U.S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

Public Roads

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A SPRING-TIME ROAD NEAR DELAWARE WATER GAP

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U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

PUBLIC ROADS

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BITUMINOUS SURFACE TREATED MACADAM AND GRAVEL ROADS

By J. F. Witt, Mem. Am. Soc. C. E., Dallas, Tex.

OLD GRAVEL ROAD SURFACE TREATED WITH AN 80 PER CENT ASPHALTIC ROAD OIL. PHOTOGRAPH MADE TWO YEARS AFTER TREATMENT.

THE problems of selecting a type of surfacing for a highway, considering all the elements of amount and type of traffic, amount of money available, and the kinds of material which can be secured at various prices, has always been one of the most perplexing problems with which highway engineers have been required to deal. The vast sums which have lately been appropriated for construction all over the country have added greatly to the responsibility of engineers, and have made it more important than ever that careful consideration be given to all factors involved in selecting the surfacing material.

If it were practicable the easiest solution would be to select one of the expensive and durable types, such as brick, or concrete, or bituminous concrete, for all roads; but there are few States and fewer counties that can afford the outlay of money that would be necessary to construct all roads of these expensive materials. One of these expensive types will, of course, be decided upon for the more important heavy traffic roads, but the problem of what surface to select for the large mileage of less important roads is not so easily disposed of. To use the natural materials close at hand, such as gravel, or shell, or sand-clay, is an expedient which results in low first cost, but such materials are unsatisfactory from a traffic standpoint, and are a constant source of annoyance and expense.

THE HAPPY MEDIUM IN COST.

Having put aside the most and the least expensive materials, the only recourse is to look to the "happy medium" in cost and wearing value for a large part of

the mileage contemplated. This takes us at once to the "bituminous surface treated" roadway. Plain water-bound macadam is a failure in this country at any rate. We are told that is it successfully used in France, but in this country we have learned by costly experience that the water-bound macadam surface is no match for the automobile and the motor truck.

By treating the surface of a properly constructed water-bound macadam or gravel road with suitable bituminous material, however, the writer has found that a surface may be built up which is entirely adequate for the large mileage of roads of intermediate importance which forms a part of every State and county system. For a number of years he has constructed roads of this character in Dallas County, Tex., and the manner in which they have withstood the effects of moderately heavy traffic has convinced him that there is real merit in this type of construction.

ON WATER-BOUND MACADAM ROAD.

The macadam should be constructed according to modern specifications of sufficient depth to prevent "breaking down" of the mechanical bond under the heaviest loads contemplated. An essential factor of this requirement is a good grade of crushed stone. There is a certain but indeterminate "thrust" at the edges of the macadam surface under loading; and as the ordinary macadam has only earth shoulders to protect its edges, a weakening of the entire structure is often the result of traffic. The use of any good type of curb is usually considered to be prohibitive in cost; but a good substitute can be constructed at moderate cost by treating the outer 12 inches on each side of the macadam with bitumen applied by the "penetration method," using 1 gallon per square yard on the base course and 1 gallon per square yard on the surface course of stone. This can be done at a cost of approximately 10 cents per linear foot of road, or approximately $530 per mile. The benefits are fully worth the investment.

When the macadam surface is finished and screenings and dust have been used to fill the voids of the body of the macadam and to fill the interstices and bond the surface, a "glazed" surface usually results after the finished rolling and especially after the road has been thrown open to traffic for a few days. Some engineers specify that the bitumen shall not be applied until such time as the traffic has prepared the surface by wearing the glaze away. The writer has tried this method and found that the traffic does not wear the surface uniformly. If the treatment is applied when that part of the road used by traffic is ready, the outer edges of the macadam will still retain the glaze, while if it is delayed until the entire surface is freed from the glaze, the center, or most heavily traveled section, will have begun to ravel, thus weakening the structure.

PREPARING FOR THE BITUMEN.

It is better to keep the traffic off the roadway until after the bitumen has been applied. Before the application of the bitumen the glaze should be removed by sweeping with either wire or fiber, mechanical or hand, brooms. The job can not be properly done, however, without the use of hand brooms. A combination of the two works economically and well. But whatever method is employed the sweeping should be done with care, so that the loose flaky material and foreign matter may be removed without loosening the mechanical bond of the surface stones.

After sweeping, the surface should be flushed with water, using a pressure-flushing tank. Whether the stone surface should be damp or dry when the bitumen is applied is open to question. The writer prefers a dry surface, although in making some tests during 1917 he found the adhesion of the surface mat to damp surfaces to be as good as to those which were dry; even to wet surfaces the adhesion was very good. In the tests 12-inch square concrete blocks were used. Twelve sets of specimens were prepared, each set being made of three specimens, one wet, one damp, and one with a dry surface. Space can not be given here to record the results of the tests made but, as stated, they did not change the writer's preference for a dry surface.

APPLYING THE BITUMEN.

After the surface has dried sufficiently the bitumen should be spread in two applications by a pressure distributor and the mineral covering should be spread to a depth of approximately one-half inch, not earlier than 2 minutes, nor, if practicable, not later than 20 minutes, after the heavier bitumen is applied. There is no rolling after the bitumen is applied. The surface is completed with the application of the mineral covering and is left to the traffic to iron out.

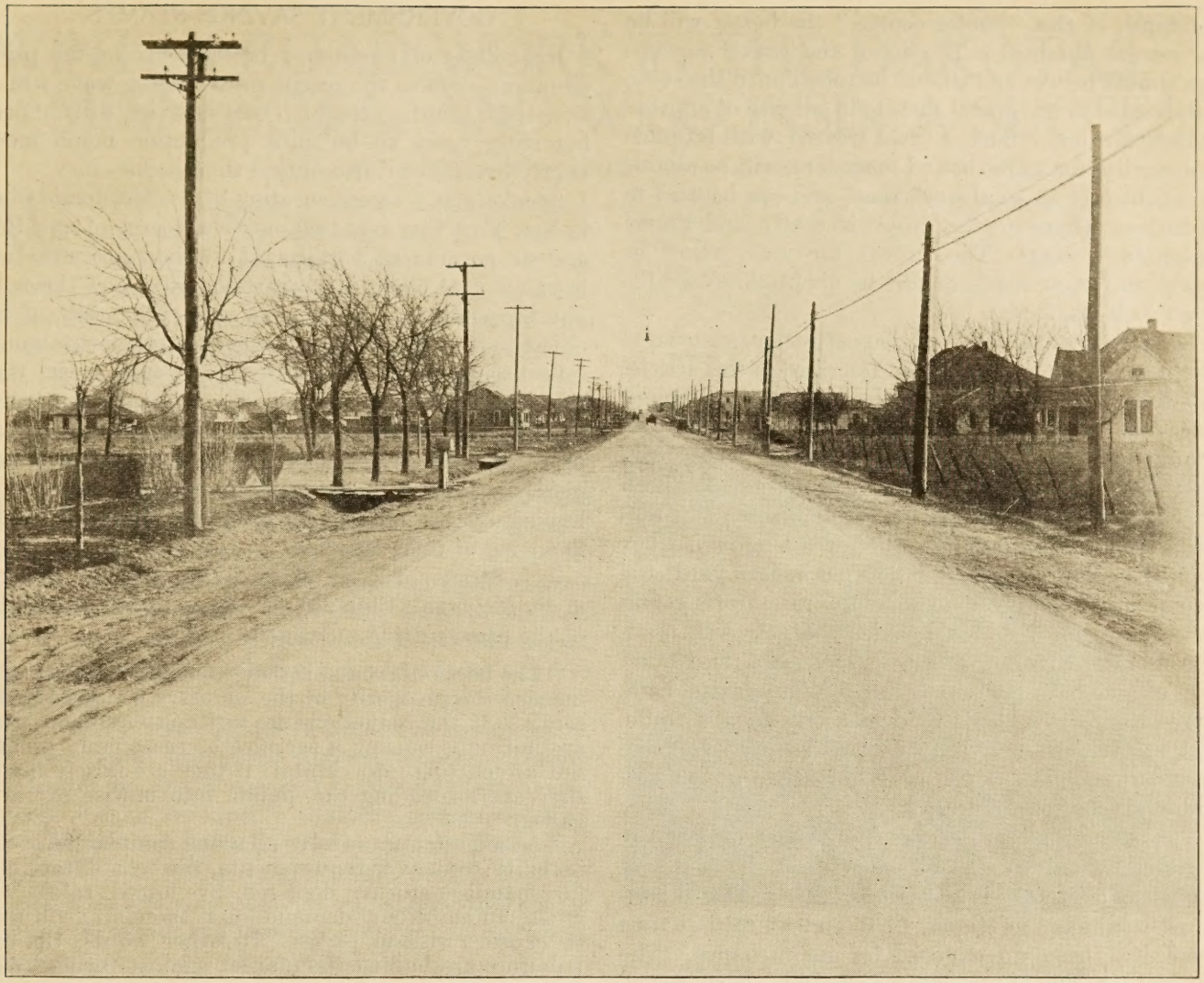
Bitumen should not be applied when the open-air temperature is below 60° F. and its consistency should be as follows:

If using asphalt: First treatment—Asphaltic road oil minimum of 55 per cent asphalt of 100 penetration. Viscosity (Engler) 50 c. c. at 60° C., 100–250 seconds. Second treatment—86 per cent asphaltic road oil. Viscosity (Engler) 50 c. c. at 100° C., 555–755 seconds.

If using coal-tar derivatives: First treatment—Specific gravity at 60° F., 1.14–1.18. Viscosity (Engler) 100 c. c. at 104° F., 125–225 seconds. Free carbon not less than 4 per cent nor more than 12 per cent. Second treatment—Specific gravity at 60° F., 1.20–1.26. Vicosity (Engler) 100 c. c. at 212° F., 125–200 seconds. Free carbon not less than 12 per cent nor more than 22 per cent.

First application of bitumen to be at the rate of 0.2 gallon per square yard.

Second application of bitumen to be at the rate of .03 gallon per square yard.



BITUMINOUS TREATED WATER-BOUND MACADAM ROAD IN TEXAS. PHOTOGRAPH TAKEN THREE YEARS AFTER CONSTRUCTION.

Using tar for the first treatment and asphalt for the second treatment produces splendid results.

The mineral covering should be graded from one-half inch in size down to dust. The run of the crusher may be used, except that dust passing a 30-mesh sieve should not exceed 15 per cent. The surface crown should be about 0.3 inch per foot.

GRAVEL WITH BITUMINOUS SURFACE.

After the first-class gravel road has had traffic sufficient to form a hard crust, the surface should be swept or water flushed until it is practically free from loose particles or foreign matter. The bitumen should then be applied in two courses in the same manner as for water-bound macadam.

Gravel should be used for covering material, and it should be clean, sharp, and well graded from 1 inch down to sand. The sand passing a No. 30 sieve should not exceed 30 per cent. A roller should be used on this covering to make sure the larger pebbles are securely bedded: after which the road should be opened to traffic.

All breaks which develop in the surface during a period of from three to five months after the road is opened to traffic should be repaired at once by a maintenance gang, equipped with a heating kettle and pouring pots; and at the end of this period the surface should be scarified for a depth of from 1 to 1½ inches.

By then disk-harrowing the scarified material, reducing it to a mealy condition, the bitumen content will be distributed uniformly throughout the depth scarified. Dress this material with the grader blader and roll it thoroughly; follow the rolling immediately with an application of one-half gallon per square yard, using the bitumen specified for "second treatment"; cover as before, with gravel, and roll, and the road is ready for traffic.

CRUSHED STONE TOP TO GRAVEL.

All this work subsequent to the first opening of the road to traffic may be avoided with splendid results, if a good quantity of crushed stone be used in sufficient amount to top the gravel with a "binder course" of stone to a depth of from 2 to 4 inches. The greater

the depth of this "binder course," the better will be the results obtained. The stone and gravel foundation should be wet and should be rolled until the stone is imbedded in the gravel surface to a depth of approximately an inch. Such a road treated with bitumen as described for water-bound macadam, will be almost as satisfactory as an all-rock road, and can be used to advantage where crushed rock is costly and gravel reasonably cheap. The crown for the gravel or gravel and rock roads should be about three-eighths of an inch per foot.

The photographs show sections of roads constructed by the writer after the manner described in this article. The first is a view of a surface-treated water-bound macadam road constructed in March, 1917. The photograph was taken in March, 1920, three years after construction, and up to that time there had been no expense for maintenance. The bituminous material used in the first application was a light coal tar, applied at the rate of 0.3 gallon per square yard; the second application was made at the rate of 0.3 gallon per square yard, and a heavier coal tar was used. The mineral covering was trap rock, of a maximum size of one-half inch and the minimum size little larger than dust. This road has withstood a traffic of 1,500 vehicles per day, of which 90 per cent have been automobiles, 5 per cent horse-drawn vehicles, and 5 per cent motor trucks.

The second picture shows the result of surface-treating an old gravel surface with an 80 per cent asphaltic road oil in November, 1918. The photograph was taken in March, 1920, and up to that time there had been no expense for maintenance. The mineral covering in this case was a clean, sharp gravel, ranging in size from 1 inch down to sand, of which there was about 40 per cent. This road has carried a traffic of 800 vehicles per day, of which 90 per cent were automobiles, 5 per cent were horse-drawn vehicles, and 5 per cent were motor-trucks.

MISSISSIPPI RIVER SCENIC ROAD.

Road District No. 1, composed of five wards in the Parish of West Feliciana, La., has voted $250,000 worth of 5 per cent, 40-year bonds, to be supplemented by United States Government aid to the amount of $200,000.

They propose to build 42 miles of standard gravel highway under the supervision of the State highway department and the United States Government, which will form a link in the great Mississippi River scenic highway from St. Paul to New Orleans.

GOVERNMENT SAVINGS STAMPS.

Regardless of temporary betterments in the price situation, such as the recent price-cutting wave which swept the country, the high cost of living will not permanently cease to be until production much more nearly overtakes consumption than it does now.

Speakers at a recent meeting of the Economic Club in New York City said that only a new orgy of spending and no permanent betterment to the price situation have resulted from the recent cut-price sales throughout the country. Were price cuts the result of increase in production, these leaders say, such cuts would reflect changed conditions which would mean that prices had taken a step toward a permanent return to lower levels. Instead of this, it was urged, the recent price cuts were caused solely by the exigencies in which merchants found themselves because of a cessation of buying by the public and questions involved in the financing of their business.

J. I. Straus, of R. H. Macy & Co., was the speaker at the Economic Club dinner who analyzed the results of the price-cutting movement.

"The horizontal cuts, if they continue, will seriously menace the prosperity of the industry concerned," he said. "If the reductions are legitimately made, they are not only causing a sacrifice of reasonable profits, but are cutting into capital; if they are falsely made, they are misleading the public into unwise extravagance.

"As manufacturers have all along complained of the inability to deliver requirements, the rehabilitation of merchandise stocks, depleted by forced sales, will create an additional demand, and, therefore, will tend to cause a rise in prices. In other words, the distributors are bulling the market against themselves."

Mr. Straus urged the decreasing of demand through voluntary self-denial and the restriction of exports by a licensing system.

Francis H. Sisson, vice president of the Guaranty Trust Co., said:

"The advantages accruing to consumers in consequence of declining prices were easily exaggerated and misunderstood. As the reductions in prices at the present are not due to overproduction," he said, "it would seem advisable to avoid a hasty conclusion that the present movement forecasts a universal and drastic drop in commodity prices."

The need, therefore, for continued saving and safe investment remains paramount. The present market prices of Liberty bonds and Victory notes, as well as the continuation of the sale of Government savings securities, offer the public the opportunity to invest their savings so as to obtain positive and assured returns.

—BUY W. S. S.—

WINTER ROAD WORK IN THE DAKOTAS, MINNESOTA, AND WISCONSIN A SUCCESS.

By E. G. Edwards, Highway Engineer, Bureau of Public Roads.

WINTER road work, consisting mainly of hauling gravel for surfacing, has been carried on for several years past in some of the counties of northern Wisconsin. The advantages obtained here are (1) the greater accessibility of the pits in winter; (2) the larger number of teams available, and (3) lengthening of the construction period.

With the ground frozen it is possible to haul across swamps and streams, as well as over sandy soils and woods roads with sleds where summer hauling with teams and wagons would be impossible. A material reduction in the length of haul is often secured and a better selection of material is possible.

The yardage which can be hauled is much greater per team, varying from 3 to 6 cubic yards to the load for one team and from 5 to 8 yards where four horses are used, the variation being due to road and weather conditions.

In farming communities it is hard to secure teams for road work during the summer months. During the winter months, however, a great many farm teams represent such an expense that the owners welcome an opportunity for putting them to work. Then, too, the contractor, or the county, where work is done by force account, is able, through carrying on this winter hauling, to retain the best men and promote efficient organization.

GRAVEL SURFACING PLACED IN WINTER, OCONTO COUNTY, WIS.

PREPARATION AND EQUIPMENT.

For good results preparation should be made in the fall for the winter's work. The pits should be stripped and approaches prepared before the ground freezes. Hauling should begin, where this is practicable, as soon as the ground freezes, using wagons until there is enough snow for sleds. Hauling should be continuous, to maintain a solid roadbed for the sleds, as where the snow is packed hard after each fall the track holds up better during the periods of thaw.

As a 7-yard load of gravel weighs something over 10 tons, a runner 3 inches wide, with a bearing length of 6 feet, or about 8 feet long, including the rise, is required. Using smaller runners on a well-maintained snow road is a mistake, as the hauling capacity of the teams is materially reduced.

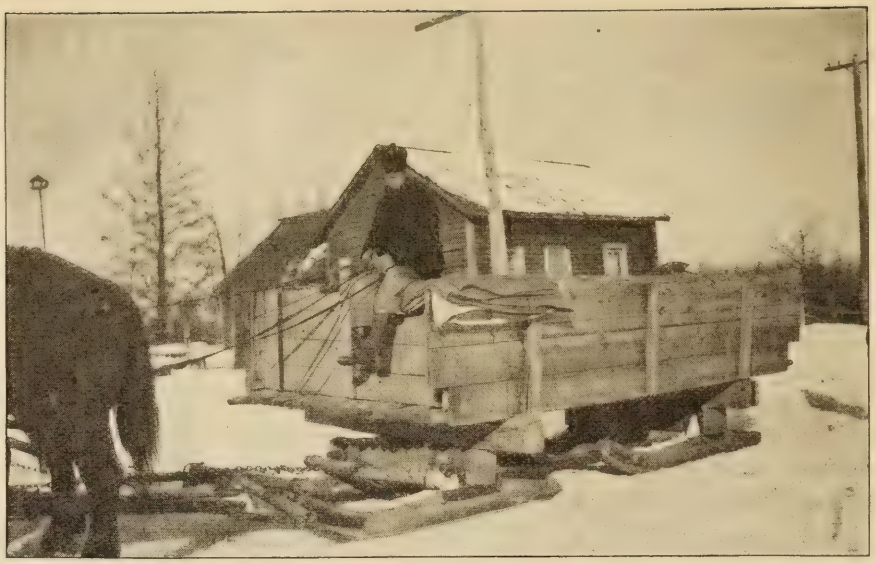
WINTER ROAD WORK IN MINNESOTA. LOADING SLEIGHS BY TRAPS ON MARSHALL COUNTY PROJECT.

Logging sleds which have been cut down from a 6 foot 8 inch to a 4 foot 6 inch gauge are commonly used. My observations lead to the belief that cutting down the gauge is a mistake. I have observed logging teams hauling 15-ton loads on 6 foot 8 inch gauge sleds with less effort than that required to haul 8 or 9 tons of gravel on similar sleds with the narrow gauge. This is accounted for by the fact that where

the wide gauge is used the track is never cut up by the horses' feet. It always gives a smooth, clean bearing on the full length of the runner, while the horses cut up the track for the sled of the narrow gauge.

Icing the track is practiced to some extent. For this purpose a tank mounted on a sled is used. A properly regulated stream of water is allowed to run from the rear of the tank into each of the tracks as the team hauls it along the road. With the 6 foot by 8 inch gauge very little renewal work is required, once the groove has been well iced.

The boxes for hauling the gravel vary from 4.5 feet to 7 feet in width and from 2 feet to 4 feet in depth, with a usual length of 12 feet. The loose planks forming the bottom are usually 3 inches thick and from 3 inches to 8 inches wide, the narrower plank being easier to manipulate in dumping. In some cases it is necessary to uncouple the sled and haul the front and rear sections out separately after dumping the gravel.



HAULING GRAVEL IN WINTER FOR ROAD WORK. LOAD OF SIX CUBIC YARDS HAULED BY TWO TEAMS 7½ MILES, OVER GRADES UP TO 6 PER CENT.

REMOVING SNOW.

Where the road has been graded the previous season, as is usually the case, the snow is cleared away by the use of a blade grader and hand shoveling, for a width about 4 feet less than the required width of surfacing. The full amount of gravel is then deposited and the gravel strip is widened and shaped to the proper cross section in the spring after the frost is out.

Where the frost goes out gradually the shoulders of the road first thaw out. The frozen road underneath the gravel thaws out more slowly and drains out through the shoulders. This leaves the road in good condition for shaping up with a road machine. In case of warm rains, coming before the road thaws out, however, the frost may be drawn from the subgrade under the gravel before the shoulders thaw out. In this case more time and labor is required to get the road into shape. The cost of shaping the gravel on the road in the spring averages about 10 cents per cubic yard.

Where the gravel is hauled before the grading is done it is stock-piled, usually at the rate of 8 to 10 piles per mile, care being taken to place the piles where the gravel will be easy of access and not interfere with the construction work. Rehandling from the stock piles to the road costs about 35 cents per cubic yard.

LOADING AT THE PIT.

Methods used for loading at the pit are practically the same as in summer. Hand loading, teams and scrapers with a trap and elevators with bins are commonly used.

The cost of loading runs from 35 cents to 45 cents per cubic yard. Spreading costs from 10 cents to 20 cents. The cost of hauling depends upon the weather to a considerable extent, as light loads must be hauled during and for a day or two after each stormy period.

The average cost where the haul is from 4 to 7 miles runs from 20 cents to 30 cents per mile per cubic yard. These prices are based on $4 per day for labor and from $7.50 to $10 per day for man and team.

At Neillsville, Clark County, Wis., disintegrated granite is taken from a quarry where some blasting is required. Here the cost of drilling, blasting, and loading is about $1 per cubic yard. The cost of an average 5-mile haul to stock piles is about $1.60 and the cost of the placing and spreading to be done later is estimated at 40 cents, making the total cost of material in the job $3 per cubic yard.

On Federal-aid project No. 20, Goodhue County, Minn., 4.5 yards were hauled on two wagons, pulled by a 6-horse team, handled by one teamster. The cost of this was 95 cents per yard for loading and hauling the first mile, and 50 cents per yard per mile for additional haul, based on $4.50 per day for labor and $3 per day for teams. During the summer it is impossible to haul more than 1.5 yards on a wagon due to sandy roads.

HEAVY TRUCKS ON FROZEN ROADWAY.

On project No. 54, Lac qui Parle County, Minn., steam shovel outfits were used to load gravel hauled by trucks of 5-yard capacity. The roads were practically clear of snow and the hauling was done both rapidly and economically over the frozen earth. It

would have been impossible to use heavy trucks on this work during the summer months, and considerable lost time would have been inevitable in using teams and wagons or light trucks.

On project No. 55, in the same county, an outfit of ten 1½-yard trucks, with pneumatic tires with an average haul of 3 miles, made a very good record. The loading was done by hand shoveling, five extra shovelers working at the pit, with the truck drivers helping to load. The drivers were paid by the yard according to the length of haul, and they averaged 20 yards per day on the average haul of 3 miles. The contract price on both these projects was 95 cents for loading and hauling the first mile, and 48 cents per mile thereafter. Both of these projects are in a heavy clay loam soil where it is practically impossible to haul loads over the dirt roads during wet weather.

In Marshall County, Minn., on a section of swamp road, the peat was used to build up the grade about 3 feet above the swamp. By the use of a disk harrow and a 10-ton roller the peat was compacted into a fairly sound roadbed, which enabled hauling by wagons in the fall before the snow came. As soon as there was enough snow the hauling was done on sleds, 3½ yards to the load, the output per team being more than doubled.

On Federal-aid project No. 12, in Minnehaha County, S. Dak., gravel was hauled by mule teams and dump wagons. Twenty teams were used in the hauling and they made six trips in a 10-hour day on a 2-mile haul. The loading was done through a trap, by teams and fresno scrapers. Extra teams were used to double up on hills between the pit and the road. This contractor had 13 Ford trucks with 1¼-yard dump bodies, which were loaded by a steam shovel and as there was very little snow during the winter of 1919–20 they gave very satisfactory service in getting the gravel onto the road.

UNLOADING 7-YARD SLEIGH LOAD OF GRAVEL, FEDERAL-AID PROJECT 85, OCONTO COUNTY, WIS.

WINTER HAULING HAS ADVANTAGES.

From the writer's observations, based on work inspected and data obtained during the winter of 1919–20, the conclusion is warranted that winter hauling of surfacing materials offers substantial advantages where conditions are favorable and when properly planned and handled.

Where the hauling can be done on sleds each team can haul at least double the quantity possible on wagons, even over roads where summer hauling on wagons is practicable.

During the summer and fall of 1919 in western Minnesota and the Dakotas, where gravel hauling on heavy trucks and with wagons of large capacity, drawn by tractors, was attempted, serious damage to the subgrade and much delay due to rainy weather invariably occurred.

On the other hand, with the subgrade once shaped and frozen solid the heavy trucks, loaded by steam shovels, were able to operate at full capacity without hindrance to traffic or damage to the road, during the entire winter.

RENCHING OUT SNOW BY ROAD MACHINE AND TEAM, KEWANEE COUNTY, WIS., FEBRUARY 28, 1920.

In many instances the contractor is barely able to finish the grading by the time for freezing up in the fall. The newly graded road, unless the gravel surfacing can be placed during the winter, is in poor condition for traffic in the spring, and the maintenance work absolutely necessary to keep the dirt grade in shape for traffic is usually much greater than is required in maintaining and reshaping the gravel surfacing while it is being compacted by the traffic.

IOWA TRIES OUT UNIQUE ROAD BUILDING EXPERIMENT.

Iowa's unique 1919 road building experiment, in which two independent individual contractor's outfits were hired with which to build the Montgomery County Federal Aid road, instead of contracting for the construction of the road with the contractors, has proven so promising in its preliminary tryout that this year five separate complete outfits have been hired and put to work in order to rush completion. The job is unique in that so far as the State, Federal, and county officials concerned know, it is the first and only one in which such a system has been tried out.

The experiment is an effort to find out under actual working conditions what it costs, under fair average conditions, to do road grading work and incidentally to have some definite and reliable basis upon which to approve or disapprove prices on such work offered by contractors at road lettings.

For a considerable time before the work was undertaken last year, bids received on road grading work ranging as high as 55½ to 60 cents per yard had been considered by the commission to be too high. When in July the low bid on the 216,000 cubic yard job of earth moving in Montgomery County was found to be 55 cents, the State and county officials decided to reject all bids and make a counter proposition to the two low contractors. The proposition was to hire their entire outfits and equipment, owners included, for a stipulated sum. The commission agreed to pay all labor hire, all bills for groceries and provisions, horse feed, and repairs to all equipment except harness. The contractors were each required to give their entire time to the management of their own outfits under constant direction of the commission resident engineer.

The work started on July 20. Good weather and good working conditions enabled the crews to make an unusually low record for the first few weeks, dirt being moved for as low an average as 30 cents. Later more difficult work was encountered. Work in the hills in the vicinity of the Nodaway River became very expensive. Sand had to be removed for long stretches and earth filled in to build up the grade. There was a great deal of grubbing, removal of trees and stumps. Over 2,500 sticks of dynamite were used. A blasting gang was kept busy during almost the entire working time. There was one 13-foot cut and one 16-foot fill. By the end of the working season the most difficult work of the entire job had been completed. Eighty thousand cubic yards of earth had been moved at a cost of $40,978.56, or an average of 52 cents per yard. The figures up to this point in a way justified the bids by the contractors of 55½ cents at the letting.

Last year there were two outfits. Each had an 18-team elevating grader outfit. Three more similar outfits have been contracted for this season, and at present the five outfits are all at work. The job was, so far as known, the first large Federal-aid job to get under way in the State this year. With the great advance in prices for labor, supplies, and food, the engineers in charge, it is feared, will have a difficult time holding the cost down to the last year's figures. However, the most expensive work has been completed. What remains is comparatively easy excavation and reasonably short hauls. With an early start with the five outfits with their hundred head of horses and mules, their 75 or 80 men, and equipment, all in good shape as a result of careful overhauling during the winter, the work will be rushed to completion just as quickly as possible. Incidentally, carrying the job over into the 1920 season will give an opportunity to find out what work is going to cost under this season's working conditions and form a reliable standard upon which to pass judgment upon 1920 grading prices. The figures obtained up to the close of work last season of 52 cents per cubic yard in a way justified the low price bid at the letting of 55½ cents. It is hoped, however, even under present conditions, to lower this average somewhat and show a substantial saving. Incidentally, it will be a matter of satisfaction to have at hand actual cost data on earth excavation and road grading on a job of such magnitude as a basis upon which to approve or disapprove bids offered by contractors at road lettings.

MARYLAND PROTECTS CONTRACTORS.

Reducing risks on highway construction has been the subject of communication between the Associated General Contractors and highway officials of the States. Replies from 40 States to a recent letter urging the insertion of a clause in their contracts protecting contractors against increase in freight rates, showed that 18 States had adopted or promised to adopt the clause and 13 have the matter under consideration. A letter from Mr. John N. Mackall, chief engineer, Maryland State Roads Commission, states that Maryland has also included the provision in highway contracts, the following clause having been added:

The bidder in naming his price for items requiring transportation of materials on common carriers, will base it on the prevailing rate of freight at the date of the opening of the bids. Should there be an increase in freight rates, the contractor will be allowed compensation for such increase.

7,565,446 MOTOR VEHICLES IN U. S.

Registrations, Licenses, and Revenues in the United States During the Calendar Year 1919.

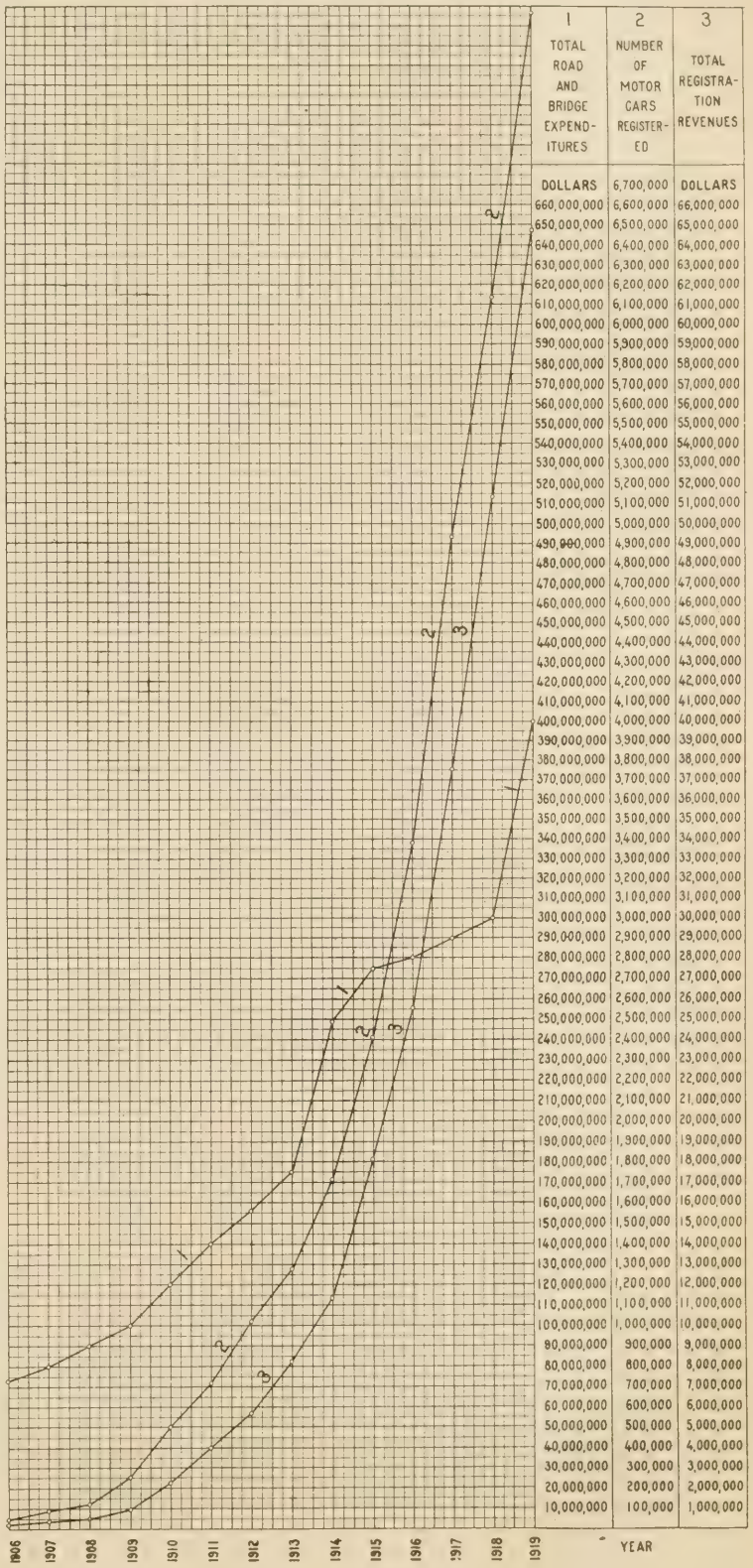
By Andrew P. Anderson, Highway Engineer, Bureau of Public Roads.

A TOTAL of 7,565,446 motor cars, including commercial vehicles, and 241,038 motor cycles were registered in 1919 in the 48 States and the District of Columbia. The registration and license fees, including those for chauffeurs, operators, and dealers, amounted to a total of $64,697,255.58.

As compared with 1918, the data for 1919 represents an increase of 23 per cent, or 1,418,829 motor cars. This increase alone represents about 10 per cent more cars than the total number registered in the United States during the calendar year 1913. In this connection it is interesting to note that the number of cars registered during 1919 in the two States of New York and Pennsylvania exceeded the total number of cars registered in the entire United States in 1912, while the revenues derived from the New York and Pennsylvania registrations during 1919 were about double those derived from all motor-vehicle registrations and licenses in the entire United States in 1912. The revenues derived from all registrations and licenses during the year 1919 exceed those of 1918 by 20 per cent, or a total of $13,219,838.97. In 1914 the total gross revenues collected amounted to only $12,381,951.

INCREASE IN A DOZEN YEARS.

The increase in motor-car registrations and revenues in the United States during the past dozen years presents many interesting comparisons. This is especially true in respect to the use made of the revenues. In 1906 the total registrations were approximately 48,000 cars, paying a gross revenue of about $193,000, or slightly more than that collected during 1919 by the State of Arizona. Furthermore, in 1906 the gross registration revenues were equivalent to less than three-tenths of 1 per cent of the total rural road and bridge expenditures for that year. In 1919 the motor-vehicle revenues represented approximately 16 per cent of the total road and bridge expenditures for the year. Furthermore, while in 1906 practcally none of the motor-vehicle revenues were applied to road maintenance and construction, in 1919 over 92 per cent of the gross returns, or $59,907,136.18, were devoted to this purpose, and of the total amount applied to road work, 70 per cent, or $42,492,604.17, was expended more or less directly under the control or supervision of the State highway departments. The remaining 8 per cent not applied to road work was expended very largely for number



plates and in carrying out the provisions of the motor-vehicle registration laws of the several States.

The approximate relations and rates of variation of the three factors, total rural road and bridge expenditures, motor-vehicle registration and license revenues, and number of motor-car registrations from 1903 to 1919, inclusive, are shown graphically on the accompanying chart.

On January 1, 1920, every State but Minnesota had made provision for some definite form of annual State registration. In Minnesota the registrations are for a period of three years, beginning January 1, 1918. Consequently, only new cars will be registered and pay a fee during 1920; the registrations made during 1918 and 1919, respectively, being effective until the close of the calendar year 1920.

USE OF MOTOR TAX FOR ROAD WORK.

For a number of years a general tendency toward devoting an ever-increasing portion of the net motor-vehicle revenues to road work under the control and direct supervision of the State highway departments has been very noticeable. Prior to 1912 only a very small portion of the motor-vehicle revenues were devoted to road work under the State highway departments, while in 1919, 66 per cent of the total motor-vehicle revenues, or $42,492,604.17, were applied to road work under the direct supervision of the State

TABLE I.—Motor Vehicle Registrations and Revenues, 1919.

State.	Automobiles.	Motor trucks and commercial vehicles.	Motorcycles.	Reregistrations or transfers.	Owners' and chauffeurs' licenses.	Manufacturers' and dealers' licenses.	Total gross motor-vehicle registration and license revenues.	Motor-vehicle revenues available for road work.		Average gross revenue return per motor car registration.	Population per motor car.	Motor cars per mile of public rural road.
								By or under State highway department.	Under direction of local authorities.			
Alabama	48,649	10,249	1,103		1,521		$541,348.70			$9.19	41	1.1
Arizona	28,979	[1]	596	1,697	484	250	164,755.68	$164,755.68		5.68	10	2.4
Arkansas	49,450	[1]		284	1,008	532	500,970.00	425,970.00		10.13	36	1.0
California	[2] 477,450	[1]	28,028	64,828	726,219	3,218	4,468,721.67	1,913,651.66	$1,913,651.66	9.36	7	7.8
Colorado	104,865	[1]	3,636	7,212	10,291	2,456	490,432.31	215,642.82	215,642.82	4.68	10	2.7
Connecticut	83,549	18,861	4,495		117,350	582	1,516,136.91	1,516,136.91		14.80	13	7.3
Delaware	16,152	[1]	699		19,725	412	286,333.00	286,333.00		17.73	13	4.4
District of Columbia	[3] 29,800	[4] 5,600	2,412		19,096	946	274,184.00			7.74	11	
Florida	48,594	6,806	1,412	1,249	2,007	430	401,317.40	[5] 294,100.00		7.24	17	3.1
Georgia	127,000	10,000	1,722	22,940	4,125	1,070	429,848.00		304,134.78	3.14	22	1.7
Idaho	42,220	[1]	731	620	906	512	729,702.94	182,425.73	547,277.21	17.28	11	1.7
Illinois	478,438	[1]	10,920	20,548	53,123	4,960	3,262,714.00	3,262,714.00		6.82	13	5.0
Indiana	227,255	[1]	8,995		6,410	1,192	1,558,740.50		1,468,281.76	6.86	13	3.1
Iowa	364,043	[1]	3,035			3,000	3,077,445.81	153,872.29	2,769,701.23	8.42	6	3.5
Kansas [9]	228,600	[1]	4,000			1,500	1,150,000.00		1,000,000.00	5.00	8	2.1
Kentucky	80,903	9,105	1,503		5,000	743	565,520.21	565,520.21		6.26	27	1.6
Louisiana	45,900	5,100	500				306,000.00		275,400.00	6.00	37	2.1
Maine	47,630	5,795	1,608	4,023	66,188	476	685,570.25	685,570.25		12.83	15	2.3
Maryland	84,828	[6] 10,806	5,872	5,583	45,764	3,360	1,776,410.22	1,277,580.31	319,395.08	18.47	15	5.8
Massachusetts	205,372	41,810	13,698	27,979	297,962	2,496	2,667,853.85	[7] 2,329,522.26		10.79	16	13.2
Michigan	288,708	37,105	7,875	28,906	448,315	967	3,719,433.39	1,694,046.76	1,694,046.76	11.41	10	4.4
Minnesota [8]	259,741	[1]	6,389	3,073	7,039	241	218,469.50	218,469.50		.84	9	2.8
Mississippi [9]	56,000	3,000	1,200				400,000.00		400,000.00	6.78	34	1.3
Missouri	244,363	[1]	4,131	14,850	23,871	2,059	1,725,076.70	1,585,155.72		7.06	14	2.5
Montana	59,324	[1]	847		1,750	429	407,848.00	368,127.33	92,031.83	6.88	9	1.5
Nebraska	185,000	15,000	2,500	700		2,700	304,450.55	228,337.92	76,112.63	1.52	7	2.5
Nevada	9,305	[1]	125			65	37,550.75	30,744.75	2,040.50	4.04	13	.8
New Hampshire	27,882	3,743	2,632	4,069	39,675	227	599,621.25	538,621.25		18.96	14	2.2
New Jersey	171,374	19,499	11,416	39,173	251,539	1,725	2,931,902.15	2,880,033.13		15.36	17	12.9
New Mexico	18,082	[1]	200			100	111,150.00	100,000.00		6.14	25	.4
New York	446,593	119,918	28,561		181,632	2,681	5,984,659.50	3,132,628.97	2,852,030.53	10.56	19	7.1
North Carolina	99,825	9,192	1,459			979	1,313,950.73	1,051,160.58		12.05	23	2.1
North Dakota	81,571	1,314	901				636,842.40	318,421.20	318,421.20	7.68	10	1.3
Ohio	511,031	[1]	20,000	13,500		4,000	2,593,000.00	2,411,490.00		5.07	10	5.9
Oklahoma	144,500	[1] [10]	1,310			1,286	1,178,130.27	1,058,859.19		8.15	17	1.3
Oregon	83,332	[1]	3,570	14,124	3,152	586	602,239.00	544,073.64		7.23	11	2.2
Pennsylvania	441,224	[11] 40,893	25,760	56,477	88,704	10,719	5,090,921.00	5,090,645.69		10.56	19	5.3
Rhode Island	36,494	8,339	2,301	5,264	49,279	246	477,223.25	428,866.77		10.64	15	20.6
South Carolina	61,143	9,000	869	1,994		1,293	389,034.68	77,806.94	311,227.74	5.55	24	1.6
South Dakota	104,628	[1]	880	1,213		1,218	322,340.50		273,989.43	3.08	7	1.1
Tennessee	80,422	[1]	1,133	5,720		456	585,181.95	62,357.10	395,712.32	7.27	29	1.7
Texas	331,310	[1]	3,889	69,911	25,618	3,272	2,624,334.29	1,053,177.59	1,294,152.53	7.92	14	2.6
Utah	30,236	5,000	1,185		1,122	203	291,325.96	275,000.00		8.27	13	4.0
Vermont	24,405	2,402	800	2,878	33,597	180	460,190.87	344,023.39	75,000.00	17.17	14	1.9
Virginia	94,100	[1]	2,520	3,000	2,600	546	900,000.00	850,000.00		9.56	24	1.8
Washington	136,500	12,275	5,050	10,838		439	2,325,323.53	2,215,323.53		15.12	12	3.5
West Virginia [12]	50,203	[1]	994	3,473	5,544	664	1,008,083.31	850,000.00	130,776.40	20.08	29	1.6
Wisconsin	225,410	10,880	7,223			1,396	2,502,852.00	1,811,438.00	603,814.00	10.59	11	3.1
Wyoming	21,371	[1]	353			194	102,114.50		81,691.60	4.78	9	1.5
Total and average	7,143,954	[13] 421,692	241,038	[13] 436,126	2,540,606	67,006	64,697,255.58	42,492,604.17	17,414,532.01	8.54	14.0	3.05

[1] Included under automobiles.
[2] Does not include 1,647 trailers, and 10,000 cars operated under exempt license.
[3] Does not include 18,300 nonresident registrations.
[4] Does not include about 2,000 nonresident registrations.
[5] Does not include 51,900 for maintenance of State Highway Department.
[6] Does not include 312 traction engines registrations.
[7] 80 per cent to State roads and 20 per cent for town roads.
[8] Registration for a 3-year period. Includes all vehicles registered first 2 years.
[9] Approximate.
[10] Does not include 2,781 traction engines registrations.
[11] Does not include 3,531 traction engines registrations.
[12] This registration period covers 18 months, July 1, 1918, to January 1, 1920.
[13] Partial total.

highway departments. The remainder, or $17,414,532.01, was expended for road work by counties or other local subdivisions with little or no direct supervision from the State highway departments.

In most States the motor-vehicle revenues are devoted to the maintenance and repair of the State roads or other improved highways. These States thus seem to have solved fairly well the difficult problem of securing funds for the maintenance of the more important roads under the ever-increasing traffic requirements. As both the traffic and the revenues increase with the number of cars, there exists a possibility of so adjusting the registration rates as to keep pace with the ever-growing maintenance changes.

A number of States having but a small mileage of improved roads have recently adopted the plan of capitalizing the motor-vehicle revenues and devoting these funds to road construction. These States are Alabama, Illinois, Maine, Minnesota, Nevada, and Utah. In these States bonds have been issued for road construction, the interest and principle of which are to be paid entirely from the motor-vehicle revenues. There seems to be no doubt that these revenues will prove sufficient for this purpose. The question which remains to be solved in these States is, what other source will yield sufficient maintenance revenues to prevent the deterioration of the roads constructed from these bond issues.

The total road mileage in the United States, outside of incorporated towns and cities, is about 2,475,000 miles. With a total registration of 7,565,446 motor cars, there was, therefore, an average of 3 motor cars for every mile of public roads in the United States. The distribution of cars in the United States, however, is

TABLE II.—Motor-car Registrations and Gross Motor-Vehicle Revenues, 1914 to 1919.

	Motor-car registration.[1]						Total gross revenues.					
	1914	1915	1916	1917	1918	1919	1914	1915	1916	1917	1918	1919
Alabama	8,672	11,634	21,636	32,873	46,171	58,898	$113,202	$180,744	$203,655	$217,700	$470,274	$541,348.70
Arizona	5,040	7,753	12,300	19,890	23,905	28,979	34,077	45,579	73,000	117,643	142,288	164,755.68
Arkansas	5,642	8,021	15,000	28,693	41,458	49,450	56,420	80,551	150,000	205,176	410,649	500,970.00
California	123,504	163,797	232,440	306,916	407,761	477,450	1,338,785	2,027,432	2,192,699	2,846,030	3,524,036	4,468,721.67
Colorado	17,756	28,894	43,296	87,460	83,244	104,865	80,047	129,801	197,795	296,808	379,559	490,432.31
Connecticut	27,786	41,121	56,048	74,645	86,067	102,410	406,623	536,970	768,728	1,080,757	1,285,164	1,516,136.91
Delaware	3,050	5,052	7,102	10,700	12,955	16,152	35,672	55,596	85,249	133,883	232,449	286,333.00
District of Columbia	4,833	8,009	13,118	15,493	30,490	35,400	20,147	29,396	47,624	55,928	220,753	274,184.00
Florida	[2] 3,368	[2] 10,850	20,718	[3] 27,000	54,186	55,400	[4] 6,736	[3] 60,000	127,176	[3] 170,000	345,775	401,317.40
Georgia	20,915	25,000	46,025	70,324	104,676	137,000	104,575	125,000	154,735	229,653	331,816	429,848.00
Idaho	3,346	7,071	12,999	24,731	32,289	42,220	58,580	121,259	213,758	412,641	576,555	729,702.94
Illinois	131,140	180,832	248,429	340,292	389,620	478,438	699,725	924,906	1,236,566	1,588,835	2,764,330	3,262,714.00
Indiana	66,500	96,915	139,065	192,194	227,160	227,255	432,303	587,318	817,285	1,096,159	1,233,128	1,558,740.50
Iowa	106,087	145,109	198,587	254,462	278,313	364,043	1,040,136	1,533,054	1,776,170	2,249,655	2,547,596	3,077,445.81
Kansas	49,374	72,520	112,122	159,343	189,163	228,600	268,471	387,588	585,762	830,878	978,837	1,150,000.00
Kentucky	11,766	19,500	31,500	47,420	65,884	90,008	85,883	117,117	184,741	287,314	402,250	565,520.21
Louisiana	[3] 12,000	11,380	17,000	28,394	40,000	51,000	[3] 12,000	75,600	112,000	166,835	240,000	306,000.00
Maine	15,700	21,545	30,972	41,499	44,572	53,425	192,542	268,412	363,562	491,696	570,171	685,570.25
Maryland	20,213	31,047	44,245	60,943	74,666	95,634	268,231	386,565	565,302	807,395	1,189,984	1,776,410.22
Massachusetts	77,246	102,633	136,809	174,274	193,497	247,182	923,961	1,235,724	1,602,958	1,969,994	2,184,821	2,667,853.85
Michigan	76,389	114,845	160,052	247,006	262,125	325,813	[4]	373,833	1,739,344	2,471,271	2,875,266	3,719,433.39
Minnesota	67,862	93,269	[5] 46,000	[6] 54,009	204,458	259,741	132,398	[3] 160,540	82,469	100,000	1,076,811	218,469.50
Mississippi	[3] 5,694	9,669	25,000	36,600	48,400	59,000	51,146	76,700	175,000	250,000	335,000	400,000.00
Missouri	54,468	76,462	103,587	147,528	188,040	244,363	235,873	323,289	439,315	617,942	1,394,762	1,725,076.70
Montana	10,200	14,540	25,105	42,749	51,053	59,324	27,000	33,120	52,768	290,936	350,914	407,848.00
Nebraska	16,385	59,000	101,200	148,101	173,374	200,000	34,325	[3] 183,000	311,334	451,303	536,897	304,450.55
Nevada	1,487	2,009	4,919	7,160	8,159	9,305	4,331	7,875	20,116	31,166	31,083	37,550.75
New Hampshire	9,571	13,449	17,508	22,267	24,817	31,625	185,288	257,776	344,434	425,305	509,335	599,621.25
New Jersey	62,961	81,848	109,414	141,918	155,519	190,873	814,536	1,062,923	1,406,806	1,923,164	2,431,757	2,931,904.15
New Mexico	3,090	5,100	8,228	14,086	17,647	18,082	19,663	29,625	47,865	80,843	105,631	111,150.00
New York	168,223	255,242	314,222	403,016	459,202	566,511	1,529,852	1,991,181	2,658,042	4,284,144	4,945,298	5,984,659.50
North Carolina	14,677	21,000	33,904	55,950	72,313	109,017	89,580	123,000	206,101	321,923	394,739	1,313,950.73
North Dakota	17,347	24,908	40,446	62,993	71,678	82,885	55,964	79,245	125,283	211,536	471,429	636,842.40
Ohio	122,504	181,332	252,431	346,772	412,775	511,031	685,457	984,622	1,286,405	1,766,427	2,125,426	2,593,000.00
Oklahoma	13,500	25,032	52,718	100,199	121,500	144,500	13,500	154,892	555,011	853,659	1,102,380	1,178,130.27
Oregon	16,447	23,585	33,917	48,632	63,324	83,332	77,592	108,881	146,232	196,787	461,422	602,239.00
Pennsylvania	112,854	160,137	230,578	325,153	394,186	482,117	1,185,039	1,665,276	2,325,057	3,268,025	4,048,186	5,090,921.00
Rhode Island	12,331	16,362	21,406	37,046	35,218	44,833	157,020	206,440	264,737	346,117	385,608	477,223.25
South Carolina	[2] 14,000	15,000	[7] 25,000	38,332	55,492	70,143	14,000	15,000	10,000	113,557	300,217	389,034.68
South Dakota	20,929	28,724	44,271	67,158	90,521	104,628	125,000	[3] 180,000	140,746	210,592	282,742	322,340.50
Tennessee	[8] 19,769	[9] 7,618	[3] 30,000	48,000	63,000	80,422	39,538	[3] 34,000	186,953	322,200	390,000	585,181.95
Texas	[2] 40,000	40,000	[7] 125,000	192,961	251,118	331,310	20,000	20,000	20,000	858,978	2,039,589	2,624,334.29
Utah	2,253	9,177	13,507	24,076	32,273	35,236	4,852	[3] 60,000	93,494	170,707	229,203	291,325.96
Vermont	8,475	11,499	15,671	21,633	22,553	26,807	154,267	218,480	297,992	363,541	398,856	460,190.87
Virginia	13,984	21,357	35,426	55,661	72,228	94,100	120,814	176,875	271,266	518,566	684,636	900,000.00
Washington	30,253	38,823	60,734	91,337	117,278	148,775	60,506	238,717	350,052	519,526	875,391	2,325,323.53
West Virginia	6,159	13,279	20,571	31,300	38,750	50,203	60,648	128,952	198,436	359,339	447,705	1,008,083.31
Wisconsin	53,161	79,741	115,645	158,637	196,253	236,200	293,580	431,977	615,721	861,278	2,076,701	2,502,852.00
Wyoming	2,428	3,976	7,125	12,523	16,200	21,371	12,140	19,880	35,625	57,421	80,000	102,114.50
Total	1,711,339	2,445,664	3,512,996	4,983,340	6,146,617	7,565,446	12,381,951	18,245,711	25,865,370	37,501,233	51,477,417	64,697,255.58

[1] Does not include motor cycles nor dealers' and manufacturers' licenses.
[2] State registrations only.
[3] Estimated.
[4] Registration law declared unconstitutional.
[5] Cars registered during 1916; total number of cars, approximately 138,000.
[6] Cars registered, 1917.
[7] Estimated number of cars in State.
[8] Total cars registered under perennial system.
[9] Registrations 1915 only.

far from uniform. Thus, New Mexico and Nevada have less than 1 car per mile of road, while Rhode Island has 21 cars, Massachusetts and New Jersey 13, and California 8 cars per mile. Furthermore, while there was an average of 1 motor car for every 14 people in the United States, in the State of Iowa there was 1 motor car for every 6 persons, in California, Nebraska, and South Dakota, 1 for every 7, and 1 for every 8 in Kansas, but only 1 car for every 41 persons in Alabama, 37 in Louisiana, 36 in Arkansas and 29 in Tennessee and West Virginia.

INCREASED FEES ON HEAVY TRUCKS.

At the beginning of 1920 there were still 12 States in which motor trucks were registered at the same rate as passenger cars. The past four or five years, however, have shown a very decided tendency toward increasing the fees required for heavy motor trucks over and above those required for passenger cars. This increase is usually based on the weight of the truck, its carrying capacity, its horsepower, or a combination of these factors. The most general practice seems to be toward definitely limiting the maximum total weight of the loaded vehicle and basing the registration fee on the carrying capacity of the truck. A few States specify no maximum load limit but provide a rapidly increasing rate per ton of load so as to discourage effectively the use of extremely heavy trucks. A number of States have also provided legislation to limit the maximum wheel load per inch of tire. It is unfortunate that the term motor truck and commercial vehicle is as yet rather indefinitely defined in the laws of a number of the States. In a few States no distinction is made between passenger and freight carrying cars, while in one State only trucks used for hire are classed as commercial vehicles.

The amount of fees collected per car for either pleasure or commercial vehicles is as yet far from uniform, and is still further complicated by the widely varying requirements for the registration or licensing of chauffeurs, owners, operators, dealers, etc. Thus, if the total gross registration and license revenues be used as a basis of revenues, and the total automobiles, trucks, and commercial vehicles as the basis for motor cars, it is found that for the entire United States the average fee per car for 1919 was $8.54. On the same basis the State of West Virginia received $20.08 per car, New Hampshire, $18.96, Maryland, $18.47, and Vermont, $17.17; while the State of Minnesota received only an average of 84 cents for each car registered within its borders, as in that State the registration is for a three-year period, the first year of which was 1918.

The States of Colorado, New Mexico, and Oregon devised an additional method of securing road revenues by levying a State tax on gasoline or other products used for the propulsion of motor vehicles. In Alabama, Delaware, Idaho, Iowa, Michigan, New York, North Dakota, Oklahoma, South Carolina, Pennsylvania, and Vermont the registration fees are in lieu of all other taxes. In other States, however, motor cars are taxed as personal property in addition to the required registration fees. Therefore, in making any comparison of fees as between the several States, this fact should be borne in mind.

TABLES FURNISH INDEX.

The registration of automobiles, motor trucks, commercial vehicles, chauffeurs and operators, dealers, and manufacturers, as well as the total gross revenues and the amount available for State road work, either by the State highway departments or under their supervision, for the year 1919, are given in Table I. The number of registrations in this table does not necessarily indicate the exact number of motor vehicles in actual use or existence in the United States, except in so far as the laws of the several States require and enforce an annual registration under these classifications. However, as all the States, with the exception of Minnesota, now require an annual State registration, these figures should furnish a very reliable index of the total number of cars in each of the several States. It is unfortunate that, during 1919, only 25 States required motor trucks and commercial vehicles to be registered in separate classes. Consequently the data in column 3 of Table I does not give a very definite index as to the total number of trucks in existence, except in those States requiring separate registration. Reference to the principal requirements for the registration of motor vehicles as given in Table IV will serve to make clear what the data in Table I actually represent.

Table II gives a compilation of the total registrations and total revenues for the years 1914 to 1919, inclusive. For further information in regard to registrations and revenues previous to 1913, the reader is referred to the graphic chart, and to Office of Public Roads Bulletin No. 48, "Repair and maintenance of highways," pages 68 to 71.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1920.

State.	Motorcycles.	Passenger cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Alabama	$3; with sidecar attachment, $5.	Less than 25 horsepower, $7.50; 25 to 29 horsepower, $12.50; 30 to 39 horsepower, $17.50; 40 horsepower and over, $20; electric cars, $12.50; steam cars, $15.	Same as passenger cars, except that those over 40 horsepower pay $25 each.[1]	Original, $5; renewal, $2.50.	None	$25 to $125.

[1] Cars used for transportation of passengers paying fare, 5 or less passenger capacity, $25; 6 to 9 passenger capacity, $40; 10 or more passenger capacity, $60; operating between towns or cities 10 miles or more apart, a flat fee of $40.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1920.—Continued.

State.	Motorcycles.	Passenger cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Arizona	$2	25 horsepower and under, $5; 26 to 40 horsepower, $10; over 40 horsepower, $15.	Same as passenger cars	Perpetual, $5.	None	1 vehicle of each class at pleasure-car rates.
Arkansas	None	All motor vehicles, $10	do	$1	do	Do.
California	$2	Electric cars, $5; all others, 40 cents per horsepower; trailers, $2.	Equipped with pneumatic tires, same as passenger cars; others pay additional; less than 2 tons unloaded, $5; 2 to 3 tons, $10; 3 to 5 tons, $15; over 5 tons, $20.	Original, $2; renewal, $1.	No fee	Regular rates for each set of plates.
Colorado	Same rate as passenger cars.	One-half of 1 per cent of cost price; minimum fee, $5.	1 ton, $10; 2 tons, $17.50; 3 tons, $25; 4 tons, $37.50; 5 tons, $50, and $25 per ton for each additional ton, carrying capacity.	$2	None	$20; additional tags, $2.50 per set.
Connecticut	$2	50 cents per horsepower	½ ton or less, $11; 1 ton, $15, and increasing to $200 for 8 tons, and $100 per ton for each ton additional.	License, $2; examination, $2.	License, $2; examination, $2.	$50 for 5 pair of plates, additional plates, $10 per pair.[1]
Delaware	$5	$2 each 500 pounds gross weight of car and load; passengers figured at 125 pounds each.	Same as passenger cars	$3	$3; family, $8.	$20 for 2 pairs of tags; extra tags, $10 per pair.
District of Columbia.	$2	24 horsepower or less, $3; 25 to 30 horsepower, $5; over 30 horsepower, $10.	do	$2	$2	Regular rates for each car demonstrated on public roads.
Florida [2]	$2	22 horsepower or less, $5; 23 to 27 horsepower, $8; 28 to 35 horsepower, $12; above 35 horsepower, $15; any car seating more than 9 persons, $100.	1 ton or less, $10; 1 to 2 tons, $25; 2 to 4 tons, $50; more than 4 tons, $100. Trailers over 500 pounds capacity same rate as trucks.	$2	None	5 cars, $15.
Georgia	$5	Not exceeding 23 horsepower, $11.25; over 23 horsepower 60 cents per horsepower.	Not exceeding 1 ton capacity, $15; others, $15 plus $7.50 for each ½ ton over 1 ton; 4 tons, $75; 5 tons, $150; 6 tons, $375; 7 tons, $1,125.	$2	do	$50 for 5 number plates.
Idaho	$5	All weighing less than 2,001 pounds, $15; 2,001 to 3,000 pounds, $20; 3,001 to 4,000 pounds, $30; over 4,000 pounds, $40.	Same as passenger cars	$2	do	$35 for one make and $25 each additional make.
Illinois [3]	$1	25 hoursepower or less, $8; 26 to 35 horsepower, $12; 36 to 50 horsepower, $20; over 50 horsepower, $25; electric cars, $12.	Total loaded weight, 5,000 pounds or less, $12; 5,000 to 12,000 pounds, $22.50; 12,000 to 15,000 pounds, $35; over 15,000 pounds, $60.	Original, $5; renewal, $3.	do	$12 for 2 plates and $12 for each pair duplicates.
Indiana	$2	Electric cars, $5; others, 25 horsepower or less, $5; 26 to 40 horsepower, $8; 41 to 50 horsepower, $15; over 50 horsepower, $20.	Less than ¾ ton, $6; 1 ton, $8; 1 to 2 tons, $10; 2 to 3½ tons, $20; 3½ to 5 tons, $30; 5 to 7½ tons, $40; over 7½ tons, $50.	$2	do	$25; duplicate plates, $1 each.
Iowa	$5	One per cent of values of car plus 40 cents per 100 pounds of weight of vehicle. Minimum fee, $10.	With pneumatic tires—1 ton capacity or less, $15; 1½ tons, $22.50; 2 tons, $30; 2½ tons, $45; 3 tons, $65; 3½ tons, $90; 4 tons, $105; 4½ tons, $120; 5 tons, $135; 6 tons, $165. With solid rubber tires—less than 2-ton capacity, same as above, 2½ tons, $55; 3 tons, $75; 3½ tons, $100; 4 tons, $115; 4½ tons, $130; 5 tons $145; 6 tons, $175; trailers, $10 to $70.	$2	do	$25.
Kansas	$2	All cars, $5 each	Same as passenger cars	None	do	$15 for 3 sets of tags; extra tags, 50 cents each.
Kentucky	$5	Less than 25 horsepower, $6; 25 to 50 horsepower, $11; 50 horsepower and over, $20.	½ ton or less, $11; 1 ton, $15; and increasing to $75 for 5 tons, and $50 per ton for each ton additional.	Original, $2; renewal, $1.	do	1 registration for each class at regular rates.
Louisiana	$2	25 cents per horsepower, with a minimum fee of $5 per car.	All motor trucks, $7.50 each	None	do	1 regular registration for each make; second-hand dealers, $10.
Maine	$3	15 horsepower or less, $5; 16 to 35 horsepower, $10; over 35 horsepower, $15.	$10 per ton capacity for cars to 5-ton capacity, then $15 per ton for each ton above 5-ton capacity.	$2	$2	$25 for 5 pairs of plates; extra plates, 75 cents each.
Maryland	$5; with side car, $8.	60 cents per horsepower; minimum charge, $10; $1.20 per horsepower if operated for hire.	With solid tires to 3-ton capacity, $20 per ton; 4-ton, $100; 5-ton, $150; 6-ton, $300; 7-ton, $500; electrics, one-half of above rates; trailers to 1-ton capacity, $10; others, $20 per ton.	$3	$2	$25 for 2 sets of tags and $12 for each additional set. For dealers in motorcycles, 4 tags, $20; additional tags, $5 each.
Massachusetts	$2	Under 20 horsepower, $5; 20 to 29 horsepower, $10; 30 to 39 horsepower, $15; 40 to 49 horsepower, $20; 50 horsepower and over, $25.	$10 for each ton capacity or fraction thereof.	Original, $2; renewal, $1; examination, $2.	Original, $2; renewal, $1.	$10, motor cycles; $25, motor vehicles, and $5 additional for each car over 5 operated on public roads.
Michigan	([4])	Electric cars, $1 for each motor horsepower plus 35 cents for each 100 pounds of weight; others, 25 cents per horsepower plus 35 cents for each 100 pounds of weight.	Same rates as passenger cars. Trailers, 50 cents for each 100 pounds of weight.	$2	$0.50	$30 for 3 cars and $10 for each additional car.[5]
Minnesota	$2	All cars, $2 for year 1920	Same as passenger cars	Original, $1.50; renewal, $1.	None	$20; extra plates, $1 per set.
Mississippi	State, $2; county, $2.	State, $2; county, electric cars, $4.80; others, 24 cents per horsepower.	4,400 pounds capacity or less, $6.40; over 4,400 pounds, $12.80.	None	do	Regular rates for 4 sets of plates.

[1] In case of manufacturers, $25, plus $1 for each car tested on public roads.
[2] Any county or municipality may charge an additional license tax, not to exceed 50 per cent of State license tax, on motor vehicles used for hire.
[3] Both cars and trucks may be registered in municipality in which owner resides.
[4] Same rate as passenger cars.
[5] In case of manufacturers, motorcycles $20, including 10 number plates.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1920—Continued.

State.	Motorcycles.	Passenger cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Missouri	(a)	Less than 12 horsepower, $4; 12 to 23 horsepower, $6; 24 to 35 horsepower, $10; 36 to 47 horsepower, $14; 48 to 59 horsepower, $16; 60 to 71 horsepower, $20; 72 horsepower and over, $24.	Same as passenger cars	$1.50	None	$10; for each duplicate, $5.
Montana	$5	23 horsepower or less, $5; 24 to 50 horsepower, $10; over 50 horsepower, $15.	One-ton capacity or less, $5; over 1 ton and less than 2, $15; over 2 tons and less than 3, $25; over 3 tons, $40.	$2	do	Cars, $50; motor cycles, $15.
Nebraska	$5	$10, plus 50 cents for each 100 pounds car weighs over 2,000 pounds.	$10, plus 50 cents for each 100 pounds total weight of loaded car exceeds 2,000 pounds.	None	do	Registration for each class.
Nevada	(a)	35 cents for each 100 pounds of total weight of loaded car.	Same as passenger cars.	do	do	$20 for 4 number plates; $1 for each duplicate.
New Hampshire	$2	15 horsepower or less, $10; 16 to 30 horsepower, $15; 31 to 40 horsepower, $20; 41 to 50 horsepower, $25; 51 to 60 horsepower, $30; over 60 horsepower, $40.	do	Original, $5; renewal, $1.	Original, $3; renewal, $1.	Cars, $50; motor cycles, $5.
New Jersey	$2	10 horsepower or less, $4.50; 11 to 29 horsepower, $7.50; 30 horsepower or over, $15.	With solid tires loaded weight ½ ton or less, $6, and $3 additional for each one-half ton gross weight to 2 tons; then $4 for each additional ton; trailers, $3.	$3	$3	$5 per car not to exceed 5.
New Mexico	$3	40 cents per horsepower	50 cents per horsepower	None	None	$25, additional tags $5 each.
New York	$2.50	25 cents per horsepower plus 40 cents per $100 of list price.	Gross loaded weight 2 tons or less, $10, and $5 each additional ton to 14; 14 tons, $70, and $10 each additional ton.	Original, $5; renewal, $2.	Original, $2; renewal, $1.	$15, plus $5 for each duplicate set.
North Carolina	$5	26 horsepower or less, $10; 26 to 30 horsepower, $15; over 30 horsepower, $20.	One ton capacity or less, $12.50; 1 to 2 tons, $25; 2 to 3 tons, $40; 3 to 4 tons, $65; 4 to 5½ tons, $100. Trailers, 1 ton capacity, $10, plus $20 for each additional ton.	None	None	$25, plus $5 for each duplicate pair of plates.
North Dakota	$3	10 cents per horsepower, plus 5 mills per dollar of selling price and 20 cents per 100 pounds net weight of car. Minimum fee, $5. Electric cars, $2.	Same as passenger cars, plus following fee for capacity rating: To 3 tons, $3 per ton; to 4 tons, $5 per ton; over 4 tons, $10 per ton. Trailers, ¼ truck fee.	do	do	Dealer pays regular fee and transfers tags to purchaser.
Ohio	$2.50	25 horsepower or less, $8; 25 to 35 horsepower, $12; over 35 horsepower, $20.	Same as passenger cars, plus 20 cents for each 100 pounds of total loaded weight.	$3	do	Regular rates for each class. Extra plates, $2 per pair.
Oklahoma	(a)	50 cents per horsepower first year; second, 40 cents per horsepower; third, 30 cents per horsepower; and thereafter 20 cents per horsepower.	Same as passenger cars	None	do	$15 for 2 tags and $1 each for additional tags.
Oregon	$6	Electric cars, $18; others, 23 horsepower and less, $15; 23 to 26 horsepower, $22; 26 to 30 horsepower, $28; 30 to 36 horsepower, $36; 36 to 40 horsepower, $48; over 40 horsepower, $56.	Electric trucks, $30; others, 1½ to 2 tons, $32, and $12 for each additional one-half ton up to 5 tons; over 5 tons allowed only on special permits.	$4	do	$30 for 2 tags and $5 for duplicate sets.
Pennsylvania	$3	40 cents per horsepower	Less than 1 ton weight same as passenger cars; others, 1 to 1½ tons, $20; 1½ to 2¼ tons, $25; 2¼ to 3 tons, $30; 3 to 3½ tons, $50; 3½ to 4 tons, $75; 4 to 5 tons, $100; over 5 tons, $150. With metal tires double above rates. Trailers, $2 to $15.	$2	No fee	$10.
Rhode Island	$2	15 horsepower or less, $5; 16 to 30 horsepower, $10; 31 to 40 horsepower, $15; over 40 horsepower, $25.	Carrying capacity 1 ton or less, $7, with $3 additional for each ton to 4 tons, and then $4 for each ton above 4 tons; over 9-ton capacity, $40 each; trailers, $10 to $30 each.	$1	$1	$25 for 5 vehicles and $5 for each additional vehicle.
South Carolina	(a)	25 cents per horsepower	Same as pleasure cars	None	None	$15 for each make.
South Dakota	$3	All cars $6 each	Capacity 2 ton or less, $6; 2 to 3½ tons, $10; 3½ to 5 tons, $15.	do	do	$25 for 6 plates, duplicates $3 each.
Tennessee	(a)	50 cents per horsepower	50 cents per horsepower, plus $5 per ton carrying capacity.	do	do	$25.
Texas	$3	35 cents per horsepower	Capacity 1 ton or less, same as passenger cars; others, 1 to 2 tons, $16; 2 to 3 tons, $32; 3 to 4 tons, $48; 4 to 5 tons, $80; above 5 tons, $100 for additional ½ ton. County license also required.	$3	do	$15; extra numbers, $5 each.
Utah	$3	Electric cars, $10; others, 25 horsepower and less, $5; 26 to 40 horsepower, $10; above 40 horsepower, $15.	Total loaded weight 1 ton or less, $10; 1 to 2 tons, $15; over 2 tons, $7.50 per ton. With pneumatic tires two-thirds and with metal tires double above rates.	$2	do	$25, and $2 for each set of duplicate plates.
Vermont	(a)	First registration, $1 per horsepower; second, 75 cents per horsepower; third registration and thereafter, 50 cents per horsepower.	Less than 3-ton capacity, $20 per ton; 3 tons and over, $25 per ton.	$3; examination, $2.	$2	$50.
Virginia	60 cents per horsepower; minimum, $5.	60 cents per horsepower; minimum fee, $10.	$15 for first ton capacity, plus $5 for each ½ ton additional capacity. Trailers, $10 first ton capacity, plus $3 for each ½ ton additional.	$5	None	$50 for 3 sets of plates; additional sets, $15 each.

[a] Same rate as passenger cars.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1920—Continued.

State.	Motorcycles.	Passenger cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Washington	$6	$10, plus 60 cents for each 100 pounds car weighs over 1,500 pounds.	$10, plus 40 cents for each 100 pounds that total loaded weight exceeds 1,500 pounds, unless empty truck weight exceeds 6,500 pounds, then 50 cents per 100 pounds. Trailers same rates.	None	None	Cars, $50; extra plates, $10 per pair; motor cycles, $10.
West Virginia	$5	Cars weighing 1 ton or less, $10, and 25 cents additional for each 100 pounds over 1 ton.	Same as passenger cars. Special rates for trucks used for hire.	$3	do	Cars, $15 per set of plates; motor cycles, $5.
Wisconsin	$4	All cars $10 each	Capacity less than 2,100 pounds, $15; 2,100 to 5,100 pounds, $20; 5,100 pounds or more, $25.	(7)	do	$25 for 4 plates; extra plates, $1 each.
Wyoming	$5	40 cents per horsepower	75 cents for each 100 pounds of weight of vehicle.	None	do	$50 for 1 plate; $2 for each additional plate.

[7] Drivers of cars operating for hire may be licensed by municipality.

TABLE IV.—Administrative provisions in force January 1, 1920, affecting motor-vehicle registrations, licenses, and revenues.

State.	Registration and licenses.					Revenues from registrations and licenses.			Revenues from fines and penalties applied to roads.	Traffic regulations made by—
	Official or department in charge.	Renewals.		Requirements for operators' and chauffeurs' licenses.	Non-residents' exemption.	Applied to—	Proportion expended for roads under supervision of—			
		Car registrations.	Operators' and chauffeurs' licenses.				State highway department.	Local road authorities.		
Alabama	State board of equalization through probate judge.	Annual, Oct. 1.	Chauffeur, annual, Oct. 1.	Chauffeur, must be 18 years old.	Reciprocity.	State highway fund.	All of net[1].	None	None	Statute.
Arizona	Secretary of State	Annual, Jan. 1.	Chauffeur, perpetual.	No examination.	6 months	State road tax fund.	All of net.	do	do	Statute and local ordinance.
Arkansas	Commissioner of State lands, highways and improvements.	do	Chauffeur, annual from date.	Chauffeur must be 18 years old.	Reciprocity.	State and county road fund.	One-half	One-half	One-half of penalty for delinquency.	Do.
California	Superintendent of motor-vehicle department.	do	Chauffeur, annual, Jan. 1.	do	3 months	State and county road work.	One-half net.	One-half net.	All, by local community.	Do.
Colorado	Secretary of State	do	Chauffeur, annual, Jan. 1.	Certificate as to competency.	90 days	do	do	do	Same as registration revenues.	Do.
Connecticut	Commissioner of motor vehicles.	do	All operators, annual, Mar. 1.	Examination.	30 days	Maintenance State roads.	All of net.	None	do	Do.
Delaware	Secretary of State	do	All operators, Jan. 1.	Must be 16 years old; no examination.	Reciprocity.	State highway department.	All.	do	None	Do.
District of Columbia.	Automobile board	do	All operators, perpetual.	Examination	do	General fund	None	do	do	
Florida	State comptroller	do	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	do	State highway department and State, maintenance fund.	All of net.	do	do	Do.
Georgia	Secretary of State	Annual, Mar. 1.	Chauffeur, annual, Mar. 1.	Must be 16 years old.	30 days	Net to State aid road fund.	do	do	do	Do.
Idaho	State highway commission through county assessor.	Annual, Jan. 1.	Chauffeur, annual.	Chauffeur, must be 18 years of age.	Reciprocity.	State highway fund.	25 per cent	75 per cent	Same as registration revenues.	Do.
Illinois	Secretary of State	do	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	60 days	State road fund.	All[1]	None	All, by local community.	Do.
Indiana	do	do	do	do	do	State highway fund.	All of net.	do	County road fund.	Do.
Iowa	do	do	do	Chauffeur must be 18 years of age and competent.	Reciprocity.	State road work.	(2)	do	Local road work.	Do.
Kansas	Secretary of State through county treasurer.	Annual, July 1.	do	Must be 14 years of age.	60 days	Net, maintenance county and township roads.	None	All of net.	None	Statute and city ordinance.
Kentucky	State tax commission.	Annual, Jan. 1.	do	Chauffeur, examination.	Reciprocity.	Net to State road fund.	All of net.	None	do	Statute and local ordinance.
Louisiana	Secretary of State	do	None		do	Net to parish road work.	None	All of net.	Same as registration revenues.	Local ordinance.

[1] Must first set aside amount necessary to finance State highway bonds.
[2] 90 per cent for construction of primary roads, 5 per cent for maintenance of highway department, and 5 per cent for registration expenses.

TABLE IV.—Administrative provisions in force January 1, 1920, affecting motor-vehicle registrations, licenses, and revenues—Continued.

State.	Registration and licenses.					Revenues from registrations and licenses.			Revenues from fines and penalties applied to roads.	Traffic regulations made by—
	Official or department in charge.	Renewals.		Requirements for operators' and chauffeurs' licenses.	Nonresidents' exemption.	Applied to—	Proportion expended for roads under supervision of—			
		Car registrations.	Operators' and chauffeurs' licenses.				State highway department.	Local road authorities.		
Maine	Secretary of state	Annual, Jan. 1.	All operators, annual, Jan. 1.	Examination optional.	30 days	State road work.	All[1]	None	None	Statute and local ordinance.
Maryland	Commissioner of motor vehicles.	do	Owner, perpetual; chauffeur, annual.	do	Reciprocity; 3 months.	Net 20 per cent Baltimore street work; 80 per cent State road maintenance.	80 per cent of net.	do	Same as registration revenues.	Do.
Massachusetts	Department of public works.	do	All operators, annual from date.	Chauffeur, examination.	Reciprocity.	Net 20 per cent small town roads; 80 per cent maintenance State roads.	All net	do	do	Statute, department of public works and local ordinance.
Michigan	Secretary of state	do	Chauffeur, annual, Jan. 1.	Examination optional.	Reciprocity to 90 days.	State and county road work.	One-half net.	One-half net.	None	Statute and local ordinance.
Minnesota	do	Triennial, 1918–1920.	do	Chauffeur, examination.	30 days	Net, State road and bridge fund.	All net	None	do	Do.
Mississippi	State auditor and county tax collector.	Annual, Jan. 1.	None		60 days	State revenues to general fund; county to county road work.	None	Net county revenue.	Net, same as county revenue.	Local ordinance.
Missouri	Secretary of state	Annual, Feb. 1.	Chauffeur, annual, Feb. 1.	Must be 18 years of age; no examination.	do	State road fund	All of net	None	None	Statutes and local ordinance.
Montana	do	Annual, Jan. 1.	Chauffeur, annual, Jan. 1.	No examination.	No limit	Net to State and county road work.	Three-fourths net.	One-fourth net.	do	Do.
Nebraska	Department of public works through county treasurer.	Annual, Jan. 1.	None	Must be 16 years old.	30 days	do	Three-fourths.	One-fourth	None	Statute and local ordinance.
Nevada	Secretary of state	First Monday in February	do	do	do	Net to State highway bond fund.	None	None	do	Do.
New Hampshire.	Commissioner of motor vehicles.	Annual, Jan. 1.	All operators, annual, Jan. 1.	Examination, all operators.	20 days	Road maintenance.	All of net	do	Same as registration revenues.	Do.
New Jersey	do	do	do	do	Reciprocity; 15 days.	do	do	do	do	Statute and motor vehicle commission.
New Mexico	Secretary of state	do	None	Must be 14 years old.	30 days	Net State and county road work.	do	do	None	Statute and local ordinance.
New York	do	Annual, Feb. 1.	All operators, annual, Feb. 1.	Chauffeur, examination.	Reciprocity.	State and local road work.[3]	75 per cent gross.	25 per cent gross.	Maintenance of State roads.	Statute, State highway commission, and local ordinance.
North Carolina.	do	Annual, July 1.	None	Must be 16 years of age.	Reciprocity to 60 days.	State road fund	All net	None	None	Statute and local ordinance.
North Dakota.	Motor vehicle registration department.	Annual, Jan. 1.	do		No limit	Net to State and county road work.	One-half	One-half	do	Do.
Ohio	Secretary of state	do	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	do	State and local road maintenance.	do	do	do	Statute, State highway department, and local ordinance.
Oklahoma	Department of highways.	do	None		Reciprocity.	10 per cent appropriated for State highway department; 90 per cent county road work.	All		All	Statute and local ordinance.
Oregon	Secretary of state	do	Chauffeur, annual, Jan. 1.	Must be 16 years of age; no examination.	do	Net to State and county road work.	Three-fourths.	One-fourth	County road fund.	Do.
Pennsylvania.	State highway department.	do	do	Affidavits as to competency.	Reciprocity.	State and State-aid road work.	All gross	None	Certain ones locally.	Do.
Rhode Island	State board of public roads.	do	All operators, annual from date.	Examination, all operators.	Reciprocity 10 days.	Maintenance State roads.	All net	do	Same as registration revenues.	State board of public roads statute, and local ordinance.
South Carolina.	State highway department.	Annual, Jan. 1.			30 days	Maintenance highway department and county road work.	20 per cent	80 per cent	None	Statute and local ordinance.
South Dakota	Secretary of state through county treasurer.	do		Must be 15 years old.	Reciprocity.	90 per cent county road work.	None	90 per cent	do	Do.

[1] Must first set aside amount necessary to finance State highway bonds.
[3] Does not apply to revenue collected within New York City, one-half of which goes to the city general fund.

TABLE IV. Administrative provisions in force January 1, 1920, affecting motor-vehicle registrations, licenses, and revenues—Continued.

State.	Registration and licenses.					Revenues from registrations and licenses.				Traffic regulations made by—
	Official or department in charge.	Renewals.		Requirements for operators' and chauffeurs' licenses.	Non-residents' exemption.	Applied to—	Proportion expended for roads under supervision of—		Revenues from fines and penalties, applied to roads.	
		Car registrations.	Operators' and chauffeurs' licenses.				State highway department.	Local road authorities.		
Tennessee	State department of highways through county clerk.	Annual, Jan. 1.	.....	.....	30 days	Net to State and county road work.	All net	.....	Same as registration revenues.	Statute and local ordinance.
Texas	State highway department through county tax collector.	....do.....	Chauffeur, annual, Jan. 1.	Must be 18 years of age.	90 days	Net to State and county highway funds.	50 per cent	50 per cent	County road work.	Do.
Utah	Secretary of state	Annual, Mar. 1.	.....do.....	No examination.	30 days	Motor vehicle registration fund.	All net [4]	None	None	Do.
Vermont	.....do.....	Annual, Jan. 1.	All operators, annual, Jan. 1.	Examination, chauffeur.	Reciprocity.	State maintenance fund.	....do.....	....do.....	.....do.....	Do.
Virginia	Secretary of commonwealth.	....do.....	Chauffeur, annual, Jan. 1.	Certificate of competency.	2 periods of 7 days each.	Net to construction and maintenance of State roads.	....do.....	....do.....	.....do.....	Do.
Washington	Secretary of state through county auditor.	Annual, Mar. 1.	None	Operators must be 15 years of age, chauffeurs 21.	90 days	Net to permament highway fund for maintenance and construction.	None	All net	Same as registration revenues.	Do.
West Virginia	State road commission.	Annual, Jan. 1.	Chauffeur, annual, Jan. 1.	Must be 14 years of age.	Reciprocity.	State road fund	All	None	None	Do.
Wisconsin	Secretary of state	....do.....	None	Must be 16 years of age.[5]	.....do.....	Net to State highway fund and county road work.	75 per cent net.	25 per cent net.	.....do.....	Do.
Wyoming	.....do.....	....do.....	.....do.....	Must be 15 years of age.	Reciprocity to 90 days.	80 per cent to county.	None	None	.....do.....	Statute.

[4] To pay interest and sinking fund on $2,000,000 State road bond.

[5] Drivers of cars operating for hire may be licensed by municipalities.

NORTH CAROLINA WORK PROGRESSING DESPITE HIGH MATERIALS COST.

The State Highway Commission of North Carolina is rapidly pushing the construction of hard surfaced roads throughout the state.

At present 109 miles of road of this type are under construction. In all, 37 projects are under consideration, representing 349 miles, of these 240 are to be built of gravel sand and other material. The 109 miles, however, do not include all the hard surfaced construction which is contemplated, but simply that which is under way.

In spite of the high costs of materials, the commission is pushing construction work, and hopes to practically complete 200 miles of hard surfaced roads within 10 months. Construction is delayed because of the fact that quarry stone which used to be $1.50 crushed and loaded at the quarry has now risen to $2.50 and $3.

PURCHASE TURNPIKES.

The Pennsylvania State highway department, jointly with the counties in which they are located, has purchased three turnpikes having an aggregate of 16.6 miles, and converted them into free highways. The three cost $114,800, half of which was paid by the State.

TREES ALONG THE ROADS.

The Milwaukee County (Wis.) Park Commission is ready to prepare plans for planting trees along from 3 to 5 miles of the county's principal highways in 1921, and to proceed at that rate until the county is completely covered. Before the work can be undertaken, however, it will be necessary to broaden the county arterial highways to the width which will be demanded by the traffic of future years, so the trees can be permanently placed. The chairman of the park commission has requested the cooperation of the State highway commission in working out a plan for wider roads in the county.

BONDS ARE NOT SELLING.

State Highway Engineer Edy, of Montana, says chambers of commerce and bankers are being appealed to in the hope that county road bonds can be sold in sufficient amounts to avoid even the temporary abandonment of the road-building program in that State. Since February 1 contracts for more than $2,000,000 worth of road work have been let, while about $500,000 of the 1919 contracts remain uncompleted. This is only half the program for the year, and unless counties are able to dispose of bonds voted last fall it will be impossible to finance the projects.

FEDERAL CONTROL OF BRIDGES OVER OUR NAVIGABLE STREAMS.

By G. B. PILLSBURY, Colonel of Engineers, U. S. Army.

NAVIGABLE streams have, from the earliest days, been recognized by the law as highways of commerce over which the public has the right of free and unimpaired use. They may be occupied and obstructed by bridges, or otherwise, only by authority of the supreme legislative body having jurisdiction over them. Their status is the same, in this respect, as that of the public highways on land. This status is not always realized. A road is directly used by all citizens, and every member of the community is personally affected if it is encroached upon. Necessarily, but few of our citizens are vessel owners. On many of our navigable streams traffic by water has been diverted to rail or road, and the interest of the great mass of the people in water transportation is not obvious, however important it may indirectly be to them. Many look with impatience on the restrictions made to the obstruction of navigable waters. These restrictions are, however, based on the fundamental law, and, wisely administered, are essential to the best interests of the country at large.

The term "navigable waters of the United States" is used in legal terminology to designate those streams and other channels over which commerce is or may be carried on between States or with foreign countries. Under the interstate-commerce clause of the Constitution, the control over these waters, so far as concerns the public right of navigation, is vested in Congress. It may be observed that most of the navigable rivers in this country are "navigable waters of the United States," since nearly all rivers form, with connecting waters and with the sea, a continuous navigation system between States. Lakes lying wholly within a State, with no navigable outlet, and, in rare cases, the isolated navigable portions of some rivers wholly within a State, are navigable waters of the State, over which the Federal Government has no control.

THE CONSENT OF CONGRESS.

Congress has provided, in a law passed in 1899 (sec. 9 of the river and harbor act of Mar. 3, 1899, 30 Stat. L., 1150), that it is unlawful to build or commence the building of any bridge over any navigable waters of the United States until the consent of Congress has been obtained, and the location and plans have been duly approved by designated Federal officials, unless the navigable portions of the river lie wholly within the limits of a single State, in which case the bridge may be constructed under the authority of the legislature of that State, but the location and plans must still be approved by the Federal officials. As the work done by the Federal Government for the improvement of rivers and harbors have, from their inception, been executed by the Engineer Bureau of the War Department, the administration of the laws for the protection and preservation of navigable waters of the United States has been placed under that bureau, and the officers designated by Congress to approve plans for bridges are the Chief of Engineers, who is the head of that bureau, and the Secretary of War.

The earlier acts of Congress authorizing the construction of bridges specified, in considerable detail, the conditions under which the grant of authority was made. As these conditions were, in general, uniform in nature, an act known as the general bridge act was passed March 23, 1906, specifying the conditions to be met in the construction of all bridges thereafter authorized by Congress. Since the passage of that act, the special acts of Congress authorizing the construction of bridges are usually of very brief and simple form. The provisions of the general bridge act do not apply to bridges erected, under authority of a State, over a river the navigable portions of which lie wholly within the State.

PROVISIONS OF GENERAL LAW.

The principal provisions of the general bridge act are that every bridge subject to its terms shall be recognized and known as a post route; that charges to the United States for the transportation of mails, troops, and munitions of war, shall not exceed the rate per mile paid for transportation over the approach routes; that the United States shall have the right to construct, maintain, and repair telegraph and telephone lines across and upon the bridge without charge; that equal privileges in the use of the bridge and its approaches shall be granted to all telegraph and telephone companies; that if the structure is a railroad bridge, all railroad companies shall be entitled to equal privileges relative to the passage of trains or cars upon payment of a reasonable compensation; that if tolls are charged the rates may be prescribed by the Secretary of War; and that if the congressional act authorizing the bridge does not specify a time for beginning and completing the structure, the authority shall be null and void unless the actual construction of the bridge is begun within one year and completed within three years from the date of the passage of that act.

Bridges crossing the Mississippi and Ohio Rivers and certain other waterways of less importance, the Harlem, the Kanawha, the Maquoketa, and the

Illinois and Mississippi Canal are governed by special provisions of the Federal law, enacted for these particular streams at different times.

In addition to the laws relating to the construction of bridges, other provisions of the Federal statutes provide for their alteration when necessary in the interests of navigation. The law on this subject is found in section 18 of the river and harbor act of March 3, 1899 (30 Stat. L., 1153), and provides, in effect, that whenever the Secretary of War has good reason to believe that a bridge, whenever constructed, is an unreasonable obstruction to navigation, he shall, after giving the owners a reasonable opportunity to be heard, require that necessary changes be made at the expense of the owners. While this law may appear drastic, and perhaps unfair to the owners of a bridge constructed in good faith in accordance with approved plans, it must be recollected that the right of navigation to the use of the stream is paramount. Alterations to bridges are in fact required only when their necessity in the interests of navigation is very thoroughly established. Another provision of the law (sec. 2 of the river and harbor act of Aug. 11, 1888) provides in effect that whenever complaint is made to the Secretary of War that the current of navigable rivers has been deflected from its natural course by bridge piers or abutments so as to cause caving of banks or otherwise cause serious damage or danger to property, he shall after due inquiry, cause the owners of the bridge to repair the damage or prevent the danger. This last provision of law is very rarely invoked.

The Federal laws relating to the construction of bridges are published in a pamphlet form, and a copy may be secured on application to any district engineer of the Engineer Department at large.

PROCEDURE IN EACH CASE.

For the execution of works of improvement on rivers and harbors, and for the administration of the laws for the protection and preservation of the navigable waters of the United States, the country is divided into some 40 Engineer districts, each in charge of a district engineer, who is usually an officer of the Corps of Engineers of the Army. The Engineer districts are grouped into 10 divisions, each having a division engineer, an officer of long experience, whose duties include, among other things, the review of recommendations made by district engineers.

All plans for bridges across navigable waters are examined and reported on, in the first instance, by the district engineer in charge of the locality, who confers with the parties applying for approval as may be necessary, holds, in the usual case, a public hearing on the application, and sees that the application and plans are in due form. He forwards the application and plans to the division engineer with his recommendations. The division engineer reviews them and submits them, with his views, to the Chief of Engineers. If the proposed bridge affords sufficient facilities for navigation, and if the papers show that its construction has the necessary legislative authority, the Chief of Engineers then approves them and submits them to the Secretary of War. After a review of the legal aspects of the case by the Judge Advocate General of the Army, his legal adviser, the plans are approved by the Secretary of War and a copy of the instrument of approval is furnished the applicant. Variations from the general procedure occur in the case of applications for bridges over the Ohio and Kanawha Rivers, where, under the special Federal law relating to these rivers, the plans must be passed upon by a board of engineer officers.

WHAT A NAVIGABLE STREAM IS.

If a bridge is to be constructed, the first question to be determined, therefore, is whether the stream is navigable water of the United States. If the river is actually used for commercial navigation, no matter how small in importance, there is, of course, no doubt about its status. It is a navigable water of the United States unless it falls within the very limited number of navigable streams having no navigable connection with waters outside of the State. It may be observed that the mere existence of occasional barriers in the way of rapids, falls, etc., which cannot in their natural condition be passed by vessels, does not destroy the navigable connection, for such barriers may be overcome by suitable works. A stream may, however, be navigable, even though it does not happen to be navigated at the present time. In a leading case, the courts have held:

> The true test of the navigability of a stream does not depend upon the manner or mode by which commerce is or may be conducted, nor upon the difficulties attending navigation. If this were so, the public would be deprived of the use of many of the large rivers of the country over which rafts of lumber of great value are constantly taken to market. It would be a narrow rule to hold that in this country, unless a river was capable of being navigated by steam or sail vessels, it could not be treated as a public highway.
>
> The capability of use by the public for purposes of transportation and commerce affords the true criterion of the navigability of a river, rather than the extent and manner of that use. If it be capable in its natural state of being used for purposes of commerce, no matter in what mode the commerce may be conducted, whether in vessels propelled by steam, wind, oars, or poles, the stream is navigable in fact and comes in law a public highway.
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> It is not to be understood, however, that every ditch or inlet in which the tide ebbs and flows, nor every small creek in which a fishing skiff or gunning canoe can be made to float at high water, is a navigable highway; but to give it the character of a navigable stream it must be generally and commonly useful to some purpose of trade or agriculture.

Certain rivers, some 20 in number, have been declared by Congress to be either in whole or in part nonnavigable. The effect of this legislation is to remove from them the operation of the Federal laws relating to the preservation and protection of navigable waters as concerns the construction of bridges and otherwise.

It may be observed that the question of navigability is not one that can be settled by the mere dictum of an executive officer of the Federal Government. It is a question of fact which, in the last resort, can be determined only by the courts. However, the question is not as difficult a one as is sometimes fancied. A reasonable inquiry in the locality will usually settle the point.

STREAM IN SINGLE STATE.

The question of the navigability of the stream being determined, the next point is whether the navigable portions of the river lie wholly within a single State or whether they extend beyond a single State. This question is readily settled.

If the navigable portions of the river extend beyond the limits of a single State a special act of Congress is necessary to authorize the construction of the bridge. Such an act should be secured through the Representative of the locality in Congress. It may not be out of place to point out that the act authorizing the construction of the bridge should be as simple and direct as possible, as the applicant must furnish proof that all the conditions recited in the act have been fulfilled. Thus, where an act authorizes the construction of a bridge across a certain river and recited that the bridge was on the route of a certain-named continental highway, it was held that the applicant must furnish proof that the proposed bridge was on the route of that highway; and the papers were returned to him for that purpose, with considerable consequent delay.

If the navigable portions of the river lie wholly within a single State, the authority of the State legislature is sufficient. Most States have general laws authorizing the construction of bridges by county boards, etc., and the charters of public service corporations often grant authority for such construction. A special act of a State legislature is, therefore, often unnecessary.

REQUIREMENTS IN DESIGN.

The legal aspects of the case having been settled, the question next arises as to the requirements to be met in the design of the bridge to satisfactorily meet the needs of navigation. These requirements include the location of the bridge with respect to the navigable channel; the spacing of the piers; the clear height of the structure above high and low water, and the length and character of draw span, if any, to be provided. The requirements necessarily differ with each waterway, and sometimes in different parts of the same waterway. All depends on the character and extent of existing navigation, and that reasonably prospective, due attention being given that suitable provision is made for passing drift and flood flows. The district engineer should be freely consulted. He will be able to advise the applicant on what the requirements of navigation are, and it will be but very rarely that a change will be necessary on account of objections brought out at the public hearing.

The working up of the design of a structure conforming to the navigation requirements and suitable for the traffic that will pass over it, rests wholly with the party building the bridge. The design in all matters, except the clearances for navigation, is not a matter of concern to the Department, except in those rare cases when the law authorizing the construction contains specific requirements as to the design and construction.

The final step is the preparation of the plans for the approval of the Department and of the application for approval, supported by the necessary evidence of legislative authority.

PREPARATION OF PLANS.

The plans required include a map showing the location of the bridge, on which, as a rule, the waterway is to be shown for a distance of 1 mile above and 1 mile below the structure; and outline plan and elevation of the bridge showing the clearances for navigation. Elaborate plans showing the details are neither required or desired. Small and compact plans are preferred. Four copies, in all, of the maps and plans are required, three for file in the various Government offices concerned, and one for the applicant after approval. It is essential that one set of the maps and plans be on tracing linen, or otherwise prepared to form a permanent and readily reproduceable record.

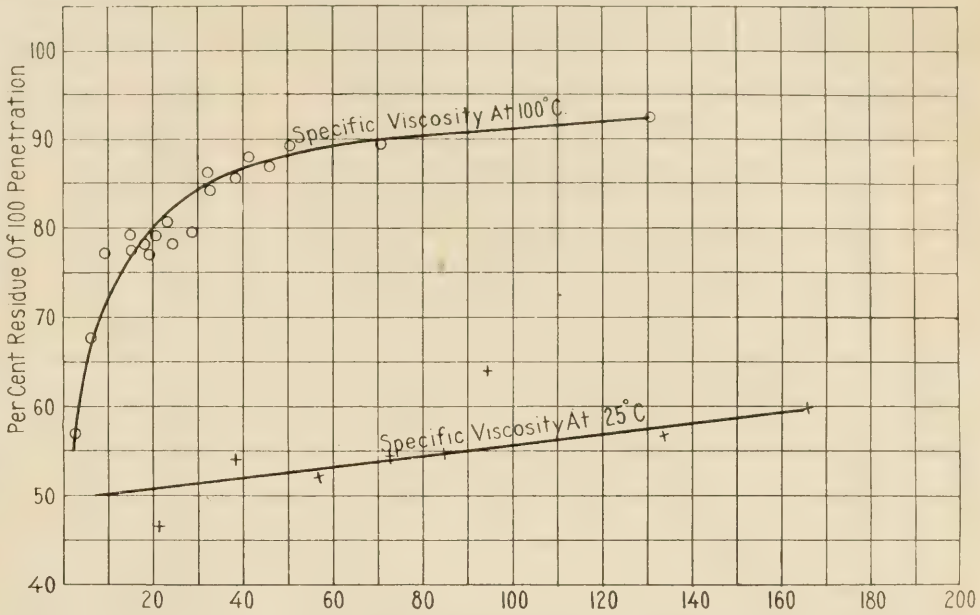
A printed form is provided for the letter of application. Accompanying it, the applicant must furnish the papers necessary to show the legal authority for the building of the bridge, and to identify the applicant as the party to whom this authority has been granted. It is unnecessary to detail here the papers necessary to this end. They are described on the printed form, and further explanation of the requirements in any particular case may be secured from the district engineer.

In summary, when the construction of a bridge across a navigable waterway is to be undertaken, those proposing to construct it should confer with the district engineer in charge of the locality at as early a date as is possible, to settle the questions of the facilities to be provided for navigation, and to post themselves on the requirements of law that must be met. The preparation of the papers in due form, the advertisement of the public hearing on the application, and the consideration by the department of the case, necessarily consume some time, and it is most important that the matter of approval be taken in hand in due season, as the law forbids the commencement of the construction until the plans are duly approved.

THE "ASPHALT CONTENT" OF ROAD OILS.

By B. A. Anderton and D. G. Taylor, Division of Tests, U. S. Bureau of Public Roads. [1]

THE grading of asphaltic road oils on the basis of the percentage of asphalt contained in them is still in extensive use as a means of differentiating between various types of oils—that is, as between their inherent nature and consistency. Notwithstanding that there are obvious difficulties in making the test, and that its value has been for some time severely criticised, a conference of State highway testing engineers and chemists, held in Washington in 1917, deemed the test of such extensive use as to warrant including it as an alternate requirement in forms of specifications drawn up for road oils. The method of making the test was also considered, and in the report [2] of the conference the recommended procedure to be followed is given as follows:



The Asphalt Contents Of Mexican Road Oils
FIG. 1

PERCENTAGE OF RESIDUE OF PENETRATION.

Fifty grams of the oil are placed in a 3-ounce deep, seamless tin box; the box is placed in a sand bath and heated over a Bunsen burner. A thermometer is suspended in the oil, the bulb not touching the bottom of the box. The temperature of the oil is kept at from 249° C. to 260° C. (480° F. to 500° F.), and the oil is stirred from time to time with the thermometer to prevent overheating in any part. Depending upon the nature of the oil, as usually indicated by its flash, consistency at 25° C. (77° F.), and the specific gravity, the operator can with experience tell about what percentage it will be necessary to evaporate before cooling and taking a penetration of the residue. It is sometimes necessary to make several trials before the desired result is obtained. When the required penetration is reached the residue left from evaporation is weighed and its percentage of the original sample taken is computed.

The Bureau of Public Roads, with a desire to investigate how closely the various characteristics of a sample would indicate the percentage of residue of 100 penetration, as suggested in this description of the test, has made a large number of determinations following the procedure given as closely as possible. From the results of this work, we will attempt in this communication to present the most significant indications as to the value of the test for asphalt content. We may divide the selected tests into three groups as follows:

(1.) Residual petroleums, asphaltic petroleums, and oil asphalt cut backs having different specific gravities and consistencies; (2) a series of Mexican products having specific gravities ranging from 0.935 to 1.024 and specific viscosities at 100° C. ranging from 2.4 to 131 and a series of Mexican products having sepcific gravities ranging from 0.935 to 0.965, with specific viscosities at 25° C. ranging from 20.4 to 165, and with flash points ranging from 42 to 105; (3) a selected sample upon which numerous tests were made to discover effects, if any, that varying conditions might have upon the results. In all the tests with the exception of those under No. 1 it was desired to obtain a residue that would yield a penetration of 100.

GROUP NO. 1 TESTS.

In the tests of group No. 1 it was found that no general relation could be discovered between the percentage of asphalt and ordinary test characteristics of the sample. The source of the oil has a great influence on the results of the test; for instance, two oils from different sources when heated for the same

[1] Paper read before the American Society for Testing Materials, Asbury Park, N. J.
[2] Standard Forms for Specifications, Tests, Reports, and Methods of Sampling for Road Materials, Bul. No. 555, U. S. Department of Agriculture, Washington, D. C., Nov. 25, 1917.

length of time will give entirely different amounts of residue, notwithstanding the fact that they have practically the same consistency or specific gravity; and when these samples have been heated until the residues show the same penetration they do not necessarily have the same percentage of residue. This was shown when tests of Mexican oils were compared with tests of other oils. Some typical results are given in Table I.

TABLE I.—*Comparison of tests made on Mexican oils with tests made on oils from other sources.*

Type of oil.	Specific gravity.	Specific viscosity.	Time heated at 249° to 260° C.	Percentage of residue.	Penetration of residue.
		° C.	Min.		
Mexican	0.965	165.0-25	45	59.5	100
Texas	.940	163.6-25	95	69.1	100
Mexican	1.004	24.4-100	45	78.4	103
Trinidad	1.004	29.1-100	90	83.6	103
Mexican	.943	94.8-25	35	64.2	97
Mid-continent	1.031	99.0-25	50	54.4	102
Mexican	.991	16.8-100	30	78.0	97
California	.994	17.0-100	120	76.4	100

A comparison of the Mexican product with the Texas product shows that when the samples had been heated until they gave the same penetration the difference in the percentage of their residues was 9.6. A comparison of the Mexican product with the Trinidad product shows that when the samples had been heated until they gave the same penetration the difference in the percentage of their residues was 5.2. With the Mid-Continent residual it is shown that a much lower percentage of asphalt results, although the original oil was slightly heavier, and the residue somewhat softer. In the last case a comparison of the Mexican product with the California product shows that there was only a slight difference in the percentage of their residues. It may be especially noted that the evaporation took place much more rapidly with the Mexican samples, and it necessarily required a shorter time to gain residues yielding a penetration of approximately 100 with such oils.

GROUP NO. 3 TESTS.

The results of tests made on materials stated under group No. 2 are given in Table II.

TABLE II.– *Percentage of residue of Mexican oils.*

SPECIFIC VISCOSITY AT 100° C.

Serial No.	Specific gravity.	Specific viscosity.	Percentage insoluble in 86° B. naphtha.	Flash point.	Percentage of residue.	Penetration of residue.
				° C.		
14104	0.935	2.4	13.8	70	[1] 56.8	100
14044	.961	6.2	17.5	98	67.6	78
12027	.995	19.8	19.6	95	77.0	90
10460	.990	9.4	17.3	100	77.2	91
10491	.991	16.8	19.4	60	78.0	97

TABLE II.—*Percentage of residue of Mexican oils*—Continued.

SPECIFIC VISCOSITY AT 100° C.

Serial No.	Specific gravity.	Special viscosity	Percentage insoluble in 86° B. naphtha	Flash point.	Percentage of residue.	Penetration of residue.
				° C.		
11147	.995	17.5	20.1	.....	78.0	95
10477	.996	18.6	18.6	75	78.4	99
11164	1.004	24.4	20.4	.....	78.4	102
10475	.993	15.7	19.4	70	79.0	97
11154	1.005	20.6	17.3	.....	79.2	98
11630	1.001	29.1	20.6	.....	79.6	100
11093	1.002	22.5	.....	.....	80.6	100
10500	1.013	32.5	.....	.....	84.4	100
14106	.991	38.7	20.0	206	85.8	100
14045	1.004	32.3	22.0	190	86.2	102
14126	.998	46.0	.....	204	87.2	92
12326	.999	41.6	20.9	.....	87.8	100
12392	1.008	51.7	.....	.....	[1] 89.0	100
10266	1.015	70.9	21.7	.....	[1] 89.3	100
12413	1.024	131.0	22.8	.....	[1] 92.4	100

SPECIFIC VISCOSITY AT 25° C.

10636	0.936	20.4	.....	.....	46.6	97
14042	.954	57.0	13.3	100	52.4	80
12026	.943	38.6	13.1	45	54.2	90
14043	.938	72.9	13.3	100	54.4	87
12391	.936	85.0	13.4	105	54.8	105
14104	.935	133.8	13.8	70	[1] 56.8	100
11810	.965	165.0	16.0	65	[1] 59.5	100
11766	.943	94.8	14.3	42	64.2	97

[1] Interpolated from results of two tests, one having a slightly higher residue and the other a slightly lower residue.

Generally speaking, it was found that an approximate relation exists between the percentage of residue of 100 penetration and between the consistency, the specific gravity, the flash point, and the percentage insoluble in 86° B. naphtha. Of these relations the one involving the consistency of the material is probably the best aid in estimating the asphalt content of an oil. From the plot between the percentage of asphalt and the specific viscosity shown in figure 1, however, it will be noted that an estimate of the percentage of asphalt of 100 penetration can be made only within rather wide limits.

Thus, judging from this graph, the percentage necessary to be volatilized from a sample having a specific viscosity at 100° C. ranging up to 60 may be inferred within not less than 3 per cent.

GROUP NO. 3 TESTS.

In group No. 3 the material selected was a Mexican asphalt having an original penetration of 177. First, six samples were taken and tested in the regular way. The first sample was heated for five minutes at the required temperature (249 to 260° C.) and each successive sample was heated five minutes longer than the preceding one. Samples numbered 2 and 3 were reheated at the required temperature. Then two additional samples, numbered 7 and 8, were heated for 20 minutes at the required temperature, number 7 being stirred very frequently and number 8 continuously. Penetration tests were made on the residues from the above samples with the results shown in Table III.

TABLE III.—*Tests made to note results from heating material different lengths of time.*

Sample No.	Time heated at 249° to 260° C.	Percentage of residue.	Penetration of residue.
1	5 minutes	99.6	150
3	15 minutes	97.6	133
2	10 minutes	97.2	129
5	25 minutes	96.4	105
4	20 minutes	96.0	100
6	30 minutes	95.2	96
	EFFECT OF REHEATING SAMPLES NOS. 2 AND 3.		
2	10 minutes	97.2	129
	5 minutes additional	96.0	100
	5 minutes additional	95.0	89
3	15 minutes	97.6	133
	5 minutes additional	96.4	102
	EFFECT OF STIRRING.		
[1] 7	20 minutes	97.6	120
	5 minutes additional	96.4	104
[2] 8	20 minutes	97.0	114

[1] Stirred very frequently. [2] Stirred continuously.

It will be noted that the loss is not proportional to the time of heating. If the test made on sample No. 4 is compared with that made on sample No. 2, it will be seen that a residue of 96 per cent gave a penetration of 100, and that when sample No. 2 was reheated for five minutes at the required temperature that a residue of 96 per cent was obtained, also yielding a penetration of 100. Again, if the tests made on samples Nos. 3, 5, and 7 are compared it will be seen that their final residues are the same (96.4 per cent), although sample No. 3 was reheated and sample No. 7 was both reheated and subjected to excessive stirring. The penetration tests on these residues showed a maximum difference of only three points. This would seem to indicate that intermittent heating or increased stirring did not affect the results to any great extent, although it must be conceded that results with such a viscous material and having such low losses are not conclusive as applied to fluid road oils.

CONCLUSIONS.

As a result of the work carried out as above described, certain conclusions are suggested to us:

1. That with a given type of oil, the consistency will indicate the percentage of asphalt.

2. That the time necessary to secure the required residue will vary within wide limits, and can not be readily estimated while making the test as described.

3. That the effect of stirring is indicated to be less than that of other factors difficult to control, which affect the results.

There are many features of the test which may be adversely criticized. Among these may be enumerated the following: The tedious and long continued attention necessary to secure even approximate results; the difficulty in maintaining the required temperature, which is of great importance to secure concordant results; the fact that the changes taking place during heating are not understood and probably are not indicative of the changes in the oil while in service on the road. At best it is a "cut and try" method, and therefore can not be based on scientific principles of testing.

Summarizing our conclusions, it may be stated that it is our belief that the percentage of asphalt gives no additional information on the suitability of a road oil for a given purpose, which is not adequately shown by the results of other tests, better understood and at the present time well standardized.

BEAUTIFYING THE ROADS.

John A. Hazlewood, chairman of the Wisconsin State Highway Commission, in an address at the rural planning school of that State discussed the ornamentation and beautifying of highways. He said, "It has long been a recognized fact that the time would come when a systematic and well-defined plan for the planting of trees and shrubs along our highways would be practicable. It will pay to do so. It can be shown by convincing arguments that trees and shrubs, if properly planted and maintained along highways, may be of true service in practicable ways as well as in beautifying the roadside. The pleasure resulting from one's passing along beneath the arches formed by rows of elms and maples should be sufficient reason for a continuance of the work.

"There are two ways in which trees and shrubs should be planted along highways. The first type may be said to exist where the trees, shrubs, and flowers form the element of the picture with the roadway as the central feature. This type of planting, has been used to advantage where the scenery along the roadside is ugly and monotonous. Many miles of ugly roadside could thus be made attractive by bringing one's interest into the road itself.

"The second type may be called the 'open type,' where the woods, meadows, fields, and distant landscape form the composition of the picture, with the trees so arranged as to afford frames for these delightful vistas and thus make the roadside more charming. Very rarely is there a highway of any length that does not, to some extent, offer the opportunity for both types of planting."

FOR MORE BONDS.

It has developed that the $4,000,000 worth of road bonds voted by Maricopa County, Ariz., a year or more ago will build only about one-half the roads contemplated at the time of the election. There is now a movement favoring the issue of an additional $4,500,000 worth.

GALVANIZED CULVERTS.

By L. G. Carmick, Assistant Chemist, Bureau of Public Roads.

AMONG the many problems that confront the highway engineer, and one that frequently causes perplexity, is the selection of the proper type of culvert. Many sorts may be, and have been used, but in most cases the matter is practically limited to a choice between concrete and galvanized iron or steel. The concrete culvert is almost indefinitely permanent in most localities, if properly constructed, but is expensive and requires time to build. Galvanized metal, though undoubtedly open to objection, is very extensively used, especially for small culverts, because of its relative cheapness, availability and convenience. It therefore becomes a matter of much importance to secure the best possible type of galvanized metal.

At present we do not know just how long a galvanized culvert should last. Probably we do not yet know how to select the best type either. Our theories on the corrosion of iron are now in process of development for it is not more than 15 years ago that the subject was taken up in earnest and became a research problem of major importance. And while considerable progress has been made no one at all familiar with it supposes for a moment that the last word on the subject has been spoken. The life of a metal culvert depends on quite a number of different factors, some of which have to do with the culvert itself and others with the conditions under which it is used. It is not proposed to discuss all of these factors here, but simply to deal with the practical aspects of one of them—the zinc, or as it is usually called, spelter coating.

THE SPELTER COATING.

Having in mind the sort of material now in general use we may say that, roughly speaking, the duration of the spelter coating will be about three-quarters of the life of the culvert. It is the present practice of the Bureau of Public Roads and of many of the State highway departments to specify that culvert sheets shall carry at least 2 ounces of spelter per square foot. This includes both sides of the sheet, so that each square foot of actual surface must have at least 1 ounce of spelter.

To determine whether or not this amount is present, it is customary to make a chemical analysis of one or more small pieces cut at random from the culverts. This is what is frequently referred to as a spot test. The test pieces are usually 2 by 2 inches or $2\frac{1}{4}$ by $2\frac{1}{4}$ inches and are of course very small in comparison to a culvert. Frequently one or two such pieces are sent to a laboratory as representative of a shipment of culverts, which may mean as much as a carload. In view of the well-known fact that the coating can not be applied with a high degree of uniformity, it has been claimed that such a system of testing is inadequate and unfair.

It was partly for the purpose of determining what value could be attached to such tests that the Bureau of Public Roads recently undertook an investigation of the matter.

VALUE OF USUAL TESTING SYSTEM.

Four of the principal mills producing culvert sheet were visited and at each of them the management extended great courtesy and every facility that could further the investigation.

At each mill a considerable number of sheets were weighed with accuracy after pickling and drying, and were then galvanized and weighed again. In this way the exact amount of spelter on each sheet was ascertained. The sheets were generally from 80 to 120 inches long and 27 inches wide. All of them were either 14 or 16 gauge. From each of these sheets a strip $1\frac{1}{2}$ inches wide was cut off from each end and discarded. A sample strip 3 inches wide was then cut off from each end and another such sample strip was taken from the middle. These strips were sent to Washington, and there three test pieces were cut from each strip. In this way nine samples were taken from each of the original sheets. All of the test pieces were cut to $2\frac{1}{4}$ by $2\frac{1}{4}$ inch size to an accuracy of 0.01 inch in a milling machine, and were then analyzed.

There are two principal methods for the determination of spelter coating. One consists in immersing the test pieces in a strong solution of lead acetate (400 grams to the liter) which removes the zinc and deposits an equivalent amount of lead in a very loosely adherent form. The other method consists in immersing the pieces in concentrated hydrochloric acid to which has been added a small quantity of a solution of antimony chloride. As this seemed a good opportunity to test the relative merits of the two methods, both were used as indicated in connection with the data given below. At first, when the antimony-hydrochloric acid method was used, the pieces were immersed for just one minute as is usually prescribed. But this seemed to give somewhat high results, so the time was shortened, first to 45 seconds and then to 30 seconds, with an apparent improvement in the accuracy of the results. At any rate it was evident that half a minute was ample time to remove all of the spelter.

RESULTS OF THE TESTS.

The results obtained by the analysis of the samples are given below. The four mills at which the sheets were galvanized will be designated by the numerals I, II, III, and IV. The expression "actual average" means the average coating on the sheets as determined by weighing them before and after galvanizing at the mills. Extreme variation is the difference between the highest and lowest of the nine tests from one sheet.

MILL I.

Sheet 1.

	Front.	Middle.	Back.
A	3.097	3.125	3.009
B	3.011	3.041	3.395
C	2.931	3.227	3.152

Average of tests 3.119
Actual average 2.830
Extreme variation .464
Antimony-acid method, one minute's immersion.

Sheet 2.

	Front.	Middle.	Back.
A	2.525	2.528	2.387
B	2.368	2.150	2.236
C	2.633	2.233	2.980

Average of tests 2.448
Actual average 2.190
Extreme variation .830
Antimony-acid method, one minute's immersion.

Sheet 8.

	Front.	Middle.	Back.
A	2.355	2.362	2.469
B	2.612	1.923	2.351
C	2.432	2.475	2.501

Average of tests 2.386
Actual average 1.970
Extreme variation .689
Antimony-acid method, one minute's immersion.

Sheet 10.

	Front.	Middle.	Back.
A	1.788	1.920	2.110
B	1.900	1.605	1.671
C	1.920	1.805	1.735

Average of tests 1.762
Actual average 1.690
Extreme variation .505
Lead acetate method.

Sheet 11.

	Front.	Middle.	Back.
A	1.920	1.970	1.781
B	2.151	1.724	1.865
C	2.369	2.094	1.926

Average of tests 1.978
Actual average 1.720
Extreme variation .645
Antimony-acid method, one minute's immersion.

Sheet 21.

	Front.	Middle.	Back.
A	1.849	1.696	1.865
B	2.054	2.123	2.092
C	1.880	1.747	2.151

Average of tests 1.939
Actual average 1.640
Extreme variation .455
Lead acetate method.

Sheet 22.

	Front.	Middle.	Back.
A	2.150	2.019	1.863
B	2.124	1.949	2.133
C	2.183	1.979	1.728

Average of tests 2.014
Actual average 1.800
Extreme variation .455
Antimony-acid method, 45 seconds' immersion.

Sheet 23.

	Front.	Middle.	Back.
A	2.499	2.225	2.615
B	2.671	2.396	2.209
C	2.648	2.360	1.943

Average of tests 2.396
Actual average 2.310
Extreme variation .728
Antimony-acid method, 30 seconds' immersion.

Sheet 27.

	Front.	Middle.	Back.
A	2.008	2.022	1.923
B	2.259	2.190	1.882
C	2.108	1.802	1.962

Average of tests 2.017
Actual average 1.980
Extreme variation .457
Antimony-acid method, 30 seconds' immersion.

MILL II.

Sheet 7.

	Front.	Middle.	Back.
A	2.062	2.019	1.828
B	2.000	1.678	1.956
C	1.850	1.733	1.996

Average of tests 1.902
Actual average 1.670
Extreme variation .385
Antimony-acid method, 30 seconds' immersion.

Sheet 9.

	Front.	Middle.	Back.
A	2.071	2.040	2.040
B	2.271	1.935	1.895
C	2.260	2.136	2.017

Average of tests 2.074
Actual average 1.960
Extreme variation .376
Lead acetate method.

Sheet 12.

	Front.	Middle.	Back.
A	2.537	2.430	2.463
B	2.324	2.383	2.291
C	2.259	2.541	2.256

Average of tests 2.387
Actual average 2.190
Extreme variation .285
Antimony-acid method, 30 seconds' immersion.

Sheet 15.

	Front.	Middle.	Back.
A	1.915	1.764	1.815
B	2.316	1.867	2.076
C	2.076	2.015	2.048

Average of tests 1.988
Actual average 1.790
Extreme variation .552
Antimony-acid method, 30 seconds' immersion.

Sheet 19.

	Front.	Middle.	Back.
A	2.270	1.970	2.389
B	2.315	1.880	1.212
C	2.198	2.110	2.076

Average of tests 2.040
Actual average 2.000
Extreme variation 1.177
Antimony-acid method, 30 seconds' immersion.

Sheet 20.

	Front.	Middle.	Back.
A	2.560	1.988	2.227
B	2.354	1.737	2.047
C	2.407	2.234	2.192

Average of tests 2.194
Actual average 2.070
Extreme variation .823
Antimony-acid method, 30 seconds' immersion.

MILL III.

Sheet 5.

	Front.	Middle.	Back.
A	1.160	2.002	2.094
B	2.057	1.856	1.956
C	2.048	1.913	1.950

Average of tests 1.892
Actual average 1.890
Extreme variation .934
Antimony-acid method, 30 seconds' immersion.

Sheet 6.

	Front.	Middle.	Back.
A	1.959	1.877	1.886
B	2.031	1.894	1.961
C	2.093	1.805	1.963

Average of tests 1.941
Actual average 1.810
Extreme variation .288
Lead acetate method.

Sheet 12.

	Front.	Middle.	Back.
A	2.141	1.989	2.102
B	2.286	2.016	2.052
C	2.128	1.972	2.133

Average of tests 2.091
Actual average 2.000
Extreme variation .314
Antimony-acid method, 30 seconds' immersion.

Sheet 13.

	Front.	Middle.	Back.
A	2.222	2.149	2.175
B	2.531	2.249	2.290
C	2.393	2.245	2.284

Average of tests 2.282
Actual average 2.260
Extreme variation .384
Antimony-acid method, 30 seconds' immersion.

Sheet 51.

	Front.	Middle.	Back.
A	2.011	1.994	1.958
B	2.325	2.046	2.084
C	2.081	2.039	2.127

Average of tests 2.074
Actual average 1.970
Extreme variation .367
Antimony-acid method, 30 seconds' immersion.

Sheet 57.

	Front.	Middle	Back.
A	2.018	1.849	1.980
B	2.160	2.005	2.016
C	1.556	1.987	1.953

Average of tests 1.947
Actual average 1.840
Extreme variation .604
Antimony-acid method, 30 seconds' immersion.

SHEET 59.

	Front.	Middle.	Back.
A	2.091	2.066	2.089
B	2.383	2.284	2.253
C	2.407	2.305	2.199

Average of tests 2.231
Actual average 2.200
Extreme variation ..... .341

Antimony-acid method, 30 seconds' immersion.

MILL IV.

SHEET 4.

	Front.	Middle.	Back.
A	1.998	1.914	1.993
B	1.921	2.011	1.753
C	2.179	1.999	1.941

Average of tests 1.970
Actual average 1.990
Extreme variation ..... .426

Antimony-acid method, 30 seconds' immersion.

SHEET 8.

	Front.	Middle.	Back.
A	2.192	2.121	2.071
B	2.171	2.302	1.994
C	2.061	1.993	2.121

Average of tests 2.114
Actual average 2.010
Extreme variation ..... .309

Antimony-acid method, 30 seconds' immersion.

SHEET 9.

	Front.	Middle.	Back.
A	2.435	2.245	2.593
B	2.298	2.355	2.282
C	2.401	2.619	2.402

Average of tests 2.403
Actual average 2.300
Extreme variation ..... .374

Antimony-acid method, 30 seconds' immersion.

SHEET 10.

	Front.	Middle.	Back.
A	2.267	2 206	2.501
B	2 282	2.212	2.418
C	2.524	2 315	2 103

Average of tests 2.314
Actual average 2.240
Extreme variation ..... .418

Antimony-acid method, 30 seconds' immersion.

INSPECTION OF SHEETS AT MILL.

A study of these results reveals several points of interest. In the first place it is evident that there is a great lack of uniformity in the coating on different parts of a sheet. In fact, the variation may amount to as much as 50 per cent of the average for the sheet, or over 1 ounce. In general, however, it was not more than half of that, the average variation for the 26 sheets being 0.522. Furthermore, the practice at the various mills seems to be very much the same. This shows clearly how little reliance can be placed on the results from one or two small test pieces. In order to secure an adequate idea of the spelter coating on a shipment of culverts it would be necessary to take quite a large number of samples, and even then the question might be raised as to whether they were truly representative. Such thorough sampling as really seems necessary involves considerable work both in the field and in the laboratory, and of course works great injury to the culverts themselves.

It would be very much better if a system could be worked out whereby the sheets could be inspected at the mill, by weighing before and after galvanizing. Such inspection might consist of weighing and branding every sheet, or it might be found practicable to weigh an occasional sheet and certify shipments on the results of such tests. Any reasonable arrangement of this sort would be welcomed by the manufacturers and would obviously be of great advantage to highway engineers and contractors.

METHOD OF ANALYSIS TO BE USED.

However desirable a system of mill inspection may be, there seems no doubt that for the present, and at times, even when we have such a system, the "spot test" will be used. Therefore, in addition to care and thoroughness in sampling, it seems well to give some thought to the method of analysis to be used.

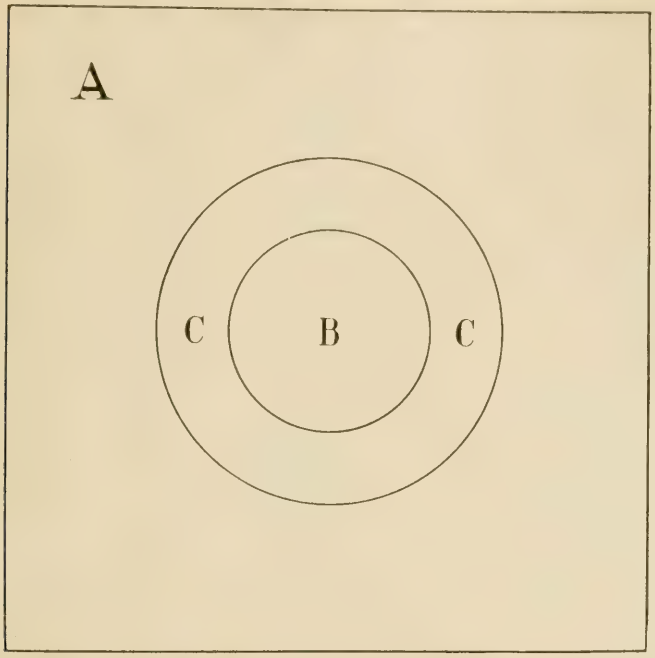
The hydrochloric acid-antimony chloride method is very quick and neat and it has been stated by many chemists that it is quite as accurate as the lead acetate method. Four sheets were analyzed by the acid method with one minute immersion as is usually prescribed. The average of these tests was 0.305 ounces higher than the actual average of the sheets. The time of immersion was then reduced to 45 seconds and this gave for one sheet an average of 0.214 above the actual. The time was then reduced to 30 seconds, and 17 sheets analyzed in this way gave an average of only 0.087 above the actual. For the purpose of comparison 4 sheets were done by the lead acetate method and these gave an average of 0.146 above the actual.

It is, of course, realized that this series of tests is too limited to serve as a basis for definite conclusions, and yet it is of interest to note that when the acid method was used with one minute immersions the results were much too high and that when the time was reduced to 30 seconds the results were remarkably accurate; more so, in fact, than those given by the lead acetate method. It would seem that these indications are worthy of careful study.

AMOUNT OF SPELTER PERMISSIBLE.

Another point to which attention was given while at the mills, was the amount of spelter that can be applied to sheets without danger of its cracking or peeling during corrugation and fabrication. This seemed to be of importance because of the claim made by some manufacturers that a coating much over 1.5 ounces was apt to be loosely adherent. It will perhaps be sufficient to state that pieces from the sheets discussed above and also a considerable number of others, all of which carried known weights of spelter, were corrugated and curved into 12 and 15 inch culverts. In the case of one sheet only was there sufficient flaking to justify an inspector in rejecting the culvert. That sheet carried 2.32 ounces of spelter, a rather heavy coating: and yet a number of

other sheets with quite as much, and in one case as high as 2.83, were fabricated without difficulty.



Hence there seems to be little reason for doubting that considerably more than 2 ounces per square foot may be safely applied. It is not to be understood that the coatings were in every case free from cracks. In some cases very slight cracks were observed on the outside of the lap where the metal had been bent rather sharply, but these were not considered important.

Zinc being electropositive with respect to iron, exerts a protective action at a considerable distance. This is well illustrated by an experiment which is quite familiar in all laboratories where this subject has been studied. If a piece of steel, A, has a hole bored in it and this hole is filled with a plug of zinc, B, and the entire surface polished smooth and bright, it will be found that the steel in the immediate vicinity of the zinc, C, will remain bright even under the most severe conditions of exposure. This protected area will usually extend for about three-eighths of an inch from the edge of the zinc. If the plug had been of tin, copper, or any other metal electronegative with respect to iron, the reverse would be true and corrosion of the iron would be more marked in the vicinity of the plug than elsewhere. For this reason, the slightest cracks or pin-holes in tin-plate constitute defects of the most serious character, but in the case of zinc coating they are of less importance.

FEDERAL AID ALLOWANCES.

PROJECT STATEMENTS APPROVED IN APRIL, 1920.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost.	Federal aid.
Arizona	26	Yuma	23.900	Selected material	Apr. 26	$250,910.00	$125,455.00
Arkansas	84	Conway	14.150	Bituminous surface	Apr. 2	117,156.32	47,156.59
	62	Washington	18.280	Gravel	Apr. 6	35,493.37	15,500.00
	70	Searcy	17.540	Macadam	Apr. 7	101,970.00	40,000.00
	87	Pope	8.230	Bituminous	Apr. 2	112,150.19	50,000.00
	44	Lonoke	12.880	Gravel	Apr. 9	96,811.55	13,000.00
	79	Conway	8.250	Bituminous	Apr. 16	117,411.18	31,000.00
	73	Searcy		Bridges	Apr. 9	17,281.00	7,200.00
	43	Lincoln and Desha	2.050	Gravel	Apr. 24	22,579.92	7,700.00
	90	Nevada	16.360	Macadam	Apr. 26	143,280.55	68,000.00
	91	Arkansas	13.950	Warrenite	do	466,526.68	57,000.00
California	53	Mariposa	7.270	Earth	Apr. 2	623,252.30	165,112.00
	54	do	5.690	do	do	224,329.60	112,161.80
	55	San Diego	4.600	Concrete	Apr. 21	122,637.35	61,318.67
	56	Shasta	15.670	do	Apr. 24	376,200.00	188,100.00
Colorado	71	La Plata	12.005	Earth	Apr. 2	99,468.30	49,734.15
	68	Rio Grande	11.358	Gravel	Apr. 7	84,740.94	42,370.47
	58	Prowers	3.144	do	Apr. 12	30,986.78	15,493.39
	117	El Paso	0.932	Concrete	Apr. 26	49,780.50	18,640.00
Georgia	131	Jackson	7.150	Sand-clay	Apr. 2	67,201.10	33,600.55
	133	Troup		Bridge	Apr. 6	134,728.44	50,000.00
	135	Elbert	10.500	Topsoil	Apr. 7	57,805.00	25,000.00
	110	Morgan	4.626	Concrete	Apr. 14	[1] 86,815.30	[1] 43,058.03
Idaho	35	Caribou	3.830	Crushed rock	Apr. 3	47,935.80	23,967.90
	38	Butte	16.000	Gravel	do	90,000.00	30,000.00
	39	Lewis	4.270	Crushed rock	Apr. 2	55,999.35	20,000.00
	40	Washington	20.000	Earth	do	194,940.90	97,470.45
	41	Teton	9.750	Gravel	do	89,999.80	32,500.00
	46	Bonneville	2.710	Concrete or bituminous	Apr. 26	85,520.93	[2] 42,760.46
	21	do	3.540	do	do	[2] 85,520.94	[2] 42,760.47
Illinois	12	Edgar and Clark	28.860	Concrete and brick	Apr. 21	1,197,647.48	598,823.74
Kansas	54	Sedgwick	5.590	Concrete	Apr. 7	375,328.24	73,950.00
	52	Wyandotte and Leavenworth	8.120	do	Apr. 9	377,058.00	121,800.00
	53	Doniphan	6.110	do	Apr. 26	311,025.00	91,650.00
Kentucky	27	Perry	3.140	Asphalt surface	Apr. 2	193,944.58	62,800.00
	28	Barren	25.850	Macadam	Apr. 12	342,601.49	171,300.74
Louisiana	66	Tensas	21.070	Gravel	Apr. 6	334,503.45	167,251.72
	65	Martin	4.950	do	Apr. 9	75,312.52	37,656.26
	41	Jefferson	2.880	Shell	do	30,466.48	15,233.24
	17	Tangipahoa	4.910	Sand-clay	Apr. 12	65,541.08	32,770.54
	56	La Salle	12.980	Gravel	Apr. 21	111,820.83	55,910.41
	53	Madison	10.490	Sand-clay	Apr. 26	134,332.55	67,166.27
	54	St. Bernard	3.220	Macadam	Apr. 30	73,282.22	36,641.11

[1] Withdrawn.

[2] Amounts given are decreases over those in original statements.

PROJECT STATEMENTS APPROVED IN APRIL, 1920—Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost.	Federal aid.
Maine	22	Kennebec	2.870	Bituminous macadam	Apr. 2	$90,893.88	$45,446.94
	23	....do	8.570	....do	...do	268,003.89	134,001.94
	24	Aroostook	3.310	Gravel	Apr. 9	55,656.04	27,828.02
	25	....do	6.510	....do	Apr. 26	112,828.32	56,414.16
Massachusetts	33	Middlesex	3.806	Macadam	Apr. 7	176,572.00	76,120.00
	36	Barnstable	25.456	Sand asphalt	Apr. 26	440,075.90	220,037.95
	34	Worcester	1.359	Concrete	Apr. 24	66,715.00	27,180.00
Michigan	33	Alcona and Alpena	26.976	Gravel	Apr. 2	462,538.98	231,269.49
Minnesota	79	Hubbard	8.810	....do	Apr. 3	48,126.10	24,063.05
	106	Benton	14.980	Concrete	...do	580,773.16	290,386.58
	115	McLeod	9.960	Gravel	...do	52,838.50	26,419.25
	157	Stasca	0.790	Brick, concrete, or asphalt	...do	31,026.20	15,513.10
	89	Le Sever	7.500	....do	...do	275,638.00	137,819.00
	108	Grant	15.370	Gravel	...do	89,860.10	44,930.05
	143	Beltrami	6.270	....do	Apr. 7	34,964.60	17,482.30
	156	....do	9.000	....do	...do	47,960.00	23,980.00
	169	Hubbard	7.460	....do	...do	40,869.40	20,434.70
	133	Waseca	14.260	....do	Apr. 12	111,174.80	55,587.40
	135	Beltrami	3.000	....do	...do	12,320.00	6,160.00
	152	Wadena	7.000	....do	...do	45,155.00	22,577.50
	153	Blue Earth	17.250	....do	...do	97,570.00	48,785.00
	158	Stasca	15.560	....do	...do	100,658.80	50,329.40
Mississippi	55	Panola	33.800	Earth	Apr. 2	213,015.00	100,000.00
Missouri	92	Marion	20.000	Gravel	Apr. 24	249,943.38	124,971.69
	96	Platte	13.700	Earth	Apr. 12	120,385.34	60,192.67
	93	....do	12.060	....do	Apr. 21	231,950.24	115,975.12
	95	Howard	1.000	Chat	...do	11,800.00	5,900.00
	94	Buchanan	0.376	Concrete	Apr. 24	29,899.26	7,520.00
Montana	84	Roosevelt	98.000	Gravel	Apr. 2	279,400.00	139,700.00
	95	Hill	36.000	....do	...do	209,880.00	104,940.00
	85	Fergus	18.000	Earth	Apr. 6	66,000.00	33,000.00
	92	Granite	8.000	....do	Apr. 2	59,939.00	29,969.50
	103	Fergus	39.000	Concrete and gravel	...do	191,400.00	95,700.00
	106	Carbon	12.000	Gravel	Apr. 9	77,932.80	38,966.40
	107	....do	8.800	....do	...do	46,545.77	23,272.88
	66	Blaine	13.000	....do	Apr. 26	74,971.60	37,485.80
	58	Flathead	3.000	Crushed rock	Apr. 24	10,988.56	5,494.28
	97	Broadwater	15.800	....do	Apr. 26	79,125.75	39,562.87
	101	Blaine	11.000	Gravel	...do	47,960.00	23,980.00
	63	Missoula	19.900	....do	Apr. 30	89,281.72	44,640.86
	102	Flathead	4.000	....do	Apr. 26	19,552.50	9,776.25
	105	Park	6.800	....do	Apr. 24	55,306.02	27,653.01
	31	....do	3.600	....do	Mar. 11	21,903.20	10,951.60
	32	....do	3.000	....do	...do	21,100.20	10,550.10
Nebraska	141	Rock and Brown	10.800	Sand clay	Apr. 6	59,899.84	29,949.92
	144	Morrill and Scotts Bluffs	16.400	Gravel	...do	78,936.00	39,468.00
	55	Saline	11.000	Earth	Apr. 9	42,570.00	21,285.00
Nebraska	108	Cherry and Sheridan	59.509	....do	...do	255,849.00	127,924.50
	145	Harlem and Phelps	25.900	....do	Apr. 26	97,977.00	48,988.50
	146	Keith	21.400	Sand clay	...do	102,410.00	51,205.00
Nevada	29	Washoe	10.483	Concrete	Apr. 3	369,194.33	184,597.16
	30	Ormsby	3.490	....do	Apr. 2	118,953.16	59,476.58
	28	Douglas	0.630	....do	Apr. 24	28,013.81	12,600.00
New Hampshire	90	Hillsborough	1.300	Asphalt	Apr. 7	25,000.00	12,500.00
	101	Rockingham	1.536	....do	Apr. 9	35,000.00	17,500.00
	106	Hillsborough	0.379	Gravel	Apr. 7	9,000.00	4,500.00
	100	Belknap	0.800	....do	Apr. 9	10,007.58	5,003.79
	91	Grafton	0.890	....do	Apr. 12	12,000.00	6,000.00
	104	Merrimack	0.820	....do	Apr. 21	10,000.00	5,000.00
	94	Cheshire	0.419	....do	Apr. 26	11,992.03	5,996.01
	97	....do	0.625	Bituminous macadam	...do	20,000.00	10,000.00
	103	Merrimack	0.455	Gravel	...do	10,000.00	5,000.00
	105	....do	1.140	....do	...do	14,097.73	7,048.86
	108	Grafton	1.930	Bituminous macadam	...do	65,000.00	32,500.00
	110	Merrimack	1.330	Asphalt	...do	25,000.00	12,500.00
	96	Hillsborough	0.380	Gravel	Apr. 24	7,500.00	3,750.00
	102	Merrimack	0.910	....do	Apr. 30	10,000.00	5,000.00
	109	Strafford	0.797	....do	...do	15,100.00	7,550.00
	113	Hillsborough	0.420	Bituminous macadam	...do	6,010.29	3,005.14
	114	Strafford	1.600	Gravel	...do	25,000.00	12,500.00
	115	Rockingham	1.210	....do	...do	15,000.00	7,500.00
New Jersey	27	Sussex	7.005	Concrete	Apr. 2	477,327.78	140,100.00
	28	Camden	4.907	....do	...do	226,949.54	98,140.00
	29	Atlantic	9.356	....do	Apr. 24	492,250.00	187,120.00
	30	Mercer, Burlington	2.457	....do	...do	166,722.82	49,140.00
	21	Morris	[1] 6.592	....do	Apr. 5	[1] 597,917.23	[1] 156,840.00
New Mexico	25	Atlantic and Burlington	[1] 2.253	Gravel	...do	[1] 88,044.65	[1] 44,022.32
New York	44	Hidalgo	8.000	....do	Apr. 24	53,807.60	26,903.80
	48	Wayne	1.600	Concrete	Apr. 3	64,000.00	32,000.00
	49	....do	1.100	....do	...do	44,000.00	22,000.00
	57	Genesee	2.100	....do	...do	84,000.00	42,000.00
	44	....do	2.800	....do	...do	112,000.00	56,000.00
	53	Jefferson	3.300	....do	...do	132,000.00	66,000.00
	60	Herkimer	1.200	....do	...do	48,000.00	24,000.00
	59	Hamilton	9.200	Bituminous macadam	...do	331,200.00	165,600.00
	32	Fulton and Saratoga	11.600	Concrete	Apr. 9	464,000.00	232,000.00
	51	Rockland	3.500	....do	Apr. 12	140,000.00	70,000.00
	52	Dutchess	3.900	....do	Apr. 9	156,000.00	78,000.00
	54	Madison	6.200	....do	...do	248,000.00	124,000.00
	55	Franklin	8.100	....do	...do	324,000.00	162,000.00
	56	Dutchess	5.000	....do	...do	200,000.00	100,000.00
	58	Cheming	2.800	....do	...do	112,000.00	56,000.00
	59	Onondaga	4.000	....do	...do	160,000.00	80,000.00
	61	Livingston	5.300	....do	Apr. 12	212,000.00	106,000.00
	15	Otsego	[1] 5.070	Macadam	Apr. 10	[1] 101,400.00	[1] 50,700.00
	23	Schoharie	2.760	Concrete	...do	94,100.00	47,050.00
North Dakota	75	Mountrail	16.000	Earth	Apr. 6	57,705.00	28,875.00
	86	Ward	12.000	Gravel	Apr. 3	67,320.00	33,660.00
	62	McLean	10.000	Earth	...do	31,460.00	15,730.00
	85	Ward	14.000	Gravel	Apr. 12	78,540.00	39,270.00
	83	....do	10.000	....do	Apr. 30	47,300.00	23,650.00
Ohio	137	Sandusky	6.540	Brick	Apr. 9	395,000.00	106,000.00
Oklahoma	30	Nowata	5.000	Gravel	Apr. 2	41,800.00	20,900.00

[1] Withdrawn.

PROJECT STATEMENTS APPROVED IN APRIL, 1920—Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost.	Federal aid.
Oregon	44	Gilliam	8.880	Gravel	Apr. 6	$63,624.00	$31,812.00
	39	Deschutes	17.500	Crushed rock	Apr. 7	179,057.89	89,528.94
	43	Crook	15.150	Gravel	...do...	168,301.48	84,150.74
	42	Umatilla	22.000	Gravel and crushed rock	Apr. 21	133,925.00	66,962.50
Pennsylvania	68	York	6.052	Concrete	Apr. 2	286,481.36	121,040.00
	69	...do	4.878	...do	...do...	245,996.10	97,560.00
	70	Adams	5.594	...do	...do...	315,639.67	111,880.00
	73	Adams and Franklin	8.364	...do	Apr. 9	457,258.49	167,280.00
	72	Adams	8.741	...do	...do...	454,998.17	174,820.00
	75	Erie	6.722	Concrete or bituminous	Apr. 12	398,063.40	134,440.00
	71	Lawrence	5.423	Concrete	...do...	289,910.70	108,460.00
	78	Monroe	7.094	Concrete and brick	Apr. 24	435,671.40	141,880.00
	76	Mercer	9.168	Concrete	...do...	484,578.10	183,360.00
South Dakota	23	Jackson and Washabaugh	7.950	Gravel	Apr. 2	[1] 47,752.22	[1] 23,876.11
Tennessee	32	Lauderdale	7.717	Macadam	Apr. 6	268,735.02	134,367.51
	35	Hamilton	10.143	Concrete	...do...	405,702.29	202,851.14
	43	Shelby	7.429	Bituminous macadam	Apr. 3	172,501.28	86,250.64
	26	Maury	11.872	...do	Apr. 24	460,557.24	230,278.62
Texas	93	Cameron	3.106	Concrete	Apr. 3	113,816.20	30,000.00
	132	Parker	31.600	Gravel	...do...	602,712.00	200,000.00
	143	Denton	8.000	...do	...do...	204,476.20	100,000.00
	149	Orange	10.000	Concrete	Apr. 6	400,070.00	200,000.00
	137	Limestone	28.329	Gravel and crushed rock	Apr. 9	325,205.49	92,600.00
	131	Bexar	16.000	Gravel and bituminous surface	...do...	179,122.02	81,078.81
	142	Harrison	23.210	Gravel	Apr. 12	378,596.83	189,298.41
	154	Bastrop	2.280	...do	...do...	20,534.56	10,267.28
	162	Potter	22.973	Bituminous	Apr. 26	575,000.00	200,000.00
	155	Gaudalupe	18.500	Gravel	...do...	149,814.50	74,907.25
	160	Upshur	8.988	...do	...do...	79,100.54	39,550.27
	153	Rains	22.300	...do	Apr. 24	265,738.26	100,000.00
	156	Titus	5.110	...do	Apr. 30	39,400.21	19,700.10
	159	Shelby	31.900	...do	...do...	565,523.66	141,380.91
	54	Walker	5.300	Gravel or macadam	Apr. 14	[2] 14,341.80	[2] 7,170.00
Utah	24	Carbon	11.030	Concrete	Apr. 12	606,725.53	222,582.42
Vermont	15	Chittenden	4.034	Macadam surface	Apr. 6	153,258.60	76,629.30
Washington	60	Snohomish	3.090	Concrete	Apr. 2	112,056.34	56,028.17
	58	Mason	1.960	Gravel	Apr. 6	29,499.80	14,749.90
	63	Stevens	4.060	...do	Apr. 21	32,743.70	16,371.85
	61	Lewis	1.240	...do	Apr. 24	34,215.50	17,107.75
	69	Chelan	1.700	Concrete	...do...	64,533.26	32,266.63
	62	Yakima	5.760	...do	Apr. 26	237,893.31	75,000.00
	51	Pierce	4.270	...do	Apr. 6	184,772.72	85,400.00
West Virginia	89	Logan	2.700	...do	Apr. 7	107,998.00	53,536.42
	91	Barbour	2.000	Macadam	Apr. 9	55,680.00	27,840.00
	93	Monongalia	2.120	Concrete	...do...	81,100.00	31,120.00
	92	Brooke	0.960	...do	...do...	24,324.30	10,240.00
Wisconsin	117	Shawano	5.020	Gravel	...do...	63,000.71	21,700.00
	143	Calumet	4.820	Concrete	Apr. 12	162,000.00	54,000.00
	104	Ozaukee	2.460	...do	...do...	90,092.20	30,000.00
	110	Waukesha	3.040	...do	Apr. 16	101,147.15	31,000.00
	131	Adams	4.500	Sand-clay	Apr. 12	45,031.14	16,000.00
	133	Waushara	2.320	...do	...do...	18,436.57	7,000.00
	159	Washington	1.710	Concrete	...do...	60,394.16	20,750.00
	162	Kenosha	3.010	...do	...do...	123,377.82	43,388.00
	163	Kewaunee	2.970	Gravel	Apr. 15	43,964.45	19,500.00
	165	Vilas	9.510	Sand-clay or gravel	Apr. 30	59,999.96	21,000.00
Wyoming	76	Park	4.964	Selected material	Apr. 2	49,808.00	24,904.00
	62	Sweetwater	16.190	...do	...do...	50,710.00	25,355.00
	67	Johnson	7.360	...do	Apr. 9	57,640.00	28,820.00
	77	Fremont	.....	Bridge	...do...	12,232.00	6,116.00
	64	Carbon	7.424	Crushed rock	...do...	73,040.00	36,520.00
	66	Campbell	21.400	Selected material	...do...	159,280.00	79,640.00
	69	Johnson	10.750	...do	...do...	83,710.00	41,855.00
	73	Laramie	9.476	...do	...do...	71,390.00	35,695.00
	78	Fremont	9.133	...do	Apr. 12	51,150.00	25,575.00
	87	...do	4.116	...do	Apr. 24	88,440.00	44,220.00
	22	Lincoln	.....	Bridge	Apr. 12	[1] 115,720.00	[1] 57,860.00

[1] Amounts given are increases over those in original statements. [2] Withdrawn.

PROJECT AGREEMENTS EXECUTED IN APRIL, 1920.

State.	Project No.	County.	Length in miles.	Type of construction.	Project agreement signed.	Estimated cost.	Federal aid.
Alabama	60	Monroe	9.230	Gravel	Mar. 15	$26,734.18	$13,367.09
Arizona	18 C, D	Pima and Cochise	11.060	Local material	Apr. 2	36,172.27	18,086.13
Arkansas	45	Lonoke	6.420	G ravel with asphalt treatment	Apr. 9	84,741.69	21,000.00
	31	Cleveland	8.030	Gravel	Apr. 1	85,880.02	23,000.00
	56	...do	4.000	Clay-bound gravel	Apr. 9	19,026.70	8,700.00
	34	Cross	2.550	Gravel and macadam	Apr. 22	26,477.00	13,200.00
Georgia	79	Bibb	6.614	Concrete	Apr. 2	255,448.57	110,855.20
	63	Wilkes	0.616	Bituminous macadam	Apr. 17	16,774.49	8,387.24
	121	Randolph	5.549	Sand-clay	Apr. 10	35,069.93	15,000.00
	61	Wilkes	2.143	Bituminous macadam	...do...	61,015.98	30,507.99
	62	...do	0.568	...do	Apr. 17	15,323.69	7,661.84
	12	Thomas	.....	Concrete bridges	Mar. 13	[1] 15,333.78	[1] 7,666.89
	4	Ocomee and Walton	.....	Sand-clay	Apr. 2	[2] 42,247.96	[2] 26,258.70
Idaho	10	Elmore	12.530	Gravel	Apr. 17	96,313.20	48,156.60
	12	...do	7.400	Crushed lava rock	...do...	74,953.06	37,476.53
Illinois	2K-15d	Kankakee	2.114	Concrete	Apr. 15	66,283.36	33,141.68
	8T	Macoupin	2.998	...do	...do...	157,189.58	65,651.95
	9-36	Bond	3.830	...do	...do...	152,712.71	76,356.35
	9-33	Madison	3.743	...do	...do...	153,646.59	76,823.29
	9-34	Bond	3.657	...do	...do...	150,506.66	75,253.33
	9-35	...do	4.519	...do	...do...	309,748.16	144,695.54
	6I	Peoria	4.952	...do	...do...	176,399.27	88,199.63
	2-5	Iroquois and Kankakee	8.435	...do	...do...	291,866.05	145,933.02
	2-4	Iroquois	6.503	...do	...do...	165,649.75	82,824.87
	6L	Peoria	1.594	...do	.....	78,099.05	31,880.00
Indiana	4	Putnam and Hendricks	8.103	...do	Apr. 2	373,004.90	162,060.00

[1] Modified agreements. Second revision. Increase. [2] Modified agreements. Amounts given are increases over those in the original agreements.

PROJECT AGREEMENTS EXECUTED IN APRIL, 1920—Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project agreement signed.	Estimated cost.	Federal aid.
Kansas	13A, B	Leavenworth	5.073	Concrete	Apr. 2	$243,278.48	$76,095.00
	34A	Bourbon	5.910	Bituminous macadam	Apr. 1	151,153.20	75,576.60
	3D	Barton	5.265	Brick and concrete	Apr. 12	175,657.98	78,975.00
	5A, B	Bourbon	8.694	Bituminous macadam	Apr. 16	218,139.31	109,069.65
	29D, G	Dickinson	3.960	Brick	Apr. 14	270,426.10	59,400.00
	38	Greenwood	5.858	Concrete	do	261,225.21	87,870.00
	18	Allen	0.920	do	Apr. 28	42,211.21	13,800.00
	33A	Bourbon	3.980	Bituminous macadam	Apr. 16	108,094.33	54,047.16
	13C	Leavenworth	4.416	Concrete	Apr. 28	201,503.08	66,240.09
Kentucky	18	Jefferson	4.507	do	Apr. 7	193,722.12	95,674.80
	19	Mercer	7.133	Water-bound macadam	do	92,745.22	46,372.61
Michigan	4A	Presque Isle		Gravel	Apr. 2	[1] 5,388.89	[1] 2,780.92
Minnesota	51	Crow Wing	19.290	do	Apr. 6	143,428.18	54,000.00
	87	Yellow Medicine	5.973	do	Apr. 9	37,163.09	17,000.00
	36	Fairbault	24.110	do	Apr. 21	198,283.75	73,000.00
Mississippi	20	Walthall	16.230	do	do	120,278.62	60,000.00
	16	Simpson		do	Apr. 2	[1] 13,541.51	[1] 6,770.66
Nebraska	34A	Garfield	5.940	Sand-clay	Apr. 11	45,467.22	22,733.61
	35A	Douglas	1.905	Earth	do	11,356.56	5,678.28
	71	Harlan and Franklin	27.400	do	Apr. 26	229,528.93	114,764.46
	72A	Cedar	10.448	do	Apr. 11	63,003.43	31,501.72
	98B	Lancaster	11.917	do	do	45,003.39	22,501.69
	115	Platte	2.590	Concrete	do	134,811.76	51,800.00
	27	Saunders and Dodge		Earth and gravel	do	[2] 21,552.72	[2] 10,776.36
New Hampshire	80	Rockingham		Concrete bridge	Apr. 9	[1] 1,047.20	[1] 523.60
	28	Merrimack and Grafton		Gravel	Apr. 14	[1] 1,113.20	[1] 556.60
New Mexico	26	Bernalillo	9.563	Concrete	Apr. 6	313,546.43	156,773.21
New York	17	Wayne	5.020	Reinforced concrete	Apr. 21	198,200.00	99,100.00
	18	do	5.950	do	Apr. 22	238,000.00	119,000.00
	36	Broone	4.350	do	do	174,000.00	87,000.00
North Carolina	67B	Nash	3.810	Topeka on concrete base	Apr. 10	158,393.54	76,200.00
	86A	Mastin and Bertie	3.090	Top soil	do	98,454.67	49,227.33
	91	Surry	10.680	do	do	112,416.31	56,207.65
	92A	do	10.827	do	do	106,022.62	53,011.31
	39	Union	12.890	Bituminous macadam or topsoil	Apr. 9	155,336.69	77,668.34
	36	Durham	4.019	Concrete and topsoil road	Apr. 22	[3] 84,991.72	
North Dakota	25	Ward	0.290	Gravel	Apr. 14	[1] 1,425.05	[1] 712.53
Ohio	76	Belmont	4.454	Water-bound macadam	Apr. 6	106,000.00	40,000.00
Oklahoma	12	Tulsa	48.070	Concrete	Apr. 27	1,270,469.46	600,000.00
	16	Hughes		Bridge	do	160,250.36	80,125.18
South Carolina	37A	Aiken	11.685	Sand-clay and gravel	Apr. 9	71,168.93	35,584.46
Tennessee	17	Overton	13.245	Limestone macadam	Apr. 26	269,741.37	134,870.68
	24	Marion	2.318	Water-bound macadam	Apr. 12	85,856.27	42,928.13
	30	Tipton	5.152	Bituminous macadam	do	148,305.74	74,152.80
Texas	53B	Jefferson	3.990	Asphalt on concrete base	Apr. 22	149,717.78	56,999.97
	96	Fisher	8.720	Gravel	Apr. 26	83,704.11	37,034.08
	105	Wood	11.534	do	do	120,258.64	41,500.00
	103	Milam	9.060	do	Apr. 30	53,785.55	26,892.77
	75	Falls		Gravel and stone	Apr. 22	[1] 21,396.46	[1] 11,856.35
Washington	32	Cawlitz	6.670	Gravel	Apr. 26	265,449.42	132,724.71
West Virginia	65	Logan	1.121	Concrete	Apr. 10	41,561.20	20,780.60
	86	Mingo	3.050	Earth	do	43,794.30	21,600.00
	48	Boone		do	Apr. 21		[1] 6,950.50
Wyoming	43	Platte	6.778	do	Apr. 22	28,066.50	14,033.20
	54	Big Horn	3.683	Selected material	Apr. 9	43,844.28	21,922.14

[1] Modified agreements. Amounts given are increases over those in the original agreement.
[2] Modified agreements. Second revision. Increase.
[3] Modified agreements. Amounts given are decreases from those in the original agreement.

NEBRASKA BUYS GRAVEL PIT.

Under the provisions of the law passed by the 1919 legislature the department of public works may acquire land and equipment for road building purposes. The section of the law dealing with this provision is quoted as follows:

That for the purpose of obtaining road materials to be used in the construction and maintenance of State highways built by or maintained under the supervision of the department of public works, said department is hereby empowered, on behalf of the State, to acquire lands and appurtenances thereto, either by purchase or by condemnation proceedings, in the manner provided by law. Said board may also purchase all necessary equipment and employ the necessary labor to remove such materials from said lands; to prepare such materials for use; and to manufacture such materials into road-making products, and may sell any surplus of such materials or products to any county or counties, or to any municipalities of the State, or to any contractor, at actual cost, for building and maintaining roads, streets, and alleys only, and the funds received therefor shall be, by said department, paid into the State treasury and credited to the State aid road fund. The cost of acquiring said lands and appurtenances, the purchase of equipment, and the use of such equipment as provided for in this section, shall be paid out of the State aid road fund.

In accordance with the provisions of the law quoted above, the department purchased May 1 a gravel pit located northeast of the town of Ashland, on the O. L. D. highway and C. B. & Q. tracks. The pit contains 750,000 cubic yards of gravel, and the site consists of 63.29 acres. The sand available in the pit may well be used for building purposes, as it is of a desirable kind. The 750,000 cubic yards of gravel is the most desirable feature, as the State is contemplating building gravel and concrete roads on many of the road projects.

The pit is located in a very desirable position, as it adjoins the Burlington Railroad, and a spur can be run very easily through the center of the location. Because of this feature, two drag lines can be operated at the same time, and the output nearly doubled, and loaded directly into the cars on track.

Another feature of the location that is of importance, is that it is located on the O. L. D. highway between Omaha and Lincoln. At the present rate of improvement it is estimated that 75 per cent of the total of 69 miles between Omaha and Lincoln will be improved after the 1920 and 1921 highway work has been completed. A large portion of this mileage will be paved, it is anticipated, and perhaps the remainder will be graveled.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

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.

REPORTS.

*Report of the Director of the Office of Public Roads for 1916. 5c.
*Report of the Director of the Office of Public Roads for 1917. 5c.
Report of the Director of the Bureau of Public Roads for 1918.
Report of the Chief of the Bureau of Public Roads for 1919.

DEPARTMENT BULLETINS.

Dept. Bul. 105. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913.
136. Highway Bonds.
220. Road Models.
230. Oil Mixed Portland Cement Concrete.
249. Portland Cement Concrete Pavements for Country Roads.
257. Progress Report of Experiments in Dust Prevention and Road Preservation, 1914.
314. Methods for the Examination of Bituminous Road Materials.
347. Methods for the Determination of the Physical Properties of Road-Building Rock.
*348. Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials. 10c.
370. The Results of Physical Tests of Road-Building Rock.
373. Brick Roads.
386. Public Road Mileage and Revenues in the Middle Atlantic States, 1914.
387. Public Road Mileage and Revenues in the Southern States, 1914.
388. Public Road Mileage and Revenues in the New England States, 1914.
389. Public Road Mileage and Revenues in the Central, Mountain, and Pacific States, 1914.
390. Public Road Mileage in the United States, 1914. A Summary.
393. Economic Surveys of County Highway Improvement.
407. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1915.
414. Convict Labor for Road Work.
463. Earth, Sand-Clay, and Gravel Roads.
532. The Expansion and Contraction of Concrete and Concrete Roads.
537. The Results of Physical Tests of Road-Building Rock in 1916, Including all Compression Tests.
555. Standard Forms for Specifications, Tests, Reports, and Methods of Sampling for Road Materials.
583. Reports on Experimental Convict Road Camp, Fulton County, Ga.
586. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1916.
660. Highway Cost Keeping.
670. The Results of Physical Tests of Road-Building Rock in 1916 and 1917.
691. Typical Specifications for Bituminous Road Materials.
704. Typical Specifications for Nonbituminous Road Materials.
724. Drainage Methods and Foundations for County Roads.
Public Roads, Vol. I, No. 11. Tests of Road-Building Rock in 1918.

OFFICE OF PUBLIC ROADS BULLETINS.

Bul. *37. Examination and Classification of Rocks for Road Building, Including Physical Properties of Rocks with Reference to Their Mineral Composition and Structure. (1911.) 15c.
*43. Highway Bridges and Culverts. (1912.) 15c.
*45. Data for Use in Designing Culverts and Short-Span Bridges. (1913.) 15c.

* Department supply exhausted.

OFFICE OF PUBLIC ROADS CIRCULARS.

Cir. 89. Progress Report of Experiments with Dust Preventatives, 1907.
*90. Progress Report of Experiments in Dust Prevention, Road Preservation, and Road Construction, 1908. 5c.
*92. Progress Report of Experiments in Dust Prevention and Road Preservation, 1909. 5c.
*94. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1910. 5c.
98. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1911.
*99. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1912. 5c.
*100. Typical Specifications for Fabrication and Erection of Steel Highway Bridges. (1913.) 5c.

OFFICE OF THE SECRETARY CIRCULARS.

Sec. Cir. 49. Motor Vehicle Registrations and Revenues, 1914.
52. State Highway Mileage and Expenditures to January 1, 1915.
59. Automobile Registrations, Licenses, and Revenues in the United States, 1915.
63. State Highway Mileage and Expenditures to January 1, 1916.
65. Rules and Regulations of the Secretary of Agriculture for Carrying out the Federal Aid Road Act.
72. Width of Wagon Tires Recommended for Loads of Varying Magnitude on Earth and Gravel Roads.
73. Automobile Registrations, Licenses, and Revenues in the United States, 1916.
74. State Highway Mileage and Expenditures for the Calendar Year 1916.
77. Experimental Roads in the Vicinity of Washington, D. C.
Public Roads Vol. I, No. 1. Automobile Registrations, Licenses, and Revenues in the United States, 1917.
Vol. I, No. 3. State Highway Mileage and Expenditures in the United States, 1917.
Vol. I, No. 11. Automobile Registrations, Licenses, and Revenues in the United States, 1918.
Vol. II, No. 15. State Highway Mileage and Expenditures in the United States, 1918.

FARMERS' BULLETINS.

F. B. 338. Macadam Roads.
*505. Benefits of Improved Roads. 5c.
597. The Road Drag.

SEPARATE REPRINTS FROM THE YEARBOOK.

Y. B. Sep. *638. State Management of Public Roads; Its Development and Trend. 5c.
727. Design of Public Roads.
739. Federal Aid to Highways, 1917.

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.
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* Department supply exhausted.