent normal maintenance and, as such, the costs should be borne by the State. (See p. 39.)

- Require that, when overlays are necessary to add structural strength to existing pavements, the costs of the portions of the overlays which would otherwise be required to provide new riding surfaces be classified as State maintenance responsibilities. (See p. 39.)
- Amend its regulations to require uniform application of overlay standards by taking positive action to improve the pavement rating system to achieve optimum use of the existing pavement and by establishing design methods which will provide greater assurance that a State is applying the proper amount of overlay to serve the design period. (See p. 52.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

The Assistant Secretary for Administration, Department of Transportation, advised GAO that the Department did not concur in the need for the actions proposed. He also questioned the need to report this matter to the Congress, because he believed that (1) the overlay program was a long-standing program which was well known to the Congress and (2) the Congress had acquiesced in the Federal Highway Administration's interpretation of the statutes.

The Assistant Secretary's comments are included as appendix II and are discussed in the appropriate chapters of this report.

Although not all the nine States commented specifically on each of the issues discussed in this report, there was general agreement with GAO's views that there would be a substantial future need for overlays, that the need would not be restricted to highway segments authorized before October 24, 1963, and that improvements were needed in the methods used for determining overlay requirements.

With regard to the relationship of overlays to the maintenance responsibilities of the States, the States' comments were too diverse to indicate general agreement or disagreement with GAO's views. Comments by officials of the nine States are discussed in the appropriate chapters of the report and are included as appendixes III to XI.

MATTERS FOR CONSIDERATION BY THE CONGRESS

This report is being submitted to the Congress to present the nature and magnitude of the overlay program. The Congress may wish to consider the long-term need for overlays in its deliberations on the funding of the Interstate System, any future expansion thereof, or any

follow-on highway program. The Congress may wish also to express its intent relative to the use of interstate funds for overlaying completed highway segments.

GAO wishes to present its views to the Congress on the administration of the program with regard to the need for the Federal Highway Administration to:

- Establish maintenance standards for the Interstate System.
- Recognize that overlays relieve a State of a portion of its maintenance responsibilities.
- Amend its regulations to establish a uniform method for determining overlay requirements.

CHAPTER 1

INTRODUCTION

The General Accounting Office has reviewed the program of the Federal Highway Administration (FHWA) for upgrading completed sections of the National System of Interstate and Defense Highways (the Interstate System). This program involves overlaying (i.e., applying an additional layer of pavement) sections of highways which were previously considered to have been completed but which showed evidence of deterioration or inability to carry the existing or future traffic in a safe and efficient manner.¹

The purpose of our review was to inquire into the magnitude and nature of the overlay program, its effect on the funding of the Interstate System, and the relationship between the program and the statutory responsibility of the States to maintain the Interstate System. We did not determine the precise causes for the deterioration of the highway segments that have been or will be overlaid or whether such overlays will solve future deterioration problems on these segments. The scope of our review is described in chapter 5.

FHWA, an agency of the Department of Transportation, is the principal agency of the Federal Government in matters relating to highways. One of its most important functions is the administration of the Federal-aid highway program. Under this program, Federal funds are made available

¹Additional layers of pavement are also used when such layers are planned to be put down during one or more stages in the life of a highway; the additional layers placed as a part of stage construction ultimately provide the total strength called for in the original design. The overlays discussed in this report are considered necessary to correct unexpected failures in pavements that were previously considered to have been completed. (See p. 14 for a discussion of stage construction.)

to all States, the District of Columbia, and Puerto Rico to finance the construction of highways on the interstate, primary, and secondary Federal-aid highway systems.

The Interstate System was authorized in the Federal-Aid Highway Act of 1944. This act authorized a 40,000-mile system. The mileage was subsequently increased to the presently authorized 42,500 miles. State highway departments are responsible for (1) route selection, (2) preparation of surveys, plans, specifications, and estimates for highway projects, (3) acquisition of rights-of-way, and (4) actual construction. They are responsible also for maintaining projects constructed under provision of Federal highway acts. FHWA is responsible for approving the States' plans, specifications, and cost estimates for interstate projects to ensure compliance with the standards for the Interstate System.

The Federal-Aid Highway Act of 1956 declared that the early completion of the Interstate System was one of the most important objectives of the act. The act specified that the system be constructed to standards adequate to serve the types and volumes of traffic estimated for 1975. The October 24, 1963, amendment to the Federal-Aid Highway Act eliminated reference to the 1975 design year and required that future interstate highways be designed to standards adequate to accommodate the types and volumes of traffic anticipated 20 years from the date of project authorization.

Some sections of the Interstate System that were authorized to be constructed before the 1963 amendment was enacted have evidenced deterioration and an inability to accommodate the types and volumes of present traffic and the traffic expected by the design year (1975) in a safe and efficient manner. As a result, these sections have been classified by the States and FHWA as being below minimum standards and in need of additional construction. Overlays of asphalt concrete (flexible pavement) that add structural strength to the existing pavement are being provided to meet this need. FHWA established a policy which provides that overlays have a total minimum thickness of 1-1/2 inches to add sufficient structural strength to be eligible for Federal-aid-interstate (FAI) participation.

As of December 31, 1969, about 70 percent of the 42,500-mile system was open to traffic, 11 percent was under construction, 15 percent was in the process of engineering or right-of-way activities, and about 4 percent was in a preliminary status. Since 1956 the States have obligated about \$39 billion of FAI funds for Interstate System projects.

The Federal share of the cost of constructing Interstate System projects is 90 percent plus an additional allowance, not to exceed 5 percent, in those States having large areas of public land. Overlays that are considered by FHWA to be eligible for FAI participation are funded at the same ratio as the original construction. The estimated total cost of the Interstate System was shown in the 1968 cost estimate--submitted by the Secretary of Transportation to the Congress--to be about \$56.5 billion and the Federal participation to be about \$50.6 billion. This cost estimate included \$200 million for overlays on about 2,800 miles of completed interstate highways.¹

On November 3, 1969, we provided the Secretary of Transportation with a draft of this report for review and comment. A reply was provided on March 24, 1970, by letter from the Assistant Secretary for Administration. This letter is included as appendix II. The Assistant Secretary also provided us with copies of the comments by the highway

¹On April 20, 1970, the Secretary of Transportation submitted to the Congress a revised estimate of the total cost of the Interstate System. The new estimate shows the total costs to be about \$69.9 billion and the Federal participation to be about \$62.5 billion. Regarding overlays, the Secretary's report states: "Included in the costs to complete the Interstate System is an item of \$175 million covering the extra stage of pavement structure required on earlier opened sections of the system to adequately accommodate design year traffic."

departments of the States of Arizona, Colorado, Maine, New Mexico, Oregon, Texas, Vermont, Washington, and Wyoming. These comments are included as appendixes III to XI. The comments of the Department of Transportation and the State highway departments are discussed in the appropriate chapters of this report.

CHAPTER 2

FHWA'S IMPLEMENTATION OF PROGRAM

TO PROVIDE ADDITIONAL PAVEMENT ON

COMPLETED SEGMENTS OF THE INTERSTATE SYSTEM

Our review showed that certain completed segments of the Interstate System had deteriorated to the extent that they were considered by the States and FHWA to be structurally inadequate to safely accommodate the types and volumes of existing traffic and traffic expected by the design year. As a result, FHWA initiated a program which allows a State to correct such inadequacies by placing an additional layer of pavement (overlay) on existing highways to add structural strength beyond that provided for in the original highway design. FAI funds are used to reimburse the States for 90 percent of the cost of the overlays.

FHWA's overlay program applies only to certain segments of interstate highways authorized for construction prior to October 24, 1963, the date of enactment of the 1963 amendment to the Federal-Aid Highway Act. The 1968 cost estimate submitted to the Congress showed \$200 million for overlaying 2,800 miles of interstate highways.

Basic design problems in highway construction have not been completely resolved, however, and it is likely that deterioration problems will occur in other segments of the highways regardless of when the highways were authorized. Therefore it seems to us that, in order for the Interstate System to safely and effectively accommodate the traffic expected for a 20-year period, overlays for the Interstate System will be needed that will cost vastly in excess of the \$200 million set forth in the 1968 cost estimate submitted to the Congress. Further, we believe that the need for overlays will increase with the passage of time and with the expected increases in weights and volumes of traffic.

Accordingly, we believe that the Congress may wish to consider specifically the long-term needs for overlays on

the Interstate System in its deliberations on the funding of the Interstate System, any future expansion thereof, or any follow-on highway program.

CIRCUMSTANCES LEADING TO THE OVERLAY PROGRAM

FAI funds are subject to limitations not imposed on other Federal-aid highway funds, principally because the legislation authorizing the Interstate System envisioned a new concept in the Federal-aid highway program--Federal participation in the initial construction costs of a limited-mileage highway system to be completed by a certain time and then turned over to the States for maintenance. Although the Interstate System is part of the Federal-aid primary system,¹ the concepts of the systems differ in that there is no provision for completion of the primary system. Federal and State funds can be used on a 50-50 ratio for constructing new primary highways or for reconstructing any sections of the primary system--including the Interstate System--but FAI funds cannot be used to reconstruct segments of the Interstate System.

The interstate highway construction program, which began in 1956, was based on the legal requirement that the highways be constructed to accommodate the types and volumes of traffic estimated for 1975. The interstate segments constructed early in the program were designed primarily on the basis of experience gained by the States in their previous highway construction activities. In 1963, the Congress, by amending section 109 (b) of title 23 of the United States Code, eliminated reference to 1975 as the design year.

In approving the 1963 amendments, the Congress recognized that the fixed 1975 design year requirement was not desirable because, with the passage of time, the application

¹A highway network of about 250,000 miles comprised of city-to-city, interstate, and intrastate highways serving essentially through traffic. Federal-aid funds are made available to all the States for use on the primary systems.

of such a design year on newly constructed highways would restrict the designed life of such highways to periods of considerably less than 20 years. The amendments required that future interstate highways be designed and constructed to accommodate the types and volumes of traffic forecast for 20 years after approval of plans for a highway. The legislative history of the 1963 act, however, is not clear as to whether the Congress intended that FAI funds be used to upgrade, to a 20-year design period, highway segments constructed or under construction at the time the amendment was enacted.

In 1967 FHWA instituted a program to evaluate those interstate segments which were authorized for construction prior to the date of enactment of the 1963 amendment. The objective of this program was to provide overlays to upgrade those highway segments on which signs of deterioration indicated the need for additional pavement to provide adequate serviceability for a 20-year design life.

FHWA requested the States to examine existing Interstate System highway segments to determine which segments needed overlays. In setting forth the conditions under which overlays could be financed with FAI funds, FHWA stated that projects authorized prior to October 24, 1963, and constructed to their ultimate design were eligible for consideration under this program.

DESIGN FACTORS CONTRIBUTING
TO THE OVERLAY PROGRAM

It is our understanding that the deterioration experienced on the highway sections needing overlays can generally be attributed to inadequate design or inadequate construction practices. Although FHWA has not determined the precise factors which caused the deterioration of the highway segments that were overlaid, FHWA officials informed us that they assumed that the basic cause was inadequate design. FHWA has taken the position that the deterioration of a highway before its design year is reached is evidence that its original design was inadequate. State and FHWA officials informed us that inadequate design generally involved the misjudgment of critical factors, such as soil support and material values, weather conditions, and the volume and weight of heavy truck traffic.

FHWA and State personnel expressed the opinion that the segments in need of overlays were underdesigned, primarily because the state of the art had not yet reached the point where adequate consideration was given to the design factors enumerated above. They informed us that deterioration in pavement would occur more rapidly than normal if any of these factors were not given appropriate consideration in the initial design and that, when these structures were initially designed, testing procedures and experience had not progressed to the point where accurate values could be assigned to these factors.

With regard to measuring and forecasting the volume and weight of truck traffic, which is one of the crucial factors to be considered in highway design, current procedures--based on guidelines prepared by the American Association of State Highway Officials (AASHO)--relate the structural requirements for a highway to the number of repetitions of 18,000 pounds of weight on a single axle which will be applied to a highway during its life--the greater the number of repetitions, the greater the structural requirements of the highway.

The following example indicates the various design factors involved in a specific overlay project.

A project in Oregon, which was completed in 1962, was constructed with 4 inches of asphalt on top of 16 inches of crushed-rock base. Prior to being overlaid in 1968, the highway was badly cracked and rutted; both the State and FHWA believed that the highway would not provide adequate service until 1975 without an overlay. We were advised by State officials that their current design procedures had been refined to reflect improved knowledge of material strengths and to incorporate more scientific information on truck traffic, such as estimates based on actual counts, forecasts of traffic increases, and consideration of axle loads. According to State officials, a thicker pavement structure would have been designed if these factors had been known and considered in the original design.

The use of new design techniques and construction practices have been sought, tested, and adopted during the interstate program. Changes in the state of the art of highway design, however, have come about gradually, partially as a result of the AASHO road tests conducted in Illinois and completed in 1962 and partially from studies and testing programs carried on by States, universities, and the construction industry. State officials informed us that, although current design techniques should improve the quality of highways, it would take some time to determine whether design techniques currently employed would eliminate the problems encountered in the past.

Compounding the problems is the fact that geological, climatic, and other conditions differ among the States. The results of AASHO road tests are used as guides by the States but are generally modified on the basis of conditions in a State or on the judgment of State highway engineers. Thus, because of such factors, any improvements in the state of the art relative to highway design would not necessarily be applicable, in whole or in part, to all States.

The overlay program applies only to highway segments authorized prior to October 24, 1963. It should be noted, however, that changes in design and construction practices have been gradual and that no dramatic changes occurred in 1963 or any time thereafter. FHWA officials informed us that it was unlikely that a flexible-pavement highway could be so constructed that it would not need one or more overlays during the design period. Thus segments authorized subsequent to October 24, 1963 will, in all probability, require overlays before their design years are reached.

STAGE CONSTRUCTION AS RELATED TO THE OVERLAY PROGRAM

Certain States constructed their flexible-pavement interstate highways to ultimate design by providing, in the initial construction, the total surface-course thickness estimated to be required for the design period. Certain other States constructed their interstate highways in stages--the base and subbase were constructed to ultimate requirements, but the surface layer of asphaltic concrete was placed in stages. Thus, if a design calls for a total of 5 inches of asphaltic concrete as the surface course, the State, under stage construction procedures, might place 3 inches during the original construction and 2 inches at a later date. Under ultimate design procedures, all 5 inches of asphaltic concrete would be placed at once.

We were informed by various State and FHWA officials that the use of stage construction had certain advantages over construction to ultimate design in that (1) more mileage could be opened to traffic at an early date because initial costs were lower and (2) the soil beneath the pavement was given time to settle and the resulting distortions in the pavement structure could be leveled out during application of the second stage.

We found that, when unanticipated distress was observed in stage construction projects, a new design

analysis¹ was made to determine whether the need existed for a thicker second stage than originally planned. When justified on the basis that additional structural strength is needed, the thickness of the second stage is increased.

In Colorado we were informed that the thickness of the second stage, as planned during the original design, generally had been adequate.

In New Mexico FHWA and State officials informed us that the second stage planned but not yet placed on interstate segments in that State generally would be adequate. They pointed out, however, that the condition of about 35 miles of highway indicated that some work might be necessary in addition to that planned for the second stage of construction.

Wyoming State officials advised us that the second stage would enable them to correct many of the problems resulting from settlement. An FHWA official informed us that, in his opinion, some of the projects would require additional thicknesses to those anticipated in the original designs.

We were informed by State of Washington officials that they followed the concept of stage construction and generally anticipated applying the second stage about 10 years after initial construction. They expressed the belief that flexible pavements could not be designed to last 20 years without overlays. On the basis of their experience, they believed that an additional layer of about 4 inches of pavement would be necessary at the end of about 10 years. The State determines the precise amount and timing of the second stage when the existing pavement shows that additional construction is necessary.

¹The procedure used to (1) establish the structural value of the existing pavement, (2) assess the serviceability of the existing pavement, (3) establish the need for, and amount of work necessary to provide, adequate serviceability.

State officials in Oregon advised us that stage construction provided an opportunity to correct distortions caused by settlement. They stated that the second stage should be applied about 5 years after initial construction.

Although officials in the States using stage construction appeared to be enthusiastic about the advantages of stage construction, certain of these States (Colorado, New Mexico and Oregon) had discontinued the use of stage construction because (1) they were uncertain as to the continuation of the interstate program and the availability of FAI funds when the second stage would be required and (2) they did not believe that full benefits could be realized from the first stage by placing the second stage prior to the scheduled termination date of the interstate program (1974).

It appears likely, therefore, that the need for overlays will increase as States discontinue the use of stage construction of flexible pavements. Moreover, even in those States that use such stage construction, the thickness of the second stage which exceeds that originally planned is similar to the additional thickness realized through the use of overlays. The cost of such additional thicknesses were not included, however, in the \$200 million estimate for the overlay program.

OVERLAYS OF RIGID PAVEMENTS

Although the overlay program was initiated primarily for flexible-pavement highways, we noted that problems had been encountered on portland cement concrete (rigid) pavements. At December 31, 1963, 8,718 miles of rigid-pavement interstate highways were open to traffic. The 1968 cost estimate included costs for overlays on 739 miles of rigid pavements. During our review, we found that the problems associated with rigid pavements needing overlays included bad cracks and joints and inadequate base structures, which resulted in unacceptable riding surfaces. Solutions to these problems are not clear-cut, because overlays of flexible pavement on top of the rigid pavements do not always solve the problems. The cracks and rough joints are sometimes transmitted through the overlays. To prevent the roughness from reoccurring, reconstruction sometimes is necessary; in other cases stabilization of the base is needed.

FHWA officials informed us that their experience had shown that, although flexible pavements required resurfacing after about 10 years, rigid pavements were expected to last 25 years before resurfacing was required. When rigid-pavement segments evidence distress and inability to carry traffic for the 20-year period, however, some additional work is necessary to keep these sections in acceptable condition. We noted that several overlays over rigid pavement had been placed in Texas with tentative FHWA approval for FAI participation. One of the projects is discussed below.

In September 1967, FHWA approved the State's plans, specifications, and estimate for overlaying a 6.5-mile segment of Interstate Route 45 with from 1 to 3 inches of flexible pavement. The initial pavement, constructed in 1958, consisted of 11 inches of unreinforced concrete. The justification for the overlay was that the joints had deteriorated and were spalling and that the riding surface was considered to be rough. FHWA records show that there had been no deficiency in the structural capacity of the pavement but that the problems had been caused by poor design of the base and joints.

The overlay was completed in April 1968 at a total cost of \$349,000, of which \$336,000 was tentatively considered by FHWA to be eligible for FAI participation. At the time of our review, the State had been reimbursed by FHWA for \$290,000 of the \$297,000 it had claimed. We were advised that, in the event that the project was not finally approved, the amount of FAI funds already paid the State would be deducted from the billings for other FAI projects.

Final approval of this project for FAI participation depends on whether the State can provide FHWA with an acceptable design analysis which demonstrates that a sufficient amount of structural strength was added by the overlay to justify expenditure of FAI funds. For this project, the depth of the overlay was based on engineering judgment rather than on a design analysis.

Although the deterioration problems relative to rigid pavements will have to be corrected, it is not clear as to whether overlays used to correct such problems should be financed with FAI funds. FHWA's policies require that, for an overlay to be eligible for FAI funding, the deteriorated pavement show a need for additional structural strength and that a design analysis show that the overlay will provide the needed structural strength. We were informed by FHWA officials, however, that there was no known method of measuring whether additional structural strength was provided by adding a flexible overlay to rigid pavement.

SCOPE OF THE OVERLAY PROGRAM

The following table shows the miles and types of pavements of the Interstate System in place as of December 31, 1963, and June 30, 1969, and those proposed to complete the system.

Miles and types of interstate pavement

	<u>Rigid pavement</u>	<u>Flexible pavement</u>	<u>Other</u>	<u>Total</u>
Constructed prior to December 31, 1963	8,717	6,713	66	15,496
Constructed between December 30, 1963, and June 30, 1969	<u>7,544</u>	<u>5,063</u>	<u>110</u>	<u>12,717</u>
Total constructed at June 30, 1969	16,261	11,776	176 ^a	28,213
Proposed for construction after June 30, 1969	<u>7,234</u>	<u>5,533</u>	<u>1,520^b</u>	<u>14,287</u>
Total Interstate System constructed or proposed	<u>23,495</u>	<u>17,309</u>	<u>1,696</u>	<u>42,500</u>

^aCombined flexible and rigid--one lane or set of lanes flexible and one rigid.

^bSurface not yet determined.

Although the Interstate System is generally considered to be a system of highways designed and constructed to carry traffic for a 20-year period, the state of the art in highway design and construction had not progressed to the point, in the early years of the program, where it would provide for 20-year highways without substantial additional construction. In 1967, when the States reviewed the flexible pavement that had been authorized for construction prior to October 1963 for the purpose of preparing the 1968 cost estimate, it was determined that 2,044 miles of pavement were in a deteriorated condition and would require overlays. Precise information as to the total mileage of flexible highways authorized for construction prior to October 1963, was not available at FHWA headquarters. As shown in the above table, however, 6,713 miles of flexible-pavement highway had been constructed at December 31, 1963.

It is generally accepted by highway engineers that both flexible and rigid pavement periodically require overlays to remedy deterioration. State and FHWA officials informed us that flexible pavements required an overlay about every 10 to 12 years, whereas rigid pavements may last 25 years before requiring overlays. As discussed earlier, changes in the state of the art in pavement design have come about gradually over a period of time as a result of research and experience. Although FHWA and State officials expressed to us their belief that these changes had improved the quality of highways, they told us that they still could not be assured that current designs would eliminate past problems. We were informed that the design process had not yet been refined to cope with all the variables encountered in designing an adequate pavement.

The overlay costs of \$200 million included in the 1968 cost estimate related only to those highway segments authorized before October 24, 1963, for construction to ultimate design that showed signs of distress when the estimate was prepared in 1967. Because problems in pavement design have not been resolved and because the October 1963 date does not represent a dramatic breakthrough in providing for improvements in pavement design, it appears to us that the need for overlays will not be restricted to highway segments authorized before October 24, 1963, and that a significant amount of the interstate mileage constructed after 1963 will also require overlays before the end of the 20-year design periods.

In responding to questions raised during our review, the Federal Highway Administrator told us that:

"The Bureau of Public Roads has taken a conservative position in the evaluation of pavement structure designs proposed by the State highway departments, and has selected a middle area above what would be a gross underdesign and below what could be termed a gross overdesign. When however, in actual service it is established that the initial pavement structure construction will not be satisfactory for the design year, additional construction is approved and authorized for participation with Federal-aid funds."

Thus FHWA has taken the position that whenever existing interstate highway segments do not provide the serviceability initially anticipated and additional pavement construction work is required to remedy deterioration and upgrade the highway, such work will be authorized with FAI participation.

AGENCY COMMENTS

In commenting on our draft report, the Assistant Secretary for Administration, Department of Transportation, did not comment on the long-term effect of deterioration of highway segments and the continuing need for overlays. He stated that (1) since there was no legal prohibition against the program and since the Congress had acquiesced in FHWA's long-standing administrative interpretation of the appropriate statutes, the Department believed that our referral of matter to the Congress was "superfluous" and (2) the substance of the overlay program and its scope were formalized on January 11, 1962, in Instructional Memorandum 21-1-62, which was well known to the Congress.

Although there is no legal prohibition against the application of the 20-year design period to highway segments approved before October 24, 1963, for construction, it is not clear from the legislative history of the 1963 amendment that the Congress intended that FAI funds be used for additional construction to extend the design period on projects constructed or under construction at the time the amendment was enacted.

The Department considers the overlay program to be similar to stage construction authorized by the 1962 memorandum. There is, however, a fundamental difference between planned stage construction pursuant to the 1962 memorandum and the overlay program. The States, with FHWA approval, plan stage construction for specific highway segments in advance, and the cost estimates for such segments reflect the total estimated cost of all stages. The overlays included in our review were programmed for highway segments which were initially constructed to their ultimate design, and the use of FAI funds for overlaying these segments was programmed only after the segments evidenced deterioration.

The distinction between planned stage construction and overlays is further highlighted by comments made by an official of the State of Washington in responding to our draft report. He defined an overlay as the repair of a pavement failing unexpectedly and defined stage construction as the planned strengthening of a pavement at a finite time period after the initial construction. A Wyoming State official

also commented on this distinction and differentiated between stage construction and overlays on the basis that deterioration of the pavement was not necessarily a consideration in stage construction, whereas advanced deterioration was a prerequisite for overlaying a segment of highway.

Although the \$200 million estimated cost of the overlay program was included in the 1968 estimate, it was defined as:

"Extra stage of pavement structure on earlier opened sections of Interstate System to adequately accommodate design year traffic."

This definition could be applied to either the overlay program or stage construction. We believe, however, that the description is misleading, because, in actuality, it related to the cost of overlays to correct deficiencies on previously completed segments of the Interstate System that were not initially planned or built under the stage construction concept.

Several States, in providing FHWA with comments on our draft report, discussed the need for future overlays to provide periodic upgrading of the Interstate System. Their comments indicate that there will be a substantial future need for overlays and that the need will not be restricted to highway segments authorized before October 24, 1963.

Some of the States comments with regard to future overlay needs follow.

Colorado

"We certainly agree with the conclusions expressed ***. There will always be a need to upgrade completed segments of the Interstate System. Some equitable method will be necessary for determining when needed and the means of funding."

Oregon

"*** we agree with the findings of this draft to the effect that we cannot guarantee that all surfacings designed since 1964, whether they be flexible or rigid, will last the 20-year design period without deterioration to the degree that would require an overlay of more than maintenance proportions. In other words, some of the surfacing constructed since 1964 may need heavier overlays than the two inches indicated on our stage construction program before the end of the interstate program."

Texas

"We believe that if truck weights are going to be allowed to increase that the Highway Trust Fund should be used to provide a continuing upgrading of the Interstate System."

Vermont

"It is our feeling that the matter of upgrading the Interstate System will eventually become a matter for Congress to decide and act upon. The report points out, and we agree, that a substantial portion of the Interstate System may not be structurally adequate to carry the design year traffic. We feel that this is not due to inferior construction or poor design practice, but is due to the admitted fact that pavement structure design is not, up to the present time, an exact science ***."

Washington

"*** the conclusions drawn from the report seem to be that overlays are necessary, that more overlays can be expected, and that it is desirable at this time to formulate some new rules for determining who is going to pay for them. With this, we can hardly disagree ***."

Wyoming

"*** it appears that Congress intended to turn over to the States upon completion of the Interstate Highway program a System that is safe, durable and so designed and constructed as to preclude it becoming a burden to the State as far as the maintenance function is concerned."

* * * * *

"*** if it is determined that the structure design of the pavement on a particular project fails to meet the standards that will be conducive to safety, durability, and economy of maintenance then the criteria upon which the design of the pavement was based must be changed and the pavement upgraded to meet the new standards that will insure compliance with the intent of Congress."

CONCLUSIONS

We conclude that the initiation of an overlay program by FHWA illustrates its recognition that much of the Interstate System will not be capable of handling the types and volumes of the design-year traffic. The overlay program was established to correct the immediate deterioration problems on the Interstate System. The problem of pavement deterioration, however, is not restricted to highway segments authorized before October 24, 1963 but relates also to highways subsequently constructed--including those built in stages--and might well continue to exist on segments of highways already overlaid.

Although the interstate program is scheduled to terminate at June 30, 1974, the need for overlays will continue past that date and into the foreseeable future. Thus the \$200 million set forth in the 1968 cost estimate represents only the short-term cost of overlays. The total overlay costs will vastly exceed those included in the estimate.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The extent to which Federal funds may be available in the future to assist the States in paying for the cost of overlays on the Interstate System is a matter for the Congress to determine. Because of the long-term need for overlays and the substantial costs involved, the Congress may wish to express its intent relative to the use of FAI funds to upgrade completed segments of the Interstate System that have deteriorated. If the Congress intends that FAI funds be used to provide periodic upgrading of the Interstate System, it may wish to specifically authorize such upgrading on the basis of a reliable estimate of the annual costs that will thereby be incurred.

The Congress may wish also to consider the long-term need for overlays on the Interstate System in its deliberations on the funding of the Interstate System, any future expansion thereof, or any follow-on highway program.

CHAPTER 3

NEED TO CONSIDER EXTENT TO WHICH OVERLAYS

RELIEVE THE STATES OF MAINTENANCE RESPONSIBILITIES

Maintenance of the Interstate System is, by law, the responsibility of the States. Section 116(a) of title 23 of the United States Code states:

"*** it shall be the duty of the State highway department to maintain, or cause to be maintained, any project constructed under the provisions of this chapter or constructed under the provisions of prior Acts. The State's obligation to the United States to maintain any such project shall cease when it no longer constitutes a part of a Federal-aid system."

Project agreements between FHWA and the States providing for Federal-aid assistance in highway construction stipulate that the States, at their expense, maintain, or cause to be maintained, those sections completed and turned over to them.

State and FHWA officials informed us that it was necessary for flexible- and rigid-pavement highways to be overlaid periodically to preserve their riding qualities. The preservation of the highways' riding qualities appears to us to be a maintenance responsibility of the States in accordance with the requirements of the Federal-aid highway legislation. Although the primary purpose of the overlay program initiated in 1967 is to add structural strength to deteriorated highways, an overlay has the effect of relieving the States of their responsibility for maintaining smooth and safe riding surfaces.

Under FHWA's overlay program, FAI funds can be used for overlays of 1-1/2 inches or more on flexible-pavement highways. We discussed with State and FHWA officials the amount of overlay required to restore the riding qualities of a highway. Although their opinions varied, they agreed, in general, that at least 1-1/2 inches of overlay was

necessary. Since FHWA approves the use of FAI funds for overlays of 1-1/2 inches or more, we believe that there is no incentive for States to overlay the interstate highways as part of their maintenance responsibilities. The thickness of the overlays which were completed in the four States where we performed our detailed review ranged from 1-1/2 inches to 5-1/2 inches. (See app. I.)

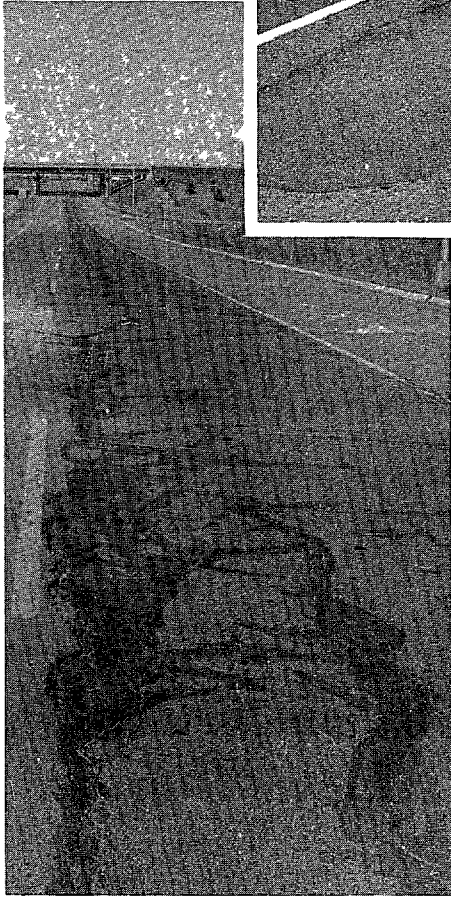
STATE MAINTENANCE PRACTICES

Section 101(a) of title 23 of the United States Code defines maintenance as the preservation of the entire highway, including surface, shoulders, roadsides, structures, and traffic control devices as necessary for its safe and efficient utilization. The Federal-aid project agreements between the States and FHWA provide that the States maintain completed interstate highway segments. FHWA has not established guidelines setting forth the specific level of maintenance expected of the States. FHWA considers the States' responsibilities, however, to be limited to "normal maintenance," which, generally, consists of repairing potholes, sealing cracks, and applying short patches.

Guidelines published by AASHO define maintenance as the preservation and upkeep of all the elements of a highway as nearly as practicable to its original condition or its subsequently improved condition. These guidelines recognize the necessity for restoring the riding surfaces of highways from time to time through the use of overlays.

The interstate highway maintenance practices of the States we visited consisted primarily of repairing potholes, applying short patches, and sealing cracks. These States have also applied seal coats¹ to segments of flexible-pavement highways. (See photographs on p. 29 showing the use of patches and seal coats.) Providing seal coats and repairing potholes will usually improve a highway's riding surface to some extent. We were advised by various State

¹A thin layer of asphaltic material used to seal cracks and pores in the highway surface in order to protect the pavement from weather.



OREGON - ON I-5 - PATCHES AND SEALS APPLIED
AS STATE MAINTENANCE THESE
PATCHES DO NOT FULLY RESTORE A
SMOOTH RIDING SURFACE



officials, however, that overlays generally would be required during the life of the highway to maintain an acceptable riding surface. Our review showed that the States had not normally provided for overlays in their interstate maintenance programs and that FHWA had not required them to do so.

We noted that, as an exception to the general practice of the States' not providing overlays, Texas had provided numerous 1- to 1-1/2-inch overlays on interstate segments without Federal-aid assistance prior to the beginning of the overlay program in 1967. These overlays were placed at periodic intervals ranging from 2 to 9 years after initial construction. State officials advised us that it always had been anticipated that an overlay would be necessary in order for the pavement structure to provide adequate serviceability through the design period. We were informed that FAI assistance would have been requested had overlays been considered eligible at the time.

OVERLAYS ON DETERIORATED RIDING SURFACES

An overlay which adds to the structural strength of a highway also has the effect of replacing a used and deteriorated riding surface. FHWA's instructions require that the justification for such an overlay be based on a design analysis which shows that the pavement, with normal maintenance, will not provide adequate serviceability for a 20-year period. According to FHWA's criteria, specific examples of flexible-pavement distress which indicate eligibility for an overlay are:

- Extensive cracking in the wheel paths.
- Rutting or deformation that extends below the surface course.
- Rough and deformed riding surface.
- Random, transverse, and longitudinal cracking that will result in early deterioration of the pavement structure.

The photographs on pages 32 to 34 show the deteriorated pavement conditions of various interstate segments scheduled for overlay in several States. As part of our review, we made visual observations of highway segments scheduled for overlays. The following examples summarize observations made by us while, accompanied by FHWA personnel, driving over a project in Oregon in April 1969.

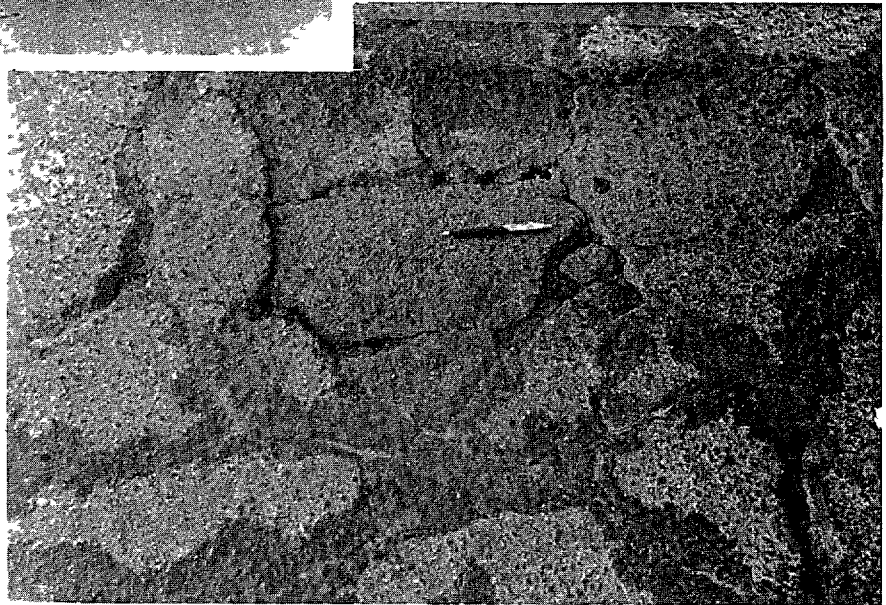
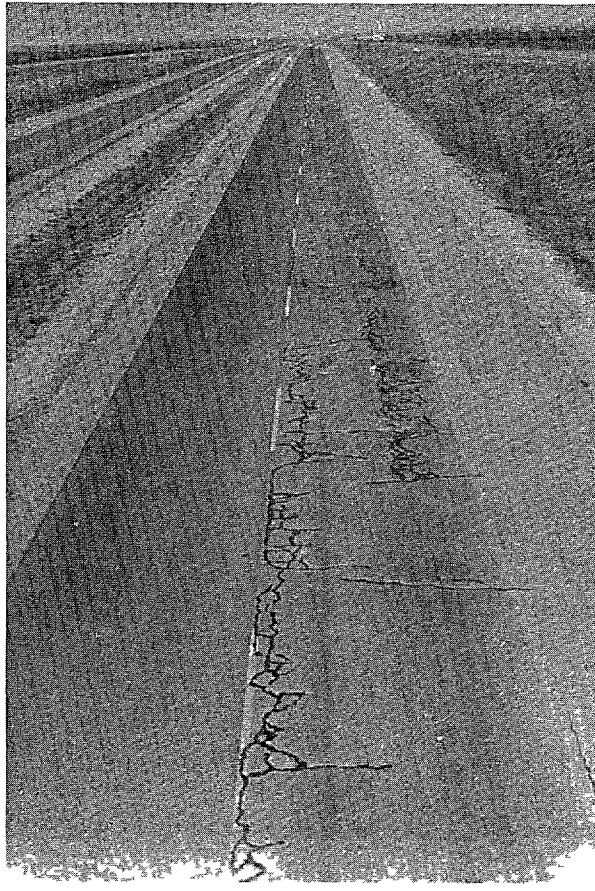
The southbound right-hand lane had almost continuous short patches and some portions showed evidence of having been patched three times; some patches were cracking and some were developing potholes. The areas where the original pavement was visible showed extensive cracking and wheel ruts about half an inch deep. We noted that the rutted and cracked surface adversely affected the riding quality of the highway. We were advised by FHWA personnel that the continued patching of the highway had not provided an adequate riding surface for any extended period of time because large numbers of patches had been placed at different times and because each patch was adequate for only a relatively short period of time.

The interstate segment on which we made our observations had been opened to traffic in 1961. The overlay design analysis prepared by Oregon showed that 9 inches of asphaltic concrete overlay was needed--6 inches to restore the deterioration in the weight-bearing capacity of the initial pavement structure and 3 inches to meet requirements of the new design standards. The State estimated that the cost of this 12.5-mile overlay would be \$2.1 million. At the time of our review, this section had not yet been overlaid.

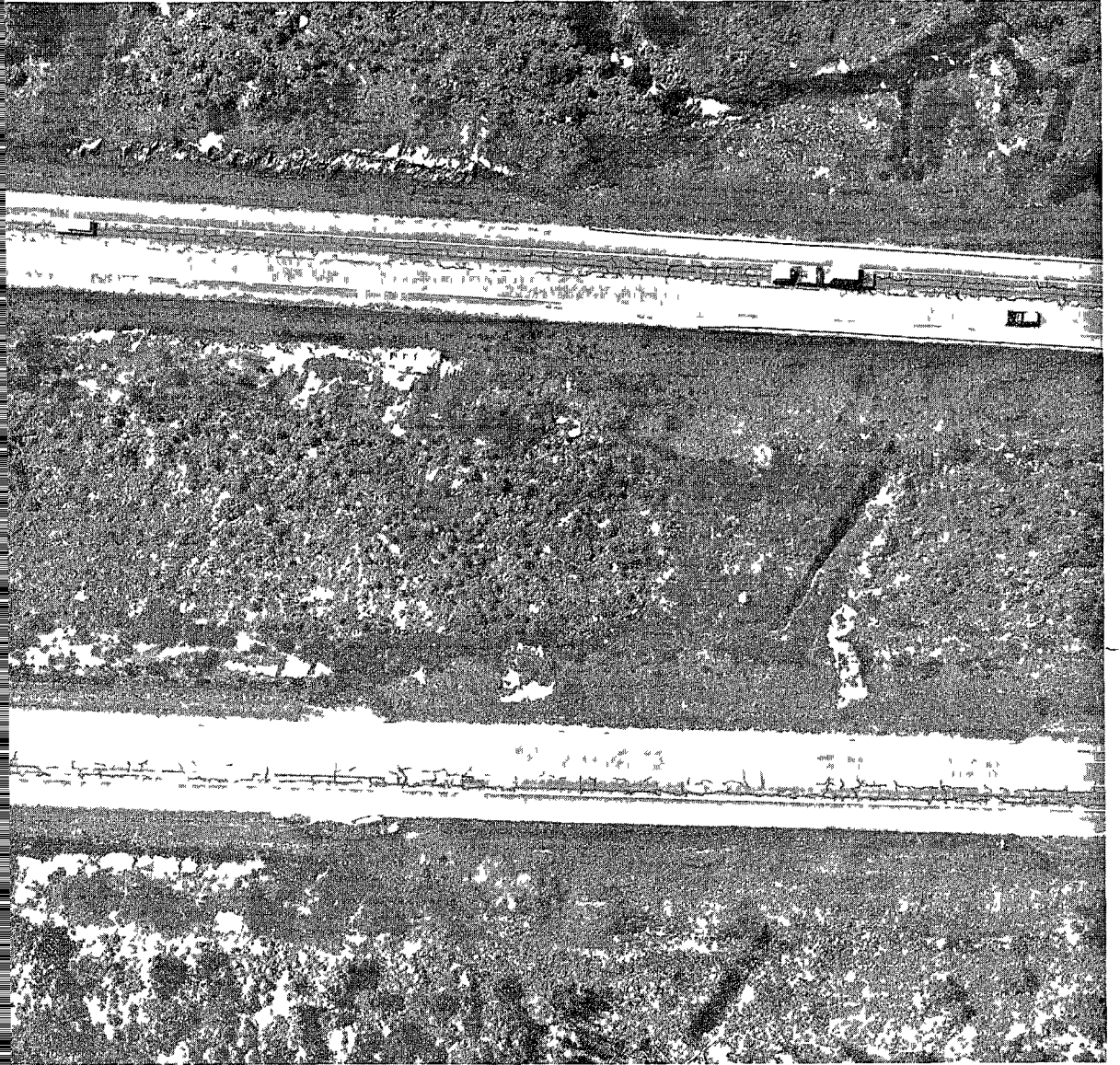
At the the time of our review, 14 overlay projects had been completed in Arizona, Maine, Oregon, and Texas. The period of use of these highway segments--the time between initial construction and the placement of the overlay--ranged from 4 to 11 years and averaged 8-1/2 years. On the basis of the generally accepted premise that flexible pavements require an overlay after about 10 years, it appears that these highway segments had reached, or were approaching, their serviceability limit with respect to the adequacy of the riding surface.



OREGON - ON I-5 - BETWEEN EUGENE AND SALEM - SHOWING DEPRESSIONS IN WHEEL PATHS FROM 1/2 TO 1 INCH IN DEPTH THIS PROJECT WAS INCLUDED IN 1968 ESTIMATE BUT HAD NOT BEEN OVERLAID AT THE TIME OF OUR REVIEW



TEXAS - ON I-20 NEAR ABILENE - THESE PICTURES WERE TAKEN IN 1968 AND SHOW
CRACKS AND DEPRESSIONS IN THE WHEEL PATHS THIS SECTION HAS
BEEN OVERLAID SINCE THESE PICTURES WERE TAKEN



AGENCY COMMENTS

In our draft report we suggested that FHWA establish maintenance standards which recognize that the periodic placement of additional layers of pavement is necessary to provide a safe and efficient riding surface and that these added pavement layers represent a maintenance function, the cost of which should be borne by the State. We suggested also that, when overlays are necessary to add strength, the portion of such overlay which represents that work which would otherwise be needed to provide a new riding surface be classified as a maintenance function and the costs thereof be charged to the States.

The Assistant Secretary for Administration advised us that the Department did not concur in our suggestions. He stated that maintenance was already defined, in section 101 of title 23 of the United States Code, as the preservation of the entire highway and that whether or not an overlay was reasonably necessary at any point in time was an engineering determination which could not be made without an inspection of the highway and an evaluation of all the pertinent facts. The Assistant Secretary also stated that, where overlays are required to preserve an interstate highway (i.e., maintenance), rather than to add to the highway's structural strength to meet the standards specified in title 23, such work was accomplished by the States at their expense.

With respect to the allocation, as a maintenance function, of a portion of the cost of overlays used to add structural strength, the Assistant Secretary stated

"We do not believe that it is practical or necessary as you suggest, to measure and separately pay for small quantities of material of variable thickness that constitute a leveling course or wedge between a theoretical base of additional overlay layer and the top surface of existing pavement. The purpose of the leveling course is to provide a plane surface on which to place the overlay layer, not to rejuvenate or protect the existing surface."

We did not suggest that the small amounts included in the overlay for leveling¹ be measured and separately paid for by the States. We realize that the purpose of the leveling course is to provide a plane surface on which to place the overlay. Our suggestion was meant to encompass more than leveling; it was directed toward recognizing the fact that, when an overlay is placed for the purpose of adding structural strength to the highway, it necessarily provides a new riding surface. Since the pavements on which overlays are placed already had a deteriorated riding surface, the placement of an overlay had the effect of relieving the States of the financial responsibility for the work necessary to restore the riding surface to an acceptable level. The small quantities of material used for leveling would be less than those required to fully restore the riding surface.

Our suggestion was directed toward establishing a policy requiring the allocation of a portion of the total overlay cost to maintenance. Obviously, to make such an allocation would require the establishment of some means, equitable to all the States, for measuring the amount of an overlay which should be considered as maintenance. Although there may be a number of alternative methods available for such measurement, perhaps the simplest method would be for FHWA to allow Federal participation in only the allocated cost of the overlay which represents the amount of overlay in excess of a minimum depth. FHWA has already established that, to be eligible for FAI participation as construction, the overlay requirement must be for at least 1-1/2 inches.

Several States, in commenting on our draft report, discussed the relationship between overlays and the States' maintenance responsibilities and our suggestions that (1) a portion of the overlay cost be allocated to maintenance and (2) FHWA establish maintenance standards which recognize

¹A small amount of material, which is in addition to that required for the overlay, is usually included in the overlay amount for purposes of filling depressions and is included also in the cost eligible for FAI participation.

that overlays are needed periodically for maintenance purpose. Following are pertinent comments.

Colorado

"*** we believe that it would be almost impossible to determine if an overlay was only for the purpose of improving riding surface or for upgrading the structural strength. According to the theory, an overlay would automatically do both. Hence again we believe that some equitable method (possibly on a length of service basis only) should be provided to determine eligibility for any federal financing of overlays."

Oregon

"We cannot agree with the draft in its application to the maintenance program. The GAO seems to conclude that the states have not performed adequate maintenance on the Interstate System because we are then able to get a measure of maintenance in the fully participating overlay work."

Vermont

"*** We would expect to perform 'normal maintenance' on the Interstate Highways in Vermont, but it is our contention that 'normal maintenance' is that maintenance required to safeguard the quality or condition of the highway, and would include maintaining ditches and drainage structures and whatever surfacing might be required to keep the surface of the traveled way and shoulders waterproof, to counteract the normal aging process of flexible pavements.

"*** Whereas the report recommends that a portion of any overlay represents 'normal maintenance,' and that therefore a portion of the cost should be borne by the states, we feel that at the present fund matching ratio of 90-10, the 10 percent

paid by the state does represent our contribution to the cost of the upkeep of the highway, when taken in addition to the other maintenance operations that are being performed."

Washington

"*** Whoever establishes these standards [maintenance standards recognizing need for maintenance overlays] should be guided by the fact that a rough riding surface is usually a precursor of structural insufficiency and simple [normal] maintenance will provide only transient, superficial relief."

Texas

"We would object to the Secretary directing that maintenance standards for highways be established with the recommendation that certain overlays be required from time to time. We feel that this is the States prerogative within the funds allocated to them."

Wyoming

"This Department is in agreement *** that overlays are required from time to time to provide a safe and efficient riding surface and should represent a normal maintenance operation [after the highway is properly designed and constructed] ***."

Although maintenance is defined in the law, as the preservation of the entire highway, normal maintenance, as practiced by the States with FHWA's approval, will not provide the level of maintenance needed for an acceptable riding surface. We believe that maintenance standards should be established that will define an acceptable level of maintenance and will treat all States uniformly. Such standards should provide the States with a better understanding of their responsibilities and should provide FHWA regional personnel with criteria with which they could provide guidance to the States in evaluating the adequacy of maintenance.

CONCLUSIONS

Normal maintenance, as defined by FHWA and as practiced by the States, does not encompass the full degree of maintenance required to provide an acceptable riding surface for pavements on interstate highways. FHWA should establish more precise maintenance requirements for interstate highways that recognize that periodic overlays are necessary to provide acceptable riding surfaces.

When new riding surfaces are provided by overlays which are considered to be additional construction for the purpose of upgrading the structural strength of highways, the States' maintenance responsibilities are being met simultaneously with the upgrading process. Accordingly, we believe that the portion of the overlay which represents that which would otherwise be required to provide a smooth and safe riding surface should be determined and that the related costs should be borne by the States.

RECOMMENDATIONS TO THE SECRETARY OF TRANSPORTATION

We recommend that the Secretary of Transportation require that maintenance standards for interstate highways be established that fully define the States' maintenance responsibilities and provide for a minimum level of the States responsibilities. We recommend also that the standards recognize that (1) overlays are required from time to time to provide safe and efficient riding surfaces and (2) the costs of such overlays represent normal maintenance and should be borne by the States.

We further recommend that, when overlays are considered necessary to upgrade the structural strength of pavements, the costs of the portions of the overlays which would otherwise be needed to provide new riding surfaces be classified as State maintenance responsibilities.

CHAPTER 4

NEED TO IMPROVE METHODS FOR

DETERMINING OVERLAY REQUIREMENTS

There are significant differences among the States in (1) the methods of evaluating the condition of highway surfaces to determine whether overlays are necessary and (2) the design procedures for establishing the amounts of overlays. In addition to the differences among States, the States' methods differ, in varying degrees, from the method set forth by AASHO and subscribed to by FHWA.

The different methods used and the application of varying degrees of engineering judgment by the States do not, in our opinion, result in uniform methods of determining the optimum time for placing overlays and the amounts of overlays. We believe that there is not sufficient assurance that (1) overlays are placed at the proper time--neither too early to ensure full economic benefit from the existing pavement nor too late to avoid undue structural damage to the pavement--and (2) the amounts of overlays are not substantially more or less than those required to provide the needed serviceability.

FHWA instructed the States to examine all sections of pavement authorized prior to October 24, 1963. Where an examination indicated that a pavement structure, with normal maintenance, would not provide adequate performance through a 20-year period from initial authorization of the project, a design analysis was to be made. The instructions required that FHWA personnel use AASHO design criteria to measure the designs submitted by the States as support for their overlay requests and the extent of FAI participation when the States' designs indicate needs for thicker overlays than would be justified by the AASHO criteria. The instructions required also that, for those States that did not use the AASHO method, FAI participation in overlays costs be limited to the amount of overlays which would be required under the AASHO criteria.

METHODS FOR DETERMINING WHETHER
AN OVERLAY IS NECESSARY

As discussed earlier, overlay requirements for flexible pavements are closely associated with the deterioration which occurs in the riding qualities of pavement. State highway officials advised us of the importance of placing overlays in time to prevent unnecessary destruction of the existing pavement. It seems that it would be equally important that these overlays not be placed until such time as the full economic benefit has been obtained from the original surface course.

In determining the need for an overlay, State and FHWA personnel first determine the condition or serviceability of the existing pavement. Serviceability is defined as the ability of a pavement to serve high-speed automobile and truck traffic. The AASHO manual for pavement evaluation provides for the use of a "present serviceability index" to measure the surface condition of pavements. A pavement condition can be rated on a scale of zero to five. A rating between four and five is anticipated for a new surface, whereas a rating of two or below indicates a need for resurfacing.

FHWA has not required the States to adopt the AASHO rating system or any other uniform pavement-rating system. In the States we visited, the State highway departments utilized a variety of methods to perform the condition examination required by FHWA. In reviewing the States' requests for overlays, FHWA apparently used the same method as did the respective States to identify those pavements in need of overlays. Although the FHWA instructions describe the type of surface deterioration which may indicate that an overlay is necessary, they do not specify the extent of such deterioration which should exist before placing the overlay.

The rating systems used by some of the States included in our review are discussed below.

Maine--Maine uses a "qualitative rating system" which is based on visual observation of crack patterns and surface features. This system results in a numerical

rating on a scale from one (bad) to five (good) and appears to be similar to the AASHO system. The State uses also an electronic device to measure the serviceability of the pavements. FHWA officials advised us, however, that they did not believe that the above systems were reliable for determining whether overlays were needed on the Interstate System. Instead, the combined engineering judgment of State and FHWA officials, based upon their visual observations of the pavement deterioration, was the method used to establish overlay needs.

Texas--In Texas, pavements were determined to be eligible for overlays on the basis of the joint engineering judgment of State and FHWA personnel. The pavements, as initially constructed, were assigned an assumed rating of five and, at the time of the condition examination, were assigned another rating to represent the current value of the pavement. The serviceability at the end of the design year was estimated by plotting the original and current values on a graph and projecting them on the basis that deterioration would continue at the same rate. This method indicates the need for an overlay when the result of this projection shows that the serviceability would be below an acceptable level prior to the design year.

Arizona--In Arizona serviceability was rated on a scale from zero to five. The ratings were based on the average values of visual ratings made by FHWA and Arizona Highway Department engineers. Those highway sections at or approaching a rating of 2.5 were scheduled for overlays. A State official advised us that Arizona did not have the equipment necessary to make the objective measurements of serviceability called for by the AASHO system.

Oregon--In Oregon no attempt was made to rate the serviceability of the pavements. Pavements were determined to be in need of overlays on the basis of visual observations of State and FHWA engineers and their judgments that the pavements could not last for the 20-year design life without overlays.

State officials advised us that they were considering the use of some objective measurements of pavement condition which would indicate when overlays are necessary.

Washington--Pavements were determined to be eligible for overlays on the basis of numerical ratings assigned by visual observations of the amount of various types of existing pavement defects. New pavements are rated at 85. When the rating drops to 60, the State considers that an overlay is required. The State estimates that the rating will drop about 2.5 points a year and that an overlay is anticipated in about 10 years.

Pavements were included in the estimate of overlay needs when the rating taken in 1967 indicated that a rating of 60 or less would be reached by 1974.

Vermont--Highways in Vermont were determined to be in need of overlays on the basis of the combined judgment of State and FHWA engineers. We were advised that numerical ratings showing the current serviceability of the pavements were not prepared.

METHODS FOR DETERMINING HOW MUCH OVERLAY IS REQUIRED

Determining the thickness of a pavement overlay requires the preparation of a design analysis which includes an evaluation of the existing pavement and soil values together with projections of the volume and weight of future traffic, principally truck traffic with heavy axle loads. FHWA requires that this determination be accomplished through use of a design analysis by whatever design method is used by each State. FHWA instructions require that the States' design analyses be prepared for each segment of the originally built pavement and be evaluated in terms of the AASHTO design methods. We found a number of differences in the design methods used.

Frequency of design analyses

Arizona, Oregon, and Texas each prepared detailed design analyses for each highway segment on which they requested FHWA approval for an overlay.

In Maine the justification for five overlay projects was based on one basic design analysis. FHWA officials advised us that this design analysis had justified overlays of 5-1/4 inches. In actual practice, however, a variety of overlay depths ranging from 1-3/4 to 5-1/4 inches were approved on an experimental basis to determine the most satisfactory overlay depth. Because only one basic design analysis was made, no determination of the existing pavement values for each originally built segment was made; FHWA did not evaluate the State's overlay design in terms of AASHTO design methods, contrary to FHWA instructions.

Frequency of pavement samples

Although FHWA's instructions require that the States determine the structural value of the existing subbase, base, and surface courses as part of the design analyses, the instructions do not specify how these values are to be established. These values are needed to determine the structural values of the existing pavement. We found that uniform procedures regarding the frequency of pavement and soil samples had not been followed by the States.

1. In Oregon, we reviewed four overlay projects, totaling 16.4 miles, included in the 1968 cost estimate and found that from two to four pavement and soil samples per overlay project had been taken for the purpose of preparing the estimates. We were informed that samples every one-half mile would be taken to establish the requirements for the final overlay designs.
2. In Maine, we reviewed five overlay projects, totaling 34 miles, and found that six pavement samples had been taken on two projects covering about 16 miles. We were informed that tests of pavement had been limited to the two projects because these pavements were considered to be representative of all pavements submitted for overlays.
3. In Arizona, the majority of the sections of the Interstate System that were identified for the 1968 cost estimate as requiring overlays were sampled at intervals of 2 to 3 miles. The samples consisted of core samples to the total depth of each of the various roadbed courses. We were informed that, in the future, the pavement would be tested at 1,000-foot intervals prior to actual overlays.
4. In Vermont, we were informed that time had not allowed them to take samples for the 1968 cost estimate but that, for actual overlay designs, approximately two samples would be taken for each overlay project.
5. The State of Texas took core samples on three of the 11 overlay projects for flexible-pavement highways. On the other eight projects, the design analysis was based on tests performed during 1964 for use in making the 1965 estimate of costs to complete the Interstate Highway System. We were informed that no uniform procedures had been followed relative to the distance between test samples taken and that engineering judgment, condition of pavement, original design of the structure, and experience were all used in determining the number and spacing of sample areas.

6. We were told that core samples were not taken in Washington unless the surface condition indicated that there had been failures in the base materials.

Comparison of design analyses with AASHO design guidelines

In its instructions for the overlay program, FHWA stated that the details of the State designs would be measured by the criteria established in the AASHO Interim Design Guides for Flexible and Rigid Pavements. Following are examples of the different States' design methods and their relationship to the AASHO design guides.

1. Arizona used the AASHO design guides. In our review of an overlay project, however, we found that, on the basis of the AASHO guidelines, overlays on certain sections were not justified. Three sections on a roadway had been provided with a 2-inch overlay. An FHWA official informed us that, even though the AASHO guidelines did not justify an overlay, these segments had been overlaid because engineering judgment and visual inspection of the roadway indicated that overlays were needed.
2. In Oregon, we attempted to evaluate the State's design using the AASHO guidelines. The State pavement design method is considered by FHWA to produce results that are comparable to those by the AASHO method. We were told by FHWA that the Oregon method was acceptable because, in the past, it had been found to be conservative compared with the AASHO method.

Our inquiry into the conversion of Oregon data to the AASHO design analysis method for five overlay projects showed that generally Oregon had requested less overlay thickness than was indicated by the AASHO method. We found, however, that firm values had not been established for certain factors which were important components of a design analysis. Any attempt to convert Oregon's design method to that of AASHO will not be fully meaningful until

these values are resolved. FHWA officials advised us that they believed that Oregon's design method was close enough for comparison purposes and that the design should be evaluated on the basis of the performance of the pavements rather than a precise comparison with the AASHO design method.

3. In contrast with the method used by Oregon, the design method used by Texas generally resulted in requests for greater overlay thicknesses than could be justified by the AASHO method. This occurred because the Texas design method assigned lower values to pavement material than the values used in the AASHO design. Although FHWA and State officials could not agree on the values of the existing pavement, FHWA limited Federal participation to the overlay thickness that resulted from a conversion to the AASHO design method.

We believe that the above examples illustrate a general lack of uniformity by FHWA in the use of the AASHO criteria for evaluating the States' design analyses and for determining FAI participation.

AGENCY COMMENTS

In our draft report, we proposed that the Secretary of Transportation direct that FHWA amend its regulations to require that overlay standards be applied uniformly throughout the States and that FHWA take positive action to (1) improve the pavement rating system to achieve optimum use of the original pavement and (2) establish design methods to provide greater assurance that the States are receiving the proper amount of pavement overlays to serve the design period.

The Assistant Secretary disagreed, in general, with the need for the proposed action and contended that the AASHO pavement rating system was being used satisfactorily in most areas. We cannot agree with the Assistant Secretary's comment. Moreover, the States which commented on this matter substantially agreed with the views we expressed in our draft report.

Our review of a representative number of States having overlay programs showed that the AASHO common criteria were not being used uniformly. In the States we visited, we found that pavement ratings were generally prepared differently in each of the States. (See pp. 41 and 42.) Although all the States considered some of the factors included in the AASHO system, some rated additional factors and some did not rate all factors. Furthermore, the States generally (1) assigned different values to the factors rated and (2) forecast future deterioration in different ways.

The Assistant Secretary also stated that application of the AASHO common criteria in the process of approving projects results in equivalence among the States in design and cost participation of pavement structures. He stated also that different thickness of overlays that occurred in different States and in different areas of a State were not indicative of a lack of uniformity but rather resulted from a combination of design considerations. He pointed out that, in evaluating and approving designs proposed by the States for overlay projects, FHWA used a single common criteria--the AASHO Interim Design Guides for Flexible and Rigid Pavement Structures.

We recognize that different thickness of overlays occur in different States or in different areas of a State because of variations in soils, climates, materials, and other factors. Certain States, however, used their own design analyses which required FHWA to convert from the States' analyses to the AASHO method. In this conversion, FHWA officials did not always have values assigned to soils, climates, materials, and traffic in terms of AASHO criteria, thus varying degrees of engineering judgment were required to convert the States' values to values used in the AASHO design method. We believe that, unless direct conversions to the AASHO method are used, uniform results will not be obtained.

Some State officials who commented on our draft report expressed dissatisfaction with the AASHO methods that had been adopted by FHWA. The dissatisfaction expressed by the officials was augmented by the comments of highway officials from other States who generally agreed that the pavement rating system should be improved and that more reliable design methods should be established. Examples of some State officials' comments are shown below:

Vermont

"*** we are in agreement with the report that a more standard method should be established, nationally, for determining when an overlay should be placed, and how thick this overlay should be. When Vermont considered the need to perform an overlay on a section of Interstate Highway, the existing Bureau of Public Roads memorandums were studied and followed. *** A standard method of determining the Present Serviceability Index would result in earlier action, before extensive failures had been allowed to occur. *** We would recommend a uniform method be adopted for the computation of overlay depths, but any standard would have to recognize that the factors of climate, construction materials, and subsurface conditions vary throughout the Country, and would have to be considered in any standard design method. National guidance would result in fairer and more uniform practices among the states."

Washington

"*** The [AASHO] guides for rigid pavements and for flexible pavements are, as their titles suggest, 'Interim' guides. They have not to this date, some seven years after first distribution, been accepted by the AASHO Committee on Design and there is considerable doubt if they ever will be accepted in their present form. The shortcomings of these guides, and there are many, are generally well recognized, especially by agencies such as ours which have design systems equally sophisticated and backed by many more years of experience. It is disconcerting, to say the least, to be continually compared to this standard."

Colorado

"*** We agree with the conclusions and recommendations expressed *** [ch. 4]."

Maine

"*** The GAO believes it essential that FHWA establish more precise procedures for determining when and where overlays should be placed and how thick they should be.

"I would like to point out that pavement overlay thickness cannot, at this time, be precisely determined. This problem is recognized by recent literature which points out the need for further research which will take several years."

Oregon

"We also agree with the draft that more accurate methods of determining the need for overlays and the thickness of them, as well as accurate costs to reflect these needs, are required and we sincerely hope that leadership from the Federal Highway Administration brings about certain

criteria which will allow us to perform this work."

Texas

"There is one area of discussion, however, on which we have a very definite opinion. We concur with their [GAO] conclusion that better and more realistic type guide lines need to be developed for determining the depth of pavement overlays.

"In our opinion, AASHO road test equations as used in the Interim Guide are not applicable to these conditions and give unrealistic answers when so used. Further evaluation and implementation of recent research work would be in order, supplemented by additional studies if necessary, to develop design guide lines for pavement overlays. An AASHO Design Subcommittee is presently working on these objectives."

CONCLUSIONS

The use of engineering judgment varies widely between State highway departments. Engineering judgment is used extensively in determining when overlays should be placed, preparing the design analysis, and relating the analysis to the AASHO standards. In some States engineering judgments were also used as the basis for increasing or decreasing the thicknesses of the overlays from the thicknesses determined necessary by the design analyses. It seems that, irrespective of design criteria used and the results of such criteria, a State can justify almost any reasonable depth of overlay on the basis of engineering judgment. We recognize that engineering judgment is an essential element of pavement design. We believe, however, that FHWA should establish criteria to minimize the use of judgment by providing more precise and uniform procedures for determining requirements.

In view of the magnitude of the overlay program and the periodic need for overlays on the Interstate System, we believe that it is essential that FHWA establish more precise

and more uniform procedures for determining when overlays should be placed and how thick they should be. We believe that such procedures are needed to provide more assurance that (1) an overlay is placed at the proper time--neither too early to ensure full economic benefit from the existing pavement nor too late to avoid undue structural damage to the pavement--and (2) the amount of the overlay is not substantially more or less than that required to provide the needed serviceability.

RECOMMENDATIONS TO THE
SECRETARY OF TRANSPORTATION

We recommend that the Secretary of Transportation require FHWA to amend its regulations to require that overlay standards be applied uniformly throughout the States. We recommend also that, to attain such uniformity (1) positive action be taken to improve the pavement rating system to achieve optimum use of the original pavement and (2) design methods be established to provide greater assurance that the States are applying the proper amount of pavement overlays to serve the design periods.

CHAPTER 5

SCOPE OF REVIEW

Our review was conducted at the Washington, D.C., office of the Federal Highway Administration, Department of Transportation, and at the FHWA division offices and the offices of the State agencies responsible for highways in the States of Arizona, Maine, Oregon, and Texas. We also visited the States of Colorado, New Mexico, Washington, Wyoming, and Vermont to obtain limited information on the overlay program in those States.

We reviewed pertinent legislation, FHWA policies and procedures, and FHWA and State records pertaining to selected segments of the Interstate Highway System that have been, or will be, overlaid. We also held discussions with officials of the FHWA and States that we visited. In the States of Arizona, Maine, Oregon, and Texas, we observed the conditions of certain segments determined by the State and FHWA as being in need of overlays and of other segments that had been overlaid. Our observations also included the extent of maintenance performed by the States on certain selected segments of the Interstate System.

APPENDIXES

SELECTED INFORMATION ON OVERLAY PROJECTS
FINANCED WITH FEDERAL-AID INTERSTATE FUNDS
STATES OF ARIZONA, MAINE, OREGON, AND TEXAS

State and project	Overlay			Original projects		Pavement use before overlay (years)	
	Length (miles)	Depth (inches)	Cost	Year constructed	Depth (inches)		Year constructed
ARIZONA							
I-8-2(57)	15 6	2 to 6-1/4	\$ 682,833	1968	2-1/2 to 3	1957-59	9 to 11
MAINE							
I-95-6(39)	6 3	3-1/4 to 5-1/4 ^a	841,548	1967	3	1958-60	7 to 9
I-95-7(61)	3 4	1-3/4 to 3-1/4 ^a	322,942	1967	3	1962	5
I-95-8(75)	4.8	3-1/4 to 5-1/4 ^a	694,951	1967	3	1957-59	8 to 10
I-95-8(83)	1 8	3-1/4 to 4-1/4 ^a		1968	3	1960	8
I-95-8(76)	1.6	3-1/4 ^a	221,307	1967	3	1957	10
OREGON							
I-80N	3 4	5-1/2	526,636	1968	4	1962	6
TEXAS							
I-10-1(108)026	6.9	3-1/2	612,356	1968	3-1/5	1960	8
I-10-1(114)032	17 35	2-3/4	946,868	1968	3	1959	9
I-20-2(76)159	10 3	3-1/2 ^b	592,072	1968	(c)	1957	11
I-20-2(77)176	15 8	3-1/2 ^b	1,083,517	1968	(c)	1957	11
I-20-2(78)193	9 3	3-1/2 ^d	475,694	1968	(c)	1956	12
I-20-2(88)236	8 2	1-1/2 ^e	419,309	1968	3	1960	8
I-20-2(90)274	5 8	1-1/2 ^d	481,897	1968	3	1959	9

^aOn those sections where less than 5-1/4 inches of overlay had been placed, the amount placed represented an initial stage. The design analysis prepared supported the need for a total overlay depth of 5-1/4 inches throughout the project.

^bInitial stage of overlay, depth of second stage not established

^cNot determined by review.

^dInitial stage of overlay, amount of second stage to be 6-1/2 inches

^eInitial stage of overlay, amount of second stage to be 6 inches



OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D C 20590

ASSISTANT SECRETARY
FOR ADMINISTRATION

March 24, 1970

Mr. Bernard Sacks
Assistant Director, Civil Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Sacks:

We have reviewed your draft report to the Congress entitled "Review of Program to Upgrade Deteriorated Segments of the Interstate Highway System." As you requested, we have obtained comments, which are enclosed, from officials of nine responsible State highway departments.

Our comments, considering the responses of the States, are summarized below.

On page 20 of the report, you concede that there is no prohibition in Title 23 U.S.C. against the overlay program. In addition, the substance of the program and its scope were formalized on January 11, 1962, in Instructional Memorandum 21-1-62, which provided for the construction of Interstate highways in stages. This was well known to the Congress.

Since there is no legal prohibition and the Congress has acquiesced in this longstanding administrative interpretation of the appropriate statutes, we believe that referral of the matter to the Congress for "expressing its intent" as stated on page 21 of the report, is superfluous.

We have already anticipated the need for an estimate of the costs of this program as you suggest on page 21. In October 1969, as a result of discussions with staff representatives of the Committee on Public Works of the House of Representatives, the Bureau of Public Roads undertook with the State highway departments, a reinventory of the work that was selected in 1967 for additions to pavements constructed prior to October 1963. The estimated cost for such work had been included in the 1968 cost estimate.

In addition, the States' and Public Roads' engineers made an evaluation in 1969 of additional pavements constructed prior to October 1963 that appeared to warrant an additional stage of construction by an overlay. The purpose was to permit that section of highway pavement to satisfactorily carry traffic through a 20-year design period. The 1970 estimate of costs to complete the Interstate System will include and identify these additional pavement costs along with appropriate explanation as was done in the report filed in 1968.

We do not concur in your recommendation on page 28:

". . . that the Secretary direct that maintenance standards for highways be established which recognize that (1) overlays are required from time to time to provide a safe and efficient riding surface and (2) such overlays represent normal maintenance and, as such, the costs thereof shall be borne by the States.

"In cases where overlays are considered necessary to add strength to highways, we recommend that the Secretary direct that part of the overlay which would otherwise be needed to provide a new riding surface be classified as a State maintenance responsibility and that the costs attributable thereto be borne by the States."

"Maintenance" is already defined in 23 U.S.C. Par. 101 as "the preservation of the entire highway." Whether or not an overlay is reasonably necessary at any point in time for a particular Interstate highway is an engineering determination, which cannot be made without an inspection of the highway and an evaluation of all of the pertinent facts. Where overlays are required for the purpose of preserving an Interstate highway (i.e., "maintenance") rather than to add to the highway's structural strength to meet the standards specified in 23 U.S.C. Par. 109, such work is presently accomplished by the States at their expense.

We do not believe that it is practical or necessary as you suggest, to measure and separately pay for small quantities of material of variable thickness that constitute a leveling course or wedge between a theoretical base of additional overlay layer and the top surface of existing pavement. The purpose of the leveling course is to provide a plane surface on which to place the overlay layer, not to rejuvenate or protect the existing surface.

It has, therefore, been the practice in the highway construction program to include the small quantity of the leveling course in the total quantity for the overlay layer using the same type or class of funds.

On page 38 you further recommend:

". . . that the Secretary direct that FHWA amend its regulations to require that overlay standards be applied uniformly throughout the States. In order to attain such uniformity we recommend that the Secretary direct that FHWA (1) take positive action to improve the pavement rating system to achieve optimum use of the original pavement and (2) establish design methods which provide greater assurance that the various States are receiving the proper amount of pavement overlays to serve the design period."

The pavement rating system developed as a part of the AASHO Road Test at Ottawa, Illinois, in the early 1960's is being used satisfactorily in most areas today. Refinements in the system, no doubt, will come with further usage and experience.

The Bureau of Public Roads (BPR), the State highway departments and other highway interests are continuously seeking to further develop and refine criteria for the design of both flexible and rigid-type pavement structures. Currently, however, the BPR has determined that the criteria outlined in the AASHO Interim Design Guides for Flexible and Rigid Pavement Structures are the most reliable available.

It, therefore, uses those criteria to measure the proposed designs submitted by State highway departments for initial pavement structure thickness and to measure the thickness of any additional pavement overlay layers. By application of those common criteria in the process of approving Federal-aid projects, the BPR obtains equivalence among the States in the design and cost participation of pavement structures that accommodate the conditions that prevail on individual projects.

The fact that different thicknesses of design for overlays occur in different States, and in different areas of a State, does not necessarily mean that the design criteria are not being applied uniformly. The differences result from dissimilarities in the supporting soils, pavement materials available, climate, traffic forecasts, and in other similar factors that enter into the design considerations.



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STATE HIGHWAY DIRECTOR

WM N PRICE
STATE HIGHWAY ENGINEER

ARIZONA HIGHWAY DEPARTMENT

MATERIALS DIVISION
1745 West Madison Street
Phoenix, Arizona 85007

November 26, 1969

Mr. H C. Tilzey
Division Engineer
U. S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads
230 North First Avenue
Phoenix, Arizona 85025

Dear Mr. Tilzey

In reference to your letter dated November 14, 1969, we have reviewed the report entitled "Review of Program to Upgrade Deteriorated Segments of Interstate Highway System".

The comments we have made are enclosed herewith.

Sincerely yours,

Wm. N. Price
State Highway Engineer

by *G. J. Allen*
G. J. Allen
Engineer of Materials

BS.ng
Enclosure

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We, therefore, believe that the provisions of the overlay program are applied uniformly throughout the States by the BPR.

We appreciate the opportunity afforded us to comment on your draft report.

Sincerely,



Alan L. Dean

Enclosure

Page 3, Paragraph 2

It is known and recognized that an asphaltic concrete pavement will need maintenance prior to a 20 year period after construction. However, the overlays we have set up in our program are not intended for this purpose. They are designed to add structural strength surface structure where the roadways are showing distress because of weak subgrade and excessive rutting and cracking which indicates additional consolidation has occurred because the roadway has been subjected to a higher volume of traffic or heavier axle loading than the roadway was designed, it appears an overlay should be allowed for additional structural strength.

Page 8, Paragraph 1

It is our policy to make a thorough investigation of a section of roadway before the final determination of the thickness of overlay required. It has never been established that the cause of failure should be documented. However, in most cases a visual observation is made of a project by engineers representing the Bureau of Public Roads, Materials Division, and District Engineers office. A report, written in longhand, is made by the engineer representing the Materials Division and is maintained in "Materials Survey" project folder. This report covers the condition of the existing pavement, the type of failures, and cause of failure if readily determined.

In addition to this, samples are cut from each existing roadway at approximately 1000 foot intervals (more frequent if deemed necessary). Samples are taken from the base material, sub-base, and subgrade at each site. The sample of asphaltic pavement is carefully examined for extreme oxidation, water in the pavement, stripping, etc.

The above mentioned samples are tested in the laboratory for gradation and plasticity index to determine if degradation has occurred in the base and subbase material or poor quality of material from the subgrade has intruded since construction. All of these conditions are considered in making the design analysis. The rutting and other deformations are measured at approximately 1000 foot intervals.

Page 9, Paragraph 3

We consider the 20 year design life to be very significant. Especially if the roadways were designed for a shorter period.

If a roadway was designed for less than 20 years, then later determined it should carry traffic for "20 year period" and found inadequate to do the same, should it not be allowed an overlay for additional structural strength, rather than considered an initial inadequacy.

Page 12, Paragraph 1

Arizona has constructed approximately 30 miles of both roadway (4 lanes) and 38 miles of one roadway (2 lanes) of the interstate system by the stage construction method, whereby a temporary surfacing was provided and opened to traffic, with the final surfacing to be placed later. The final surface has been placed on the one roadway (2 lane) miles as indicated above. Most of the 2 roadway (4 lane) sections have not received the final surfacing.

In addition to the above, several miles of primary highway were taken into the interstate system without any FAI money being spent to upgrade them at that time because the surface was of sufficient quality they did not warrant an overlay, and it should be pointed out there are a few miles of these roadways still in service and have not received an overlay to this date. These are included in the overlay estimate.

Page 35, Last Paragraph

It did not take the full 2 inch thickness to meet the design equation on the sections of roadway mentioned. However, there was definite need for an overlay. Since 2 inches (1½ inch asphaltic concrete plus ½ inch of asphaltic concrete finishing course) was the minimum overlay that could be laid in a practical method, this was the thickness placed. The condition of pavement prior to the overlay was such, the maintenance crew was continually patching the cracks and chuckholes caused from blocks of pavement breaking out. The ruts were from 1/4 to 5/8 inch in depth.

It should be pointed out the 27, 29, and 26 year life of the pavement referred to is from the life analysis only and apparently does not take into consideration the design equation that must be satisfied for a 20 year design.

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INTERSTATE

THE STATE DEPARTMENT OF HIGHWAYS



STATE OF COLORADO

November 17, 1969

ION OF HIGHWAYS
TE OF COLORADO
E ARKANSAS AVE
R COLORADO 80222

CHAS E SHUMATE
EXECUTIVE DIRECTOR
&
CHIEF ENGINEER

Mr. A. R. Abelard
Division Engineer
Bureau of Public Roads
Room 267, Building 40
Denver Federal Center
Denver, Colorado 80225

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Dear Mr. Abelard:

Subject: Draft of Report entitled "Review of Program to Upgrade Deteriorated Segments of the Interstate Highway System:

We have reviewed draft report entitled "Review of Program to Upgrade Deteriorated Segments of the Interstate Highway System" and found that it points out many facts that we have all been aware of for many years.

We have never felt that the state-of-the-art for either flexible base or rigid pavement design methods has developed to the point of being anything near an exact science. Considering that projected traffic volume data is continually changing due to unforeseen developments and the economics of materials and construction methods used are continually changing, we believe that considerable "engineering judgment" will always be necessary in making a proper decision.

We certainly agree with the conclusions expressed on pages 19, 20 and 21. There will always be a need to upgrade completed segments of the Interstate System. Some equitable method will be necessary for determining when needed and the means of funding.

In regard to conclusions on pages 27 and 28, we believe that it would be almost impossible to determine if an overlay was only for the purpose of improving riding surface or for upgrading the structural strength. According

Mr. A. R. Abeland
November 17, 1969
Page 2

Interstate

to the theory, an overlay would automatically do both. Hence again we believe that some equitable method (possibly on a length of service basis only) should be provided to determine eligibility for any federal financing of overlays.

We agree with the conclusions and recommendations as expressed on pages 37 and 38.

Very truly yours,



CHAS. E. SHUMATE
Chief Engineer

CES:as

cc: L. C. Bower
F. K. Merten
T. C. Reseigh
A. Zulian

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JERS
 ZNS
 CHAIRMAN
 O A LACHARITE
 D SHAW

TER L POOR
 CHIEF ENGINEER



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Maine State Highway Commission

AUGUSTA, MAINE 04330

November 21, 1969

R. D. Hunter, Division Engineer
 Bureau of Public Roads
 Room 614, Federal Building-Post Office
 Augusta, Maine 04330

Dear Mr. Hunter:

Reference is made to your letter to me under date of November 12, 1969 in which you enclosed for review purposes one copy of GAO Draft Report Entitled "Review of Program to Upgrade Deteriorated Segments of Interstate Highway System."

William D. Harris, Design Engineer, has commented on certain statements contained in the report and his comments are attached hereto for your information. I believe they are self-explanatory.

If you have any questions we will be glad to have you get in touch with us in this matter.

Very truly yours,

David H. Stevens, Chairman
 Maine State Highway Commission

DHS/b
 attach.

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APPENDIX V

Page 2

COMMENTS BY WILLIAM D. HARRIS REGARDING "REPORT TO THE CONGRESS OF THE UNITED STATES, REVIEW OF PROGRAM TO UPGRADE DEGRADED SECTIONS OF THE INTERSTATE HIGHWAY SYSTEM, FEDERAL HIGHWAY ADMINISTRATION, DEPARTMENT OF TRANSPORTATION" (Draft Copy)

Chapter 2, page 18

GAO states that, "it appears to us that a significant amount of the approximately 27,000 miles being constructed after 1963 may also require overlays before expiration of the Interstate construction program."

Our new pavement design north of Stillwater Avenue in Old Town is in excellent condition after 4 years of use. Based on a 1974-1976 interstate completion date I cannot possibly visualize the need for an overlay, therefore, Maine should not be included in this assumption.

prior to 1972
I also disagree with the statement on page 19 that states, "flexible pavements will require an overlay to restore the riding qualities after about every 10 to 12 years." We have many primary roads today that have adequate riding surfaces which are older than 10 years. As previously pointed out, our new interstate design north of Old Town is 4 years old and is rated excellent.

Chapter 3, page 27 -

CONCLUSIONS

It is concluded by GAO that the portion of overlay needed to restore the safe and efficient riding surface of the existing pavement should be borne by the States.

The pavement structure in question was designed prior to the AASHTO Test Road, therefore, a design analysis was never developed. It was assumed at that time that the design would give adequate service, however our actual experience proved otherwise. This is the primary truck route through the center of the State, therefore, I-95 undergoes severe loading conditions compared to our other highways. Design analyses made in 1967 show that this road was structurally underdesigned. Cracks occurred in the pavement in about 3 years and they continued to increase at an accelerated pace. Other conditions such as water, frost and the open graded nature of our bituminous macadam base course accelerated pavement failure beyond our expectations, in fact, this condition cannot be accurately predicted with Test Road data.

Our I-95 received normal maintenance.

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We feel that had the interstate been constructed as it was north of Stillwater Avenue in Old Town, overlays would not be needed at this time. Our design analysis overlay depth of 5 1/4" is required to establish structural integrity to the existing pavement structure before additional damage is done which could result in complete removal and replacement of the existing structure (including pavement and granular base courses).

Chapter IV, page 33
Frequency of Design Analyses

In the paragraph pertaining to Maine, the inference is made by GAO that Maine's overlay depths were not based on the Design Analysis because we use more than one overlay depth, however, the Design Analysis called for 5 1/4".

We certainly did not ignore the Design Analysis but did choose to construct the 5 1/4" in two stages. The first stage varied from 1 3/4" to 5 1/4", whereas the second stage would consist of 5 1/4" minus the first stage. The second stage would be applied near the terminus of interstate funds or when required to improve the structural quality of the pavement. This procedure would allow us to evaluate our design analysis under actual operating conditions, thereby allowing us to make minor adjustments prior to placing the second stage overlay.

Chapter IV, page 37
CONCLUSIONS

The GAO believes it essential that FHWA establish more precise procedures for determining when and where overlays should be placed and how thick they should be.

I would like to point out that pavement overlay thickness cannot, at this time, be precisely determined. This problem is recognized by recent literature which points out the need for further research which will take several years.

11/19/69

NEW MEXICO
STATE HIGHWAY COMMISSION



P O BOX 1149
SANTA FE, NEW MEXICO
87501

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November 13, 1969

Harold W. Adkison
Division Engineer
Room 113, United States Courthouse
Bureau of Public Roads
Santa Fe, New Mexico

Dear Sir:

Subject: GAO Draft Report - Overlays on Interstate Systems
Pavements

Returned herewith is a draft copy of a proposed report of the General Accounting Office to the Congress concerning overlays on Interstate Systems Pavements.

This office has no particular comment to make other than as noted on page 14 of the subject report, the investigators, while not making an out and out statement, appear to agree with the stage construction concept.

Yours very truly,

L. G. BOLES
State Highway Engineer

By:

Wyman W. Guthrie
Materials & Testing Engineer

WWG/vs
cc: Charles W. Johnson
attachment



OREGON STATE
HIGHWAY DEPARTMENT

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HIGHWAY BUILDING • SALEM, OREGON • 97310 • Phone 364-2171

November 25, 1969

Mr. R. E. Simpson
Division Engineer
Bureau of Public Roads
Post Office Box 300
Salem, Oregon 97308

Dear Sir:

Re• 08-35 1

Our comments on the General Accounting Office draft report entitled "Review of Program to Upgrade Deteriorated Segments of the Interstate Highway System" are as follows.

Although this draft is 43 pages, much of it is repetitious and much of it relates to law or mileage statistics

For review purposes, there are three major points that warrant consideration:

- 1 To inquire into the magnitude and nature of the states' overlay program.
2. To inquire into the effect on the funding of the Interstate Highway System.
3. To inquire into the relationship between the program and the statutory responsibility of the states to maintain the Interstate System

The magnitude of the program became apparent in the 1968 Cost Estimate when it was determined that at least 30 percent of the asphalt concrete surfaced highways and 85 percent of the rigid pavements constructed before December 1963 were in a distressed condition and in need of overlays. The total estimated cost at that time for this work was \$200 million.

Mr Simpson
Page 2
November 25, 1969

In Oregon, surfacing sections designed and constructed prior to 1963 made use of procedures in existence at the start of the interstate program. Generally, for flexible pavements, a 3-1/2 to 4-inch depth of asphaltic concrete over varying depths of base rock was considered adequate. However, in the late 1950's and early 1960's, it became apparent that we were not designing strong enough, particularly with respect to the top portions of the surfacing section. This underdesign came about as a result of a lack of knowledge of the supporting values of the soil conditions and an underestimation of the heavy truck traffic increase that occurred. Consequently, we were experiencing accelerated deterioration in our surfacings. In 1964, continued observations and studies led to a different method of design (and this was based partially on the basis of AASHO road tests) which has been in use since that date. We believe that we are now providing adequate strength for the design life of our sections, when one considers that we have used stage construction procedures up until about the last year.

Nevertheless, we agree with the findings of this draft to the effect that we cannot guarantee that all surfacings designed since 1964, whether they be flexible or rigid, will last the 20-year design period without deterioration to the degree that would require an overlay of more than maintenance proportions. In other words, some of the surfacing constructed since 1964 may need heavier overlays than the two inches indicated on our stage construction program before the end of the interstate program.

We also agree with the draft that more accurate methods of determining the need for overlays and the thickness of them, as well as accurate costs to reflect these needs, are required and we sincerely hope that leadership from the Federal Highway Administration brings about certain criteria which will allow us to perform this work.

We cannot agree with the draft in its application to the maintenance program. The GAO seems to conclude that the states have not performed adequate maintenance on the Interstate System because we are then able to get a measure of maintenance in the fully participating overlay work. Our maintenance program has preserved the Interstate System as needed in a safe and efficient manner. On older sections very substantial amounts of surface maintenance has been accomplished in order to keep these older sections from deteriorating abnormally. It must be stated Oregon experienced in 1968-69 one of the worst winters in history.

Mr Simpson
Page 3
November 25, 1969

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As a result, many highways--including some on the Interstate System--suffered considerably. The State of Oregon has been very hard-pressed this year in order to provide the necessary maintenance to these highways. This difficulty has been two-fold. First, from a standpoint of sufficient funds to handle the required work and second, from a standpoint of capability of producers to produce the necessary asphaltic concrete.

Nevertheless, we believe that we have met the challenge and that we have met our maintenance responsibility.

Under the circumstances, we do not agree with the draft that the states should bear a portion of the overlay costs on the basis that they have not maintained the surfaces adequately.

We agree with the conclusions in this draft concerning the methods used to determine overlays. In the past few months, we have been gathering Benkleman Beam deflections on sections of the interstate where we have previously performed condition surveys. With these deflections, it was possible to determine overlay depths by the California deflection method and compare them with the depths determined by our condition surveys. We find that the two methods check very closely for required depths. Under the circumstances, we suggest that the deflection method is accurate and has definite advantages over any other known method because.

- (a) It is faster, easier, cheaper and nondestructive.
- (b) The predominant cause of surfacing failure is failure from fatigue, the result of excessive deflection under load. The deflection method offers a positive method of monitoring the rate of deterioration in a surfacing, and determining the load-carrying capacity at any time.
- (c) This method has been recommended for adoption in Final Report NCHRP 1-11, "Evaluation of AASHO Interim Guides for Design of Pavement Structures", and so has general distribution.
- (d) Use of the present flexible guide to determine depth of overlays requires judgment in assigning strength coefficients to each layer of the existing pavement. Errors in assigning strength values

Mr Simpson
Page 4
November 25, 1969

can result in overdesign or underdesign.
The deflection method, by measuring the load-
carrying capacity directly, eliminates the
need for assigning values.

In summary, and with the exception of maintenance,
we do not disagree with most of the conclusions as reported
in the draft.

Very truly yours,



Forrest Cooper
State Highway Engineer

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COMMISSION
WITT C. GREER CHAIRMAN
ROBERT C. PETRY JR.
BRETT MORRIS

TEXAS HIGHWAY DEPARTMENT

AUSTIN TEXAS 78701

November 21, 1969

STATE HIGHWAY ENGINEER
J. C. DINGWALL

IN REPLY REFER TO
FILE NO. D-SF

Mr. J. F. Cary
Division Engineer
Bureau of Public Roads
Austin, Texas

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General Accounting Office Draft Report "Review of Program to Upgrade Detrimental Segments of the Interstate Highway System"

Dear Sir:

Reference is made to your letter dated November 10, 1969, in which you requested our comments regarding the General Accounting Office's Draft Report. Our staff has reviewed the draft report and find it to be very general in nature, however, we would like to offer the following comments thereto. As you are aware many sections of our Interstate were constructed prior to the designation of the Interstate System and were constructed on right of way purchase by the counties. Prior to the Interstate System, the Texas Highway Department constructed many projects using stage construction. This was a usual and normal practice and at the time of the inception of the Interstate System the plans for many projects had been previously completed and then were let with Interstate Funds upon its beginning. These projects did not provide for the type of ultimate design that we now use on the Interstate System.

We offer the following specific comments referred to by page numbers:

1. Page 14 - Overlay of Rigid Pavements

We note that the GAO states that the problem associated with rigid pavements needing overlays consists of primarily bad cracks and joints and an inadequate base structure which resulted in unacceptable riding surface. We believe that this is adequate justification for an overlay. We would like to

Mr. J. F. Cary

November 21, 1969

point out that in nearly every case where we overlay any concrete pavement, regardless of the system, we do some reconstruction by removing badly broken and deteriorated concrete slabs.

2. Page 16

The GAO states that they were informed that a flexible overlay over a rigid pavement either added no strength to the total pavement structure or added so little that it would not be beneficial from a structural standpoint. Based upon the many years of experience in our Department, we believe that flexible overlay over rigid pavement does add strength and is a benefit from a structural design point. This has been confirmed in recent deflection studies by the Department.

3. Page 17 - Scope of Overlay Program

As previously pointed out many miles of Interstate System in Texas were constructed prior to the Interstate System. We believe that the report should show those sections that which we so incorporated in the Interstate System. In Texas there is approximately 200 miles that was constructed prior to the Interstate System.

4. Page 21 - Matters for Consideration by Congress

We believe that if truck weights are going to be allowed to increase that the Highway Trust Funds should be used to provide a continuing upgrading of the Interstate System.

5. Page 25 -

We note that the GAO states that Texas has provided numerous overlays on Interstate segments as a part of their maintenance program. These were not placed as a part of our maintenance program, but out of the regular funds used to construct the Highway System. FAI participation would have been requested for this project had it been considered eligible at that time.

Mr. J. F. Cary

November 21, 1969

6. Page 28 - Recommendations to the Secretary of Transportation

We would object to the Secretary directing that maintenance standards for highways be established with the recommendation that certain overlays be required from time to time. We feel that this is the States prerogative within the funds allocated to them.

7. Page 37 - Conclusions

There is one area of discussion, however, on which we have a very definite opinion. We concur with their conclusion that better and more realistic type guide lines need to be developed for determining the depth of pavement overlays.

In our opinion, AASHO road test equations as used in the Interim Guide are not applicable to these conditions and give unrealistic answers when so used. Further evaluation and implementation of recent research work would be in order, supplemented by additional studies if necessary, to develop design guide lines for pavement overlays. An AASHO Design Subcommittee is presently working on these objectives.

Sincerely yours

/s/ J. O. Dingwall

J. O. Dingwall
State Highway Engineer

OFFICE OF THE
COMMISSIONERSTATE OF VERMONT
DEPARTMENT OF HIGHWAYS
MONTPELIER

05602

November 21, 1969

A. R. Purchase, Division Engineer
U. S. Bureau of Public Roads
Federal Building
Montpelier, Vermont 05602

Dear Mr. Purchase:

We have received and completely staff reviewed the General Accounting Office Draft Report entitled "Review of Program to Upgrade Deteriorated Segments of the Interstate Highway System," forwarded with your letter of November 10, 1969. We are pleased to comment on this report, because we feel it has great importance both to this State and nationally.

It is our feeling that the matter of upgrading the Interstate System will eventually become a matter for Congress to decide and act upon. The report points out, and we agree, that a substantial portion of the Interstate System may not be structurally adequate to carry the design year traffic. We feel that this is not due to inferior construction or poor design practice, but is due to the admitted fact that pavement structure design is not, up to the present time, an exact science. For a highway designed for a twenty year life, it is implied that the highway will be geometrically designed to have the capacity to carry the predicted traffic volume over the twenty year period, as well as being structurally designed to carry the weight of the vehicles. Whereas it might be possible to construct a flexible pavement that would give acceptable service for a twenty year period, it is probably more practical and more economical in the long run to structurally upgrade the pavement several times during the twenty year geometric life of the highway. On this basis, it would appear perfectly logical to expend FAI funds for this structural upgrading.

This report goes at length into the question of the responsibilities of the states to perform maintenance on the Interstate System. We would expect to perform "normal maintenance" on the Interstate Highways in Vermont, but it is our contention that "normal maintenance" is that maintenance required to safeguard the quality or condition of the highway, and would include maintaining ditches and drainage structures, and whatever surfacing might be required to keep the surface of the traveled way and shoulders waterproof, to counteract the normal aging process of flexible pavements. To this end, Vermont has, since 1965, placed a thin overlay on 5 miles of our Interstate Highway. It is obvious that a portion of our Interstate Highways have undergone a structural breakdown under traffic loads, and that this breakdown could not have been prevented by "normal maintenance," and cannot be repaired by "normal maintenance."

A. P. 1001-10

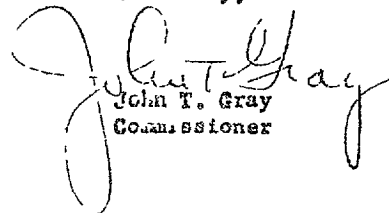
November 21, 1969

Furthermore, we feel that it is important that Congress recognize that the burden of maintenance of the System does not fall equally on all states. The Interstate System mileage was not assigned to the states on a per capita or land area basis, but was based on the requirement to create a complete and integrated network of highways for interstate travel and defense considerations. As a result some states, such as Vermont, will bear a greater burden than other states when it comes to the upkeep of the System. Whereas the report recommends that a portion of any overlay represents "normal maintenance," and that therefore a portion of the cost should be borne by the states, we feel that at the present fund matching ratio of 90-10, the 10 percent paid by the state does represent our contribution to the cost of the upkeep of the highway, when taken in addition to the other maintenance operations that are being performed.

In commenting on the conclusions presented in Chapter 4 of the report, we are in agreement with the report that a more standard method should be established, nationally, for determining when an overlay should be placed, and how thick this overlay should be. When Vermont considered the need to perform an overlay on a section of Interstate Highway, the existing Bureau of Public Roads memorandums were studied and followed. A joint field inspection with Bureau personnel was conducted, and it was evident by visual inspection that the road surface had deteriorated to the point where the riding qualities were poor, and the road had failed structurally. A standard method of determining the present Serviceability Index could result in earlier action, before extensive failures had been allowed to occur. Likewise, in determining the depth of overlay to be applied, Vermont performed various tests on the roadway, and performed the design analysis in accordance with existing Bureau of Public Roads instructions. The results obtained were used, modified only by practical paving considerations. We would recommend a uniform method be adopted for the computation of overlay depths, but any standard method would have to recognize that the factors of climate, construction materials, and subsurface conditions vary throughout the Country, and would have to be considered in any standard design method. National guidance would result in fairer and more uniform practices among the states.

In conclusion, we feel that the matter of keeping the Interstate in good condition, whether it be called stage construction, overlays, or maintenance, is of extreme importance, and that the Congress should be made fully aware of the ramifications of this problem. It would be our hope that Congress recognize that the problem is of national significance just as the Interstate System itself is of national importance, and that it would be in the best interests of the Country and the states to have a portion of the Highway Trust Fund used for the upkeep and upgrading of the Interstate System.

Sincerely,



John T. Gray
Commissioner

JTG/BAB/mcl
cc: R. H. Arnold via EVS
R. J. Nicholls
BPR Liaison Section

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STATE OF WASHINGTON
DANIEL J. EVANS, GOVERNOR



WASHINGTON
STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

G. H. ANDREWS, DIRECTOR
HIGHWAYS LICENSES BUILDING
OLYMPIA

November 28, 1969

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IN RUPP
SEATTLE
RENZ GOETZ SECRETARY
OLYMPIA

Mr. Roe P. Rodgers
Division Engineer
Bureau of Public Roads
Olympia, Washington

Re: GAO Draft Report "Review
of Program to Upgrade
Deteriorated Segments of
Interstate Highway System"

Dear Sir:

Thank you for sending us a copy of the above draft report.

The conclusions drawn from the report seem to be that overlays are necessary, that more overlays can be expected and that it is desirable at this time to formulate some new rules for determining who is going to pay for them. With this, we can hardly disagree and the GAO report seems generally fair and objective in these areas, except as noted hereafter.

We have several comments on statements contained in the GAO report which are found later in this report. In addition, we would like to comment on two particular aspects of the GAO report: first, the basic concept of stage construction versus overlays, and second, the "reverence" with which the AASHO Interim Guide is viewed throughout the report.

We feel there is a distinct difference between "pavement overlay" and second stage construction. Overlay connotes repair of a pavement failing unexpectedly, while "second stage" means the planned strengthening of a pavement at a finite time period after the initial construction. Our philosophy, as pertains to pavement design, is stated quite well on Page 13 of the GAO report -- "Washington follows the concept of stage construction and generally anticipates application of the second stage about 10 years after initial construction. They expressed their belief that flexible pavements cannot be designed to last 20 years without an overlay. Based on their experience, they believe that an additional layer of pavement from 2 to 4 inches is necessary at the end of about 10 years".

Obviously, if this concept is accepted as valid, and we believe it is, then we are placing second stage pavement, not overlays, and this GAO report is referring to someone else as far as we are concerned.

Mr. Roe P. Rodgers
November 28, 1969
Page 2

In those few instances where we have asked for Federal Interstate participation in the second stage pavements, we have gone through all of the necessary steps as though they were overlays. We would like to stress the above point, we have in each instance made a detailed study of the existing pavement structure, evaluated all conditions such as traffic, environment, etc., and made a complete design analysis to determine the amount of the second stage pavement. This is contrary to the statements on Page 8, Paragraph 1, and Page 35, Paragraph 3, of the GAO report.

The staging of future pavement layers, which is a basic part of our design procedure is in every sense a planned and designed operation and as such should not be considered as overlay construction. It is designed to realize the "full economic benefit" of the investment - using the GAO terminology on Page 30, Paragraph 1. Actually "optimum economic benefit" more correctly describes our procedure.

The second aspect of the GAO requiring comment is the apparent reverence with which the AASHO Design Guides are seemingly viewed by all agencies of the government, the FHWA and the GAO. The guides for rigid pavements and for flexible pavements are, as their titles suggest, "Interim" guides. They have not to this date, some seven years after first distribution, been accepted by the AASHO Committee on Design and there is considerable doubt if they ever will be accepted in their present form. The shortcomings of these guides, and there are many, are generally well recognized, especially by agencies such as ours which have design systems equally sophisticated and backed by many more years of experience. It is disconcerting, to say the least, to be continually compared to this standard.

Although the report is generally objective, we could not overlook several items where some clarification of our practice and intentions is necessary. Some of these are discussed below -- it would take much too long to discuss each instance where the GAO's interpretation of design methods and procedures is superficial and fails to recognize ramifications of design practices.

Page 8 of the report states, "We did not attempt to isolate the precise factors which caused the deterioration of the highway segments that were or will be overlaid. However, we were unable to find any instances where State or FHWA officials made such determinations." This is simply not the case in our State. In every instance of roadway failure in our State whether for the purposes of overlay, second stage construction, or any other construction, we always make such a determination.

Further on in the same paragraph, they mention that deterioration of pavements can generally be attributed to inadequate design and that inadequate design encompasses such factors as traffic evaluation, soil support, etc. This is correct. It is in the realm of traffic forecasting that our greatest errors have occurred. Generally speaking, traffic volume has increased far faster in our State than the forecast indicated. This is one area certainly where a structural design such as the AASHO guide or ours, both of which utilize a "traffic load" parameter, could not be faulted. In addition, there is no way we know to enable an "adequate" design life of 20 years for asphalt concrete, without stage construction, no matter how many factors are evaluated correctly.

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Mr Roe P. Rodgers
November 28, 1969
Page 3

Further on in the report, it is alleged that the state-of-the-art of designing pavements had not reached the point where all of the design factors were given adequate recognition. We would like to point out that in our design system we evaluate every design factor that is evaluated in the AASHO guide formula and have been doing it for nearly twenty years. In some cases, as above with traffic data, the input has not proven to be adequate, but all of the factors were evaluated including the fact that no design procedure for AC can be expected to last twenty years without attention. Our design accommodates this fact by calling for stage construction -- a basic and necessary part of the design.

We would also like to defend, if that is the right word, our pavement rating system. This is not, as seems to be implied, a mere visual appraisal. It is a very practical and reasonable system that is quite objective in the way it is used. The essential difference between our system and the AASHO psi system lies in two areas: our system does not include equipment such as the Chloe profilometer which only worked on the AASHO test track and hasn't worked since, and it does recognize incipient failure and potential lack of serviceability through ratings of various degrees of distress.

One last observation we feel compelled to make, and which may appear to be somewhat contradictory to what we have said before, has to do with the apparent de-nigration of engineering judgment. We can appreciate the auditors' concern over what might seem, to him, the considerable design latitude allowed under "engineering judgment", but we can visualize no design system, not ours, and most certainly not the AASHO guide system, in which a certain amount of engineering judgment will not be necessary. In fact, it seems that use of the AASHO guide requires more exercise of engineering judgment than our method if any good can be realized from it.

In summary, it does appear that the GAO team has learned from their contacts with the highway departments that a 20-year design for flexible pavements cannot be realized by initial construction only. They have indicated that, within the framework of the Interstate policies, overlay construction contains some element of maintenance which is supposed to be the responsibility of the States rather than the Federal Government. Basically, the fallacy lies in the thinking behind the Interstate System that flexible pavements could be designed for twenty years, constructed to that design, and then require essentially no attention until the end of twenty years. We, together with other states, recognized this fallacy and determined that the optimum use of road construction money, regardless of its source, accrues from the stage construction of flexible pavements, with the second stage to be applied ten years, on the average, after initial construction.

This concept, unfortunately, is not compatible with the rules set up for administration of the Interstate System, and brings about the conflict between what is maintenance and what is stage construction or "structural overlay". It does appear to us, however, that the Federal Highway Administration has adopted a reasonable way of recognizing reality in structural pavement design by allowing overlays -- under the conditions imposed by appropriate policy and procedure memoranda. The report recommends that maintenance standards recognize need for overlays to establish "a safe and efficient riding surface" -- and that these be considered

Mr Roe P. Rodgers
November 28, 1969
Page 4

normal maintenance to be state funded. Whoever establishes these standards should be guided by the fact that a rough riding surface is usually a precursor of structural insufficiency and simple maintenance will provide only transient, superficial relief.

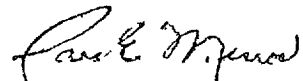
On the whole, the report seems quite objective for auditors except for the fact that they cannot believe that engineering judgment was, is, and always will be an essential part of structural pavement design and evaluation regardless of the number of laws passed, the number of audits conducted, or the number of dollars spent on test roads. Their objectivity is also questionable in accepting the AASHO design guides as infallible.

Lastly, the inference should not be drawn from this report that no design analyses was made for overlay construction on Interstate highways in the State of Washington. Each and every instance where overlay construction was approved for Federal funds was done on the basis of a detailed structural analysis which provided justification for such overlay.

Pavements are structures, true, but they are primitive structures when compared to bridges where all the materials components are subject to precise quality control and their strength and long-term durability can be predicted with confidence. The pavement designer, unfortunately, must deal with natural materials which seldom obey a neat set of performance criteria. He must take the heterogeneous materials as may exist and rearrange, stratify, treat or otherwise process them into a foundation which, hopefully, will interact as predicted with the overlying pavement portion of the total pavement structure. The fact that premature "failures" are the decided exception attests to his competence in meeting this complex challenge.

Very truly yours,

G. H. ANDREWS, P.E.
Director of Highways



By: CARL E. MINOR, P.E.
Assistant Director for
Management Services

CEM:meb

cc: W. A. Bulley
W. M. Foster
Roger V. LeClerc

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Stanley K Hathaway Gore
R G Stepp Superintenc

WYOMING
STATE
O BOX 1708 CHEYENNE WYOMING 82001
HIGHWAY
COMMISSION

November 28, 1969

32-02

Mr G M Williams
Director of Engineering and Operations
Bureau of Public Roads
Washington, D C 20591

Bureau of Public Roads
General

Dear Mr Williams

Your memorandum of November 7, 1969 to the Regional Federal Highway Administrators with which you enclosed the General Accounting Office draft report entitled "Review of Program to Upgrade Deteriorated Segments of the Interstate Highway System" and a request for this Department's comments has been referred to us by Mr John M. Demmer, Division Engineer of the Bureau of Public Roads This letter contains several comments reflecting the opinions of the Department Staff

First of all it should be pointed out that there appears to be some confusion on the part of General Accounting Office representatives regarding the terms "overlay", "Stage construction" and "deteriorated segments" While it is recognized that procedures of the various states visited by G A.O personnel may vary to a great extent, the report refers to "overlays" without reference to "stage construction" or whether "deteriorated segments" are involved or if the upgrading is a part of the final stage of surfacing

It should be noted that a distinct difference exists between the use of an "overlay" of a pavement that has been constructed to the ultimate design thickness and which shows deterioration as opposed to an "overlay" which is in effect a part of the planned stage development of the roadway surface and where deterioration is not necessarily a consideration

In all fairness it should also be pointed out that under the second situation referred to in the preceding paragraph, additional thickness of the overlay above and beyond that contemplated at the time of the original design may be authorized under a current FHWA policy concerning adjustment in design procedures for those projects constructed prior to October 1963

But the salient point here is that some states including Wyoming, have utilized the stage construction method on Interstate System projects in which the total design

requirements are not met until completion of the final stage regardless of the adequacy of the design. Whether or not the General Accounting Office considers the final stage in such instances as an "overlay" in the sense that it is a state responsibility and not eligible for federal participation is difficult to determine from the draft report

It would appear that since the original plans as well as the program authorization includes an ultimate surfacing thickness of 4" plus a 1" leveling course for those Interstate System projects constructed in Wyoming that no difficulty should be encountered in obtaining authority to complete these projects in accordance with the program documents.

There is some concern that the draft report tends to challenge the stage construction procedures as being costly and not entirely within the scope of the program. The experience of the Wyoming Highway Department with this procedure has been overwhelmingly favorable and we heartily endorse its continued use.

The following advantages and benefits have been realized by the stage construction procedure

1. More mileage of 4 lane divided highway has been made available to the highway user (the source of revenue for this program) at an earlier date. By opening up segments of the Interstate System at an earlier point in time, the highway user is provided a safer and more efficient facility than he was using before. The cost benefits to the user resulting from this procedure are unknown but they most certainly must far exceed any additional construction cost that might arise from the stage construction feature.

2. Initial project costs are lower when stage construction is used because of the opportunity to correct whatever deficiencies may have developed to the roadway structure prior to the time the final stage of surfacing is applied. The advantage here is that stage construction precludes the need to overdesign in questionable situations by providing an opportunity to correct deficiencies as noted above. This results in a more economical design and lower costs.

Following the award of our first Interstate Highway contract in 1956 which was a 19 mile section on I-80 west of Wamsutter and which was designed to what we considered at that time a complete project it was the consensus of the Department Staff that we were undoubtedly underdesigning as a result of our ability to accurately forecast the rate of increase in traffic at that point in time that could be reasonably expected to occur on the new Interstate Highway System. With this in mind it was mutually agreed between the Bureau of Public Roads and the Wyoming Highway Department that we would design on the basis of stage construction until at least a trend had developed that would provide more accurate forecasting methods.

This thinking has proven sound since the fore-mentioned project began to deteriorate and in 1965 required extensive repairs performed by contract and financed with

State funds Although this project was designed to adequately serve the traffic for the design year of 1975 it actually fell far short of that goal

As a result of the decision to utilize stage construction in Wyoming, there remains approximately 475 miles of pavement which requires the final stage of surfacing.

Due to changes in design procedures resulting mainly from the AASHO Road Test as well as certain research work and a change in the federal law extending the design period to 20 years from the design date, it is evident that a portion of this mileage will require an additional thickness over and above that originally planned.

It is presumed that this additional thickness can be justified on the basis of being within the intent of Congress, a fact apparently not considered by the General Accounting Office in its draft report.

Section 109 of Title 23 states in part ----"The Secretary shall not approve plans and specifications for proposed projects on any Federal-aid system if they fail to provide for a facility (1) that will adequately meet the existing and probable future needs and conditions in a manner conducive to safety, durability, and economy of maintenance, (2) that will be designed and constructed in accordance with standards best suited to accomplish the foregoing objectives and to conform to the particular needs of each locality ----"

From this it appears that Congress intended to turn over to the states upon completion of the Interstate Highway program a System that is safe, durable and so designed and constructed as to preclude it becoming a burden to the state as far as the maintenance function is concerned.

If total compliance with this intent of Congress is to be achieved, criteria for all phases of design should be based upon those standards deemed necessary to achieve this objective.

For example, if it is determined that the structural design of the pavement on a particular project fails to meet the standards that will be "conducive to safety, durability, and economy of maintenance" then the criteria upon which the design of the pavement was based must be changed and the pavement upgraded to meet the new standards that will insure compliance with the intent of Congress. In this case FAI funds should be made available for participation in the cost of the upgrading.

This concept should apply regardless of the fact that the deficiency occurs in the design of the pavement or of the sub-grade.

It should be pointed out that in many areas of the country variable soils and swelling soils contribute to a condition that is not "conducive to safety durability and economy of maintenance".

Although considerable research is being conducted to improve "the state of the art" and results of this research are being applied to the design of sub-grades which are composed of soils of this type, problems and failures still occur. Procedures that effect positive cure of the ill-effects of these soils are not reliable and are quite costly when implemented. Because of this such cures are not always warranted, a fact that again emphasizes the desirability of stage construction (as previously described in this letter) as well as a literal and practical interpretation of the intent of Congress as described in Section 109 of Title 23.

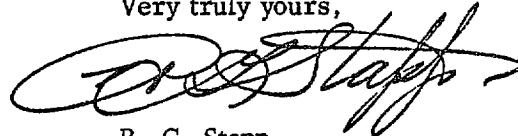
There is no argument against the statement contained on Page 22 of the draft report which says "Maintenance of the Interstate System is by law a state responsibility". But it can be argued that prior to accepting this responsibility, the state should be assured that FAI funds will be provided to properly design and construct a facility that will be "conducive to . . . economy of maintenance". This Department is in agreement with the opinion expressed in the draft report that overlays are required from time to time to provide a safe and efficient riding surface and should represent a normal maintenance operation but only after the provisions of the federal law have been fulfilled.

This appears to be the crux of the entire matter of upgrading pavements on the Interstate System by the use of overlays. The scope of the problem is well covered in the draft report. But this Department must take issue with the General Accounting Office personnel who prepared the report since it is quite apparent little if any consideration has been given to that portion of the federal law so often quoted in this letter.

We believe these concepts to be in the public interest. Much concern has been expressed by the states regarding the high cost of maintenance of the Interstate System. Some states are proposing federal assistance to help defray these rising maintenance costs. Other states oppose this proposition. All states should agree that the Interstate Highway System should be turned over to the states in such a way to assure economy of maintenance. Present policies preclude this.

It is requested the position of the Wyoming Highway Department in respect to this question be presented to the appropriate committees of both the House of Representatives and the Senate during their deliberation of the General Accounting Office Report.

Very truly yours,

A handwritten signature in dark ink, appearing to read "R. G. Stapp", written in a cursive style with a long horizontal flourish extending to the right.

R. G. Stapp
Superintendent

PRINCIPAL OFFICIALS OF THE FEDERAL GOVERNMENT
RESPONSIBLE FOR THE ADMINISTRATION OF
THE INTERSTATE HIGHWAY PROGRAM

	<u>Tenure of office</u>	
	<u>From</u>	<u>To</u>
SECRETARY OF TRANSPORTATION:		
John A. Volpe	Jan. 1969	Present
Alan S. Boyd	Apr. 1967	Jan. 1969
FEDERAL HIGHWAY ADMINISTRATOR:		
Francis C. Turner	Mar. 1969	Present
Lowell K. Bridwell	Apr. 1967	Feb. 1969
DIRECTOR OF PUBLIC ROADS:		
Ralph R. Bartelsmeyer	May 1969	Present
Francis C. Turner	Jan. 1967	Mar. 1969