PUBLIC ROADS

A JOURNAL OF HIGHWAY RESEARCH

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

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NORTH CAROLINA'S RECENT ECONOMIC PROGRESS IS LARGELY THE RESULT OF THE IMPROVEMENT OF ITS ROADS

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FIVE YEARS OF STATE ROAD BUILDING AND ITS RESULTS[1]

By FRANK PAGE, Chairman, State Highway Commission of North Carolina

The building of our State system of highways in North Carolina during the last five years has linked together our great trunk-line railroads and our waterways into an effective transportation machine.

On the coast our ports receive imports from all the world distributed to our Carolina markets by rail and motor. A coastwise shipping takes potatoes, melons, and truck produce to Baltimore, Washington, and New York.

Our trunk-line railroads take our fabricated tobacco, cotton, and furniture from the factories of Gastonia, Durham, Winston-Salem, and High Point and deliver them to all parts of the United States and other countries.

Our 6,500 miles of State highway system—4,500 miles improved plus the secondary feeder roads—are the means by which much of the raw materials get to the factories and thence to the rails. Conversely they are the means of distribution of our imports and food products to our people.

In this period of five years from 1921 to 1926, North Carolina has probably made greater progress agriculturally, industrially, and socially than any other State in the Union in a similar period of time.

One of the most important factors in this metamorphosis has been our highway improvement program, involving the building of $125,000,000 worth of highways since 1919—most of it since 1921 when we issued $50,000,000 in bonds and later $35,000,000 more to build a State system of highways.

What has been the result? Has it helped or hurt industry, agriculture, the taxpayer, the 4,000 miles of trunk-line railroads and 1,000 miles of short lines in the State?

A few facts will help us to understand what has happened since 1920 and 1921.

We have increased the number of our farms by 13,000 during a period when the number of farms for the country as a whole fell off.

We have built consolidated rural schools valued at $35,000,000. To these each school day are brought 100,000 pupils in 2,000 school busses operating 40,000 miles—largely on the State system.

We have developed 40 cooperative farm marketing associations, many of them stimulated by our State Department of Agriculture, and engaged in shipping carload after carload of poultry, eggs, hogs, fruits, and vegetables that we formerly never grew for outside sale.

Roadside markets and city curb markets have stimulated the growing of truck produce on our farms and are the outlet for the farm surplus. The farm women are the merchandisers of this surplus and with the first available cash money most of them have ever had are putting modern conveniences into their homes, dressing themselves and their children better, painting their houses, and beautifying their yards.

We have recovered our lost provinces—those sections of the State to the far east and west formerly foreign to the State so far as transportation connections of any kind were concerned. To reach some of these points in our own State involved rail travel through one and sometimes two adjoining States. Our highways were out of the question for travel to these places. To-day the roads have gone through and we have put every part of the State within reach of every other part—almost from sunrise to sunset over the State highway system.

ONE OF THE SAND-ASPHALT ROADS RECENTLY CONSTRUCTED IN THE COASTAL SECTION OF THE STATE

The State of North Carolina has taken the lead in spindle hours operated by cotton mills.

The true value of our property has multiplied eight times since 1900 while the entire country was increasing the true value of property by four times.

The question may arise as to how far the highways can be credited with bringing this about. Let us analyze the situation further.

HOW WAS HIGHWAY IMPROVEMENT ACCOMPLISHED?

We have built our State system and are maintaining it entirely at the expense of the road user.

There is no State property tax for highways. State highway moneys come from three sources—bonds, motor registration fees, and gas taxes. The bonds are issued serially and are retired through a sinking fund maintained entirely by the motor taxes.

In 1921 the State legislature established a State highway system, 6,500 miles in length and tapping every county seat and every town and city of importance. The State is now maintaining 6,200 miles of road—all but some 300 miles of mountain trails. The roads first improved were naturally those between the cities because communication between them was necessary before tying in the more remote parts of the State.

North Carolina is predominantly agricultural, with manufacturing centered in the Piedmont section around Durham, Winston-Salem, Greensboro, Charlotte, Gastonia, High Point, and Raleigh. Our highway system makes our industry and agriculture interdependent—each supplying the other. The lumber for our furniture factories, cotton for the cotton mills

[1] A statement made by the writer in hearings before the Interstate Commerce Commission on interstate operation of motor trucks and busses, I. C. C. Docket 18,300.

BEFORE THE ROADS WERE IMPROVED THE MOUNTAINOUS SECTION OF THE WESTERN PART OF THE STATE WAS A LOST PROVINCE. TO REACH IT BY HIGHWAY WAS IMPOSSIBLE. TO REACH IT BY RAIL ONE TRAVELED THROUGH TWO ADJOINING STATES

and tobacco for the great factories at Durham and Winston-Salem are produced within the State and move both by rail and highway at the beginning and end of fabrication.

INFLUENCE OF HIGHWAY IMPROVEMENT ON AGRICULTURE

In 1925 there were 283,491 farms in North Carolina with nearly 7,000,000 acres under cultivation. This cultivated area represents about 27 per cent of the area in farms and about 23.5 per cent of the taxed area of the State.

The three leading money crops—cotton, corn, and tobacco—occupied 72 per cent of the cultivated area of the State, and with grain and hay constituted 92 per cent of the cultivated area.

Diversification, however, is becoming more popular and improved highways now make available the markets for the products of diversification. Some 40 cooperative farm marketing associations, mostly organized since 1920, with the excellent aid and advice of the State department of agriculture are the medium of much produce selling. With the exception of the farmers' federation at Asheville it is doubtful if any of them operate their own trucks. Roadside markets are fast becoming a factor in disposing of farm surplus products.

William A. Graham, State Commissioner of Agriculture, stated:

> The good roads in this part of the State have made it possible to supply the manufacturing cities from farms located as many as 40 miles away or farther. Prior to the advent of good roads the farmer who lived as much as 10 miles from town rarely took produce to market unless his roads were in what he would call prime condition, and then it took him an entire day to make the trip.
>
> The town was then forced to get its supplies from sources outside the State, as it could hardly draw on more than 75 square miles of territory for local production. With the coming of good roads the market gardens of the cities have grown from the former area of 50 to 75 square miles to 1,000 to 1,200 square miles or more. Here we find diversified farming—cotton, corn, tobacco, potatoes, wheat, oats, and vegetables—all growing on the same farm the same year.

Mr. Graham's statement forcefully illustrates the very large intrastate movement of produce from farm to city and of manufactured commodities from city to farm in return, almost entirely by motor truck.

The total value of North Carolina crops last year was $320,000,000.

IN 1911 THIS FARMER REQUIRED FOUR HORSES TO HAUL 520 FEET OF LUMBER 5 MILES. THE TRIP TOOK HALF A DAY AND THE FARMER RECEIVED FOR HIS LUMBER $2 A HUNDRED

BUT NOW THE ROADS HAVE GONE THROUGH AND HAVE PUT EVERY PART OF THE STATE WITHIN REACH OF EVERY OTHER PART—WITHIN A DAY'S JOURNEY

During the year 1925 North Carolina truckers shipped to points out of the State 15,555 carloads and 490,000 express packages of truck, which brought nearly $12,000,000 direct to the producers.

The highways have been the medium for no small amount of new agricultural tonnage reaching the rails. This is particularly true of poultry and hog shipments. In 1924 we shipped out of North Carolina 464,285 pounds of poultry, in 1925 some 750,000 pounds, and in 1926 (year ended June 30 in each case) the total reached 1,900,000 pounds, 250 per cent more than the 1924 figure.

As to hogs, in 1924 there were shipped 23 carloads, in 1925 this increased to 58, and in 1926 to 80 carloads, or more than three times the 1924 figures. Just the other days one of our State college men told of seeing 32 farmers receive a check for $11,000 covering the shipment of eight cars of hogs they had brought in to three rail-shipping points by motor truck.

Shipment of eggs in 1924 totaled 6,681 cases and increased to more than 8,000 cases in 1926.

Dairying.—The State has lately turned strongly to the possibilities of dairying. It goes without question that highway improvement has been quite largely responsible for getting large quantities of milk into our southern cities. The larger ones show an increase of 250 per cent in milk consumption.

Nine of the principal cities of the State now pay farmers of surrounding sections $4,178,520 annually for milk. Incidentally, this supply has been developed and handled almost entirely over the highway so that the railroad has not entered as a competitive transportation factor.

The highways have assisted in the establishment of milk plants. John Arey, of the State college, reports the establishment of seven milk plants in the State since 1920. There were but five at that time. There are now 15 creameries making butter, 7 of them also established since 1920, with others now under construction.

Some 7,500 farmers sell cream to these establishments with an annual butter production of 2,000,000 pounds.

Fruits and Vegetables.—The United States Bureau of Agricultural Economics reports car-lot shipments of fruits and vegetables out of North Carolina for the five-year period 1921 to 1925, inclusive, as follows (some of the smaller lots are not included, which accounts for the difference between this total and one previously given for 1925):

Car-lot shipments of fruits and vegetables from North Carolina

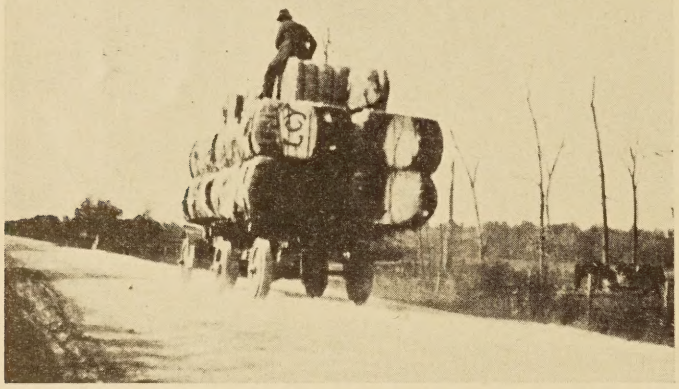
Crop	Year				
	1921	1922	1923	1924	1925
Apples	77	384	220	433	344
String beans	128	219	261	559	459
Cabbage	251	213	364	263	371
Canteloupes	894	700	620	401	655
Cucumbers	641	687	1,175	1,639	1,562
Lettuce	445	622	718	714	537
Mixed vegetables	66	326	758	1,093	853
Peaches	594	1,452	215	1,657	2,024
Spinach	2	5	25	21	11
Strawberries	503	1,101	1,668	2,046	1,634
Sweet potatoes	982	721	654	720	1,189
Tomatoes	1			8	
Turnips and rutabagas	6	9	5	2	3
Watermelons	1,657	993	1,542	664	991
Potatoes	3,071	4,202	3,475	6,566	4,052
Total	9,318	11,634	11,700	16,786	14,685

There is of course evident the effect of crop and market fluctuation, particularly in potatoes in 1924,

but the sum total has been steadily increasing. Much of this tonnage moved to rail points over the highways. Some, particularly the potatoes, moved by water to rail shipping points. Each year, however, a greater percentage of certain crops comes by motor truck from longer distances to rail-shipping points.

Peaches.—The sandhills of North Carolina produced an enormous crop of peaches this year. Unfortunately the Georgia crop was a little late so that our peaches got into northern markets about the time theirs did, depressing the price to all producers.

Here the highways were of considerable value, not so much in the car-loading of peaches as in the distribution of the surplus throughout the State. The truck was a safety valve, which handled the equivalent of 100 carloads or more of the grades which could not be shipped by rail. These went by truck direct to home markets. Another 10 to 15 carloads were shipped by rail to other cities in the State and from there marketed by truck.



At Present Cotton Can be Moved at Any Time. The Condition of the Road Plays Little Part Except to Cheapen the Cost of Hauling the Raw Cotton to the Gin

Five years ago the peach growers would have taken their loss, for the highways were not there to help them dispose of this grade of peaches. And too, the rails did not lose the business, because most of these peaches were too ripe to ship by rail.

ROADSIDE MARKETS PROVIDE NEW OUTLET FOR DIVERSIFIED PRODUCTION

At Hot Springs, N. C., there is a farm of 4 acres that two years ago, prior to putting through an improved road, produced little more than enough to support the farmer and his family who lived on it. This year they have not only lived well on it, but have cleared $2,200 in cash by marketing at their front gate the fruit and vegetables they produced.

Another farmer, operating a farm of 200 acres at Awanonoa has been clearing $25 a day for the summer and fall from the surplus produced on his farm. Here the market has no attendant but is conducted on the honor system and the owner claims never to have lost a cent. Prices are indicated and the buyer makes his own change.

Another farmer in Alamance County daily brings his cream 56 miles into Raleigh and delivers it to a creamery.

In Anson County a farm woman is canning goods at the farm. She travels 12 miles with a horse and wagon over the improved highway and sells her canned goods at the curb market in Wadesboro. For 10 years prior to the bettering of this road she had not been in Wadesboro more than twice. Now with the first cash she has seen for years, she is buying clothes for herself and children and conveniences for the house.

We have now 29 curb markets in different cities at which the farmers last year sold nearly a quarter of a million dollars worth of surplus produce from the farm. Five years ago there were only two or three of these markets, and those only in the larger cities.

The roads around Rocky Mount, N. C., were improved a little more than three years ago. A curb market was established 31 months ago and to date has resulted in the sale of $32,500 worth of produce.

Another phase of this curb market development is the growth of community booths within them. In one of these booths, one farm woman sells $10 worth of cakes a week, another has cleared $150 this year on canned soup mixtures, while still another has made $520 from her garden and chickens.

Not the least of the advantages of these markets has been the social contact between the city and farm. Each has learned what the other is doing. The farm women use the receipts from their produce sales to buy conveniences for the farm home—clothing, books—everything they have wanted but could not get before for lack of funds. Incidentally, all these purchases make increased business for the railroads, waterways, and highways.

HIGHWAY SERVICE AND THE COTTON AND TOBACCO INDUSTRIES

Cotton.—Just now we are faced with an over-production of cotton with attendent ill effects. The doctrine of diversification is being advocated. Our cotton fields are small and the soil is adaptable to other products so that we have all conditions favorable to production. Marketing facilities exist in the cooperative associations holding out the buying power of distant markets; near-by cities have their curb markets and the highways are at hand over which both can be reached.

At present cotton can be moved at any time. The condition of the road plays little part except to cheapen the cost of hauling the raw cotton to the gin.

Tobacco.—The chief influence of the improved highway on the tobacco grower has been to change his marketing processes. Prior to this development there were usually one or two small tobacco warehouses in each marketing town. The tobacco grower came to these with his crop, taking all of one day with his mule and wagon to get there. The next day was spent in arranging the tobacco in baskets, grading and sorting it on the warehouse floor and closing sales with the buyers who visited these towns. The warehousemen cleared all sales and were therefore the commission merchants.

The grower now loads his truck at sunrise, travels up to 40 or 50 miles, puts his product on the warehouse floor, sells it and is back home again the same day. The process of marketing is shortened and cheapened; fewer buyers are required; the grower is always sure of a market at the larger point at any time he chooses to go; and he gets a better price for his product.

The industries of the State use rail transportation predominantly. They do, however, make frequent and necessary use of the highways.

One instance shows the service the highways rendered one cotton mill company, where the rail haul was

circuitous and a delivery point a half mile from the railroad was involved.

In May this year a manufacturing company at Concord, N. C., bought 100 looms from a firm at Newton, N. C. The distance is 65 miles by highway and about 72 by rail.

The manufacturing company contracted with a trucker for $650 to take the looms from Newton to Concord, handling five every 12 hours and working night and day.

To ship by rail it would have been necessary to ship the looms single deck for lack of skilled labor to store them double deck. The freight charges between the two points on this basis were $515, plus $300 for labor and trucking from the station at the other end of the haul to the plant half a mile away, plus certain unknown charges for blocking the looms in the cars.

picked up by motor express that afternoon 40 miles away and delivered to the factory the next morning By that afternoon the order received 36 hours before was on the railroad loading platform.

One other service is given the mills by the highway and motor transport. This additional transportation is a guarantee against mill shutdowns or delays in filling orders due to uncertain or undependable rail service, car shortage, etc. Cotton warehouses maintain their own trucks and when a mill needs raw cotton urgently it is sent by motor truck. It costs more to send it that way, but this cost is offset by the mill's ability to keep running and meet consumer demands on it.

Cottonseed oil.—The cotton gins are usually located near the fields and several of them will supply one oil mill with seeds. Formerly the seeds were hauled to a rail siding or into town to the rail freight station when

THE NUMBER OF FARMS HAS INCREASED BY 13,000 DURING A PERIOD WHEN THE NUMBER FELL OFF IN THE COUNTRY AS A WHOLE

The two State highways and one county highway involved in the movement by truck were thus worth $165 to the manufacturing company in this one instance alone.

Most of the raw materials come to the cotton mills by rail and most of their finished products go out by rail. The highway, however, permits them to draw on a wider supply of labor, principally from the farm.

The truck line past the door is a guarantee against delays in productions and shipment. A telephone call to a near-by city, perhaps 40 to 50 miles away, for 100 feet of leather belting or a few feet of pipe with orders to deliver to the truck line and the needed supplies are in the factory a few hours later.

The other day a mill received an order for immediate delivery of goods to be shipped in boxes of unusual size. None was on hand. Time did not permit of ordering for rail shipment. The order for the box shooks was placed by telephone; the shooks were

the gin itself was not on a siding. Now it is not infrequent to haul the seeds by truck direct from the gin to the cottonseed oil mill, thereby avoiding extra handling delays, etc.

Furniture.—The center of the furniture industry is at High Point and is served almost entirely by rail, both as to raw materials and finished product. One exception is worthy of note. At Asheboro and Thomasville in particular (near-by towns) many split,cane-bottom chairs are made. The cane bottoms are sent out as piece work by truck to farms and residences in the neighboring sections. As the work is completed the bottoms are gathered by truck, carried back into town for assembling and rail shipment from there to market.

INFLUENCE OF HIGHWAY IMPROVEMENT ON CITIES

The smaller cities in particular have felt the impulse to growth called forth by the improving of the highways connecting them with larger and more progressive

cities. Now nearly all of them have new hotels, new business houses, municipal office buildings, paved streets, and better homes. Some of the larger cities show this growth more specifically.

Raleigh is now the trading center for 172,000 persons, 31,000 of these within the corporate limits and the balance within an area of 25 square miles. The city's population has increased from 24,418 in 1920 to 31,000 as of July 1, 1926. Building permits have increased from $862,322 in 1920 to $3,502,011 in 1925. There has been $17,000,000 worth of building in the last five years with the total assessed valuation for the city in 1926 given as $45,000,000.

The relation of highway to rail during this period is shown by a statement from Plate Collins, secretary of the Kinston Chamber of Commerce, October 23:

Volume of shipments by rail has increased 20 per cent since 1923 in spite of the fact that a big part of short-haul freight formerly handled by the railroad now goes by trucks.

THE USE OF BUSSES HAS CAUSED THE SUSPENSION OF SOME LOCAL TRAIN SERVICE BUT HAS NOT MATERIALLY AFFECTED THE NUMBER OF THROUGH PASSENGERS CARRIED BY THE RAIL LINES

The Goldsboro Chamber of Commerce estimates "increase in business 25 per cent caused more and better homes both in city and country, increase in both mercantile and factory buildings."

From William T. Ritter, secretary of the Winston-Salem Chamber of Commerce, comes the following:

Our retailers report a 65 per cent greater purchasing power per capita in our trade territory. The property valuation in our county has increased over $30,000,000 since 1921, and some $2,000,000 worth of homes are being erected by our citizens on areas located on the main highways serving this city. The outputs of our industries as well as agricultural areas have shown tremendous increases since 1921, and there is no gainsaying but that the State's highway program is responsible in no small measure for this increased prosperity.

John D. Topping reports from Asheville, one of the resort centers of the State, for the past eight months of 1926 as compared with the same period for 1925:

The dollar volume of business shows 45 per cent increase over 1925—204 per cent increase over 1919. The following figures show increases in 1926 over 1925: Bank deposits, 26 per cent; post office, 22 per cent; building permits, 42 per cent. Seven hundred residences inside the city and an equal number outside being built. Number of visitors increased 25 per cent.

The secretary of the Greensboro Chamber of Commerce, says of Greensboro that it is to-day, "the natural traveling center for 1,500 salesmen and agents because of accessibility over good roads. This and other factors have created a demand for homes and other facilities costing more than $25,000,000 as represented by the volume of building permits in the last six years. Good roads have widened our retail-trade territory to an irregular area extending from 15 to 50 miles and has put more than half a million people within one hour of the city."

All this increased consumer demand has, of course, been beneficial to rails, manufacturers and wholesalers and retailers alike. We have, however, developed new methods of distribution, particularly in the short haul.

In the eastern part of the State a distributing company operates an extensive motor-truck service in putting its staple and perishable groceries in the retail markets.

At Charlotte, N. C., a chain-stores company distributes daily from its warehouses to its retail stores in North Carolina and South Carolina. It is said that the equivalent of 6 or 7 carloads of groceries is delivered in this manner under contract with a motor-truck operating concern.

MOTOR VEHICLE REGISTRATION

The registration of passenger automobiles was 127,405 in 1920 and is to-day 338,192, an increase of 265 per cent over 1920.

The State has registered now 33,161 trucks against 13,455 in 1920, an increase over that year of 247 per cent.

On July 1, this year, these vehicles had paid registration fees for the last fiscal year amounting to $8,630,754 and $6,898,548; in gasoline taxes, a total of $15,529,302 for the fiscal year ended June 30, 1926.

The highway system of the State was built primarily to meet the demand of the passenger vehicles for a better roadbed over which to operate. With the improvement of the roads, however, there has developed an economic dollars-and-cents return in commercial motor transportation. To the individual passenger-car operator there is a return of lower operating expenses, shorter time involved in trips, etc.

Potatoes and sweet potatoes are handled by boat and highway to the rail connection and thence to market by the rail line from the eastern part of the State.

Imports totaling nearly $14,000,000 came through the port of Wilmington last year, and were distributed to Carolina markets by rail and motor.

From 4 to 5 tons of fish are hauled daily by motor truck from Morehead City and other ports to points as far inland as 200 miles. Here the movement was formerly by express so that the highway has replaced the rail in distribution of fish from this point.

At New Bern, a packet company brings in sugar which requires the services of several trucks daily to distribute throughout the State.

RELATION OF HIGHWAYS TO RAILROADS

The year-round resorts of North Carolina have attracted a tremendous number of tourist visitors from all parts of the country. Pinehurst has almost an entirely rail movement of visitors. Golf, tennis, horseback riding, motoring, and particularly our mountain air are just as much salable commodities as our cotton and tobacco.

GOLF, TENNIS, HORSEBACK RIDING, MOTORING, AND PARTICULARLY OUR MOUNTAIN AIR ARE JUST AS MUCH SALABLE COMMODITIES AS COTTON AND TOBACCO

Hotels have sprung up rapidly in all our cities and resort centers to care for these visitors and the farmers in the surrounding country are turning to truck produce to feed them.

Some local train service has been reduced, yet in a survey of passengers carried by bus over a seven-day period, parallel to a rail line with excellent through service over a distance of 90 miles, the corporation commission found that the busses carried only 234 through passengers out of a total 6,115 handled between terminals in that period.

Many of our rail connections have been circuitous and the automobile and bus were substituted immediately, the highways permitted. For example, from Charlotte to Asheville (two of the largest cities in the State) is a distance of 120 miles by an improved road completed in 1923. To reach Asheville by railroad from Charlotte one must go through the States of Georgia and North Carolina via Spartanburg, S. C., a distance of 240 miles.

Williamston and Windsor are two towns of 1,800 and 1,200 population, respectively. They are 12 miles apart and separated by the Roanoke River. Prior to the completion of a bridge and improvement of the road between them in 1922, it required 24 hours to go from one town to the other. Now, the trip is usually made in as many minutes.

Unquestionably the passenger car and improved highways have greatly stimulated the traveling habit. Many people who formerly traveled by local train now have their own cars. Many who have tasted travel in their own cars try the longer distances by rail. Unquestionably most of the rail loss of passenger business has been in local business which has gone to the private automobile. We may well give attention to the question of substituting the bus for the local passenger train. In many cases this would relieve such lines of undue burdens in providing service for the small percentage of such business remaining.

Two other cities, Moorehead City and Beaufort are just 2½ miles apart—separated by an arm of Bogue Sound, yet the shortest highway connection is 45 miles. A rail line now connects the two, but the upkeep of the trestles which must be replaced very frequently because of destruction by the sea-water pests is understood to cost more than the revenue derived from the operation. A highway bridge three-fifths of a mile long, with highway connections is now being extended from Moorehead City to Beaufort. Undoubtedly all freight and passengers could here more economically be transferred to the highway.

Comparative figures for 1922 and 1925 are available from the State corporation commission records on some phases of the rail freight business handled within the State.

Comparative figures for three important trunk lines—the Atlantic Coast Line, Southern, and Norfolk & Western—for the years 1922 and 1925 show the tonnage originated on those lines within the State. Unfortunately the information is not available in a comparative way for years prior to the highway improvement begun in 1921. If it were, it is certain the increase in tonnage originated would be even more striking.

Tonnage originated within the State

Carload of—	1922	1925
	Tons	*Tons*
Products of agriculture	543,680	603,388
Animals and products	32,035	46,640
Products of mines	501,411	698,788
Products of forests	1,683,072	1,750,710
Manufactures and miscellaneous	1,251,534	1,476,724
Total carload	4,011,732	4,576,250
Less than carload	686,145	683,406
Grand total	4,697,877	5,259,656

As will be noted the 1925 carload figures show an increase of 564,518 tons over 1922, or 14 per cent increase in carload tonnage originated in the State.

The less-than-carload situation showed a loss of less-than-carload tonnage originated by the Atlantic Coast Line, but an increase for both the Southern and Norfolk & Western, the total not quite offset, however, by the loss sustained by the Atlantic Coast Line.

Beginning with 1921 our program of highway construction involved extensive rail hauling of cement, sand, and gravel. Also a tremendous tonnage of automobiles has been handled by these rail lines not alone in North Carolina but in the entire South.

Here again it is unfortunate that the figures can not be obtained for years prior to 1921, but as they stand they are illuminating as to the increased rail tonnage from these sources. The same three railroads are used; figures are given in tons of 2,000 pounds and do not include cement tonnage.

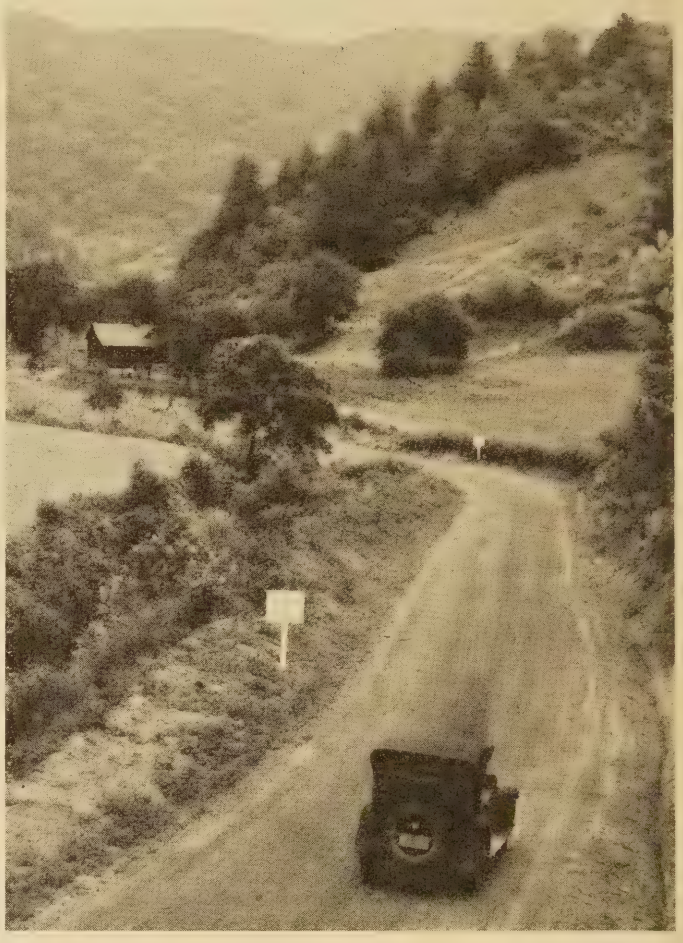
	Tonnage originated within the State		Received from connecting carriers	
	1922	1925	1922	1925
	Tons	*Tons*	*Tons*	*Tons*
Stone, gravel, and sand	451,208	667,140	1,129,147	1,466,826
Automobiles and auto trucks	1,065	16,992	42,307	100,736

The tonnage of stone, sand, and gravel originated within the State showed an increase in 1925 over 1922 of 215,932 tons or nearly 48 per cent whereas the tonnage received from connecting carriers increased nearly 30 per cent.

Tonnage of motor vehicles originated in the State is rather insignificant because so few vehicles are made there. The tonnage received from connecting carriers, however, increased 138 per cent. In both instances, although the percentage of increase is important the volume of this kind of business is the more significant item.

Movement of all kinds of freight within the State, both intrastate and interstate, is given below. The figures for only three roads were comparable for the years 1922 and 1925. Here again it is not possible to determine the percentage moving from outside points into North Carolina and from points in North Carolina to interstate destinations. The figures are in tons and are given for the Atlantic Coast Line, the Southern, and the Carolina, Clinchfield & Ohio.

	1922	1925
	Tons	*Tons*
Carload freight	20,657,105	24,861,828
Less-than-carload freight	1,635,168	1,763,373
	22,292,273	26,625,201



MANY PEOPLE WHO FORMERLY TRAVELED BY LOCAL TRAIN NOW HAVE THEIR OWN CARS. UNQUESTIONABLY THE IMPROVED ROADS HAVE STIMULATED THE TRAVELING HABIT

They cover all freight handled by these lines in the State of North Carolina, whether originating on these lines, part of interstate shipments from and to North Carolina points, or simply a trans-State movement.

ELECTRIC AND SHORT LINE RAILROADS

Just as the State reached a point of progress which attracted capital to project electric interurban lines the automobile came into prominence followed by the demand for road improvement. As a result these projects did not go beyond paper or in some instances the surveying. As a result we are to-day not faced with the problems in this respect that many States are.

Many of the branch steam lines and short-line steam railroads have served their purpose. People seem to prefer travel on the highway in their own cars and using their own trucks. It is time we recognized this and educated public opinion to the economic waste in forcing these lines to continue operations at a loss when the same public after voting to force continued operations, refuses to patronize the roads. The public must choose which type of transportation it wants and if the choice favors the highway there must be a closer coordination of rail and highway service.

(continued on p. 189.)

AN UNUSUAL CONSTRUCTION RECORD

STOP-WATCH RECORDS ON MISSOURI CONCRETE PAVING CONTRACT SHOW EFFICIENCY ABOVE 90 PER CENT

Reported by C. F. ROGERS, United States Bureau of Public Roads

During the 1925 construction season the Ross Construction Co., of Kansas City, Mo., Henry Kleifeld superintendent, completed a concrete paving job in Lafayette County, Mo., on which the standard of efficiency was so high that the results obtained deserve the acknowledgment of the widest possible publicity. One 5-bag mixer was used on this work. The batch was a standard 5-bag batch of the standard proportion of 1 : 2 : 3½. The pavement section was the standard Missouri Maricopa section with dimensions of 9 by 6 by 9 inches.

During the full construction season a little over 24 miles of pavement were laid, not quite all of it on this project. At no time was more than one mixer used, although the company had an extra mixer available which was used as stand-by equipment. The records obtained by the Bureau of Public Roads do not cover the full year's work, which was continued for something more than a month beyond the period for which the record was kept. However, the balance of the record would add little or nothing in the way of information to what is here given.

TABLE 1.—*Daily record of concrete road construction on Missouri Federal-aid project 228*

Section	Date (1925)	Hours of work	Length of pavement laid	Average length of pavement laid per hour	Weather and remarks
			Feet	*Feet*	
F	Apr. 22	5	381		Fair and warm.
	23	10	877		Cool and cloudy.
	24–25	Idle.			Rain.
	26	10	883		Fair and cool.
	27–28	Idle.			Rain.
	29	4	315		Stop, 40-mile wind.
	30	10	909		Fair and cool.
Total for month		39	3,365	86.3	
	May 1	10	1,006		Fair and warm.
	2	10	1,005		Do.
	3	10	978		Do.
	4	10	1,003		Cool and cloudy.
	5	10½	1,034		Fair and cool.
	6	10	965		Cool and cloudy.
	7	5	491		Rain in morning.
	8	5½	494		Rain in afternoon.
	9–10	Idle.			Rain.
	11	10	991		Fair and cool.
	12				Move to section E.
E	13–14	Idle.			Rain.
	15	5	392		Rain in afternoon.
	16–17	Idle.			Rain.
	18	5	434		Wet subgrade, morning.
	19	10	997		Fair and cool.
	20	11	1,104		Fair and warm.
	21	10½	1,027		Do.
	22	10	1,000		Do.
E and F	23	11	1,102		Cool and cloudy.
F	24	Idle.			Stockpile low.
	25	10½	1,072		Fair and cool.
	26	10	1,015		Fair and warm.
	27	10	968		Cool and cloudy.
	28	8½	835		Cloudy, 4.30 rain.
	29	1	46		Connecting slab.
	30 and 31				Move to section D.
Total for month		183½	17,959	97.8	
D	June 1	1	56		Cloudy, warm, rain
	2–3	Idle.			Wet subgrade.
	4	5	345		Fair and warm.
	5	10	840		Do.
	6	10	884		Fair and hot.
	7	10	894		Do.
	8	10	914		Do.
	9	10	883		Bridge approach.
	10	10	696		Do.
	11	10½	1,066		Fair and warm.
	12	5½	542		Rain in afternoon.

TABLE 1—*Daily record of concrete road construction on Missouri Federal-aid project 228*—Continued

Section	Date (1925)	Hours of work	Length of pavement laid	Average length of pavement laid per hour	Weather and remarks
			Feet	*Feet*	
D	June 13	Idle.			Wet subgrade.
	14	10	989		Fair and warm.
	15	10	952		Fair and hot.
	16–19	Idle.			Rain and wet subgrade.
	20	10	964		Fair and hot.
	21	10½	1,038		Do.
	22	4	360		Rain in afternoon.
	23	Idle.			Wet subgrade.
	24	7	654		Rain.
	25	10	1,024		Fair and cool.
	26	10½	1,040		Fair and warm.
	27	10	1,031		Do.
	28	8½	834		Do.
	29	Idle.			Rain.
	30	10½	1,027		Fair and warm.
Total for month		183	17,033	93.0	
	July 1	10	887		Fair and hot.
	2	10	953		Do.
	3	10½	1,003		Do.
	4–5	Idle.			Rain and wet subgrade.
	6	10½	1,045		Fair and warm.
D and E	7	10½	1,060		Fair and hot.
	8	10	1,012		Do.
	9	9	863		Do.
	10	10	955		Do.
	11	10	782		Bridge approach.
	12	9	846		Rain, 5 p. m.
	13	2	155		Rain, 9.30 a. m.
	14	Idle.			Wet subgrade.
	15	10	856		Heavy subgrade.
	16	10	913		Fair and warm.
	17	10	900		Do.
	18	10	979		Do.
	19	Idle.			Low water supply.
	20	1½	94		Rain, 10 a. m.
	21	5	469		Wet subgrade, morning.
	22	10½	1,060		Fair and warm.
	23	10	1,015		Do.
	24	10½	1,050		Do.
	25	9	798		Cloudy and cool.
	26	Idle.			Rain.
	27	10	932		Fair and warm.
	28	10½	1,048		Do.
E and F	29	4	335		Move to section F.
F	30	9	906		Rain.
	31	7	635		Wet subgrade, morning.
Total for month		228½	21,551	95.6	
	Aug. 1	10	972		Fair and warm.
	2	10	990		Do.
	3	5	503		Cement low.
	4	10½	1,057		Fair and warm.
	5	10½	1,088		Do.
	6	10	1,000		Do.
	7	5½	499		Rain in morning.
	8	11¼	1,151		Fair and warm.
	9	6½	614		Move to section B.
	10–13				Do.
B	14	7	400		Fair and warm.
	15	11¾	1,129		Do.
	16	10½	907		Do.
	17	Idle.			Rain.
	18	10½	980		Fair and warm.
	19	10½	989		Do.
	20–21	Idle.			Rain and wet subgrade.
B and C	22	10½	990		Fair and warm.
C	23	10½	985		Do.
	24	10½	1,071		Do.
	25	10½	1,056		Do.
	26	10½	1,023		Do.
	27	11½	1,089		Do.
	28	10¾	1,068		Do.
	29	10½	1,060		Do.
	30	9½	906		Move loader.
	31	10½	1,006		Fair and warm.
Total for month		234¾	22,533	95.9	
	Sept. 1	10½	1,002		Do.
	2	10½	998		Do.
	3	10½	988		Do.
	4	10	934		Do.
	5	10½	1,064		Do.
	6–7	Idle.			Rain and wet subgrade.
	8	9	863		Fair and warm.
	9	10¾	1,073		Do.

TABLE 1.—*Daily record of concrete road construction on Missouri Federal-aid project 228*—Continued

Section	Date (1925)	Hours of work	Length of pavement laid	Average length of pavement laid per hour	Weather and remarks
			Feet	*Feet*	
C	Sept 10	7	651		Cloudy, rain.
	11–13	Idle.			Rain.
	14	5	443		Rain, afternoon.
	15	10½	1,038		Fair and warm.
	16	11½	1,110		Do.
	17	10	978		Do.
C and D	18	10	834		Do.
Total for month		125¾	11,976	95.2	
Total		994½	94,417		
Average		94.94 feet per hour for 994½ hours.			

Table 1 shows the number of hours of work each day, the number of lineal feet of pavement laid, and the reasons for such delays as were encountered. The table also shows the total number of days of work, the total number of feet laid, and the average number of feet laid per hour for each month and for the whole period. The record of 94.94 feet laid per hour for 994 hours of operation with 42.2 batches per hour for every hour worked is the highest production that bureau representatives have ever found.

Table 2 is a stop-watch analysis of a perfect hour's operation—the only one ever encountered in a good many hundred hours of stop-watch readings on mixer operation. Table 3 gives the stop-watch readings on an ordinary hour's production; and Table 4 gives the summary of seven successive studies made on this job and indicates the efficiency maintained during ordinary operation.

TABLE 2.—*Stop-watch study of a perfect hour's operation on concrete pavement construction, Missouri Federal-aid project 228* [1]

Batch No.	Mixing time			Batch No.	Mixing time		
	Charge	Mix	Discharge		Charge	Mix	Discharge
	Minutes	*Minutes*	*Minutes*		*Minutes*	*Minutes*	*Minutes*
1	0.16	1.04	0.06	27	0.16	1.03	0.06
2	.16	1.04	.06	28	.16	1.02	.04
3	.16	1.05	.06	29	.16	1.04	.04
4	.16	1.02	.04	30	.16	1.04	.06
5	.16	1.04	.04	31	.16	1.04	.08
6	.16	1.04	.05	32	.16	1.06	.04
7	.16	1.05	.03	33	.16	1.03	.06
8	.16	1.02	.05	34	.16	1.02	.06
9	.16	1.03	.06	35	.16	1.04	.05
10	.16	1.04	.03	36	.16	1.03	.04
11	.16	1.04	.06	37	.16	1.06	.05
12	.16	1.03	.04	38	.16	1.05	.07
13	.16	1.04	.06	39	.16	1.03	.05
14	.16	1.02	.04	40	.16	1.03	.05
15	.16	1.04	.06	41	.16	1.03	.06
16	.16	1.02	.09	42	.16	1.06	.06
17	.16	1.04	.05	43	.16	1.04	.08
18	.16	1.02	.05	44	.16	1.04	.04
19	.16	1.04	.05	45	.16	1.03	.04
20	.16	1.04	.04	46	.16	1.04	.07
21	.16	1.04	.05	47	.16	1.05	.05
22	.16	1.04	.04	48	.16	1.06	.09
23	.16	1.01	.04				
24	.16	1.05	.05	Total	7.68	49.79	2.53
25	.16	1.03	.04	Average	.16	1.04	.05
26	.16	1.05	.05	Percentage	13	83	4

[1] During this hour's operation 48 batches were produced—the maximum possible number under the specifications. There was no lost time.

This record is published because it is a practical demonstration of the fact that very high efficiency can be maintained on paving work if the job is properly organized and energetically administered. It may be of interest to add that while the stop-watch studies reported in Tables 2 and 3 were taken by representatives of the Bureau of Public Roads, the use of the stop watch was not new to the superintendent of this job and the studies revealed nothing that he had not learned before the bureau's representatives arrived. The job was not only well organized but its organization was based on a thoroughgoing conception of the principles of scientific management, which have been discussed in previous articles on concrete construction work published in PUBLIC ROADS.

TABLE 3.—*Stop-watch study of an ordinary hour's operation on concrete pavement construction, Missouri Federal-aid project 228*

Batch No.	Mixing time			Lost time		
	Charge	Mix	Discharge	Mixer trouble	Truck shortage	Water-supply trouble
	Minutes	*Minutes*	*Minutes*	*Minutes*	*Minutes*	*Minutes*
1	0.16	1.03	0.10			
2	.16	1.07	.08			
3	.16	1.02	.06			
4	.16	1.05	.07			
5	.16	1.03	.08			
6	.16	1.01	.10	.08		
7	.16	1.02	.06			
8	.16	1.05	.10		.02	
9	.16	1.03	.07			
10	.16	.96	.06			
11	.16	1.01	.06			
12	.16	1.02	.06			
13	.16	1.02	.07			
14	.16	1.00	.03			
15	.16	1.04	.05			
16	.16	1.03	.06			
17	.16	1.01	.04			
18	.16	.96	.05			
19	.16	1.03	.07			
20	.16	1.04	.07			
21	.16	1.01	.06			
22	.16	1.01	.05			
23	.16	1.04	.10		1.86	
24	.16	1.05	.06			
25	.16	1.01	.06			
26	.16	.97	.05			
27	.16	1.01	.07			
28	.16	1.00	.07			
29	.16	1.03	.07			
30	.16	.96	.08			
31	.16	1.05	.10		.10	
32	.16	1.06	.04			
33	.16	1.00	.05			
34	.16	1.01	.08			
35	.16	1.03	.10		.04	
36	.16	1.02	.10		.06	
37	.16	1.05	.10			1.24
38	.16	1.06	.10			
39	.16	1.06	.08			
40	.16	1.07	.07			
41	.16	1.04	.07			
42	.16	1.06	.10	.10		
43	.16	1.04	.09			
44	.16	1.02	.06			
45	.16	1.02	.10			
Total	7.20	46.11	3.19	.18	2.08	1.24
Average	.16	1.02	.07			
Percentage	12	77	5½		3½	2

TABLE 4.—*Summary of seven stop-watch studies on Missouri Federal-aid project 228*

Study No.	Number of batches per hour	Efficiency of outfit column 2 divided by 48	Mixer time				Lost time	
			Charge	Mix	Discharge	Total	Truck delays	Water-supply trouble
		Per cent	*Seconds*	*Seconds*	*Seconds*	*Per cent*	*Seconds*	*Seconds*
1	44	91.7	9.6	62.4	3.0	92	8	
2	44	91.7	9.6	61.8	3.0	91	9	
3	45	95.8	9.6	61.2	4.2	94½	3½	2
4	44	91.7	9.6	61.8	4.2	92	8	
5	42	87.5	9.6	62.4	4.2	89½	10½	
6	48	100.0	9.6	62.4	3.0	100		
7	45	95.8	9.6	61.2	4.2	93¾	6¼	

MODERN HIGHWAY TRAFFIC AND THE PLANNING OF STATE HIGHWAY SYSTEMS

Reported by Dr. J. G. McKAY, Chief, Division of Highway Economics, United States Bureau of Public Roads

The last 15 years have seen the reemergence of highway transportation, one of the oldest methods for the movement of people and goods, from the position of comparative unimportance to which it had fallen during the period of greatest railroad development to a position of the first rank in the national scheme of transportation. Mass movement of people and commodities on the principal routes of the various State highway systems confronts us as a fact and not a theory.

The general field of motor-vehicle transportation can be divided into three major classes of service. First is the local distribution of commodities and local transportation of people. This service constitutes in tonnage the bulk of the motor-truck movement and is primarily the distribution of goods within cities and their suburban areas. In Connecticut 67.1 per cent; in Ohio 64.2 per cent; and in Pennsylvania 77.3 per cent of the net tonnage transported by motor truck is hauled less than 30 miles. Seventy per cent of the net tonnage hauled in Cook County by motor truck is a direct distribution of commodities to points of final use. In passenger transportation the principal function is also mass transportation within local areas.

The second principal class of motor-vehicle service supplements existing rail and water service by extension of freight and passenger service into areas not served by rail or water lines; substitutes motor-vehicle service for rail operation of unprofitable branch lines; and provides a combined service in conjunction with railroads or boat lines or both. The primary function of the motor vehicle in this joint movement is the movement of people or goods in the short haul.

The third class of motor-vehicle service is the so-called long-haul transportation. This type of service is not important as to quantity of movement nor would it appear to be economically sound. For motor trucks, at least, the volume of tonnage in the long-haul zone is comparatively small and decreasing in importance. In Connecticut 15.2 per cent; in Pennsylvania 6.9 per cent; and in Ohio 15.9 per cent of the net tonnage is hauled over 60 miles. Usually long-haul transportation is limited to movements in which speed of delivery or some special characteristic is the principal determining factor.

A relatively small percentage of motor trucks are engaged in the commercial transportation of freight. On the Maine highways 8.7 per cent; on the Pennsylvania highways 13.6 per cent; and on the Ohio highways 21 per cent of the loaded trucks are commercial, operating either for hire or on contract.

Analysis of motor truck transportation in the several States shows that the development of a large system of motor trucking over a considerable area beyond the short-haul is economically unsound. The movement out of cities is primarily a local process of distribution. The movement toward cities consists largely of goods produced in the area, principally food products. The volume of goods moving between two shipping points is unbalanced in the short-haul and progressively unequal with increase in distance. This fact negatives the development of long-haul motor truck transportation as a system of haulage.

The cost of providing motor-truck common-carrier service increases with increase in distance, owing primarily to the increasing terminal cost ratio to total net revenue, return movement of empty trucks, and partial loads at full rates or full loads at low rates.

The principal function of the motor vehicle as part of a correlated system of rail, water, and highway transportation, as indicated by present trends, seems to be its development in the short-haul zone with great potential possibilities of volume service in terminal areas of dense population.

The functional relationship of the motor vehicle and water transportation would appear to be the transfer of goods to and from docks and the mechanical organization of motor truck loading and unloading methods in the water shipping area to facilitate rapid loading and unloading of cargoes.

The principal service of the motor truck as a part of organized rail transportation is primarily in the rail freight transfer areas and in the short-haul movement of rail package freight. Whatever we may think of present motor vehicle operating methods, if there is a real demand for this type of service it will continue to develop. The problem lies in the intelligent organization, improvement and control of this new type of transportation. Probably the next few years will see the organization of large motor vehicle operating companies functioning as a part of existing rail and water systems or as independent operating companies. Since the haulage of goods and people can be generally safeguarded by regulatory legislation, it would seem that present rail or water lines should qualify as the responsible financial and experienced agencies of mass transportation of people and goods in this rapidly developing field of motor vehicle transportation.

Meanwhile, no matter under whose guidance the organization of motor vehicle operation is developed, there remains the present problem of intelligently planning highway systems to serve this rapidly growing method of transportation.

PLANNING THE IMPROVEMENT OF HIGHWAY SYSTEMS

There is no fundamental difference in principle between the public business of developing systems of highways, and private enterprises engaged in producing commodities or in the performance of services. For example, light and power, gas and telephone utilities and other industries are all engaged in the production of their commodities for public use. The history of their modern development and expansion is largely a development based upon a careful analysis of the demand for their product by present and potential consumers in a given area. The soundness of their analysis of the need for new service and the expansion of their plant anticipating the demand for their product has been an influential factor in the progress or lack of progress of many communities.

The same basic economic and engineering principles of management that exert such a controlling influence in the field of private business should govern the public business of production in the highway field.

Applied to the public business of a State responsible for developing a connected system of improved highways to facilitate the transportation of people and commodities, the first basic principle of production management is that the various sections of a highway system selected for improvement and the type of improvement chosen for each section should be based upon present and expected future traffic demands, modified by the various physical and economic characteristics which affect the choice of specific construction types to be built on the various sections of a State highway system.

The second principle is the familiar one of the budget upon which all financially sound industries operate. Applied to the highway business it involves; (1) the determination of the amount of money required to complete the improvement; (2) the apportionment of the cost among those who benefit from the improvement of the highways, and provision through necessary legislation for raising the required highway funds. This management must insure the expenditure of the money in accordance with a predetermined plan of improvement in which each route or section of a route is to be improved to the degree required by the traffic and to no greater or less degree. The raising of revenue is the responsibility of the State legislature, and is always the final limiting factor in any program of public works. Provision by a legislature of more than the necessary revenue is apt to encourage waste; provision of sufficient funds, well managed by the highway department, results in a well-balanced system of highway improvements and the economic development of the State as a whole; provision of insufficient improvement funds defers the true improvement of a highway system, forces the highway department to spread uneconomically its expenditures of State funds over the entire State system, usually results in the development of a highway system below the requirements of traffic, and, if continued over a period of years, increases the total ultimate cost of highway transportation.

The establishment of scientific plans for highway development, which will result in the maximum of highway improvement and highway transportation service, with available revenue, labor, equipment, and building materials, requires a careful analysis of highway traffic, the trend of its development and its distribution over the highway system. The necessity of such an analysis is now recognized by highway executives, but their efforts have been handicapped by lack of precise knowledge of the character and amount of present and expected future traffic using the various sections of the system.

The plan of State highway improvement may materially alter the economic and social development of a people as a whole or any section thereof. The location and improvement or lack of improvement of a given route is of vital importance not only to the traffic of the immediate locality but also to the traffic of larger areas. Therefore, the development of a system of highways should not be judged as miles and types of highways constructed each year but considered in terms of the movement of people and goods. The planning and construction of a connected system of highways deal in fact with the destiny of localities and States, their agriculture, their industries, the growth of suburban areas adjacent to centers of population, and the social activities of a people. This is a tremendous social responsibility and not merely a problem of physics concerning mixtures of cement, water, brick, steel, bitumens, stone aggregate, gravel, equipment, and labor into what we now term the modern road.

WHETHER TO IMPROVE AND HOW MUCH THE FIRST QUESTIONS

The major problem is not one of the particular type of materials to use, but rather whether to build or not, and how much highway service should be furnished in a given area. Upon the proper solution of these problems depend the well-being and progress of a people. Considering the improvement of highways from this point of view there can be no question concerning the necessity of developing sound plans for highway improvement over a period of years in the several States, and of providing the necessary money to carry out economically the proposed plan of improvement.

The principal classes of highway improvements are: (1) New construction, (2) stage construction, (3) reconstruction, (4) building of bridges and culverts, (5) highway and railroad grade separations, (6) widening of present highways, and (7) methods of guiding and safeguarding traffic.

Each of these classes of improvement, although more or less distinct as a class, is part of a general scheme of betterment, and especially within congested population and traffic areas the highway engineer faces the urgent need of solving all these complicated problems of highway improvement. The development of the plan as a whole, including each of the several classes of improvement, should be based largely upon present and expected future traffic and "lay-out" and condition of the existing highway system in any given area.

The first step in planning a program of highway improvement is the measurement of the present, and the prediction of the future volume and character of traffic on the State primary, secondary and tertiary systems. The principal traffic factors involved in judging the relative traffic importance of the three systems, or sections of each system, are the average daily and maximum total traffic, and the average daily and maximum truck traffic using each section. The average daily number of loaded light (one-half to 2½-ton), medium (3 to 4-ton) and heavy (5 to 7½-ton) vehicles is an important factor in the determination of the plan of improvement as well as in the selection of the types to be constructed.

The second step is the determination of the relationship between population and demands for highway service and the consideration of present density of population and population trends as an aid in the development of a plan of improvement which will most efficiently serve the traffic needs of this population.

The next step is the classification of the various highways or sections of highways as major traffic routes (class A), secondary traffic routes (class B), and minor traffic routes (class C). A class A highway is defined as one that requires one of the so-called rigid types of improvement, concrete, brick, bituminous concrete, or their equivalent. A class B highway is defined as one that requires a so-called flexible type of improvement, such as standard bituminous penetration macadam or its equivalent. A class C highway is defined as one that requires other lesser types of improvement.

The principal traffic factors involved in such a classification are:

(*a*) Average daily and maximum total traffic and truck traffic.

(*b*) Forecast of average daily total traffic and truck traffic for periods of 5 and 10 years.

(*c*) Average daily and expected future number of loaded light, medium, and heavy trucks for each route or section of route.

(*d*) The ratio of the total number loaded trucks to the total traffic in order to separate for special consideration routes or sections of routes on which motor trucks are an abnormally large or small proportion of total traffic.

(*e*) The number and frequency of critical heavy loads.

(*f*) Average maximum traffic as one measure of the width of the improvement, the necessity for improvement of additional parallel routes and the "by-passing" of congested centers of local traffic.

(*g*) Analysis of highway maintenance and capital costs and vehicle operating costs as an important factor in determining the traffic limits for the various types of improvement.

The fourth step is the measurement of motor-vehicle mileage on the primary, secondary, and tertiary highway systems, and the estimate of the earning capacity of these three systems to determine the relative vehicle-use value of each as a guide in developing the plan of improvement and the budgeting of construction and maintenance funds.

Finally, we must have a thorough analysis of the present system and the physical condition of the existing improvements on it, since the plan of betterment must, in general, incorporate the existing State highway system as the basis of the improvement plan.

SPECIAL CONSIDERATION NECESSARY FOR HIGHWAY SYSTEM ADJACENT TO CITIES

A State plan of highway improvement can be separated into two distinct planning phases.

The first is the general State plan, consisting of a connected system of primary, secondary, and tertiary routes serving each section of the State. It should be recognized that just as there is a considerable variation in the present and expected future volume of traffic on the highway systems of the different States, so there is within each State also considerable variation in the present and expected future traffic on the various sections of the primary and secondary system.

The second phase of the State plan is the special consideration necessary in areas adjacent to centers of population. The improvement plan of the State and the plan of improvement of the larger cities within it should be worked out cooperatively.

This cooperative planning is essential to the proper location and entry of State routes into congested traffic areas, to avoid dumping traffic from one or more than one State route into an already congested area, to provide for adequate connections and improvement of the city streets that join State routes at city limits, to make provision for "by-passing" congested traffic areas, to eliminate obstructions to the easy movement of traffic, and finally to provide belt, arterial, and secondary local traffic routes to facilitate the rapid, safe, and unobstructed flow of traffic in congested traffic areas.

In the final analysis the worth of a transportation survey and the resulting plan of highway improvement is measured by the actual highway construction, reconstruction and widening program which is carried into effect over a period of years.

The State highway engineer, as the executive director of the public business of providing highways, is responsible (1) for the analysis of the traffic demand for his product on the various sections of the State system; (2) for a financial analysis of the yearly cost, the revenues required, the funds available, and for the establishment of a budget for the period of the improvement program; and (3) for the business and engineering management of the improvement program.

The major limiting factor is the financial program set up by the legislative organization responsible for raising the revenue to give reality to any plan of highway improvement; and therefore a large part of the responsibility for the character and condition of a State system of highways rests upon the department of the State government responsible for the raising of highway funds and not upon the department charged with the duty of constructing the highways.

(Continued from p. 184.)

One illustration is to the point. It so happens that the writer was engaged in 1909 in building 12 miles of branch-line railroad from Carthage to Pinehurst to connect with a main line at this latter point. There was a buggy factory at Carthage as well as two or three other factories, then served by a branch line 10 miles long from one of the large trunk-line railroads.

The second line was built to compete with the first for the output of the town's factories and for the hauling to it of coal, raw material, and supplies which service incidentally afforded the town relief from high rates prevailing on the other branch line.

The town was thus situated in a general way at the apex of a triangle composed of these branch lines on two sides and the main lines on the third. Neither of these branches made much money serving as feeders to the main line and as time went on handled less and less business. The interests which had in 1911 bought the branch from Pinehurst to Carthage tore up the tracks about 1914. In his connection with the State Highway Commission 10 years later, the writer took part in building a State highway on the grade of the branch rail line he had built in 1909.

To-day the products of the buggy factory move by highway either from Carthage to the rail station at Pinehurst or over another State highway by truck to Sanford. The remaining branch line into Carthage was sold some time ago to a group of local people who wished its operations continued, but its business has declined almost to the vanishing point and it is probably only a question of time until it will be abandoned. Its business is largely in the moving of heavy, bulk freight such as coal, sand, and gravel.

Our problem in the highway field when and where called on to provide adequate highways to replace these branch lines will be the finding of means to move these heavy commodities longer distances over the highways. Other tonnage of many of these lines has either gone or is going more and more rapidly to the highways because of the generally short distances involved and the small aggregate total of such tonnage.

The data furnished might be multiplied ad infinitum but these illustrations will doubtless serve to indicate the important transportation service now rendered the State by our highway system. It serves the other transportation agencies equally as well as it serves industry, agriculture and other groups.

New fields of industry, and agriculture are being opened, and the old fields are being stimulated immeasurably by the highway. It goes without saying that all this assures to the rail carriers much business from the South and proportionate prosperity.

THE USE OF HIRING CARS AND BUSSES ON RURAL HIGHWAYS

Reported by HENRY R. TRUMBOWER, Economist, United States Bureau of Public Roads

According to the report of the Commissioner of Internal Revenue, 165,372 motor vehicles were engaged in the business of carrying passengers for hire on June 30, 1925. The internal revenue law provides that owners of automobiles for hire with a capacity of from two to seven passengers shall pay a yearly excise tax of $10 to the Federal Government, and those owning automobiles used to carry passengers for hire which have a capacity of eight and over are obliged to pay an annual tax of $20. For the year ended June 30, 1925, the Federal Government collected in this manner $1,838,079 which comprised the taxes upon 141,849 cars of small capacity, and 23,523 cars of large capacity, the latter being largely of the motor-bus type.

These figures show that 85 per cent of the passenger automobiles used for hire in the United States are small cars with a capacity of from two to seven passengers. The cars seating more than seven passengers constituted only 15 per cent of the total number of hiring cars. The taxicabs used in cities account for by far the largest number of cars of the smaller passenger capacity.

The proprietors of the cars paying this tax numbered 96,475. When this number is compared with the total number of hiring cars it is seen that the ownership averages but 1.5 cars of both types, large and small, per owner or proprietor. In spite of the fleets of taxicabs owned by one individual or by a company the average number of cars owned by an operator is less than two.

The ratio of passenger cars for hire to the total population of the country is one car for every 686 people. At the close of 1924 there were 15,460,649 passenger automobiles in the United States. For every passenger car used for hire, therefore, there were then approximately 90 passenger cars used by their owners as private cars.

The ratio of the number of hiring passenger cars to the population differs in the several States and also in the various sections of the country. In Table 1 there are shown for the various groups of States the total number of passenger cars for hire, the estimated population, and the number of persons per passenger car used for hire.

TABLE 1.—*Number of hiring cars and relation to population by groups of States*

Group of States	Total number of passenger cars for hire	Population	Number of persons per car
New England	17,840	7,883,449	442
Middle Atlantic	44,272	23,929,700	540
East North Central	30,807	23,302,538	756
West North Central	15,016	13,057,696	869
South Atlantic	17,972	15,007,396	835
East South Central	10,364	9,170,847	885
West South Central	13,195	11,068,039	840
Mountain	6,426	3,736,666	580
Pacific	9,480	6,345,595	669
Total	165,372	113,501,926	686

For these several groups of States the variation in the number of persons per car ranges from 442 in the New England States to 866 in the West North Central States, the average for the whole country being 686. At first glance it would appear as if the number of persons per car were smaller in those States where the population is most dense. That holds true for the New England and the Middle Atlantic group of States, which contain many and large cities. In such cities the number of taxicabs operated is naturally large. On the other hand, in the Mountain States the number of persons per car is 580, just slightly higher than in the Middle Atlantic States, where the ratio of persons to cars is 540. In these Mountain States this ratio is less than in any one of the other groups of States except the New England and the Middle Atlantic groups.

RATIO OF HIRING CARS TO POPULATION WIDELY DIFFERENT IN VARIOUS STATES

In the individual States a still greater variation in persons per car is found. In New Hampshire, for example, there are 218 persons for every passenger automobile used for hire; that is the lowest ratio found anywhere. The highest is found in North Dakota, where there are 1,690 persons per car. The rest of the States are found between these two extreme ratios. In Table 2 the States are classified according to the number of persons per car.

TABLE 2.—*Classification of States according to number of persons per hiring car*

NUMBER OF PERSONS PER HIRING CAR

200	300	400	500	600
New Hampshire. Vermont.	Colorado. Maine. New York. Wyoming. District of Columbia.	Florida. New Jersey. Rhode Island.	Connecticut. Maryland. Massachusetts. Nevada.	California. Illinois. Indiana. Missouri.
700	**800**	**900**	**1,000**	**1,100**
Arizona. Idaho. Kansas. Kentucky. Texas.	Alabama. Arkansas. Michigan. Oregon. Virginia. Washington.	Delaware. Iowa. Montana. New Mexico. Ohio. Oklahoma. Tennessee. West Virginia. Wisconsin.	Minnesota. Mississippi. Nebraska. Pennsylvania. South Carolina.	Louisiana. North Carolina.
1,200	**1,300**	**1,400**	**1,500**	**1,600**
Utah.	South Dakota.	Georgia.		North Dakota.

Examination of this summary discloses no particular reason for the variation in the distribution of the hiring cars. In States as widely different in density of population as New York and Wyoming and Nevada and Massachusetts, the ratio between passenger cars used for hire and population is approximately the same; New York has 396 persons per car, Wyoming has 353; Nevada has 540 persons per car and Massachusetts 555. In Georgia the ratio is 1,440 persons per car and in the adjoining State of Alabama it is only 872 persons per car. Nevertheless the density of population in these two States differs very slightly; in Alabama it is 45.8 persons per square mile and in Georgia 49.3. The density of population does not appear to be the controlling factor as to the per capita use made of passenger cars for hire. To a certain

extent it may be said that the extent to which the hiring cars are used depends upon the distribution of the population of a State between urban and rural communities. In the New England States 79.2 per cent of the population is urban; in the Middle Atlantic States the corresponding ratio is 74.9 per cent. In those two groups of States is found the smallest number of persons per passenger car used for hire. The Mountain States, however, appear to be an exception to this rule. There the urban population amounts to but 36.4 per cent of the total population while the ratio of number of persons per car is 580, the third lowest of the different groups of States. The lack of sufficient transportation facilities in this group of States may account for the relatively greater development of the transportation of passengers by common-carrier automobiles.

The proportion of small-capacity automobiles engaged in the transportation of passengers for hire also differs in the several groups of States. Table 3 shows the number and percentage relationship of the 2 to 7 passenger cars and the cars with a passenger capacity of 8 and over.

TABLE 3.—*Number of small and large capacity hiring cars by groups of States*

Group of States	2 to 7 passenger cars		8 passengers and over		Total number of hiring cars	
	Number	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*
New England	15,492	87	2,348	13	17,840	100
Middle Atlantic	38,383	86	5,889	14	44,272	100
East North Central	25,236	82	5,571	18	30,807	100
West North Central	13,161	88	1,855	12	15,016	100
South Atlantic	15,566	87	2,406	13	17,972	100
East South Central	9,547	92	817	8	10,364	100
West South Central	12,131	92	1,064	8	13,195	100
Mountain	5,206	81	1,220	19	6,426	100
Pacific	7,127	75	2,353	25	9,480	100
Total	141,849	85	23,523	15	165,372	100

The small-capacity car is found to be predominant in each of the geographic sections, the average for the country being 85 per cent. In the various groups of States it ranges from 75 per cent in the Pacific States to 92 per cent in the East and West South Central States. These relationships differ still more widely in the individual States. In the individual States the cars of large capacity range from 4 per cent of the total number in Nevada to 45 per cent in Wyoming. The States are classified in the following tabulation, Table 4, according to the ratio which the large-capacity cars bear to the total number of cars used for hire.

TABLE 4.—*Classification of States according to ratio of large-capacity hiring cars to the total number of hiring cars*

Ratio of number of large-capacity hiring cars to total number

0 to 9 per cent	10 to 19 per cent	20 to 29 per cent	30 to 39 per cent	40 to 49 per cent
Alabama.	Arizona.	California.	Michigan.	Wyoming.
Arkansas.	Colorado.	Delaware.	New Jersey.	
Georgia.	Connecticut.	Indiana.	Washington.	
Louisiana.	Florida.	Maryland.		
Maine.	Idaho.	Minnesota.		
Mississippi.	Illinois.	Ohio.		
Nebraska.	Iowa.	Oregon.		
Nevada.	Kansas.	Utah.		
New Hampshire	Kentucky.			
New Mexico.	Massachusetts.			
New York.	Missouri.			
North Dakota.	Montana.			
Oklahoma.	NorthCarolin .			
Rhode Island.	Pennsylvania.			
South Carolina.	South Dakota.			
Tennessee.	Vermont.			
Texas.	Virginia.			
West Virginia.	Wisconsin.			
	District of Columbia.			

In 12 of the States the large-capacity cars used for hire amount to over 20 per cent of the total number of cars used as common carrier passenger cars. The extent to which these large-capacity cars or busses are used depends upon the development of bus service within cities and upon the rural highways. In New Jersey, for instance, where 30 per cent of the passenger cars for hire are of the large-capacity or bus type, a very extensive motor-bus service has been developed in the urban and suburban sections of the northern part of the State where there are a number of large cities and where the population is very dense. It may be said that in that case the bus service is primarily urban and suburban. In Washington it is found that 32 per cent of all of the passenger cars for hire are of the large-capacity type and 68 per cent have a capacity of from 2 to 7 passengers. This comparatively large number of large-capacity cars is very largely due to the development of interurban bus service. In Washington that type of service is very extensive.

NUMBER OF HIRING CARS USED ON RURAL ROADS ESTIMATED

These data from the reports of the internal revenue collectors furnish no clews with respect to the use of these passenger cars for hire within cities and towns on the one hand and in interurban or suburban service on the other. From facts which have been ascertained relative to the number of motor busses operating over the rural highways of certain States it is possible to make an estimate of the number of the large-capacity cars for hire which are operated in interurban and suburban service. In seven of the States it was found that there were 823 common carrier passenger vehicles operating on regular routes over rural highways and outside of towns and cities.[1] All of these had a capacity of eight passengers and over. In these same States the internal revenue collector's reports show that there were in all 2,442 of the large-capacity cars. This would indicate that about a third of the large type of cars are used on interurban and suburban routes, the rest in service on city and town streets. According to these figures it is perhaps not far from the facts to say that approximately 8,000 of the 23,523 large-type motor cars used for hire are operating in interurban and suburban service.

A very much smaller proportion of the small type of cars, seating from one to seven passengers, is found on the rural highways. In the same seven States referred to above [2] it was found that there were only 507 small-type passenger cars engaged in common carrier service on interurban and suburban routes. The Internal Revenue collector's reports show that there were in all 12,677 of these small-type cars in the same States. It follows, therefore, that approximately 4 per cent of the small-type cars were operated over rural highways and the remaining 96 per cent or 12,170 cars were engaged in urban service. If this ratio is applied to the total of 141,849 small-type cars reported by the Internal Revenue Department it follows that about 5,670 cars of this type are in rural common carrier service.

Upon the basis of these estimates it may be said that out of a total of 165,372 passenger cars, consisting of both large and small types used for hiring purposes, about 13,670, or about 8 per cent, are operated over interurban and suburban routes.

[1] TRUMBOWER, HENRY R., THE MOTOR BUS AS A COMMON CARRIER, Public Roads, p. 213, vol. 6, No. 10, Dec. 1925.

[2] Connecticut, New Hampshire, West Virginia, Kentucky, Arizona, Washington, and Maryland.

THE PENETRATION OF WOOD PRESERVATIVES

Reported by ROBERT I. RUDOLPH United States Bureau of Public Roads

The specifications of the American Association of State Highway Officials for timber highway bridges require that the heads of the treated timber piles after having been cut to receive caps and prior to the placing of caps shall be treated to prevent decay. Two methods of treatment are specified. The first consists of three applications of a mixture composed of 60 per cent creosote oil and 40 per cent tar roofing pitch, and the second consists of three treatments with hot creosote oil after which the portion so treated is covered with hot roofing pitch. Tests have been made by the Bureau of Public Roads to determine the relative value of such treatments as to the depth of penetration into the wood.

Because of difficulty in procuring treated timber pile heads, the tests were made on wood blocks treated as specified by each of the two methods.

The wood blocks used for the purpose were approximately 6 by 6 by 12 inches in size and were made from a commercially known long-leaf, air-dried, dressed, Georgia yellow pine.

The analysis of the tar roofing pitch was as follows:

Specific gravity at 25°/25° C		1. 264
Softening point		55° C.
Bitumen soluble in CS_2	per cent	74. 86
Organic matter insoluble	do	24. 98
Inorganic matter insoluble	do	0. 16
Ductility at 25° C., centimeters		100+
Distillate up to 300° C	per cent	4. 49
Residue	do	95. 31
Water		Trace.
Specific gravity of distillate at 38°/15.5° C		1. 043

The creosote oil showed the following analysis:

Specific gravity at 38°/15.5° C		1. 062
Insoluble in benzol	per cent	. 03
Coke	do	5. 33
Water		None.
Distillate to 210° C	per cent	0. 70
210°–235° C	do	8. 66
235°–270° C	do	26. 43
270°–315° C	do	27. 39
315°–355° C	do	20. 43
Residue	do	16. 00
Specific gravity of distillate (235°–315° C.) at 38°/15.5° C		1. 028
Specific gravity of distillate (315°–355° C.) at 38°/15.5° C		1. 084
Float test of residue at 70° C	seconds	131

Mixture of 60 per cent creosote oil and 40 per cent tar roofing pitch:

Specific viscosity at 40° C	1.03

Before beginning the work it was decided to broaden the scope of the tests by treating separate groups of blocks by each of the two methods specified with cold and hot applications of preservative. Thus by the first method a group of blocks was treated with a cold mixture of creosote oil and tar and another group with a hot mixture of creosote oil and tar. By the second method one group was treated with cold creosote oil and another with hot creosote oil and the specimens of both of the latter groups were covered with hot roofing pitch. Each of the groups treated with preservative consisted of three wood blocks.

The preservative was thoroughly brushed on the end of the block and allowed to dry. The material applied hot was heated to a temperature of 70° C. The first application was fairly dry after one and one-half hours and a second treatment was given. This coat took somewhat longer to dry and the third treatment was applied at the end of three hours. It was noticeable at the time of treatment that the creosote-oil applications seemed to be absorbed more readily than the creosote-oil and tar mixture. Tar heated to a temperature of 105° C. was applied two hours after the third application of creosote oil. The tar did not adhere readily to the creosoted surface and could not be brushed on. Therefore the hot tar was poured upon the treated ends and the entire surface was covered and smoothed over by means of a hot knife.

The tops of the blocks were sawed off 2 inches below the treated ends. These tops were then split at different sections and the average distance of penetration measured. The results of these measurements are given in Table 1.

TABLE 1.—*Average penetration of preservatives applied*

Treated with creosote oil and tar mixture (cold)		Treated with creosote oil and tar mixture (hot)		Treated with creosote oil (cold), covered with tar (hot)		Treated with creosote oil (hot), covered with tar (hot)	
Block	Average penetration	Block	Average penetration	Block	Average penetration	Block	Penetration
	Inches		*Inches*		*Inches*		*Inches*
1	1/8	1	1/8	1	13/64	1	14/64
2	1/8	2	1/8	2	13/64	2	16/64
3	1/8	3	1/8	3	12/64	3	15/64
Average	1/8	Average	1/8	Average	7/32	Average	1/4

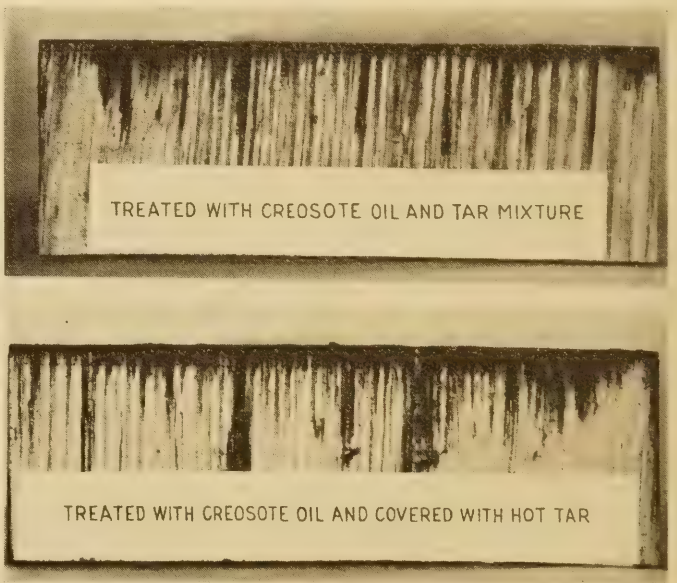


FIG. 1.—COMPARISON OF THE DEPTH OF PENETRATION OBTAINED ON REPRESENTATIVE BLOCKS BY THE TWO METHODS OF TREATMENT

Figure 1 shows the depth of penetration obtained on representative blocks by the two methods of treatment.

Nearly all of the wood blocks had a small portion of sapwood at one of the corners. The blocks treated with creosote oil, either cold or hot, showed that the creosote oil had penetrated this sapwood for a distance in excess of 2 inches. This was not so evident in the blocks treated with the mixture of creosote oil and tar.

ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS

Applicants are urgently requested to ask only for those publications in which they are particularly interested. The Department can not undertake to supply complete sets nor to send free more than one copy of any publication to any one person. The editions of some of the publications are necessarily limited, and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, this city, who has them for sale at a nominal price, under the law of January 12, 1895. Those publications in this list, the Department supply of which is exhausted, can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free.

ANNUAL REPORT

Report of the Chief of the Bureau of Public Roads, 1924.
Report of the Chief of the Bureau of Public Roads, 1925.

DEPARTMENT BULLETINS

No. 105D. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913.
*136D. Highway Bonds. 20c.
220D. Road Models.
257D. Progress Report of Experiments in Dust Prevention and Road Preservation, 1914.
*314D. Methods for the Examination of Bituminous Road Materials. 10c.
*347D. Methods for the Determination of the Physical Properties of Road-Building Rock. 10c.
*370D. The Results of Physical Tests of Road-Building Rock. 15c.
386D. Public Road Mileage and Revenues in the Middle Atlantic States, 1914.
387D. Public Road Mileage and Revenues in the Southern States, 1914.
388D. Public Road Mileage and Revenues in the New England States, 1914.
390D. Public Road Mileage and Revenues in the United States, 1914. A Summary.
407D. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1915.
*463D. Earth, Sand-Clay, and Gravel Roads. 15c.
*532D. The Expansion and Contraction of Concrete and Concrete Roads. 10c.
*537D. The Results of Physical Tests of Road-Building Rock in 1916, Including all Compression Tests. 5c.
*583D. Reports on Experimental Convict Road Camp, Fulton County, Ga. 25c.
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*670D. The Results of Physical Tests of Road-Building Rock in 1916 and 1917. 5c.
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1279D. Rural Highway Mileage, Income and Expenditures, 1921 and 1922.

DEPARTMENT CIRCULARS

No. 94C. TNT as a Blasting Explosive.
331C. Standard Specifications for Corrugated Metal Pipe Culverts.

MISCELLANEOUS CIRCULARS

No. 60M. Federal Legislation Providing for Federal Aid in Highway Construction.
*62M. Standards Governing Plans, Specifications, Contract Forms, and Estimates for Federal Aid Highway Projects. 5c.

FARMERS' BULLETINS

No. *338F. Macadam Roads. 5c.
*505F. Benefits of Improved Roads. 5c.

SEPARATE REPRINTS FROM THE YEARBOOK

No. *739Y. Federal Aid to Highways, 1917. 5c.
*849Y. Roads. 5c.
914Y. Highways and Highway Transportation.

OFFICE OF PUBLIC ROADS BULLETIN

No. *45. Data for Use in Designing Culverts and Short-span Bridges. (1913.) 15c.

OFFICE OF THE SECRETARY CIRCULARS

No. 49. Motor Vehicle Registrations and Revenues, 1914.
59. Automobile Registrations, Licenses, and Revenues in the United States, 1915.
63. State Highway Mileage and Expenditures to January 1, 1916.
*72. Width of Wagon Tires Recommended for Loads of Varying Magnitude on Earth and Gravel Roads. 5c.
73. Automobile Registrations, Licenses, and Revenues in the United States, 1916.
161. Rules and Regulations of the Secretary of Agriculture for Carrying out the Federal Highway Act and Amendments Thereto.

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH

Vol. 5, No. 17, D– 2. Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements.
Vol. 5, No. 19, D– 3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
Vol. 5, No. 20, D– 4. Apparatus for Measuring the Wear of Concrete Roads.
Vol. 5, No. 24, D– 6. A New Penetration Needle for Use in Testing Bituminous Materials.
Vol. 10, No. 5, D–12. Influence of Grading on the Value of Fine Aggregate Used in Portland Cement Concrete Road Construction.
Vol. 10, No. 7, D–13. Toughness of Bituminous Aggregates.
Vol. 11, No. 10, D–15. Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.

*Department supply exhausted.

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

STATUS OF FEDERAL AID HIGHWAY CONSTRUCTION

AS OF

SEPTEMBER 30,1926

STATES	FISCAL YEARS 1917-1926			FISCAL YEAR 1927									BALANCE OF FEDERAL AID FUND AVAILABLE FOR NEW PROJECTS	STATES
	PROJECTS COMPLETED PRIOR TO JULY 1, 1926			PROJECTS COMPLETED SINCE JUNE 30, 1926			*PROJECTS UNDER CONSTRUCTION			PROJECTS APPROVED FOR CONSTRUCTION				
	TOTAL COST	FEDERAL AID	MILES	TOTAL COST	FEDERAL AID	MILES	ESTIMATED COST	FEDERAL AID ALLOTTED	MILES	ESTIMATED COST	FEDERAL AID ALLOTTED	MILES		
Alabama	$ 18,226,411.34	$ 8,725,985.09	1,298.3	$ 1,033,288.73	$ 492,916.35	75.7	$ 5,938,997.16	$ 2,809,565.96	282.4	$ 141,817.86	$ 70,908.93	13.4	$ 2,260,078.67	Alabama
Arizona	10,949,878.25	5,863,772.35	729.8	272,263.37	172,004.74	26.7	1,480,029.04	1,018,028.97	80.9				2,563,442.94	Arizona
Arkansas	18,364,544.50	7,666,698.35	1,323.0	535,286.95	262,461.46	38.9	4,412,266.23	2,089,640.28	284.6	1,169,443.90	580,750.55	89.4	1,006,253.36	Arkansas
California	27,142,596.90	13,003,592.30	1,068.0	2,962,808.88	1,471,835.86	105.7	10,051,011.39	4,916,686.49	239.8	361,129.85	199,807.86	5.6	2,480,892.49	California
Colorado	13,905,904.64	7,127,288.18	745.0	734,611.99	398,706.82	29.1	5,521,006.50	2,666,676.46	245.7	367,491.95	199,837.34	24.3	1,933,303.20	Colorado
Connecticut	5,414,567.19	2,100,585.80	117.1	415,786.78	153,899.62	8.0	4,831,765.69	1,314,166.86	60.6	1,015,854.12	281,827.61	14.8	483,201.11	Connecticut
Delaware	4,918,052.29	1,781,665.60	124.3	672,626.55	275,874.75	17.6	769,795.50	334,016.25	17.9	243,288.10	71,705.55	8.3	10,795.85	Delaware
Florida	3,832,680.26	1,824,362.32	132.9	2,111,145.69	1,049,833.65	62.7	8,378,324.74	3,785,525.05	227.2	430,300.34	167,816.51	1.9	1,257,416.47	Florida
Georgia	24,791,206.97	11,664,237.86	1,794.0	1,998,849.78	981,417.94	129.4	11,764,126.92	5,706,114.50	536.6	31,696.14	15,848.05	7.6	64,334.65	Georgia
Idaho	11,061,198.14	5,882,112.70	724.7	559,674.29	277,975.81	18.9	2,951,067.43	1,808,258.53	195.2	599,657.75	345,287.73	60.4	245,992.23	Idaho
Illinois	44,116,611.86	20,619,995.74	1,377.7	2,012,307.84	980,960.66	68.1	9,084,347.31	4,413,190.03	328.7	909,576.93	428,978.44	30.6	3,389,073.13	Illinois
Indiana	16,949,425.87	8,172,125.19	534.3	2,408,698.84	1,135,591.61	71.0	17,470,671.26	8,223,878.57	502.5				672,759.63	Indiana
Iowa	29,062,375.40	11,926,302.10	2,114.8	1,963,084.70	911,665.80	153.3	12,986,351.76	5,744,179.50	663.2	1,719,562.61	601,968.35	76.0	301,447.25	Iowa
Kansas	32,826,601.64	12,590,489.25	1,160.6	522,940.32	235,898.35	48.9	13,455,886.18	5,236,974.47	745.6	2,925,031.07	1,027,403.41	126.0	373,645.52	Kansas
Kentucky	20,737,706.10	8,492,082.25	758.3	350,565.12	126,381.50	9.1	7,930,690.06	3,716,021.58	382.8	564,016.62	282,008.29	33.5	596,315.38	Kentucky
Louisiana	13,830,592.68	6,144,739.99	1,055.9	394,175.75	192,034.39	18.7	3,839,666.52	1,861,498.23	188.5	1,440,684.19	621,640.40	45.7	452,494.99	Louisiana
Maine	8,747,552.76	4,192,507.39	303.6	454,430.00	189,894.49	16.5	2,676,213.43	952,195.53	73.4	1,084,926.14	402,821.22	33.2	727,409.37	Maine
Maryland	10,924,943.10	5,112,991.22	423.3				1,350,356.90	641,523.57	72.2	426,154.66	170,540.72	16.2	1.49	Maryland
Massachusetts	18,353,767.71	6,657,260.82	374.5	342,513.05	87,146.25	4.5	4,939,295.15	1,356,464.15	69.2	773,451.02	199,013.17	11.9	1,808,841.81	Massachusetts
Michigan	25,997,240.78	11,827,052.30	963.0	390,946.77	188,717.04	13.6	13,675,367.82	6,227,830.93	397.4	536,564.96	190,152.69	7.8	1,908,612.04	Michigan
Minnesota	37,170,985.95	15,586,116.56	3,181.9	2,893,342.12	1,304,359.07	250.6	7,011,319.45	2,583,500.00	340.6	2,745,520.32	49,000.00	128.7	68,804.37	Minnesota
Mississippi	15,146,088.52	7,414,534.10	1,129.0	821,126.41	407,936.55	49.9	7,847,680.14	3,831,403.27	396.8	384,133.70	185,185.26	37.6	288,958.82	Mississippi
Missouri	28,989,166.92	13,736,014.85	1,543.2	5,336,817.94	2,347,472.10	160.9	15,971,990.70	6,341,521.53	433.3	342,099.68	143,422.14	5.0	218,005.38	Missouri
Montana	11,400,983.81	6,333,465.89	1,054.9	819,458.01	487,231.02	56.4	1,984,894.66	1,679,352.17	162.4	913,774.29	506,109.37	99.1	4,418,726.55	Montana
Nebraska	11,533,401.62	5,474,202.52	1,768.3	1,000,643.23	493,466.59	103.6	13,828,929.84	6,760,495.70	1,448.3	549,528.26	262,795.00	62.3	1,644,275.19	Nebraska
Nevada	7,558,195.51	5,130,934.59	538.8	1,504,547.76	1,308,267.18	145.1	2,309,406.57	1,983,504.16	266.5	78,768.60	69,095.79	11.5	303,413.28	Nevada
New Hampshire	4,992,558.60	2,377,450.07	237.6				1,536,842.84	696,021.06	44.4				96,020.87	New Hampshire
New Jersey	16,346,301.01	5,098,342.21	290.3	1,321,609.25	264,655.29	15.2	7,898,314.85	2,700,498.56	45.4	1,087,730.42	250,995.00	16.7	152,928.94	New Jersey
New Mexico	12,404,337.77	7,339,657.38	1,427.0				2,829,243.51	1,927,724.72	224.7	267,533.70	165,350.34	26.7	1,539,653.56	New Mexico
New York	43,224,279.79	17,911,957.19	1,197.0	2,054,794.43	740,976.18	45.2	37,845,123.00	10,009,870.20	633.6	7,513,300.00	1,745,447.50	98.2	3,636,943.93	New York
North Carolina	27,009,419.47	11,177,337.94	1,257.9	3,621,683.44	1,412,891.77	73.3	5,464,235.08	2,497,344.60	153.8	1,335,706.60	629,631.69	53.7		North Carolina
North Dakota	12,313,311.40	6,031,859.78	2,193.1	1,661,628.40	795,770.69	210.9	6,665,365.24	3,530,457.07	936.4	528,473.66	264,236.77	80.0	126,334.79	North Dakota
Ohio	47,699,532.90	17,371,787.03	1,364.1	1,668,165.08	712,351.45	58.8	13,236,973.61	5,137,017.18	400.9	1,719,468.32	514,710.00	32.1	1,995,930.34	Ohio
Oklahoma	28,247,950.33	13,159,999.15	1,178.9	872,674.87	425,274.55	37.0	2,658,104.70	1,107,658.72	100.9	2,396,706.25	956,809.93	145.9	410,044.65	Oklahoma
Oregon	17,027,878.42	8,593,214.79	939.2	702,784.65	403,640.92	23.7	3,018,523.75	1,635,338.95	120.6	232,363.19	139,417.91	7.4	107,734.43	Oregon
Pennsylvania	61,366,150.80	21,560,732.04	1,188.8	250,508.96	47,888.62	3.2	29,042,660.25	8,291,474.66	582.7	3,426,073.22	1,076,158.45	68.4	362,527.23	Pennsylvania
Rhode Island	3,988,616.09	1,558,829.06	86.7	274,781.19	113,520.00	7.6	1,245,917.75	326,130.00	21.8	764,687.46	209,880.00	13.9	459,209.94	Rhode Island
South Carolina	15,020,639.90	6,766,322.93	1,481.9	1,046,962.27	398,353.63	54.0	5,840,403.71	2,550,512.35	198.4	99,046.24	42,921.58	10.3	43,413.51	South Carolina
South Dakota	17,468,373.19	8,603,826.97	2,181.2	949,031.24	468,642.17	163.6	3,797,788.55	1,925,242.26	657.3	44,142.53	24,278.39		144,800.21	South Dakota
Tennessee	21,624,631.57	10,276,584.02	780.0	947,593.41	448,148.71	34.8	8,683,001.65	3,857,158.99	238.1	1,312,094.83	399,784.45	42.5	298,914.83	Tennessee
Texas	69,163,673.48	27,440,254.72	4,920.2	3,074,600.03	1,363,924.00	226.6	17,082,593.67	7,560,903.80	710.6	4,492,220.89	2,170,333.77	122.2	2,071,014.71	Texas
Utah	8,253,178.03	5,098,440.68	546.4	393,597.51	293,480.96	29.4	1,716,879.71	1,297,322.97	158.9	867,511.03	559,555.59	52.0	569,976.80	Utah
Vermont	4,242,042.64	2,017,699.51	134.5	21,059.66	10,529.83	0.1	2,248,735.41	874,948.98	42.3	41,251.89	13,104.61	0.7	352,224.07	Vermont
Virginia	21,990,249.44	10,385,728.11	1,005.5	994,947.67	453,729.25	34.5	5,943,722.43	2,556,461.06	166.7	347,790.04	27,640.23	6.4	77,955.35	Virginia
Washington	17,078,511.63	7,782,909.46	668.6	300,577.74	116,642.49	8.7	3,716,334.38	1,810,600.00	52.9	757,108.08	261,000.00	46.7	174,624.06	Washington
West Virginia	9,473,716.44	4,141,062.65	392.9	457,126.16	193,696.41	12.4	5,534,119.93	2,182,384.47	153.8	1,396,733.60	619,160.80	67.4	216,206.67	West Virginia
Wisconsin	24,856,508.19	10,392,705.73	1,592.1	101,729.42	50,664.71	9.3	8,836,656.57	4,201,185.88	391.9	352,994.47	169,917.50	13.7	2,624,341.18	Wisconsin
Wyoming	10,928,302.56	6,040,887.05	1,133.5	665,939.52	424,150.00	80.3	2,686,023.34	1,707,301.34	205.8				393,935.61	Wyoming
Hawaii							1,050,897.93	312,635.18	15.9				787,517.82	Hawaii
TOTALS	966,692,834.36	426,178,703.58	52,526.6	53,893,735.77	25,072,881.13	2,812.5	371,039,920.21	156,698,405.74	14,900.1	48,729,409.48	17,314,258.89	1,855.7	46,110,750.66	TOTALS

* Includes projects reported completed (final vouchers not yet paid) totaling: Estimated cost $ 100,781,053.83 Federal aid $ 43,398,999.98 Miles 3833.1