
Annual Report of the State Highway Commission of Minnesota

#Minnesota. State Highway Commission

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Minnesota Highway Department

Charles M. Babcock.....Commissioner of Highways
John H. Mullen.....Deputy Commissioner and Chief Engineer

STAFF

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W. F. Rosenwald.....Maintenance Engineer
M. J. Hoffman.....Assistant Maintenance Engineer
O. L. Kipp.....Construction Engineer
R. M. Cooley.....Superintendent of Equipment

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DIVISION ENGINEERS

C. A. Forbes C. L. Methven R. K. Bliler
W. E. Matters D. W. Webster
C. L. Motl W. P. Chapman

Gift of Senator E. C. ...

LETTER OF TRANSMITTAL

St. Paul, Minn.

Hon. J. A. O. Preus, Governor of Minnesota, St. Paul, Minn.

Dear Sir: I am transmitting herewith, a report of the activities of the State Highway Department during the calendar year of 1920.

Yours very truly,

A handwritten signature in cursive script, appearing to read "C. B. Babcock".

Commissioner of Highways.

ROAD CONSTRUCTION

Road construction in Minnesota during the years 1919 and 1920 exceeded any previous period in the history of the state and is only exceeded by two other states in the union for the same period. This remarkable amount of work was made possible by action of the legislature at the 1919 session which gave authority to the counties to issue bonds for arterial road construction in connection with federal aid. Further encouragement was given the counties by the legislature in the proposed constitutional amendment which provides for refundment to counties for permanent work on the trunk highways financed by the counties. In considering this volume of work accomplished under the direction of the legislature it is interesting to note a comparison to the work done during the year 1920 by neighboring states as follows:

| State. | Brick. | Concrete. | Bituminous. | Stone or Gravel. | Grading. |
|--------------------|-------------|--------------|-------------|------------------|----------------|
| Iowa | 7.9 | 41.7 | | 105.2 | 255.1 |
| Illinois | 28.0 | 299.0 | 14.0 | 6.0 | 120.0 |
| Michigan | 0.4 | 43.2 | 17.3 | 294.4 | 106.9 |
| Missouri | 0.0 | 18.8 | 6.2 | 81.5 | 204.3 |
| Minnesota | | 67.0 | 12.4 | 832.0 | 1,120.0 |
| Wisconsin | 0.0 | 103.0 | 10.0 | 793.0 | 653.0 |
| Total | 36.3 | 572.7 | 59.9 | 2,112.1 | 2,459.3 |

The greater portion of the work in this biennium was done in the year 1920 for the reason that it was rather late in the season for starting work after the legislature had adjourned in 1919. However, our last annual report shows work done in 1919 in the following amount:

| | Miles. | Cost. |
|---------------------------|--------|----------------|
| Grading | 1,054 | \$3,326,135.40 |
| Gravel surfacing | 748 | 2,048,213.93 |
| Bridges constructed | 125 | 562,344.81 |

During the year 1920 plans were prepared, checked and approved by the Highway Department for the following mileage of work:

| | Miles. |
|--|--------|
| Grading without surfacing | 495 |
| Grading and gravel surfacing | 850 |
| Gravel surfacing without grading | 133 |
| Grading and paving | 200 |
| Paving without grading | 19 |

The total amount of grading work planned with or without surfacing amounted to 1,545 miles, which involved the handling of 12,397,326 cubic yards of excavation at an estimated cost of \$7,438,395.60. The total amount of gravel surfacing for which plans were approved during 1920 amounted to 988 miles, involving 1,258,057 cubic yards of gravel at an estimated cost of \$2,964,000.00. The total paving for which plans were completed and approved amounted to 219 miles, involving 2,093,501 square yards of paving at an estimated cost of \$6,603,878.25. The total estimated cost of the work for which plans were approved, including bridges, culverts, and other miscellaneous items, as well as the items mentioned above, was estimated to cost

\$19,733,962.01. Approximately 25 per cent of the work covered by these plans has not yet been placed under contract or started by day labor forces.

Plans were prepared sufficiently in advance during the early part of 1920 so that a large amount of work was placed under contract during the early part of the season. In fact, by the first of June it became apparent that it would not be possible to place under contract all of the work which had been contemplated by the counties, and for which plans were being rapidly completed. A questionnaire was therefore sent to all the highway engineers in the state, requesting information as to the status of the uncompleted contracts in each county and the amount of the various types of road building equipment actually in service, and the date on which any of it would be released for additional work. The information secured by this questionnaire confirmed the opinion of the department that the amount of work already placed under contract was more than sufficient to keep all of the available equipment busy for the remainder of the season, and it was therefore determined to issue an order to abandon further lettings of road work except where it could be shown that equipment was available for the construction of the project or where the work was of an unusually urgent nature.

A tabulation of the data received on this questionnaire revealed the fact that the number of men and the quantity of equipment and stock actually engaged in highway construction in the state comprised the following totals:

| | |
|-------------------------------|--------|
| Men employed | 6,092 |
| Steam shovels | 36 |
| Locomotives | 26 |
| Dump cars | 281 |
| Lineal feet of track | 98,523 |
| Elevating graders | 145 |
| Blade graders | 363 |
| Wheel scrapers | 1,158 |
| Slip scrapers | 1,011 |
| Fresnos | 526 |
| Dump wagons | 1,460 |
| Mixers | 69 |
| Finishing machines | 30 |
| Motor trucks | 466 |
| Trailer wagons | 91 |
| Tractors | 136 |
| Loading bins | 57 |
| Belt loaders | 31 |
| Derricks | 14 |
| Drag lines | 23 |
| Screens | 26 |
| Horses and mules..... | 6,212 |
| Pile drivers | 18 |
| Pumps | 44 |
| Lineal feet pipe..... | 13,000 |
| Asphaltic heating plants..... | 2 |
| Steam rollers | 2 |

The total volume of work which the foregoing equipment were able to complete during the season of 1920 is shown in detail in this report, but it is interesting to note that following are the totals of the various items of work completed:

GRADING—1,120.9 miles, comprising 9,409,849 cubic yards of excavation, costing \$5,737,016.36, the average cost per cubic yard for the grading being 61c, which includes the cost of overhaul, loose and solid rock excavation.

GRAVELING—831.69 miles, comprising 1,023,992 cubic yards of graveling costing \$2,481,700.82. This is an average of 1,230 cubic yards of gravel per mile, costing \$2.42 per cubic yard.

PAVING—12.39 miles of asphaltic concrete, comprising 107,546 square yards of paving costing \$325,699.08. Also 66.98 miles of Portland Cement concrete, comprising 714,361 square yards of paving costing \$2,228,616.59.

CLEARING AND GRUBBING—3,275.18 acres, costing \$240,540.89.

GUARD RAIL—205,555 lineal feet or 39.0 miles, costing \$134,529.33, which is an average cost of \$3,449.48 per mile.
TILE DRAIN—613,841 lineal feet or 116 miles, costing \$186,915.42, which is an average cost of \$1,611.34 per mile.
PORTABLE CULVERTS—153,923 lineal feet, costing \$332,102.87.
MONOLITHIC CULVERTS—335 containing 7,054.81 cubic yards of concrete, costing \$325,112.98.
BRIDGES—198, costing \$1,716,797.91.
TOTAL COST OF CONSTRUCTION—Completed on state roads in the year 1920, including miscellaneous items not enumerated above, \$14,405,091.06.
STATE AID—\$1,250,202.20, paid on 1920 construction.
FEDERAL AID—\$2,711,620.00, paid on 1920 construction.

The progress which has been made by Minnesota in federal aid construction during the past year has been noteworthy. The Bureau of Public Roads issues a monthly report, showing among other things, the status of the various states relative to the number of miles and the estimated cost of federal aid work placed under construction, and the total value of the work completed with the amount of federal aid payments made on such completed work. During the year Minnesota stood high in all of these items, and the last report dated December 31, 1920, a reproduction of which will be found (see chart) on page ??, shows Minnesota occupying third place in practically all of these items, the states of Illinois and Pennsylvania being the only two which show a larger total of federal aid received for complete construction.

An analysis of our detailed report on federal aid construction shows the following totals:

| | |
|--|-----------------|
| Total length of projects under agreement, miles..... | 1,576.8 |
| Estimated cost of such project..... | \$18,732,000.00 |
| Allotment of federal aid to these projects..... | 6,633,410.32 |
| Value of the work on these projects during 1920..... | 9,666,011.00 |
| Total value of work done to date..... | 12,710,155.87 |

On this completed work the various counties of the state have received a total of \$3,675,113.85, of which \$2,711,620.00 was received during 1920.

The state aid work completed during the year on which no federal aid was received amounts to the difference between the cost of the total construction, or \$14,105,091.06, and the total value of the federal aid construction during 1920, which is \$9,666,011.00. This gives a total value of state aid construction jobs of \$4,439,080.06.

The 1920 construction includes the following jobs which deserve special mention:

Federal Aid Project No. 125, which is a grading and gravel surfacing job in Wabasha county near Wabasha, consisting of 1.51 miles of continuously ascending grade, most of which is 5 per cent. This job provides for the elimination of a narrow winding road, containing numerous steep pitches and sharp turns. The construction is laid out so as to provide an improvement of a permanent nature, on which a pavement of any desired type may suitably be placed. The cost of this work on account of the rock excavation encountered amounted to \$71,250.87. A picture is being included in this report which shows the nature of the construction on the new road, and the old road which has now been abandoned.

Federal Aid Project No. 148, which is a grading and gravel surfacing job in Hennepin and Dakota counties, 9.83 miles in length. The notable part of this project consists of the heavy grading in connection with the Minnesota River crossing. The fill across the bottom averages approximately

15 feet in height, and contains 366,129 cubic yards of material which is obtained from large cuts at each end of the fill. A picture showing a portion of this work is included in this report.

Federal Aid Project No. 127, which is a grading and gravel surfacing job in Stevens county, near Morris, 17.46 miles in length. The gravel surfacing for this project was obtained from a pit located near one end of the project, and the maximum haul from this pit to the other end was approximately 18 miles. A portion of this project was not ready for gravel surfacing, but 15 miles of the subgrade was finished, and the contract for gravel surfacing that portion was let early in the fall. The contractor used a fleet of 45 trucks, and in spite of the fact that the haul averaged approximately 10 miles, completed the gravel surfacing of the 15 miles in five (5) weeks' time. It was found much more economical to haul by truck, even at the length of haul, rather than ship the material 40 or 50 miles by train and haul from the nearest sidings, from which the average haul would have been only $2\frac{1}{2}$ miles.

Lac qui Parle county deserves special mention in that they have gravel surfaced the greatest mileage of state roads during the year. Our detailed report shows that they have surfaced 72.99 miles with 71,168 cubic yards of gravel, at a cost of \$162,046.44. A large amount of this work was completed under contract with large trucks operating during the months of January, February and March, while the roads were frozen. After the spring breakup very little gravel surfacing was done with these large trucks, as it was found that the roads over which these trucks hauled were damaged excessively by the hard tires and heavy loads. The engineer therefore made arrangements for graveling during the remainder of the season with light trucks equipped with pneumatic tires. The result obtained with this equipment during the summer months was very gratifying, both from a standpoint of low cost of hauling as well as low cost of road maintenance in connection with the hauling.

During the season, 17 paving contracts were under construction, in which various methods and types of equipment were used. The high records for progress were made on three projects, namely, Project No. 114, Sherburne county; Project No. 107, Watonwan county, and Project No. 64, Rice county.

On the first of these projects a central mixing plant was used, which was equipped with a six-bag mixer. The average pavement laid on this contract was 870 square yards per day, with a maximum of 2,196 square yards laid in an actual running time of slightly less than ten hours. The plant was so equipped that the mixer discharged in eight seconds, and the time for charging the mixer was not over five seconds. It is therefore apparent that this equipment was capable under perfect conditions, of delivering an even greater yardage during a ten-hour day.

On the second of these a central proportioning plant was used, the material being hauled from this plant with 2- and $2\frac{1}{2}$ -ton trucks equipped with pneumatic tires and an ordinary dump body divided into two compartments. A four-bag paving mixer was used on this work, and the average output per day was 681 square yards. The maximum output was 1,658 square yards. The subgrade on this project was in a very satisfactory

condition during the time of operation, except for a period of a week or ten days when frequent rains seriously affected the progress of the work and the general subgrade conditions.

On the third of these paving jobs a central proportioning plant was used with industrial haul from the plant to the mixer. Both steam and gasoline engines were used, but it is believed that the gasoline engines proved more satisfactory on account of their light weight and low center of gravity. The mixing equipment consisted of a mixer mounted on a steam shovel base, and a tower of structural steel built over it for hoisting the batch boxes. The base also carries the hoisting engine used for this purpose. The whole is pulled by a 35-horsepower steam tractor, which supplies steam to both the hoist engines and the upright engine which turns the mixer. The average output of this plant was 736 square yards per day, while the maximum output was 2,145 square yards, which were laid in ten hours and twenty-one minutes mixing running time.

The specifications on all of this work required a 1-2-4 mix, and the average thickness was $7\frac{1}{4}$ inches, the pavement being $6\frac{1}{2}$ inches at the side and $7\frac{1}{2}$ inches at the center with a curved crown and flat base.

Pictures illustrating the projects which have been described, as well as other construction jobs are included in this report.

The engineering and supervision of the 1920 construction was under the immediate supervision of the highway engineers of the counties in which the work was situated. The method of handling the work varied according to the requirements of the various projects. The number of engineers employed in supervising this work is estimated at 275 engineers and instrument men, besides rodmen, chainmen, and miscellaneous assistants. This estimate does not include the force employed by the central office of the Highway Department.

BRIDGE CONSTRUCTION

As shown in the tabulated report, there were built on state roads during the 1920 construction season 335 monolithic culverts at a total cost of \$325,112.98 and 198 bridges at a cost of \$1,716,797.91. This report covers only completed work on state road construction and in addition to the above bridges, the department has furnished plans for 136 bridges on county and township roads. The estimated value of these latter bridges is \$676,000.00 giving a total value for all bridge plans of approximately \$2,493,000.00, exclusive of culverts.

During the past year special attention has been given to four features, involving design and construction methods. These features are as follows: Area of waterway under the bridge, the securing of adequate foundations, roadway of such width that future traffic will be amply provided for, and a higher quality of finish on all exposed concrete surfaces.

The matter of waterway area is especially important in this state, on account of the fact that each year larger areas are put under cultivation and in conjunction with this, large areas are drained by means of open ditches. This has a material effect in the rapidity with which the water

reaches the streams and consequently requires that all bridges be designed with an ample factor of safety in this respect.

Securing of adequate support, for the foundations of bridges is of prime importance, as more bridges have been destroyed on account of the foundations being undermined than from all other causes.

On account of the permanent construction of these bridges, the roadways should be of such width as will adequately care for whatever traffic the future may develop. During the past year especial attention has been devoted to securing better alignment and finish on the concrete work than has hitherto been obtained. Greater attention has also been given to what might be called the artistic features of bridge construction, in providing railings so designed that they relieve the monotonous appearance afforded by the plain rail of concrete. This has been accomplished largely by the use of open railing.

ROAD MAINTENANCE

During the year 1920 over \$2,500,000.00 was expended for maintenance of the state aid system of 13,653 miles by the several counties under the supervision of this department. This is approximately an increase of a million dollars over the 1919 expenditure, and the difference in results obtained was very markedly noticeable. Although increased labor costs affected the total to some extent, a large portion of the increase was due to the efforts of this department to extend the patrol system and to raise the standard of maintenance effectiveness throughout the state.

Special attention was directed to the adequate maintenance of the main arterial state roads, and with this in view the highway engineers of the several counties were requested to prepare a pre-season schedule of requirements and estimates of cost based on the patrol system of maintenance. These schedules were checked by the division engineers and subsequently submitted to the county boards for adoption and authorization of the Highway Engineer to carry out the maintenance program outlined. Seventy-one of the counties responded and approximately 5,600 miles of the arterial state roads were covered by the patrol system. In practically every case the expenditures by the county exceeded the pre-season schedule and estimates considerably. The impetus of the movement in many cases prompted a like method of maintaining the lateral state roads, and the increase in maintenance efficiency is a very creditable indication of the generally acknowledged importance of continuous maintenance.

Of the state roads maintained during the year, 4,507.5 miles are gravel surfaced; 145.4 miles are paved, and 3,512.5 miles are graded, but unsurfaced, and the remainder of 5,488 miles only partially improved.

During the last week in August and the first week in September, traffic observations for seven consecutive days were made at 210 different points on the state roads throughout the state, the results of which are listed in accompanying tables. It is significant that of all traffic recorded, 5.5 per cent were trucks as compared with 3.5 per cent in 1918, and 3.4 per cent in 1919. Motor vehicles comprised 93 per cent of the total traffic. In another table we have shown the comparison of traffic at points where observations

have been made two or more years 't's noticeable that in practically every case there has been a regular increase and when taken collectively, it is found that for every 100 cars recorded in 1920 there were 78 in 1919, 62 in 1918, 52 in 1917, and 39 in 1916.

The year 1920 was the first in which the maintenance of concrete roads has been taken up directly by the department, and so far has consisted mainly of sealing the cracks as a protection against spalling, and to prevent seepage of water through them. Due to the fact that the concrete roads were widely scattered, the cost of maintenance was unduly high, and averaged about \$44.50 per mile for a total of 31¼ miles taken care of. Several kinds of material were used, but the results are not definitely conclusive as to the relative merits, since under different circumstances each had its merits and objections.

As a whole the results obtained during the past season have served to further demonstrate the direct relation between adequate maintenance and "Travelability." The application of this principle in making special provision for heavily traveled arterial state roads has reflected general commendation which I take great pleasure in crediting to the generous co-operation of the several county boards and highway engineers.

EXCESS WAR MATERIAL

The purpose of this branch of the organization was primarily to receive from the War Department such war materials as were declared surplus and by act of Congress allotted to the highway departments of the several states, to unload and repair this material, and to deliver it to the different counties of this state in suitable condition for the work for which it was intended.

A complete list of all materials received is shown on the accompanying statements. Since the bulk of material, or that having 90 per cent of the value of the entire allotment, is trucks and tractors, these two items have received the most attention.

Before these trucks and tractors arrived, the Highway Department received from nearly all of the counties, applications for what they considered necessary equipment to carry out their road building programs, the agreement being that the counties should pay all necessary costs of shipping, repairing, and equipping such trucks and tractors as were allotted to them.

Upon receipt of these applications, an allotment of trucks was made, based on the amount of work required of the trucks and on the funds available in each county. There not being enough tractors to supply all the counties, they were allotted wherever they could be used to the best advantage.

As the trucks arrived at intervals and in comparatively small shipments, an effort was made to supply the counties with a proportionate share until sufficient trucks arrived to complete the allotments. It was originally planned to supply each county with the same make of trucks for its entire fleet and to place the different types where they would be most suitable for local conditions. This plan, however, could not be carried out because the Army did not continue to send the makes of trucks originally allotted to this state.

To carry on the work, arrangements were made with the State Agricultural Society to obtain the use of the unloading platforms at the Fair Grounds and also the use of some of the State Fair buildings for temporary storage purposes. A mechanical organization was then formed to unload and repair the trucks for delivery to the various counties.

As the majority of the trucks necessitated body and hoist equipment, it was found more expedient and cheaper to have them equipped before they were driven out to the counties.

The trucks of the first shipment were new, and no difficulty was experienced in getting them in good running order and in sending them to the various counties. However, as the shipments continued to arrive it was found that a great many trucks were in very bad shape, either from neglect in storing or in continued use by the Army, and the dire need of a machine shop properly equipped to make extensive repairs was readily seen. The necessity was even more apparent upon the arrival of three carloads of spare parts which had to be stocked in a permanent building in order that they might be shipped to the counties as needed. The legislature in the special session of 1919 made an appropriation to erect and equip such a building to be located at the State Fair grounds.

During the remainder of 1919, 135 trucks and 20 tractors were delivered to counties, and during 1920, 254 trucks and 6 tractors were delivered beside considerable other road-building material.

A loss of time and considerable expense were incurred in moving the machinery and equipment in and out of the grounds for the State Fair. There was also a delay in the progress of the work owing to the fact that the building was not completed on time. However, the building is now fully equipped with the necessary machinery and is in operation. The building was not designed for storage space other than that required for about eighteen trucks. There is a testing and assembling room and a machine shop equipped with one large and one small lathe, a milling machine, a tire press, two drill presses, a power saw, a floor grinder, an air compressor and receiver, pneumatic hammers and drills, motor stands, benches and all small tools.

There is also a stock room, a tire-storage room and an office. The rest of the space is devoted to the dismantling of trucks and making minor repairs and adjustments. In connection there is a blacksmith shop equipped with a forge, anvil, and power hammer.

During the period of four months, from September 1st to January 1, 1920 the shop replaced 90 new tires at the cost of dealers' price for tires, without charge for pressing them on or off, made numerous major repairs on rear axels, transmissions, and engines at the actual cost of mechanic's time, filled 500 orders for spare parts at actual cost, and overhauled the trucks still undelivered.

Fourteen touring cars used by the engineers for road inspection have been assembled and equipped. These cars are supplied with gas, oil, tires, and are kept in repair.

In order to finance the freight payments on equipment and the other expenses incidental to shipments and deliveries, arrangements were made