61C

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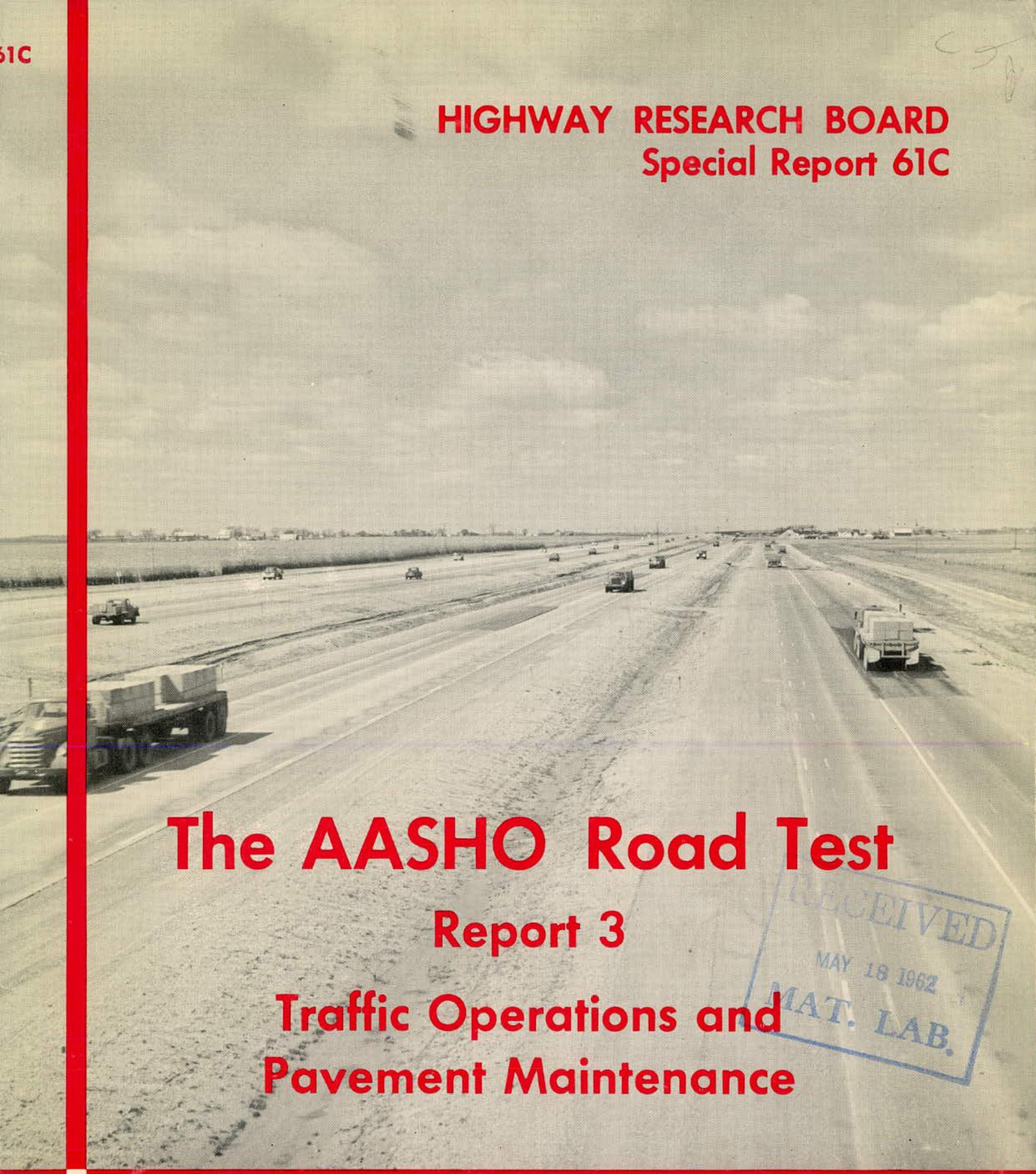
Special Report 61C



The AASHO Road Test

Report 3

Traffic Operations and Pavement Maintenance

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The AASHO Road Test

Report 3

Traffic Operations and Pavement Maintenance

By the

HIGHWAY RESEARCH BOARD

of the

NAS-NRC Division of Engineering and Industrial Research

Special Report 61C

Publication No. 952

National Academy of Sciences—National Research Council

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This is one of a series of reports of work done under a fiscal agreement of June 10, 1955, between the National Academy of Sciences and the Bureau of Public Roads relating to AASHO Road Test Project; and under individual agreements covering Cooperative Highway Research Project (AASHO Road Test) made between the National Academy of Sciences and the several participating state highway departments, members of the American Association of State Highway Officials.

Included in the series are the following reports:

Report	*Subject*	*HRB Special Report No.*
1	History and Description of Project	61A
2	Materials and Construction	61B
3	Traffic Operations and Pavement Maintenance	61C
4	Bridge Research	61D
5	Pavement Research	61E
6	Special Studies	61F
7	Final Summary	61G

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Preface

The AASHO Road Test was conceived and sponsored by the American Association of State Highway Officials as a study of the performance of pavement and bridge structures of known characteristics under moving loads of known magnitude and frequency. It was administered and directed by the Highway Research Board of the National Academy of Sciences—National Research Council and was considerably larger and more comprehensive than any previous highway research study.

This report is the third in a series of major reports on the AASHO Road Test. The first report is a history and description of the project. The second is a detailed account of the materials and the construction of the test facilities. Subsequent reports cover the results of the research on pavements and bridges as well as the results of certain special studies carried out at the test site.

This report is presented in three chapters. The first is a brief description of the project; the second describes the test vehicles, their operation and maintenance; the third covers the maintenance of the test pavements and bridges.

The basic data for this report are available in the form of IBM printouts or are on file for review in the Highway Research Board library. A comprehensive catalog of available data systems may be obtained from the Board.

Acknowledgments

Assistance of personnel from many organizations was required in preparing for and carrying out test traffic operation and maintenance of the test pavements. It is impractical to list every individual in this report. However, the efforts of the following organizations are particularly acknowledged:

The Department of Defense, for services of personnel of the U. S. Army Transportation Corps Road Test Support Activity (AASHO), and technical advice and services of personnel from the Transportation Corps, Department of the Army.

The Automobile Manufacturers Association and the Truck Trailer Manufacturers Association, and their member companies, for technical advice and services in many areas, and specifically for assistance in preparing for the carrying out of vehicle operations and maintenance programs.

The American Petroleum Institute, and representatives of member companies, for technical advice and services.

The Tire Industry, and representatives of member companies, for technical advice and services.

The S. J. Groves and Sons Company, General Contractors, for the loan of key personnel.

District 3, Ottawa, Illinois Division of Highways, for technical advice and services pertaining to traffic operation and pavement maintenance.

The many organizations, agencies and firms for extraordinary efforts in furnishing necessary supplies, materials and services for the vehicle operations and pavement maintenance.

Definitions of Terms

The following are definitions of terms used throughout this report:

Truck Tractor. A motor vehicle designed primarily for drawing truck trailers and constructed so as to carry part of the weight and load of a semitrailer.

Semitrailer. A truck trailer equipped with one or more axles and constructed so that the front end and a substantial part of its own weight and that of its load rests on a truck tractor.

Fifth Wheel. A device used to connect a truck tractor to a semitrailer and to permit articulation between the units. It generally is composed of a lower half, mounted on the truck tractor and consisting of a trunnion, plate, and latching mechanism, for connection with a kingpin mounted on the semitrailer.

Axle Load Application. The passage of one loaded axle, or a tandem axle combination, over a given point on the pavement. At the Road Test all vehicles except those in lane 2 of Loop 2 had two equally loaded single axles or tandem axle combinations. Therefore, each passage of a vehicle, except as noted, provided two axle load applications.

Present Serviceability Index. A numerical index computed from objective measurements of certain types of surface characteristics and indicative of the ability of the pavement to serve traffic at any particular time in its life history. At the Road Test the index was on a scale of 0 to 5, in which 0-1 was termed very poor, 1-2 was poor, 2-3 was fair, 3-4 was good, and 4-5 was very good. Those unfamiliar with the concept may obtain some perspective from the following: The best new pavements have an average serviceability index of about 4.5; it appears that state highway departments would want to improve the pavements on main highways when their serviceability had dropped to a range of 2.5 to 2.0.

At the Road Test pavements were considered unsafe for traffic and were dropped from study when the serviceability reached 1.5. The present serviceability of each of the Road Test sections was determined every two weeks during the traffic testing, and performance of the pavements was considered to be represented by the trend of serviceability with load applications. (A brief explanation of the serviceability-performance concept is included in Road Test Report 1 (HRB Special Report 61A) and a detailed explanation is given in HRB Bulletin 250.)

Class 1 Cracking (flexible pavements). Fine, random cracks having no discernible definite pattern.

Class 2 Cracking (flexible pavements). A progression of Class 1 cracking into a definite pattern of cracks with widening of the cracks and slight spalling of the crack edges.

Class 3 Cracking (flexible pavements). A progression of Class 2 cracking with pronounced widening of cracks and separation of the surfacing into individual, loose pieces.

Wheelpath. One-half the width of a 12-ft wide traffic lane or test section.

Fog Seal. A bitumen sprayed at a very light rate on the surface of the asphaltic concrete.

Spot Seal. One application of bitumen covered with one application of stone chips.

Skin Patch. One application of bitumen covered with a thin layer of pre-mixed bituminous patching material.

Overlay. Bituminous concrete, machine laid.

Deep Patch and Reconstruction. Backfilling of an excavated hole with dense-graded aggregate, followed by surfacing with bituminous concrete. (Any such patch smaller than a full test section was called a deep patch.)

Wedge-Constructed Sections. Structural sections in flexible pavement tangents in which type of base material was an experimental variable. (The bases in these 160-ft long sections were constructed as "wedges" with the

thickness decreasing uniformly in the direction of traffic.)

"Free" Maintenance. Maintenance performed before a section was taken out of test, within the limits of the criteria outlined in this report (Section 3.1), and considered to be either a repair of a construction deficiency or a repair that did not alter the original structural characteristics of the pavement.

Removal and Replacement of Surface. Removal of surfacing material only and replacement with hot-mix. (A modified form of deep patch often done just prior to overlay.)

Data System. A collection of data which contains initial observations, summarized data, or results from analysis. A four-digit code is used to identify each data system in the Road Test.

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THE AASHO ROAD TEST
Report 3
Traffic Operations and Pavement Maintenance

Chapter 1

Description of the Project

This chapter is a brief description of the AASHO Road Test, including its background and concepts, and the location and layout of the test facilities.

1.1 BACKGROUND AND CONCEPTS

The AASHO Road Test was conceived and sponsored by the American Association of State Highway Officials as a study of the performance and capabilities of highway pavements and bridges under moving loads of known magnitude and frequency. The test was intended to develop engineering knowledge that could be used in the design and construction of new highway pavements and bridges, and in the preservation and improvement of existing pavements. It was intended also that the findings be used, in conjunction with data from other research, in advancing toward an ultimate goal of determining an optimum economic balance between vehicle operation costs and the costs of the highways.

The project was financed by 49 states, the District of Columbia, the Commonwealth of Puerto Rico, the Bureau of Public Roads of the U. S. Department of Commerce, the Automobile Manufacturers Association, the American Petroleum Institute, and the American Institute of Steel Construction. The Department of Defense, through the U. S. Army Transportation Corps Road Test Support Activity, furnished drivers for the test vehicles and personnel for the supervision of the drivers. Foreign countries and domestic materials and transportation associations were granted the privilege of resident observers and staff consultants at the project site, and their services were used in the conduct of the research.

The basic concepts of the AASHO Road Test were outlined in 1952 by the Working Committee of the AASHO Committee on Highway Transport. This committee also selected the test site near Ottawa, Illinois, about 80 miles southwest of Chicago.

In November 1954 the American Association of State Highway Officials approved the undertaking of the test. In February 1955 the Executive Committee of the Highway Research Board, with the approval of its parent organization, the National Academy of Sciences—National Research Council, accepted the responsibility of administering and directing the project.

A detailed history and description of the project is given in AASHO Road Test Report 1 (HRB Special Report 61A). AASHO Road Test Report 2 (HRB Special Report 61B) is a comprehensive account of the materials and construction of the test facilities, including summaries of data on materials and construction control and the as-constructed characteristics of the pavement and bridge structures.

The specific objectives of the project placed major emphasis on determining significant relationships between the performance of pavements of various designs and the loading applied to them, on developing a means of evaluating pavement capabilities, and on determining the significant effects of loading on bridges of known design and characteristics. Basic data from all Road Test experiments are filed on IBM cards and in other forms in

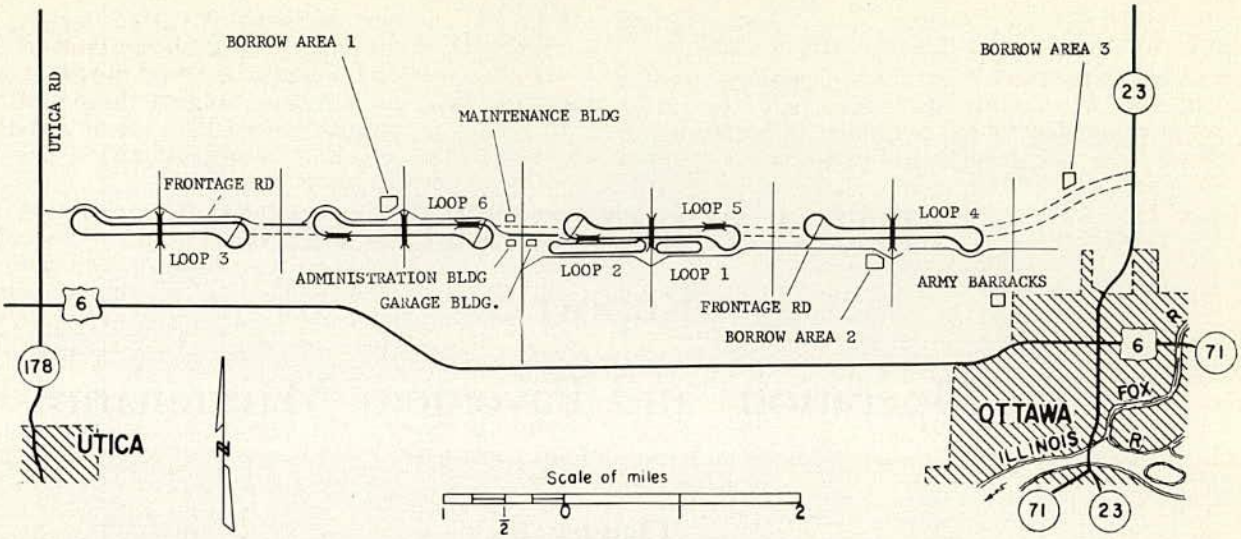


Figure 1. Map of AASHO Road Test.

numbered data systems. Data systems associated with bridge research are listed in Appendix A, Road Test Report 4; all other data systems are listed in Appendix I, Road Test Report 5.

Another requirement of the objectives was to provide a record of the type and extent of effort and materials required to keep each of the pavement test sections, or portions thereof, in a satisfactory condition until discontinued for test purposes.

1.2 LAYOUT OF THE TEST FACILITIES

The test facilities were constructed on eight miles of the right-of-way for U. S. Interstate Route 80 northwest of Ottawa, Illinois.

The facilities were built in six loops (Fig. 1). The four large loops (3 through 6) were constructed for testing under tractor-semitrailer traffic, Loop 2 was constructed for testing under light truck traffic, and Loop 1 was designed for testing with static and creep speed

Figure 2. View of Loop 5 (at left) and a portion of Loop 2. Test vehicles for Loop 5 are parked in the crossover road in the turnaround.

loads and for observations of the effects of time and weather on pavements with no traffic.

Each loop was a segment of four-lane divided highway whose parallel roadways, or tangents, were connected by turnarounds at both ends to form a two-lane loop. Tangents were 6,800 ft long in Loops 3 through 6, 4,400 ft in Loop 2, and 2,000 ft in Loop 1. On the four large loops the turnarounds had 200-ft radii and were superelevated (banked) at a rate of 0.1 ft per ft on the inner lane and 0.2 ft per ft on the outer lane, which allowed equalized lateral forces at 25 mph. The turnarounds on Loop 2 were superelevated at the same rates, but had 42-ft radii. Loop 1 had no superelevation.

The pavement on the north tangent and east turnaround of each loop was a flexible-type pavement constructed with and without subbase, with and without base, and with an asphaltic concrete surface. The pavement on the south tangent and west turnaround of each loop was a rigid-type pavement constructed with and without subbase, and with and without reinforcing steel in the portland cement concrete surface.

On each tangent the pavements were constructed in short sections of varied design. In most sections the design variables involved different levels of thickness of the component layers of material. On each tangent these sections made up a complete factorial experiment that included all possible combinations of the selected thickness levels.

In each tangent, pavement thicknesses for the factorial experiment sections were varied about a selected design that was considered adequate for the loading to be applied. Some of the factorial sections were thinner than the selected design, some were at or near it, and some were thicker.

Each structural section was built the full width of the 24-ft pavement and was separated into two identical test sections by the pavement centerline. The section length varied with the pavement design, and was 100, 120, 160 or 240 ft. Sections were separated from adjacent sections by short (10 ft to 70 ft) transition pavements.

In certain sections on the tangents of the four large loops, base type and shoulder paving were also design variables.

Including Loop 1, there were 836 pavement

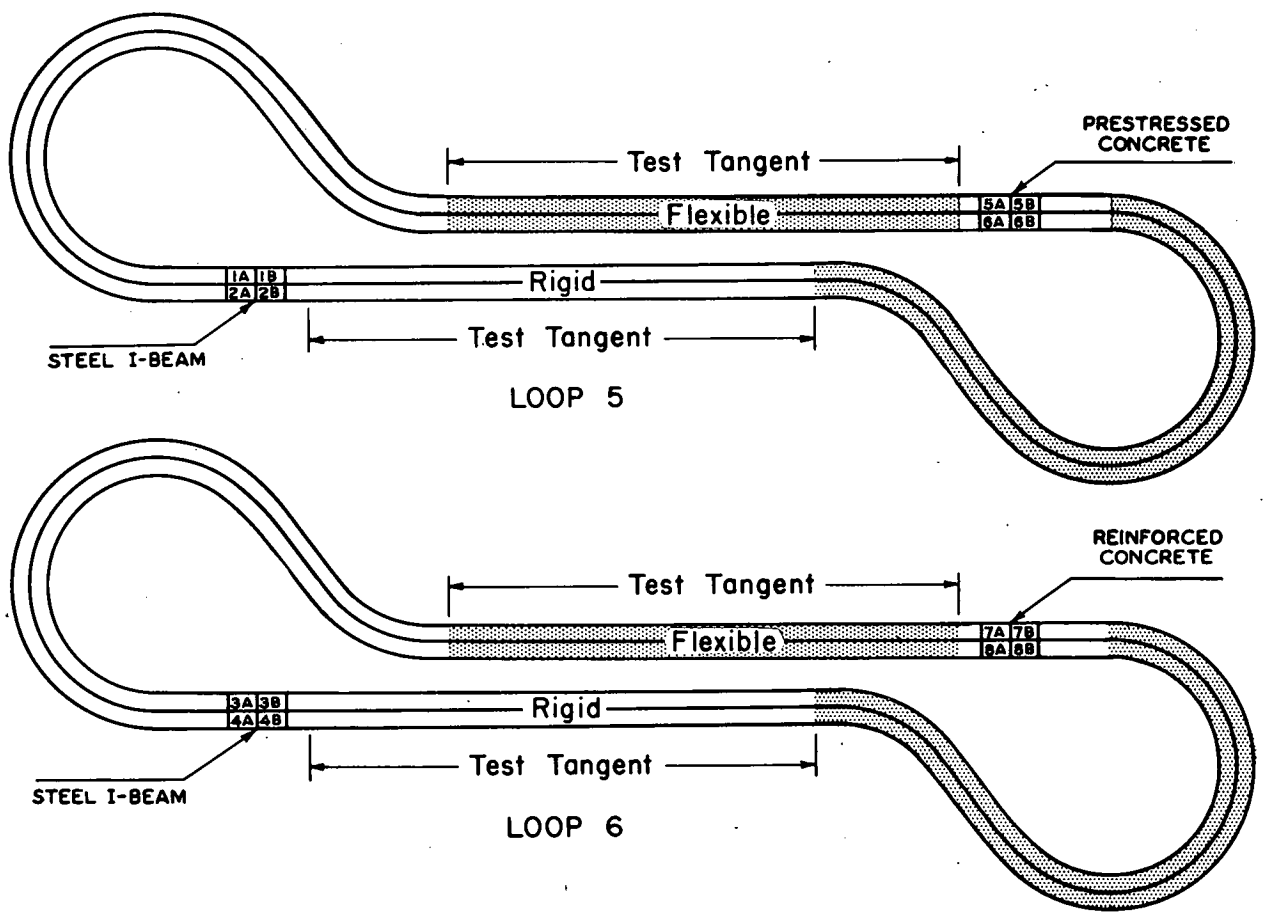


Figure 3. Locations of test bridges.

Figure 4. Test bridge site. Four 50-ft span bridges are built on common substructure.

test sections. Of these, 716 were subjected to controlled traffic loading.

The test facilities for the bridge experiments were constructed at four locations in Loops 5 and 6 (Fig. 3). At each location four separate 50-ft span bridges were built on a common substructure. Each bridge was a simple-span one-lane structure consisting of three beams and a reinforced concrete deck slab. In eight bridges the beams were wide-flanged rolled steel I-sections, some with and some without tension coverplates. In four bridges the beams were precast prestressed concrete I-sections; in the remaining four, the beams were reinforced concrete T-beams cast monolithically with the slab.

The bridge designs were based on stress levels substantially higher than those used in current practice.

Two of the original steel beam bridges failed early in the test traffic period and were removed and replaced with steel beam bridges of different design.

Road Test Report 1 (SR 61A) includes detailed descriptions of the layout of the test facilities and the pavement and bridge experiments.

The layout of the test loops provided ten lanes for traffic operation. Ten different combinations of axle load and axle arrangements were selected, and each was assigned to a traffic lane. Thus, any one pavement test section or test bridge was subjected to repetitive dynamic loading by vehicles with identical axle loads and axle arrangements.

Chapter 2

Vehicle Operations

This chapter outlines the objectives, organization and duties of the project's Operations Branch. It describes the characteristics of the test vehicles, their operating schedules and controls, and their accident record. It also discusses the procedures, policies and organization for vehicle maintenance.

Since the traffic operations at the Road Test were of a specialized nature, the data reported herein are for these special conditions and it is neither intended nor implied that they are indicative of normal vehicle fleet operation.

2.1 ADMINISTRATION

2.1.1 Operations Branch

The original plans for the AASHO Road Test, as outlined by the Working Committee of the AASHO Committee on Highway Transport, envisioned the application of one million axle loads on all surviving sections of test pavement in two years of traffic operation. This theoretical figure would have been possible with the original number of vehicles only if they had operated all of the scheduled time. As this was not possible, the number of vehicles was increased in January 1960 and a seven-day driving schedule was initiated to attain the objective.

The primary objective of the Operations Branch at all times was to approach, as nearly as possible, 100 percent of the theoretical rate of load applications.

The Operations Branch supervised test traffic operation and schedules, maintained the test vehicles, kept records pertinent to traffic operation and vehicle maintenance, and provided for liaison with the Army Transportation Corps Road Test Support Activity.

The Project Director and the Assistant to the Project Director maintained administrative control over the branch. Actual supervision of the branch was carried out by an Assistant Operations Manager and a Shop Superintendent.

When test traffic was officially inaugurated on October 15, 1958, the Operations Branch personnel consisted of the Assistant Operations Manager, the Shop Superintendent, a records clerk, a special services engineer, and two mechanics. However, as the work load developed and personnel requirements became clear, the branch was quickly expanded. By mid-1960, at the peak of traffic operation, branch personnel numbered 62. At that time, employees were assigned as follows:

Assistant Operations Manager	1
Shop Superintendent	1
Shop Foreman	2
Chief Records Clerk	1
Chief Parts Man	1
Chief Tire Man	1
Office Clerk	3
Clerk-Typist	1
Mechanic	20
Mechanic's Helper	12
Tire Man	9
Lubrication Man	3
Parts Man	3
Parts Runner	3
Fuel Attendant-Janitor	1
Total	62

There was little precedent to assist the management in planning the work programs of the Operations Branch. Invaluable advice and assistance were given by the Advisory Panel on Vehicles, the Special Subcommittee on Operations, the Automobile Manufacturers Association, the Truck Trailer Manufacturers Association, and representatives of various manufacturers. However, the operation of the test vehicle fleet involved many problems which were foreign to normal fleet operation.

As new problems arose policies and procedures were modified as necessary to meet the situation. Supervisory personnel within the branch were given authority to deal with problems and to make decisions within the scope of their specialized fields. Complete authority and responsibility for the vehicle maintenance program was delegated to the Shop Superintendent. He, in turn, delegated authority to foremen, the chief parts man, and the chief tire man.

In addition to its responsibility for scheduling test traffic, the Operations Branch maintained records of vehicle trips and axle load applications on each loop, and made daily reports on the number of applications and the

reasons for any application losses. The Branch also maintained records on the receipt and disbursement of parts, tires, fuels, and lubricants, as well as maintenance and fuel consumption records for each vehicle.

The Operations Branch was quartered in a prefabricated steel building located near the Administration Building at the center of the project (see Fig. 1). The building contained office space for the Assistant Operations Manager, the clerical staff, and the Shop Superintendent; a parts supply room; and the vehicle maintenance shop.

2.1.2 Army Transportation Corps Road Test Support Activity

The Army Transportation Corps Road Test Support Activity was a special military unit

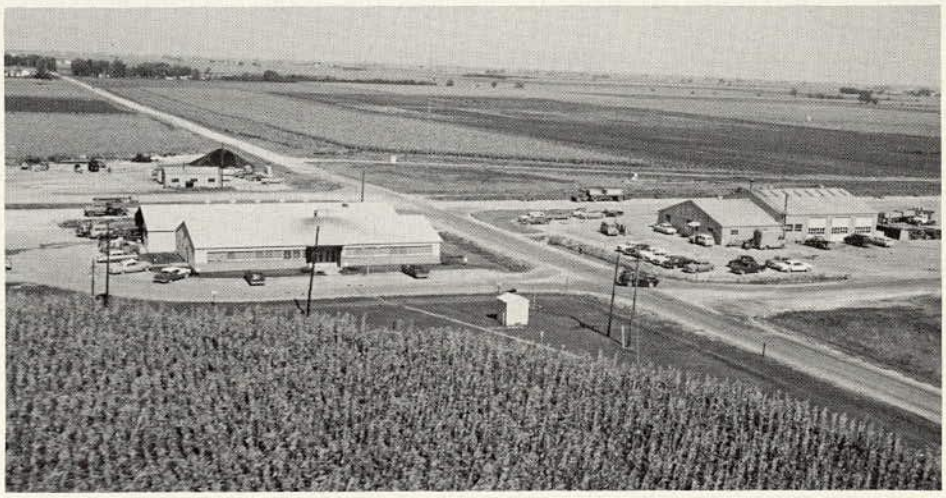


Figure 5. Administration Area at center of project. Building at left contains staff offices and laboratory. Building at right contains the Operations Branch and vehicle maintenance shop. Pavement maintenance building and equipment yard are to the rear.

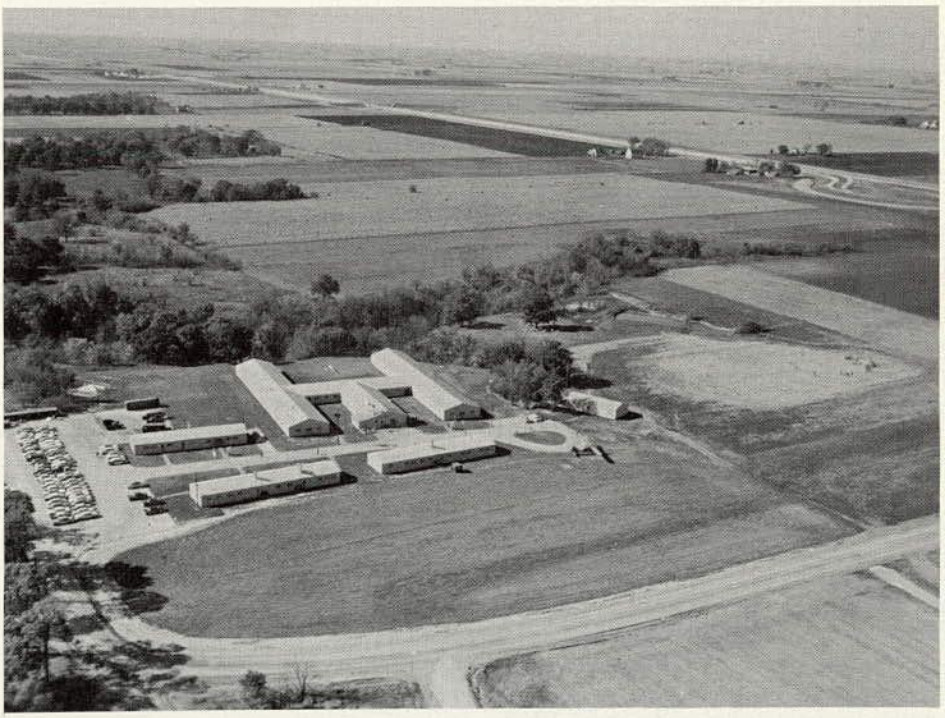


Figure 6. Housing, administration and recreational facilities for the Army Support Activity were in these five buildings near the east end of the project.

stationed at the AASHO Road Test site. Its primary mission was to support the project by supplying and supervising drivers for the test vehicles.

The services of the military unit were made available to the project through the cooperation of the Department of Defense which has a vital interest in the nation's highway network.

The Support Activity was made up of enlisted men and officers from the 10th and 62nd Medium Truck Companies, 48th Transportation Group, Fort Eustis, Virginia. Personnel were quartered in facilities provided by the Project and located just southeast of the eastern end of Loop 4 (see Fig. 1). These facilities, consisting of five prefabricated steel buildings (Fig. 6), were named Wallace Barracks.

Advance elements of the units arrived on the project in July 1958; the entire unit was on the project by September 1, 1958. Initial strength of the unit was approximately 300 officers and enlisted men.

In December 1959 the size of the unit was increased to approximately 450 officers and enlisted men in order to provide driver support for the increased number of vehicles and stepped-up driving schedules starting in January 1960.

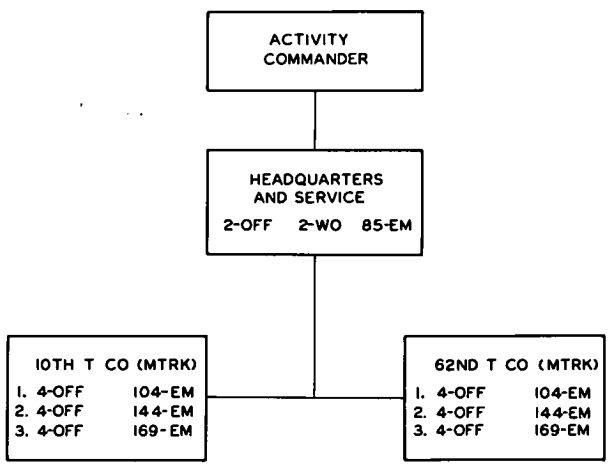
The unit strength declined rapidly following the end of the regular test traffic on November 30, 1960. However, a small nucleus of the unit remained to furnish driver support during special tests carried out at the project site during the winter of 1960-61 and the spring of 1961. All military personnel had left the project by mid-July 1961. In the organization chart for the Operations Activity Group (Fig. 7) the three periods correspond to the changes in number of vehicles and days of operation.

Two experienced Transportation Corps officers, a colonel and a lieutenant colonel, served as commanding officers during the three years that the Support Activity was in existence. A major and a captain served at various times with the title of executive officer or deputy commander.

Junior officers commanded the companies and platoons which furnished drivers for the test vehicles. Top grade non-commissioned officers held many of the administrative posts and were in direct charge of the driver crews.

Driver personnel were usually young enlisted men in the lower regular or specialist grades. Most of these men were assigned to the unit when they were within six to eight months of completing their service in the Army. Thus, there was a constant turnover of drivers as men were discharged and new men were assigned to the unit as replacements. Only two drivers served with the unit throughout the entire regular test traffic period. One of these men amassed a record of approximately 75,000 miles of driving on the test loops.

As in the case of the Operations Branch, there was little precedent to guide the functioning of the Support Activity. Again, there were many problems foreign to the normal functions of a military organization. Close working relations, which materially assisted in the suc-



PERIOD	OFFICER	WARRANT OFFICER	ENLISTED MEN	TOTAL	TRUCKS OP	WORK WEEK
1. OCT 58 – DEC 59	10	2	293	305	120	6-DAY WEEK
2. JUL 60 – DEC 60	11	2	373	386	198	6-DAY WEEK
3. JAN 60 – JUN 60	11	2	423	436	198	7-DAY WEEK

Figure 7. Operations Activity organization chart.

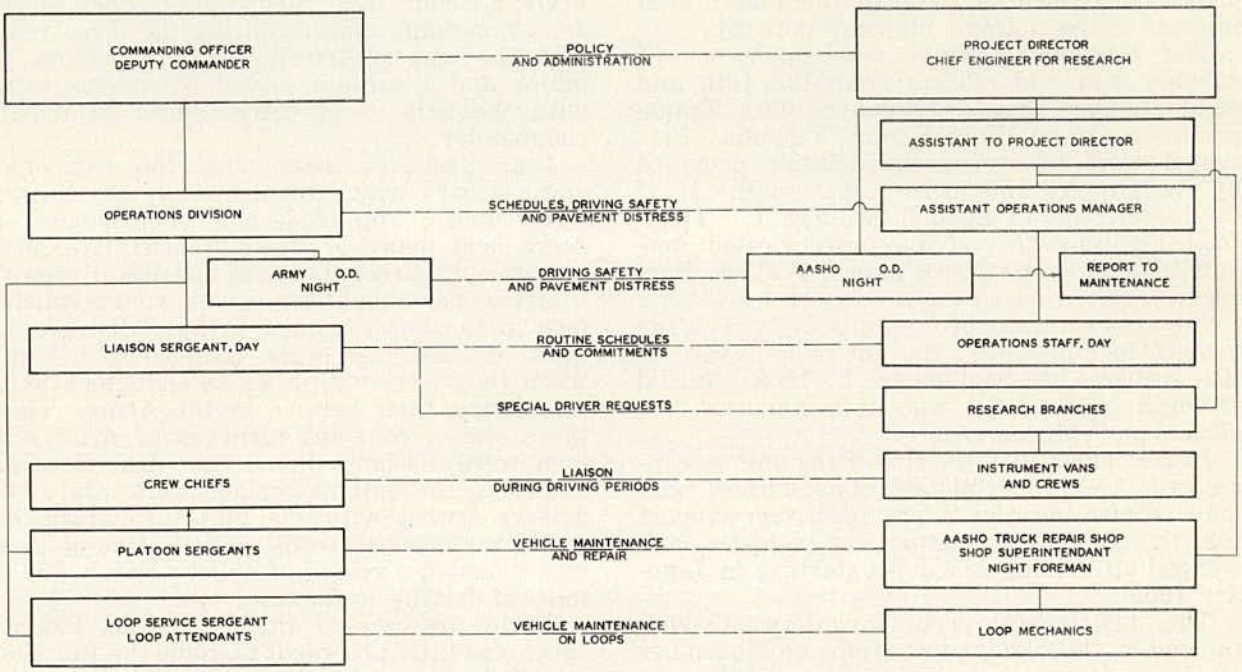


Figure 8. Support Activity—research liaison.

Figure 9. Drivers were served hot meals in the crew shelter located on each test loop.

cessful completion of the research project, were developed between the Support Activity and the project staff (see Fig. 8).

Driving on the test loops was an exceedingly monotonous chore which created problems of driver alertness and efficiency. In addition, operations schedules were such that driver crews frequently were subjected to abnormal work, rest, and recreation hours. As a consequence, there were many problems involving sleeping, feeding, and recreation. The unit mess operated on an around-the-clock schedule and transported hot meals to the driver crews working on the test loops. The organization chart for the operations unit responsible for the support of this driving schedule is shown in Figure 10. A fine safety record stands as a tribute to the officers and men of this unit who maintained a constant watch for any circumstance that might lead to any accident.

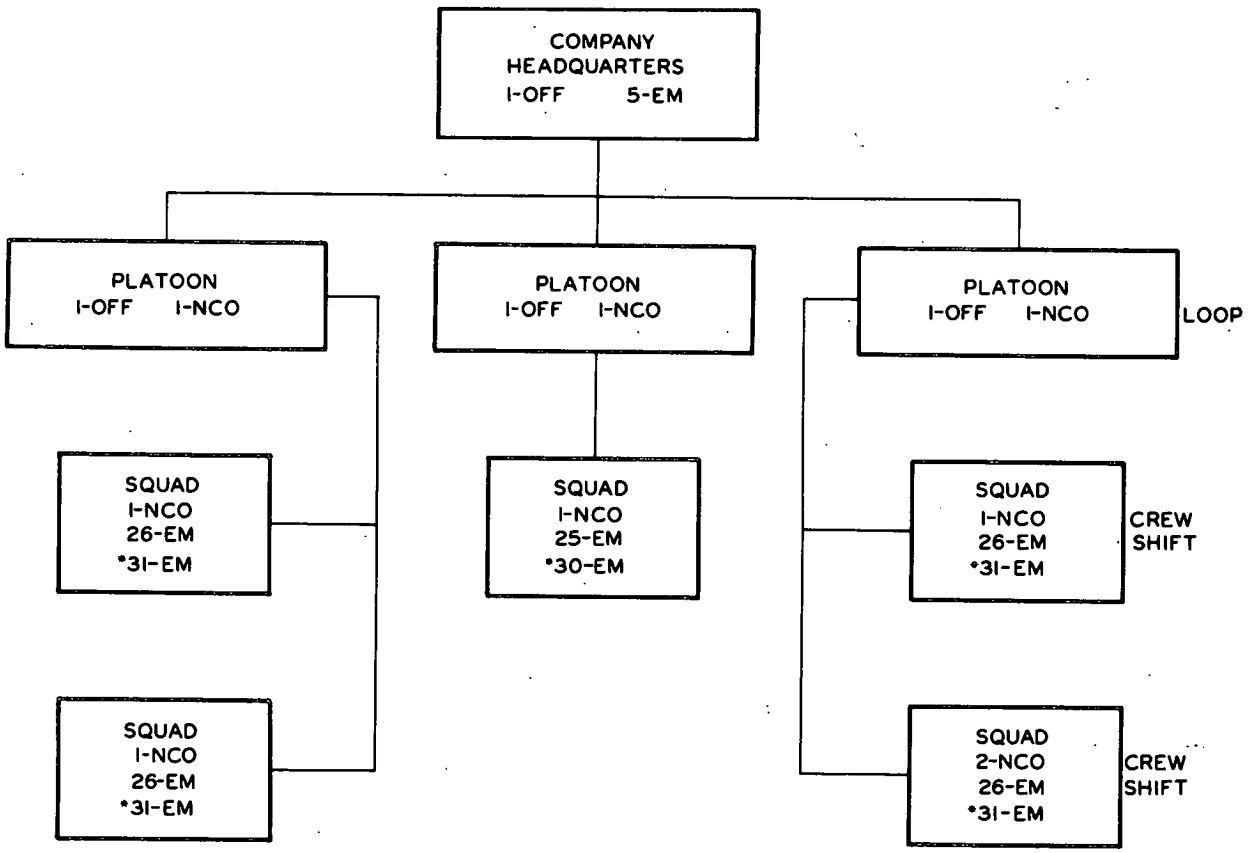
The driver housing facility was planned to alleviate, as much as possible, the problem of recreation. In addition to the necessary buildings for living quarters, mess hall and kitchen, administration, supply and medical facilities, there were game rooms, a television room, a music room, a library, a small post exchange, a craft shop, and a photographic dark room. The facility was located on sufficient land to allow for parking lots and athletic fields.

Certain studies of the drivers and their reactions to the monotonous operation were made by the Human Factors Research Branch of the Adjutant General's Office.

2.1.3 Operations Costs

The test vehicles amassed a total of 17,474,000 miles of operation during the conduct of the test, of which 17,164,000 miles were driven during regular and special tests. The cost per mile of operation for the entire vehicle fleet was about $0.21. This figure excludes the cost of drivers, driver housing, and vehicle license fees.

Table 1 is a breakdown of net costs and per-mile costs of the various items included in the total cost of operations. Inasmuch as it is not possible to list the breakdown by vehicle weight classes, the information given is for all test vehicles combined. The total has been reduced by the amount recovered at the conclusion of the project from the sale of vehicles, buildings, equipment, and parts, and the refunding of certain taxes. Prior to these reductions the gross cost was $3,951,500 or $0.23 per mile.



*DRIVER STRENGTH JANUARY 1, 1960 TO JUNE 30, 1960 (7-DAY WEEK OPERATION)

Figure 10. Operations unit organization chart.

TABLE 1

NET OPERATION COSTS, TESTS VEHICLES, TOTAL MILES 17,474,000

Item	Expended ($)	Cost per Mile ($)
Salaries and wages:		
Administrative and Supervisory	25,000	0.0014
Clerical	46,300	0.0026
Service	563,300	0.0322
Social Security Taxes	14,800	0.0008
Subtotal	649,400	0.0372
Fees and other services:		
Services	23,200	0.0013
Plant and equipment:		
Maintenance Equipment	7,000	0.0004
Automotive Equipment	838,700	0.0480
Garage Buildings (estimate)	127,500	0.0073
Other Equipment (incl. fuel tanks & shelters)	33,500	0.0019
Subtotal	1,006,700	0.0576
Expenses and supplies:		
Insurance and taxes	36,700	0.0021
Fuel	459,200	0.0263
Lubricating oil, etc.	35,300	0.0020
Tires and recaps	410,300	0.0235
Repair parts	843,100	0.0482
Other materials and supplies	114,500	0.0066
Subtotal	1,899,100	0.1087
Total	3,578,400	0.2048

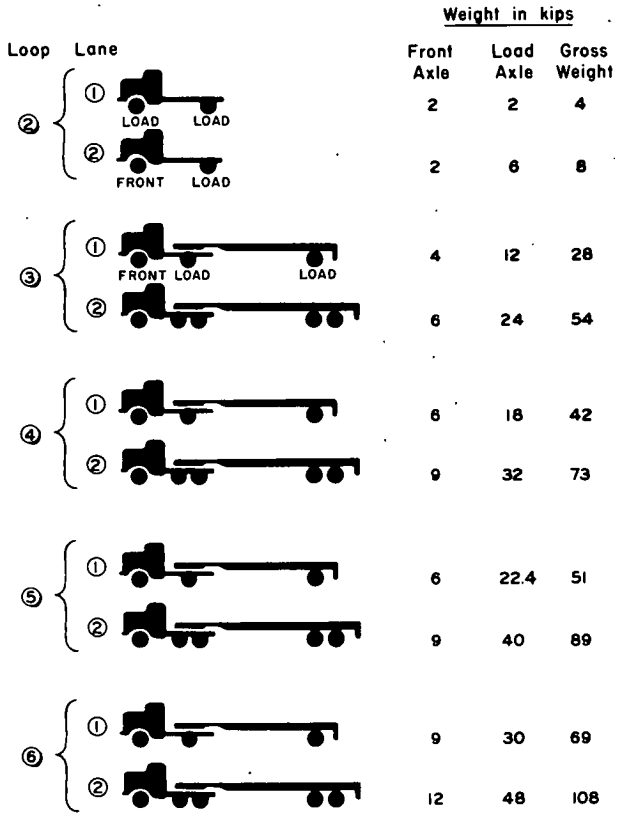


Figure 11. Typical test vehicle axle loadings.

Table 2 gives the identifiable driver and administrative costs for the Support Activity computed according to U. S. Army regulations. The period covered is from July 1958 to June 1961. The cost per mile of operation was approximately $0.17, not including the cost of quarters and building maintenance.

2.2 VEHICLE CHARACTERISTICS

2.2.1 General Description

The layout of the AASHO Road Test provided ten lanes for traffic operation. All vehicles assigned to any one lane had identical axle

TABLE 2

DRIVER AND ADMINISTRATIVE COSTS, SUPPORT ACTIVITY

Item	Chargeable ($)	Cost per Mile ($)
Pay and allowances:		
Officers	211,580.00	0.012
Enlisted Men	2,488,300.00	0.142
Travel and transportation	224,020.00	0.013
Supply costs[1]	15,960.00	0.001
Total	2,939,860.00	0.168

[1] Military furnishings and expendables.

loads and axle arrangements. Figure 11 shows the configurations and axle loadings for the vehicles in each traffic lane.

On Loops 3 through 6 all vehicles were truck tractor-semitrailer combinations with three-axle vehicles (two single load axles and steering axle) assigned to the inner lane, designated Lane 1, and five-axle vehicles (two tandem load axles and steering axle) assigned to the outer lane, designated Lane 2.

On Loop 2 the vehicles assigned to the inner lane were conventional "pick-up" trucks on which both the steering axle and rear axle were considered as load axles. On the outer lane of Loop 2 the vehicles were small single-unit trucks with platform bodies on which only the rear axle was considered as a load axle.

Figure 12 shows a typical vehicle, with load, from each of the ten traffic lanes.

The specifications for all vehicles were developed around available commercial equipment. Some minor modifications were made to fit the vehicles for the specific task they were to perform.

General specifications for test vehicles were developed by a Special Technical Subcommittee of the Automobile Manufacturers Association. These proposed specifications are given in Appendix A of this report.

Deviations from the proposed specifications were as follows:

The proposed specifications required all tractors to be equipped with at least 36-in. fifth wheels. In some cases, this requirement was changed to 30 in. on some of the lighter vehicles.

The specifications recommended power steering on all combination vehicles. However, all vehicles had conventional steering, except one model on Loop 6, Lane 2.

The specifications also recommended the use of gasoline-powered vehicles on Loops 2, 3, 4, and 5; and the use of diesel-powered vehicles on Loop 6. Gasoline-powered vehicles were used on Loops 2 and 3 as well as on the inner lanes (single axle) of Loops 4 and 5. Diesel-powered vehicles were used on the outer lanes (tandem axle) of Loops 4 and 5 as well as on both lanes of Loop 6.

Detailed specifications for the trucks, tractors and semitrailers were developed by the project staff with the assistance of the Advisory Panel on Vehicles and representatives from various manufacturers.

Figure 13 shows the specified dimensions for the combination vehicles for Loops 3 through 6. Table 3 gives actual mean distance between axles for each traffic lane. (See Data System 2523 for detailed axle and wheel spacings.)

An initial fleet of 70 vehicles was purchased by the project, with the U. S. Bureau of Public Roads acting as agent. Purchase was on the basis of competitive bidding so arranged that no manufacturer could supply all trucks and tractors or all semitrailer units.

TABLE 3

MEAN DISTANCE BETWEEN AXLES

Loop	Lane	Distance Between Axles (in.) [1]			
		1 and 2	2 and 3	3 and 4	4 and 5
2	1	112	—	—	—
	2	129	—	—	—
3	1	142	239	—	—
	2	134	48	238	50
4	1	143	237	—	—
	2	132	48	238	50
5	1	139	239	—	—
	2	142	51	237	50
6	1	151	240	—	—
	2	132	54	233	50

[1] To nearest inch.

The following firms supplied trucks and truck tractors:

Autocar Division, White Motor Company
Chevrolet Motors Division, General Motors Corporation
Diamond T Motor Truck Division, White Motor Company
Dodge Division, Chrysler Motor Corporation
Ford Division, Ford Motor Company
GMC Truck and Coach Division of General Motors Corporation
International Harvester Company
Mack Trucks, Incorporated
Reo Division of White Motor Company
White Motor Company

The following firms supplied the semitrailer units:

Alabama Trailer Company
Andrews Industries
Dorsey Trailers
Highway Trailer Industries
Hobbs Trailers Division, Fruehauf Trailer Company
Kingham Trailer Company
Lufkin Foundry and Machine Company

The original fleet consisted of 70 vehicles, made up of 14 small single-unit trucks, 56 truck tractors and 56 semitrailers. Later, 8 additional truck tractors were purchased. Another addition of 48 units brought the fleet total to 126 vehicles: 22 small trucks, 104 truck tractors and 96 semitrailers.

The additional 48 vehicles were obtained during the latter part of 1959 at the height of a nationwide steel industry labor dispute. The efforts of the Automobile Manufacturers Association and the Truck Trailer Manufacturers Association were largely responsible for enabling the project to secure the trucks, tractors and semitrailers. A few of the vehicles did not conform exactly to the original vehicle specifi-

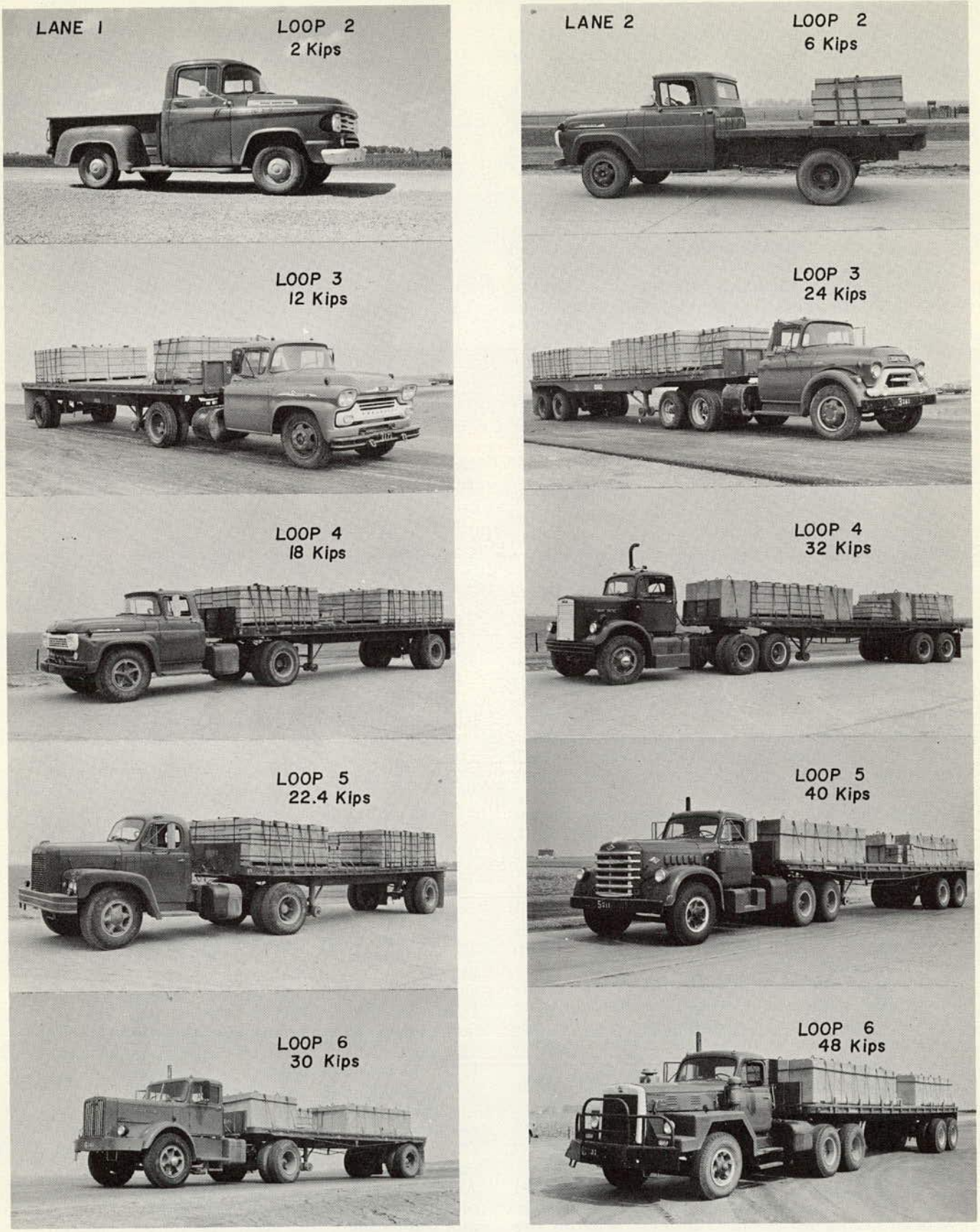


Figure 12. Loaded vehicle from each traffic lane.

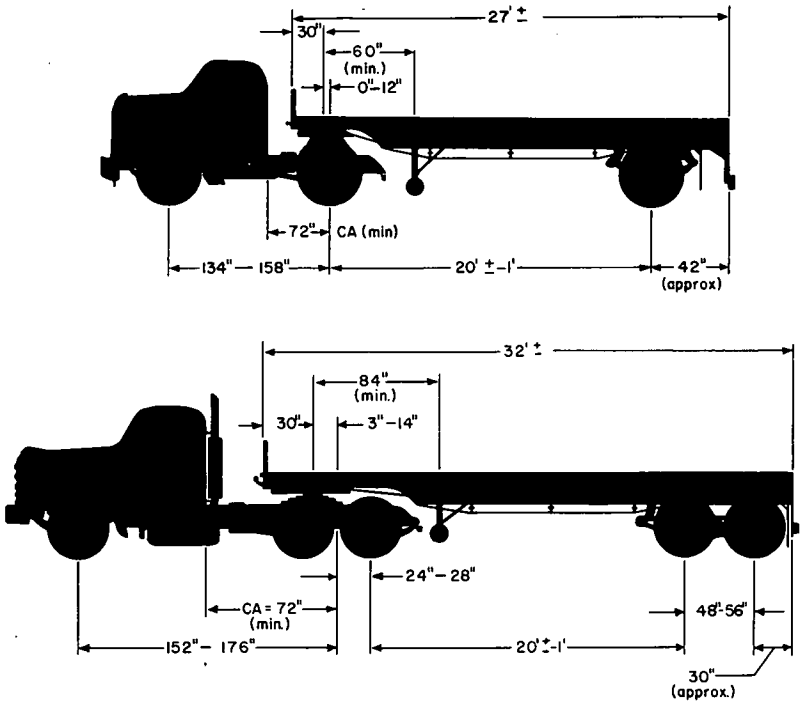


Figure 13. Test vehicle dimensions.

cations in that they were of the "cab-forward" type. However, specified load axle weights were maintained despite the different configuration of the vehicles.

Each test vehicle was assigned a four-digit code number that identified it according to loop, lane, and sequence number. The first digit indicated the loop, the second designated the lane, the third gave the vehicle's position in number sequence, and the fourth indicated whether the unit was a tractor or a semitrailer. For example, unit 4241 operated on Loop 4 in Lane 2 (tandem axle) and was the fourth vehicle in number sequence for that lane. The fourth digit (1) indicated that the unit was a truck-tractor. The corresponding semitrailer was numbered 4242, with the fourth digit (2) indicating a semitrailer.

Vehicles added to the fleet in January 1960 had code numbers using the letters F, G, H, K, L and M in place of the third digit.

2.2.2 Loading

Delivery of the initial 70 test vehicles began in June 1958, and all trucks, tractors and semitrailers were on the project by late September. As it was received, each piece of equipment was serviced and checked for compliance with specifications; tractor and semitrailer combinations were made up; and dimensions and empty weights were recorded for load calculation purposes. Table 4 gives mean empty and loaded axle weights for each lane. (See Data System 6507 for detailed weights of each vehicle.)

The original loads consisted of hollow-core concrete building blocks stacked four rows high on 39- by 47-in. wooden pallets and secured with steel bands. Each pallet contained 40 blocks and weighed about 2,550 lb.

The positioning of the pallets on the vehicles was calculated so that the desired axle loads could be achieved with a minimum number of blocks and with no load more than two pallets (72 in.) high.

The hollow-core blocks were used in an effort to create loads with the relatively high center of gravity commonly found on commercial van-type vehicles operating on the highways.

Banding of blocks on pallets and loading of the vehicles was done by personnel of the Operations and Maintenance Branches. A multipurpose Gradall was used to place the pallets of blocks on the vehicles. Each vehicle was checked for proper axle load; adjustments were made, if necessary; and the loads were secured on the vehicles with steel bands. Vehicles were weighed on an electronic platform scale installed at the project site by the Illinois Division of Highways.

Sufficient vehicles were loaded and weighed to permit traffic operation on October 15, 1958,

TABLE 4

MEAN TEST AXLE WEIGHTS

Number of Vehicles	Loop	Lane	Axle Weight (lb)							
			Empty			Selected Test Axle Load	Loaded [1]			
			Front	Rear	Trailer		Front	Rear	Trailer	Gross
8	2	1	2,170	1,390	—	2,000 S	2,000	2,000	—	4,000
14 [2]	2	2	2,560	1,990	—	6,000 S	2,000	6,000	—	8,000
13	3	1	3,490	4,980	3,780	12,000 S	4,200	12,150	12,150	28,500
13	3	2	4,760	8,550	6,040	24,000 T	5,550	24,250	24,700	54,500
13	4	1	4,440	6,020	4,100	18,000 S	5,600	18,100	18,300	42,000
13	4	2	7,330	10,130	6,760	32,000 T	8,800	32,200	32,500	73,500
13	5	1	4,960	6,350	4,550	22,400 S	5,600	22,800	22,600	51,000
13	5	2	7,410	11,930	7,440	40,000 T	8,800	39,900	40,300	89,000
13	6	1	8,150	8,910	5,740	30,000 S	8,850	30,250	29,900	69,000
13	6	2	9,300	14,020	8,760	48,000 T	10,900	48,800	48,300	108,000
126										

[1] Loaded axle weights on each vehicle were kept within a tolerance of ±5 percent from the selected test axle load.

[2] One additional vehicle was purchased for this lane to replace one which had been damaged beyond repair; 14 units operated, 15 units were purchased.

the date set for the official inauguration of test traffic. However, on that date a vehicle from Lane 2 of Loop 4 overturned while entering the parking area in the west turnaround of the loop. All traffic was suspended while this accident was investigated.

Investigation of the accident centered upon the effect of the high-center-of-gravity loads, and it was decided that the loads created an unsafe condition when the vehicles were on the loop turnarounds or entering and leaving the parking areas.

Accordingly, all vehicles except those on Loop 2 were reloaded with the load height limited to approximately 36 in. above the bed of the vehicle. On some vehicles this involved only the repositioning of the palletized building blocks. This was true of all vehicles on Loop 3

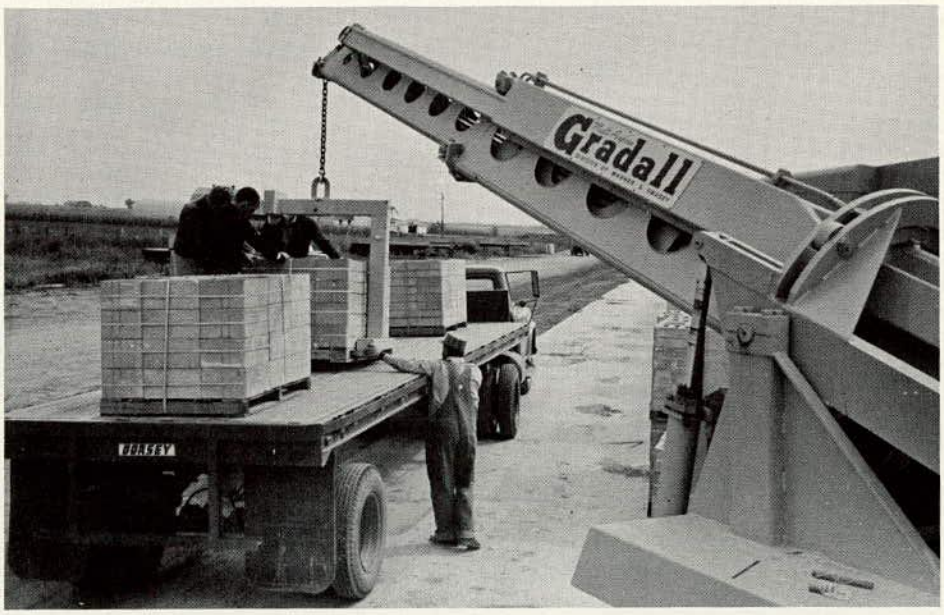


Figure 14. Project crews placing original loads of hollow-core building blocks on test vehicles.

and on the inner (single axle) lanes of Loops 4 and 5. On all other vehicles the load height was reduced by using solid concrete blocks measuring 24 by 34 by 36 in. and weighing approximately 2,550 lb each.

Figure 15 shows typical vehicles from Loop 6 before and after reloading.

Test traffic operations were halted from October 15 until November 5, 1958, to allow reloading and rebanding of all vehicles from Loops 3 through 6.

2.2.3 Tires

Recommendations on tire sizes and pressures for each type of test vehicle were made by the Special Technical Subcommittee of the Automobile Manufacturers Association, which set up the basic specifications for the vehicles. Table 5 gives data on the tires used on the vehicles in each of the ten traffic lanes.

The tires did not conform to the committee's recommendations in two of the traffic lanes. In Lane 1 of Loop 6, the tires used were 12.00 x 24/14, whereas the recommendation was for 13.00 x 20/16. In Lane 1 of Loop 5, the tires used were 11.00 x 20/12, although the recommendation was 11.00 x 20/14. These substitutions were made because of the difficulties encountered in purchasing the recommended tires.

All tires were tube-type except those used on the pick-up vehicles in Lane 1 of Loop 2, which were of the tubeless type.

2.3 TRAFFIC OPERATION

2.3.1 Pre-Test, Special, and Post-Test Traffic

The first vehicles began operating on the test loops on September 13, 1958. This traffic, called conditioning traffic, was composed of vehicles carrying loads that were approximately one-half of the scheduled test loads for Loops 3 through 6. Empty pick-up trucks were operated for a few trips in both lanes of Loop 2.

The pre-test traffic had several purposes: to condition the pavements, to familiarize drivers with vehicles and operating patterns, to permit field checks of measuring devices, to permit collection of preliminary data before full loads were applied, and to help break in the test vehicles.

Traffic was scheduled to operate only during daylight hours. However, the schedule was changed to an early-morning, late-evening operation to reduce interference with contractor's forces who were still working on the roadway shoulders. The operating speed was 30 mph and the drivers were instructed to use a special transverse placement pattern to get coverage over the entire pavement surface. Table 6 is the load application record during the pre-test traffic period.

During the regular test traffic period a small amount of special light traffic was operated on various loops from time to time to allow the research branches to make special measurements. Special studies included such factors as speed, placement, change of load, tire size,

Figure 15. Vehicles on Loop 6 loaded with hollow-core blocks (upper) and with large solid concrete blocks (lower).

TABLE 5

TIRE DATA

Loop	Lane	Test Load (lb)		Tire Size and Ply Rating	Tire and Rim Assn. Std.			Data at Tire and Rim Assn. Standard Conditions		
		Axle Load	Per Tire		Load (lb)	Inflation[1] (psi)	Rim (in.)	Gross Contact Area (sq in.)	Unit Ground Pressure[2] (psi)	Tire Spring Rate (lb/in.)
2	1	2,000	1,000	6.70x15/4[3]	1,065	24	4.5	36.6	29.1	990
	2	6,000	1,500	7.00x16/6	1,580	45	5.5	37.4	42.3	2,250
3	1	12,000	3,000	7.50x20/10	2,980	75	6.0	45.4	65.7	4,200
	2	24,000	3,000	7.50x20/10	2,980	75	6.0	45.4	65.7	4,200
4	1	18,000	4,500	10.00x20/12	4,580	75	7.5	67.8	67.5	5,100
	2	32,000	4,000	9.00x20/10	4,120	75[4]	7.0	59.3	69.5	5,050
5	1	22,400	5,600	11.00x20/12	5,150	75	8.0	77.7	66.4	5,300
	2	40,000	5,000	11.00x20/12	5,150	75	8.0	77.7	66.4	5,300
6	1	30,000	7,500	12.00x24/14	6,780	80	8.5	97.3	69.7	7,000
	2	48,000	6,000	12.00x20/14	6,020	80	8.5	86.4	69.8	6,180

[1] Taken with tires at approximately the prevailing atmospheric temperatures, and do not include any inflation build-up due to vehicle operation.
[2] Calculated with assumption of uniform pressure.
[3] Tubeless tire; Tire and Rim Association standard inflation pressure is 28 psi for 1,065-lb load.
[4] Tire and Rim Association standard inflation pressure is 70 psi for a recommended maximum load of 3,960 lb. This tire was operated at 75 psi inflation pressure and the data given for this pressure are at a load of 4,120 lb. A measured value of the gross contact area was not available for these conditions, but was assumed to be the same as that for 3,960-lb load at 70 psi.

and axle configuration. Except in a few accidental cases, no pavement section or bridge was subjected to loads greater than those applied by the regular traffic.

Because the test bridges were located near the turnarounds (Fig. 3), vehicles could not attain high speeds when running in the normal (counterclockwise) direction. Therefore, during these special bridge studies some vehicles were operated in a reverse direction, during non-traffic periods, on Loops 5 and 6 to allow for higher speeds over the test bridges.

A record of all special traffic was kept and included in the load application record for each lane and test bridge.

TABLE 6

PRE-TEST LOAD APPLICATIONS

Loop	Applications	
	Lane 1	Lane 2
2	192	192
3	1,536	1,454
4	1,576	1,576
5	1,538	1,544
6	1,548	1,548

Additional traffic was operated on Loops 2, 4, 5 and 6 after the regular test traffic period for certain special studies carried out during the spring of 1961. Vehicles used in these studies included regular test vehicles, vehicles with special suspension systems and/or various tire designs and pressures, construction equipment, and several types of military vehicles. The vehicles and the special studies are described in AASHO Road Test Report 6 (SR 61F).

2.3.2 Regular Test Traffic

Test traffic was officially inaugurated on October 15, 1958, but was immediately suspended for a re-examination of vehicle loads and, subsequently, the reloading of tractor-semitrailer units (see Section 2.2.2). Full-scale traffic was resumed on November 5, 1958, and officially ended on November 30, 1960. A few vehicles were operated in Lane 2 of Loop 6 until December 3, 1960, to balance its axle load application count with other traffic lanes.

At the beginning of test traffic, schedules called for the operation of six vehicles per lane in Loops 3 through 6, four vehicles in Lane 1 of Loop 2, and eight vehicles in Lane 2 of Loop 2. There was one standby unit for each lane.

On July 5, 1959, an additional truck tractor unit was added for each lane of the four major loops, and the vehicles previously held on standby were placed in service when possible. Loop

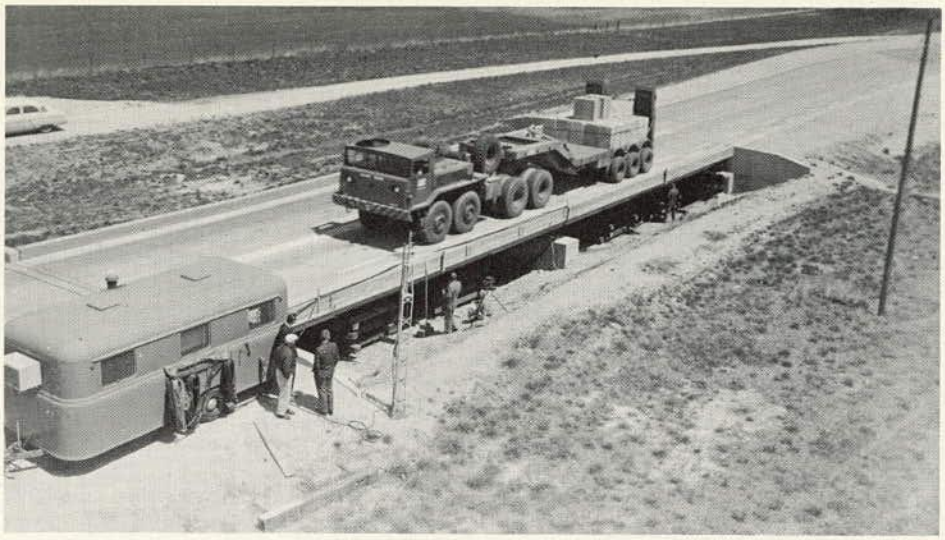


Figure 16. Several types of military vehicles were used on bridges during special studies in the spring of 1961.

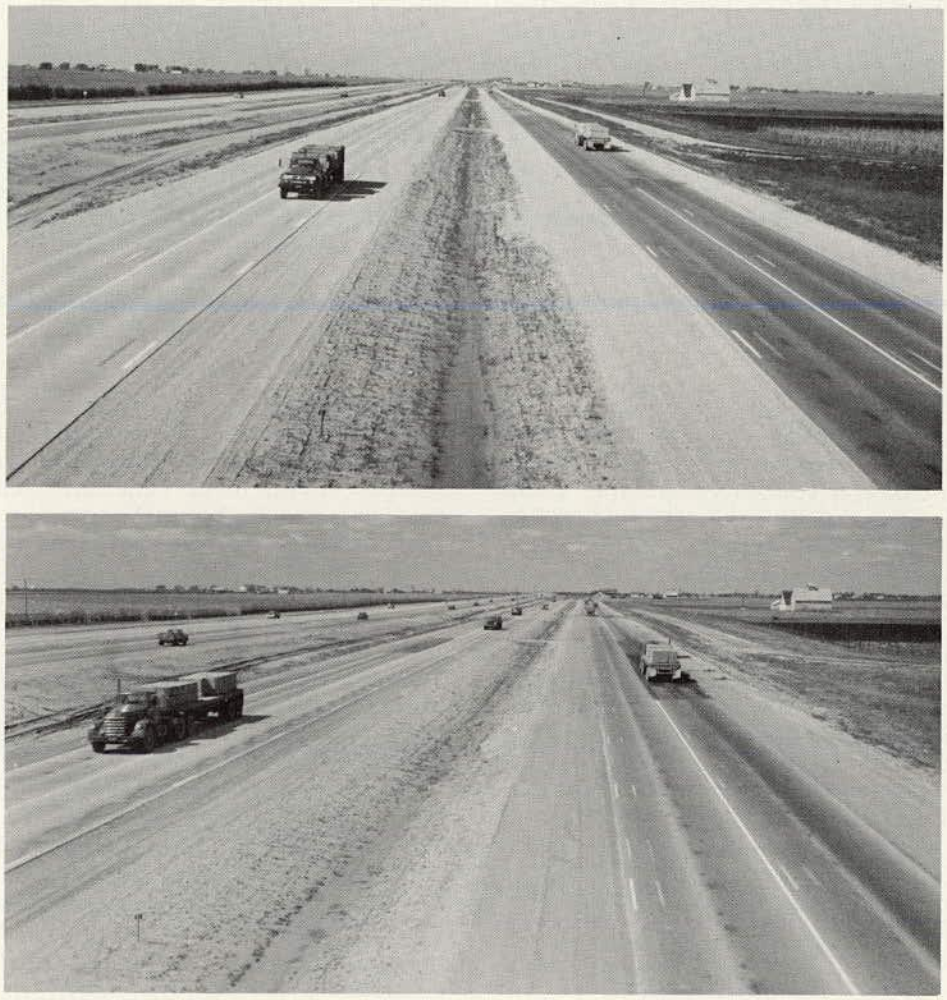


Figure 17. Typical traffic density on Loops 5 and 2 with 12 vehicles (upper) and 20 vehicles per loop (lower).

2 was able to keep pace by occasionally adding its standby units to the traffic stream.

In late 1959 five additional tractor-semitrailer units were purchased for each lane of Loops 3 through 6. Three additional vehicles were purchased for Lane 1 of Loop 2, and five for Lane 2 of Loop 2. These units were all in service by January 7, 1960, bringing the number of available vehicles to 13 tractors and 12 semitrailers for each lane of the major loops, eight vehicles for Lane 1 of Loop 2, and 14 vehicles for Lane 2 of Loop 2, for a total of 126 vehicles, plus one Loop 2 Lane 2 vehicle which was damaged beyond repair and no longer used. Schedules called for the operation of 10 vehicles per lane in the major loops, 6 (sometimes 7) in Lane 1 of Loop 2, and 12 (sometimes 13) in Lane 2 of Loop 2.

During the 25 months of regular traffic operation, a total of 556,880 vehicle trips (1,113,760 applications) was made in each traffic lane, and thus over each surviving test section.

Traffic operation required close cooperation between the project's Operations Branch and the Army Transportation Corps Road Test Support Activity. The Operations Branch scheduled traffic as necessary to carry out the research activities of the project. The military unit supplied two shifts of drivers and supervisory personnel for each operating day, on schedules that usually covered other-than-normal working hours.

At the beginning of test traffic the daily operations schedule covered 18 hr and 40 min, leaving a 5-hr and 20-min period for pavement and vehicle maintenance, special studies, and the various routine measurement programs carried out by the project research branches. The driving schedules were arranged on the basis of a 10-min break," or rest period, in each hour of driving, in accordance with standard military practice. In addition, 30-min breaks were allowed for meals so that actual driving time totaled 900 min, or 15 hr per day.

The 15 hr of actual driving time per day remained unchanged throughout the entire test traffic period. However, the schedules were modified as conditions demanded. The major change involved dropping the pattern of driving 50 min and halting 10 min. Instead, schedules were set up for longer driving and longer break periods at the beginning of a shift and shorter driving and break periods (with more frequent breaks) during the latter part of a shift. This arrangement was found to be more efficient and was preferred by the drivers.

Such schedule changes eventually lengthened the daily operations period to 19 hr and 5 min while retaining the actual 15 hr of driving time.

Three separate schedules, designated A, B and C, were set up. Normally these were rotated, in order, each two weeks. Occasionally, the demands of pavement maintenance made it expedient to alter the regular rotation and to keep the 5-hr traffic break within normal working hours.

These three schedules were used in order that test loads would be applied to the pavements during all hours of the day over the two-year period of testing. If only one schedule had been chosen there would have been certain hours of the day that the pavements would not have received any test traffic. During any one two-week schedule there were hours when traffic did not operate. However, for the two-year test period traffic operated at some time during all hours of the day and night.

Table 7 gives the three operations schedules as revised and made effective July 1, 1960. However, these schedules are similar to those used throughout most of the test traffic period, differing only in minor details.

All schedules were arranged so that the 5-hr traffic break occurred during daylight hours. It is obvious that this was desirable in the interest of efficient pavement maintenance and research measurement programs. However, as a result, a large percentage of all test traffic operated at night.

Traffic operated on a six-day-a-week schedule from November 5, 1958, to January 7, 1960, when it was stepped up to seven days a week. Operations went back to six days a week on July 1, 1960, for the remainder of the test traffic period.

Figure 18 shows the time that traffic was scheduled to operate during the two-year testing period. The black area represents driving time, the white area is non-driving time; the letters are schedule designations. Figure 19 is a summary chart showing the scheduled driving time coverage, in percent, for the two-year period of test traffic. The shaded area indicates the percentage of driving time that was scheduled during the hours shown. It can be seen that driving was scheduled 100 percent of the time between 2100 hours (9:00 p.m.) and 0500 hours (5:00 a.m.) and about 62 percent of the time between 0500 hours and 1000 hours 10:00 a.m.).

Occasionally, traffic did not start and stop in all lanes at the same time because of pavement maintenance, special studies, or weather conditions.

A detailed record of traffic operation was kept in project log books, designated AASHO Road Test Data System 6502.

Control of traffic operation was handled cooperatively by project personnel and supervisory personnel from the military unit.

Over-all liaison was maintained through an Operations Sergeant assigned to the project Operations Branch. Field supervision was the responsibility of an Army Officer of the Day

and various project personnel. During normal project working hours the Operations Branch assumed this responsibility. During other than normal hours a project Duty Officer was stationed at the Administration Building.

The Army Officer of the Day was in charge of all drivers and was responsible for seeing that established driving procedures were observed. The project Duty Officer kept the operations log book and was responsible for checking on pavement or bridge distress and damage. When such damage was so severe as to make traffic operation unsafe, or when research measurements were indicated, the Duty Officer recorded any research data needed and called a maintenance crew to make repairs.

Both duty officers (Army O.D. and Project O.D.), as well as other military officers and noncommissioned officers, had vehicles equipped with two-way radio units. The radio net base station was in the Administration Building, and units were located at the military headquarters, in crew shelters on each test loop, in the vehicle maintenance shop, and in the pavement maintenance building. Thus, communication was maintained among all supervisory personnel concerned with the traffic operation.

All military drivers assigned to the Support

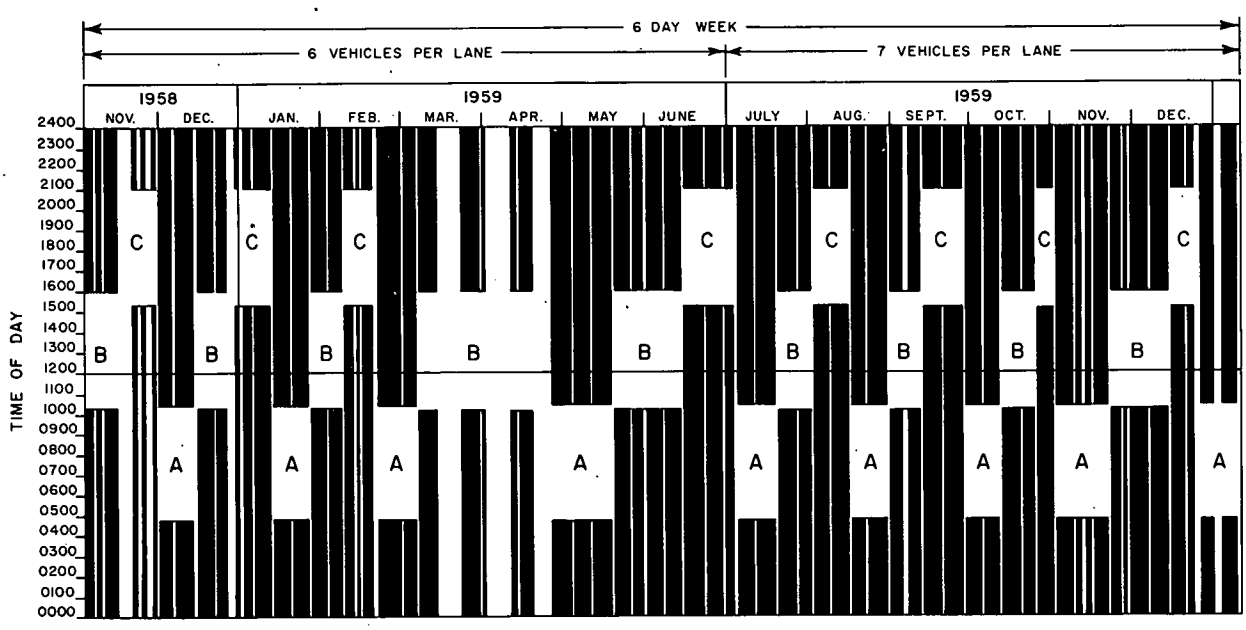
TABLE 7

REVISED SCHEDULES
EFFECTIVE JULY 1, 1960

1st Shift			SCHEDULE A	2nd Shift		
Drive	1000–1130	90	1000–0505	Drive	1940–2110	90
Break	1130–1145			Break	2110–2125	
Drive	1145–1315	90		Drive	2125–2255	90
	1315–1355	Meal		Break	2255–2310	
Drive	1355–1525	90		Drive	2310–0040	90
Break	1525–1540		Week starts		0040–0120	Meal
Drive	1540–1640	60	1940 hr Sun.	Drive	0120–0220	60
Break	1640–1655		Week ends	Break	0220–0235	
Drive	1655–1740	45	1925 hr Sat.	Drive	0235–0320	45
Break	1740–1755			Break	0320–0335	
Drive	1755–1840	45		Drive	0335–0420	45
Break	1840–1855			Break	0420–0435	
Drive	1855–1925	30		Drive	0435–0505	30
		450				450

1st Shift			SCHEDULE B	2nd Shift		
Drive	1530–1700	90	1530–1035	Drive	0110–0240	90
Break	1700–1715			Break	0240–0255	
Drive	1715–1845	90		Drive	0255–0425	90
	1845–1925	Meal		Break	0425–0440	
Drive	1925–2055	90		Drive	0440–0610	90
Break	2055–2110		Week starts		0610–0650	Meal
Drive	2110–2210	60	1530 hr Sun.	Drive	0650–0750	60
Break	2210–2225		Week ends	Break	0750–0805	
Drive	2225–2310	45	1035 hr Sat.	Drive	0805–0850	45
Break	2310–2325			Break	0850–0905	
Drive	2325–0010	45		Drive	0905–0950	45
Break	0010–0025			Break	0950–1005	
Drive	0025–0055	30		Drive	1005–1035	30
		450				450

1st Shift			SCHEDULE C	2nd Shift		
Drive	2030–2200	90	2030–1535	Drive	0610–0740	90
Break	2200–2215			Break	0740–0755	
Drive	2215–2345	90		Drive	0755–0925	90
	2345–0025	Meal		Break	0925–0940	
Drive	0025–0155	90		Drive	0940–1110	90
Break	0155–0210		Week starts	Break	1110–1125	
Drive	0210–0310	60	2030 hr Sun.	Drive	1125–1225	60
Break	0310–0325		Week ends		1225–1305	Meal
Drive	0325–0410	45	1535 hr Sat.	Drive	1305–1350	45
Break	0410–0425			Break	1350–1405	
Drive	0425–0510	45		Drive	1405–1450	45
Break	0510–0525			Break	1450–1505	
Drive	0525–0555	30		Drive	1505–1535	30
		450				450



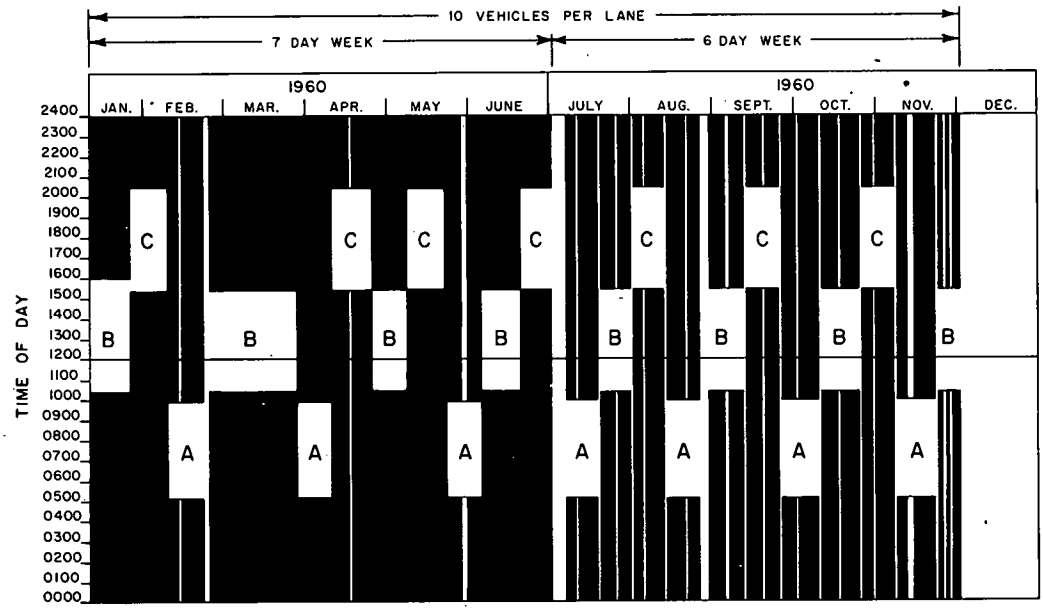


Figure 18. Test traffic driving schedules.

Activity were qualified to operate the Army's M-52 tractor-semitrailer vehicle. However, many were unfamiliar with the various types of commercial vehicles on the project. A training program was started with classroom instruction on driving patterns and procedures followed by on-the-loop familiarization with new drivers riding as passengers with experienced drivers. Generally, new drivers were assigned to the smaller vehicles on Loops 2 and 3. Those with satisfactory records moved up to the heavier vehicles to replace men leaving the unit.

Insofar as possible, each driver was assigned to a particular vehicle. He was then responsible for checking the vehicle before starting operations and reporting any deficiencies noted during operation.

Drivers assigned to the project had a monotonous and difficult task. Each driver was required to be on-post at Wallace Barracks and rest for 8 hr prior to the start of his shift. Each shift covered approximately 9½ hr, and at least another 30 min was consumed in traveling each way from the barracks to the loops and back. In addition, the driver's military duties averaged about an hour per day. Thus, approximately 20 hr per day were required, leaving only 4 hr for "off-post recreation". For the driver who came off duty at 5:30 a.m. this was rather meaningless. Each driver was on duty for five days a week.

Drivers were transported between the bar-

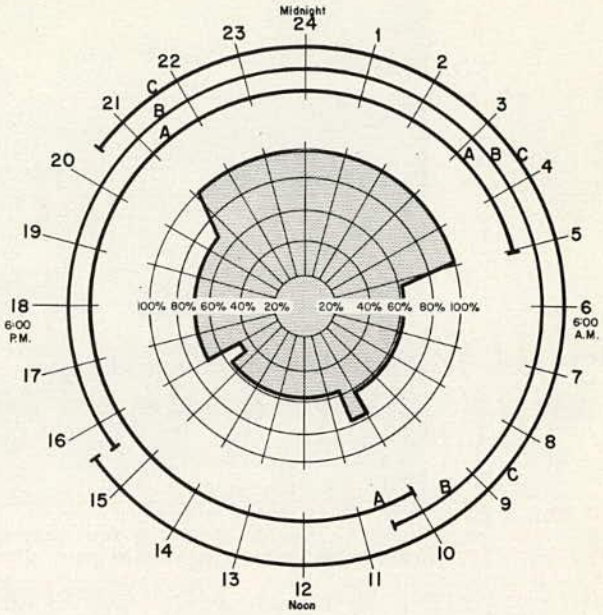


Figure 19. Driving time schedule and percent of time driven (24-hr clock).

Figure 20. Drivers checked vehicles and loads before starting operations.

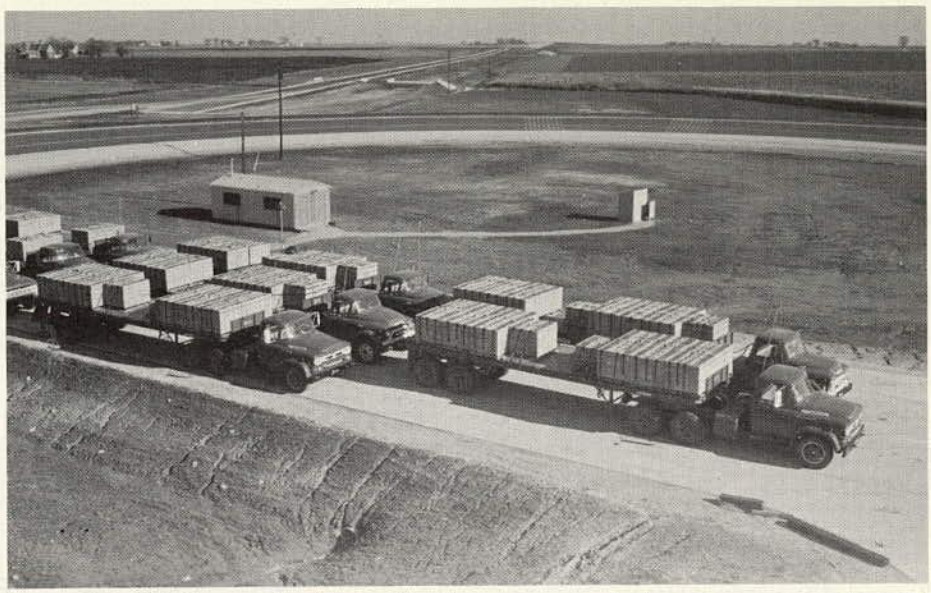


Figure 21. Vehicles on the four major loops were parked on crossover roads in the turnarounds, where a shelter was provided for drivers and fueling facilities were available.

racks and the loops by military buses. They arrived on the loop about 30 min before the scheduled start of operations, allowing time for checking vehicles and receiving special instructions from the loop sergeants. The test vehicles on the four major loops were parked in crossover roads in the easterly turnarounds of Loops 3 and 6 and the westerly turnarounds of Loops 4 and 5. Loop 2 vehicles were parked on an access pavement running between Loops 5 and 6. Fuel, motor oil and radiator water were stored at the crossover, and a 12- by 36-ft building was provided for a crew shelter and headquarters for the loop sergeant.

Each loop sergeant, or crew chief, was responsible for starting and stopping the traffic according to schedule, keeping a count of the number of trips made by each vehicle, and checking on driving patterns and procedures.

The crew chiefs and other military supervisors frequently rode in the test vehicles or in the traffic stream in passenger vehicles. They checked speed, interval between vehicles, transverse placement and observed pavement condition as well. Frequently they were able to detect developing mechanical trouble on vehicles or were able to spot a sleepy or inattentive driver and have him stop, thus preventing a possible source of trouble.

Standard operating procedure on the loops called for staggering the vehicles in the two lanes and maintaining a minimum interval of 800 to 1,000 ft between vehicles in adjacent lanes. All vehicles operated in the same direction (counterclockwise), and no vehicle was allowed to pass another. If one vehicle stopped

Figure 22. The loop turnarounds were superelevated at a rate of 0.2 ft per ft on the outer lane. All vehicles normally used this lane when traveling at 25 mph or faster.

Figure 23. Guide lines were painted on left side of each traffic lane to assist drivers in maintaining proper transverse placement.

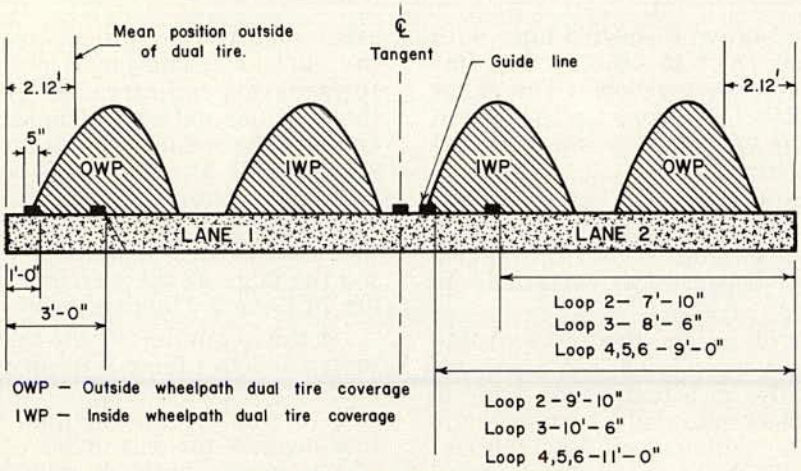


Figure 24. Programed placement.

on the pavement for any reason, all traffic on the loop halted.

2.3.3 Speed and Placement Control

At the start of traffic operations, drivers on the four major loops were instructed to maintain a constant 30-mph speed on the tangents and turnarounds. On Loop 2, the radius of the turnarounds made it necessary to reduce speed at these points to about 15 mph.

The 30-mph speed on the turnarounds apparently caused excessive tire wear. In addition, many drivers reported feeling on the verge of losing control in the turns. Accordingly, speeds were set at 35 mph on the tangents and 25 mph on the turnarounds of the major loops (35 and 15 mph on Loop 2). At these speeds drivers were able to decelerate after leaving the test sections on one tangent and accelerate back to 35 mph before reaching test sections on the other tangent.

Speed was controlled by several means. One vehicle on each of the four major loops was designated as the "lead" truck in the traffic stream. These vehicles were equipped with recording speedometers. Thus, if the lead vehicle maintained proper speed others were forced to do so to keep proper intervals between vehicles. Each loop sergeant could make a general speed check merely by observing the time required for a given number of trips around the loop. In addition, frequent speed checks were made by supervisory personnel as they moved about the project.

The transverse placement of the vehicles on the test pavements was programed to follow the observed placement of heavy trucks on actual highways as reported by the Bureau of Public Roads for two-lane roads with 12-ft lanes. Guide lines were painted along the left side of each traffic lane to assist drivers in maintaining transverse placement.

TABLE 8

TRANSVERSE PLACEMENT

Loop	Mean Distance, Pavement Edge to Outer Edge Dual-Tire (ft)								
	Lane 1			Lane 2			Flex. Mean [1]	Rigid Mean [1]	Loop Mean [1]
	Flex.	Rigid	Mean [1]	Flex.	Rigid	Mean [1]			
3	2.29	2.14	2.21	2.74	2.44	2.56	2.50	2.27	2.37
4	1.54	1.80	1.65	2.43	2.53	2.47	1.99	2.16	2.06
5	1.74	1.72	1.73	2.19	2.11	2.15	1.96	1.91	1.93
6	1.18	1.32	1.27	2.09	2.06	2.07	1.74	1.74	1.74
Mean [1]			1.72			2.28			2.01
BPR Studies [2]			—			2.2			—

[1] All means are weighted.

[2] Bureau of Public Roads study as reported in *Public Roads*, Aug. 1958, for 12-ft, 2-lane pavements with grass or gravel shoulders.

The guides were 5-in. wide dashed lines with 20 percent coverage (8 ft in 40 ft). One line was white, the other was yellow. The inner edge of one line was 1 ft from the pavement edge; the inner edge of the other line was 3 ft from the pavement edge.

Figure 24 shows the position of the guide lines and the programed placement frequency curves. The distance from centerline varied from loop to loop because of variations in vehicle width.

Several methods of automatically recording transverse placement were tried, but none was satisfactory. Initially, an attempt was made to use overhead switches actuated by an antenna on each vehicle. The switches, on 6-in. centers, operated relays which controlled overhead lights indicating proper wheelpath sequence to the drivers. Switch failures and other mechanical problems were encountered. Another system used the Bureau of Public Roads placement strip, which has a series of metal contacts embedded in a molded rubber base. The high traffic density caused the strips to wear out rapidly. A third system used pressure switches embedded in the pavement surface, but mechanical problems and surface water rendered these useless.

The most successful method of checking on transverse placement used 16- or 35-mm single-frame photographs of each vehicle, taken on a sample basis and shot from the overpasses near the middle of each major test loop. Placement was determined from measurements on a projected picture. This system was limited to daylight hours and to the one bridge location on the four loops. No suitable system was developed for Loop 2.

Table 8 is a summary of transverse placement data taken from limited samples. It indicates distinct variations in placement among the various traffic lanes, despite consistent efforts by the military unit officers to maintain the specified pattern. The table shows that the heavier the vehicle the nearer to the shoulder it operated. Tandem units operated nearer the pavement centerline than did single axle units. This condition must be ascribed partly to the fact that drivers in Lane 1 (single axle) could see the edge of the pavement better than drivers in Lane 2 (tandem axle).

At the beginning of the test the drivers were instructed to follow a programed placement as follows: travel one trip in ten (10 percent) with the outside of the dual tires on the guide line nearest the pavement edge, travel 7 trips (70 percent) with the tire edge between the guide lines and 2 trips (20 percent) with the tire on the line nearest the centerline. The automatic placement counting devices were also programing devices to indicate to the driver which position he was to drive. This was to eliminate the necessity of the driver having to remember the driving position for each trip.

Because the automatic devices did not perform satisfactorily, the drivers were later instructed to drive always between the guide lines with the expectation that the random driving position of different drivers would accomplish the programed result. By observation and by sampling this procedure was found to be satisfactory.

2.3.4 Axle Load Applications

The number of axle load applications on each of the ten traffic lanes was determined from a vehicle trip count made by the loop sergeant on each loop. These counts were checked occasionally with mechanical counters. Daily counts were summarized by the Operations Branch

and punched on IBM cards. This information is contained in AASHO Road Test Data System 6500.

Printouts of the applications record were distributed periodically to the research branches. In addition, a daily summary was posted in the Administration Building to aid the project staff in scheduling maintenance and research operations and application balancing.

Every effort was made to keep load applications as nearly equal as possible in the ten traffic lanes. When any one lane fell behind the others, the standby vehicles were put in service to bring the applications back into balance. If the extra vehicles were not available, the numbers of vehicles in other lanes were reduced accordingly.

Although it was not possible to maintain exact balance at all times, extra care was taken to insure balance during critical periods of rapid pavement distress.

Figure 25 is a cumulative summary of load applications, by months, for each traffic lane and shows the relative balance between lanes.

The Operations Branch also maintained a record which indicated the efficiency of the traffic operation by comparing the actual load applications achieved against the theoretical number that could have been made if all vehicles had operated 100 percent of the scheduled time. The differences between theoretical and actual were designated "lost applications," which were broken down into several categories, each indicating the reason for the loss. The reasons for application losses were application balancing, vehicle maintenance, adverse weather (which necessitated stopping traffic), reduced speeds (due to weather conditions or rough pavement), pavement maintenance, and miscellaneous.

Figure 27 shows the percentages of cumulative applications lost because of the several reasons previously listed. The ordinate scale on the left shows percentage of cumulative applications lost, and the ordinate on the right shows percentages of attained applications.

Percentages of the theoretically possible total number of cumulative applications at the end of test traffic on December 3, 1960, were: attained applications, 79.9; losses due to application balancing, 4.2; vehicle maintenance, 4.5; adverse weather, 2.0; reduced speeds, 1.6; pavement maintenance, 6.2; miscellaneous, 1.6.

Figure 28 compares cumulative theoretical and actual applications.

The loss of applications attributed to adverse weather occurred mostly during the winter when snow and ice made driving unsafe and when vehicle engines were difficult to start because of subfreezing temperatures.

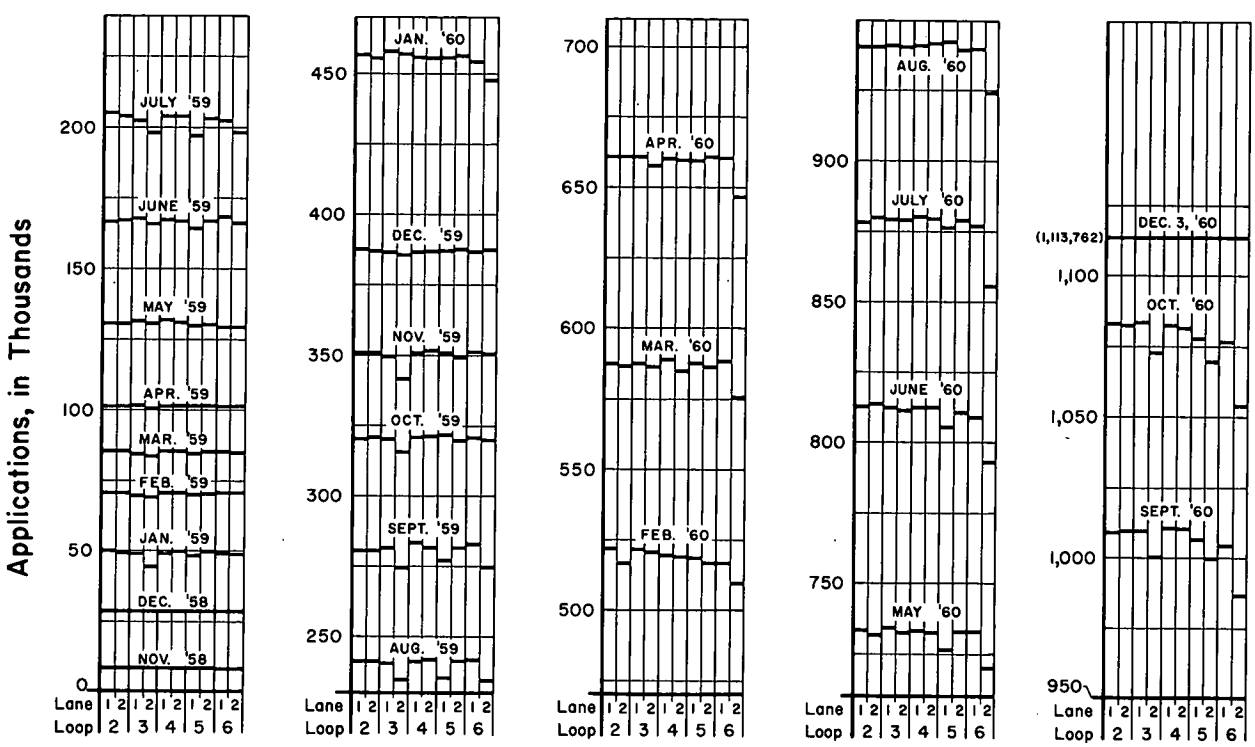


Figure 25. Cumulative axle applications at end of month.

Figure 26. During periods of adverse weather traffic operations were governed by safety considerations. Snow and ice conditions usually resulted in operating at reduced speeds.

2.3.5 Accident Record

The nature of the test traffic operation made it probable that accidents and mishaps would occur on the test loops. Thus, efforts of project and Army personnel were aimed at minimizing the number of accidents and reducing their severity.

Shortly after the beginning of test traffic a board was organized to review all accidents involving test vehicles in an effort to determine causes and to suggest methods of preventing similar occurrences. Both military and project personnel were on the board with direction resting primarily with the military unit commander.

Table 9 gives the number of accidents by type. Many of those listed would not be considered "reportable" accidents if they had oc-

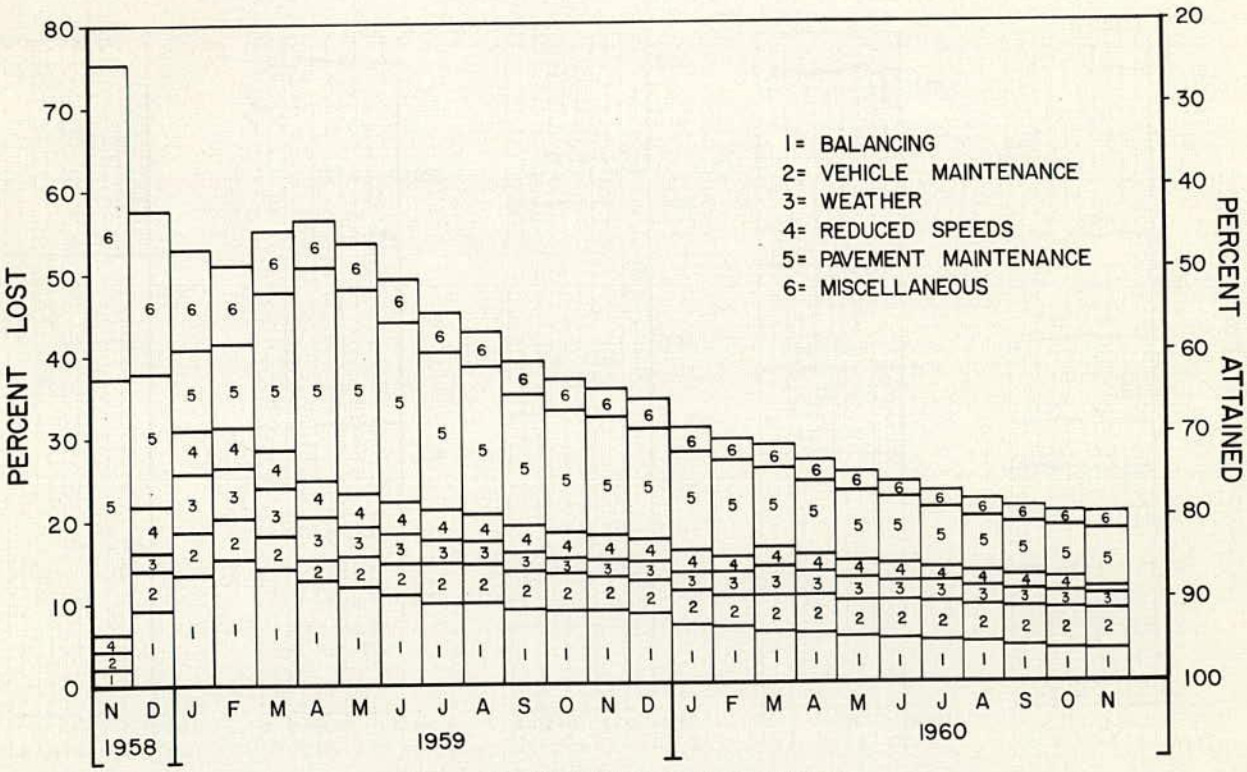


Figure 27. Cumulative lost applications.

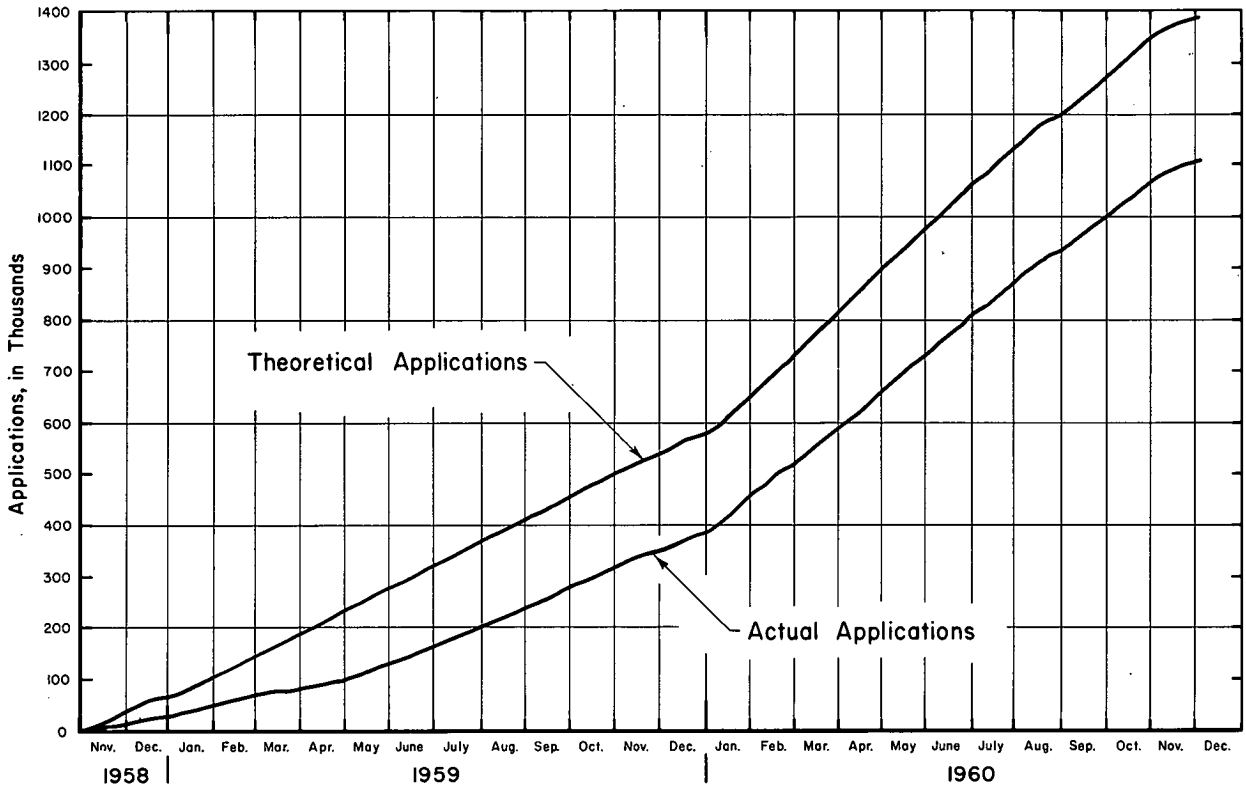


Figure 28. Applications *vs* time.

curred on a normal highway. In fact, 51 of the 141 listed accidents resulted in property damage of less than $25. Many of these minor mishaps occurred in or near the parking area while vehicles were starting or stopping operations. The breakdown of accident cost is as follows: less than $25 property damage, 51; $25 to $250, 42; $250 to $500, 19; $500 to $1,000, 16; over $1,000, 13. The total cost of 141 accidents was $53,814 for the 17,474,000 miles driven throughout the project. Appendix B shows accident classification, experience, and location.

It appeared that many of the accidents on the loops (running off turnarounds and tangents, hitting test bridges, etc.) were the result of drowsiness or inattention caused by the long, monotonous hours of driving. All supervisory personnel were continually concerned with this problem, and every effort was made to alleviate it. For example, broadcast band radios were installed in all test vehicles in mid-1959 in order to relieve the monotony to some extent. Drowsy drivers were instructed to pull out of the traffic stream and were given an extended rest period. A few drivers, who appeared to be accident prone, were relieved of driving and assigned to other duties.

Despite all precautions several serious accidents occurred. Two of these resulted in fatalities. Specialist Fourth Class Melvin L. Kaiser of Willows, Calif., was killed on December 12, 1959, when his vehicle ran off the tangent on Loop 6 and overturned. Specialist Fourth Class Gary L. Edlin of New Albany, Ind., was killed on October 31, 1960, in a rear-

TABLE 9

TYPE AND NUMBER OF ACCIDENTS

Type	Number
Upset	9
Collision:	59
With test bridge abutments (7)	
With other vehicles[1] (52)	
Other (property damage)[2]	22
Subtotal	90
Other (no property damage)[3]	51
Total	141

[1] Rear end, sideswipe, etc.; primarily during starting and stopping procedure.

[2] Jackknife, left test track; vehicle damage over $25.

[3] Deviations from test track, incidental scrapes, negligible property damage.

end collision on Loop 5. Several other vehicles were severely damaged, but none of the other accidents resulted in serious injury to the driver.

Although there were a few accidents involving project personnel, no serious injury was sustained by any employee, on the project site, during the conduct of the road test.

2.4 VEHICLE MAINTENANCE

2.4.1 Organization of Shop

The project's vehicle maintenance shop originally was set up and equipped to perform only minor maintenance of the test vehicles. It was intended that the shop would do such work as lubrication and oil changing, motor tune-up, adjustment of brakes and clutches, and minor repairs and replacement of parts. All major repair work was to be "farmed out" to commercial garages and shops in the vicinity of the project.

Shortly after operations began in the fall of 1958 it became apparent that such a program would result in undue delay to test traffic. Maintenance of vehicles off the project proved to be too time consuming. Commercial garages often could not give priority service to the project vehicle. Furthermore, they did not stock many necessary replacement parts, and normal procedures for obtaining such parts required considerable time. Therefore, it was necessary to alter plans for the shop organization and to increase personnel, equipment and the stock of parts in order to perform major repairs on the project.

Shop personnel was increased sufficiently to handle the work; ultimately, the shop became a 24-hr operation. Two full shop crews were on duty, one working from 7:00 a.m. to 4:00 p.m. and the other from 7:00 p.m. to 4:00 a.m. Two-man "swing shift" crews were on hand for emergency repairs during the remaining six hours.

In order to undertake major repair work additional equipment was purchased and the shop began to stock more parts, including large components such as motors, transmissions and axles. However, parts supply continued to be one of the major problems throughout the entire test traffic period. The problem was compounded by the fact that the shop was servicing ten different makes and many different models of truck tractors. Maintenance of a complete inventory of parts for these tractors (plus parts for the trailers) was impracticable, so stocks were kept of only those items for which there was a recurring need.

Every effort was made to facilitate speedy acquisition of the necessary parts. The shop superintendent and chief parts man were given authority for direct purchase on the basis of best possible price for quickest delivery. Contacts were set up with representatives of the vehicle manufacturers who could locate needed parts and arrange for air shipment to nearby cities.

In order to reduce delivery time, arrangements were made to pick up parts at supply houses, agencies, and air-freight terminals. Thus, the shop organization included three men designated as "parts runners," who made such pick-ups and transported the parts to the project.

The problems of vehicle maintenance increased as the original fleet began to amass considerable operating mileage, and also as the number of test vehicles increased. In late 1959, when the fleet was being increased from 78 to 126 units, the shop was enlarged from 4 to 6 bays, or from about 3,800 sq ft to 5,700 sq ft of working space.

As the fleet grew and the work load increased, it became necessary to provide for more precise control of the maintenance work.

Figure 29. Several accidents such as this occurred on the loop turnarounds. The driver of this vehicle remained in the cab and was not injured despite the extensive damage to the vehicle.

Figure 30. Interior of vehicle maintenance shop shortly after beginning of full-scale traffic in November 1958.

A control board was established on which was listed each vehicle code number, the location of the vehicle, repairs required, parts needed to complete the repair, and whether parts were on the job or on order. This board was used extensively by the shop superintendent in establishing priorities for the work and in assigning work to mechanics.

2.4.2 General Maintenance Procedures

Whenever possible major maintenance work was done by replacement of components such as motors, transmissions, differentials, clutches, springs and fifth-wheel mounts. This system made it possible to return the vehicle to operation in a relatively short time and to repair or rebuild the damaged component on a time-available basis or to have the repair done by commercial garages off the project. This was particularly true in the case of certain components which manufacturers recommended be repaired by factory-trained mechanics.

Work also was done by off-project shops whenever the project shop became overburdened and it was determined that certain vehicles could be returned to operation quicker by sending them to local garages. In addition, there were some types of repair work for which the project shop was not equipped. For example, no attempt was made by the project shop to repair vehicles involved in accidents resulting in major damage to bodies and frames.

Certain other work was done by outside personnel under contract to the project. For example, all welding was done by contract forces. On occasion there was considerable work of this type to be done. One of the major tasks of this nature was the rebuilding and reinforcing of semitrailer frames, some of which suffered fatigue failure as a result of constant operation under full load.

As much as possible of the repair work was done on the test loop. The vehicles were brought to the shop only when absolutely necessary. To facilitate this procedure certain mechanics and helpers were assigned as loop "trouble shooters". These men were assigned to specific loops, thus reducing the number of vehicle types on which they worked, fixing definite areas of responsibility and creating closer cooperation between shop personnel and the supervisory military personnel on the test loops. These loop mechanics performed routine work in the shop until a trouble call came from their assigned loop. They went to the scene, made the repairs if possible, or recommended that the vehicle be brought to the shop. In addition, the loop mechanics were responsible for checking and repairing or otherwise disposing of all deficiencies noted on the daily reports of the drivers.

Table 10 is a summary of truck and truck tractor component replacements, Table 11 gives similar information on semitrailers.

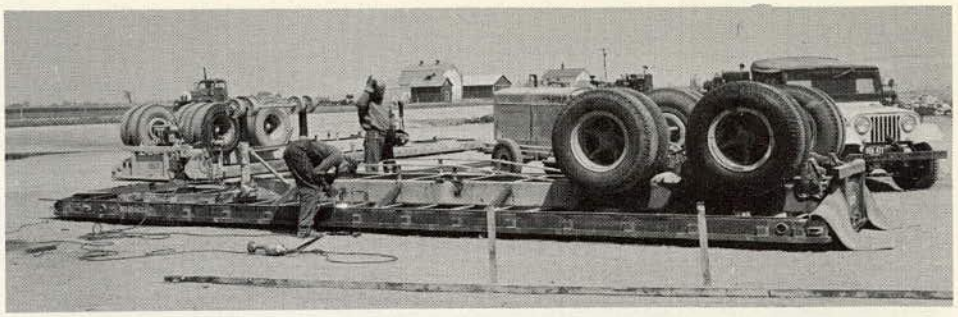


Figure 31. Welding crew rebuilding and reinforcing frame of a semitrailer that suffered fatigue damage as a result of constant operation under full load.

TABLE 10

TRUCK COMPONENT REPLACEMENT SUMMARY [1]

Loop	Lane	Total Vehicles	Test Axle Loads (lb)	Gross Weight (lb)	Total Miles [2]	No. of Components Replaced [3]						
						Engine	Transmission	Power Divider or Differential	Weld Frame	Spring		Clutch [4]
										Front	Rear	
2	1	8	2,000 S	4,000	1,079,204	2(2)	3(2)	2(2)	0	0	1(1)	7(5)
2	2	15	6,000 S	8,000	2,227,592	14(10)	9(6)	24(8)	1(1)	35(14)	22(11)	20(6)
3	1	13	12,000 S	28,500	1,793,712	39(12)	14(10)	11(7)	0	19(10)	24(12)	34(11)
3	2	13	24,000 T	54,500	1,831,998	60(8)	60(10)	22(8)	2(2)	11(7)	9(5)	51(10)
4	1	13	18,000 S	42,000	1,780,133	15(8)	15(9)	11(6)	9(7)	16(8)	34(12)	25(7)
4	2	13	32,000 T	73,500	1,761,902	16(9)	6(4)	8(6)	1(1)	11(8)	14(7)	9(4)
5	1	13	22,400 S	51,000	1,764,862	38(13)	47(12)	15(10)	0	5(4)	31(11)	93(13)
5	2	13	40,000 T	89,000	1,761,694	19(9)	29(10)	11(6)	16(6)	21(10)	74(12)	37(12)
6	1	13	30,000 S	69,000	1,744,542	14(9)	19(7)	4(2)	6(4)	15(6)	127(13)	12(5)
6	2	13	48,000 T	108,000	1,687,933	29(13)	43(11)	5(5)	7(6)	23(7)	14(7)	31(10)
Total		127	—	—	17,433,572	246(93)	245(81)	113(60)	42(27)	156(74)	350(91)	319(83)

[1] These data are for the specialized operating conditions of the Road Test, and it is neither intended nor implied that they are indicative of normal truck or fleet operation.

[2] As of December 3, 1960, close of test traffic.

[3] Figures in parentheses are number of vehicles requiring component replacement.

[4] Includes disc, or pressure plate, or housing, or all three.

TABLE 11

TRAILER COMPONENT REPLACEMENT SUMMARY [1]

Loop	Lane	Total Trailers	Test Axle Load (kips)	Total Miles [2]	No. of Components Replaced [3]		
					Spring	Dolly Leg	Weld Frame
3	1	12	12 S	1,793,700	151(6)	3(2)	1(1)
3	2	12	24 T	1,832,000	23(7)	2(1)	11(5)
4	1	12	18 S	1,780,100	32(12)	2(1)	4(3)
4	2	12	32 T	1,761,900	70(12)	2(1)	42(10)
5	1	12	22.4 S	1,764,900	30(11)	10(5)	30(10)
5	2	12	40 T	1,761,700	43(10)	11(4)	73(12)
6	1	12	30 S	1,744,500	53(12)	4(2)	14(6)
6	2	12	48 T	1,687,900	98(12)	17(8)	36(10)
Total		96	—	14,126,700	364(82)	51(24)	211(57)

[1] These data are for the specialized operating conditions of the Road Test, and it is neither intended nor implied that they are indicative of normal truck or fleet operation.

[2] As of December 3, 1960, close of test traffic.

[3] Figures in parentheses are number of vehicles requiring component replacement.

CLASS "A" MAINTENANCE

TRUCK NO. _____ DATE _____

MILEAGE _____ MECHANIC _____

GAS VEHICLES (6000 MILES)

CHECK:
- Plugs ☐
- Points ☐
- Condenser ☐
- Timing ☐

ADJUST:
- Valves ☐
- Fan Belts ☐
- Engine R.P.M. ☐

CHECK:
- Front End ☐
- Drive Line ☐
- Wheels ☐
- Springs ☐
- Frame ☐
- Oil and Grease Leaks ☐

CHECK AND ADJUST:
- Brakes ☐
- Clutch ☐
- Emergency ☐

CHECK:
- Lights ☐
- Horn ☐
- Windshield Wipers ☐

CLASS A-1 MAINTENANCE EACH 18,000 MILES
- Check and Repack Wheel Bearings ☐
- Backflush Injectors ☐

DIESEL VEHICLES (12,000)

ADJUST:
- Valves ☐
- Injectors ☐

CHECK:
- Fuel Pressure ☐
- Fuel Filters ☐
- Horn ☐
- Lights ☐
- Wipers ☐
- Wiring ☐

CHECK:
- Springs ☐
- Frame ☐
- Wheels ☐
- Steering ☐
- Drive Line ☐
- Oil Leaks ☐
- Grease Leaks ☐

CHECK AND ADJUST:
- Brakes ☐
- Clutch ☐
- Emergency ☐

ADJUST:
- All Belts ☐

CLASS A-1 MAINTENANCE EACH 24,000 MILES
- Repl. Dry Air Cleaner ☐
- Check and Repack Wheel Bearings ☐

CLASS "B" MAINTENANCE

TRUCK NO. _____ DATE _____

MILEAGE _____ MECHANIC _____

Each 2,500 MILES
- Change Oil and Filter ☐
- Clean Oil Bath Air Cleaner ☐
- Check Air Filter to Road Ranger ☐
- Check Shutterstat Fluid ☐
- Blow Out Dry Air Cleaner ☐
- Grease Chassis ☐
- Check Transmission Lub. Level ☐
- Check Differential Lub. Level ☐
- Grease Fith Wheel ☐
- Drain Water From Fuel Tanks ☐

Each 10,000 MILES
- Change Transmission Lubricant ☐
- Change Differential Lubricant ☐

Each 24,000 MILES
- Change Dry Air Cleaner ☐

Figure 32. Preventive maintenance form.

Figure 33. Army personnel refueled test vehicles from storage tanks located on the test loops.

TABLE 12

FUEL STORAGE

Location	Capacity (gal)	
	Diesel Fuel	Gasoline
Garage	2,000	5,000 [1]
	—	2,000 [2]
Loop 3	—	4,000
Loop 4	2,000	2,000
Loop 5	4,000	2,000
Loop 6	5,000	—
Total	13,000	15,000

[1] Loop 2 and Army vehicles.
[2] Project vehicles.

TABLE 13

FUEL DISPENSED

Loop	Gasoline (gal)	Diesel (gal)
2	335,000	—
3	790,000	—
4	392,000	368,000
5	390,000	418,000
6	—	837,000
Staff and maint.	160,000	12,000
Total	2,067,000	1,635,000

2.4.3 Preventive Maintenance

Preventive maintenance on the test vehicles was done frequently. This policy was dictated by the nature of the test traffic operation and by the need to prevent major breakdowns of equipment and keep vehicles operating at peak efficiency. Certain shop mechanics, helpers and lubrication men were assigned full time to the preventive maintenance program.

Figure 32 is a reproduction of the shop's preventive maintenance form. It will be noted that Class B maintenance was concerned almost entirely with lubrication, whereas Class A maintenance involved checking and/or adjusting parts and components on the entire vehicle. Class B maintenance was scheduled every 2,500 miles; Class A maintenance, every 6,000 miles for gasoline vehicles and every 12,000 miles for diesel vehicles.

2.4.4 Fuel and Lubricants

Specifications for fuel and lubricants were drawn up by the Operations Branch on the basis of recommendations made by the vehicle manufacturers. Bids were accepted from qualified suppliers, and annual contracts were awarded on the basis of price. During the traffic operations period four major "brand name" products were used at various times.

Fuel storage tanks and pumps were installed on each of the four major loops (3 through 6) and at the garage building. Test vehicles from Loop 2 were fueled at the garage building because the loop was nearby. All other test vehicles were fueled on their respective loops. Staff vehicles and Maintenance Branch equip-

TABLE 14

FUEL AND ADD OIL SUMMARY [1]

Loop	Lane	Total Vehicles	Test Axle Load (lb)	Gross Weight (lb)	Total Miles [2]	Total Fuel (gal)	Miles per Gallon [3]	Qts. Oil Added	Miles per Quart
2	1	8	2,000 S	4,000	1,079,204	75,461	(G) 14.3	1,151	937
2	2	15	6,000 S	8,000	2,227,592	184,925	(G) 12.0	2,722	818
3	1	13	12,000 S	28,500	1,793,712	318,044	(G) 5.6	3,783	473
3	2	13	24,000 T	54,500	1,831,998	472,285	(G) 3.9	7,055	262
4	1	13	18,000 S	42,000	1,780,133	391,091	(G) 4.5	3,671	485
4	2	13	32,000 T	73,500	1,761,902	368,286	(D) 4.8	8,366	210
5	1	13	22,400 S	51,000	1,764,862	390,874	(G) 4.5	5,123	344
5	2	13	40,000 T	89,000	1,761,694	417,216	(D) 4.2	6,061	290
6	1	13	30,000 S	69,000	1,744,542	341,965	(D) 5.1	6,617	263
6	2	13	48,000 T	108,000	1,687,933	492,721	(D) 3.4	8,506	198
Totals		127	—	—	17,433,572	3,452,868	—	53,055	—

[1] These data are for the specialized operating conditions of the Road Test, and it is neither intended nor implied that they are indicative of normal truck or fleet operation.
[2] As of December 3, 1960, close of test traffic.
[3] (G) = gasoline; (D) = diesel.

ment were fueled from a separate tank at the garage building. Table 12 gives the locations and capacities of the fuel storage tanks on the project.

Fuel was delivered in tank trucks and metered into the various storage tanks. The proper grade of motor oil also was stored in bulk on each loop and at the garage building. As each vehicle was fueled and/or had motor oil added, a disbursement ticket was made out giving the vehicle number, the mileage and the amount of fuel or motor oil. At the end of each driving shift the Army crew chief for each loop compiled the individual tickets into a fuel summary report.

Fuel summaries and individual tickets were delivered to the Operations Branch, enabling the branch to keep a running account of receipts and disbursements for each storage tank as well as fuel and motor oil consumption records on each vehicle. The latter record often served as an indicator of developing mechanical trouble in a vehicle.

Table 13 gives the total amount of gasoline and/or diesel fuel dispensed for each test loop and for the staff vehicles and Maintenance Branch equipment.

Table 14, a summary of fuel and motor oil consumption by vehicles in each of the ten traffic lanes, gives the average miles per gallon of fuel and per quart of motor oil for the vehicles in each lane.

Figure 34. At the peak of operations, two three-man crews were used to check and service tires on the test vehicles.

TABLE 15
TIRE WEAR SUMMARY[1]

Loop	Lane	To First Recap (Original Tread)		To Follow Recaps	
		No. of Tires	Average Mileage	No. of Tires	Average Mileage
2	1	73	18,866	86	17,584
2	2	112	45,025	97	31,206
3	1	140	26,655	183	17,031
3	2	326	19,871	309	17,083
4	1	199	35,130	144	21,457
4	2	444	25,881	426	18,863
5	1	195	27,608	316	18,136
5	2	451	23,203	596	18,062
6	1	247	24,694	209	21,885
6	2	528	19,123	420	18,606

[1] These data are for the specialized operating conditions of the Road Test, and it is neither intended nor implied that they are indicative of normal truck or fleet operation.

2.4.5 Tires

At the peak of test traffic operation in 1960 the Road Test vehicle fleet was equipped with 1,524 tires. Tires per vehicle ranged from four on the pick-up trucks in Lane 1 of Loop 2 to 18 on the tandem axle vehicles running in the outer lanes of the four major loops. Altogether, 4,270 tires were used during the test traffic period.

The Vehicle Maintenance Shop kept a supply of spare tires amounting to 10 to 20 percent of the total number being used. These included tires stored at the shop, new tires enroute from the supplier, and tires being recapped.

The project awarded contracts, on a bid basis, with three suppliers for new tires and with four recapping firms located in the area. Several different "brand-name" tires were supplied.

The shop organization included a chief tire man who supervised a group of nine employees

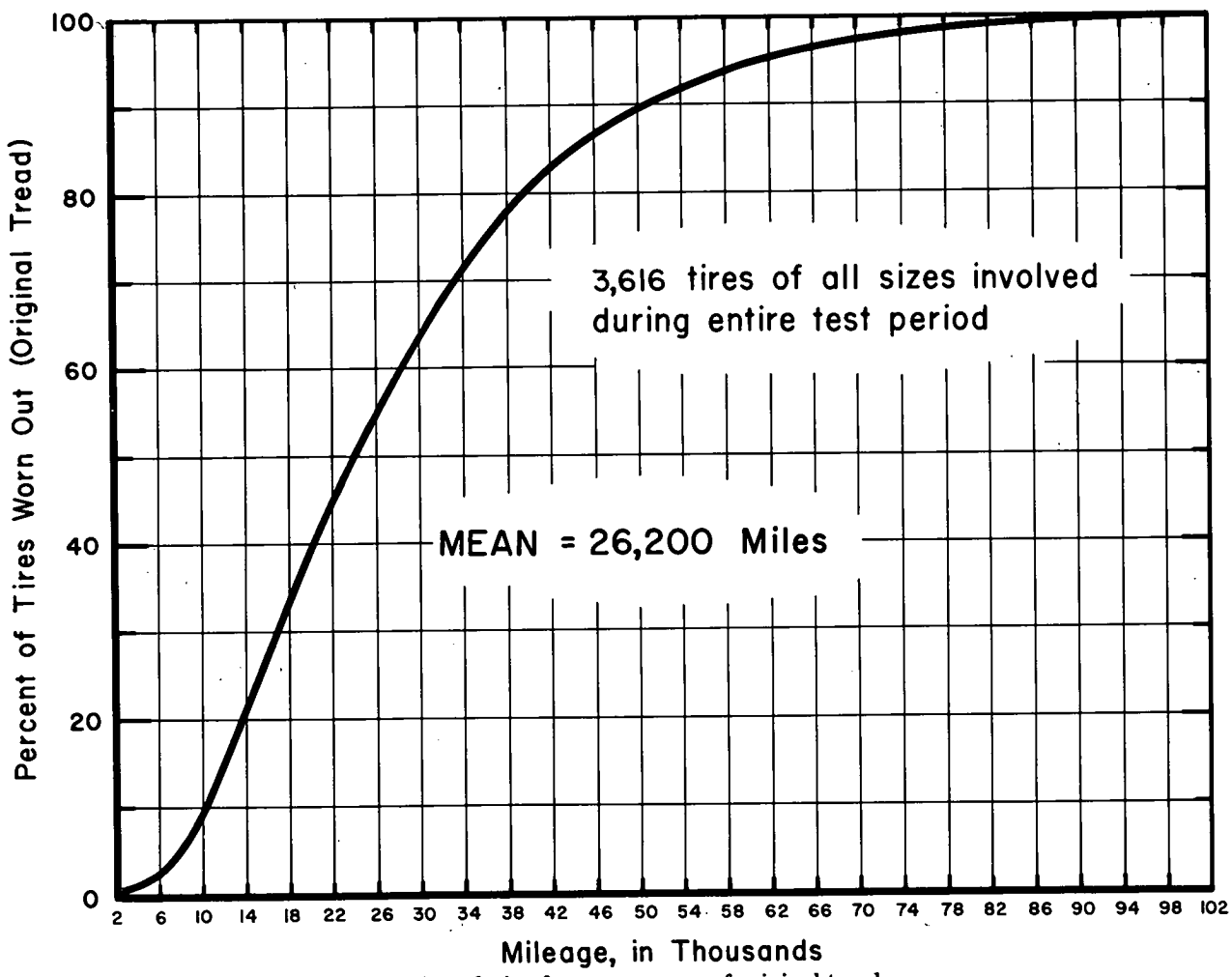


Figure 35. Cumulative frequency curve of original tread wear.

engaged in maintaining tires. The tire men were organized into two crews, each with a vehicle to carry tools, equipment, and an air compressor. One crew serviced vehicles on Loops 3 and 6; the other serviced vehicles on Loops 2, 4 and 5.

Tire wear was a constant problem throughout the test traffic period, and every effort was made to control contributing factors such as inflation pressures, vehicle speed and driving patterns. Minor variations in any of these factors were found to produce considerable effect on the rate of tire wear.

For example, vehicle speed on all loops was initially set at a constant 30 mph. However, the superelevated turnarounds had been designed for no side thrust at 25 mph. The additional 5-mph speed apparently caused extreme tire wear, although faulty driving patterns may also have been a contributing factor. Tire mileage improved considerably when turnaround speeds were reduced to 25 mph.

Tire mileage improved throughout the entire test traffic period. This was probably due to a combination of such factors as decreasing coefficient of friction on the pavements, improved control of inflation pressures, and more experienced drivers.

The Operations Branch maintained a complete life history on every tire used, and summarized the information in bimonthly reports giving the average and cumulative average mileage obtained on tires used in each of the ten traffic lanes. A summary of these reports is given in Table 15.

Figure 35 is a cumulative frequency curve indicating the percentage of new tires removed for recapping at given mileages. The figure covers new tires used on the test vehicles and shows the arithmetic mean of 26,185 miles for original tread only.

Chapter 3

Pavement Maintenance

This chapter outlines the purposes and policies which governed maintenance of the test pavements and bridges. It describes the equipment, materials and methods of maintenance, and the extent of the maintenance operation.

3.1 PURPOSES AND POLICIES

The primary objective of the AASHO Road Test was to determine significant relationships between the performance of highway pavements of known designs and the loadings applied to them. Thus, it was necessary that all pavement test sections be treated alike so that the performance of any section could be compared directly with the performance of any other section.

The concept of identical treatment for all pavement sections was particularly vital in pavement maintenance practices. Consequently, definite rules, regulations and criteria were set up to govern the maintenance operation. In addition, a staff Maintenance Review Committee was given the responsibility of insuring comparable treatment for all sections of pavement. This Committee was made up of the Project Director, the Chief Engineer for Research, and the Maintenance Engineer.

Actual maintenance operations were under the direction of the Maintenance Engineer. The personnel requirements of this branch of the project staff varied according to the amount of work to be done.

The main purposes of the maintenance program were: (1) to repair minor and localized pavement damage which might be associated with construction deficiencies and the presence of drainage structures; (2) to retard the progression of damage from those areas which had been repaired to those areas still in test; (3) to repair or replace pavements removed from testing and, thus, to facilitate test traffic operation and prevent damage to test vehicles; and (4) to provide the services needed to keep the test pavements and surrounding areas in a condition which would facilitate the safe and efficient operation of the entire project.

One of the five specific objectives of the AASHO Road Test directed the staff to "Provide a record of the type and extent of effort and materials required to keep each of the test sections, or portions thereof, in a satisfactory condition until discontinued for test purposes." Such a record was kept for all sections which required maintenance. Records are available under AASHO Road Test Data System 6300.

However, it should be noted that only minor maintenance was permitted until a pavement section had deteriorated to the point that it was declared unserviceable and removed from testing. Therefore, there may be little similarity between maintenance as practiced at the Road Test and maintenance as practiced on in-service highway pavements. In addition, there was no study of different or alternate maintenance procedures and practices.

A limited study was made of selected test sections which were removed from testing and repaired with an asphaltic concrete overlay. The results of this study are reported in AASHO Road Test Report 5 (HRB Special Report 61E).

The specific criteria which governed maintenance were developed by the staff with the assistance of the Advisory Panel on Maintenance. An original statement of policies and criteria was prepared following a request by the National Advisory Committee in July 1958. These criteria were revised in the light of actual field experience on the project, and the following final statement was adopted by the National Advisory Committee in January 1960.

Part 1 Road Test Maintenance Policy

The policy for pavement maintenance at the AASHO Road Test was to permit maintenance of all types in order to keep traffic operating, but when maintenance of a type that changed the structure of a section was performed, the section was removed from the basic experiment and thereafter was considered to be in a special category. In the case where a section was overlaid without deep patches it was continued under study independent of the original or basic experiment.

The following procedures were considered not to affect the original structure: mowing, snow and ice removal, ditch and culvert cleaning, shoulder maintenance, fog seal, crack and joint sealing, and the repair of construction deficiencies (within the limits set forth hereinafter in the criteria for each type of maintenance).

The following procedures were considered to change the structure: seal coat, large skin or deep patches, and overlay.

Following are the rules which governed the maintenance work on the project.

Figure 36. Project maintenance forces placing a skin patch consisting of an application of bitumen and pre-mixed bituminous patching material.

Part 2 General for All Pavements

Maintenance procedures depended upon the condition of the test section to be repaired, as described in the following:

Case 1. No patching had been done previously, but distress within the test section was so general that the failure was obviously attributable to the pavement design and not to a construction deficiency. Maintenance was delayed until the present serviceability index dropped to 1.5, at which time the section was dropped from the basic experiment and maintenance was performed as necessary.

Case 2. No patching had been done previously, but distress was not general, so that it was not clear whether the failure was due to inadequate pavement design or to a construction deficiency. There were then two alternatives:

A. If the required length of patch, measured parallel to the centerline, exceeded the limits set forth in the criteria which follow, maintenance was delayed until the index reached a value of 1.5, at which time the section was dropped from test.

B. If the required length of patch was less than the limits set forth in the criteria which follow, the section was maintained, the index was determined after maintenance, and the section was retained in the basic experiment.

Case 3. The condition of the section was the same as in Case 2, except that one patch had been placed previously. There were two alternatives:

A. If an extension of the existing patch beyond the limits set forth in the criteria was required, or if a patch in a new area was required, maintenance was delayed until the index reached 1.5, at which time the section was dropped from the basic experiment.

B. If no maintenance in a new area was required, and the old patch could be repaired without exceeding the limits set forth in the criteria which follow, the index was determined after the old patch was repaired and the section was retained in the basic experiment.

Part 3 Criteria for Flexible Pavement

1. *Fog Seal*

Purpose: A fog seal was used to correct a construction defect in which a small amount of asphalt was needed on the surface of the asphaltic concrete to correct raveling or crumbling due to insufficient asphalt content in the original mix.

Criteria: A fog seal was permitted in any section or part of a section in which there was raveling or crumbling due to insufficient asphalt content.

2. *Spot Seal*

Purpose: A spot seal was applied to prevent surface water from entering the pavement structure through surface cracks and to correct other minor surface defects.

Criteria: A spot seal was permitted to be applied to that area of pavement surface of approximately one square yard which had Class 2 cracks, but which did not have a sufficient depression to require a skin patch. No more than two such spot seals were permitted in either wheelpath of a section.

If the rate at which distress was developing indicated the need for a skin patch, a deep patch, or reconstruction, spot seals were not applied.

3. *Skin Patch*

Purpose: Skin patches were used to level localized depressions in the pavement surface which made the riding characteristics unsafe or disagreeable to the driver, where water might have ponded and been held on the pavement surface, and to help prevent further deterioration.

Criteria: A skin patch was permitted when a small localized depression developed in the surface of either wheelpath to a depth of 1½ in. That amount of the depression which exceeded ¼ in. in depth was brought to grade; however, the total length of a patch could not exceed 10 ft (of the 100-ft factorial design sections).

If the rate at which distress was developing indicated the need for deep patch or reconstruction, a skin patch was not applied.

In the case of wedge-constructed sections and those sections with tapered shoulder paving, the length of each skin patch could not exceed 10 ft, but no limit was set on the number of patches.

4. *Deep Patch*

Purpose: Deep patches were used to reconstruct a small portion of either wheelpath when substantial evidence indicated that the distress was due to localized non-uniformity in the embankment soil or the pavement structure and was not typical of the entire section.

Criteria: A deep patch was permitted when the distress in a localized area no more than 5 ft in length had progressed to Class 3 cracks and it was apparent from the rate at which distress was developing and/or from the magnitude of surface deflections that a skin patch or a spot seal had not or would not correct the condition or stop the distress from progressing to adjacent areas. However, the length of each deep patch could not exceed 10 ft (of the 100-ft factorial design sections). The patch was constructed to a thickness considered sufficient to carry the remaining test traffic.

In the case of wedge-constructed sections and those sections with tapered shoulder paving, the length requiring deep patch, plus 5 ft, was patched without limit on the number permitted.

5. *Overlay*

Purpose: An overlay of asphaltic concrete was applied in some sections to permit traffic to operate over sections which had become unserviceable or unsafe. The overlaid sections which had not been deep patched were then observed as special study sections.

Criteria: An overlay was permitted on a section which had been discontinued from the basic experiment if in the judgment of the Maintenance Review Committee an overlay was warranted.

When an overlay was placed, it usually covered the entire test section. A few part section overlays were placed on sections of wedge construction and on those sections with tapered shouldered paving.

Figure 37. A multiple-pan vibratory compactor was used frequently to compact crushed stone used as a base in deep patches.

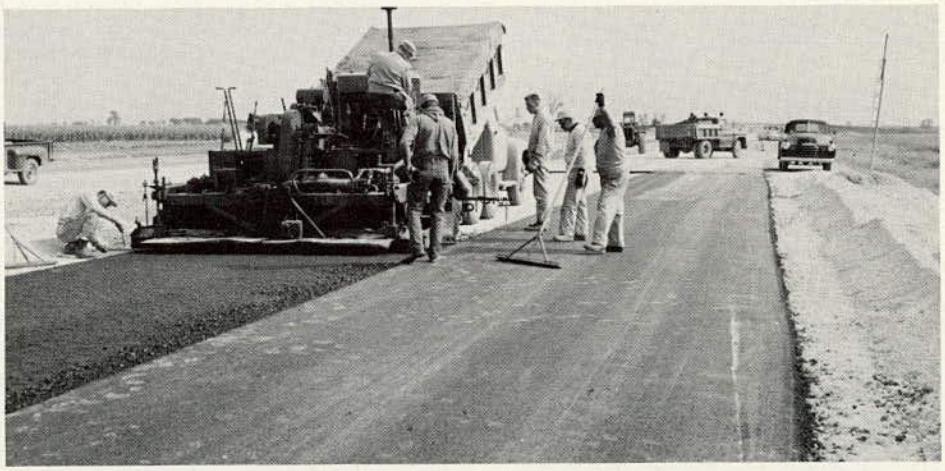


Figure 38. Many sections declared out of test were reinforced with a hot-mix asphaltic concrete overlay. Routine measurements and observations were continued on selected overlaid sections.

6. *Reconstruction*

Purpose: Reconstruction was done in order to replace those sections in which the application of maintenance procedures had not been or would not likely be effective in keeping the pavement in a servicable condition for continuation of test traffic.

Criteria: Reconstruction was permitted in either wheelpath or a full test section which might or might not have had any previous maintenance, but had been discontinued from the basic experiment, if in the judgment of the Maintenance Review Committee the deterioration was so rapid that other maintenance procedures would not be effective. The rate at which distress was developing was an important consideration in determining if reconstruction should be done. When reconstruction was done, an entire wheelpath or test section was replaced to a thickness considered sufficient to carry the traffic for the remainder of the test program.

Part 4 Criteria for Rigid Pavement

1. *Skin Patch*

Purpose: Skin patches were used to level localized depressions in the pavement surface which made riding characteristics unsafe or disagreeable to the driver, where water might have ponded and been held on the pavement surface, and to help prevent further deterioration.

Criteria: Skin patches were permitted when a depression of the pavement surface was at least 1½ in. lower than the surrounding surface. That amount of the depression which exceeded ¼ in. in depth was brought to grade; however, the total length of patch could not exceed the length of one panel (15 ft in the 120-ft non-reinforced sections and 40 ft in the 240-ft reinforced sections).

If the rate at which distress was developing indicated the need for a deep patch, overlay, or reconstruction, a skin patch was not applied.

2. *Joint and Crack Sealing*

Purpose: Joints and cracks were sealed to help prevent surface water from entering the subbase through the joints and cracks, and to help prevent solids from filling the openings.

Criteria: Sealing of joints and cracks was permitted each fall and spring as necessary or when a length of at least 10 ft had opened to a width of ¼ in. at the pavement surface.

3. *Deep Patch*

Purpose: Deep patches were used to reconstruct a small portion of either wheelpath when substantial evidence indicated that the distress was due to localized non-uniformity in the embankment soil or the pavement structure and was not typical of the entire section.

Criteria: A deep patch was permitted when the distress in localized areas had progressed to a point where it was apparent that a skin patch had not or would not correct the condition or stop the distress from progressing to adjacent areas. The length of each patch could not exceed the length of one panel (15 ft in the 120-ft non-reinforced sections and 40 ft in the 240-ft reinforced sections). The patch was constructed to a thickness considered sufficient to carry the remaining test traffic.

4. *Overlay*

Purpose: An overlay of asphaltic concrete was applied in some sections to permit traffic to operate over a section which had become unserviceable or unsafe. The overlaid sections which had not been deep patched were then observed as special study sections.

Criteria: An overlay was permitted on a section which had been discontinued from the basic experiment if in the judgment of the Maintenance Review Committee an overlay was warranted.

5. *Reconstruction*

Purpose: Reconstruction was done in order to replace those sections in which the application of maintenance procedure had not been or would not likely be effective in keeping the pavement in a serviceable condition for the continuation of test traffic.

Criteria: Reconstruction was permitted in either wheelpath or in a full test section which may or may not have had any previous maintenance, but had been discontinued from the basic experiment, if in the judgment of the Maintenance Review Committee the deterioration was so rapid that other maintenance procedures would not be effective. The rate at which distress was developing was an important consideration in determining if reconstruction should be done. When reconstruction was done an entire wheel-

Figure 39. Many of the thinner pavement sections were excavated and rebuilt following their removal from testing. Here, an entire test section has been dug out prior to backfilling with crushed stone and surfacing with hot-mix asphaltic concrete.

path or test section was replaced to a thickness considered sufficient to carry the traffic for the remainder of the test program.

Part 5 Criteria for Other Maintenance

1. *Shoulder*

Purpose: The shoulder area was maintained to provide drainage and lateral support for the pavement.

Criteria: Shoulder grading was permitted as needed in the judgment of the Maintenance Review Committee.

2. *Ditches and Culverts*

Purpose: Ditches and culverts were cleaned to provide adequate drainage for the roadway.

Criteria: Ditch and culvert grading and cleaning were permitted as needed.

3. *Snow and Ice Removal*

Purpose: Snow and ice were removed from the pavement and shoulder surface to provide safe driving conditions and to allow the drivers to see the transverse position guide lines painted on the pavement surface.

Criteria: Snow plows in conjunction with chemicals and abrasives were permitted as needed to keep the pavements and shoulders free from snow and ice.

4. *Traffic Markings*

Purpose: The traffic markings were maintained to provide guide lines to control the transverse placement of the vehicles on the pavement.

Criteria: The paint stripes were repainted as needed and replaced if they had been obliterated by some maintenance procedure.

5. *Pavement Sweeping*

Purpose: The pavements were swept to keep them reasonably clean and to provide a smooth surface for instruments which made measurements on the pavement surface.

Criteria: The pavements were swept as needed.

6. *Mowing*

Criteria: Mowing was done when needed.

3.2 PROCEDURES

3.2.1 General Information

Application of the maintenance criteria required coordination between the project's research branches and the Maintenance Branch. Personnel from the pavement research branches were responsible for making measurements of permanent distortion of the pavement surface and computing the present serviceability index. This index was the basis for determining pavement "failure" and consequent removal from testing; major maintenance usually followed soon after removal from test.

Personnel from the pavement research branches also served with the Maintenance Review Committee on routine and special inspections of the test pavements. This committee observed all test sections remaining in test to determine, in line with the approved criteria, the type and extent of maintenance required on those sections showing distress. The committee declared sections out of test in cases where it was obvious that the serviceability index was below the 1.5 level. In cases where there was doubt, the committee requested the research branches to make the necessary measurements and compute the index.

A full inspection by the Maintenance Review Committee was made daily during critical spring and fall periods when conditions were conducive to rapid pavement distress. At other times, inspections were made once or twice a week. The work performed by the Maintenance Branch was based on the recommendations of the committee.

For sections remaining in test, maintenance was of a minor nature. Each test section was allowed a limited amount of so-called "free" maintenance as outlined in the approved criteria. However, the criteria did not allow other maintenance which would alter the structural characteristics of a section until it had been declared out of test.

Once a section was declared out of test by the committee, or on the basis of research measurements, it was eligible for major maintenance. Some sections, usually those with the lighter designs, were removed and replaced with new pavement of a design considered adequate for the remainder of the test traffic period. In other sections, distressed areas were repaired and the entire section was overlaid with asphaltic concrete. A few sections were merely patched as needed.

Flexible-type pavement was used for all deep patching and reconstruction inasmuch as portland cement concrete construction would have required a curing period and a consequent delay in test traffic operation.

Insofar as possible, all maintenance work was done by personnel of the project's Maintenance Branch using project-owned equipment. However, it was necessary to augment these forces during critical spring and fall periods. Contractors were engaged on a force-account basis during the late fall of 1958, the spring and fall of 1959, and for a short period in the spring of 1960.

The spring of 1959 imposed the heaviest maintenance work load. Full-scale test traffic had begun in early November 1958, just prior to the winter freeze, and many pavement sections of light design were still in test when the ground began to thaw in late February 1959. Consequently, a large number of sections showed serious distress in a short period of time.

During the spring of 1959 the project Maintenance Branch employed approximately 15 men and the contractor employed up to 85 men on the job. The contractor also furnished additional equipment and machinery valued at about $600,000 (purchase cost). The equip-

Figure 40. Manpower and equipment frequently were concentrated on small areas requiring maintenance in order to complete the work during the 5-hr traffic break.

ment was leased to the project on the basis of a monthly standby charge plus an additional charge for each hour of operation. The equipment was leased with a one-month guarantee to the contractor; after that period any piece included in the standby list could be removed if so directed by the project staff. Additional equipment could be added at any time it was needed. This proved to be a satisfactory arrangement for hiring both men and equipment because it gave the project staff control over working hours and the amount of equipment to be used during difficult working seasons. Traffic was expedited immeasurably by this system of maintenance operation. Project-owned and leased equipment is listed in Section 3.2.2.

Every effort was made to perform pavement maintenance work during the daily 5-hr traffic break and to interfere as little as possible with operation of the test vehicles. However, it was not always possible to complete the work during the break period. In such cases traffic was delayed on the loops under repair, but was allowed to operate normally on other loops.

Maintenance work was always on an urgent basis during all the critical periods because it was highly important to keep test traffic operating. Field crews frequently worked from dawn to dusk, and were often on the job on Sundays and holidays. Generally speaking, when any pavement repair job was started, it was completed and the pavement was available for traffic testing that same day. Occasionally, work was done at night under floodlights. During the critical periods, a night crew of two to four men was assigned to make temporary repairs to distressed sections. Thus, traffic could be operated until regular crews made more permanent repairs.

The critical periods also coincided with periods of weather least suited for many maintenance operations. Cycles of freezing and thawing were common in both spring and fall, as were periods of heavy snow and rainfall. Deep patching frequently required digging out frozen or semi-frozen material, and hot-mix asphaltic concrete was sometimes placed in rain or snow with extremely low air temperatures prevailing.

Admittedly, such operations were not efficient by normal maintenance standards. However, they were necessary.

Scheduling of maintenance work was also a major problem. For the most part, it was done on a day-to-day basis because it was impossible to predict more than a day or so in advance which test sections would require repair. Furthermore, the extent and type of repair often could not be determined until just prior to starting work. Thus, it was difficult to schedule manpower, equipment and materials, particularly during periods when the hot-mix asphalt was being purchased from a plant off the project.

Despite the extraordinary efforts of maintenance personnel, traffic operations were sometimes delayed or canceled entirely. During the spring of 1959, for example, test traffic was halted during three one-week periods to allow extensive pavement maintenance. From February 28 to June 6, 1959, only 679,050 axle load applications were recorded for all test loops out of a theoretical 1,452,544. Of the approximate 773,000 applications lost, pavement maintenance time was responsible for 543,000. In other words, the traffic operated at about 47 percent of the theoretical rate, and applications lost because of pavement maintenance were about 37 percent of theoretical.

This example is taken from the most critical spring period. For the entire 25 months of traffic operation, pavement maintenance was responsible for the loss of less than 900,000 applications, or only about 6 percent of the total possible number of applications in all lanes.

3.2.2 Equipment

Table 16 lists equipment used to accomplish the maintenance work during the critical spring period in 1959. Individual pieces of equipment were removed from rental as the work load reduced. All were released by June 12, 1959. Contractor help was needed during other critical periods, but not to the extent required during this first spring.

In the summer of 1959 additional equipment was purchased (all "used") for the project crews to use in the maintenance work. These units included:

No. of Units	Description
1	Front-end loader, crawler, 2¼-yd bucket
1	Asphalt finisher
1	Roller, 8- to 10-ton tandem
1	Loboy trailer and tractor unit
8	Dump truck, tandem axle, 8-yd box
1	Pavement breaker, self-propelled, 600-lb drop hammer
1	Bituminous distributor, truck-mounted, 1,000-gal capacity
1	Vibratory compactor, multiple pad, self-propelled
2	Trucks, pick-up

This additional equipment was necessary so that the project crews could perform all the maintenance operations. A contractor force could not always be engaged on the short notice dictated by pavement failure, nor were they willing to work during odd hours as dictated by traffic schedules.

3.2.3 Materials

The materials used for most maintenance work were crushed stone, cold-mix and hot-mix asphaltic concrete.

The crushed stone was the same material used as base course in the shoulder areas of the original flexible pavement test sections. In construction plans and specifications for the Road Test, the material was designated as Crushed Stone Base, Type A (see Road Test Report 2, SR 61B).

The stone was obtained from two sources near the project and was hauled by truck to three stockpiles, one located between Loops 3 and 6, another in the Administration Area between Loops 6 and 5, and the third between Loops 5 and 4. Occasionally, stone was hauled directly from the source to the site of maintenance work on the project.

Approximately 72,000 tons of stone were used during the test traffic period. Of this amount, 95 percent was used in test pavement maintenance and the remaining 5 percent on frontage and entrance roads, parking lots, and other miscellaneous work. Table 17 gives the gradation of the crushed stone material.

The hot-mix asphaltic concrete was produced on the project or purchased from a local plant.

During the late fall of 1958 and the spring of 1959 the hot mix was produced by a plant left on the project by the paving contractor. The continuous-type plant, rated at 100 tons per hour, had been used to produce the asphaltic concrete surface course mix during construction. For maintenance work the plant was leased on the basis of a daily rental plus operating expenses, and was used to produce about 17,000 tons of hot mix. The plant was removed in May 1959.

After May 1959 hot mix was purchased from a local producer at a contract price which varied with the tonnage per day. One price was set for times when the plant was in normal production; a different (higher) price prevailed when the plant was operated for project use only. This arrangement made the plant available to the project during seasons when it would not normally operate, and some hot-mix paving was done on the project in all months of the year.

The contract plant produced approximately 14,000 tons of hot-mix asphaltic concrete for use on the project. The mix was hauled by project-owned trucks or by the contractor working on a force-account basis.

Pavement maintenance required 99 percent of the 31,000 tons of hot mix produced or purchased. This amounted to about 5,500 tons more hot mix than was used in the original construction of the flexible-type test pavements. It was approximately the amount of material required to pave 9.9 miles of 24-ft roadway 4 in. thick. Table 18 gives the characteristics of the hot-mix asphaltic concrete.

When hot-mix material was not available, cold-mix asphaltic material was used for skin patching and filling small holes. It was employed also as a cushion and leveling course under the pierced-plank mats used as temporary riding surfaces, described later.

The cold mix was purchased from a local producer who maintained a stockpile at his plant. During the test traffic period approximately 525 tons were used.

The cold-mix material was usually heated in a portable patching unit to make it easier to handle in winter and more stable under traffic. Normally, cold-mix patches were removed prior to covering a section with hot mix because the lower stability of the cold mix adversely affected the overlays.

TABLE 16

MAINTENANCE EQUIPMENT

Contractor-Leased		Project-Owned	
No. of Units	Description	No. of Units	Description
2	Backhoe, ½ cu yd	1	Gradall
1	Gradall	1	Motor grader
2	Front end loader, 2¼ yd, crawler	1	Roller, 5-8 ton, tandem
1	Front end loader, 2 cu yd, rubber tired	1	Front end loader, 1 cu yd bucket, rubber tired
18	Dump truck, 10-yd bed	4	Dump truck, 4 yd bed
1	Asphalt, hot plant, continuous mix, 100 tons per hr	1	Air compressor, 125 cfm, tools
2	Asphalt finisher	2	Roller, vibratory, hand operated
1	Roller, 3-wheel, 10 ton	1	Portable patching unit
2	Roller, tandem, 5-8 ton	1	Jeep, with rotary broom and plow
1	Roller, pneumatic, 15-wheel	2	Pick-up truck
1	Crane, 1 cu yd clamshell	2	Water tank, 1,000 gal, trailer mounted
1	Loboy tractor and trailer		
3	Vibratory compactor, multiple pad, self-propelled		
2	Pavement saw		
1	Mobile concrete breaker		
2	Air compressor, portable, 125 cfm, tools		
3	Motor grader		
4	Light plant (for night work)		
6	Pick-up truck, foreman and mechanics		
1	Flatbed tool truck		
1	Welder, portable, electric		
2	Water truck, 2,500 gal		

3.2.4 Patching and Reconstruction

Skin patches (one application of bitumen covered with a thin layer of pre-mixed bituminous material) were made with either hot or cold mix, depending on the nature of the patch and availability of hot-mix material.

The material for skin patches was spread by hand and compacted with a single-wheel, hand-operated, vibratory roller or with the tires of a dump truck. The roller was always used on hot-mix material, and occasionally on the cold mix.

TABLE 17

GRADATION OF CRUSHED STONE [1]

Sieve	Spec. Limits (% Passing)	Test Results	
		Mean (% Passing)	Range (% Passing)
1 in.	100	100	98.9-100
½ in.	60-90	69.7	63.1-83.1
No. 4	40-60	46.4	33.3-59.8
No. 8	25-50	35.8	28.1-46.8
No. 16	20-40	27.1	21.0-35.3
No. 200	5-15	12.3	9.9-15.6

[1] Plasticity Index, 0 to 4 percent.
Los Angeles abrasion loss, not to exceed 45 percent.
Sodium sulfate soundness, 5 cycles, not to exceed 25 percent.

In preparing the pavement for deep patching, the surfacing was cut with a saw, pneumatic pavement breakers with spade bits, a self-propelled pavement breaker, or the bucket teeth of a Gradall. Excavation was done with

TABLE 18

CHARACTERISTICS OF HOT-MIX ASPHALT [1]

Sieve	Passing Sieve (%)			
	Binder		Surface	
	Job Mix	Sample Mean and (Range)	Job Mix	Sample Mean and (Range)
1 in.	95-100	100 (100)	—	—
¾ in.	86-96	91.6 (85.2-98.2)	—	—
½ in.	64-74	67.4 (56.7-79.1)	100	100 (100)
No. 4	40-50	39.6 (33.1-51.8)	53-63	59.1 (49.4-75.2)
No. 10	28-34	29.9 (23.6-37.6)	36-42	40.0 (36.9-50.5)
No. 40	18-24	20.6 (14.2-25.0)	22-28	25.4 (19.3-33.9)
No. 200	3-6	5.4 (4.4-6.9)	3.9-6.9	6.5 (4.7-8.3)
Asphalt content	3.8-4.2	4.1 (3.6-4.4)	4.3-4.8	4.6 (4.4-5.2)

[1] Asphalt cement used in both binder and surface mix was 70-85 penetration grade.

Figure 41. A hand-operated vibratory roller was used to compact crushed stone when excavated areas were too small for conventional compaction equipment.

the Gradall or a backhoe; some small holes were made by hand. The depth of patching depended on the loads to be applied. Therefore, it varied from loop to loop.

Crushed stone was used to backfill each deep patch. It was compacted in thin lifts with equipment appropriate to the size of the hole; *i.e.*, multiple-pan-type vibratory compactor, tandem roller, hand-operated roller, or a tamping foot on a pneumatic pavement breaker. Hot-mix asphaltic concrete was used to surface the patch. Occasionally cold mix was used as a temporary expedient and replaced with hot mix when convenient. Table 19 gives the depth of crushed stone and thickness of surfacing for deep patches and reconstructed sections in each loop.

Reconstruction was similar to deep patching except that one or more entire test sections were replaced instead of part sections. Excavation of these large areas was begun with a Gradall or backhoe and continued until a sufficient area was completed to allow working space in the hole for the crawler loader to finish the excavation. The crushed stone was dumped into the excavation and leveled with a motor grader. It was compacted in 4- to 6-in. lifts by self-propelled, multiple-pan, vibratory compactors.

Traffic was allowed to operate over the stone base for one to ten days before the asphaltic concrete surface was placed. The stone base was reshaped with a motor grader before paving. This procedure made it possible to get traffic back in operation sooner, to provide additional consolidation of the stone base, and to schedule paving during the normal daily traffic break. Calcium chloride was spread on top of the open stone sections to help stabilize the base and to reduce dust.

Most of the reconstructed sections were strengthened at later dates with an additional 1- to 3-in. overlay applied during normal break periods.

3.2.5 Use of Pierced Steel-Plank Mats

In many cases a temporary riding surface on damaged pavement sections was provided by the use of pierced steel-plank mats of the type used by military units for temporary roads and aircraft landing strips.

The mats were obtained from the Army through the cooperation of the Commanding Officer of the Army Transportation Corps Road Test Support Activity. The mats, 14 in. wide and 10 ft long, could be interlocked to make a

TABLE 19

STRUCTURAL DESIGN OF DEEP PATCHES AND RECONSTRUCTED SECTIONS

Loop	Depth (in.)		
	Stone	Surface	Total
2	6–8	2	8–10
3	12–13	3	15–16
4	17–18	3	20–21
5	18–19	3	21–22
6	17–18	4.5	21.5–22.5

continuous mat to cover any desired area. Approximately 42,000 sq ft (120 tons) of mats were obtained for use on the project.

In some cases the mats were used as "free" skin patches and to cover deep patches pending final paving. They were frequently used by night crews to cover distressed areas until day crews could make more adequate repairs.

Traffic operations were materially aided by use of the mats during regular test and special test periods.

3.2.6 Miscellaneous Maintenance Procedures

Joint and Crack Sealing. Joint and crack sealing was done as necessary and when project maintenance forces could be spared from other work. During 1959 when cracks were sealed only in those portland cement concrete sections where the cracks were wide enough, or spalled enough, to accept the hot-poured sealing material (approximately ¼ in.) In October and December 1959 cracks and joints were sealed as needed in Loop 3. In July 1960

Figure 42. Traffic was allowed to operate over crushed stone prior to placing the surfacing. Calcium chloride was used to stabilize the granular material and reduce dust.

Figure 43. Pierced steel-plank mats were used successfully as a temporary riding surface over damaged areas pending more permanent repairs.

cracks and joints were sealed as needed in Loops 3, 4, 5 and 6.

The sealing material was a petroleum asphalt filler with a penetration of 45 to 60, at 77 F, 100 grams, 5 sec, designated PAF–2 by Illinois specifications.

Shoulder Maintenance. The crushed stone surface of the roadway shoulders was bladed with a motor grader as required. Occasionally, the material was recompacted with a tandem steel– or rubber-tired roller.

During the traffic period it was considered necessary to blade shoulders three times on Loop 2 and an average of nine times each on the other four traffic loops. In addition, shoulders were bladed in the vicinity of all major pavement maintenance as part of the work clean-up.

A motor grader also was used to blade down all accumulations of subbase material extruded on the shoulder of rigid pavement sections. This operation is not included in the count of normal shoulder blading because it did not involve all test sections.

Additional crushed stone material was placed on shoulders at those locations where major maintenance raised the elevation of the pavement surface.

Sweeping. Pavement sweeping, although not a common maintenance procedure on rural highways, was done frequently at the Road Test. All pavements were swept prior to the biweekly operation of the longitudinal profilometer in order to remove any loose material which might affect the profile (roughness) readings. In addition, pavements were always swept in the vicinity of major maintenance operations.

Sweeping was done with a rotary broom attached to a Jeep vehicle and driven by a power take-off. Bristles on the broom were replaced 14 times during the traffic period.

Snow and Ice Removal. The average snowfall at the project site is approximately 25 in. per year. Safe and efficient traffic operation required equipment for removal of snow and ice from the test pavements and turnarounds.

The four small, project-owned dump trucks were equipped with reversible front-mounted snow plows for snow removal on the test loops, frontage and entrance roads, and parking lots. The Jeep was also equipped with a push plow for use in small areas and on Loop 2 where the relatively heavy dump trucks were prohibited. Snow was plowed shoulder-to-shoulder and piled in the ditches.

Two of the dump trucks also were equipped with hydraulically-operated salt-sand spreaders mounted in place of the tailgate. These were used to spread salt-sand mixtures and straight salt, as needed. Spreading operations to remove packed snow and ice were confined, for the most part, to the superelevated turnarounds. However, light applications of salt and sand were made on the test tangents about seven or eight times during the test traffic period.

Calcium chloride was added to the salt whenever air temperature was below 15 F. Approximately 533 tons of sodium chloride (salt) and 20 tons of calcium chloride were used during the two winters of test traffic operation.

Painting and Mowing. Each lane of test pavement had two intermittent paint stripes to guide drivers in the transverse placement of the vehicles. There was also a conventional reflectorized solid centerline stripe.

The original paint striping was done in the fall of 1958 prior to the start of test traffic, and the lines were repainted in the spring and fall of 1959 and the spring of 1960.

Figure 44. Salt and abrasives were used on the loop turnarounds to remove snow and ice and permit traffic operation.

Figure 45. Guide lines on Loop 2 were painted by hand because the weight of paint striping equipment exceeded that of the test vehicles.

Paint striping was done by crews and equipment from the Illinois Division of Highways District 3 offices in Ottawa. On Loop 2 project crews painted stripes by hand because the mechanized equipment was heavier than the normal test loads operating on the loop.

Regular crews from the Illinois District 3 office also performed grass mowing, as needed, along the project right-of-way.

3.3 MAINTENANCE SUMMARIES AND TYPICAL HISTORIES

It is impracticable to show in this report the complete maintenance histories for all test pavement sections on which maintenance was performed. Such information is contained in Data System 6300, and is available from the Highway Research Board at the cost of reproduction.

The following tables contain summaries of data or show typical maintenance histories.

Table 20 is a monthly summary of maintenance operations showing the number of times each operation was performed. It does not give the extent of the work. However, it does indicate that the heaviest work load occurred during the two spring periods.

Table 21 contains examples of typical maintenance histories for two selected test sections, one flexible and one rigid-type pavement. The first example shows section 166, which is in Loop 3, tangent 1 (flexible), Lane 2 (tandem), design 1 (main factorial), 2.0 in. of surface, no base, no subbase, and 24.0-kip test load. This section had 2 "free" skin patches before it was removed from test, and the remainder of the work was done after it was discontinued from the test.

Tables 22 and 23 are summaries of all "free" maintenance; that is, maintenance performed on test sections prior to their removal from testing. The data contained in these tables are considered essential to a complete understanding of the performance of each original pavement test section. They are the data mentioned in the official objectives of the project, which directed the staff to "provide a record of the type and extent of effort and materials required to keep each of the test sections or portions thereof in a satisfactory condition until discontinued for testing purposes." Tables 21, 22 and 23 are IBM printouts from Data System 6300.

3.4 OTHER MAINTENANCE OPERATIONS

3.4.1 Test Bridges

Prior to the start of regular test traffic, maintenance forces placed railroad tie cribbing under 12 of the 16 test bridge spans on Loops 5 and 6. The cribbing was a safety measure, and was intended to support the bridge in case of sudden failure.

Maintenance forces also made repairs on the bridges as required. On several occasions it was necessary to straighten expansion rockers that supported the bridge beams. On one occasion it was necessary to saw 2 in. off a concrete deck slab that was binding against an abutment wall.

Maintenance forces were responsible for restoring bridges to useful condition after they were removed from testing. This involved jacking the bridge to near level and placing supporting timbers on the cribbing.

Prior to the Special Studies period in the spring of 1961, cribbing was placed under all

bridges as a safety precaution during the accelerated fatigue tests and tests to failure with increasing overloads.

3.4.2 Turnarounds

Routine maintenance of the turnaround pavements was similar to that carried out on the loop tangents. However, the restrictive criteria did not apply because the turnarounds did not contain test sections.

In the spring of 1959 distress became evident in the flexible pavement turnarounds at the east ends of Loops 3, 4, 5 and 6. During March and April a 3-in. asphaltic concrete overlay was placed on each.

By the fall of 1959 the overlays on the flexible turnarounds of Loops 5 and 6 again became rough because of shoving of the surfacing, apparently caused by insufficient stability in the overlay mix.

In October a contractor was hired to use road planing equipment on the two turnarounds. This attempt to smooth the surface met with only moderate success. It was difficult for the planer to work efficiently because of the steep superelevation (0.2 ft per ft) and the sharp curve (200-ft radius). However, the surface was smoothed sufficiently to allow traffic operation for the remainder of the test period without further major maintenance.

In the summer and fall of 1960 the rigid pavement turnarounds on all traffic loops began to show a marked increase in slipperiness during wet weather. This condition probably was caused by the polishing action of the tires of the turning vehicles. In November, with only a short period remaining for regular test traffic operation, muriatic acid was applied to the outer lane of the rigid pavement turnarounds on Loops 5 and 6. The acid (18°) was applied by hand with 3-gal garden sprinkling cans at a rate of 1 gal per 15 sq yd of pavement surface. Prior to applying the acid the pavement surface was sprayed lightly with water to assist in spreading the acid uniformly. The acid was allowed to remain on the pavement about one hour before the surface was flushed with water.

TABLE 20

MONTHLY SUMMARY OF MAINTENANCE OPERATIONS

Month	Operations Performed (no.)							
	Reconstruction	Deep Patch	Section Overlay		Skin Patch	Remove & Replace Surface	Spot Seal	Fog Seal
			All	Part				
Oct. 1958	2	—	—	—	—	—	—	—
Nov.	4	45	—	—	5	3	—	—
Dec.	—	7	8	2	4	2	—	—
Jan. 1959	—	—	—	—	4	—	—	—
Feb.	—	—	4	3	5	4	—	—
March	55	47	42	3	14	3	—	—
April	32	55	27	1	—	—	—	—
May	20	42	76	20	23	8	—	—
June	2	8	14	13	12	4	—	—
July	—	17	5	2	6	8	—	—
August	—	8	4	—	8	3	—	—
Sept.	—	16	17	16	34	1	—	—
Oct.	8	19	1	—	18	1	—	—
Nov.	4	10	12	2	7	2	—	—
Dec.	—	2	12	—	2	2	—	—
Jan. 1960	—	1	9	9	8	2	—	—
Feb.	—	—	27	13	10	1	—	—
March	—	—	46	24	29	18	—	1
April	—	1	67	30	11	34	—	—
May	—	1	38	4	7	23	—	—
June	—	—	31	4	1	10	2	—
July	—	—	1	1	6	1	—	—
August	—	7	28	6	2	14	—	—
Sept.	—	—	2	1	1	—	—	—
Oct.	—	—	6	2	1	1	—	—
Nov.	—	—	—	—	—	—	—	—
Total	127	286	477	156	218	145	2	1

TABLE 21
Typical Maintenance Histories

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LOOP	TANGENT	LANE	DESIGN	SH. PAV.	SURF. THICK.	B. THICK OR REIN.	BASE TYPE	SUBBASE THICK.	SECT. NO.	LOAD	CUM. APPL'S.	MAINT. TYPE	PATCH LENGTH	PATCH WIDTH	BASE DEPTH	SURFACE DEPTH	COORDINATES LONGITUDINAL BEGIN	LONGITUDINAL END	TRANSVERSE BEGIN	TRANSVERSE END	AASHO DAY
					in.	in.		in.		KIP	100's	CODE	ft.	ft.	in.	in.	ft.	ft.	ft.	ft.	
FLEXIBLE SECTION																					
3	1	2	1	0	02.0	0	0	00	166	24.0	593	1*	8	6.0	00	03.0*	092	100	00.0	06.0	957
3	1	2	1	0	02.0	0	0	00	166	24.0	620	1*	2	2.0	02	00.0	071	073	01.5	03.5	961
3	1	2	1	0	02.0	0	0	00	166	24.0	725	5	10	8.0	00	00.0	016	026	04.0	12.0	979
3	1	2	1	0	02.0	0	0	00	166	24.0	758	1	3	4.0	02	00.0	015	018	00.0	04.0	984
3	1	2	1	0	02.0	0	0	00	166	24.0	766	4	100	12.0	09	00.0	000	100	00.0	12.0	990
3	1	2	1	0	02.0	0	0	00	166	24.0	766	7	100	12.0	00	02.0	000	100	00.0	12.0	995
3	1	2	1	0	02.0	0	0	00	166	24.0	820	3	100	12.0	00	01.5	000	100	00.0	12.0	1000
3	1	2	1	0	02.0	0	0	00	166	24.0	847	5	28	12.0	00	00.0	072	100	00.0	12.0	1010
3	1	2	1	0	02.0	0	0	00	166	24.0	887	5	8	11.0	00	00.0	040	048	01.0	12.0	1014
3	1	2	1	0	02.0	0	0	00	166	24.0	1306	3	40	12.0	00	01.5	060	100	00.0	12.0	1062
3	1	2	1	0	02.0	0	0	00	166	24.0	1607	3	40	12.0	00	01.5	060	100	00.0	12.0	1088
3	1	2	1	0	02.0	0	0	00	166	24.0	7402	3	100	12.0	00	01.0	000	100	00.0	12.0	1433
RIGID SECTION																					
3	2	1	3	0	03.5	0	0	00	189	12.0	2102	6*	3	5.0	00	06.0	117	120	07.0	12.0	1131
3	2	1	3	0	03.5	0	0	00	189	12.0	2119	1*	8	5.0	00	01.5	112	120	07.0	12.0	1132
3	2	1	3	0	03.5	0	0	00	189	12.0	2180	6*	6	5.0	00	03.0	112	118	07.0	12.0	1137
3	2	1	3	0	03.5	0	0	00	189	12.0	2542	2	45	12.0	13	00.0	075	120	00.0	12.0	1167
3	2	1	3	0	03.5	0	0	00	189	12.0	2585	2	42	12.0	13	00.0	033	075	00.0	12.0	1170
3	2	1	3	0	03.5	0	0	00	189	12.0	2603	2	33	12.0	16	00.0	000	033	00.0	12.0	1171
3	2	1	3	0	03.5	0	0	00	189	12.0	2709	7	120	12.0	00	03.0	000	120	00.0	12.0	1178
3	2	1	3	0	03.5	0	0	00	189	12.0	3505	3	120	12.0	00	01.0	000	120	00.0	12.0	1248
3	2	1	3	0	03.5	0	0	00	189	12.0	7369	3	120	12.0	00	01.0	000	120	00.0	12.0	1431

FROM DATA SYSTEM 6300

CODE LEGEND

COLUMN NO.

1. LOOP NUMBER
2. TANGENT: 1- FLEXIBLE
   2- RIGID
3. LANE 1 OR LANE 2
4. DESIGN: 1. MAIN FACTORIAL - RIGID AND FLEXIBLE
   2. SHOULDER PAVING - FLEXIBLE
   3. SHOULDER PAVING - RIGID
   4. BASE TYPE STUDY - FLEXIBLE
   5. SUBSURFACE STUDIES LOOP 1 - RIGID
   6. SURFACE TREATMENT LOOP 2 - FLEXIBLE
5. SHOULDER PAVING:
   0. WITHOUT PAVING
   1. 6 FEET UNIFORM - RIGID
   2. 0 TO 8 FEET TAPERED - FLEXIBLE
6. SURFACE THICKNESS, INCHES
7. FLEXIBLE PAVEMENT - BASE THICKNESS, INCHES
   RIGID PAVEMENT:
   0. NON-REINFORCED
   1. REINFORCED
8. FLEXIBLE PAVEMENT BASE TYPE:
   0. CRUSHED STONE
   1. GRAVEL
   2. BITUMINOUS STABALIZED
   3. CEMENT STABALIZED
9. SUBBASE THICKNESS, INCHES - FLEXIBLE AND RIGID
10. TEST SECTION NUMBER
11. TEST AXLE LOAD, KIP
12. CUMULATIVE TEST LOAD APPLICATIONS, 100'S
13. MAINTENANCE TYPE CODE, SEE COLUMN AT RIGHT
14. PATCH LENGTH, FEET
15. PATCH WIDTH, FEET
16. PATCH BASE DEPTH, INCHES
17. PATCH SURFACE THICKNESS, INCHES
18. COORDINATES FROM SECTION BEGINNING, FEET
19. SAME AS 18.
20. COORDINATES FROM PAVEMENT CENTERLINE, FEET
21. SAME AS 20.
22. AASHO CALENDER, DAY 1 = JULY 2, 1956

COLUMN 13
MAINTENANCE TYPE CODE

1. SKIN PATCH
2. DEEP PATCH
3. OVERLAY
4. RECONSTRUCTION
5. LANDING MAT
6. REMOVE AND REPLACE SURFACE
7. PAVE DEEP PATCH OR RECONSTRUCTION
8. SPOT SEAL
9. FOG SEAL
0. MATERIALS SAMPLING TRENCH

* ON TYPE CODE - "FREE" MAINTENANCE
* ON SURFACE DEPTH - COLD MIX USED

TABLE 22

"Free" Maintenance, Flexible Pavement

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
																	Coordinates				
Loop	Tangent	Lane	Design	Sh. Pav.	Surf. Thick.	B. Thick. or Rein.	Base Type	Subbase Thick.	Sect. No.	Load	Cum. Appl's.	Maint. Type	Patch Length	Patch Width	Base Depth	Surface Depth	Longitudinal Begin	Longitudinal End	Transverse Begin	Transverse End	AASHO Day
					in.	in.		in.		Kip	100's	Code	ft.	ft.	in.	in.	ft.	ft.	ft.	ft.	
3	1	2	1	0	02.0	6	1	08	112	24.0	5669	1*	10	2.5	00	01.5*	040	050	08.5	11.0	1359
3	1	2	1	0	02.0	3	1	00	114	24.0	278	2*	5	6.0	10	02.0*	095	100	06.0	12.0	912
3	1	2	1	0	04.0	3	1	08	122	24.0	5687	6*	11	3.0	00	04.0	070	081	01.0	04.0	1360
3	1	1	1	0	04.0	6	1	04	123	12.0	6059	0*	4	12.0	10	04.0	096	100	00.0	12.0	1376
3	1	1	1	0	04.0	6	1	04	123	12.0	9321	0*	4	12.0	10	04.0	085	089	00.0	12.0	1517
3	1	2	1	0	02.0	0	0	04	126	24.0	48	6*	4	6.0	02	02.0*	096	100	06.0	12.0	865
3	1	1	1	0	03.0	3	1	08	129	12.0	1289	1*	12	3.0	00	01.5*	000	012	08.0	11.0	1060
3	1	1	1	0	03.0	3	1	08	129	12.0	1337	1*	12	3.0	00	01.5*	000	012	08.0	11.0	1067
3	1	2	1	0	02.0	0	0	08	134	24.0	732	5*	5	12.0	06	00.0	095	100	00.0	12.0	981
3	1	2	1	0	02.0	3	1	04	136	24.0	724	5*	11	10.0	00	00.0	089	100	02.0	12.0	978
3	1	1	1	0	04.0	6	1	08	139	12.0	9321	0*	4	12.0	14	04.0	001	005	00.0	12.0	1514
3	1	2	1	0	02.0	0	0	08	144	24.0	724	5*	15	10.0	00	00.0	085	100	01.0	11.0	978
3	1	2	1	0	04.0	3	1	00	146	24.0	873	5*	7	5.0	04	00.0	042	049	07.0	12.0	1013
3	1	1	1	0	03.0	6	1	08	155	12.0	9649	0*	2	12.0	14	03.0	096	098	00.0	12.0	1534
3	1	1	1	0	04.0	6	1	00	161	12.0	1289	1*	8	2.5	00	02.0*	000	008	09.0	10.5	1060
3	1	1	1	0	04.0	6	1	00	161	12.0	1289	1*	7	2.5	00	02.0*	000	007	01.5	04.0	1060
3	1	1	1	0	04.0	6	1	00	161	12.0	1340	1*	8	2.5	00	01.5*	000	008	09.0	10.5	1067
3	1	1	1	0	04.0	6	1	00	161	12.0	1349	1*	7	2.5	00	01.5*	000	007	01.5	04.0	1067
3	1	2	1	0	04.0	6	1	00	162	24.0	1483	1*	5	3.0	00	01.5	000	005	01.0	04.0	1079
3	1	2	1	0	04.0	6	1	00	162	24.0	1483	1*	6	4.5	00	01.5	094	100	06.5	11.0	1079
3	1	2	1	0	04.0	6	1	00	162	24.0	1517	2*	5	12.0	15	00.0	095	100	00.0	12.0	1081
3	1	2	1	0	04.0	6	1	00	162	24.0	1607	2*	5	12.0	00	02.5	095	100	00.0	12.0	1088
3	1	2	1	0	02.0	0	0	00	166	24.0	593	1*	8	6.0	00	03.0*	092	100	00.0	06.0	957
3	1	2	1	0	02.0	0	0	00	166	24.0	620	1*	2	2.0	02	00.0	071	073	01.5	03.5	961
3	1	1	2	2	02.0	3	1	08	183	12.0	1161	2*	5	12.0	15	00.0	000	005	00.0	12.0	1047
3	1	1	2	2	02.0	3	1	08	183	12.0	1220	7*	5	12.0	00	03.0	000	005	00.0	12.0	1053
6	1	1	1	0	04.0	6	1	16	253	30.0	5510	6*	11	3.0	00	06.0	064	075	09.0	12.0	1352
6	1	2	1	0	04.0	6	1	08	304	48.0	1281	1*	10	3.0	00	01.5	090	100	08.0	11.0	1061
6	1	1	1	0	04.0	9	1	16	309	30.0	10494	0*	2	12.0	27	02.0*	096	098	00.0	12.0	1571
6	1	1	1	0	06.0	9	1	12	311	30.0	6303	0*	3	12.0	00	01.0	097	100	00.0	12.0	1387
6	1	1	1	0	06.0	9	1	12	311	30.0	9262	0*	4	12.0	25	02.0*	085	089	00.0	12.0	1513
6	1	1	1	0	06.0	9	1	12	311	30.0	10156	1*	20	12.0	00	01.5	080	100	00.0	12.0	1557
6	1	2	1	0	04.0	9	1	08	322	48.0	1555	0*	4	12.0	18	03.0	089	093	00.0	12.0	1083
6	1	1	1	0	05.0	6	1	16	327	30.0	10520	0*	2	12.0	25	02.0*	002	004	00.0	12.0	1572
6	1	1	1	0	05.0	9	1	12	331	30.0	10520	0*	2	12.0	22	04.0*	023	025	00.0	12.0	1572
6	1	1	1	0	06.0	9	1	16	333	30.0	6154	0*	4	12.0	27	04.0	095	099	00.0	12.0	1379
5	1	2	1	0	04.0	6	1	12	426	40.0	5658	1*	10	8.5	00	01.0*	068	078	02.0	10.5	1359
5	1	2	1	0	05.0	3	1	04	440	40.0	946	5*	16	7.0	04	00.0	006	022	05.0	12.0	1018
5	1	1	1	0	05.0	6	1	12	445	22.4	6036	0*	3	12.0	17	06.0	097	100	00.0	12.0	1375
5	1	1	1	0	03.0	6	1	12	487	22.4	1161	1*	5	3.0	00	01.5	095	100	01.5	04.5	1048
5	1	1	1	0	03.0	6	1	12	487	22.4	1161	1*	20	3.5	00	01.5	080	100	07.0	10.5	1048
5	1	2	1	0	03.0	6	1	12	488	40.0	5495	1*	7	3.0	00	02.0	093	100	00.0	03.0	1352
5	1	2	1	0	03.0	6	1	12	488	40.0	5698	6*	10	4.0	00	03.0	090	100	00.0	04.0	1361
4	1	1	1	0	04.0	3	1	12	575	18.0	6019	1*	8	4.0	00	01.5	000	008	08.0	12.0	1374
4	1	2	1	0	04.0	3	1	12	576	32.0	6922	1*	10	9.5	00	01.5	000	010	01.5	11.0	1411
4	1	2	1	0	05.0	3	1	04	580	32.0	1905	0*	4	12.0	09	03.0	054	058	00.0	12.0	1115
4	1	2	1	0	05.0	3	1	04	580	32.0	1905	0*	4	12.0	09	03.0	088	092	00.0	12.0	1115
4	1	1	1	0	05.0	6	1	12	581	18.0	6090	0*	3	12.0	20	03.0	097	100	00.0	12.0	1377
4	1	1	1	0	05.0	6	1	12	581	18.0	6337	1*	3	12.0	00	01.0	097	100	00.0	12.0	1388
4	1	1	1	0	05.0	0	0	08	587	18.0	1058	1*	20	3.0	00	01.5	005	025	08.0	11.0	1038
4	1	2	1	0	05.0	0	0	08	588	32.0	1201	1*	17	3.0	00	01.5	062	079	08.0	11.0	1054
4	1	2	1	0	05.0	0	0	08	588	32.0	1230	1*	170	3.0	00	03.5	062	079	08.0	11.0	1056
4	1	1	1	0	05.0	3	1	12	593	18.0	5826	1*	10	2.5	00	01.5*	063	073	08.0	10.5	1366
4	1	2	1	0	05.0	0	0	04	606	32.0	859	6*	8	5.0	00	03.0	046	054	07.0	12.0	1006
4	1	2	1	0	05.0	6	1	04	616	32.0	5231	9*	6	3.0	00	00.0	022	028	08.0	11.0	1340
4	1	2	1	0	05.0	6	1	04	616	32.0	5849	1*	5	3.0	00	01.0*	025	030	08.0	11.0	1369
4	1	2	1	0	05.0	6	1	04	616	32.0	6023	1*	10	3.0	00	01.0*	023	033	08.0	11.0	1376
4	1	2	1	0	05.0	0	0	12	622	32.0	6951	1*	10	3.0	00	01.5	090	100	08.0	11.0	1413
4	1	2	1	0	03.0	6	1	08	624	32.0	4955	1*	10	3.0	00	01.5*	033	043	08.0	11.0	1327
4	1	2	1	0	05.0	6	1	04	630	32.0	7329	1*	3	3.5	00	02.5	000	003	06.5	10.0	1430
4	1	1	1	0	05.0	3	1	08	631	18.0	4964	1*	10	3.0	00	00.5*	038	048	08.0	11.0	1327
4	1	1	1	0	03.0	0	0	04	633	18.0	19	2*	17	6.0	17	02.0*	000	017	06.0	12.0	858
2	1	1	5	0	00.0	6	1	04	713	2.0	4449	1*	1	1.0	00	02.0*	010	011	09.0	10.0	1305
2	1	1	6	0	00.0	3	1	04	715	2.0	4120	1*	1	2.0	00	02.0*	098	099	03.0	05.0	1292
2	1	2	6	0	00.0	3	1	04	716	6.0	7	2*	27	6.0	07	02.0*	000	027	06.0	12.0	858
2	1	2	6	0	00.0	3	1	04	716	6.0	18	2*	14	12.0	07	02.0*	024	038	00.0	12.0	862
2	1	2	1	0	01.0	0	0	00	722	6.0	7	6*	28	6.0	00	02.0*	010	038	06.0	12.0	858
2	1	2	6	0	00.0	3	1	00	726	6.0	7	2*	21	6.0	07	02.0*	012	033	00.0	06.0	858
2	1	1	1	0	01.0	0	0	04	727	2.0	759	5*	10	4.0	00	00.0	000	010	08.0	12.0	982
2	1	1	1	0	01.0	0	0	04	727	2.0	802	2*	15	12.0	07	00.0	000	015	00.0	12.0	997
2	1	2	1	0	01.0	0	0	04	728	6.0	7	2*	15	7.0	07	02.0*	000	015	05.0	12.0	858
2	1	2	1	0	01.0	0	0	04	728	6.0	7	2*	11	6.0	07	02.0*	085	096	06.0	12.0	858
2	1	2	1	0	01.0	0	0	04	728	6.0	7	2*	19	6.5	07	02.0*	061	080	05.5	12.0	858
2	1	2	1	0	01.0	0	0	04	728	6.0	18	2*	6	5.0	08	02.0*	000	006	00.0	05.0	862
2	1	2	1	0	01.0	0	0	04	728	6.0	18	2*	6	6.5	07	02.0*	080	086	05.5	12.0	862
2	1	2	1	0	01.0	0	0	04	728	6.0	22	2*	47	6.0	07	00.0	015	062	06.0	12.0	864
2	1	1	1	0	02.0	0	0	04	729	2.0	7784	8*	12	2.0	00	00.0	085	097	07.0	09.0	1447
2	1	1	1	0	02.0	0	0	04	729	2.0	7784	8*	8	1.0	00	00.0	092	100	01.5	02.5	1447
2	1	1	1	0	02.0	0	0	04	729	2.0	8130	6*	11	1.5	00	03.0	089	100	02.0	03.5	1460
2	1	1	1	0	02.0	0	0	04	729	2.0	8389	1*	8	2.0	00	01.0*	092	100	01.5	03.5	1474
2	1	2	1	0	02.0	0	0	04	730	6.0	790	5*	6	11.0	00	00.0	000	006	01.0	12.0	996
2	1	1	1	0	02.0	3	1	00	731	2.0	9756	1*	3	3.5	00	01.0*	000	003	02.0	05.5	1538
2	1	1	6	0	00.0	0	0	00	733	2.0	10	1*	4	3.5	00	02.0*	000	004	07.0	10.5	858
2	1	2	1	0	01.0	3	1	00	744	6.0	320	1*	2	3.0	00	02.0*	000	002	08.0	11.0	921
2	1	2	1	0	01.0	6	1	00	756	6.0	1025	3*	25	12.0	00	01.0	000	025	00.0	12.0	1034
2	1	2	1	0	02.0	3	1	00	760	6.0	1440	6*	3	1.5	00	02.0	085	088	09.0	10.5	1076
2	1	2	1	0	02.0	3	1	00	760	6.0	1440	6*	7	1.5	00	02.0	065	072	09.0	10.5	1076
2	1	2	1	0	02.0	3	1	00	760	6.0	1711	6*	8	4.0	00	02.0	087	095	07.0	11.0	1097
2	1	2	1	0	02.0	3	1	00	760	6.0	1832	6*	10	5.0	00	02.0	000	010	07.0	12.0	1109
2	1	2	6	0	00.0	6	1	04	762	6.0	931	6*	1	1.0	00	03.0	010	011	07.5	08.5	1017
2	1	1	1	0	02.0	0	0	00	771	2.0	6267	6*	4	2.0	00	02.0*	096	100	07.0	09.0	1384
2	1	2	1	0	03.0	3	1	00	774	6.0	6272	6*	3	3.0	00	02.0*	088	091	07.0	10.0	1384
2	1	2	1	0	03.0	3	1	00	774	6.0	6476	6*	4	4.0	00	02.0*	093	097	06.5	10.5	1394
2	1	2	1	0	03.0	3	1	00	774	6.0	6527	6*	17	6.0	00	04.0	083	100	06.0	12.0	1396

NOTE: See Table 21 for code legend.

TABLE 23

"Free" Maintenance, Rigid Pavement

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
																	Coordinates				
																	Longitudinal		Transverse		
Loop	Tangent	Lane	Design	Sh. Pav.	Surf. Thick.	B. Thick. or Rein.	Base Type	Subbase Thick.	Sect. No.	Load	Cum. Appl's.	Maint. Type	Patch Length	Patch Width	Base Depth	Surface Depth	Begin	End	Begin	End	AASHO Day
					in.	in.		in.		KIP	100's	CODE	ft.	ft.	in.	in.	ft.	ft.	ft.	ft.	
3	2	1	3	0	03.5	0	0	00	189	12.0	2102	6*	3	5.0	00	06.0	117	120	07.0	12.0	1131
3	2	1	3	0	03.5	0	0	00	189	12.0	2119	1*	8	5.0	00	01.5	112	120	07.0	12.0	1132
3	2	1	3	0	03.5	0	0	00	189	12.0	2180	6*	6	5.0	00	03.0	112	118	07.0	12.0	1137
3	2	2	3	0	03.5	0	0	00	190	24.0	1969	6*	19	2.5	00	07.0	056	075	06.0	08.5	1124
3	2	2	3	0	03.5	0	0	00	190	24.0	1984	6*	9	3.5	00	07.0	058	067	06.0	09.5	1125
3	2	2	3	0	03.5	0	0	00	190	24.0	2030	1*	4	5.0	00	01.5*	116	120	07.0	12.0	1129
3	2	2	3	0	03.5	0	0	00	190	24.0	2127	6*	9	2.0	00	03.0	024	033	06.0	08.0	1137
3	2	2	1	0	05.0	1	0	06	192	24.0	5861	1*	9	2.0	00	01.5*	063	072	09.0	11.0	1369
3	2	2	1	0	05.0	1	0	06	192	24.0	6030	6*	15	6.0	00	10.0	065	080	06.0	12.0	1376
3	2	2	1	0	03.5	0	0	03	196	24.0	3121	1*	10	6.0	00	02.0*	000	010	06.0	12.0	1215
3	2	1	1	0	03.5	1	0	06	205	12.0	1716	1*	4	3.0	00	01.5*	236	240	09.0	12.0	1096
3	2	1	1	0	03.5	1	0	06	205	12.0	1784	1*	5	5.0	00	01.5	235	240	07.0	12.0	1104
3	2	1	1	0	03.5	1	0	06	205	12.0	1944	1*	11	6.0	00	01.5*	229	240	06.0	12.0	1118
3	2	1	1	0	03.5	1	0	06	205	12.0	1985	2*	12	6.0	15	00.0	228	240	06.0	12.0	1122
3	2	1	1	0	03.5	1	0	06	205	12.0	2028	7*	12	6.0	00	03.0	228	240	06.0	12.0	1125
3	2	1	1	0	03.5	1	0	06	205	12.0	2119	1*	5	6.0	00	01.0	223	228	06.0	12.0	1132
3	2	1	1	0	03.5	1	0	06	205	12.0	2526	1*	18	6.0	00	00.5	222	240	06.0	12.0	1166
3	2	1	1	0	03.5	1	0	06	205	12.0	2585	1*	5	6.0	00	05.0*	222	227	06.0	12.0	1170
3	2	1	1	0	03.5	1	0	06	205	12.0	2603	2*	9	6.0	11	02.0*	218	227	06.0	12.0	1171
3	2	1	1	0	03.5	1	0	06	205	12.0	2726	1*	10	5.0	00	02.5	193	203	07.0	12.0	1179
3	2	2	1	0	03.5	1	0	06	206	24.0	2040	1*	3	3.0	00	01.0*	237	240	07.0	10.0	1130
3	2	2	1	0	03.5	1	0	06	206	24.0	1235	1*	5	4.0	00	01.5	235	240	06.0	10.0	1156
3	2	2	1	0	03.5	1	0	06	206	24.0	2459	1*	5	6.0	00	00.5	235	240	06.0	12.0	1166
3	2	2	1	0	03.5	1	0	06	206	24.0	2690	1*	6	3.0	00	02.0	132	138	06.5	09.5	1181
3	2	2	1	0	03.5	1	0	06	206	24.0	2690	1*	8	2.5	00	01.5	208	216	07.0	09.5	1181
3	2	1	1	0	03.5	1	0	03	209	12.0	2403	1*	6	3.5	00	02.0	234	240	08.5	12.0	1156
3	2	1	1	0	03.5	1	0	03	209	12.0	2436	2*	15	6.0	13	00.0	225	240	06.0	12.0	1158
3	2	1	1	0	03.5	1	0	03	209	12.0	2495	7*	15	6.0	00	05.0	225	240	06.0	12.0	1164
3	2	1	1	0	03.5	1	0	03	209	12.0	2726	1*	13	5.0	00	01.0	110	123	07.0	12.0	1179
3	2	2	1	0	03.5	1	0	03	210	24.0	2638	1*	17	6.0	00	02.0	208	225	06.0	12.0	1178
3	2	2	1	0	03.5	1	0	03	210	24.0	2672	2*	25	6.0	13	02.0	000	025	06.0	12.0	1180
3	2	2	1	0	03.5	0	0	09	214	24.0	2086	1*	6	3.0	00	02.0*	009	015	06.5	09.5	1137
3	2	2	1	0	03.5	0	0	09	214	24.0	2201	1*	22	3.5	00	02.0	004	026	06.0	09.5	1144
3	2	2	1	0	03.5	0	0	09	214	24.0	2729	1*	24	4.0	00	01.0	004	028	06.0	10.0	1185
3	2	1	3	1	03.5	0	0	00	223	12.0	1267	1*	6	4.0	00	02.0	118	124	08.0	12.0	1058
3	2	1	3	1	03.5	0	0	00	223	12.0	1317	2*	17	6.0	16	00.0	103	120	06.0	12.0	1062
3	2	1	3	1	03.5	0	0	00	223	12.0	1349	6*	3	6.0	00	03.5*	117	120	00.0	06.0	1067
3	2	1	1	0	03.5	1	0	09	231	12.0	2787	1*	12	5.0	00	01.5*	029	041	07.0	12.0	1184
3	2	1	1	0	03.5	1	0	09	231	12.0	2800	1*	11	6.0	00	01.0	029	040	06.0	12.0	1185
3	2	2	1	0	03.5	1	0	09	232	24.0	2672	1*	10	4.0	00	03.0	141	151	06.5	10.5	1180
3	2	2	1	0	03.5	1	0	09	232	24.0	2690	2*	28	6.0	18	02.0	127	155	06.0	12.0	1181
3	2	2	1	0	05.0	1	0	09	234	24.0	7114	1*	2	12.0	00	01.5*	040	042	00.0	12.0	1419
3	2	2	1	0	03.5	0	0	06	240	24.0	2030	2*	30	5.0	15	00.0	000	030	07.0	12.0	1129
3	2	2	3	1	03.5	0	0	06	244	24.0	2716	1*	15	5.0	00	02.0*	065	080	06.0	11.0	1184
3	2	2	1	0	05.0	1	0	03	252	24.0	10811	5*	10	3.0	00	02.0*	030	040	07.0	10.0	1587
6	2	1	1	0	09.5	1	0	09	339	30.0	8549	6*	17	6.0	00	14.0	103	120	06.0	12.0	1481
6	2	1	1	0	09.5	1	0	09	339	30.0	8975	1*	17	6.0	00	01.5	103	120	06.0	12.0	1500
6	2	2	1	0	08.0	1	0	03	342	48.0	4530	1*	25	6.0	00	03.0	145	170	06.0	12.0	1311
6	2	2	1	0	08.0	1	0	03	342	48.0	5407	1*	8	11.0	00	01.5	142	150	01.0	12.0	1352
6	2	2	1	0	08.0	1	0	03	342	48.0	5562	5*	10	3.0	00	01.0*	147	157	08.0	11.0	1359
6	2	2	1	0	08.0	1	0	03	342	48.0	6009	6*	12	7.0	00	12.0	165	177	05.0	12.0	1379
6	2	2	1	0	08.0	1	0	03	342	48.0	6009	6*	12	7.0	00	12.0	145	157	05.0	12.0	1379
6	2	2	1	0	08.0	1	0	03	342	48.0	6009	1*	37	12.0	00	01.0	140	177	00.0	12.0	1379
6	2	1	1	0	08.0	1	0	09	347	30.0	6906	1*	25	7.0	00	05.0	215	240	05.0	12.0	1410
6	2	1	1	0	08.0	1	0	09	347	30.0	7256	1*	35	6.0	00	05.0	200	235	06.0	12.0	1425
6	2	1	1	0	09.5	1	0	03	371	30.0	8975	2*	4	5.0	08	12.0	012	016	07.0	12.0	1500
6	2	1	1	0	09.5	1	0	03	371	30.0	9095	5*	13	6.0	00	02.0*	005	018	06.0	12.0	1506
6	2	1	1	0	09.5	1	0	03	371	30.0	9262	6*	10	7.0	00	15.0	030	040	05.0	12.0	1513
6	2	1	1	0	09.5	1	0	03	371	30.0	9262	3*	40	12.0	00	01.5	000	040	00.0	12.0	1513
6	2	1	1	0	09.5	1	0	03	371	30.0	10721	3*	40	12.0	00	00.5	000	040	00.0	12.0	1580
6	2	1	3	0	08.0	0	0	00	373	30.0	7171	5*	15	6.0	00	02.0*	105	120	06.0	12.0	1422
6	2	1	1	0	08.0	1	0	06	385	30.0	8393	1*	9	4.5	00	03.0	083	092	07.5	12.0	1475
6	2	1	1	0	08.0	1	0	06	385	30.0	8897	2*	8	4.0	08	12.0	083	091	08.0	12.0	1496
6	2	2	1	0	08.0	1	0	06	386	48.0	4105	5*	5	3.0	00	05.0	225	230	09.0	12.0	1294
6	2	2	3	1	08.0	0	0	06	402	48.0	7359	1*	15	12.0	00	02.0	000	015	00.0	12.0	1436
6	2	2	3	1	08.0	0	0	06	402	48.0	8360	1*	15	12.0	00	02.0	000	015	00.0	12.0	1482
5	2	2	3	1	06.5	0	0	06	490	40.0	4954	1*	5	4.0	00	01.5*	020	025	07.0	11.0	1327
5	2	2	3	1	06.5	0	0	06	490	40.0	5658	1*	6	4.0	00	01.5*	019	025	07.0	11.0	1359
5	2	2	3	1	06.5	0	0	06	490	40.0	5862	1*	10	4.0	00	01.5*	020	030	07.0	11.0	1369
5	2	2	1	0	06.5	1	0	06	492	40.0	2900	5*	30	6.0	00	00.0	021	051	06.0	12.0	1192
5	2	2	3	0	09.5	0	0	00	494	40.0	4934	3*	5	12.0	00	01.0	000	005	00.0	12.0	1326
5	2	2	1	0	06.5	0	0	09	506	40.0	3686	1*	15	6.0	00	01.5	020	035	06.0	12.0	1261
5	2	2	1	0	06.5	0	0	09	506	40.0	3883	1*	15	6.0	00	01.0	020	035	06.0	12.0	1283
5	2	2	1	0	06.5	0	0	03	514	40.0	3261	1*	11	6.0	00	02.0*	030	041	06.0	12.0	1223
5	2	2	1	0	06.5	0	0	06	518	40.0	3462	1*	15	5.0	00	02.0	030	045	07.0	12.0	1244
5	2	2	1	0	06.5	1	0	09	550	40.0	2866	1*	24	5.5	00	02.0	006	030	06.5	12.0	1189
5	2	2	1	0	06.5	1	0	09	550	40.0	2900	5*	25	6.0	00	00.0	015	040	06.0	12.0	1192
5	2	2	1	0	06.5	1	0	09	550	40.0	3140	2*	40	12.0	21	00.0	000	040	00.0	12.0	1213
5	2	2	1	0	06.5	1	0	09	550	40.0	3307	7*	40	12.0	00	03.5	000	040	00.0	12.0	1227
5	2	2	1	0	06.5	1	0	09	550	40.0	4270	3*	40	12.0	00	01.0	000	040	00.0	12.0	1298
5	2	2	1	0	06.5	1	0	09	550	40.0	5862	1*	12	4.0	00	01.0*	038	050	07.0	11.0	1369

NOTE: See Table 21 for code legend.

TABLE 23

"FREE" MAINTENANCE, RIGID PAVEMENT (Cont.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
LOOP	TANGENT	LANE	DESIGN	SH. PAV.	SURF. THICK.	B. THICK. OR REIN.	BASE TYPE	SUBBASE THICK.	SECT. NO.	LOAD	CUM. APPL'S.	MAINT. TYPE	PATCH LENGTH	PATCH WIDTH	BASE DEPTH	SURFACE DEPTH	COORDINATES LONGITUDINAL BEGIN	LONGITUDINAL END	TRANSVERSE BEGIN	TRANSVERSE END	AASHO DAY
					in.	in.		in.		KIP	100's	CODE	ft.	ft.	in.	in.	ft.	ft.	ft.	ft.	
4	2	2	1	0	06.5	1	0	03	642	32.0	8534	1*	14	11.0	00	03.0	226	240	01.0	12.0	1480
4	2	1	1	0	05.0	0	0	06	647	18.0	2925	1*	14	6.0	00	01.5*	021	035	06.0	12.0	1193
4	2	1	1	0	05.0	0	0	06	647	18.0	2986	1*	22	6.0	00	01.5*	018	035	06.0	12.0	1201
4	2	1	1	0	05.0	0	0	06	647	18.0	3216	1*	20	6.0	00	02.0*	015	035	06.0	12.0	1219
4	2	2	1	0	05.0	0	0	06	648	32.0	2743	1*	25	6.0	00	01.5	000	025	06.0	12.0	1180
4	2	2	1	0	05.0	0	0	06	648	32.0	3218	1*	15	6.0	00	02.0*	010	025	06.0	12.0	1219
4	2	2	1	0	06.5	0	0	03	650	32.0	4157	1*	12	12.0	00	03.0	000	012	00.0	12.0	1294
4	2	2	1	0	06.5	0	0	03	650	32.0	5980	6*	9	9.0	00	13.0	000	009	03.0	12.0	1374
4	2	2	1	0	06.5	0	0	03	650	32.0	6922	6*	15	12.0	00	10.0	000	015	00.0	12.0	1411
4	2	2	1	0	06.5	1	0	09	654	32.0	9310	1*	17	6.0	00	05.0*	150	167	06.0	12.0	1513
4	2	2	1	0	06.5	1	0	09	654	32.0	9325	6*	27	6.0	00	15.0	145	172	06.0	12.0	1515
4	2	2	1	0	06.5	0	0	06	656	32.0	8534	1*	10	9.0	00	03.0	000	010	03.0	12.0	1480
4	2	1	3	0	05.0	0	0	00	659	18.0	2942	1*	6	5.0	02	00.0	095	101	07.0	12.0	1194
4	2	1	3	0	05.0	0	0	00	659	18.0	3045	1*	7	5.0	00	03.0	095	102	07.0	12.0	1206
4	2	2	3	0	05.0	0	0	00	660	32.0	2866	1*	8	5.5	00	02.5	000	008	05.5	12.0	1189
4	2	2	3	0	05.0	0	0	00	660	32.0	2883	2*	20	6.0	18	00.0	000	020	06.0	12.0	1191
4	2	2	1	0	05.0	1	0	09	674	32.0	4080	5*	20	6.0	00	00.0	100	120	06.0	12.0	1291
4	2	1	1	0	05.0	0	0	09	677	18.0	2850	1*	27	6.0	00	03.0	025	052	06.0	12.0	1187
4	2	2	1	0	05.0	0	0	09	678	32.0	2801	1*	24	7.0	00	02.0	093	117	05.0	12.0	1185
4	2	1	3	1	05.0	0	0	06	679	18.0	6020	6*	15	6.0	00	13.0	000	015	06.0	12.0	1374
4	2	1	3	1	05.0	0	0	06	679	18.0	6020	3*	15	12.0	00	01.0	000	015	00.0	12.0	1374
4	2	2	3	1	05.0	0	0	06	680	32.0	3592	5*	15	12.0	00	00.0	000	015	00.0	12.0	1252
4	2	2	3	1	05.0	0	0	06	680	32.0	3610	2*	15	12.0	17	00.0	000	015	00.0	12.0	1254
4	2	2	1	0	05.0	1	0	03	682	32.0	2883	2*	19	6.0	17	00.0	138	157	06.0	12.0	1191
4	2	2	1	0	05.0	1	0	03	682	32.0	2894	5*	30	6.0	00	00.0	135	165	06.0	12.0	1192
4	2	2	1	0	05.0	1	0	03	682	32.0	2934	1*	12	6.0	02	00.0	218	230	06.0	12.0	1195
4	2	2	1	0	05.0	1	0	03	682	32.0	2965	5*	20	5.0	00	00.0	215	235	06.0	11.0	1198
4	2	1	3	1	05.0	0	0	00	693	18.0	3176	1*	10	5.0	00	02.0*	030	040	06.0	12.0	1215
4	2	1	3	1	05.0	0	0	00	693	18.0	3209	1*	5	5.0	00	02.0*	035	040	06.0	12.0	1217
4	2	1	3	1	05.0	0	0	00	693	18.0	3216	1*	10	6.0	00	02.0*	030	045	06.0	12.0	1219
4	2	2	3	1	05.0	0	0	00	694	32.0	3178	1*	10	6.0	00	02.0*	110	120	06.0	12.0	1215
4	2	2	3	1	05.0	0	0	00	694	32.0	3211	1*	10	6.0	00	02.0*	110	120	06.0	12.0	1217
4	2	2	3	1	05.0	0	0	00	694	32.0	3218	1*	17	6.0	00	02.0*	103	120	06.0	12.0	1219
4	2	2	3	1	05.0	0	0	00	694	32.0	3233	5*	10	6.0	00	00.0	105	115	06.0	12.0	1220
4	2	2	1	0	06.5	0	0	09	704	32.0	6578	5*	8	4.5	00	06.5	050	058	07.5	12.0	1398
2	2	1	1	0	02.5	1	0	00	781	2.0	7287	6*	1	12.0	00	05.0	000	001	00.0	120	1426
2	2	2	1	0	02.5	1	0	00	782	6.0	3281	1*	5	5.0	00	02.0*	120	125	06.0	110	1223
2	2	2	1	0	02.5	1	0	00	782	6.0	3518	6*	5	5.0	00	02.0	120	125	06.0	110	1248
2	2	2	1	0	02.5	1	0	00	782	6.0	3697	1*	8	6.0	00	01.0	120	128	06.0	120	1261
2	2	2	1	0	02.5	1	0	00	782	6.0	3904	1*	15	6.0	00	01.5	120	135	06.0	120	1283
2	2	2	1	0	02.5	1	0	03	800	6.0	7397	6*	2	12.0	00	03.0*	238	240	00.0	120	1433
2	2	2	1	0	02.5	1	0	03	800	6.0	7505	6*	6	12.0	00	04.0	234	240	00.0	120	1437
2	2	2	1	0	02.5	1	0	03	800	6.0	8138	6*	10	12.0	00	10.0	230	240	00.0	120	1460
2	2	2	1	0	02.5	1	0	03	800	6.0	8387	1*	8	2.0	00	03.0	120	128	08.0	100	1474
2	2	1	1	0	02.5	0	0	00	805	2.0	7287	6*	9	12.0	00	05.0	111	120	00.0	120	1426
2	2	2	1	0	02.5	0	0	00	806	6.0	2737	1*	1	3.0	00	01.5	119	120	07.5	105	1180
2	2	2	1	0	02.5	0	0	00	806	6.0	2807	1*	6	6.0	00	01.5*	114	120	06.0	120	1186
2	2	2	1	0	02.5	0	0	00	806	6.0	2998	2*	8	6.0	12	03.0	112	120	06.0	120	1202
2	2	2	1	0	02.5	0	0	00	806	6.0	3904	1*	9	6.0	00	01.5	106	115	06.0	120	1283

NOTE: See Table 21 for code legend.

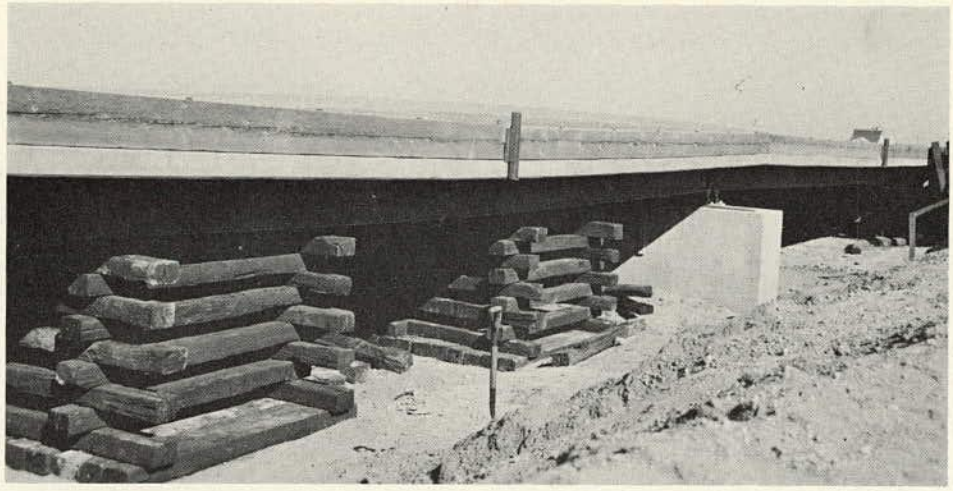


Figure 46. Maintenance forces placed railroad tie cribbing under test bridges.

The acid treatment produced a marked increase in friction; no further treatment was necessary during the remainder of the regular and special test traffic period.

A further test of the acid treatment was made on a small section of portland cement concrete pavement on a level tangent. Tests made with the General Motors Corporation skid trailer showed a wet coefficient of friction of 0.39 before and 0.67 after the treatment.

3.4.3 Services to Other Branches

The Maintenance Branch performed miscellaneous services for other branches of the project, primarily the Operations and Materials Branches.

Maintenance personnel and equipment were used in the loading, unloading and load maintenance on the test vehicles. Loads were made up of solid concrete blocks and hollow-core building blocks, and were tied down to the trailer decks with steel bands. Wooden cleats and heavy chains were also used to prevent load shifting. The Gradall was used to handle the blocks.

The Gradall was used several times for righting overturned vehicles and for towing disabled vehicles.

Figure 47. Maintenance forces assisted in loading and load banding on test vehicles.

In addition, maintenance crews were responsible for clean-up work when accidents occurred in the test loops. This usually consisted of cleaning away the blocks spilled from the test vehicle involved.

The Maintenance Branch assisted the Materials Branch in certain phases of its testing program. Several 3- by 12-ft trenches were cut in the pavements for thickness measurements and various tests on the underlying materials. Maintenance equipment and personnel frequently assisted in cutting the trenches, as well as repairing the pavement for traffic operation.

Rigid pavements were cut with a saw; flexible pavement surfacing was cut with a pneumatic hammer equipped with an asphalt cutting bit. The Gradall was used frequently to remove the pavement surface and, when necessary, underlying granular material.

After tests were completed by the Materials Branch the trenched area was backfilled with crushed stone, which was compacted with a small vibratory roller or a tamping foot on the pneumatic pavement breaker. The area was surfaced with hot mix, if available, or with a temporary patch of cold mix.

3.4.4 Radio Communications

The project's radio network was important in expediting the maintenance work. The base station was located in the Administration Building at the center of the project, with auxiliary units at the headquarters of the Maintenance and Operations Branches and the Army Support Activity as well as in most field vehicles and in the driver crew shelters on each traffic loop.

The radio network was used effectively in supervising the movement of maintenance equipment and crews along the 8-mile project and in coordinating the flow of materials from plants and stockpiles. It also was valuable to the Maintenance Review Committee in directing Research Branch measuring crews during the periodic inspections of the test pavements.

Appendix A

TEST VEHICLE SPECIFICATIONS

On April 8, 1957, the Automobile Manufacturers Association Committee for the AASHO Road Test submitted a proposed revision of the "Controlled Traffic Testing" section of the report, dated May 1955, of the Working Committee of the AASHO Committee on Highway Transport. The revision included "Proposed Specifications for Test Vehicles," which are given in the following, altered only as necessary to provide designations for loops and traffic lanes as used throughout this report.

PROPOSED SPECIFICATIONS FOR TEST VEHICLES

The following general test vehicle specifications have been prepared by the AMA Truck Technical Subcommittee. These specifications have been developed around available commercial equipment, and were revised in December 1956 to reflect revisions in AASHO test vehicle types.

General Data

1. All tractors for the inner lanes of Loops 3 through 6 are 4 x 2 type, and for the outer lanes of Loops 3 through 6 are 6 x 4 type with inter-axle differentials.
2. All tractors to be equipped with trailer brake connections and with at least 36-in. fifth wheels.
3. All trailers to be flat beds and to have a front corner radius of not less than 10 in.
4. All tractors to have either full air or air over hydraulic brakes, including hand control valve, and all trailers to have full air brakes.
5. All tractors to be equipped with dual safety tanks with a combined capacity sufficient for a minimum of 450 miles of operation without refueling.
6. All tractors to be geared for at least 40 mph and have engines that develop at least 1 net horsepower for each 500 lb GCW, based on axle loads shown on the attached chart, plus calculated front axle load.
7. All tractors to be equipped with fresh-air cab heaters and heavy duty rear view mirrors, approximately 6 x 16 in. with double brackets right and left.
8. Power steering is recommended on all combination vehicles.
9. It is recommended that gasoline-powered vehicles be used for Loops 3, 4, 5 and 2 and diesel-powered vehicles for Loop 6.
10. Vehicles for Loops 3 and 2 to have disc wheels and vehicles for Loops 4, 5 and 6 to have cast wheels.
11. Suspension systems for both single and tandem axles on both trucks and combination units will be present conventional leaf-spring types. Springs will meet manufacturer's specifications for the particular loads. The 2,000-lb axle vehicles will be equipped with front and rear shock absorbers.
12. Air pressure in tires will be such as to insure that the wheel load per square inch of tire contact area will be maintained as nearly uniform as possible for all test vehicles and axle loads. It is not practical, however, to apply these conditions to the 2,000-lb axle vehicles.
13. The spacing of load axles for Loops 5 and 6 should be 18 to 22 ft for single axles and 22 to 26 ft for tandem axles, measured from center to center of tandem axle group. It is desirable to have the same axle spacing for each lane.
14. Vehicles for Loop 2 are to be of the single unit two-axle type.
15. The 2,000-lb axle vehicles in Loop 2 are to exert a 2,000-lb load on each of the front and rear axles. The 6,000-lb axle vehicles in Loop 2 are to exert a 6,000-lb load only on the rear axles, with the front axles to carry a considerably lower load in line with conventional practice on two-axle trucks.
16. The 2,000-lb axle vehicles may be of the pick-up truck type. The 6,000-lb axle vehicles should be of the light truck type with platform body.
17. Minimum acceleration requirements for Loop 2 vehicles are from 10 mph to 30 mph in 220 ft. These vehicles also will be required to operate in a small turning radius.

Appendix B

TEST VEHICLE ACCIDENT CLASSIFICATION AND EXPERIENCE

1. TEST VEHICLE ACCIDENTS

Test vehicle accidents were classified for record and analysis purposes in accordance with the following criteria. Categories, and classification thereto, were based on the following:

(a) Any accident involving disabling injury, or (because of the potential for injury) the upset of the driven vehicle, or collision with the test bridge guard rails was a major accident even though property damage sustained may have been negligible.

(b) Rear-end collisions, unless disabling injuries were sustained as a result, were considered minor on the project because of the peculiar circumstances under which they were experienced. They usually occurred in the process of halting and parking at a point where the physical plant was crowded, and, because of the heavy loads, a relatively light blow produced excessive property damage (especially on Loops 5 and 6). A blow of equal or greater severity, under similar circumstances on Loops 2 and 3, resulted in far less property damage. Thus, categorization solely on the basis of property damage sustained would have distorted the accident picture for comparison between loops.

(c) Accidents not specifically defined above, and irrespective of types, from which negligible property damage ($25 or less) resulted, were recorded and were considered in the accident statistics utilized locally. They were not, however, computed in the project accident rate.

2. TYPES

(a) *Upset.* All accidents involving overturn of the vehicle.

(b) *Collision.* All accidents involving impact with:
- (1) "Test bridge" guard rails.
- (2) Vehicle ahead—"Rear end."
- (3) Vehicle behind while—"Backing."
- (4) Vehicle adjacent—"Side swipe."

(c) *Other.* All accidents not included in above types:
- (1) Jackknife.
- (2) Leaving test track.

3. CATEGORIES

(a) *Category I—Major*
- (1) All accidents involving injury or fatality irrespective of type.
- (2) All accidents involving upset of the driven vehicle irrespective of property damage involved.
- (3) All accidents involving collision with test bridges, irrespective of property damage involved.
- (4) All accidents, except rear-end collisions, in which property damage exceeded $500.

(b) *Category II—Minor*
- (1) All accidents involving rear-end collision not resulting in disabling injuries, irrespective of monetary loss involved.
- (2) All accidents involving property damage of less than $500 but more than $25.

(c) *Category III—No Property Damage* (NPD)
- (1) Accidents, not involving a disabling injury, in which vehicles leave test track, and accidents of an incidental nature involving property damage of $25 or less and no personal injury.

4. ACCIDENT EXPERIENCE

The location of accidents on the project are shown in Figure 1-B.

Accident trends and experience in accordance with the foregoing criteria are shown in Figure 2-B. Four accidents (of all categories) were experienced in the 1958 traffic operations, 32 in 1959 and 54 in 1960 when traffic operations were approximately doubled. Weather conditions were the apparent cause of high accident rates in January and March 1959 and January, March and September 1960.

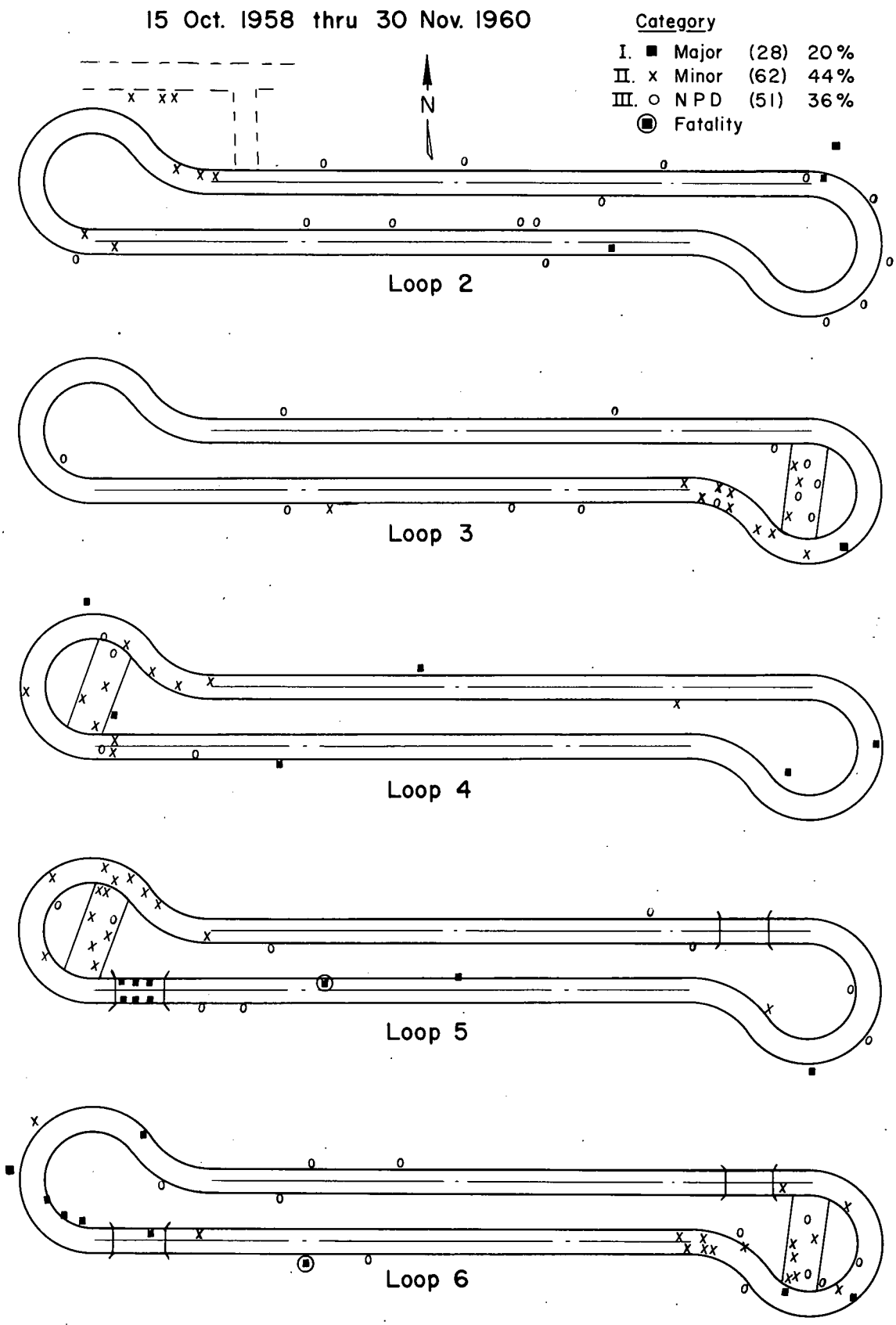


Figure 1-B. Accidents by category and location.

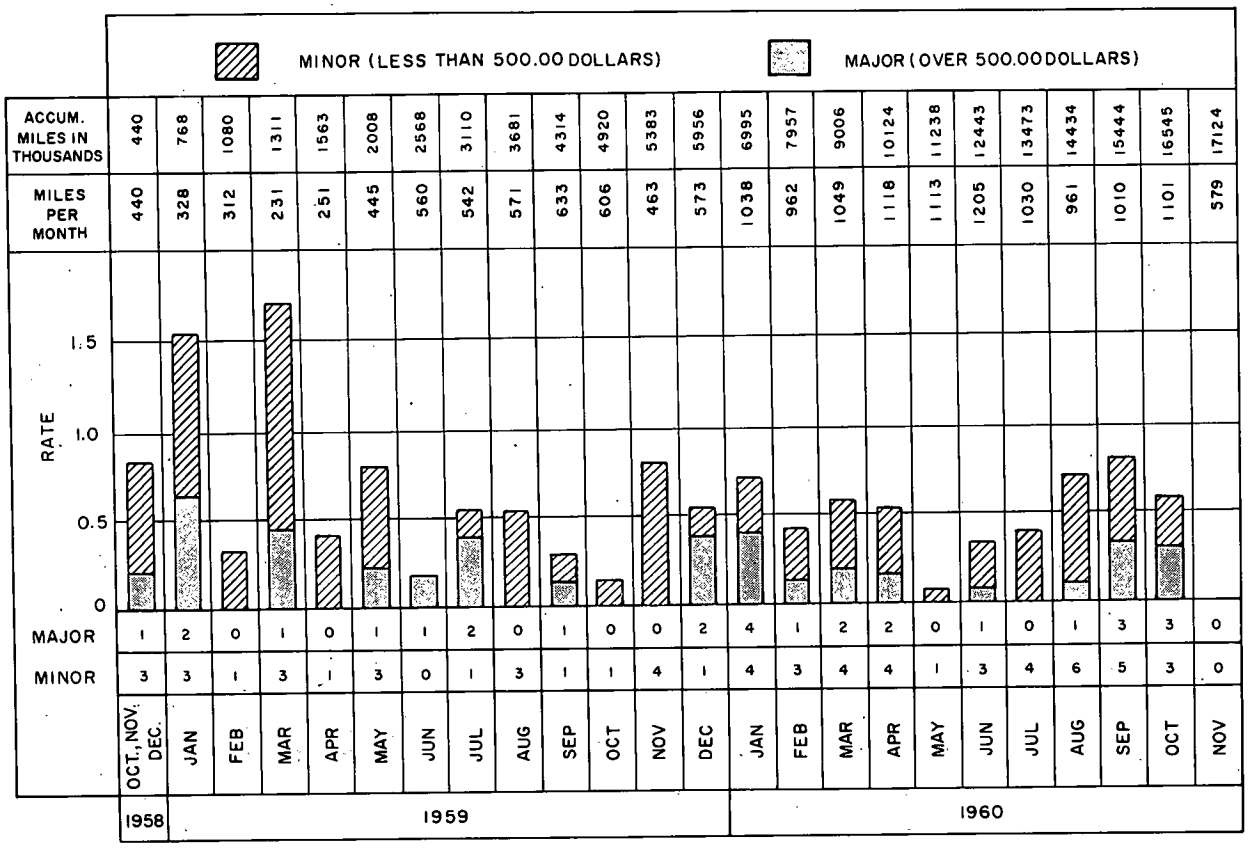


Figure 2-B. Accident experience.

Appendix C

REGIONAL ADVISORY COMMITTEES

These committees were appointed by the Highway Research Board to maintain liaison between the state highway departments and the research project, through the National Advisory Committee. Three members of each Regional Committee were appointed to the National Advisory Committee.

Region 1

F. M. Auer, Planning and Economics Engineer, New Hampshire Department of Public Works and Highways

E. B. Bly, Engineering Assistant to Commissioner, Vermont Department of Highways

T. V. Bohner, Special Assistant, Engineering Department, D. C. Department of Highways and Traffic

W. M. Creamer, Chief, Highway Staff Services, Connecticut State Highway Department

F. W. Hauck, Supervising Civil Engineer (Road Designing), Rhode Island Department of Public Works

C. D. Jensen, Director of Research and Testing, Pennsylvania Department of Highways

G. W. McAlpin, Assistant Deputy Chief Engineer (Research), New York State Department of Public Works

J. F. McGovern, Structures Maintenance Engineer, Massachusetts Department of Public Works

L. W. Novinger, Contract and Design Engineer, Delaware State Highway Department

V. A. Savage, Engineer of Primary Highways, Maine State Highway Commission

W. Van Breemen, Research Engineer, New Jersey State Highway Department

The following were members of the Region 1 Advisory Committee during the years indicated:

H. F. Clemmer, formerly *Chairman;* Consultant, D. C. Department of Highways and Traffic (1956-1960)

R. A. Farley, formerly Deputy Secretary, Engineering, Pennsylvania Department of Highways (1956-1958)

W. C. Hopkins, Deputy Chief Engineer, Maryland State Roads Commission (1956-1961)

F. S. Poorman, Deputy Secretary, Engineering, Pennsylvania Department of Highways (1959)

L. K. Murphy, formerly Construction Engineer, Primary Highways, Maine State Highway Commission (1955-1959)

Region 2

T. E. Shelburne, *Chairman,* Director of Research, Virginia Department of Highways

W. F. Abercrombie, Engineer of Materials and Tests, Georgia State Highway Department

T. L. Bransford, Engineer of Research and In-Service Training, Florida State Road Department

L. D. Hicks, Chief Soils Engineer, North Carolina State Highway and Public Works Commission

G. W. McAlpin, Director, Program Office, and Assistant Chief Engineer, West Virginia State Road Commission

J. D. McMahan, Construction Engineer, South Carolina State Highway Department

A. O. Neiser, Assistant State Highway Engineer, Kentucky Department of Highways

T. W. Parish, Assistant Chief Engineer (Construction), Louisiana Department of Highways

R. S. Patton, Engineer of Surveys and Designs, Tennessee Department of Highways and Public Works

Angel (2) Silva, Director, Puerto Rico Department of Public Works

H. O. Thompson, Testing Engineer, Mississippi State Highway Department

J. F. Tribble, Materials and Research Engineer, Alabama State Highway Department

E. L. Wales, Engineer of Materials and Tests, Arkansas State Highway Commission

The following was a member of the Region 2 Advisory Committee during the years indicated:

J. L. Land, formerly Chief Engineer, Bureau of Materials and Tests, Alabama State Highway Department (1956)

Region 3

W. E. Chastain, Sr., *Chairman,* Engineer of Physical Research, Illinois Division of Highways

J. G. Butter, Consultant, Iowa State Highway Commission

E. A. Finney, Director, Research Laboratory, Michigan State Highway Department

R. A. Helmer, Research Engineer, Oklahoma State Highway Department

J. W. Hossack, State Engineer, Nebraska Department of Roads

C. P. Jorgensen, Manager, Research and Planning, South Dakota State Highway Commission

H. E. Marshall, Research Engineer, Ohio Department of Highways

R. L. Peyton, Assistant State Highway Engineer, State Highway Commission of Kansas

J. S. Piltz, Engineer of Design, Wisconsin State Highway Commission

C. K. Preus, Materials and Research Engineer, Minnesota Department of Highways

F. V. Reagel, Engineer of Special Assignments, Missouri State Highway Commission

W. T. Spencer, Soils Engineer, Indiana State Highway Department

W. A. Wise, Director, Field Division, North Dakota State Highway Department

The following were members of the Region 3 Advisory Committee during the years indicated:

L. N. Ress, formerly State Engineer, Nebraska Department of Roads (1956-1958)

H. G. Schlitt, formerly Deputy State Engineer, Nebraska Department of Roads (1959)

C. W. Allen, formerly Research Engineer, Ohio Department of Highways (1956-1958)

J. H. Swanberg, Chief Engineer, Minnesota Department of Highways (1956-1958)

Region 4

R. E. Livingston, *Chairman,* Planning and Research Engineer, Colorado Department of Highways

J. R. Bromley, Superintendent and Chief Engineer, Wyoming State Highway Department

L. F. Erickson, Assistant Construction Engineer, Idaho Department of Highways

L. B. Fox, Construction Engineer, Montana State Highway Commission

T. S. Huff, Chief Engineer of Highway Design, Texas State Highway Department

F. N. Hveem, Materials and Research Engineer, California Division of Highways

C. W. Johnson, Materials and Testing Engineer, New Mexico State Highway Commission

D. F. Larsen, Chief Materials Engineer, Utah State Road Commission

C. E. Minor, Materials and Research Engineer, Washington Department of Highways

W. G. O'Harra, Materials Engineer, Arizona Highway Department

W. M. Wachter, Highway Engineer, Hawaii Division of Highways

W. O. Wright, State Highway Engineer, Nevada Department of Highways

The following were members of the Region 4 Advisory Committee during the years indicated:

W. T. Holcomb, formerly Assistant State Highway Engineer, Nevada Department of Highways (1956-1959)

I. B. Miller, Operations Engineer, New Mexico State Highway Commission (1956-1958)

B. E. Nutter, formerly Territorial Highway Engineer, Hawaii Territorial Highway Department (1956-1958)

S. B. Sanders, formerly District Engineer, Montana State Highway Commission (1956-1958)

W. C. Williams, State Highway Engineer, Oregon State Highway Commission (1956-1961) (deceased)

ADVISORY PANEL ON MAINTENANCE

This panel was appointed by the Highway Research Board to advise it on pavement maintenance techniques and to assist in formulating pavement maintenance criteria for the project.

R. C. Boyd, *Chairman,* Maintenance Engineer, Iowa State Highway Commission

B. W. Davis, Maintenance Engineer, North Carolina State Highway Commission

H. E. Diers, Engineer of Maintenance, Illinois Division of Highways

Otto Hess, Engineer-Manager, Kent County, Michigan, Road Commission

G. G. Love, Assistant Chief Engineer for Maintenance and Equipment, Massachusetts Department of Public Works

S. E. Ridge, Special Programs Coordinator, Office of the Assistant to the Federal Highway Administrator, Bureau of Public Roads

J. L. Stackhouse, Maintenance Engineer, Washington Department of Highways

ADVISORY PANEL ON VEHICLES

This panel was appointed by the Highway Research Board to advise it on vehicle procurement and specifications.

Carl Saal, *Chairman,* Chief, Traffic Operations Division, Bureau of Public Roads

T. F. Creedon, Highway Engineering Advisor, Automobile Manufacturers Association

J. B. Hulse, Managing Director, Truck Trailer Manufacturers Association

A. E. Johnson, Executive Secretary, American Association of State Highway Officials

C. H. Perry, Deputy Director of Transportation Engineering, Office of the Chief of Transportation, Department of the Army

ADVISORY PANEL ON ECONOMIC DATA

This panel advised of those measurements and observations that should be made in order to provide data needed by the Bureau of Public Roads to fulfill its obligation to Congress in the matter of highway cost allocation.

G. P. St. Clair, *Chairman,* Director, Highway Cost Allocation Study, Bureau of Public Roads

R. R. Bartelsmeyer, Chief Highway Engineer, Illinois Division of Highways

H. S. Fairbank, Consultant, Baltimore, Maryland

R. G. Hennes, Professor of Civil Engineering, University of Washington

A. E. Johnson, Executive Secretary, American Association of State Highway Officials

R. E. Jorgensen, Engineering Counsel, National Highway Users Conference

J. O. Morton, Commissioner, New Hampshire State Highway Department

R. Newcomb, Consulting Economist, Washington, D. C.

H. W. Nicholson, Professor of Economics, Clark University

G. C. Richards, Commissioner, Public Works Department, Detroit, Michigan

K. B. Rykken, Director, Highway and Legislative Department, American Automobile Association

R. M. Zettel, Research Economist, University of California

The following were members of this panel during the years indicated:

J. A. Maxwell, Professor of Economics, Clark University (1956-1958)

L. N. Ress, *Chairman,* formerly State Engineer, Nebraska Department of Roads (resigned 1959)

SPECIAL SUBCOMMITTEE ON OPERATIONS

This subcommittee was appointed by the National Advisory Committee to advise it and the project staff on means of increasing the efficiency of vehicle operations and attaining the planned number of axle load applications.

R. E. Livingston, *Chairman,* Planning and Research Engineer, Colorado Department of Highways
R. R. Bartelsmeyer, Chief Highway Engineer, Illinois Division of Highways
L. C. Lundstrom, former Chairman, Automobile Manufacturers Association Committee for Cooperation with AASHO Road Test, and Director, General Motors Proving Ground
B. W. Marsh, Director, Traffic Engineering and Safety Department, American Automobile Association
D. K. Chacey, Director of Transportation Engineering, Office of the Chief of Transportation, Department of the Army

SPECIAL AASHO SUBCOMMITTEE ON OPERATIONS AND FINANCE

This special subcommittee was appointed by the Executive Committee of the American Association of State Highway Officials to study test road traffic operations and make recommendations on how to attain the planned one million test load applications.

They recommended that additional money be contributed by the participating agencies for the purchase of additional vehicles and that a seven-day driving schedule be followed to achieve the desired number of load applications.

D. H. Stevens, Past President of AASHO, and Chairman, Maine State Highway Commission
B. D. Tallamy, former Federal Highway Administrator, Bureau of Public Roads
R. R. Bartelsmeyer, Chairman, AASHO Committee on Highway Transport, and Chief Highway Engineer, Illinois Division of Highways

AUTOMOBILE MANUFACTURERS ASSOCIATION SUBCOMMITTEE FOR COOPERATION WITH WORKING COMMITTEE OF THE AASHO COMMITTEE ON HIGHWAY TRANSPORT

This subcommittee was responsible for recommending major specification items for the test vehicles used in the AASHO Road Test, and worked with and gave technical advice to the Working Committee during the original planning and development of the AASHO Road Test Project Statement and Project Program.

W. F. Sherman, Manager, Engineering and Technical Department, Automobile Manufacturers Association
I. E. Johnson, Manager, Chrysler Corporation Proving Ground
W. R. Westphal, Experiment Engineer, Truck Engineering Development Section, Ford Motor Company
H. H. Barnes, Director, General Motors Proving Ground
Carl A. Lindbloom, Division Chief Engineer, Advanced Engineering Group, International Harvester Company
J. N. Bauman, Vice President, The White Motor Company

The following also was a member of this subcommittee:

F. B. Lautzenhiser, Consultant (retired 1955)

AUTOMOBILE MANUFACTURERS ASSOCIATION COMMITTEE FOR COOPERATION WITH THE AASHO ROAD TEST

This committee recommended specifications for test vehicles used in the AASHO Road Test. As a committee, but more often in individual capacities, they also devoted considerable time and effort to the numerous operating problems that arose during the test traffic phase of the project.

W. B. Love, *Chairman,* Chief Truck Chassis Engineer, Studebaker-Packard Corporation

T. F. Creedon, *Secretary,* Highway Engineering Advisor, Automobile Manufacturers Association

Harry Bernard, Director of Service, Mack Trucks, Inc.

John Walker*, Manager, Sales Engineering, Mack Trucks, Inc.

J. C. Gillie, Ground Maintenance and Construction Engineer, Chrysler Corporation Proving Ground

W. A. Jensen, Assistant Chief Engineer, Reo Division of the White Motor Company

J. H. Letsinger, Assistant Manager of Engineering, International Harvester Company

L. C. Lundstrom, Director, General Motors Proving Ground

M. T. Hayes*, Assistant Truck Engineer, General Motors Corporation Truck and Coach Division

P. H. Pretz, Director, Testing Operations Office, Ford Motor Company

W. A. McConnell*, Manager, Vehicle Testing Laboratories, Ford Motor Company

D. B. Wheeler, Assistant to Chief Engineer, White Motor Company

M. A. Hanna, Jr.*, Sales Engineer, White Motor Company

The following also served on this committee:

H. H. Barnes (*Chairman,* 1955-56)

L. C. Lundstrom (*Chairman,* 1957-58)

I. E. Johnson (*Chairman,* 1959-60)

R. E. Cass (1955-59), Assistant to the President, White Motor Company

* Alternate

SPECIAL PUBLICATION SUBCOMMITTEE FOR ROAD TEST REPORT 3, TRAFFIC OPERATIONS AND PAVEMENT MAINTENANCE

This subcommittee was appointed by the Highway Research Board to review AASHO Road Test Report 3, "Traffic Operations and Pavement Maintenance," and recommend approval of the report for publication.

E. H. Holmes, *Chairman,* Bureau of Public Roads

W. F. Abercrombie, Engineer of Materials and Tests, Georgia State Highway Department

R. C. Boyd, Maintenance Engineer, Iowa State Highway Commission

H. E. Diers, Engineer of Maintenance, Illinois Division of Highways

W. C. Johnson, Manager, Tire Test Division, Goodyear Tire and Rubber Company

R. A. Lill, Chief, Highway Engineering, American Trucking Associations

R. E. Livingston, Planning and Research Engineer, Colorado Department of Highways

L. C. Lundstrom, former Chairman, Automobile Manufacturers Association Committee for Cooperation with AASHO Road Test, and Director, General Motors Proving Ground

B. W. Marsh, Director, Traffic Engineering and Safety Department, American Automobile Association

H. O. Thompson, Testing Engineer, Mississippi State Highway Department

PROJECT PERSONNEL

Project Staff and Engineers

W. B. McKendrick, Jr., Project Director
W. N. Carey, Jr., Chief Engineer for Research
Peter Talovich, Business Administrator
L. A. Ptak, Accountant
R. S. Semple, Purchasing Assistant
A. C. Tosetti, Assistant to the Project Director
W. R. Milligan, Assistant Operations Manager
D. L. Thorp, Shop Superintendent
A. C. Benkelman, Flexible Pavement Research Engineer
L. E. Dixon, Assistant Flexible Pavement Research Engineer
H. M. Schmitt, Assistant Flexible Pavement Research Engineer
F. H. Scrivner, Rigid Pavement Research Engineer
W. R. Hudson, Assistant Rigid Pavement Research Engineer
R. J. Little, Assistant Rigid Pavement Research Engineer
I. M. Viest, Bridge Research Engineer
J. W. Fisher, Assistant Bridge Research Engineer
P. E. Irick, Chief, Data Processing and Analysis
R. C. Hain, Assistant Chief, Data Processing and Analysis
J. F. Shook, Materials Engineer
D. R. Schwartz, Engineer of Reports
H. R. Hubbell, Assistant Engineer of Reports
H. H. Boswell, Maintenance Engineer
James Gardner, Maintenance Superintendent
Allen Bartelson, Maintenance Supervisor
R. C. Leathers, Engineer of Special Assignments
H. C. Huckins, Supervisor, Instrument Laboratory
W. J. Schmidt, Chief, Public Information

The following were also members of the project staff:

H. H. Cole, Shop Superintendent (1958)
Moreland Herrin, Assistant Materials Engineer (1958)
L. Q. Mettes, Materials Engineer (1956)

Staff Consultants and Engineer Observers

The following resident staff consultants and engineer observers were on the project during the traffic phase.

B. E. Colley, Senior Development Engineer, Portland Cement Association
F. N. Finn, Special Projects Engineer, The Asphalt Institute
S. M. King, Special Projects Engineer, American Trucking Associations
R. I. Kingham, Resident Engineer to AASHO Road Test, Canadian Good Roads Association
W. E. Teske, Highway Engineer, Paving Bureau, Portland Cement Association
G. A. Wrong, Principal Soils Engineer, Province of Ontario, Canada

The following also were staff consultants or engineer observers:

G. D. Campbell, Director of Technical Services, Canadian Good Roads Association (1956-1957)
R. A. Lill, Highway Engineer, American Trucking Associations (1955-1957)

The following non-resident engineer observers periodically visited the project:

E. R. Feldman, Highway Engineer, Division of Competitive Transportation, Association of American Railroads
E. J. Ruble, Research Structural Engineer, Association of American Railroads
Rockwell Smith, Soils Engineer, Association of American Railroads

U. S. Army Transportation Corps Road Test Support Activity (AASHO)

Commanding Officer
Col. A. A. Wilson (1958-59)
Lt. Col. R. J. Lombard (1959-61)

Deputy Commander
Maj. W. A. Duncan (1958-60)
Capt. R. G. Farwell (1960-61)

Company Commander
Capt. R. D. Smith (1958-59)

Temporary Personnel

The following junior engineers assigned to the project by the Bureau of Public Roads for periods of six months as part of their training program performed engineering tasks in the Operations and Maintenance Branches of the Road Test:

Operations: K. B. Casey
J. S. Wesley
R. L. Diffenderfer

Maintenance: C. A. Ballinger

THE NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL is a private, nonprofit organization of scientists, dedicated to the furtherance of science and to its use for the general welfare. The ACADEMY itself was established in 1863 under a congressional charter signed by President Lincoln. Empowered to provide for all activities appropriate to academies of science, it was also required by its charter to act as an adviser to the federal government in scientific matters. This provision accounts for the close ties that have always existed between the ACADEMY and the government, although the ACADEMY is not a governmental agency.

The NATIONAL RESEARCH COUNCIL was established by the ACADEMY in 1916, at the request of President Wilson, to enable scientists generally to associate their efforts with those of the limited membership of the ACADEMY in service to the nation, to society, and to science at home and abroad. Members of the NATIONAL RESEARCH COUNCIL receive their appointments from the president of the ACADEMY. They include representatives nominated by the major scientific and technical societies, representatives of the federal government, and a number of members at large. In addition, several thousand scientists and engineers take part in the activities of the research council through membership on its various boards and committees.

Receiving funds from both public and private sources, by contribution, grant, or contract, the ACADEMY and its RESEARCH COUNCIL thus work to stimulate research and its applications, to survey the broad possibilities of science, to promote effective utilization of the scientific and technical resources of the country, to serve the government, and to further the general interests of science.

The HIGHWAY RESEARCH BOARD was organized November 11, 1920, as an agency of the Division of Engineering and Industrial Research, one of the eight functional divisions of the NATIONAL RESEARCH COUNCIL. The BOARD is a cooperative organization of the highway technologists of America operating under the auspices of the ACADEMY-COUNCIL and with the support of the several highway departments, the Bureau of Public Roads, and many other organizations interested in the development of highway transportation. The purposes of the BOARD are to encourage research and to provide a national clearinghouse and correlation service for research activities and information on highway administration and technology.