U.S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

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BITUMINOUS MACADAM, SHOWING CUT AND DRAINAGE, BALTIMORE COUNTY, MD.

In this number "Public Roads" presents papers read by members of the American Association of State Highway Officials at the recent convention of that Association in Chicago. While the Bureau of Public Roads takes no occasion either to endorse or differ from any of the statements made in these papers it is believed that they are of sufficiently great interest to the thousands of readers of "Public Roads" who could not be in attendance at the convention to warrant their reproduction.

Owing to the necessarily limited edition of this publication it will be impossible to distribute it free to any persons or institutions other than State and county officials actually engaged in the planning or construction of highways, instructors in highway engineering, periodicals upon an exchange basis, and Members of both houses of Congress. Others desiring to obtain "Public Roads" can do so by sending 15 cents for each numbers or $1.50 for annual subscription to the Superintendent of Documents, Government Printing Office, Washington, D. C.

U. S. DEPARTMENT OF AGRICULTURE

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PUBLIC ROADS

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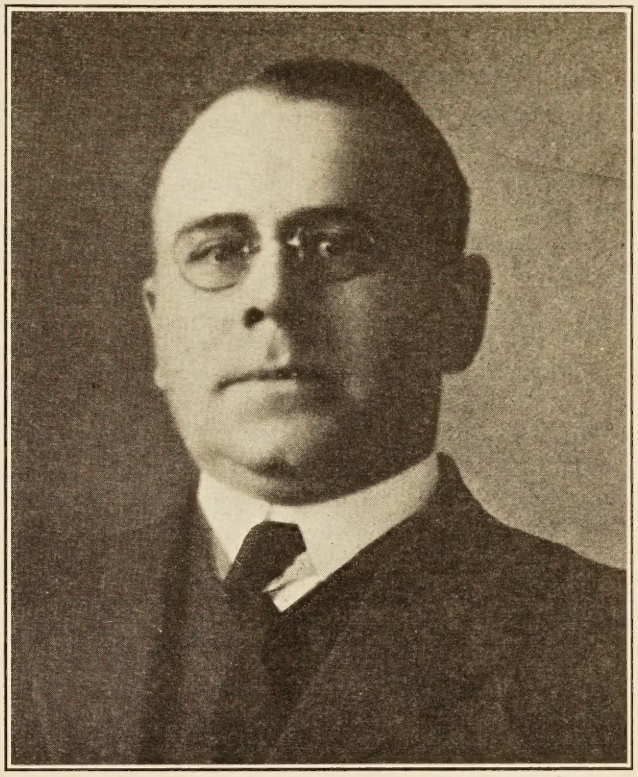
The Federal Aid Road Law and Changes Suggested by its Practical Operation

THOMAS H. MacDONALD, Chief Engineer Iowa State Highway Commission.

THERE is a clamor for improved roads—improved roads at once and everywhere. No other word expresses the situation. Sometimes the clamor seems to admit of an interpretation like this: "Improved roads anywhere, if at once."

Improved roads are needed, and more, they are needed at once. The lack of improved roads made itself keenly felt as one of the weaknesses of this Nation during the period of the war. The determination to overcome this weakness by an accelerated program of highway improvement exists as a general sentiment and finds expression in a multiplicity of ideas, some sane; some the merest froth. Road improvement is not peculiarly a reorganization or reconstruction problem developed by the war. There is no fundamental difference in the service which improved roads will return to the public now compared to the service which improved roads rendered before the war. The difference is mainly one of degree. More people have found more uses for motor vehicles, particularly more motor trucks, resulting in a demand for more service from the public highways. The difference, as stated, is one of degree.



THOMAS H. MacDONALD

THE HIGHWAYS OF THE FUTURE.

From the engineering side it has been clearly shown that the roads of the future must be built to carry a larger number of units, heavier maximum loads, and higher speeds. From the administrative standpoint, the radius of utility of the motor vehicle has been so greatly extended as to demand a continuity of routes and an arrangement of highway systems that are not limited by municipal or even State boundaries. We have the post war problem, then, and the prewar machinery with which to handle the problem.

There seems to be a disposition in some quarters to overlook existing agencies and to pass the responsibility for undertaking the super-program of road improvement demanded along to the Federal Government. The activities and accomplishments of the Federal Government during the past two years are undoubtedly worthy of this compliment on the part of those who desire forthwith and at once the consummation of their ideas; that is, good roads everywhere. This attitude, however, will stand the keenest and coldest analysis, in the light of past experiences in turning over matters of this character to the Federal Government without its own consent. The Federal aid road act we have. It is the product of cooperation. It is the first law of any importance ever secured from Congress dealing in a broad way with the improvement of the public roads of the United States. We have in it a foundation on which to build, and on close analysis we have found it a worthy and suitable foundation.

It will be recalled that at the Chicago convention of this association in December, 1915, three years ago, careful consideration was given the proposed bill in the form prepared by the executive committee. Prior to the Chicago convention the bill had received a favorable vote by letter ballot from a majority of the then organized 37 State highway departments. At the Chicago convention none of the principles written into the bill were changed and only minor changes were proposed. The measure as it appears on the records of that convention, with a few modifications, met the approval of the Secretary of Agriculture and was passed almost unanimously by both houses of the Sixty-fourth Congress. It became effective immediately when signed by President Wilson on July 11, 1916. In six months, therefore, from the final consideration of the proposed measure by this association, Congress had approved the plan as submitted and had definitely and substantially

committed the Federal Government to a policy of participation in the improvement of rural highways. It is within the record, therefore, to say that this act three years ago represented fairly the judgment of all of the State and Federal departments intrusted with its administration in a degree rarely found in legislative acts affecting so many different administrative units.

LAW RESULT OF COOPERATION.

As it stands to-day this law is the tangible product of all the yesterdays of endeavor to secure by substantial financial support recognition on the part of Congress of the importance of the public highways to the national life, and of the responsibility of the Federal Government to assist in their permanent improvement.

The history of attempted road legislation is long. The agitation was so general that speeches in favor of Federal participation became standardized from one end of this country to the other. Perhaps no other legislation actually secured required greater subjugation of personal and selfish motives. The Federal aid road act embodies something finer than the realization of any sectional idea. It typifies the spirit of cooperation—cooperation between the individual States, between the several groups of States, and between the States and the Federal Government. It is indicative of the results which may be secured by united endeavor by this association and is, judging by past experiences, the method which must be followed in securing a modification of Federal legislation on this subject.

Within six months after the majority of the State highway departments agreed between themselves and with the Secretary of Agriculture upon a reasonable plan for Federal participation in highway improvement, that plan was adopted and vitalized by an appropriation of $75,000,000, a sum sufficient in prewar times to forecast the inauguration of a permanent policy.

In order to meet the terms of the Federal aid act, it was necessary for 11 States to form new highway departments and for all the remainder of the States to secure appropriations or modifications of existing statutes.

SUCCESS OF FEDERAL AID ACT.

Almost before the States were ready to operate under the act we were involved in the war with its consequent disorganization of highway departments and almost complete shut-down of all highway activities. We have not, therefore, had any fair trial of the Federal aid road act under reasonably normal conditions.

We may assume that the plans as proposed was fairly acceptable to a majority of the State highway departments. The plan was not founded upon precedents, for there were no precedents. We have not had sufficient experience as yet to judge of the ultimate results which will be produced. It seems to me, however, that this measure, even under abnormal conditions, has been of the greatest service to a majority of the State highway departments. It came at a time to assist greatly in consolidating and holding against the attacks of unfriendly interests the positions which had been attained by many of the departments and placed the sterling mark of approval upon highway engineering and administration developed by the individual States. The recognition by Congress of the individual State highway departments and the demand in the post-road act that the State manitain an efficient, sufficiently supported State highway department has done more to establish highway work on a sound and certain basis than any other factor. It is doubtful if the executive committee or the membership of this association as a whole realized, when the Federal aid act was given final consideration, the extremely varied conditions this act would be called upon to meet in the various States.

STATE DEPARTMENTS ON LAW.

It has been my good fortune in preparing for this discussion to receive from 35 of the 48 State highway departments a discussion of their experiences up to this time with this act. These letters describe so many and such varied sets of conditions that my admiration for the post-road act has been greatly increased by the few pronciples embodied in the act which have been found to work any hardship even under the extreme range of conditions.

Take for instance the statement from Nevada. Mr. Cottrell, State highway engineer, says "Nevada is the only State in the Union having less than one person per square mile of area. Eighty-eight per cent of its area still remains with the Federal Government. We have in all only four rural free-delivery routes."

Mr. Heath, acting commissioner for Kentucky, writes: "The eastern section of Kentucky needs more roads than any other part of the State. Most of the construction must be thorough entirely new country."

Mr. Brown, acting State highway engineer for South Carolina, says: "It has been our experience in this State in more than one case that bridges and trestles through swamps were of very great importance, both locally and as links of through highways."

It is a far cry from conditions thus described to the established road systems of Massachusetts, Connecticut, and other of the Eastern States.

It is, therefore, very remarkable that there are contained in the reports from the 35 State highway departments, representing 75 per cent of all of the States, criticisms of only three features which are embodied in the Federal aid measure.

These features are as follows:

1. The interpretation placed upon the post-road requirements by the Solicitor of the Department of Agriculture.

2. The limitation of $10,000 per mile to cover Federal participation.

3. The amount of the appropriation carried.

THE POST-ROADS PROVISION.

After a careful consideration of the reports from all of these States, I am unable to find in any statement of the limitations or handicaps which the departments have suffered any other reference to the principles of the Federal aid road act itself. The verdict on the post-road limitations is nearly unanimous. There are perhaps four States which report no difficulty encountered as yet, but the verdict of the remainder is unanimous and certain. The difficulty with this feature has been very general. It has existed in New Jersey and Massachusetts as well as in the States of the middle and far West.

It is doubtful if this feature merits any considerable discussion. Mr. Cotterill, chief engineer for the Washington State department, says, "Assuming therefore, that the post-road feature must stand, it should, either by amendment of the act or regulation, be extended to include any sections of main highway whose improvement will make same better adapted for post road purposes, present or future. Revision of location is a vital prerequisite of any permanent improvement, and the Federal-aid law and regulations should not tempt away from revised locations. It ought to be sufficient that the project generally follows existing post roads without insistance upon identity of locations with all local detours, and without arousing unnecessary local jealousies and controversies by a demand for specific affidavit from local officers without authority to deliver the goods."

It was clearly the intent of this association to secure a measure which would allow the improvement of any road which would fit into a system of main highways, State or National, and any interpretation which is placed upon the Federal aid act which limits in the slightest degree the use of funds for this purpose, or requires unnecessary work on the part of the departments or arouses local discussions and petty bickerings, is foreign to the purposes of the act. It is to be regretted now that this measure was not based upon the general-welfare authority of the Constitution rather than upon the post-road feature. It is certain, however, that to a majority of the State highway departments nothing less than the elimination of all evidence relative to post-road features of roads proposed for improvement will be satisfactory, and any arrangement which can receive the support of this association must produce this result.

OTHER FEATURES TO BE CHANGED.

The objection to the $10,000 per mile limitation was supported by only one or two of the highway departments. As would be expected, this feature would only handicap the construction of the highest type of roads. It must be remembered that this act was passed when prices were materially lower and that the $20,000 limit on an equal basis of Federal and State funds seemed to provide fairly for all reasonable construction. Commissioner Duffey of New York, says, "The question of the maximum amount per mile which the Federal Government will contribute at the present time, taken in conjunction with our own State law, allows no construction of Federal-aid roads in this State, as the roads which we desire to build can not at present be built for $20,000 per mile. Even though the close of actual warfare is attained, it is too early as yet to draw any definite conclusions as to the time when more normal condition will prevail and materially lower prices for labor and material be reached. If the date when these lower levels are to be reached is long deferred, it is quite probable that the demand for permanence of construction will urge the commencement of the work even though the cost be very high. In that event the maximum limitation of $10,000 per mile would be objectionable."

The third feature, that is the amount of the appropriation carried by the post-road act, was referred to by only one or two departments, but this seems to me to be the most essential criticism of any. Mr. Hirst of Wisconsin, says, "The amount of Federal aid is entirely inadequate. It does not make very much difference financially what each State gets, but it is a fact that the expectations of the people have been aroused as to Federal-aid construction and the Federal-aid funds available are very disappointing. For the moral effect we believe that the Federal appropriation should be made at least $50,000,000 each year."

The Federal-aid funds have been a wonderful stimulus in securing the appropriations by States and counties and it naturally follows that the greater the Federal appropriation the greater will be the total of the funds available for securing the roads which are demanded. In Iowa we find that the counties are voluntarily contributing additional funds, which, for projects already approved, will average approximately the same amount as the Federal appropriation, thus distributing the burden, one-third Federal, one-third State, and one-third county.

PROPOSED AMENDMENTS TO ACT.

These three features cover all of the amendments which are needed to the Federal aid act itself to meet all of the objections which have been voiced by 75 per cent of the State highway departments.

There has been sent out by the Bureau of Public Roads recently a draft of a measure which proposes amendments to the act, as follows:

By striking out the word "may" in section 2 and substituting the word "can." With this amendment section 2 in part would read, "The term rural post road shall be construed to mean any public road over which the United States mails now are or can hereafter be transported."

The second amendment proposed is to strike out the limitation of $10,000 per mile in section 6. This would leave the Secretary of Agriculture free to approve any road project for which one-half of the funds were otherwise provided.

The third amendment proposes an increase in the funds available, as follows: $50,000,000 immediately available; $75,000,000 available July 1, 1919; $75,000,000 available July 1, 1920, and $100,000,000 available during each of the years 1921, 1922, 1923, and 1924. These sums are in addition to the sums named in the act, which are as follows:

For the fiscal year ending June 30, 1919, $15,000,000.

For the fiscal year ending June 30, 1920, $20,000,000.

For the fiscal year ending June 30, 1921, $25,000,000.

These amendments to the post road act should eliminate every criticism of the law itself which experience up to this time has produced.

EXCEPTIONS TO REGULATIONS.

The rules and regulations promulgated by the Secretary of Agriculture for carrying out the Federal aid act have been confused by some departments with the law itself. There are a number of exceptions taken to the regulations, some of which are meritorious, some clearly less the fault of the Federal department than of the State departments themselves, but all are of such a nature that no difficulty should obtain in securing the proper adjustment. These are briefly summarized as follows:

1. Conflicts between the State laws or the State constitution and the Federal aid requirements.

2. Limitation or refusal to allow the expenditure of Federal aid funds for certain costs entering into the completed roads, including preliminary engineering, right of way, advertising for bids, and like expenditures.

3. Plans, specifications, and survey requirements. More latitude is desired in the use of scales, in the number of cross sections, in the engineering data required for the submission of projects, and in the estimates of quantities.

4. Adherence to standard specifications in instances where a deviation is desirable.

5. Difficulties or delays encountered in securing approval of plans, specifications, and estimates, or of obtaining quick decisions or of obtaining the approval of the district engineers of monthly vouchers.

Many of the causes of complaints would be eliminated by the granting of greater authority to the district engineers of the Federal department.

Under the above classification can be grouped nearly every complaint which has been mentioned by the departments. There does not seem to be any difficulty included in this list which can not be settled satisfactorily by reasonable revision of the present rules and regulations, and it is my opinion that the Secretary of Agriculture and the Bureau of Public Roads would be willing to consider these matters on their merits. This seems to be a work that the executive committee of the association, having in its possession the statements from the departments of their difficulties, could take up at once and secure an adjustment of all meritorious grievances. A plan of this character seems to me to possess sufficient merit to adopt as a permanent policy. It would require only a little effort on the part of the Federal and State departments to perfect a scheme of cooperation to such an extent that there would be practically no difficulties encountered.

It would not be proper to close this discussion without referring to the many statements made by the State departments relative to the cooperation and pleasant relations which have existed between the departments and the Federal department and its district engineers.

LAW IS LIBERAL AND A SUCCESS.

As stated in the first paragraphs, the present Federal aid law is the product of cooperation. From the expressions of the highway departments this cooperation is being maintained, and generally a cordial spirit between the State and Federal departments prevails. From a careful investigation of the whole subject I have become personally convinced that the Federal aid act is as liberal a measure as can be expected; that the States are bound by few limitations, and that where rules and regulations exist which fail to meet the general purpose of the act itself, or which are productive of delays or embarassments or misunderstandings between the State and Federal departments, these should be eliminated in conference. It is not to be expected that the Federal Government will appropriate large sums for the improvement of public roads of the Nation unless it maintains a method by which it insures to its own satisfaction the proper use of these funds.

The demand upon Congress from every side for large appropriations for all purposes is tremendous, and for my part I am convinced that no matter how meritorious is the appropriation for that purpose we will succeed in securing greater recognition from Congress if we maintain the spirit of cooperation which now exists between the States and the Federal department.

License fees for Motor Vehicles and Drivers and How to Grade Them

H. ELTINGE BREED, First Deputy Commissioner of Highways, New York.

THOSE who benefit from an improvement should be the ones to pay for it. Like many another obvious truth, that easy-sounding statement conceals the kernel of our perplexity. Who benefits by improved highways and in what proportion? The question involves the economics of taxation; the answers to it are as radically opposed as Kitchin and Lodge.

They run the gamut from those who would place the entire cost of highway construction and maintenance upon the direct users of the roads, to those who would exempt them and make the general public foot the total bill. In between are the various degrees of compromise, all of them advocating, in different ratio, some tax on the public and some on the vehicles. To prepare the way for this middle group let us briefly consider the arguments of the two extremes. Many of them appear in replies to a questionnaire that I sent to a number of State highway officials and to representatives of automobile associations and industries.

THE PLEA THAT PUBLIC PAY TAX.

The strong plea for exempting the direct users of roads and placing the entire cost upon the public is of course that the public is ultimately the great beneficiary.

I may never own a car or ride in one, but when my child is taken critically ill, his life may depend upon the speed of the good road over which the doctor can reach him. Shall I hesitate to pay my share toward it?

I may never have letters to send or goods to export, yet inevitably the life of my household and business depend upon the receipt of supplies from without. Shall I not help pay for the route over which they travel?

Even though I may never use the public schools I gladly pay the school tax, because through education it enhances the life of the community, and hence my own welfare.

I pay for police and fire protection though personally I may never need either, and I don't demand that people whose houses burn up, or who have burglars arrested, shall pay a special fee. Should I not be willing, as one of the public, to pay for the public benefits derived from good roads, especially as I am bound to receive from them not only a share in the general good, but direct personal advantages?

The argument sounds convincing. It is ably supported by Mr. George Diehl of the American Automobile Association.

H. ELTINGE BREED

An interesting suggestion for application of the entire tax upon the public is made by Mr. Ellis Dutton. Land bordering the highway, whose value is directly increased by it, shall carry the greatest burden of expense; contiguous lands and the general public less, proportioned as far as possible upon the benefits they receive. Says Mr. Dutton: "In every case where streets or roads are paved the increased value of the property is more than the cost of the improvement. Shouldn't these benefited lands pay for the paving * * * and in less proportion contiguous lands and the general public?"

But as in the case of so many other convincing arguments, there is a practical difficulty, not insuperable perhaps, but considerable. The traffic demands for and upon highways are greater than the tax-paying power of the public can sustain. More and more traffic—an increase in New York State of 390 per cent in motor vehicles in the last seven years—more need for new routes and good maintenance, higher and higher taxes, until the point is reached where the increased cost of the roads does not yield the taxpayers a commensurate return in public benefits. The gain accrues to private pocketbooks. Thence we swing to the opposite extreme that says that the motor vehicles

using the roads and directly profiting from them should be the ones to pay for them. I purposely omit horse-drawn traffic here, as being an increasingly negligible factor upon our highways.

THE ILLINOIS MOTOR-TAX IDEA.

Illinois is the chief exponent of taxing motor traffic for the entire cost of the highways.

The arguments advanced by Mr. Bradt of Illinois in favor of their arrangements are:

1. The practical difficulties of raising money through a general public tax. The political party in power, particularly in election year, is so anxious to keep down taxes, that it is loath to secure funds for absolutely necessary work. The tax burden in Illinois is already very heavy.

2. The greatest benefits from the roads accrue to the direct users of them. Motorists gain directly through the lower cost of running on good roads. Hence the user should pay.

3. The public really pays a share through the increased cost of service and commodities received over these highways.

On the strength of these arguments, Illinois has authorized bonds for $60,000,000 for highway improvement, all of which will be paid from automobile, dealers, motor cycle, and chauffeurs' license fees, the greater part being derived from automobile fees. The system to be built from this sum will extend 4,800 miles, and, it is estimated, will carry 40 to 50 per cent of the total State traffic. It comprises, however, only 5 per cent of the total road mileage. The other 95 per cent will have to be maintained and improved through general taxation.

So even the State that has gone farthest in taxing vehicles for highway purpose, has stopped short of the ultimate, 95 per cent in mileage, and 50 per cent in traffic.

USERS CAN NOT BEAR ALL COSTS.

The practical objections to putting the whole cost of the highways upon motor car users are obvious. In the first place, even if it were practicable, it would not work—which is not quite so much of a bull as it sounds. It would not work because of argument No. 3. All cars engaged in any kind of public service—by far the greater and more destructive number when you include the motor trucks—would immediately charge the expense of the fee to the cost of their service, increasing the price to the consumer, so that the public would be paying just the same, only a little more so, for the benefits it receives via the highway route. Indirect taxation may tickle the palate, but it is fundamentally bad for financial digestion. The relatively small number of car owners who do not perform any public service for which they charge would bear the brunt of disproportionately high taxation. This immediately raises the question of how far we believe in class taxation. Is it, or is it not justifiable?

Moreover, I don't believe it is generally practicable to raise highway funds exclusively through taxation of vehicles. It would tend to limit the number of vehicles, and the fewer these were the more each one would have to pay, until the limit that any one could endure would be reached. Then the roads would have to suffer—less new construction, poorer maintenance, until the public realizing that the loss of good roads was costing far more than the taxes necessary to sustain them, would rise up and demand that they be continued.

A PRACTICAL WORKING BASIS.

It is really the theory of marginal utility that adjusts the difference between the two extremes and offers us a working basis. The public is willing to pay up to the margin where the utility it receives from the road compensates the money outlay in taxes. Beyond that it cannot economically go. But so great is the destruction of the roads under heavy traffic that taxes on this basis will not meet the entire cost of maintenance and desirable new construction. The difference must probably be met by a tax on vehicles. Now, the vehicles are willing to pay up to the margin where the tax levied upon them is commensurate with the especial value that they, as direct users, receive from the road in distinction from the nondirect-using public. Believing therefore that both classes of beneficiaries should contribute toward the support of highways it remains to adjust the balance between them.

The point of marginal utility for the public seems to be reached at paying for the construction of new roads. The cost of these is great, so is the immediate benefit derived by the public. More exactly than such balances can usually be made, the point of marginal utility for the vehicles seems to be reached at paying for maintenance. The cost of maintenance is great—so also is the damage done by motor vehicles to roads for which the public has paid. I make these two statements a priori, from a study of cost data and of the means taken by the different states to raise the necessary funds for highway purposes. They are, of course, open to dispute. I offer them as an hypothesis, because motor truck fees must be considered in relation to the objects for which they will be used.

LET FEES PAY FOR MAINTENANCE.

If we consider the fees in relation to maintenance, Connecticut offers us some interesting experience. Mr. Bennett, the commissioner there, is working on the theory that the income from motor fees should approach the outgo for maintenance.

Here are the schedules of Connecticut's heaviest revenue producers in fees:

	Per annum.
For passenger cars, per horsepower	$0.50
For commercial vehicles:	
Up to 1,000 pounds	11.00
1-ton	15.00
3-ton (an increase of $5 per half ton)	35.00
5-ton (an increase of $10 per half ton)	75.00
7-ton (an increase of $12½ per half ton)	125.00
7½-tons	150.00
8-tons	200.00
(Then for each additional ton or a fraction over a ton, $100.)	
Each motor cycle	2.00
Each chauffeur or operator	2.00

Here are the schedules of New York's heaviest revenue producers in fees:

Passenger cars:	Per annum.
25 horse power	$5.00
25 to 35 horse power	10.00
35 to 50 horse power	15.00
50 horse power or more	25.00
For commercial vehicles:	
2 tons or less	10.00
14 tons (an increase of $5 a ton)	70.00
(And for each ton over 14, $10 per ton.)	
For trailers:	
2 tons or less	5.00
2 to 5 tons	10.00
5 to 7 tons	15.00
7 to 10 tons	20.00
10 to 14 tons	30.00
(And $5 for each ton above 14.)	
For passenger omnibuses:	
Up to 5 passengers	15.00
Not less than 6 passengers nor more than 7	24.50
Not less than 8 passengers nor more than 10	30.50
Not less than 11 passengers nor more than 16	43.00
Not less than 17 passengers nor more than 20	52.00
Not less than 21 passengers nor more than 22	55.00
Not less than 23 passengers nor more than 26	61.50
Not less than 27 passengers nor more than 30	67.50
(And an additional $2 for each passenger over 30.)	
Motor cycles	2.50
Chauffeurs:	
First year ($3 for license, $2 for examination)	5.00
Renewal	2.00

According to motor-car owners with whom I have talked, these fees are paid willingly, both as a matter of abstract justice in repairing the damage done by the vehicles themselves, and as a matter of personal interest to the motorist. Through the payment of fees for maintenance of good roads they assure themselves that they will lower operating expenses, decrease hazards, and curtail delays.

PROPER USE OF FEES LEVIED.

But here is an important point in considering motor-car fees in relation to maintenance: **The cost of maintenance depends upon the efficiency of your highway department.** Put in incompetents or grafters, and the fees will either go beyond bounds or the maintenance will fall short. The general public is not yet educated to knowledge of and insistence upon the best use of the taxes it pays. It is all up to the motor-car users and industries to see that the money for highway purposes be expended by honest men of proven ability. Whether they like to or not they must concern themselves in politics to the extent of securing good highway men in State service, for the success of their business depends upon the success of the roads and the success of the roads depends upon highway administration.

For instance, for years Mr. Bennett has been building in Connecticut durable types of pavement with maintenance charges of $100 to $200 per mile per year—a very different proposition from laying waterbound macadam with a maintenance of $1,000 a mile or upward a year under heavy traffic. If motor-vehicle fees are to cover maintenance wisdom must be shown in laying permanent types of pavement for heavy traffic, so that repairs will be kept at a minimum.

The maintenance itself must be well advised and executed. Millions of dollars can be squandered on poor materials or work delayed or done at the wrong time. The proverbial stitch saves nine. The motorist must insist that repairs be promptly made, so that his fee is used to the limit of advantage. In justice to himself he can not shunt off the responsibility upon some unknown official.

In New York State motor fees are a trifle lower than those in Connecticut. For the last two years they have almost covered the cost of maintenance. Last year fees aggregated $4,284,114; maintenance was $4,939,916. For nine months of this fiscal year ending November 1, fees were $4,571,852.75, while maintenance was over $54,000 less. Maintenance is high now because almost all our earlier roads, built to sustain traffic up to 3 tons, are protesting against traffic ten times that weight. The maintenance includes many complete resurfacing jobs done with durable pavements. As we build better roads maintenance should decrease, even with increase of traffic. Motor-vehicle fees can then be lowered. They will probably be close to the scale now advocated by the Highway Industries Association in its uniform motor-vehicle traffic law.

TRUCK LOADS MUST BE LIMITED.

Another important point to consider in relation of motor-truck fees to maintenance is limitation of damage that any one vehicle may do to your pavement. It is manifestly unfair to expect all motorists to pay for the destruction done by a few excessively heavy trucks, as unfair as to expect the public to pay $50,000 a mile for new roads to sustain such trucks. There must be an arbitrary limit of load for which we can design our roads. Otherwise, as fast as they are built, roads will attract to themselves traffic

heavier than they are designed to bear. The road and the load will be forever outstripping each other, with great economic loss both of the original investment in the road and in the appallingly high maintenance. In addition to regulation of weight of load there must also be regulation of other destructive factors, such as width and kind of tires, springs, speed, etc. If, after our roads are built in accordance with these regulations, it seems in course of time desirable to put much heavier loads upon them, we may well consider the suggestion made by Mr. Whinery that we lay narrow-gauge tracks on either side of our pavement to carry the heavy trucks.

With these regulations, it is obviously only fair to proportion the fee to the vehicle in accordance with its probable requirements upon maintenance funds. It would not be fair to tax the little two-passenger flivver the same amount as the 12-ton truck.

Mr. Nelson P. Lewis, chief engineer, board of estimate and apportionment, New York City, says: "The plan of grading the annual fee in proportion to the gross weight and carrying capacity is rational, and it might well go further and make the total width of the vehicle, where such width exceeds 7 feet, an element in the determination of this fee."

The fees should undoubtedly be graduated in accordance with the destructive factors to the road of the vehicle in question. Such a graduation is now made in many States.

A graduated scale of motor vehicle fees to cover the cost of highway maintenance necessitated by the cars themselves would not, I believe, fall too heavily upon any one. There are, of course, objections to it, but it seems to me the fairest adjustment yet made in taxation between the vehicle and the highway, the motorist and the public.

Day Labor and Force Account Work and the Bonus System in Highway Construction

CHARLES M. UPHAM, Chief Engineer, Delaware State Highway Department.

IN LOOKING into this subject I find that with some officials in certain sections of the country the method of doing work by day labor is very popular, but compiling the opinions of a great number of highway engineers, I think that the day-labor system has become unpopular and has the name of being costly and expensive and is without any of the advantages claimed for the contract system. The recent abnormal times that we have just passed through has compelled us to solve many problems. The day-labor system is one of the unsolved problems, though its name is old. During the last two years we have seen how in many instances the day-labor system has come to the rescue in emergencies, and in only a few instances has the work been carried on at abnormal cost. In many instances the reasons for high costs could undoubtedly be traced to other causes than the fundamental principles of the day-labor system.

WHEN SYSTEM GIVES GOOD RESULTS.

In localities where the supervision of the day-labor system has been efficient and the organization permanent, this system has produced and is still producing good results in construction at reasonable costs, costs that often are lower than those obtained by the contract system. Advocates of both the day-labor and contract system state that, properly controlled, their system produces better work. With proper supervision, inspections, and specifications the same results can be obtained either way, so that advantages can be compared merely to costs. By theoretical analysis it can be shown how the day-labor system is not as costly as the contract system, for it does not include the contractor's profits, nor the percentage that is included in the proposal for contingencies.

No State officials desire contractors to do work without profit, nor do they want the uncertainty of their plans and specifications that make the contractor's proposal become a gamble. It is accepted by all that the contractor should be paid the cost of his work plus a reasonable profit. In contract work there is generally figured a fair profit and also a percentage for contingencies that do or do not happen. These percentages are in addition to the actual cost of the work which in itself includes the pay for capable foremen, efficient supervision, and generally an allowance for the contractor's salary, provided this is not included in the percentage that is added to cover the profits. In other words, the contractor has provided for payment of all his expenditures plus a reasonable profit and an allowance for contingencies. If these contingencies happen the contractor should receive a payment covering them, but if they do not happen it simply makes a gamble out of the proposal, with the contractor the winner.

WHY CONTRACT SYSTEM IS FAVORED.

The day-labor system on the other hand does not include either of these charges of profit or contingencies, but it is the resulting expenditure of the actual cost of the work. Why is it then that day labor has not become universally adopted? Why is

it that the day-labor system is looked upon with suspicion and turned down by engineers wherever there is a possibility of doing work by contract system?

Many cities, towns, and States began their public work by day labor. After a short period we find that in nearly every instance many of these cities, towns, and States have adopted the contract system to protect themselves, and they now get their work done at more reasonable costs.

That the fear of high costs resulting from the day labor system existed in earlier days is shown by the fact that early in 1800 we find engineers advocating the abolishment of day labor. It is said that Telford estimated the cost of work produced by the day labor system was 50 per cent higher than by the contract system. A railroad engineer informs me that he was somewhat surprised that the cost of day-labor construction was from 25 to 100 per cent higher than contract work. It is said that in 1909, Metcalf and Eddy went into the comparison of costs of day labor and contract work, and in a report to the Boston Finance Commission the result was in favor of the contract work. In a few other instances, however, the results show that the work done by day labor is cheaper than that done by contract, but these cases are in the minority. From these statements it seems that the results point in favor of the contract system for securing good work at reasonable cost.

DEVELOPMENT OF TWO SYSTEMS.

Before condemning the day labor system, however, a comparison of the development of each is interesting.

Probably the first so-called contracts were contracts for day labor. One instance is shown by a contract covering the digging of a canal in one of the Eastern States, in which it is stated that the contractor should furnish a certain number of men with satisfactory picks and sufficient shovelers to shovel the dirt picked by the first men, and sufficient wheelers to wheel the dirt shoveled. While this was a contract, it was a contract for day labor. The output in general was controlled by the number of men employed, but the amount of work the men did depended to a certain extent on the foreman or supervision. The next step was a closer control of the amount of work completed rather than the number of men working.

This was development in the contract system and made this system become popular among contractors. By securing the best supervision and using certain ingenious devices, short cuts in doing work by the contract system were developed and larger profits resulted. As for the owner, the work was completed quicker and at no greater cost. The contract system thus became popular for these various reasons, and especial attention was paid to this system both by owners and engineers. Specifications and detailed plans were developed and complete control of the work was secured. Costs were kept reasonable by the fact that the successful contractors maintained an organization of the best supervision and most up-to-date methods and machinery possible and consequently they could complete work at a comparative low figure and still make a profit.

ABUSE OF DAY-LABOR SYSTEM.

What became of the day labor system in the meantime? Cities, counties, and towns, and some States whose officials were changed every election would commence work by the day labor system. Many times the official would have had no experience in the particular line of work that he undertook, and for supervision he would fill these positions with his friends or political supporters. The result of this poorly organized, inefficient, supervision was high costs, and sometimes poor and faulty work. About the time the official became experienced and could have produced satisfactory work at reasonable cost, a house cleaning removed him from office and the same thing was done all over again by the next official. The day labor system has been abused by such methods as these, and there has never been any great attempt to develop this system to the degree that the contract system has been developed. The force account method may be a step in the development of the day labor system, and the cost plus percentage or the cost plus fee method is another stage in the development of the day labor system.

That the day-labor system is being abused is shown by the statement of a well-known contractor that I interviewed while looking up facts and information on this subject. This contractor has done considerable highway work and has six large contracts under construction. Five of these were day labor or force account work, the sixth was a straight contract. He spent practically all his time on the sixth contract and when asked why he did this remarked that the other five contracts were day-labor contracts and he could not lose anything, but because this was a straight contract, he must give it most of his time and also his best men. This is a bit of the abuse that makes day labor cost more than contract work, and this loose control and indifference by officials is the very thing that is condemning the day labor system.

HIGH COST DUE TO POOR ORGANIZATION.

High cost in day-labor construction was many times blamed on the principles of this system, but as a matter of fact the real reason was the inefficient organization and the lack of control. Because of the high costs, many cities and towns immediately condemned the method of day-labor system, and without any attempt to overcome the weak points

in the system inaugurated the contract system, a system in which the control and methods had already passed through the experimental state and now was on a developed, definite, and sound basis.

With the same regulations and restrictions and the same personnel in day-labor system as in contract system, both should carry on the work at the same cost to the owner. In the contract system the contractor's profits and payment of the possible contingencies must be added to the costs. A few reasons why the day-labor system is expensive is because this system is generally harnessed by laws that limit the payment of the foreman and supervisors, and thus deprive this system of the privileges of the high class of supervision of the contract system. Many times the law also states just what the labor shall be paid. This again is a serious obstacle for the day-labor system to combat.

The limit of salaries of foreman and supervisors subject the day-labor system to many obstacles, for very often it happens in this day-labor system the limit in wages command supervisors and managers of only ordinary ability, or only partially experienced in their particular line.

The contract system on the other hand is not restricted as to obtaining the best supervision of labor. The successful contractor is a man of exceptional ability, one who represents the survival of the fittest. With this ability and the resources for efficient supervision the contract system is immediately put on a firm basis.

PRINCIPLE ITSELF NOT AT FAULT.

Therefore it seems that the day-labor system should not be condemned through reasons of the principles of the system itself, but should be passed through a period of development to the same extent the contract system has been developed. It should not be ridden with laws that combat the motives of the system. It is true a few steps have been taken in this development in the form of force-account work and in the cost plus percentage or cost plus fee system. The day-labor system will never be universally popular or successful until it is given the same freedom as the contract system and is controlled by the same standard of supervision and efficiency.

This subject is supposed to include a few words in regard to bonuses, presumably in connection with labor; but so much time has been taken in the discussion of the day-labor system, that I will only touch the subject of bonuses wherever it can be used in connection with developing the day-labor system. It is especially opportune to speak of the subject of bonuses in connection with the development of the day-labor system.

In practice we find that among contract laborers some men do more work and better work than others while they all may be receiving the same compensation. This does not encourage the men to do their utmost but is conducive to producing a matter of fact interest in their work. The ideal condition would be a piece-rate system, to pay all the men in proportion to the amount of work they turn out. This is not always possible in each individual case but it can generally be developed with groups of men at least.

BONUS SYSTEM PROVES EFFICIENT.

By analysis the bonus system means a piece-rate system with a minimum guarantee. An interesting fact that happened during the past construction season describes one of the advantages of the bonus system: Two contractors, 7 miles apart, on the same road, having practically the same territory from which to draw labor, were constructing a concrete road. Both contractors at the beginning paid $4 per day for labor The one added a bonus system, the other stated he would raise the wage if necessary. The man paying the bonus averaged $4.25 per day in paying for his labor. Consequently he soon drew more and better labor. The second contractor seeing his men leave, raised his wages to $4.25 and then to $4.50, and finally to $5, but at no time did he complete as much work with the same number of men as the contractor that paid $4 minimum wages plus a bonus. This was really the piece-rate system with a minimum guarantee.

The bonus system made each man a sub-contractor and his wages depended on his efforts and the amount of work completed. If the day labor system of doing work could have the benefit and advantage of this spirit among its labor, a great step in developing the system would be taken.

SYSTEM SHOULD BE DEVELOPED.

While the idea of bonuses seems to be old, it has not been used to any great extent especially among contract labor. The only reason for this seems to be that this branch is another detail not yet developed.

To develop the bonus system among contract labor, as it has been developed in the industries, may at the same time make it possible to produce a labor that can be used successfully in the day labor system and we may then expect many of the present day difficulties for the successful use of the system to be overcome, and we might possibly find the same efficiency and control in this system as is found in the industries. The operation of that system of day labor that has been found so costly and so unpopular among engineers, may, with the help of the bonus system be developed on an economic plan, closely approaching in practice the theoretical principles of the day labor system, and becoming a popular method of carrying on highway construction.

The Present Situation, and How We Are Meeting It in New England

Col. W. D. SOHIER, Chairman Massachusetts Highway Commission.

THE New England States—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut—have an area of about 62,000 square miles, or a little more than 2 per cent of the area of the United States. They are quite thickly populated and have developed large industries.

New England contains over 7 per cent of the population and over 10 per cent of the entire valuation of the United States, with only 2 per cent of the area. It has over 87,000 miles of rural highways, nearly 4 per cent of the total in the United States, or about twice the average number of miles of rural highway for each square mile of territory.

Its yearly crops before the war were worth over $141,000,000, or 2½ per cent of the crops of the country, and its manufactured products were over $2,500,000,000 a year, or nearly 13 per cent of the manufactured products of the country.

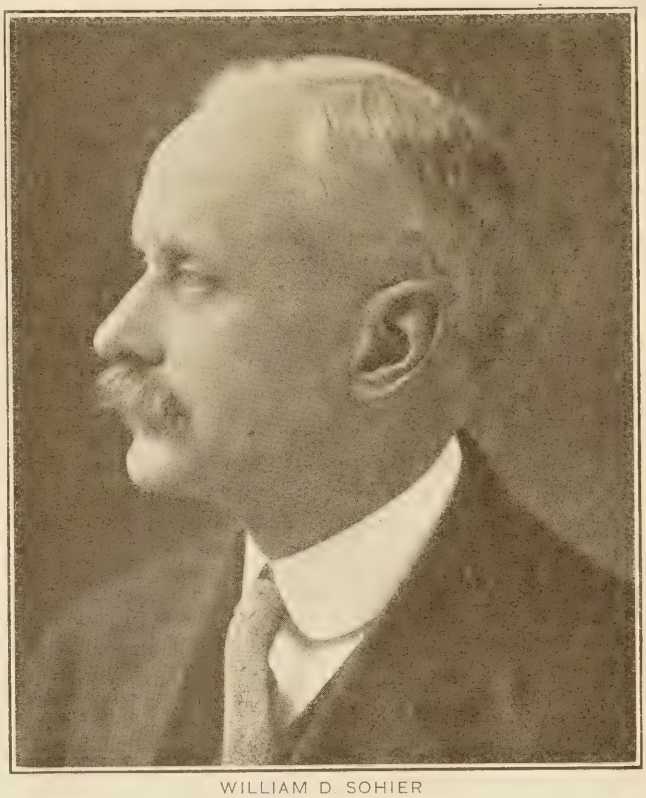
IMPROVED HIGHWAY MILEAGE.

The New England States, especially Connecticut and Massachusetts, were among the very first to adopt a State highway or State aid system. As a matter of fact, I believe New Jersey was the only other State to begin a comprehensive State or State-aid system of improved highways 25 or 26 years ago. The results accomplished in New England show clearly the advantage of such a system.

I am using the figures published by the United States Office of Public Roads to January 1, 1917, allowing for recent improvements. Out of about 75,000 miles of improved rural highways in the United States maintained under the State or State-aid system, 11,589 miles, or 15½ per cent, were in New England. Nearly one-half of these highways were in Connecticut and Massachusetts.

There were in the United States about 69,000 miles of highway which had been constructed under the State or State-aid system, and of these more than 9,000 miles, or 13 per cent, were in New England. (I believe the figures published by the department are only rural highways and exclude improved highways and streets in cities, towns, and villages.)

It is stated that there are 287,000 miles of rural highway that have been surfaced in the United States. More than 40,000 miles of these, or about 14 per cent, are in New England. If city, town, and village streets were added, the mileage would be much larger.



WILLIAM D. SOHIER

In 1916 we found that there were over 23,000 miles of highway in Massachusetts, and that about one-half of them were improved roads or streets, to wit, roads that had been graded, drained, and had material brought in to build the road. Most of these were constructed with a gravel surface or of some stronger material.

Since those statistics were made in my home State, Massachusetts, the mileage of road improved as State highway or State-aid roads has increased from 1,100 miles credited to us by the Government, to over 2,300 miles of improved highway that is maintained. I believe some of our neighboring States have done as well or even better.

The conditions are quite different in the six New England States. The three northern States—Maine, New Hampshire, and Vermont—are, to a great extent, agricultural and lumbering States, although they have also great attractions for summer residents and tourists. With the exception of relatively a few miles on the main trunk lines, their highways do not have any large bulk of heavy traffic.

ROADS CARRYING HEAVY TRAFFIC.

The other three States, Massachusetts, Rhode Island and Connecticut, on the other hand—while

there is considerable farming in Massachusetts and Connecticut, and quite a little intensive farming in Rhode Island—are in the main manufacturing States, and are very thickly populated, their roads carrying very heavy traffic. The highways in these States are also used on through routes to the seaboard from the interior, and have had to carry a considerable amount of trucking for the Army.

These last three States can afford to spend very much more per mile of road, both in construction and maintenance, than the northern States. Most of the improved highways in the three northern States are, and must be, constructed of local materials, being very largely gravel roads or improved dirt roads.

The main trunk lines in Massachusetts, Rhode Island, and Connecticut have been very largely constructed during the last 20 to 25 years, starting originally with some gravel and a great many miles of waterbound macadam work, continuing bituminous macadam and concrete.

The traffic on these roads has very largely increased year by year on account of the manufacturing and especially because of the war activities during the last year. The roads have had to be considerably widened; many of them have had to be resurfaced. It has been found everywhere where there was heavy truck traffic that a 14 to 16 foot width of hardened surface was insufficient on main highways; that at least 18 feet was necessary or it sheared off on the edges.

It has been found that waterbound macadam roads or roads with surface treatments will not, unless upon unusually good soil or foundations, withstand heavy trucks and truck traffic, especially when the frost is coming out of the ground in the spring.

THE ROAD WORK DONE IN 1918.

I think every one of the New England States this year has confined its work to its most important main through lines. They have cut down construction to a minimum, and the little construction that has been done has been on the main through lines.

They have also, as far as possible, when funds would permit, reconstructed or resurfaced the worst and weakest portions of these main trunk lines, attempting whenever possible to build a road that would be sufficient to stand up under the modern increased traffic.

In common, no doubt, with all the States, we have been handicapped by a shortage of labor and materials, especially bituminous materials, shortage of railroad cars and transportation, and we have had to pay very large and constantly increasing prices for labor, for teams, for materials, and for everything that went into the work.

In Massachusetts we have had something over 80 of our engineers, foremen, etc., go to the war. Of course the same thing has happend to the laborers and patrol men, which meant very much harder work on the part of the few men who remained, especially the division engineers and their assistants who had charge of the field work, and perhaps more particularly those who had charge of the patrol gangs and maintenance work.

The cost of road work in New England has increased substantially from 50 to 100 per cent, this being an estimate of increased cost of construction or reconstruction including materials, and probably very nearly as large an increase of cost of maintenance, especially of the old waterbound macadam roads, of which there are very many miles in Massachusetts, Rhode Island, and Connecticut, which it was impossible to reconstruct and which were very much damaged by truck traffic, especially when the frost was coming out of the ground.

INEFFICIENCY OF LABOR.

Experienced engineers and contractors with whom I have talked, and I think the commissioners in the other States, agree that they think that there have been two main causes of the increased cost of the work; first, increased wages, and second, and at least equally important, the inefficiency and instability of the labor when we did secure it.

While the cost of labor, teams, materials, etc., has been constantly increasing year by year for some time, not only because of an increase in the amounts paid but also because of shorter hours of labor in many States, the work in 1917 and 1918 has been very much more expensive than in 1916 because of war conditions.

The cost of maintenance in all the New England States has practically increased from 50 to 75 per cent unless possibly in Connecticut where there was a considerable increase in 1917, so that in 1918 the cost increased only 20 per cent on labor items.

In most places the cost of construction or reconstruction has increased from 75 to 100 per cent or even more. In a few of the country districts the cost of the work has not increased so much because local labor and teams were used when they were not urgently needed on the farms. Also, the patrol men and men employed on the maintenance of the main roads are more permanent, as they generally are men who live in the locality.

Whereas in 1916 laborers were paid $1.75 to $2 for an 8-hour day, in Massachusetts, in 1918 we had to pay on the average, except for local men, from $3.20 to $4 for an 8-hour day. Teams which in 1916 cost from $4.50 to $5.50 a day cost in 1918 from $6 to even $8 per day. The cost of materials and freight also increased from 50 to over 100 per cent from 1916 to 1918.

INCREASED COSTS IN TWO YEARS.

This is well shown by two sections of State highway that were resurfaced in two towns, one section in

each town, in 1916, and the second in 1918. Both were contracts advertised and let, the construction being the same each year.

Herewith are costs for surfacing work let on adjoining sections of State road in Lunenburg and Phillipston for 1916 and 1918.

Lunenburg.

	1916	1918
Excavation	$0.60	$1.30
Trap rock	2.70	3.60
Bitumen, furnished and applied	.15	.24
Stone fill	1.00	2.35
Sand filler	1.35	1.60
Stone screened	1.40	2.75

Using the quantities in the 1918 surfacing the increase over cost for 1916 was 57 per cent.

Phillipston.

	1916	1918
Excavation	$0.80	$1.50
Borrow	1.25	1.75
Trap rock	3.50	4.30
Bitumen, furnished and applied	.17	.25
Sand filler	1.25	2.00

Increased cost of 1918 contract for above items was 33 per cent above cost if 1916 prices are used.

The cost of maintaining the older waterbound macadam or gravel roads on the main lines is well shown by the following table:

Town.	1916	1918
Athol (west)	$175.05	$504.52
Bernardston (east)	485.89	819.14
Erving (east)	462.06	1,477.56
Fitchburg (west)	130.62	202.29
Gardner (west)	487.80	1,188.68
Shelburne (village)	225.95	501.98
Templeton (east)	330.19	882.18
Winchendon (Maple Street)	364.35	872.68

These roads have all been maintained by surface treatments of asphaltic oil and kept constantly patched.

A very considerable item in the increased cost is due to the increasing use of motor trucks and especially the heavy motor trucks carrying 3 tons or more on solid tires.

In Massachusetts, Rhode Island, and New Hampshire a good many miles of improved road suffered quite severely, especially in the early part of the season, because it was impossible to obtain the bituminous materials, or get their requests for permits granted during the first three or four months of the season. Lately the situation has much improved.

WEIGHT AND SPEED OF TRUCKS.

I believe one of the most important topics to be considered at this convention should be the devising of some sensible, stringent, and uniform regulation governing weight, speed, and width of motor trucks that are to use our roads; that excessively heavy loads must be absolutely prohibited or prevented from using any of our highways or bridges when the highways or bridges have not as yet been made adequate to sustain such vehicles and loads.

Road building is a constant evolution, because no sooner is the improved road built to carry a vehicle of a certain weight and size than the builder of the vehicles tries to increase both the weight and size.

I personally believe that there should be a very stringent regulation and limitation on both the weight and speed, as well as the width of the vehicles that are allowed to use our highways and bridges. I believe also that if heavy trucks are to be allowed to use the highways there should be some provision for routing them so they can not wander at will over out little country roads, destroying bridges and culverts and tearing up roads that are now adequate for all local traffic.

If heavy trucks are to use the highways they should be confined to the main lines only, and only such weights should be permitted as can safely use the highways and bridges that have been constructed. Otherwise we shall have a great many miles of road that it has taken many years to improve and build up destroyed, many bridges broken down, and our main roads will be put out of commission so that no one can use them for long periods of time.

FUTURE HIGHWAY TRAFFIC.

What will our highways have to carry in the near future?

We can only judge of this by our past experience. That the motor traffic will increase is sure. This is well shown by the following table, showing the increase, in Massachusetts, in motor vehicles in six years, and in the number of operators and the fees collected:

	1912	1915	1918	Per cent increase 6 years.
Automobiles and trucks	50,132	102,633	191,019	280
Motor cycles	5,034	9,520	12,708	150
Operators and chauffers	65,600	133,700	225,272	240
Motor-vehicle fees	$616,236	$1,235,723	$2,159,257	250

There are over three times as many automobiles and trucks registered as there were six years ago, over three times as many operators, and the fees collected are three times as large.

All these fees are spent in maintaining and improving our main highways. In fact, last year, we practically maintained all our main highways with the money collected from this source.

How the truck traffic has increased is shown by the following table:

	1915	1916	1917	1918	Per cent increase 3 years.
Trucks	12,053	18,194	25,505	32,676	171
Automobiles	90,580	118,615	145,801	158,343	75
Motor cycles	9,520	10,713	10,956	12,708	33

The number of trucks and commercial vehicles registered has increased from over 12,000 in 1915, to over 32,000 in 1918—more than 2½ times as many trucks as there were three years ago.

DAILY TRAFFIC ON MAIN ROADS.

The change that has taken place in traffic is clearly shown by the following table. This is made up from traffic counts taken every three years from 1909 to this year. An actual count is made for 14 hours a day for 7 days in August and 7 days in October. The table which follows shows the average number of vehicles that are using our main highways, and is based upon the average count in each of these years at 44 stations on main lines.

44 stations.	1909	1912	1915	1918	Per cent increase 9 years.
Light horse	91	68	40	24	[1] 73½
Heavy horse	88	88	72	43	[1] 51
Total horse	179	157	112	67	[1] 62½
Automobiles and light trucks	131	280	555	923	604
Heavy truck	.....	17	45	75	[2] 341
Total motors	131	296	600	998	661
Total vehicles	310	454	712	1,064	243

[1] Decrease. [2] In 6 years.

This clearly shows what is happening on our roads.

In 1909 there were practically no trucks using our roads. In 1912 there was an average of 17. In 1915 there were 45, and in 1918, 75, using the roads at the same stations. In other words, the number of trucks using the main highway has increased 4½ times in 6 years.

The change in the traffic is perhaps even more graphically shown by the following table of percentages:

PER CENT OF TOTAL TRAFFIC.

	1909	1912	1915	1918
Light horse	29	15	5½	2
Heavy horse	28	19	10	4
Total horse	57	34	15½	6
Trucks	.....	4	6½	7
Motors	43	62	78	87

It is astonishing but true that while horse-drawn vehicles constituted 57 per cent of all the traffic on our main highways in 1909, in 1918 there was only 6 per cent of the traffic horse-drawn vehicles; and motor vehicles, which were only 43 per cent of our traffic in 1909, were 94 per cent in 1918. We must not forget that the total traffic using the roads has increased over three fold.

While the horse-drawn vehicles are to-day only 6 per cent of the total traffic using our highways, the heavy motor trucks, to wit, over 1 ton, not on pneumatic tires, have already become 7 per cent of the total traffic. Perhaps even more significant is the change in the last 3 years. During that short period of time both the automobile traffic and the motor truck traffic has increased 66 per cent, or an increase of about 22 per cent a year.

While the average traffic shown in the foregoing tables gives a fair indication of what is happening all over the State, there are a number of main highways that are tributary to our larger cities and manufacturing plants and the seaboard, where the traffic, and especially the truck traffic, has increased very much more rapidly. This is shown by the accompanying comparison of the traffic at 15 points on main trunk lines:

DAILY TRAFFIC ON MAIN ROADS.

	Year.	Total horse.	Automobiles.	Trucks.	Total vehicles.
Brookfield	1915	36	607	19	662
	1918	56	1,119	83	1,258
Shrewsbury	1915	142	922	39	1,103
	1918	66	1,575	112	1,753
West Boylston	1915	118	529	22	669
	1918	65	1,195	85	1,345
Deerfield	1915	234	281	25	540
	1918	344	873	64	1,281
Westwood	1915	76	967	49	1,092
	1918	28	1,379	179	1,586
Concord–Acton	1915	48	653	19	720
	1918	38	1,484	238	1,760
Concord–Harvard	1915	57	238	16	311
	1918	55	523	107	685
Fall River	1915	326	763	61	1,150
	1918	508	1,840	403	2,751
Longmeadow	1915	115	1,150	83	1,348
	1918	54	2,062	135	2,251
Salem	1915	144	1,113	181	1,438
	1918	51	2,636	224	2,911
Revere traffic and Saugus	1915	301	.....	212	.....
	1918	215	.....	398	.....

Brookfield, the first, is on the main line between Worcester and Springfield, carried a certain amount of Army supply traffic.

Shrewsbury is on the mian line between Worcester and Boston.

West Boyslton is on the main line between Worcester and Fitchburg and doubtless had some traffic tributary to the Army cantonment at Camp Devens.

Deerfield is on the main line in the Connecticut Valley, between Greenfield and Vermont points and Springfield and Connecticut points.

Westwood is on the main line between Boston and Providence, about 12 miles out of the city of Boston.

The counts on two different roads in Concord show the amount of traffic that was put onto the roads by the building of an Army cantonment. Camp Devens is located at Ayer, about 36 miles out of Boston, and the change in the traffic on these two roads is undoubtedly due to the presence of that cantonment. The two roads together had 35 trucks in 1915, but three years later, in 1918, they had 345, or over ten times as many. The total number of automobiles was less than 900 in 1915 and over 2,000 in 1918, three years later.

The count in Fall River is on the main road running westerly out of that city and covers traffic going to several places, the main traffic going north to Taunton and west to Providence.

Longmeadow is situated just south of Springfield, and covers the traffic going south toward Hartford and Connecticut points.

Salem is on the main line to New Hampshire points, and also to the North Shore.

The last count, Revere and Saugus, shows traffic on two roads, one of them being recently opened, and the counts merged in order to show the increase in truck traffic going to the city of Lynn, which is a large manufacturing city situated about 11 miles from Boston. Here the number of trucks had increased from 176 a day to 398 a day in three years.

These figures show very clearly what is going to happen in the immediate neighborhood of our big cities on the main trunk lines connecting large industrial centers with each other.

Undoubtedly a good deal of this traffic was due to war conditions, the roads being used by Army trucks and by more than the usual number of commercial vehicles because of the congestion on the railroads.

On the other hand, the traffic counts also show that this increase in heavy truck traffic is two or three times greater on main through lines connecting important cities together that are within 40 miles of each other, and that the truck traffic there has increased much more than it has on the through routes in the country districts.

It is perfectly clear, however, that the highways of the future will have to be constructed wide enough and strong enough to carry with reasonable safety the constantly increasing number of vehicles that will go over them; that a highway will have to be provided that can stand up under the constantly increasing traffic in motor trucks.

This means that the old waterbound macadam roads which were built 5 or 6 inches thick on ordinary soil will not last or be economical, even with a surface treatment, if they are on a main route that has to carry an average of 50 to 100 heavy motor trucks a day.

A well-drained foundation will be necessary even for bituminous macadam, unless the subsoil is porous and well-drained sand or gravel, and even then it may be found more economical, to build a more expensive and stronger pavement on main routes that have a large amount of heavy truck traffic.

The Present Situation and How We are Meeting It in the Middle West

JON A. HAZLEWOOD, Chairman Wisconsin Highway Commission.

JUDGING from reports from the various States in the Central West, those engaged in the road game are meeting the present situation patiently and courageously. The financing of more road work than could possibly be done with the labor and transportation facilities seems to have been true in each section.

1918 COMPARED WITH OTHER YEARS.

Michigan reports that 793 miles were accepted and rewards paid, while in 1917 1,053 miles of road were constructed and State rewards claimed. This makes a loss of about 25 per cent. Kentucky reports the construction of 1918 was about 25 per cent of that of 1917. In Iowa the actual unit of road and bridge work accomplished in 1918 will be less than 50 per cent of the construction in 1917.

Minnesota states that the construction in 1918 compares favorably with previous years. While only three-fourths of the average annual mileage of previous years was completed the work was of more substantial character. Illinois reports that 1918, compared with previous years, shows that the State aid work constructed amounted to about one-twentieth. The total road expenditures by townships was curtailed about 50 per cent, due largely to the inability of towns to secure oils for earth roads.

North Dakota operated for the first year under a State highway commission, but notwithstanding it has been able to supervise the expenditure of almost $2,500,000 on its highways. Shortage of labor on account of the demands made for harvesting and thrashing forced the road work to come to a standstill about the 1st of August. South Dakota reports that the war has very greatly handicapped the work in that State.

Kansas reports their highway commission was in the course of organization in 1917, and during that year there was practically no work performed. Work in 1918 was very limited in scope and character. Construction for 1918 has been restricted in Nebraska on account of war conditions. About 215 miles of road however were put under contract involving an expenditure of $468,400. This is the first year Nebraska has given aid to its public highways. In Wisconsin it is estimated that the season's work in 1918 will be only 60 per cent of the work carried on during the previous year.

ARRANGEMENTS MADE FOR YEAR'S WORK.

Michigan reports that no special arrangements were made in 1918 over other years except that they had to pay more for work and work harder in order to construct the mileage undertaken. New

labor-saving devices came in to help out in the situation to a marked degree.

Kentucky reports that they were unable to make any special arrangements to carry on their work, but confined it to counties where local material was available. Convict labor was used to a limited extent. Minnesota reports they had no special arrangements for handling the work of this year different than in any other year.

Illinois reports that the supply of local material was so small as to make it impossible for them to change types of road construction; in fact, the lack of local material was chiefly responsible for the almost complete shut down of road construction in the State. The only important change made in Illinois construction methods was involved in Federal-aid road work. Five labor gangs on concrete roads were used.

North Dakota and South Dakota also report that they made no special arrangements for construction work in 1918. Kansas states that no special arrangements were made for 1918 construction work. A few contracts were let and carried out in the usual manner, and those upon which bids could not be obtained were abandoned. In Nebraska no special arrangements were made for 1918 work, except that the use of machinery was encouraged.

In Wisconsin, owing to the restrictions which were enforced, the only work which could be attempted on anything but the smallest scale was grading and surfacing operations, involving the use of local materials, where no rail shipments were required. Only about one-third of the normal bridge work was done.

THE COST IN 1918 AND RECENT YEARS.

Michigan reports the cost of work, compared with recent years, as 25 per cent higher, and Kentucky about 25 per cent higher than in recent years. Iowa states that the increase in the cost of bridge work was at least 50 per cent over that of 1916. The increased cost of grading on account of labor amounted to about 75 per cent over that of 1917, and the increased cost of surfacing, including paving, was 50 per cent over that of previous years. Minnesota reports the cost approximately 30 per cent higher than in 1917.

Illinois reports that the State-aid work which was completed this year was under previous contracts and the old prices held, so that they have no means of knowing the cost of the work compared to other years. The cost of force account work as yet has not been summarized accurately, but approximately it will run about 30 per cent over prewar prices. In North Dakota the work may be said to average about 40 per cent to 50 per cent higher than the cost of previous years, and in South Dakota to almost 75 per cent more.

Kansas states they cannot compare the cost of 1918 work with recent years, as this is the first year of operation under their highway commission. In Nebraska the cost of the work done in 1918 has been approximately one-third higher than similar work done in recent years. In Wisconsin, the cost of labor advanced more in proportion than the cost of material. The increase was 15 per cent to 25 per cent over 1917, the higher percentages applying to work where the labor item was the largest.

CHANGES IN ENGINEERING FORCES.

Michigan states that the department has suffered greatly in personnel in the last two years due to men entering the service. Thirty-nine men from the engineering department out of not to exceed 100 men at any time in the history of the activity, entered the military service. Reports state that it has been necessary to use girls in the drafting room and to resort to a good many makeshifts that heretofore were thought impossible.

Kentucky reports that no changes in engineering organization were made except that the legislature passed an act requiring the State department to make surveys and plans for all road construction. Heretofore the surveys and plans had been made by the counties, subject to approval by the State officials. The act necessitated the employment of field engineers and assistants.

Iowa states that it was absolutely impossible for them to obtain a sufficient number of men to handle the drafting and engineering work, so they substituted women for men. The women employed were trained in this work by the highway commission. A woman who was a graduate engineer was placed in charge of the draftswomen. The Iowa commission was well pleased with the results obtained.

Resident engineers in Minnesota were required to handle considerable of the instrument and detail work, which is otherwise taken care of by the assistant State engineers.

Illinois reports that they employed in 1917, 125 engineers. Since war was declared about 87 engineers employed by the department either enlisted or were drafted. The curtailment of the work undertaken made it unnecessary to replace many of these men. Previous to the war they had seven district engineers. Seven districts were combined this year into five districts.

North Dakota states that as this was the first year of their commission they had not fully or definitely established an organization to require any changes to meet the conditions encountered. They have had, however, to assemble the work in several counties, so it could be taken care of by one engineer, and in the case of force account work have had to make special assignments of engineers to look after

particular parts of certain projects. In South Dakota the work has been handled in 1918 very much as in previous years, except with a more limited number of employees.

Kansas states that no material changes in their engineering department took place in 1918, the only notable feature being that their State engineer, Mr. Gerhart, entered military service, which somewhat affected the personnel of their organization. No changes were made in the engineering arrangements of Nebraska during 1918. In Wisconsin the engineering force was approximately one-half of what it was at its maximum in 1917. The greatest portion of the force stayed through the active part of the season, but in all 46 men left the department to enter the United States Army service. Some of these men were replaced, but rarely with men of the same caliber. The surveys and plans, however, have been held up to the old standard with the exception of a very few sample grading jobs, which have been allowed to be built with only field staking out.

CONSTRUCTION PLANS FOR 1919.

Michigan reports that plans for 1919 call for greater mileage than has ever been heretofore undertaken. The last legislature passed a road assessment tax act, which makes it possible to start road work on petition and pay part of the cost by special assessment on the district which is to be especially benefited. The department has more than 1,000 miles of these petitions which can be acted on as soon as labor conditions warrant. These, taken together with the federal aid roads which will be built by the State and the 1,000 miles of road which will be built by townships and counties of the State, will make possible and probable the largest road program ever carried out in the State. Kentucky reports that the department plans for a largely increased program of construction and maintenance work during 1919.

Iowa is not contemplating any greatly increased program of road work for 1919. The hope is to be able to carry forward to successful construction the federal aid projects upon which they were unable to obtain bids this year.

Minnesota states the plans for 1919 have not been perfected, but they ascertain that there will be approximately $4,000,000 worth of work done on the State road system next year, principally grading and gravel surfacing.

Illinois contemplates as large a road construction program as it is possible to put under way with the engineers they are able to obtain.

North Dakota has a large road program to carry out next year. One of the principal lines of work of the highway department is the Federal aid work, which involves the construction of about $600,000 worth of work annually for a period of four years. The engineers' problem is particularly difficult, due to the fact that the cost of the roads is expected to be not much more than $1,500 a mile. South Dakota has eight projects which it contemplates building in 1919.

Kansas states it has its Federal aid projects well in command. It expects to carry forward a general good roads program for 1919. Nebraska's plans for 1919 contemplate the improvement of 752 miles of road with State and Federal aid amounting to $1,660,000, besides the building of many county and State aid bridges, which will bring the total expenditures to $2,000,000.

Wisconsin expects to carry forward a maintenance program of road work in 1919, in addition to a very full program of road construction on Federal aid projects and State aid work. County boards in the State have made very liberal appropriations for road construction and road maintenance, so that the program in Wisconsin will certainly be a big one for next year, very probably much the largest in her history.

PUBLIC SUPPORTS ROAD WORK.

In Michigan public sentiment favorable to road improvement is continually increasing. The highway commissioner states that propaganda is hardly necessary in Michigan in order to stimulate the work. Kentucky states that public sentiment is very favorable toward road construction, and is especially favorable to road maintenance.

Iowa reports that the sentiment for road work was never stronger. The increase of motor vehicles of all kinds has been very marked and in localities the operation of motor truck routes on a regular schedule has been established. Minnesota reports public sentiment strongly supporting all feasible and practical road programs.

Illinois has evidenced its interest in the road movement by voting a bond issue of about $60,000,000 by a majority of approximately 200,000. The bond issue law calls for the construction of 4,800 miles. People there have been given to understand that $66,000,000 would be made available by the bond issue and Federal aid combined, or about $13,800 per mile.

North Dakota reports that the sentiment for building and maintaining better roads and developing the State highway and better county systems of roads is all that could be expected. South Dakota reports that public sentiment is good and the people are looking forward to better highways and are willing to meet it with proper taxation.

Kansas public sentiment is the very best. Reports state that Kansas has been lacking pride in this important work until the beginning of 1917, but since that time the State has experienced a decided change in sentiment and the road program is sure to

go forward by leaps and bounds. The public sentiment in Nebraska is becoming enthusiastic as the people become educated to the value of good roads. In Wisconsin public sentiment for road construction and maintenance is all that could be hoped.

PROPOSED STATE LEGISLATION.

Michigan looks forward to the State building and maintaining the trunk lines, and does not look for any material change except the strengthening of the trunk-line legislation.

Kentucky reports that the legislature does not meet until the winter of 1920, consequently there is no legislative program developed for next year.

Iowa contemplates the changing of the proposed plans for road and bridge work. The State reports that the most necessary legislation relates entirely to the financing of road construction and maintenance, and legislation along this line is expected during the coming winter.

Minnesota wishes to bring about legislation providing a more favorable condition for a bond issue for hard surfacing of highways along the lines of the Illinois plan. Much effort is being put forth to bring about a more hearty support in favor of a more liberal plan of financing road construction and maintenance.

In Illinois a considerable amount of legislation is contemplated to correct minor defects in the present road law, but none of this might be considered of special interest. Efforts will be made to pass legislation for the regulation of highway traffic, with especial reference to maximum loads.

North Dakota reports that the law under which the commission is operating is ambiguous and indefinite in many respects, but has nevertheless been found to be a workable law. If no road organization interests itself in highway legislation for the coming session of the legislature there is some reason to believe that the department will attempt to make certain recommendations for the improvement of conditions over the present law, providing for more ample funds. Much study and attention must be given to legislation in the State in order to provide conditions necessary for the proper maintenance and construction of their system of roads.

South Dakota is looking forward to better highway legislation, favorable to providing more funds for road work. No definite plan has thus far, however, been worked out.

Kansas reports that there will be no legislation which is of especial interest. The present law does not permit State aid on account of constitutional provisions. The State expects to get an amendment passed by the legislature and submit it at an election in order to permit State aid There may possibly be some efforts to change the method of distributing automobile funds. Nebraska's legislative program has not been formulated.

Wisconsin states that there is not expected to be any radical change in highway laws of the State at the coming session of the legislature. There may be some additions made to the State trunk highway system. It appears that there is some inequity in the distribution of maintenance funds which it is probable will be removed.

CONDITIONS MET IN 1918.

In the Central West construction in 1918 has been between 25 per cent and 50 per cent below 1917; almost every State highway department has been forced to make special arrangements to handle the surveying, drafting, and engineering work on account of the large number that have been called away from service. The cost of work done was about 40 per cent higher than in 1917, owing to the increased prices of materials and labor. Some of the State departments were obliged to throw back on the counties and divisions a part of the surveying, drafting, and engineering work formerly done by the State. In many cases women were trained and employed for drafting.

CONSTRUCTION TO BE INCREASED.

The plans for 1919 work in most of the States were not much more comprehensive than work done this year at the time reports were made. Now that the war is over it is quite likely that the scope and character of the work will be enlarged upon, since contracts might be more numerous and labor and materials more available. Now that the ban is raised, and a policy of governmental encouragement substituted, we can look forward to highway work going along by leaps and bounds. Public sentiment for road work could not be better anywhere than it is in the Central West; proposed legislation in the States seems to be along the line of speeding up the construction of hard-surfaced roads through bond issues, and for establishing a more complete and scientific system of road maintenance.

ROAD BONDS IN MISSOURI.

There is a movement in Missouri for submission to the people of the question of a road bond issue amounting to $50,000,000. The proposition is to use motor-license receipts for paying the principal and interest on the bonds. Outside of this bond issue the legislature this winter is likely to consider important road legislation in order to hasten construction of a State system as outlined by the State Highway Department, which was created in 1917. Sentiment in the State in favor of better roads is steadily growing.

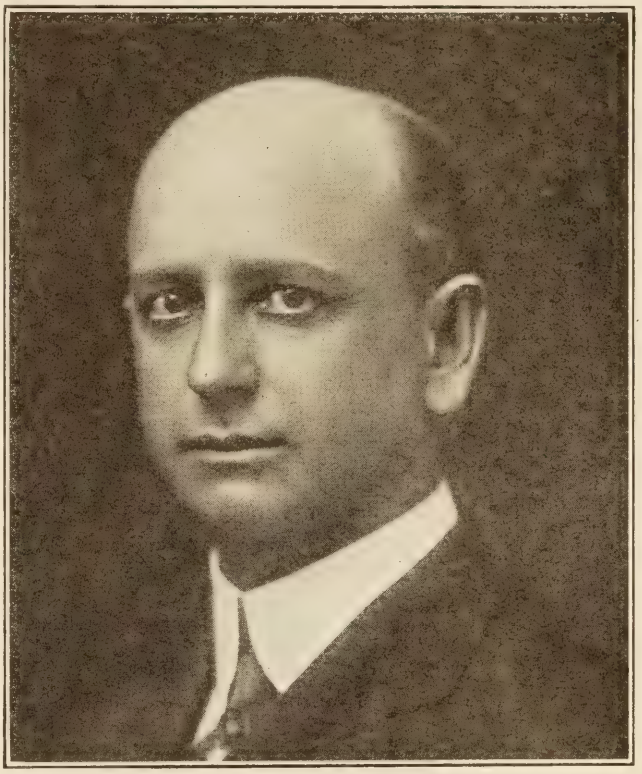
The Present Situation and How We are Meeting it in the South

W. S. KELLER, Engineer Alabama State Highway Department.

WHEN this program was prepared, it was "before the war." I am thankful with you that it is now "after the war" and I feel sure we all look forward with eagerness to the great work that will be set before us in 1919, and with renewed vigor make up for the time lost in whipping the Hun.

If I was permitted to confine my remarks to the restricted territory of Alabama, rather than the entire South, I would feel no uneasiness that what I say would be questioned. If the representatives of several Southern States do not agree with me and think I am misrepresenting their States, I warn them to keep quiet on pain of being exposed as those who ignore polite requests for information. As I, too, am sometimes guilty of overlooking requests, I forgive them, provided, of course, they will never let it occur again, and promise to forgive me for like omissions.

From information furnished me from other States, together with our own experience, I can partially, though poorly, give an account of the South.



W. S. KELLER

REDUCED CONSTRUCTION IN 1918.

The shortage and high cost of labor, the high cost of materials and machinery and the Government restrictions on the purchase and shipment of materials have reduced construction to approximately one-third of what it was in 1915 and 1916.

The extension of aid by the Government has been a stimulus, especially in my own State, to carry on despite the handicaps. Very few contracts were awarded, for the good reason that no bids were offered. Contractors were more afraid of the uncertainty of labor than the prevailing high wages. Convict labor has made it possible for many projects to be constructed that otherwise would have been indefinitely postponed. We are much better down South than we used to be, and do not have many convicts and a well-manned convict outfit is an exception rather than the rule. No able-bodied convict now has to work out his fine, for there is always some one ready to settle for him and take a chance on getting it back in labor, and many counties have had to abandon this method of road building. The State of Georgia has, perhaps, been most fortunate, because of the fact that State convicts are worked on the roads, whereas, in the other States only county men can be so used.

If any special arrangements were made to overcome labor shortage and Government restrictions, I was ignorant of it. We have to a certain extent used labor-saving devices and machinery to advantage. We have found it hard to replace the negro and the mule.

THE INCREASE IN COST OF WORK.

The cost of work during the current year will average 50 per cent greater than in 1916 and 1917. The cost has varied greatly. Where work was in close proximity to a military camp or Government works of any kind prices were much higher than at places far removed from them. An average cost on four items in Alabama will give a clear idea of the increase:

1917:	
Earth excavation (rock excluded), per cubic yard..	$0.22+
24-inch D. S. vitrified-clay pipe, per linear foot....	1.82
Sand-clay surfacing within 1 mile, per cubic yard..	.32½
Class A concrete, per cubic yard.....	15.00
1918:	
Earth excavation (rock excluded), per cubic yard..	.33¾
24-inch D. S. vitrified-clay pipe, per linear foot....	2.54
Sand-clay surfacing within 1 mile, per cubic yard..	.50
Class A concrete, per cubic yard.....	20.00

One peculiar factor that has added to the cost of our work is the dislike of the average negro laborer for work when he has any money. It simply burns a hole in his pocket and he must lay off several

days in every week in order to spend it, with the consequent more or less demoralization of work and the resultant increase in cost.

ENGINEERING ARRANGEMENTS.

No two States are doing their engineering work exactly alike, and to answer this question intelligently, it would necessitate a detailed statement from each State. No doubt every State contemplates advantageous legislation permitting improved engineering arrangements. I can state, however, that the South is fully awake to the value of engineering, supervision of road construction, and maintenance, and we can look forward with a degree of certainty to a time when every county will have an engineer.

SOUTH TO SPEND $15,000,000 IN 1919.

Plans for 1919: Federal aid for the Government fiscal years 1918 and 1919 for nine Southern States amounts to $4,175,583.80. A like amount form the States gives a total of $8,351,167.60. Only a fractional part of this appropriation was used during the past year. As an offset for what has been used, fully as much of the 1920 appropriation will be spent by some of the States. I think a conservative estimate of the amount that will be spent for road construction in the South from all sources will be fully $15,000,000. In making this statement, I am assuming that labor conditions will materially improve. I can also safely say that the roads that will be constructed in the future will be better roads than those built in the past.

PUBLIC SENTIMENT FAVORABLE.

With us in times past it was necessary to hold frequent meetings at which silver tongue orators, generally with a political bee in their bonnets, would expatiate at length on the great benefits to be derived from a system of good roads. In order for a county to issue bonds an extensive and sometimes expensive campaign was necessary. From one extreme we have gone to the other. It is now necessary to warn county officials from putting their counties hopelessly in debt and to such an extent that all the tax funds go to pay interest, with nothing left for maintenance.

The road sentiment in the South is good. We do need, however, to educate our people to the point where each individual will so appreciate his road that he will protect rather than abuse it. We are too prone to throw the entire responsibility for the upkeep of our highways upon road officials, while at the same time we openly violate a road law. I am sorry to say that we have not the respect for road laws that you of the North have.

I am pleased to say that the South is now thoroughly convinced of the futility of building cheap roads and bridges to sustain heavy traffic. Like the rest of the country we have had to meet conditions brought about by the rapid evolution of travel and especially the great increase in truck haulage.

The Federal road law has been a very pleasing factor in the further development of road sentiment with us.

Recent Damage to Eastern Road Systems and Problems New Conditions Developed

W. G. THOMPSON, State Highway Engineer of New Jersey.

EXCEPT as the methods employed in repairs differ with the types of pavement predominant in our respective localities, our recent road problems were, I think, quite similar.

These problems, briefly stated, were: A traffic, unprecedented as to volume and weight; shortage of labor and materials due to Governmental restrictions and operations; and uncertain rail delivery due to war priorities. We had also to reckon with winter conditions such as the Eastern States had not experienced since the blizzard of 1888. Highway officials and others responsible for the upkeep of the roads found it difficult to make headway against this combination of conditions, as generally speaking the existing highways in this country were not designed to bear the loads which passed over them between July, 1917, and July, 1918.

Until the advent of the motor vehicle macadam roads were considered suitable for rural and interurban traffic in the Eastern States. With the coming of the automobile it was soon evident that such pavement would not suffice without excessive maintenance charges, but most States and smaller communities lacked the courage, or perhaps we should say foresight, to adopt programs providing for more durable pavements, hence we found ourselves faced with the problem of maintaining thousands of miles of macadam pavement utterly unsuited to a traffic growing by leaps and bounds as to volume, weight, and speed.

MACADAM FORMERLY EFFICIENT.

For more than 30 years macadam construction was the best known and quite satisfactory for the traffic

using it. The transition from horse-drawn to motor vehicles was so rapid and the destruction of pavements due to high speed and suction of pneumatic rubber tires was so widespread that many communities were and still are unable to adjust themselves financially to the new needs. When motor cars first appeared none but the wealthy could own and operate them, and as they were looked upon as a favored few the ordinary taxpayer did not look favorably upon spending large sums to build smooth durable country highways solely for the pleasure of city people. When the price of automobiles became so low that ordinary citizens could own them, and owners increased to the thousands and millions, people began to take an interest in highways and Mr. Ordinary Citizen, who formerly voted in town meeting against the appropriation of $600 to repair all the roads in the township, began to ask: "What is the matter with these cussed highway officials?" The disgraceful part of the matter is that most of said cussing was done on Sunday afternoons when he took the family to ride.

I think it will be conceded that there was no widespread interest or concerted action for good interurban and country highways until the farmers and people of ordinary means began to buy automobiles, though the use of our roads for freight transport made necessary by munitions business incidental to the opening of the European war in 1914 soon made it evident that then existing types of pavement would not stand the strain.

FOUNDATIONS AND DRAINAGE FAIL.

The entry of our country into the European war and the railroad congestion of last winter subjected our roads to the supreme test, under which many of them failed most lamentably, although every effort was made to keep the through routes passable. Most of our failures were due to insufficient and unstable foundation and inadequate drainage, which lack of drainage in conjunction with the expansive effect of frost in many places simply turned the roads upside down. Added to this, the incessant passage of heavily loaded trucks turned the saturated sub-base into a quagmire. A consequence of this was a loosening of the stones in the underside of the pavement, resulting in such a disintegration of the structure that in many cases the rear wheels broke through the crust and it was necessary to jack up the vehicle and place planks under the wheels to extricate it.

These conditions applied not only to the water bound and bituminous macadam pavements, but to the asphaltic concrete pavements laid on macadam or broken stone foundations as well. We had many cases where expensive bituminous pavements laid on macadam bases of insufficient thickness, and inadequately drained, blew up or broke through under the heavy loads and constant traffic. When I say constant traffic I mean a continuous procession of trucks in both directions, besides the thousands of passenger and lighter cars. As an instance of the density of passenger-car traffic to and through the New Jersey coast resorts, a census was taken on a Sunday afternoon last summer at a bridge where all traffic along the shore must converge to cross a stream. Between 2.30 and 6.30 p. m. more than 5,000 cars passed a given point. It is easily realized that the problem of providing improvements adequate to sustain such a traffic is a serious one.

I believe I am safe in saying that highways in the East suffered greater damage during 1917 and 1918 than during the preceding three years. Neglect or inability to remove snow caused the ruin of miles of eastern pavements last winter. Heavy trucks wallowed through and finally broke a path, which eventually wore down to the pavement. Other vehicles followed the same track, which except for certain stretches was used for several weeks; thus the entire traffic was confined to a few inches of width in each wheel track instead of being equally distributed over the entire surface. This naturally resulted in deep ruts which were difficult, and in many cases, impossible to repair properly.

HEAVY SKID CHAINS DO DAMAGE.

Another destructive factor was the heavy skid chain used by the trucks. Many of these had links one-fourth inch thick and were so spaced that there were but three wraps to the wheel; therefore, instead of action resulting from the lighter chains on passenger cars where the chains are about 6 inches apart, there would be the impact and grind of these heavy chains for each one-third revolution of the wheel. No pavement could withstand such a pounding and and grinding. The man who will invent a nonskid device for heavy trucks which will reduce the destructive effect of the present chains will earn the undying gratitude of highway officials. I believe it will be necessary to forbid the use of such heavy chains, as it is impossible to build pavements to withstand their action.

This should not be taken as a brief against the widespread use of motor trucks, as I believe in the future of the motor truck, and that it will be an important factor in reducing the cost of living, particularly when roads suitable for trucks the year round are built into every farming community in this country.

The possibilities for the future of highway transportation are unlimited, but the possibilities of the highways are limited, that is, there must be a limit to the weight, tire width, and speed of vehicles using the highways, as the destruction of the past year bears evidence. If an arbitrary limit as to weight is not adopted, the race between the trucks and the highways will be a merry-go-round with the trucks always a little ahead.

HEAVY CONCRETE PAVEMENTS.

Our effort in New Jersey to lower maintenance costs and provide foundations to carry the loads resulted in the laying of concrete pavements 8 inches thick at the sides and 10½ inches thick at the center on our main through routes. It remains to be seen whether this thickness will suffice, as its adoption was purely arbitrary, and with the hope that it would prove a solution of our difficulty.

As an indication of the difficulties encountered in maintaining pavements during the past year, and of the increase in traffic volume, our traffic census on one main route shows an increase of more than 300 per cent over that of early months of 1917. Mr. Breed, of New York, reports an increase of truck tonnage varying from 50 to 400 per cent and an average increase of 150 per cent over that of 1916. Similar increases are noted in Pennsylvania, Delaware, Maryland, and the seaboard states of New England. It should be understood that these heavy increases are on the main or interstate routes, especially in Connecticut, New York, New Jersey, and Pennsylvania.

It is easy to imagine the difficulty of maintaining or rebuilding main highways under such traffic conditions. In localities where suitable detours were not available traffic was carried on the shoulders or on improvised passage ways over the roads where repairs were in progress, though at additional expense.

Where detours were available they were generally secondary or township roads built for the ordinary farm traffic, and naturally went to pieces under the pounding of heavily loaded trucks. This damage to secondary roads amounted to hundreds of thousands of dollars, and should be borne in mind by shippers and truck owners generally. Unusual efforts were uncomplainingly made to keep the trucks moving as a patriotic duty during the war period. Mr. Edward R. Viets, of the Service Recorder Co., of Cleveland, states that motor trucks increased from 60,000 in 1912, to 600,000 in 1918. These 600,000 are only a nucleus around which will be built a real fleet of trucks.

SATISFACTORY ROADS WILL COME.

The highway authorities of this country are awakening to their responsibilities and will build, as rapidly as possible, pavements capable of sustaining the traffic. It must be realized, however, by all truck users, that up to the present there has been no attempt to coordinate, so to speak, the needs of truck users and manufacturers with the means at the command of highways officials. As a consequence motor-vehicle development has far outstripped highway ability to carry it.

Need for Engineers for Highway Work and How Qualified Ones Will be Found

JOHN H. MULLEN, Deputy Commissioner of Highways, Minnesota.

THE subject "Engineers for highway work" was intended to cover a discussion of means for taking care of engineering on road work under war conditions, as practically all of the larger highway engineering organizations have been greatly depleted in the past two years. This deficiency had in many cases forced the closing down or abandonment of projects which could otherwise have proceeded, and particularly in the Middle West, where large construction forces and considerable machinery unsuited for other work was not made use of for the reason that engineers were not available for supervision.

This was an engineers' war and to the engineer must be given considerable credit for the remarkable success of our forces. It was to the engineer that our Government appealed for management of the cantonment construction, for the building of docks, railways, and the organization of transportation facilities, and when the great drive opened, it was the engineer who was in the advance, removing obstructions, building bridges, highways, and railroads, and keeping open the lines of communication, so that a continuous supply of munitions, food, and reinforcements was available when needed to support the advancing armies.

WORTH OF ENGINEER SHOWN.

Truly the engineer has demonstrated his worth in this emergency and it is a blessing to humanity that such men were available. It was the duty of those not so fortunate as to have directly participated in the war to adjust themselves to war conditions, assume some of the burden for those overseas, and endeavor to carry on the work in such a manner that the returning engineers would find their interests protected and the engineers who were obliged to stay at home doing their share in maintaining the progress and efficiency of the country were given proper recognition. That is what we were to discuss, but fortunately the war has ended, and now our problem seems even greater. The country evidently has become aroused to the need for highway improvement and is willing to

spend millions of dollars for that purpose, provided there is assurance that the work will be properly handled. The public, however, does not know how this should be done, and has but a very hazy idea of the need for scientific organization and expert supervision of highway improvement.

The engineer's work in France and the progress already made in this country has, to a certain degree, opened the eyes of the public in this respect, but there is little known of the careful investigations, the close study, the hard work, and the infinite amount of detail attendant upon the successful prosecution of highway improvement. In the public mind, satisfactory results are generally credited to the contractors or superintendents of the work, who do not consider it unethical to advertise. This matter of publicity is very important and the people should be well informed on the management of highway affairs so that the engineers will be given due credit for their work.

A GREAT FIELD FOR ENGINEERS.

Highway administration offers a great field for engineers, but which will not be developed unless it is made possible to pay adequately for engineering services. This has not generally been done. Many States have worked up very efficient organizations and have been obliged to maintain them at a low expense on account of lack of funds. Some of these departments are held together through interest in the work and loyalty to the service, but this is a practical age, and if the proper kind of men are to be employed, if initiative is to be encouraged and efficiency promoted there must be a material reward. In the past few years it has been the experience of many engineers to have had charge of work on which the foreman and machine operators were drawing 50 to 100 per cent more pay than the engineer. Knowledge of this does not create respect for the profession by those employed on the work, nor does it increase the engineer's self respect and confidence in his position of authority. Highway engineering requires as much training, experience, and application as dentistry or the law and as a profession is held responsible for the condition of the public highways, which are the main arteries of business in the country and which affect the individual and community more intimately than any other public work. Therefore in the light of fairness and good business this profession should also be recognized by proper compensation, otherwise it will be difficult to interest able engineers in the work.

THE QUALIFICATIONS NECESSARY.

The qualifications for a highway engineer do not seem to be generally agreed upon. It is frequently stated that this position requires only from 10 to 25 per cent technical knowledge and the remainder common sense. The natural consequence of such statements is to mislead the public and discredit the profession. It is true that the work requires the exercise of a great deal of common sense, but that is fundamental and true of any other important work. The highway engineer must have a groundwork of engineering knowledge, acquired through years of practical experience and study or by technical schooling. Without advanced technical training a man is greatly handicapped in engineering, but on the other hand, experience proves that men who have overcome this handicap are generally the most efficient.

Highway engineering is a new science, in the process of development, and the man who can accumulate and systematize knowledge of this subject as it develops will make a successful highway engineer, provided he has the preliminary training or engineering experience as a foundation. Actual training in this branch of work has not given engineering colleges much concern up to the present time, which, however, is not a serious matter, for traffic conditions have changed so radically in the past few years that the principles involved are entirely different. We are now at the opening of a new transportation era and the volume and importance of contemplated highway work calls for the special training of a large number of men. At the same time it is realized that engineering colleges are not generally equipped to give this training, and therefore it falls upon the State highway engineers to lend assistance in directing the work of the student, so that upon leaving college he will not have to serve such a long apprenticeship before taking charge of work.

To efficiently perform the duties of highway engineer requires not only technical qualifications, but also knowledge of public affairs, administrative ability, capacity for detail, and the knack of handling men. The engineer devoting all of his time to the work is in the best position to study traffic conditions and the economics of the situation, to advise the govern ing boards, and direct public sentiment along proper lines.

DEPENDENCE UPON THE ENGINEER.

There is a growing tendency, especially in the Western States in which highway departments have been organized for several years, to place the entire responsibility for highway management in the county upon the highway engineer. Boards of supervisors have other interests demanding their attention and are placed in authority primarily to carry out public policy and to protect the public interests. It is not expected that they are qualified to direct engineering operations and they gladly receive the cooperation of the engineer if convinced that it is cooperation and not interference which the engineer offers. But

an engineer should not assume such responsibility unless he is willing to apply a tremendous amount of study and work to the task. He must make a study of the present and prospective tonnage and passenger movement on the highways, of the availability of road materials and shipping facilities, and also of the economical types of road and bridge construction to meet the various conditions, and must inform the people of their needs in such a way that funds will be provided to carry on the work. A survey and accounting organization has to be worked up so that adequate and complete plans and supervision will be provided and comprehensive cost data made available; also that traffic and service records may be kept, and all factors governing road policy and administration tabulated and orderly arranged. There is practically no end to the detail connected with highway management if properly handled.

It may not be amiss at this time to go into the general policy of highway administration, and to caution the Federal and State authorities of the danger of too rigid standardization. General standards and principles must be established, of course, but individual initiative must be given full opportunity for development. Highway engineering is an art, not a trade.

RECOGNITION AND COMPENSATION.

Getting back to the problem of engineering organization and taking all conditions into account, the prospect does not appear at all difficult for the immediate future, provided, however, that there is recognition of service and proper compensation, for then the profession will attract engineers who have been in military service, having previously had training and experience on railroads, highways, or similar work, and whose military duty has forced a respect for detail and given an opportunity for handling men. Not only that, but their observation of the remarkably good road conditions in Europe, where the actual construction is nothing to speak of but where the maintenance system is so amazingly complete, has awakened many of the engineers to the highway possibilities in this country and a consequent desire to participate in the work. This situation will undoubtedly take care of the immediate needs, but some means must be devised for training the large number of men who will be required to take charge of the tremendous amount of road building to be carried on in the next few years. Experience has demonstrated the need for a combination of practical work with engineering studies, and it would seem expedient for the various highway departments to cooperate with engineering colleges in this respect. This policy in general is in line with the recommendations by Dr. Mann in his excellent report for the joint committee on "Engineering Education." An attempt has been made in Minnesota to follow a similar policy, and a number of subordinate positions in the State highway engineering force have been filled during the summer months by university students, thus providing more efficient help on surveys and inspection and also giving the practical training so necessary to a complete education.

ROADS GIVE WORK TO FARMERS.

The State Highway Commission has recently completed roads in Blaine and Hill Counties, Mont., selected not only to give improved highways urgently needed but to furnish work to farmers who met with losses of their crops last year through unfavorable weather. One of the roads, 6 miles long, in which much gumbo was encountered, was difficult for any kind of travel in wet weather and could only be used for heavy traffic in dry weather. It was graded, subgraded on gumbo, given a clay binder, and topped with a compact gravel surface, and all bridges were built to stand a 20-ton load. All the labor and teams were furnished by farmers residing in the immediate vicinity of the road. This was also true in the work on the other road constructed, which was cut through bluffs and shortened the existing road 4 miles. These roads were built on the State-aid plan, by which the State bore 40 per cent of the cost.

COUNTY WANTS GOOD ROADS.

Winnebago County, Ill., is after better roads and wants them in a hurry. Grant Highway passes through that county and is in bad condition. Investigation showed that probably not until 1922 would the State commissioners of highways be able to help Winnebago from the $60,000,000 bond fund recently voted in Illinois, and a movement was started to provide a county fund. It is proposed to vote an issue of $1,500,000, the funds to be used at once in building roads. It is estimated that this amount will build a system of 77 miles of concrete roads. A large meeting of farmers and town people, held December 30, voted unanimously to support the proposition. Farmers voted that they would stand a tax of 6 cents an acre per year for 20 years on their land to take care of the bonds.

TREES TO ADORN ROADS.

H. A. Green, president of the Monterey, Cal., Tree Growing Club, has offered to the State Forestry Department 1,000 live oak trees for planting along the roads. The Forestry Department has approved and put the matter before the State highway commission.

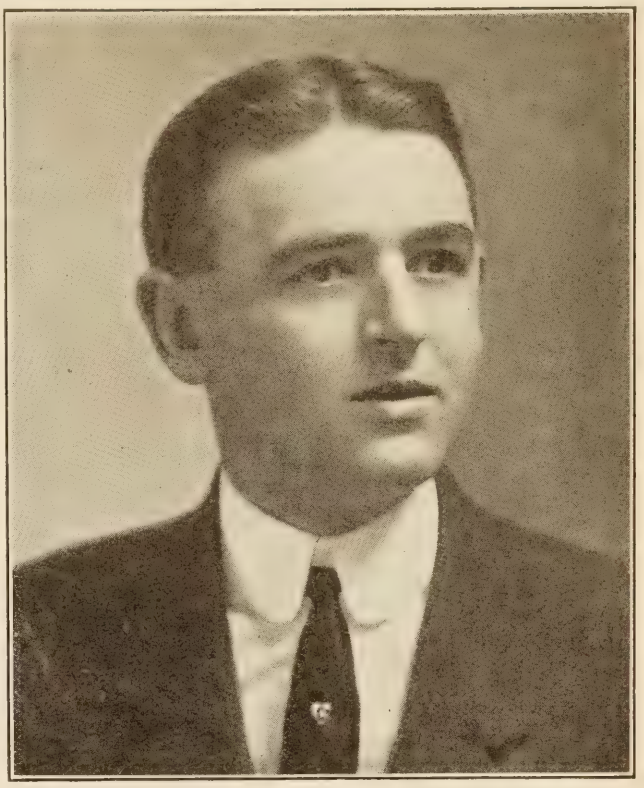
Laying Out, Marking, and Maintaining a State Trunk Highway System

A. R. HIRST, State Highway Engineer of Wisconsin.

IT IS becoming increasingly evident that if our States are to have a completed system of modern highways within this generation, their expenditures must be largely concentrated upon definite and restricted systems of highways, and not spread indiscriminately on all roads, as in the past. In order to make possible this concentration the state highway systems must be most carefully selected, for this policy of concentration will meet much opposition, which opposition will in many cases prevail unless the basic layout is honestly, logically, and adequately made.

Wisconsin has in the past two years established such a system, and our methods of doing it and the lessons we have learned in the doing of it will doubtless be of interest to the States which have, or will shortly have, similar problems.

The whole cost of establishing, marking, administering, and maintaining the Wisconsin trunk highway system and the State's share of the cost of all Federal aid construction on it is made available by appropriating 75 per cent of the net proceeds of the motor-vehicle license fees for these purposes. The remaining 25 per cent goes back to the counties for the maintenance of other main roads.



A. R. HIRST

WHAT SHOULD A STATE SYSTEM BE?

Our conception is that a State trunk highway system is a system of highways interconnecting every county seat in the State, also every city or village having a population of 1,000 or more; offering full access to the agricultural, scenic, manufacturing, and resort interests located within the State; and connecting also with the principal highways of all surrounding States.

We believe that the State trunk highway system should include approximately 10 per cent of the total public highway mileage lying outside the limits of incorporated cities and villages. This percentage may be high for some of the more thickly populated States and it may be low for the sparsely settled ones.

The present Wisconsin State trunk highway system comprises 5,000 miles, or about 6½ per cent of our total rural road mileage. This system, however, is not entirely adequate. We expect the legislature will add from 1,500 to 2,500 miles within the next few years, bringing it up to about 10 per cent.

SELECTING THE SYSTEM.

In our State the selection was made jointly by the State highway commission and a committee of five from the legislature, appointed by the governor. There was complete cooperation between the two bodies, and we believe that the result reached jointly was much more satisfactory to the people of the State than action by either body alone would have been.

The first step in the layout was to select and place upon a map all roads in the State which, from the best available information, were the main lines of travel. These were studied very carefully and another map made showing a tentative system including the most desirable routes, but not exceeding the maximum mileage allowed by the statute. These highways were strategically located so that parallel highways were placed a reasonable distance apart, and so that the areas untouched by any road were approximately equal in territory of equal development. As a result of this very careful preliminary work, it was found that the tentative system coincided largely with the system finally selected.

RECONNOISSANCE SURVEYS MADE.

After this had been done our division engineers made a careful reconnoissance survey of all the routes on the map, together with competing routes, where such existed, and such other routes as seemed

to them to be worthy of consideration. This survey was made by automobile; the division engineer, who drove the car, acted as observer, and was assisted by a recorder who kept a record of all features of the road by tenths of miles on a prepared pad sheet. The features recorded included the character and condition of the road and its surface, culverts, bridges, drainage, soil, character of surrounding country, cheese factories, creameries, schoolhouses, farmhouses, mail routes, railroad crossings, turns, hills, bad conditions generally, and all other information of engineering and public interest. The actual mileage on the various routes was, of course, taken. By tabulating these sheets it was possible, in case of doubt between two competing routes, to get a very close idea of their comparative merit.

After all probable routes had been surveyed hearings were held at each county seat. At these hearings large scale maps showing the routes under consideration in the county and vicinity were displayed, and the advocates of all routes, especially the competing routes, were given full opportunity to present their views. As evidence of the interest in the layout, most of these county hearings were attended by from three to six hundred people, and much valuable information was obtained. The important result, however, was that the people knew that all possible routes had been investigated and that the advocates of all of them had been given a fair chance to be heard.

ARRIVING AT FINAL LAYOUT.

After a series of hearings covering a particular section of the State, the State highway commission and the legislative State trunk highway committee, which sat jointly with the commission in many of these hearings, met at Madison and determined the official system for that section. Important considerations in arriving at the final layout were: The population served, the grades, the supply of materials locally available for construction and maintenance along the various roads, and the transportation facilities available where local materials were not to be had. In many cases the choice between competing routes was determined by the character of the soil over which the two passed.

In laying out the 5,000-mile system in Wisconsin about 7,500 miles were surveyed. About five months were required by all the necessary operations and the total cost to the State was approximately $20,000, or at the rate of $4 per mile for each mile finally located on the system, including the cost of the final survey (described hereafter) made in the spring of 1918.

The maintenance of this system was taken over by the counties under the general direction of the State on May 1, 1918, as required by law. As early as possible in the spring of 1918 a second survey of the lines as finally established, connected, and numbered was made. This survey was for the twofold purpose of recording the condition of the highways by tenths of miles at the minute State maintenance began, and for the second purpose of determining the location of the mileposts and patrol sections, the information to be placed upon the direction and danger signs, and their location, etc.

We feel that a condition survey is necessary at the exact moment the maintenance of the system is begun, first, to obtain an accurate measurement of the system as finally laid out, and, second, to make a record of the exact condition of the system so that improvements made can be later registered and compared with the original condition.

We have worked out a system of progress reports using colored crayon and tack entries on charts and maps so that the past and present condition of any section of the system and all structures on it can be determined at a glance.

A tabulation of this final condition survey (made as of May 1, 1918) shows that there were actually 4,999 miles of road on the system subject to State maintenance.

MARKING THE SYSTEM.

Our State trunk highway law provided that each State trunk highway should be given a number, which should be displayed along the road itself in a standard design, similar on all State trunk highways except the number. The State trunk highways are numbered in order of their length in miles from 10 upward, the longest (456 miles) being number 10. The idea in selecting 10 as the lowest number was that every highway number should contain two digits and thus give uniformity.

After considering a large number of designs for the standard marker it was decided to use a triangle containing at the top the words "State Trunk Highway," then the number in large figures, and in the lower point of the triangle the word "Wis." The triangle is 10 inches wide at the top and 13 inches long, and is placed on telephone poles on a white-lead and oil-paint background 18 inches wide, the triangle and lettering being coach black. We find that it is advisable to be rather profuse with these road markers. The white bands are just as valuable as the marker itself in outlining the route. Where a turn should be made the white band is widened to 30 inches and an "R" or an "L" stenciled beneath the marker in the white field. These markers were placed upon the telephone and telegraph poles, fences, culvert-end walls, and in some cases on boards nailed on trees, where other objects were not available.

COST OF THE MARKING SYSTEM.

By the cooperation of the 71 counties the whole system was marked in one week. Each county did the marking within its limits, the stencils and instructions being furnished by the State highway commission. The cost of marking in the counties varied with the care taken, the complexity of the roads, the length in the cities, etc.; the highest county rate per mile was $5.25; the lowest $1. The total cost of marking 5,300 miles was about $9,000, or at the rate of $1.70 per mile. The system of numbering the highways has proven to be very satisfactory. The principal highways are now called by their numbers just as naturally as people call trains by number.

We have erected county line signs and State line signs giving the name of the two counties and the county highway commissioner's name and address. On the same principle every patrol section has a sign at each end giving the name of the patrolman each way from that point. These two types of signs are placed so that the traveler may know who is responsible for the maintenance of the section of road over which he has just passed and of the section into which he is passing. We have found these signs very valuable in stimulating the natural spirit of competition and pride, which should exist in patrol work.

MILEPOSTS AND DIRECTION SIGNS.

We have also set up standard mileposts or markers showing the State trunk highway standard design and number and the mile number measured from the east or south end of that especial State trunk highway. These mileposts serve to tie our office records to the road itself, and also enable any traveler encountering good or bad conditions to boost or complain to us, as the case may demand, and enables us to locate the exact place mentioned. Culverts and bridges are numbered and tied into the mile numbers—thus the first culvert in mile No. 25 on trunk highway 10 is 10–25–1, and the first bridge is 10–25–11, etc. All mileposts are of wood and cost us about $1.50 each erected.

We are erecting about 2,000 direction signs. These are board signs painted white with black lettering. They are divided into "on system signs"; that is, signs at intersections directing both ways to places on that State trunk highway or beyond, and giving the mileage; and "off system signs", located at intersections with other roads and directing to important points not on the State trunk highway system. These "off system signs" are located only at the intersection with the one road which should be taken from the State trunk highway to the point in question.

SPECIAL METAL DANGER SIGNS.

We have also designed and have had made special metal danger signs for railroad grade crossings and dangerous hills and curves. These are the only metal signs we have used and cost $1.365 each f. o. b. Madison. Caution signs stenciled on telephone poles or other convenient objects are used where there is no real danger if reasonable care is exercised. Direction signs and all other signs are erected on wooden or concrete posts painted white.

In addition to the above, all of which serve to outline the course of the system in one way or the other, we expect next year to paint or whitewash the end walls of all culverts, the end posts of all bridges, to place posts painted white at the end of all culverts without end walls, and where the fills are not high and we have no guardrails we will outline the edge of the fills with stones painted white or with occasional white posts.

Including the marking of the triangles (costing $9,000), the total cost of marking, signing, and protecting the State trunk highway system will be $25,000, or at the rate of $5 per mile.

MAPS OF THE SYSTEM ARE NEEDED.

The next thing after the system is laid out, surveyed, recorded, and marked is the publication of a map, which will enable the traveling public to properly select their routes and the numbers. We are publishing a wall map (scale 1 inch equals 6 miles) showing all roads in the State, with the State trunk highway system, and the secondary roads outlined in red. This is small enough for general office use, and while the sale of such a map is limited, it is valuable for display in hotels, garages, clubs, etc.

The map for general public use in touring is published on a scale of 1 inch equals 16 miles. In addition to showing the numbered and marked State trunk highway system and the principal secondary roads, points of historic and scenic interest and State institutions are also located and numbered. Accompanying this map is a little booklet on Wisconsin, giving her history, an index to historic, scenic, manufacturing, and State property features located on the map, some record of its agricultural and manufacturing resources, and other material of interest. These maps are sold for 10 cents each.

CONCENTRATE ON TRUNK SYSTEM.

All Federal aid construction is concentrated on the State trunk highway system. The legislature has also provided that at least one-half of the State aid money, together with the county funds, should be expended on this system. In so far as possible these funds will be used to construct those places at present impossible to maintain in their present condition. We have no hope of reconstructing the entire system in an adequate manner for several years, but are using the limited funds available to get rid of the road terrors and thus strengthen the weak links in the transportation chain.

In our State aid construction for the next year or two we are going to relax from our previous standards and convert construction funds into heavy maintenance work covering much more mileage. This will be true in both grading and surfacing work. Results secured by our gang maintenance this year fully justify this extreme departure from our previous practice if good patrol maintenance is immediately established.

MAINTAINING THE SYSTEM.

We do not believe that a State should lay out a state trunk highway system unless from the instant it is laid out it is maintained by the state at the expense of the state. The maintenance should be either under the direct control of the State highway department or, if under county control, subject to direct State supervision.

If a State lays out a State trunk highway system, it must at the same time provide for its adequate maintenance. The counties will not maintain it, the towns will not maintain it, neither will the cities nor the villages, because all of them reason that some day the Federal Government or the State, or both, are going to build it, or at least help to build it on very favorable terms, and why should they spend any money on it for either construction or maintenance. We hold it a truism that the establishment of a preferred system of roads by any unit of government should carry with it the immediate maintenance of that system by the establishing unit. The State should pay for the maintenance, for State control without State money is bound to be difficult, not to say impossible, to administer. The same general principles would absolutely apply to any Federal system which might be laid out.

There is much to be said for the Wisconsin system, in which the State has general supervision, the county organizations carry out the details of the maintenance work in accordance with State requirements, and the State repays the cost to the counties when the work is properly done. A one year's trial of this method has worked out quite well in Wisconsin. We can not say that it has or has not worked out as well as would a system of exclusive State control. Under the plan of organization, long established for State aid construction, county maintenance directed by the State seemed to be the logical method, and we will say that almost without exception the county organizations have cooperated wonderfully well and have gotten excellent results. Where they have not, our law gives the State department adequate remedies.

WISCONSIN'S PATROL SYSTEM.

We believe in the patrol maintenance system. Patrol sections of proper length, whatever the character of the highway, should be placed in charge of a patrolman who is solely responsible to those above him for the condition of his section. We have established about 480 patrol sections in our 5,000 miles of highway, varying in length from as little as 6 miles on very bad earth road stretches, to as much as 20 miles on some of the macadam truck patrol sections. We believe that the average patrol section should be not more than 7 miles if the road is an earth road in average condition.

Patrolmen in Wisconsin were secured through advertisements in local papers after the patrol sections were determined. Applicants were asked to appear at the county seat and were looked over and questioned by county authorities and a representative of the State highway department. Starting salaries were fixed at from $120 to $135 per month and the patrolman is required to furnish a good team and a wagon. The county furnishes the remainder of the tools, consisting usually of a small four-wheeled road grader for two horses; a road planer or road drag, or both; plow, shovels, picks, brush hooks, etc. Patrolmen are required to sign a contract and to give a bond for $500.

ROAD SCHOOLS FOR PATROLMEN.

After the selection of the patrolmen county road schools were held at each county seat at which the division engineer and the county highway commissioner explained in detail the methods to be used in patrol maintenance. A pamphlet on patrol maintenance was also published by the commission giving instruction for the gang and patrol maintenance of the various types of road.

Of the 480 patrolmen originally hired 75 were discharged and replaced before the end of the season. It was necessary in many cases to raise the compensation so that at the end of the season the scale was from $120 to $140 per month. Next year, unless conditions change, we expect to pay more, especially for the better patrolmen. The patrolmen are engaged continuously during the maintenance season, which with us lasts about eight months. In the winter season we expect to use them a part of the time for winter hauling of surfacing materials and for snow removal, where the counties are forced to remove the snow owing to the failure of local units to do so. The patrolman's wagon is marked with the standard triangle and number and he is required to wear a distinguishing badge, to display a flag when off the road during working hours, and to make daily and semimonthly reports.

EXPECTATIONS HAVE BEEN MET.

In general the patrolmen have more than justified our expectations. At least 65 per cent of them have given excellent service. About 20 per cent are on the division line between good and poor, and about 15 per cent will not be with us next year. We have had a small percentage of sections which as a result of a combination of disasters have given

us considerable worry. We believe that when a section threatens to become a continuous "hoodoo" the only thing to do is to take it in hand and devote the organization's time and money to it until it is brought up to standard.

In 1918 we will reduce the length of many of our patrol sections and thus increase the number of our patrolmen. This increase will probably be about 20 per cent and will cut the average length of our sections from 10.5 to 8.7 miles.

GANG MAINTENANCE ORGANIZED.

In addition to the patrol maintenance we organized each county for a certain amount of gang maintenance. This includes heavy road machine grading; scarifying, shaping, and placing light resurfacings on old gravel and macadam roads; also the surface treatments. Roughly the expenditures for maintenance have been divided, one-half for patrol maintenance and one-half for gang maintenance. The expenditures in 1918 were at the rate of about $250 per mile. The cost of patrol maintenance per mile on earth and gravel roads averaged $125, the remainder being expended for gang maintenance or maintenance of the more expensive surfaces, such as macadam.

Wisconsin made an error in distributing the funds available for maintenance to the counties pro rata with the State trunk highway mileage lying in them. The distribution of maintenance funds should be made by the State department on the basis of maintenance needs. Other States should not repeat our mistake.

MAINTENANCE EXPERIENCE.

It may be interesting to summarize briefly some of the conclusions we have reached as a result of one year's State maintenance. These may not be final but they seem well founded on our experience so far.

We find that earth roads of light clay or loam are easy to maintain either by dragging and planing or with the road grader, providing we have a rain about every 10 days. Continued dry spells are almost as troublesome as continuous wet spells, especially on light soils.

The two horse four-wheeled blade grader is the most effective tool for earth and road maintenance. The road planers are the second most effective, but must be built much stronger than usually shown or sold if they are to stand the pounding of constant use.

We are going to start an intensive campaign for applying sand or gravel light surfacing on earth roads which are sticky or slippery after rains. We have been astounded at the results from light (2 to 4 inches) sand and gravel coatings on heavy clay soils if followed by patrol maintenance. This is probably the most valuable lesson we have gotten from this year's maintenance experience.

We have learned that well-maintained earth roads need very little crown. The flatter and wider an earth road the better if it has good drainage and is kept constantly smooth. The same is true for all other types.

KEEPING UP SAND ROADS.

On sand roads we find that marsh hay and straw are effective if covered with sand at the time of application and that sand much prolongs the life of these materials. Cedar bark and cedar shavings are the best temporary sand coverings. Our tar-hay experiment on sand was quite successful but this method of sand maintenance is entirely too expensive, costing at least $700 per mile per year to maintain a good 16-foot composition surface. We believe that the economical thing to do with sands is to cover them with good clay or gravel as rapidly as funds permit. Tar-hay, hay, straw, and weeds wear out rapidly and are far more expensive in the long run than a clay or gravel permanent treatment under even very disadvantageous and expensive hauling conditions.

The roughest roads on the State trunk highway system have been the waterbound macadam roads which have been surface treated in past years. It is probably theoretically possible to maintain a limestone macadam road with surface treatments, but with the instruments of maintenance in the way of man power we have to use in these days effective results are very difficult to obtain. The untreated water-bound macadam roads maintained with light coatings of sand, pea gravel or stone screenings, or even with a road machine, have been more satisfactory than have the treated macadams that were not properly maintained from their construction. We expect as rapidly as possible to scarify all of our worn macadam roads, widen them to 16 or 18 feet, and cover them with a coating of two or three inches of fine gravel.

We have about given up the water-bound stone macadam road as too expensive a proposition to maintain. Some of the penetration macadams bound with tar or asphalt have given much better service than expected and have shown themselves superior in maintenance possibilities to any water-bound structure we have built. This is another reversal of a former opinion.

GRAVEL ROAD EASY TO MAINTAIN.

We have found that the most satisfactory cheaply built roads to maintain are the gravel roads. We have scarified many miles of old gravel roads and at a cost of $200 or less per mile have produced a surface very satisfactory and easy to maintain. The more experience we have with gravel the more convinced we are that it is the lowest cost surfaced road, both to build and maintain, and much superior to water-bound macadam. We believe that the

particles of gravel in the top four inches of a gravel road should not be larger than one inch, and we would crush even finer if it were not so expensive to produce fine crushed gravels. Gravel roads give the best and smoothest service without surface treatments. If it is necessary to treat them to eliminate dust use very light oils and don't try to build up a protective coat.

We have found trucks and tractors not generally satisfactory for patrol maintenance. Trucks give too much opportunity for joy riding, are economical only when used for hauling, and then only when rapid loading and unloading facilities are available. Tractors give fair service but to make them economical the sections must be so long that a part of the road lies undragged for too many hours after it gets in condition for dragging. It is a fact that with both the trucks and tractors that if the patrolman starts as soon as a road is fit for dragging, on the long sections the road has become too dry before he completes the two round trips necessary. Furthermore, neither tractors nor trucks provide the ditch and shoulder maintenance that can be gotten with a team. We are going to distinctly discourage the use of both trucks and tractors in patrol maintenance except as supplements to team patrol, and stand by old Dobbin.

MAIN ROADS NEVER SO GOOD AS NOW.

Summing up the maintenance results we can say that on the State trunk highway system in Wisconsin, despite the fact that our construction has been cut to less than half of the normal due to war conditions, the main roads in Wisconsin were never so good as they have been throughout this season. We estimate that in one year we have improved the average condition of the 5,000 miles at least 50 per cent. Competent estimates are that in the one year the increased number of miles per hour which can be safely averaged by auto over the State trunk highways is 7 additional miles. This improvement and this increased mileage per hour means much.

We believe that any State can equal or surpass this record at an average cost of about $250 per mile per year. If more money can be made available the first few years, so much the better. We have learned to have the greatest respect for the less expensive methods of maintenance and construction which we did not entertain heretofore.

We feel distinctly confident that if one year has enabled us to produce the results which have been produced, a succession of years will give us a passable highway system at an expense within our means. Maintenance will bridge over the gap which there must be between our present practically unroaded condition and the ultimate system of adequate highways built to bear modern traffic, which all States are going to have as fast as these systems can be financed and built.

Probably the best commentary on the maintenance results of this year is the fact that at the November meetings of our county boards many of the counties adopted county trunk highway systems to be maintained in 1919 by the counties by the patrol system. It is probable that the total mileage on these county systems is half that on the State system, so that Wisconsin will have 7,500 miles of patrolled highways in 1919.

A PLEA FOR STATE MAINTENANCE.

The States which are doing nothing to maintain through routes until they are constructed are making a grave mistake. Much can be done with the most unpromising system of roads if moderate maintenance funds are expended efficiently under the patrol system. It must be conceded that earth roads and the light types of temporary surfacings fail upon certain occasions to give 100 per cent service every day in the year, but on a surprisingly large number of days they can be made practically as good as any road.

If any State expects to build a complete modern State trunk highway system within a year or two, it need not establish State patrol maintenance; if it can not, we urge it to get into the real maintenance game and wrest the best results possible out of what it now has in the way of roads.

If an as yet unroaded State, with insufficient funds available for construction on a large scale, wishes to do the most for its roads and for its people, we are convinced that for a few years it can do it by expending its money largely in intelligent maintenance, good grading and temporary surfacings over the entire system, than by building a few miles of high-class construction in isolated stretches. In the average State $2,000,000 a year will adequately maintain and do much to improve a road system of 7,000 miles or more; it will build each year about 80 miles of modern road.

Eventually we must all build certain of our main highways of the highest type of construction. We must immediately construct in this manner certain stretches which can not be maintained so that they may bear the traffic which does or should use them, but the great mass of roads, even the most important roads, in the average state must wait several years before they can be rebuilt adequately. Why not recognize the fact and devote less state funds to construction and more to maintenance, not only of the inadequate road structures already built, but of the common earth roads as yet untouched?

I know this is unorthodox, especially coming from a State highway engineer, but if it be treason, make the most of it. For the next few years, if we have our way, Wisconsin is going to devote herself largely to maintenance and temporary grading, draining, and surfacing. When we do spend large funds for final construction in that period, it will be for adequate widths of concrete or brick or whatever type may surpass these in final economy and ease of maintenance. These roads which can not be maintained unless surfaced and which we are financially unable to build of the final type, will be built largely of fine crushed gravel, surfaced at least 16 feet wide.

The Elimination of Grade Crossings with Railroads Demands Serious Attention

M. W. WATSON, Acting State Highway Engineer of Kansas.

THE ever-increasing traffic of motor vehicles on the public highways accompanied by high speed and careless driving has directed the attention of highway officials to the necessity for safeguarding the public not only from their own carelessness but from that of others as well. Railroad grade crossings are, without doubt, the source of a large percentage of all accidents.

During the months when motor traffic is at its height we hear almost daily of some car being demolished at one of these places, and many times an entire family killed. These things seldom impress us to any great extent until some time, sooner or later, we are called upon to face it among our own family or circle of friends.

Aside from the human standpoint the cost to the railroads is quite large when considered over a period of a few years. Expensive litigation often follows one of these accidents and the railroad company is often obliged to pay damages when the driver was in the wrong.

Many times the driver of the car is wholly in the wrong, but we must provide safety devices to protect the innocent from the careless and unthoughtful person.

In the thickly populated sections of the country railroad crossings occur at frequent intervals and no one who has any regard for his own safety can help but feel a pronounced degree of uncertainty whenever he crosses one of these tracks.

M. W. WATSON

PRESENT LAWS ARE INADEQUATE.

Until the development of the present-day motor traffic, with the exception of roads and streets in the most densely populated portions of the country or in large cities, very little attention was paid to the elimination of grade crossings and from data collected from the different States it is very apparent that the laws on the subject of grade crossings at the present time are very inadequate.

Accident Bulletin No. 65, of the Interstate Commerce Commission, which covers the three months of July, August, and September, 1917, shows that during that period there were 1,054 accidents at railroad grade crossings. In these accidents 553 persons were killed and 1,278 injured; of which number, strange as it may seem, one of the persons killed was a railroad employee not on duty.

The Legislature of Kansas when creating the State highway commission provided that in the establishment of a system of county roads comprising from 10 per cent to 25 per cent of the total road mileage in each county, that the board of county commissioners and county engineer should as far as practicable eliminate all railroad grade crossings either by subways, viaducts, or by relocation of the highways. It is further provided that in the event that the county officials fail to give proper attention to crossings, the State Highway Commission can by order cause the elimination of them.

Grade crossings may be divided into several classes, as follows:

1. Crossings which can be eliminated by the construction of a subway under the railroad;
2. Crossings which can be eliminated by the construction of a highway viaduct over the railroad;
3. Crossings which can be eliminated by a relocation of the highway;
4. Crossings which can be eliminated from the main traveled highways by diverting the travel to other roads.

ELIMINATION BY SUBWAYS.

Elimination by the construction of subways is an expensive proposition and involves many pertinent features. The topography in the vicinity of the crossing must be such that its construction will be feasible. In Kansas we find that in many cases the

crossings are so low that the construction of a subway would not only be extremely expensive, but would be impracticable for lack of satisfactory drainage and due to the probability of it filling with drifting snow in winter.

An important point to be considered in the construction of a subway is the clear view of approaching vehicles that can be obtained through the opening. We have frequently noted subways that were constructed to eliminate grade crossings which are more dangerous to travel due to collision between vehicles than from the railroad itself.

Our practice requires that the subway carrying a highway under a railroad or an electric railway shall have a clear roadway of not less than 18 feet, a clear head room of not less than 14 feet, and the subway shall be laid out, wherever practical, so that there will be an unobstructed view of the center line of the road for 300 feet at a distance of 150 feet on either side of the subway.

General practice throughout the country seems to require the railroad companies to bear the larger part of the cost of constructing subways. Many times the railroad is required to build the structure and pay for the excavation within the right of way, while the highway officials pay for the excavation outside the right of way and for the pavement.

It is unnecessary to dwell upon the details of subway construction, which are purely technical and are undoubtedly familiar to the members of this organization.

VIADUCTS ARE TOO EXPENSIVE.

The overhead crossing, like the subway, is an expensive method of elimination and it also requires a proper topograph, otherwise the expense frequently makes this method impractical. Like the subway, the overhead crossing is generally prohibitive in Kansas due to the general level-lying country, necessitating expensive approach grades.

In constructing the viaduct it is necessary to take into account the matter of clearance and the proper approach grades to the structure. Frequently overhead crossings are constructed with very narrow, steep grades which are an obstruction to the highway. In some States the laws are explicit in regard to clearance required.

Kansas practice requires that the bridge structure shall have a clear roadway of not less than 18 feet in width and that the approaches thereto shall be at least 24 feet wide. The grade of the approach must not exceed 5 per cent. The clear height of the structure is required to be at least 22 feet above the top of rail.

RELOCATION OF THE HIGHWAY.

A common method of eliminating grade crossings is the relocation of the highway, especially trunk lines or principal county and State roads, so as to avoid the crossings. This is especially true in the Middle Western States where railroads were originally run so as to get into the largest possible number of townships and counties, thus crossing many sections diagonally. It has been found from our experience that the cost of relocation when a hard surfaced road project is contemplated will be practically nothing, the cost of the land required for the relocation being overbalanced by the saving in the square yardage of pavement, and it is also a decided advantage to the traveling public, since the length of road is decreased.

The Kansas law provides that the railroad companies shall pay from 50 per cent to 75 per cent of the cost of the new right of way, while the county or the township, as the case may be, shall pay the balance, and that the cost of constructing the new road shall be divided in equitable proportions as determined by the State highway commission.

The commission has ordered the elimination of 159 crossings by relocating the highway to parallel the railroad. Very few of these crossings have come to the point of settlement and the ones which have been completed have been settled by agreement between the board of county commissioners and the railroads. Six of the orders have been rescinded.

DIVERTING THE ROAD TRAFFIC.

In many instances the crossing can be eliminated from the main traveled road by diverting the travel to existing laid-out roads which have not previously been used due to their not having been placed in proper condition for travel. In this case the entire expense is usually borne by the highway unit.

Too little attention is given to legislation for grade-crossing elimination and when laws are passed the authority is usually vested in a public utilities or service commission which is primarily interested in the railroad's viewpoint, and in many instances neglects the best interests of the highway. Laws similar to the Kansas law which vest the entire authority in the highway commission should be given careful consideration.

In addition to the separation of grades or other means of eliminating and protecting grade crossings a campaign for the education of all motor-car drivers should be promulgated. A person before being allowed to drive a car on the highway should be required to pass an examination on certain rules of the road, with special reference to safety, not only for his own protection but for the safety of others as well. We can not do away with railroad accidents within a reasonable length of time by eliminating crossings, as the expense necessarily limits us to a certain number each year. For this reason we must take some precautionary measure to instruct and educate the public in addition to elimination of all possible crossings.

Coordinating the State Highway Systems of the Various States

C. M. BABCOCK, State Highway Commissioner of Minnesota.

COORDINATION of highway systems, both with reference to county and State lines, is one of the important phases of the highway question.

I presume that every member of this convention has experienced more or less trouble in obtaining coordinated improvements among the various counties of his State. Remembering this difficulty, when we were proceeding with the full authority of the State behind us, how much more vexsome becomes the question when we address ourselves to the problem of obtaining coordinated improvements between the various States with no authority beyond our State line.

This question, however, is just as important as it is difficult to solve. There is no doubt but the impetus given to the road-building program, both by development in highway transportation methods and the object lesson of broken-down rail transportation in the early days of our participation in the war, will result in an era of road building, which in the character of the roads built and in the mileage improved will exceed the wildest dreams of the good-roads enthusiast of only a few years ago.

C. M. BABCOCK

NECESSITY FOR COORDINATION.

But this road-building program will not serve its greatest good unless the improvements made in one State are undertaken with a view to what is being done in the adjoining Commonwealths. What the people want and what the Nation needs are roads which begin somewhere and lead to somewhere and, if the ideal is to be approximated, it will make no difference if these "somewheres" are located in different States.

We have been, and are, passing through a period of evolution in all the phases of the highway question. It is not so many years ago that we were building roads in many of our States on the "road district" plan, the limits of the district embracing only 4 or 5 miles of highway. From this small unit we advanced to the township plan, which made all the roads in one township a district and provided for a system of improvement extending over a maximum area of 6 miles square. The township unit was supplanted by a county unit and this in turn by State roads, which is now the maximum unit in the country.

Now, while it is probably true that a large proportion of our roads will be constructed on the basis of the State as a unit, so that State highway systems are possible, we will have to operate with a view to national needs and this will require coordination between the State highway systems, just as our individual State needs has forced coordination between county highway systems.

To me a State highway system is destined to be nothing more nor less than one of the 48 units of the entire highway system which will bind closely together all parts of this wonderful country of ours.

That highway transportation, one of the three forms of intercommunication between the various communities of our country, is of the utmost importance to the fullest economical development has been demonstrated most clearly through the operations of the various highways transport committees during the war. Reaching to the very doorstep of the Nation's population, affording an outlet for products never before marketed, and bringing to the inhabitants of the rural districts the output of factory and mine and forest, the highways must be improved, not upon narrow and crazy-quilt methods, but upon a comprehensive system which will serve not only the county or the State, but the entire Nation.

WILL PROVE COMPLEX PROBLEM.

In some States this coordination of highways systems will prove rather a complex situation, espe-

cially where the boundary lines are mere imaginary lines drawn across the map but which definitely mark where the road system of one State must stop and that of another begin. In other cases, where the boundary line is a river or some other natural barrier, the question will be far more simple. Here the systems of the adjoining States, in all probability, will be forced to coordinate by the converging lines of traffic.

Take, for instance, the case of Minnesota. Most of our eastern boundary is fixed by two rivers, the Mississippi and the St. Croix. All of our roads which are intended to afford an outlet to Wisconsin naturally converge at the points of location of bridges which span these rivers. Wisconsin, also, in seeking an outlet to Minnesota, builds its roads so as to reach these bridges and, of course, the problem of coordinating the highway systems of these two States practically solves itself.

But to the south and west our problem is entirely different. The boundary line between Minnesota and Iowa is officially described as "43° 30′ north latitude." All of the roads north of that imaginary line are a part of the Minnesota highway system, while those south of it are a part of the Iowa system. There are no bridges to converge traffic upon any particular line; there are no large cities in which any considerable amount of traffic will either originate or terminate; in fact, there is nothing that will force a coordinatiom of the highway systems of the two States.

Yet these systems must be coordinated if the best results and maximum benefits are to be obtained. Minnesota doesn't want to improve a road running south to this line of 43° 30′ only to have it end in an unimproved highway from there south. Neither does Iowa want any of its roads leading north to end in impassable highways when this mystic line is reached.

HOW IS COORDINATION TO COME?

Both economy and business sense demands that this coordination be brought about in some way. But how this is to be done is a problem, the solution of which is far less apparent than the demand for the formula.

Of course there has been much commendable cooperation between the highway departments of the various States, thanks to the good offices of this organization, but with an era of extensive and intensive road construction confronting the departments of every State, it is evident that the most direct cooperation now becomes necessary.

There are only two ways in which this coordination of State highway systems can be obtained. The first of these is by Federal supervision which will compel one State to lay out and construct its system with a view to what is being done in the other adjoining Commonwealth. The second is by voluntary cooperation, sanctioned, or ordered by the legislatures of the various States, which will result in each State taking into consideration what is being done by its neighbors.

To the first plan there are many objections. Among these might be mentioned as the most pertinent that the various States are not likely to take kindly to too much Federal supervision, preferring to retain complete control over all things relating so intimately to the affairs of the State as do the highways, and also that Federal supervision will result in placing about road construction entirely too much red tape for the welfare of the roads.

MUST BE VOLUNTARY COOPERATION.

The second proposition, on the other hand, has, so far as I can see, only one serious defect and that is the one which will be apparent to all. It is, briefly stated, "Will the States actually cooperate if working on this plan?"

My idea of applying this plan is to have the legislatures of the various States require the highway department to communicate officially with the highway department of the adjoining State before undertaking the improvement of any road which leads to the State line. If it is found that each State is planning improvements which do not coordinate, the highway departments should then endeavor to agree on changes which will make the improvements coordinate. If they are unable to agree, they should then be instructed to report the diagreement to the governors of their respective States, who, as a last resort, could leave the matter to arbitration.

Of course, most of the actual lines of improvement will naturally coordinate as the roads are pretty well designated by lines of traffic and the most of the work in this direction would be to obtain improvements at the same time on both sides of the State line. If this is done, the roads will become continuous thoroughfares, similarly improved and likely to remain in a similar condition for a considerable length of time.

BONDS FOR COLORADO ROADS.

At a recent luncheon of Denver business men State Highway Commissioner Ehrhart detailed a program for improving Colorado highways, based on a proposed bond issue of $12,500,000. The system outlined, founded on a report of Chief Engineer J. E. Maloney, includes 363 miles of 18-foot concrete highway and 2,873 miles of graded, hard-surfaced road. It includes detailed improvement of every main road in the State, in addition to considerable new construction. After he had outlined the proposed system the business men voted to ask for an issue of $20,000,000 in bonds, which, beginning in 1921, should be issued yearly as needed.

Snow Removal from Country Roads by Successful Pennsylvania Plan

GEORGE H. BILES, Second Deputy State Highway Commissioner of Pennsylvania.

WHEREAS the demand for an open highway in winter may not be of such an imperative nature as during the great world conflict, which has just ended, I believe there are many main arteries of travel that should be equal to the transportation requirements the year around. It is conceded, of course, that the necessity for an open road is not entirely universal; in other words, it does not apply to all our highways, but every State has and will continue to have roads that must be kept open in spite of the arguments and mass of evidence that may be submitted by advocates to the contrary notwithstanding. We must confess that figures can be presented that favor transportation over the railroads instead of over the highways, but the function of a road official gives him little option in a matter that is so vital, at the same time, an actuality.

GEORGE H. BILES

INCREASED MAINTENANCE COST.

The evolution of other things may work along parallel lines with the evolution of traffic, which it has been our fortune to observe during the last decade. As an example, 10 or 15 years ago and previous to the advent of heavy motor traffic, the ordinary country road of waterbound macadam was maintained annually in first-class condition for between $300 and $500 per mile, while at the present time these same roads cost for upkeep between $1,200 and $1,500 per mile per year, which is a direct result of the change in the character of traffic which has had to be met and is being met quite successfully, and people are generally adapting themselves to these ever-changing conditions. I merely cite this to illustrate the point that it is not a question in this work of snow removal on many of the trunk lines of the economics of certain classes of transportation, but one for the official in charge of the road to master to the satisfaction of the people he is expected to serve by getting traffic through when called upon to do so; in other words, a plain case of fact versus theory.

There is ample opportunity to study the economics of the work itself when the snow is removed from certain types of improved highways from year to year, for it can be safely said that the keeping of the surface free from snow is a great benefit to the road, allowing more uniformity in the action of frost and other elements and tending to neutralize their effects. We have concrete examples of this on some of the modern types of highway in our State, especially in the populated centers where the snow has been piled from the footwalks a considerable depth along the sides of the street and traffic has been permitted to cut a track through the center, which eventually wears down to the surface of the pavement, exposing a limited area to the action of traffic and the elements, leaving the sides protected. The subgrade under the center of the pavement, therefore, thaws first and the sides are upheld by frozen earth. This condition either fractures the pavement or leaves it supported so that traffic will. It would be advisable under such circumstances, if the snow can not be removed entirely from these highways, to keep the center covered with snow of not too great a depth to seriously impede traffic, in order to protect the road until the snow on the whole surface melts away. This method has also proven good practice along the unimproved highways, many of which carry sleighs and general team traffic principally, where it is not necessary or advisable to remove the snow down to the road surface, as will be explained later.

ESSENTIALS IN REMOVAL WORK.

There are two fundamentals in snow removal work that are essential to success, and these are preparedness and perseverance. In speaking of preparedness, one naturally thinks first of labor, equipment, organization, etc., but power to anticipate is of inestimable value and exemplifies the axiom that "forewarned is forearmed." This is made possible through the cooperation of the United States Weather Bureau Office in furnishing forecasts of approaching storms either by wire or mail, depending upon the importance of the districts affected.

Upon the first appearance of snow the work resolves itself into one of perseverance, for it is only by fighting the succeeding storms that success can be attained.

Next comes the material things, the most important of which is organization and system in operation, for we may have a most excellent idea but if poorly executed it usually becomes lost in the maze of confusion. Pennsylvania has a colossal maintenance proposition in the care of over 10,000 miles of all kinds of highways, improved and unimproved, employing at certain periods of the season over 12,000 men, and was fortunate when called upon to keep the highways open to have a system of organization and management based on modern scientific business principles flexible and practicable enough to expand naturally and take over this added responsibility.

SNOW FENCE MOST ECONOMICAL.

Since the organization of the maintenance division of the Pennsylvania State Highway Department in 1913, composed of the assistant engineers, county superintendents, caretakers, laborers, etc., which has complete control of the snow-removal work under the direct supervision of the second deputy commissioner, studies have been made of snow conditions on the main trunk lines, and at a number of places it has been shown that the snow fence is the most economic plan, and considerable fence has been constructed and being put in place at the present time. A fair average price for the fence complete in place at the present time is 50 cents per foot. The design is similar to the standard used by the large railroad companies, consisting of eight hemlock boards 10 feet long 6 inches wide and 1 inch thick placed 6 inches apart and framed together with three braces of 2 by 4 hemlock, placed 3 feet 9 inches apart from the center, to which is bolted at each brace and 9 inches from the top a 2 by 4 support 6 feet 6 inches long. These supports are bolted to hemlock stakes driven in the ground 15 inches, which are 2 feet 6 inches long and made of 2 by 3 inch material. The frame is held in place in front by additional stakes driven in the ground vertically, which are 2 feet 6 inches long and also 2 by 3 material. There is approximately 75 feet of lumber in each 10-foot section of fence.

Just recently a case was brought to my attention where we were expending approximately $200 per year to open the drifts on a certain short, troublesome section of highway in one of our northern counties, on which the placing of 350 feet of snow fence relieved us of further expenditures and promoted great local satisfaction.

The important industrial position of the State of Pennsylvania has afforded an opportunity for probably a keener appreciation of the volume and character of present-day traffic than is probably the case in many of the States. These activities were carried on continuously through all seasons of the year, and means of communication and transportation had to be kept open for their use. Aside from the local demands last winter our State was called upon to keep the main trunk lines open for the use of the United States motor convoys operating between the central west and the seaboard. This route in this State extends from the Ohio State line via Beaver Falls, Pittsburgh, Greensburg, Bedford, McConnellsburg, Chambersburg, Gettysburg, and Littlestown to the Maryland State line, a distance of approximately 225 miles. A more severe winter has not been recorded in the history of the Weather Bureau in our State, and it is gratifying to know that in spite of such unusual conditions the State highway department was able to successfully cope with the situation.

SYSTEM OF HANDLING WORK.

The system of operation for handling this work, established and used by the State highway department, will be described briefly: Arrangements were made with the Weather Bureau office at Pittsburgh and weather forecasts wired both to the main office of the department at Harrisburg and the local designated stations along the line of the important Government motor convoy route. Upon receipt of this information instructions were sent to the various districts to organize men and equipment for action. Stationed at the larger towns along the line of the highway were motor trucks equipped with snow plow attachments, road machines, drags, shovels, etc. The patrol system of men who were employed regularly on the highway formed a nucleus to create the larger forces to handle the work. Each caretaker or patrolman was assigned to a certain particular section with instructions to report conditions immediately to the district head or superintendent, who in turn either wired or phoned the main office at Harrisburg. If the conditions were abnormal, the superintendent of highways of the county communicated with the assistant engineer who arranged an immediate inspection and authorized such steps to be taken as were deemed necessary to expedite the

work. The first report of the local man was followed by a postal-card report form giving the details and addressed to the central office. This information was charted as soon as received and a bulletin maintained at all times for general information. If the drifts were unusually deep and the road not opened within 24 hours headquarters was advised, which afforded an opportunity to keep in complete control of the entire work at all times.

When one takes into consideration that a major portion of our State is mountainous and many sections are in altitudes of between 2,000 and 3,000 feet, in which there are stretches of highway many miles in length where there is not a sign of habitation for refuge or shelter, being entirely at the mercy of the winter elements, it would appear that what is possible of attainment in Pennsylvania under such conditions is true of most other States.

Aside from the dearth of labor that was felt over the entire country at this time, there were sections where it was impossible to get labor of any character, and the mountains and villages for miles around had to be scoured for hands, who were transported by sleighs to the site of the work.

FIRST WORK WAS BREAKING A TRACK.

Work began when the heavy fall of snow came in the early part of December by breaking a track with road drags and small V-shaped plows drawn by teams. These were followed by road machines or motor trucks with plow attachments. Turnouts were made at convenient intervals, and as soon as possible thereafter the road was widened to a width of between 14 and 18 feet, depending upon the location. The entire travelable width of roadway was finally opened, in order that traffic would not cut through to the road surface during periods of freezing and thawing, as has already been mentioned.

The snow at first was removed to within 3 inches of the road surface and what did not melt afterwards was removed entirely.

I will qualify remarks just made by saying that these methods apply particularly to improved roads, for if traffic is permitted to track during periods of freezing and thawing on such highways the surface becomes affected to various degrees, depending on the type of the road. We have a number of miles of water-bound macadam roads with bituminous-surface treatments on the main trunk lines, and in order to preserve them during such periods it is essential to distribute the traffic. On the unimproved roads the snow is not taken off entirely down to the surface, but several inches is left for the travel to pack, and as it softens more snow is dragged from the sides, in order to keep the surface comparatively smooth at all times. Rolling of snow is done on the lesser important lines, but this has not been very satisfactory on the roads where there is much motor traffic, on account of the rough condition that results when the surface becomes cut up. The snow being rolled and wet from time to time with sleet and rain storms becomes almost as hard as ice. However, there are a number of roads where the travel is light and used mostly by horse-drawn vehicles where this method will suffice.

HANDLING THE HEAVY DRIFTS.

There were heavy drifted conditions where there had to be special treatment. These were generally located in cuts where drifts were so deep and banks so high on either side that the snow had to be shoveled and hauled out. As soon as any portion of roadway was open shovelers followed cutting openings from the edge of the road to the side ditches at various points along the road, which assisted greatly in the protection and drainage of the surface. In addition to this, all side drainage and culverts were kept open and free of obstruction. This precautionary measure produced very good results, and when the snow passed away in the spring the general conditions were in better shape both as to drainage and surface than they had been at any previous time, in spite of the fact that the roads had suffered greater traffic and increased weight of loads than they had at any time in their history.

Snows up to 12 inches in depth can be handled advantageously with road machines and from 12 to 36 inches, if not too heavy, can be moved with motor trucks with plow attachments with excellent results. The truck is run along one side of the highway and back on the opposite side at the rate of about 4 miles per hour and carries a small crew of men with shovels that are used when the snow piles up in front of the blade, which it will do especially when the snow is wet. When there is a greater depth than 3 feet a large A-shaped plow is used. This implement is 30 inches high at the nose and 6 feet at the back, with 20-foot legs, and 16 feet wide at the back, made of 2½-inch oak plank and 4 by 4 inch framing, held together with movable braces and drawn by a heavy tractor, and it has proven a very economical and effective device. The movable braces are provided for the purpose of permitting vehicles to pass during the operation if it is necessary. The light tractors for this work do not hold the road and have been found unsatisfactory. Mechanical devices are preferable in the majority of cases, but if the drifting is a continuous performance in cuts, it resolves itself into a shoveling proposition.

To keep the roads open under conditions similar to last winter, it costs from $50 to $200 per mile, depending upon the location and other conditions.

IS PART OF MAINTENANCE WORK.

In 1912, when our system of roads was taken over for maintenance, the highway laws with respect to keeping up the roads were not generally interpreted

to mean that snow should be removed, for it was an uncommon thing for the local road officials prior to this time to open the drifts. In many places the fences along the line of the highways were removed and the fields used until the snow passed away. If the thaws caused the fields to become soft, in which condition the traffic would do them considerable injury, some effort was made to make the roadway passable. This era quickly passed and with the changing and increased traffic the demands became great for an open highway the year around, and in 1913 this responsibility was assumed by the State highway department and practically all the main trunk lines were kept open from this time on. The records for the winter of 1917–18, which covered the period from December to March, show 22 snowstorms varying in depth up to 16 inches, with drifts ranging from 3 feet to 16 feet in depth, the general average being 4 to 6 feet.

I firmly believe that where statutes permit, and if they do not the legislative bodies should pass enabling measures at once, it should be no longer an optional matter with the road officials in charge of our highways to prevent closing them by snows, for when we consider the enormous winter traffic on some of our roads, argument is futile.

Maintenance of Sandy Roads As Developed by the Conditions Existing in Texas

GEORGE A. DUREN, State Highway Engineer of Texas.

IN TEXAS the maintenance of sandy roads is our great problem, as it is no doubt a great problem in the other States of the Union. We do not, however, recognize a road as being a sandy road as long as there is present even in a small degree a foreign substance that acts as a binder. Our greatest problem in Texas in the maintenance of sandy roads is involved in dealing with the vast areas of Texas where the soils are sands with a minimum amount of binder, where heretofore the most excellent roads were secured across the grass-grown plains by the simple expedient of marking out a path for travel by removing the occasional stones and tufts of grass. The automobile, by keeping to these ruts, found a hard, smooth, and durable roadway, but the same areas when the adjoining lands were plowed, or when the roadway was pulverized by use of plows and grading machines, were found soon to become sandbeds. Generally speaking, the problem of maintenance of sandy roads is a problem of construction, in which some other form of road is substituted for sandy road.

TEXAS SANDY ROADS BUILDING.

The State Highway Department of Texas has at present under way the construction of the following projects as a measure of hereafter maintaining what have been in the past extremely sandy roads:

Brooks Co., State aid project No. 25, 10 miles, at cost of	$30,000
Brooks Co., Federal aid project No. 2, 20 miles at cost of	61,000
Ward Co., State aid project No. 14, 10 miles at cost of	45,000
Ward Co., Federal aid project No. 5, 17.6 miles at cost of	40,000
Ector Co., Job number 136, 7 miles at cost of	25,000
Crane Co., State Job No. 13, 1.5 miles at cost of	4,500
Culberson Co., State project No. 29, 53.6 miles at cost of	77,000
Culberson Co., Federal project No. 1, 50.4 miles at cost of	45,000
Hudspeth Co., Job No. 321, repairing State Highway No. 1, at cost of	8,000
Nolan Co., State aid project No. 19, 9.6 miles, at cost of	54,000
Nolan Co., Federal aid project No. 49, 13.7 miles at cost of	66,000
Mitchell Co., State aid project No. 12, 10 miles at cost of	49,000
Mitchell Co., Federal aid project No. 7, 7.5 miles at cost of	40,000

In the above projects we are, after providing drainage openings and completing the grading of the road to desired cross section and profile, placing on it a road metal of good road building gravel or crushed stone. The projects mentioned above in Brooks, Ward, Ector, and Crane Counties are in areas where not only the traffic must be sustained by a road metal, but in order to prevent the sandy road from blowing away we are covering the shoulders and slopes with materials such as clay and caliche. The projects in Midland, Nolan, and Mitchell Counties differ from ordinary road construction in the fact that where the adjacent lands are under cultivation provision has to be made to prevent the roadways from becoming buried under accumulating sands blown from adjoining fields.

Now, a general treatment in these sections is to elevate the roadway from 18 to 24 inches above the ground line in order that the crown of the road will be swept clear of sand by the wind, and the maintenance consists mainly in occasionally removing the sand that piles up on the leeward side of the road.

WINDBREAKS FOR TEXAS ROADS.

Some attempt has been made to protect the roadways with windbreaks somewhat after the fashion of snow fences, but without any appreciable or marked results in Texas. The barb-wire fences on each side of the road frequently served as an excellent barrier of this kind, as a result of their catching and holding what we call "tumble weeds." A wire fence frequently has the appearance of a dense, heavy hedge of shrubbery, which on close inspection proves to be accumulations of these weeds blown against and entangled on the wires. During the rainy seasons many weeds grow to a large size with wide extending branches. After a long, dry spell the winds uproot the weeds from the soil and blow them across the prairie. They are

circular in shape, and at a distance have the appearance of a sheep or a small-sized balloon. After becoming entangled in the wire fence, occasionally when the wind shifts they will move across the country in countless thousands and almost in a solid line, giving the appearance of a vast herd of buffalo.

These weeds make an excellent sand arrester, but they are only temporary expedients.

TREATMENTS OF SANDY ROADS.

There are many different treatments of sand roads in Texas that should be mentioned; namely, in Jasper county pine needles are cheap and plentiful, and have been used to good advantage in mixing with the sand roads with excellent results. In Orange county sawdust is cheap and plentiful and has been used in a few places to fill bad chug holes and as a mud-hole filler with satisfactory results. In Navarro county cotton stalks have been used with some satisfaction in improving a bad sandy stretch of road near Chatfield, stalks being laid in a mat crossways of the road to a thickness of 6 inches and covered with a layer of sand. In the same way wheat and oat straw have been used with some improvement in the traffic condition of a certain strip of the road near McKinney, Tex.

As a general rule, the sandy areas of the State in which are found our most sandy roads are areas which are sparsely populated and, therefore, demands created by traffic are not excessive. The more fertile parts of the State, and, consequently, the most densely populated, are those sections where black waxy soil is found and those sections where the soil is a sandy loam. In the sandy-loam areas the soil is mixed with calcareous deposits or other form of binder, giving the soil stability and enhancing its fertility. Occasionally in these areas the roads are quite sandy, but in general they are of a character generally described as top soils or sand clay.

SAND IN GULF-COAST REGION.

Along the Gulf coast of Mexico and paralleling it and extending back from it a distance of approximatley 150 miles we have sandy roads. These sands are fine grained and are, in fact, sea sands. They are different from the sands found in the famous sand clay roads of North and South Carolina. Our chief difficulty in the past in the construction of roads of this material was due to the failure to secure skilled engineering supervision to carry on the work. Close to the sea where material is mostly sandy silt I know of only one attempt that has been made to construct highways of any importance with this material as it stands, but in every other case construction was made with some other type of road-building material, such as gravel, shell, or some more superior type of road surfacing.

There are some excellent natural highways along the water's edge on Padre Island and other points along the Gulf beach. However, there is no traffic, for the reason that on account of many bays extending mainland, it is not along the line of traffic. These sands, found in almost the entire stretch of the Gulf coast between high tide and low tide, make ideal automobile speedways. The virtue of this type of sandy road consists in the fact that the voids in the sand are filled with water and with salt cyrstals with considerable adhesive value, preventing mechanical displacement of sand particles. The maintenance of these roads consists merely in a sufficient amount of dragging to eliminate small washes and depressions formed by incoming or receding tide water. Roads made of the same material become practically impassable when after becoming entirely dry, they are once disturbed or broken.

We have some exceptions to this general rule, due to the presence of clay mixed in with the beach sand. Texas Federal aid project number 69 from Rockport to Corpus Christi is a project in which construction is performed with the use of beach sand or mud placed in the embankment in the usual way, and after shaping and grading some of the same material is placed wet on the surface in a thin layer and thoroughly dragged while wet. A hard, smooth and, satisfactory surface is secured, capable of sustaining a fairly heavy traffic. In dry weather this surface compares favorably with the best type of gravel road, and in wet weather is satisfactory in every respect, except that it becomes extremely slippery, the cure for which is a thin layer of mud shell used on the surface.

A TYPE FOUND SATISFACTORY.

Mr. R. H. Phillips, county engineer, has charge of this work, and is a warm advocate of the use of this type of construction. He explains that the county authorities found it necessary to construct some roads across some low salt flats, and since there was no other material available they constructed the road out of this material and were amazed at the excellent results obtained.

The northeast sections of the State consist of ferruginous sands which have considerable natural binding properties. Under light traffic they are quite satisfactory, since they are usually compacted by rain and traffic. The South Texas sands are of a calcareus nature, and although they have fairly good cementing quality under traffic they are quickly ground into a fine powder and extremely dusty roads are obtained.

WEST TEXAS WIND-BLOWN SAND.

In west Texas there is a large area of wind-blown sand, which is a very fine quartz sand of a reddish color and which supports little vegetation

except shinnery. This shinnery is a form of oak bush only about 18 inches high, which bears abundantly full-sized acorns. In the same area, that is, west Texas, the sand is usually interlaid by rather soft gyp rock broken into rather large pieces, and occasionally this gyp rock is found in pulverized condition, in which case we have a sand which is gypsum by nature, which under traffic becomes a dust. West Texas is subject to continued dry spells to such an extent that methods of maintenance practiced successfully in other States do not prove effective. Approximately 80 per cent of the hard-surfaced roads in the country near the coast are built with mud shell, so that this is an important road material in this section of the State. It compacts with a hard and impervious crust, and with proper maintenance in wet weather it is quite satisfactory, but under continued dry weather or under heavy motor traffic it becomes quite dusty. It is the principal material in the coast country for road construction on these sandy areas. We are having good success in highway construction through these sandy areas with the use of shell, on which shell a bituminous surface is applied. This combination makes satisfactory, economical road construction, the sand permitting good drainage and impervious bituminous surfacing preventing the shell from becoming soft and rutted in wet weather.

The Gulf coast sands are, generally speaking, soft sands; that is, when run between the fingers they do not give that sharp, gritty sensation. They are fine grained and round in shape, mixed with a proportion of silt.

WHERE SAND-CLAY TYPE POSSIBLE.

Leaving the coast and traveling inland the sands become coarser almost in proportion to their distance from the coast, and at a distance of about 150 miles from the coast the sands begin to merge into gravel. In the same area is located indurated sandstone which includes almost every variety of induration, and very often within the space of a few feet it may be found varying from the loose sands to a hard quartzite somewhat like the St. Peter's sandstone found in Indiana and Illinois, from which we derive our Standard Ottawa Sand. The grains, however, are slightly smaller in size, and some excellent sand-clay roads have been constructed with the use of them. Their qualities are perhaps exaggerated to some extent by reason of the contrast between improved roads with their use and the unimproved roads common in this area. Within this belt we have an average rainfall of more than 40 inches, which perhaps is the real reason that satisfactory results are obtained. I am of the opinion that for sand-clay roads to be successful it requires approximately 40 inches average rainfall in a year, unless the clay is of an exceptionally good binding iron oxide variety.

South of San Antonio, where the average rainfall is between 20 and 30 inches, and where 90 per cent is in winter, road construction is rather difficult, and is rendered still more difficult by reason of the calcareous nature of the sand and its tendency to become a powder. These sands are soft sands and can not be satisfactorily worked into sand-clay roads. Road construction, therefore, must necessarily be that of resurfacing with some other material, such as gravel or crushed stone. These are white sands supporting little vegetation except live oak, which occurs occasionally in protected spots in groups of several trees called "live-oak mots."

HIGH-GRADE ROADS TO BE BUILT.

The State of Texas has ample wealth and vast resources, and we now have the opportunity to avail ourselves of the services of our returning soldiers to relieve the shortage of skilled labor. Under these conditions it must necessarily follow, I think, that a great road-building campaign will follow, and our sandy roads will be improved in a similar manner to those improved by El Paso County. El Paso is our most westerly county, and one where sandy roads and low rainfall exist. They improve their highways by the construction of concrete roads and Warrenhite roads. Their roads cost between $20,000 and $30,000 per mile, and are equal in quality to the best types of street paving. Texas is financially able, and we are disposed to improve our sandy roads so that hereafter they will be maintained not as sandy roads but as concrete roads, brick roads, asphaltic concrete roads, and the like.

PROPOSED ROAD PROGRAM.

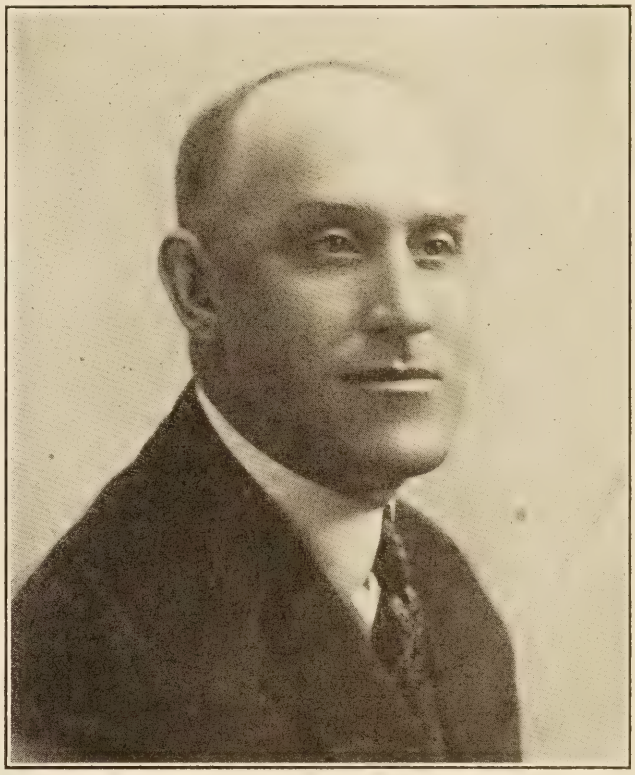
Judge T. E. Patterson, chairman of the Georgia State highway department, has put before the special highway commission of the legislature a comprehensive plan to secure adequate roads in that State. It is in the form of an amendment to the constitution. It provides a State highway system to be constructed and maintained by the State; the Illinois plan of specifically specifying the road routes of the State system, which will connect all county seat towns and cities by hard surfaced roads; the creation of a State highway commission, appointed by the governor, to consist of a member from each congressional district; a bond issue of $40,000,000, secured by the motor taxes under an amortization plan, work on the roads to be let by contract, to start simultaneously in each of the 12 congressional districts and to be completed within five years; the counties to be left as they are now, with their convict forces to maintain county roads.

Unit Price and Cost-Plus System of Contracts for Public Work

ALEXANDER W. GRAHAM, State Highway Engineer of Missouri.

THE COST of construction always has been and always will be the engineer's main problem. The purchaser demands high-grade design and construction, but he does not want to pay one cent more than is absolutely necessary. The purchaser also demands that the cost of the construction be known in advance. Very often the engineer is told that a certain amount of money is available for this or that piece of construction and is instructed to proceed without delay.

If the engineer is confronted with the limited-funds problem he will naturally turn to the unit price contract, as he knows the number of units to construct, and if he secures a proposal whose unit prices are not above the estimate he naturally feels that the work will be done for the available funds. At this point the old standard clause, which we all insert in our specifications, which states that the contract be let to the lowest and best responsible bidder, etc., presents itself.



ALEXANDER W. GRAHAM

A GUESS PROPOSITION.

Under the system of competitive bidding, contracting is a guess proposition. There is nothing to prevent persons without experience or organization, but who can secure financial backing, from submitting bids much lower than those submitted by reputable contractors, and in a number of cases the lowest bid will be one that is below the actual cost of the work. Now enters the clause in our specifications relative to the lowest and best bidder. How many of you have ever been able to convince the purchaser that the lowest bid was not the best? Invariably the purchaser takes the position that, as the contractor has furnished a gilt-edge bond, and that competent inspection has been provided for, why is it necessary to pay more for the work?

The engineer knows that an inexperienced contractor can not and will not do the work as well as an experienced man would, and yet the purchaser, very often not familiar with construction work, is hard to convince that he will get value received by paying more than the lowest bid entails.

It is human nature to think that the other fellow's game is much easier than the one in which we are engaged. Therefore at practically every letting there will be found at least one bidder who is bidding for the first time, taking for granted that the reports that he has heard concerning the enormous profits to be derived from the work proposed are true. He is willing to be contented with small profit, or none at all, in order to learn the business and is certain that the reason for his bid being so much lower than any other is that the other fellow is expecting enormous profit. The engineer knows, however, that with an inexperienced contractor he can not get the class of work he desires, no matter how many competent inspectors are employed. As soon as the work gets well under way the contractor begins to realize that he is bound to lose money, and then comes the "battle royal." Every clause in the specifications is scrutinized and every contention possible is raised. The invariable result is a spirit of getting as good work as possible, get through, and forget it.

To approve a bid other than the lowest is more difficult on public work than on work being done for private interests. We all know how reasonable and fair the public is to its officials(?). If a contract is let to any other than the lowest bidder the public *knows* that something is wrong—some one is getting something he is not entitled to.

"LIQUIDATED DAMAGES."

When a contract is let to an inexperienced contractor, the usual result is that he fails to complete the work within the specified time limit. Now comes our old friend, "liquidated damages." We

all camouflage by stating that the sum mentioned in the specifications is not to be construed as meaning a penalty but as liquidated damages. How many of you have ever seen this clause enforced? We all know that during the time the work is being done that one can always find countless reasons why the work was delayed. No matter who was to blame, the average man is willing to believe the contractor's statement concerning the causes for the delay. Attorneys seem to disagree as to whether you can compel a contractor to pay a sum of money for not completing a piece of work within the time specified. The courts are not inclined to look with favor upon fixing a penalty for nonperformance. The use of the words "liquidated damages" does not remove the difficulty; if the court thinks that in fact the sum stated (or any provision named) is in effect a penalty, it will refuse to sustain it.

There are two cases where "liquidated damages" seem to meet the approval of the courts. First, where the parties to a contract have in advance computed, ascertained, and agreed upon a sum as "liquidated damages." Second, where the amount of damage can not be definitely determined and a sum is fixed and stated as "liquidated damages." In this second case, however, the sum so fixed must appear to the court to be reasonable; otherwise the court will regard it as a penalty. The question in my mind, then, is how to arrive at the amount of the damage. To me it is rather intangible, especially so in highway work. We know that if the road is not finished that it is more or less of a damage to the public, but how much is the damage? You may suggest that the engineer compute the damage, state the amount in the specifications, and when the contract is awarded the signing of the contract settles the question. But does it settle the question? In construction contracts where blank forms are provided for a number of bidders, it can hardly be maintained that the parties have beforehand computed and ascertained the damage. Does it not more often mean that the contractor has entered into the agreement, "for better or for worse," trusting that he will be able to finish the work on time, and if not, expecting to have reasons to show that the time should be extended, or be able to prove that the amount stipulated is excessive and should be construed as a penalty? It is noticeable that this problem will generally occur when the contract has been let to inexperienced or irresponsible contractors, and this again emphasizes the fact that more attention should be given to the award of the contract. If the contract has been awarded to a reputable contractor, 90 per cent of the difficulties have been eliminated, because the contractor knows what to do and how to do it. He knows that the sooner he can complete the work the more profit he can expect, besides gaining a reputation which will be valuable in the future. Again, we all know how much easier it is to adjust differences of opinion regarding the specifications if the work is going along nicely and every one satisfied with the class and progress of the work.

COST-PLUS FORM OF CONTRACT.

Having given you my ideas concerning the unit-price form of contract, I will now attempt to discuss a form of contract which seems to be considered by some authorities as the panacea for all construction ills, which is the cost-plus form of contract.

One of the principal arguments used in favor of this form of contract is that the purchaser assumes the risks which are thrown on the contractor by the unit-price form of contract. It would seem, then, that the inexperienced contractor is eliminated. It gives the purchaser the power to select the contractor on the basis of past efficiency, and to leave to him the carrying out of the work just as its design is left to the engineer. It is claimed that this can be safely done in spite of the percentage form of contract, because, should the contractor fail in point of cost, time, or quality to meet the requirements of the work, he would injure his reputation and diminish his changes of obtaining future business and his ability to secure higher returns. From the above we may assume that contractors will be compelled to apply for work in much the same manner that engineers apply for positions. Going a step further we may expect agencies to come into existence whose work will be to list and classify contractors in order that it may be possible to secure the proper type of contractor for the work contemplated.

Just why it is assumed that a contractor will take more interest in the work, perfect a more efficient organization, and do the work for a smaller cost if the purchaser and not himself pays the bills, is difficult for me to understand. I remember one cost-plus job, on which I happened to be a member of the engineering staff, the contract of which provided that the contractor furnish certain power equipment, the cost of maintenance being borne by the purchaser. Shortly after the work started it seemed that every boiler of the work had flue trouble, which spread over the work until everything and everybody seemed to be afflicted with the "flu."

DEPENDENCE ON CONTRACTOR.

I am convinced that, for this type of contract to be successful, the purchaser must select a contractor in whom he can place perfect confidence and turn the job over to him. If the purchaser is doubtful as to whether he is being treated fairly and places a representative on the work to advise him concerning the expenditures of the contractor, endless friction will result. It might be suggested

that the engineer in charge of the work be given the authority to act in this capacity, but I am not inclined to think this feasible. The engineer might act as auditor and be in position to say that the expenditures claimed were correct, but to give him the authority to say that whether or not the contractor shall make certain expenditures, or to pass on the question as to the number and salaries of employees, etc., is wrong. It is rather unusual to find two men whose ideas coincide in regard to the handling of construction work. Therefore, I say again, that the contractor must be given full authority to act as he deems best.

Now, we are confronted with the same problem as in the unit price form of contract which is the problem of knowing whether you have selected a contractor in whom you can place implicit confidence. I may have the wrong idea concerning human nature, but I am inclined to the belief that the average man puts forth his best efforts when the efforts affect his pocketbook. It is claimed that the contractor will use every effort to keep the cost down in order that he may build up a reputation which will enable him to secure further business. This may be true if inexperienced or irresponsible contractors are employed on this form of contract that some one will have to pay the cost.

Permit me again to say that the solution of contract trouble lies primarily in the selection of the contractor. I am certain that if funds are available to allow a cost which will give a responsible contractor a fair return, and if our laws will permit public officials to select the contractor, I would be willing to accept either type of contract. I feel, however, that before public sentiment will favor public officials being given the authority to select the contractor, that an educational campaign will need to be conducted. At the present time it will be charged that this system invites various abuses and we know there are many legal difficulties in the way of adopting such a system on public work, besides the great political difficulty of obtaining as good management by Government bodies which supervise construction work as there is by private ownership; and until the public has been educated as to the value of this form of contract and is willing to put such responsibility on its officials, "excuse me."

Utilizing More Mechanical Devices in Highway Construction and Maintenance

FRANK F. ROGERS, State Highway Commissioner of Michigan.

THE COST of materials and labor entering into road construction has advanced to such high figures that in many localities it has been a question of attempting to save in the cost of labor or practically discontinue road building. In Michigan the sentiment for good roads is so great that it would have been impossible for the State highway commissioner to stop road building entirely during the war period, even if he had attempted to do so. In fact there never was so much money available for road-building purposes in Michigan as during the past year.

During the fiscal year ended June 30, 1918, only 783 miles of State reward roads were approved, showing a slow-down over the previous year of approximately 25 per cent. However, the first five months of the present fiscal year ending November 30 shows a total of 560 miles of road accepted, as compared with 391 miles during the same period of 1917 or a 43 per cent increase over the previous year, in spite of all the war-time handicaps.

Indeed some peculiar economic conditions have manifested themselves. In most localities in Michigan there was a surplus of team labor and a great dearth of manual labor. In one county the commissioners reported more available labor than during any of the past three years. This was attributed to the fact that many retired farmers who heretofore had ample incomes from their farms, now, due to the high cost of living, found it necessary to supplement their farm incomes with more or less manual labor. These men were all past middle age and the inducement of very high wages for manual labor, from 35 to 50 cents an hour, doubtless had some influence in inducing them to become day laborers.

I do not know that anything new or startling has been used in Michigan by way of labor-saving mechanical devices but a few things are worthy of note.

TRACTOR IN GRADING AND DITCHING.

In grading operations tractors have largely superseded horsepower. Tractors were not only used for hauling blade graders but ditching has been successfully done with the Ford tractor and flat board scrapers. A scraper was hitched to each end of the tractor, which has a very short wheel base. The tractor then was moved across the road alternately forward and backward, but with a slight angle to the center line of the road so as to "cut over" the width of the scraper with each move. As the tractor moves ahead the scraper hitched to the rear end draws a full load up onto the road grade while the scraper hitched

to the front end is backed to the ditch and vice versa. This way of using the tractor is said to be much more rapid than the work of two teams.

Grading has also been done with the same type of scraper by using a small gasoline reversible hoist placed on a truck stationed in the center of the road grade. A scraper was hitched to each end of the cable, the center of which was wound on the drum so that as one scraper was drawn out of the ditch with a full load the other was released and backed to the ditch and vice versa. This method of grading has also been quite satisfactory.

Steam shovels have been used quite extensively in road grading, not only where the excavation is heavy but sometimes on rather light work where not more than a foot or even less had to be scalped off from the old grade.

DELIVERY BY MECHANICAL POWER.

Mechanical power for delivering materials to the roads has been used quite extensively and ranges from the motor truck to the industrial railway. In fact it may be said that mechanical hauling has very largely displaced team hauling on Michigan roads. I have in mind one case where a motor truck is making five trips with three yard loads of gravel on a haul so long that teams working on the same job make only two trips with two-yard loads, the truck delivering 15 yards as compared with four yards for each team. It should be remembered, however, that truck hauling is not a success on heavy grades nor in loose sand or deep mud.

The industrial railway has been used very successfully on long hauls and on light grades. Wayne County and Delta County and some contractors have used the industrial railway with much success.

Mr. L. E. Adams, county highway engineer of Alger County, Munising, Mich., reports: "We have been using the motor truck for the transportation of materials along the highway in the construction of macadam roads for the past four years and find a great saving in cost over team labor. The cost of truck hauling is less than one-half the cost of team hauling. We like the 4-wheel drive truck for dragging earth and gravel roads and for general maintenance work. The heavy 5-ton trucks are used only on construction work, for they move much slower than the lighter truck."

Mr. K. I. Sawyer, county road engineer of Marquette County, Ishpeming, Mich., reports: "Our road grading has been done the past season using a Fordson tractor to haul the road machinery. This substituted one man and the machine for two or three teams. It is impossible to make a cut equivalent to three teams, or for that matter hardly equivalent to what two teams would do, but the speed of the work is such that by making lighter cuts and more of them work equivalent to a three-team grader outfit has been accomplished.

"One of our drag men also uses a Fordson tractor in his dragging operations. I am not satisfied as to the advisability of this, for where there is a crust on the road, as in sand-clay construction, the question arises as to whether the lugs on the wheels do not do as much damage as the dragging does good.

CUTTING DOWN COST BY MACHINERY.

"The county operates one surfacing truck which is driven by the maintenance superintendent. This enables him to cover all his work and at the same time deliver the necessary supplies and small equipment from our warehouse to the various maintenance and construction jobs.

"In our surfacing operations in 1916 we employed 17 men and 5 teams, including roller men, foreman, and cook. The past year we employed a maximum force of eight men, including foreman and roller men, and one team and laid approximately double the amount of stone on longer hauls.

"The machinery used on this job was one hand pump; a 6-horsepower Fairbanks gas engine; a 250-gallon Morse centrifugal pump, both mounted on one set of skids and belt connected. The same apparatus was used for pumping water for sprinklers and pumping bitumen from tank cars into the tank wagons. A motor truck also was substituted for four teams. An endless belt conveyor of the grain type without buckets was used for unloading the stone cars. This took the place of six men while the spreading apparatus on the truck cut down the necessary spreading crew. The roller crew remained the same, but because of better watering conditions one sprinkler with a team proved all that was necessary except on long hauls or in exceedingly dry weather. When water had to be pumped by hand two teams and two extra men were required for the same work. I might add that we resorted to winter hauling on a considerable portion of our gravel surfacing work in order to cut down the cost, and I am nearly convinced that winter hauling with team and spreader will compare favorably with motor-truck hauling in summer."

EFFICIENT CONSTRUCTION PLANT.

The R. D. Baker Co., of Detroit, on the North Saginaw Road in Genesee County, in laying 10½ miles of 18-foot reinforced concrete on a 30-foot roadbed, costing $270,000, developed a construction plant where the aggregates were dumped from cars and motor trucks into a power loader, elevated to storage bins, loaded into 1½-cubic-yard dump cars, hauled in trains on a portable 30-inch gauge track by a motor engine to the concrete mixer, where the cars were hauled up an incline track by cable and the aggregates dumped into a segmental revolving drum, each segment containing one "charge" of coarse aggregate and one "charge"

of fine aggregate, which was automatically measured and dumped into the charging hopper of the mixer. The Portland cement in bulk was loaded into a covered car, transported and elevated in the same way, from which it was measured in a swinging dump box and dumped into the charging hopper immediately following the aggregate.

This plant reduced labor to a minimum and made it easier, while the aggregates were kept clean and the subgrade perfectly maintained.

C. F. Winkler, county road engineer of Gogebic County, writing regarding road maintenance, says: "The past summer I had built two sets of car camps on wheels, two camps in a unit, a cook and sleeping camp. These, with two tractors, have maintained our road from Bessemer to the Iron County line, a distance of approximately 70 miles, as never before and at a saving of the cost of the tractors. In other words, I figure one summer's work will pay for the tractors.

"The camp car is, as all know, no innovation, but with tractors a move can be made every day, if necessary, thus keeping the crew within easy working distance of the job; hence the economy of this plan."

A NOVEL CONCRETE ROLLER.

J. W. White, county highway engineer of Monroe County, Monroe, Mich., reports the use of a novel concrete roller as follows:

"Our first concrete roller was a small one made of 2-inch plank 3 feet in diameter and 15½ feet long and weighed 2,200 pounds. This roller had a tendency to make the concrete wavy, which was attributed to the small diameter, so we had a larger one constructed with a diameter of 5 feet and weighing only 2,000 pounds. The surface of both rollers was concave so as to give the required crown to the roadbed.

"We find that rolling compresses a 5-inch slab of concrete between a quarter and three-eighths of an inch. We have rolled 10 miles during the season just closed, and if the above statement is correct on the basis of one-fourth inch compression, we have squeezed 657 cubic yards of voids and water out of the 5-inch slab. This statement sounds rather large, but seems to be backed by facts.

"The larger roller is made of steel and cost a little over $400. It has not added one dollar to the construction cost of the road other than the initial cost of the roller, and our experience would indicate that one roller could be depended upon to roll several hundred miles of concrete without wearing out.

"The surface of the rolled slab is as true as the average concrete road surface. The roller picks up the mortar just enough to leave a pebbled effect, which forms an ideal base for the asphalt top.

"In the finishing operation we have a templet which rides on the forms and is dragged ahead by the mixer. When 15 or 20 feet of concrete have been spread the roller is rolled back and forth an average of three times.

"The size of the roller gives it the appearance of being very cumbersome but it is easily rolled by hand by the two men whose duty it has been to put the finishing touch on the slab.

"We have constructed approximately 40 miles of concrete road in Monroe County in the last three years and until we hit on the idea of rolling to get a well compacted concrete our work was in spots very unsatisfactory."

GRAVEL BY SLUICING AND WASHING.

Alex. McKay, county road engineer of Calhoun County, explains a method of obtaining road gravel by sluicing and washing as follows:

"The washing plant is now at its fourth location. I have no definite data regarding the first two sets, as to amount of material moved to secure the gravel. On the first location we were able to secure an average of 100 yards per day for most of the time, but the later sets have been in more difficult situations.

"At the third set north of Bedford, work began March 19, 1918, and ended August 31, 1918. The prospect was so poor that we located at that point only after every other prospect had been investigated and we had spent over $100 digging into every hill and running down many reports within a radius of three miles. The pit was cross-sectioned before and after working, thus the figures as to yardage moved are quite accurate. All the gravel was hauled by the yard so we have another check on the total amount of material secured.

"The largest day's run was 44 yards and the smallest 15 yards. Men employed were: Foreman at $5, engineer at $3.50, hoseman and general helper each at $3. About 28 gallons of kerosene were used each day in two engines. A 15 horsepower engine ran a 3-inch centrifugal pump, giving approximately 250 gallons per minute at about 20 pound pressure at the nozzle through 500 feet of 6-inch spiral pipe. A 6 horsepower engine was used to run a revolving screen and elevator. A bar 'grisley' on top of bins removed oversize stone. Water was secured from a nearby creek. Our fine screen was a square mesh of $\frac{1}{16}$-inch opening, but there was very little fine sand carried over.

Total days worked, 10 hours each	131
Total yards gravel secured	3,200
Average daily yardage	25
Average daily cost of operations	$19.16
Total cost of operation	$2,511.81
Total yards moved from pit	10,500
Average cost per yard in bin	$0.78

"After getting all the available gravel in that location we moved the plant to the fourth or its present location, 1½ miles farther from the road. This pit was much more stoney and required an additional man to fork stone away from the sluices. This pit had been worked two years before and abandoned on account of the large amount of oversize stone and number of sand packets.

Total cost of moving	$162.00
In operation from September 6 to November 15, total number of days worked, 10 hours each	56
Total yardage secured	2,036
Average cost per day	$21.00
Average yardage per day	36
Average cost per yard in bins	$0.59

"It will be noted that no depreciation of machinery is figured. The total plant cost is around $2,500. Our experience with washing gravel has been that we can work over a large amount of poor material and secure a good road building metal at reasonable cost. We can not compete with good pits located advantageously with this small portable outfit, unless due credit is given for the excellence of the material thus obtained."

I regret that lack of time has made it impossible for me to go into this subject more thoroughly for I have found it very interesting, although I presume that reports from other States as to mechanical devices used would be fully as interesting as anything I have been able to offer.

NEW JERSEY 1919 PROGRAM.

The State highway department of New Jersey plans to build this year about 50 miles of the State highway system, at a total cost of about $1,980,851. The program adopted last July for this year's work was for the expenditure of $2,341,325, but it has been necessary to cut down the planned construction by the elimination of three sections because not over $2,000,000 is available.

In the work convicts will be used for a part of the roads. Prisoners from the State reformatory will be used to complete the road between Menlo Park and Rahway, while from the State prison labor will do the construction work on two other sections. Altogether about 75 from the reformatory and 225 convicts from the State prison will be employed.

MADE NAME OF AMERICAN SYMBOL OF COURAGE AND FORTITUDE.

Lieut. Harris E. Petree, a stenographer in the Bureau of Public Roads from June, 1915, to June 9, 1917, when he enlisted in the aviation service, was killed September 26, 1918, in combat with seven enemy scout planes behind the German lines. Details of his death, which have been received, te all story of remarkable courage. There is no brighter page than his in the history of the heroism shown in the American Expeditionary Forces.

Letters to his father, Frank Petree, of Oregon, Mo., from the commander of his squadron and from the Red Cross give details of his bravery. Lieut. Petree was at first reported missing in action. Lieut. Edw. J. O'Connor, commanding the 139th Aero Squadron, wrote December 23:

"Your son was last seen circling the aerodrome gaining altitude preparatory to joining a patrol of about 10 other machines. On this date we lost two other pilots from this patrol, who were forced to land behind the German lines and were made prisoners, and who have since returned to the squadron. They brought information from German sources that your son was brought down and was dead when found, with several bullet holes in his body, one of which had lodged in his head, undoubtedly causing instant death in mid-air, as the German report states further he came to earth with motor full on and the machine landed nose first.

"Lieut. Petree was a man loved by his brother officers and the enlisted men in the organization; very conscientious, he never failed to respond to the call of duty; he was an excellent pilot, and had he been spared I am sure he would have been one of our most successful aviators, and the final German reports indicate he did not die without a struggle, but on the other hand fought his adversaries to the last.

"It is some consolation to a parent to know that such a son willingly and unselfishly pursued his ideals to the hazardous extent necessary of a pursuit pilot, and gave his all to our country and its great cause."

The Director of the Bureau of Communications of the Red Cross, W. R. Castle, jr., wrote January 22:

"We are sending you some details of your son's death, and we can only tell you how proud we are to have the honor of being the bearers of such tidings. Our Paris office has cabled us, under date of January 18:

> "'Aviator Merrian Cooper, with assistance of the Red Cross, visited the region and reports the following: Lieut. Harris E. Petree, Pilot, 139th Aero Squadron, was killed September 26. He is buried in Cemetery de Lut, southeast of Longuyon. He was killed in a combat of one hour against seven enemy scout planes. He had several opportunities to escape but returned again and again. Is hero of the village, made the name of American symbol of courage and fortitude.'

"Among all the accounts of the bravery of our young aviators which have come to us, this is the most glorious, and to you, who have paid the price of the sacrifice, we pay all honor."

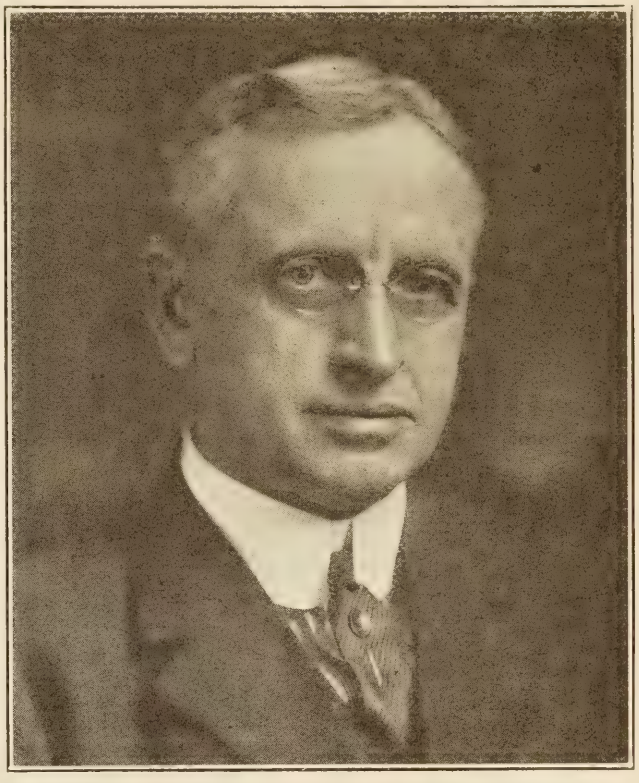
Preparation for the Reconstruction Period Following the End of the War

S. E. BRADT, Superintendent of Highways, Illinois.

AT THE time this topic was assigned to me after-war conditions were largely a matter of speculation and even to-day with the war won there is still but little indication of what those conditions are to be. For the purpose of reaching a fair conclusion as to these problems we have consulted the heads of economic departments of at least 10 of the universities of this country, and also the State and Federal departments of labor. In addition to this we have had access to the reports of the leading statistical organizations, as well as to the magazine writers of this country and of England.

In the war just closed the men actually engaged are counted by the millions as compared to hundreds of thousands in any previous war. Money has been expended by the hundred billions as compared to the hundred millions heretofore. The disturbance of normal conditions has been in proportion to the men and money involved. Hence the task of readjustment is correspondingly greater than that following previous wars.

We mobilized in the United States for the Army and Navy approximately 4,500,000 men. It has been estimated that it has required 4 civilians to each man in the army to provide food, clothing, and other war necessities, which would mean approximately 18,000,000 men in war work. Of the above number probably 3,000,000 of civilians are employed in war industries, the necessity for which ceased with the signing of the armistice. These men will be released from their present employment as rapidly as contracts can be legitimately canceled, and the war industries closed down. Adding to this 3,000,000 civilians approximately 3,000,000 soldiers and sailors, shortly to be released, we have a total of 6,000,000 people who must be returned to their old places or be given new ones. Those returning to their old places in many instances will displace others now filling them. The reabsorption of this vast number of men into our industrial life is the main problem that now confronts this Nation.



S. E. BRADT

LABOR AND THE WAGE PROBLEM.

The two phases of this problem that more directly concern those in charge of highway work are:

1. Its probable influence upon wages.

2. Our duty to assist in this crisis through the employment of labor.

This condition of labor seeking employment undoubtedly presages among other things a readjustment of the wage scale. Indications are that this readjustment will be very gradual and that we may not for many years, if at all, reach the pre-war schedule. While the conditions following the Civil War may not be any guide in the present situation, yet it is of interest to know that wages from 1865 to 1870 made a gradual increase, while at the same time commodity prices gradually decreased. Wages are so much higher now than at the close of the Civil War and unemployment likely to be so much greater, that we do not look for a similar increase. On the other hand, while commodities are higher yet we must remember that we are now subject to a measure of government price control; and what is of greater import the war area is so much larger, involving a world shortage of foodstuffs, that very little if any decline can be expected until another harvest at least.

With this situation confronting us shall we assume the attitude of holding our money awaiting a considerable decline in prices of labor and material, or shall we proceed to carry on a moderate amount of work with the idea of giving relief to our citizens, both through the improvement of the roads and the employment of those released from war work?

WAGE COST SHOULD NOT STOP WORK.

Personally, I am of the opinion that the immediate economic value of highway improvement is so great that we can afford to carry on this class of work, so long as its cost is not out of line with the cost of labor and commodities at the time the work is done. While the cost of improving the roads may have increased from 60 per cent to 75 per cent, the value of the commodities being hauled over the roads has in many instances increased over 100 per cent. The farmer can afford to give the same number of bushels of wheat for the improvement of roads over which to market his crops when wheat is worth $2 per bushel as he could when wheat was worth $1 per bushel. Likewise, the owner of an automobile or motor truck can afford to pay a higher price now for a 365-day road when gasoline and tires and repairs are high than he could a few years ago when these automobile essentials were much lower. The fact is that the cost of roads to-day, measured not by dollars but by the things we produce on our farms and in our factories and the selling price of labor, is no greater to-day than it was three years ago.

PUBLIC WORK SHOULD BE RUSHED.

Again, from the standpoint of assisting in the employment of labor during this crisis, it is undoubtedly the duty of the State to do what it can to tide over this period of uncertainty and unrest. This problem of the unemployed is not alone the problem of the United States; it is the problem of every country that has been involved in this world-wide war. Right Hon. Arthur Henderson, member of Parliament, says: "Many urgently needed public works will have to be taken instantly in hand by the Government, such as the building of houses, the making and improving of roads, railroads, canals, and the reclamation of land." Prof. Harold C. Moulton, of the United States War Labor Policies Board, says that all public and semipublic works which have been held up by the war, or for which a need has become apparent since the war began, should be pushed now with the greatest possible speed to reduce unemployment to the minimum. He refers especially to the improvement of roads by State governments and to the resumption of street and public utility improvements by municipalities.

President Wilson, in a recent letter, addressed to Secretary of Agriculture Houston, urges that the Government resume in full measure the highway construction operations under the Federal-aid road act, and to do so as speedily as possible. Further, that additional appropriations be made available in order that this work may be extended. It would then be in the line of our duty as highway officials to make all preparation possible for the early resumption of highway improvement. Our suggestion, however, would be that contracts be limited to the amount of work that can be completed within the season, with a clause providing for cancellation of contract at the option of the State if the work is not completed within the time specified.

ILLINOIS' BIG ROAD PROGRAM.

Undoubtedly Illinois has made the greatest financial preparation of any of the States for the after-the-war highway work. The fiftieth general assembly, which convened in January, 1917, passed a law providing for a referendum upon the question of issuing $60,000,000 in bonds for the improvement of a State-wide system of highways. This measure became a law in June, 1917, after the United States had entered into this world-wide conflict. It was generally conceded, both in and out of the legislature, that if the war was still on at election time its approval by the people was doubtful. Within a short time after the adjournment of the legislature Governor Lowden made public a statement to the effect that if the bond issue was passed by the people no bonds would be sold or construction begun until after the war. With this statement he forecast the probable situation at the close of the war, namely, a surplus of labor and a shortage of work, and urged the people to vote the bonds in order that Illinois might be prepared to do her part in giving employment to the returning soldiers and to civilians thrown out of work by reason of the closing of war industries. This phase of the question appealed to the people and was no doubt responsible for a goodly part of the large majority of votes given the bond issue at the election.

I have seen no estimate made by any competent authority as to the duration of the readjustment period and I shall not hazard a guess myself. However, I believe there is still time for other States to make financial preparation and still be able to assist in this readjustment work.

$700,000,000 FOR HIGHWAY WORK.

From answers received to inquiries sent to all State highway departments it appears that there will be available for highway work during the ensuing two years approximately $700,000,000, involving the employment of approximately 400,000 men each year for the working season, estimated at 180 days. Undoubtedly the amount available and included in this sum will be materially increased by many of the States.

In connection with preparation for highway work we would urge return to normal conditions through the release of control of highway bond issues by the Capital Issues Committee. It is apparent that if the proceeds of these bonds is to be made available at an

early date to assist in preventing unemployment, the various political units which are entitled to issue them should be permitted to proceed without further delay. I believe this to be a proper matter to receive the attention of this association.

There is another condition brought about by the war which has added materially to the cost of roads, viz, the matter of freight rates. Prior to the time of utilities commissions and the Interstate Commerce Commission many States were given concessions in freight rates on road-building material. These have not only been annulled, but the rates on this material have been increased in some instances out of proportion to advances on other commodities. I believe that some relief should be obtained, especially during this emergency.

Still another line in which preparation should be made is in the matter of engineers. More than two-thirds of the Illinois force are now engaged in Government service. The colleges can not supply the demand. It is, therefore, desirable that some concerted action be taken with a view to having these men now in Government service released as rapidly as possible to make preparation for home enterprises.

Our greatest railway development in the United States covered a period of about 12 years, following closely the end of the Civil War. This was brought about to some extent at least through the settlement upon the lands of many of the returned soldiers. The soldiers who have been in France and Belgium and Italy and have seen the government roads of those countries, reaching to the smallest hamlets, will not be satisfied with conditions in our agricultural sections until we, too, have a system of roads fairly comparable to those on the Continent. If we expect those boys to return to the farms from which they came or to the farms in new sections we must prepare the way by a system of roads that will connect them not only with their adjacent communities but with the country as a whole.

Engineering Treatment of Necessary Railroad Grade Crossings

RODMAN WILEY, Commissioner of Public Roads of Kentucky.

THE subject assigned me is of such a specific nature that I beg leave to depart somewhat from the text in order to discuss a little more freely grade crossings in general. I shall use in its broadest sense the term engineering.

I appreciate the fact that I am attempting to discuss a complex problem and realize that any suggestions made will perhaps be radical, and most likely impracticable, but I am contented with the effort if a discussion of the problem will bring forth other ideas which have as an aim more cooperation between railroad companies and the people, which will result in a reduction of the loss of human lives.

When travel was mostly by steel-tired vehicles, the danger at crossings was at a minimum, and naturally the question did not receive, and was not expected to receive, the consideration it does to-day when most men are endeavoring to save time and make money, and the majority of the travel is by automobile and automobile truck. In order to take care of this new method of travel the highways are now carefully planned, particular care is being taken to see that the proper type of surfacing is used, wide, strong and expensive types of bridges are being built, but the grade crossings are receiving practically no attention.

PROTECT CROSSINGS TO SAVE LIFE.

A chain is no stronger than its weakest link, and naturally one would suppose that inasmuch as we build safe roads and safe bridges to prevent loss of life and materials so should grade crossings be properly protected for the same reason.

It is believed that some railroad companies and the public in general have failed to appreciate the act that the highways are one of the great systems of transportation and entitled to the same consideration as that given other transportation systems.

It has been customary for some years when one railroad crossed another railroad company's track for the one desiring the crossing to not only receive permission from its senior but to furnish the necessary frogs and install all interlocking signals. The same is true when interurban lines cross railroad tracks.

We know it is impossible to span a navigable stream with either a highway or railroad bridge without first receiving a permit from the Federal Government. The Government specifies the length of span and the height the bridge must be placed above low water; in other words, the Government appreciates the fact that neither of the other two systems of transportation shall interfere with the safe passage of boats. Yet until very recently it was known to be almost an unheard of thing for highway officials to be consulted when a road was to be crossed by either railroad, interurban, or street car lines. In many instances such has been done without even installing danger signals.

THERE IS LACK OF ATTENTION.

In the majority of cases crossings are treated the same to-day as 10 years ago, and it appears that the

principal cause of the trouble has been the lack of attention not only on the part of the officials but on the part of the people, which naturally implies the lack of engineering advice.

Statistics show that the railroad companies pay out considerable sums of money because of accidents and deaths at grade crossings. Naturally such corporations endeavoring to reduce their expenditures to a minimum, and especially to save human lives, have installed all sorts of safety devices, a great many of which are absolutely ignored by the public. We now find stationary electric bells in some cases, swinging electric bells in others, electric lights, and finally at the most important places we see gates and watchmen.

Considered from a purely financial standpoint very few railroad crossings are properly maintained, so that a machine is damaged each time it passes over one. Suppose that the damage to a machine amounts to only one cent and that a hundred machines pass that crossing in a day. That means that damage has been done to the extent of one dollar per day, $360 per year, which is the interest on $6,000.

I take it that necessary grade crossings are made so because of great difficulties which would be encountered in eliminating them. Such things as the topography of the country, rights-of-way trouble, damage to property and, in its final analysis, lack of funds, because certainly the majority of crossings are unnecessary provided the money is available to eliminate them.

It makes no difference what is suggested there will always be accidents so long as we have grade crossings, and anything that is done is merely an insurance against death or accident, and the first question would most naturally be, who should pay the bills? We find that when either a highway or railroad company crosses a river, which is navigable, it pays the bills, and when one railroad company crosses another the junior company pays the bills. The same is true of interurban lines crossing railroad tracks.

PUBLIC SHOULD PAY PART OF COST.

One might naturally think that the railroad grade crossing question should be handled in the same manner. The railroad company, however, being a corporation, is liable for damages and should and perhaps would in most cases be willing to pay part of the cost, even though it might have priority claim at the crossing. But certainly if the people are determined to travel at a greater rate of speed, so that their lives are more in danger than they have been in the past when most grade crossings were allowed to come into existence, and especially when human nature and human carelessness enter so much into the proposition, the public should pay some part of the cost. It should be remembered that the people, not the railroads, have changed their method of travel.

No two men behave exactly in the same manner when crossing a railroad track. A few will stop and listen for approaching trains, others will slow up their machines and look hurriedly to the right and left, but the majority will plunge headlong over the track without taking any precautions whatever. Certainly no concern should be penalized for the lack of attention paid to all warnings, especially when the railroad is a necessity and is rightfully allowed to exist under the laws of the country.

The highest courts in many of our States have refused to give judgment against railroad companies because the drivers of automobiles have not exercised reasonable precautions in crossing railroad tracks.

It is a question of human life against money and I venture to say that very little will ever be done until the public appreciates the value of a human life. All sorts of excuses will be given and accepted, because in order to properly protect their own lives and the lives of their fellow men the people would have to pay a little more taxes.

SAFETY MEASURES RECOMMENDED.

Some engineers after carefully studying the question have recommended that the highway on each side of the railroad track should be made straight and level for some distance back of the track. That, of course, is a great precaution, and would tend not only to prevent accidents from collisions with trains but it would also tend to prevent accidents on the highways, as sufficient sight distance would be provided. Others recommend all sorts of electrical devices and interlocking signals to warn men that a train is within a certain distance of the crossing.

All electrical devices, however, are liable to get out of repair, and might not in isolated districts receive attention for many days. In such cases no warning would be given in the interim, so we can not depend entirely upon such things.

Because most accidents are due to the speed at which automobiles are driven, there should be a national law preventing any manufacturer under heavy penalty from making any pleasure automobile that can attain a greater speed than 30 miles per hour, and then every driver can keep his car under control.

Considerable danger could be removed if a great many of the roads were relocated and that could be done in a great many instances. Where a road parallels a railroad for some distance before crossing, the road should, if possible, be at least 300 feet from the track and the crossing should, if feasible, be made at right angles to the track. In addition, all obstructions to the view should be removed so that when a man makes the turn preparatory to crossing the track he can see both ways up and down the railroad for some distance.

BUILD ROAD PARALLEL TO TRACK.

As an added precaution, it would be well to build a road parallel to the railroad track for a distance of perhaps 300 feet each side of the main road, and, in all probability, it should be on the railroad company's right of way. The surface of the road should be at the same elevation as the top of the rails; in case a man saw he could not clear the track, or in other words that he was caught, he could turn,

either to the right or left, off the main highway and run his car parallel to the track and prevent a collision.

Of course such things as electric lights, electric bells, etc., should be used in all cases because they always serve as a good warning.

Important crossings should be well paved, the paving to be level with the top of the rails so as to prevent a man killing his engine on the track; also to save the wear and tear on vehicles.

Less important crossings could be paved with timber, say 2 inches thick, set on edge, sized so as to make it level with the top of the rails, the timber to be nailed to the ties and to each other and all points of contact to be tarred. This would make a rather inexpensive improvement and it is believed the results would be admirable, as 2 by 4's spiked together and tarred have been used very successfully as flooring for bridges in Kentucky.

As a general proposition it would be well, as has been advocated, to make the road straight and level with the top of the track for a distance of at least 300 feet each side of the center line of the railroad and to have all obstructions, such as brush, high banks, etc., removed, so that a man can see both up and down the track when traveling any part of the 600 feet.

In as much as crossings might be divided into several classes according to their hazardous nature and volume of traffic passing over them, it might be well for representatives of the railroad companies in the various states to meet with the proper highway officials, take a census of all crossings, and divide them into classes. At the most hazardous or otherwise important crossings, from a standpoint of travel, in addition to doing all that has been said, it might be well to have gates and watchmen.

PRECAUTIONS BY THE DRIVER.

Sufficient precaution should be taken either in the way of making such changes as have been advocated, or else the driver of a vehicle should be required to stop and himself or one of the occupants of the vehicle be required to walk across the track before attempting to drive across.

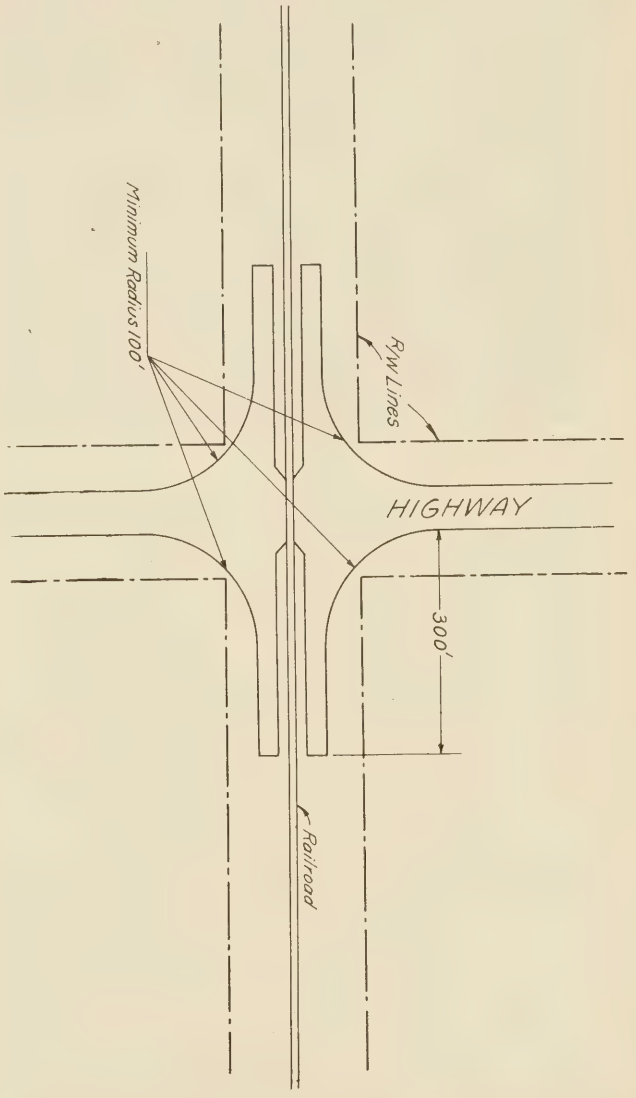
A street intersection in a busy town might be considered a necessary grade crossing. It is not, of course, in all cases a railroad crossing, but is subjected to a great volume of traffic. We find that soon after the advent of the automobile the police departments in practically all towns had watchmen stationed at the intersections to take care of the traffic.

An examination of the practice of street car companies and interurban companies in crossing the railroads shows that almost invariably the street cars or the interurban cars are required to stop on one side of the track, the conductor crosses the railroad track and signals the car ahead.

I know that complaints would be made by the autoists because of the time required to stop their machines and walk across the tracks. But when a man attempts a journey in an autumobile he is aware of the fact that he will, in all probability, have punctures and blow-outs and he is willing to take his chances in order to save time, and travel when it suits his convenience, and certainly if he is willing to repair two or three punctures in the course of a journey in order to go as he pleases, he should not complain if a few minutes of his time are taken up endeavoring to save his life.

The public should appreciate the fact that no precaution on the part of any railroad company will save a man's life if he is determined to be a fool.

Men know that insurance is a good thing, but oftentimes it is neglected and they die and leave their families penniless. They also know that tuberculosis is usually fatal, but the warnings of a doctor are unheeded and they die a wretched death, and so with railroad crossings. They are dangerous, always will be dangerous, it makes no difference what precautions are taken, and men will endure more danger in such cases because in order to safe-



SKETCH SHOWING PLAN FOR SAFETY ROAD PARALLEL TO RAILROAD TRACK AT GRADE CROSSINGS

guard their lives they will have to take a little more time and it might cost them a little money to eliminate the danger. All recommendations will amount to naught until it is appreciated that the highways are one of the great systems of transportation and entitled to the same consideration as other transportation systems, and until the people are ready and willing to place the roads under proper engineering supervision and act on the advice of engineers in everything connected with the system, and finally until the people appreciate the fact that the expenditure of most any sum of money is desirable if it prevents the loss of a single human life.

Railroad Car Shortage for Movement of Road Material and How to Meet it

CLINTON COWEN, State Highway Commissioner of Ohio.

THE colossal events that have been staged and acted in rapid succession since July, 1914, are too well known to require repetition.

The tottering and final collapse of the civil and military power of Russia, almost at the very time the United States entered the world's greatest conflict, were events sufficient to fill the minds of the thinking people of this country with a degree of apprehension that few were, at the time, willing to confess.

The rapid transition from civil to military conditions naturally resulted in much confusion. The administration of every official seemed to have a trend toward the policy of "safety first."

Thus it was we first felt in highway construction the blighting effect of car shortage.

The increased demand on railroad service on account of war activities must be apparent to all who are at all familiar with the necessities of the War Department for maintaining and supplying, not only our troops in all requirements of army service, but furnishing a substantial part of the requirements of our allied armies. But to this alone can not be laid the blame for the alleged car shortage. The development and maintenance of most railroad properties has not kept pace with the ordinary commercial development of the country, to say nothing of the abnormal increase due to the war.

TWO CAUSES OF CAR SHORTAGE.

A trip over almost any railroad running out of Columbus, Ohio, especially the roads running north and south connecting the coal mines with the Great Lakes, would have shown that the car shortage was due largely, if not entirely, to lack of motive power and proper terminal facilities. Had the terminal facilities and motive power been properly developed, I am of the opinion that there would not have been a serious curtailment of freight shipments for road construction.

But, dealing with a condition rather than a theory, the fact remains that shipments of road materials were in most cases irregular, uncertain, and very unsatisfactory. The above conditions were met and to a considerable extent overcome by consistent management in avoiding delays which formerly were traceable to the management of operations on the work. Formerly shippers were often notified by the superintendent in charge of construction to discontinue shipping until further notice, without apparent or sufficient reason, but during the car-shortage period, shipments were continued if possible, even at the expense of an extra handling of the material by storing it until ready for use. Another means of overcoming the difficulty was a wider use of local materials which were prepared for use by portable plants.

MOTOR TRUCK SOURCE OF RELIEF.

But the greatest source of relief was found in the use of the motor truck.

This instrument of modern mechanism that has wrought such havoc with many of our roads seems destined to become an indispensable means of transporting material in highway construction. One noticeable incident of this was in the construction of a concrete foundation for which the materials were shipped originally by rail to a point within two miles of the work. When freight shipments were suspended, not a day was lost before the contractor had in the service a small fleet of trucks hauling stone direct from the quarry some fifteen miles from the site of the improvement.

Another instance worthy of mention is where stone was hauled by rail about six miles to a point from which the average wagon haul to the road would be about a mile and a half. Terminal facilities became obstructed and it was necessary to resort to trucks, which was done, and the work was carried forward with surprising economy and rapidity. The elimination of one handling at the railroad, the ability to spread the stone almost perfectly by tilting the truck bed to proper angle and the general stabilizing effect on the work, enabling the contractor to use advantageously a greater gang of laborers, are some of the reasons why trucks may be used to an advantage on short hauls and even on moderately long hauls where roads are in condition for truck service. To the contractor, a direct haul from the quarry means the saving of the cost of loading, demurrage charges, and congested conditions that so often arise due to irregularity in railroad delivery.

A STIMULATION TO THE ENGINEER.

The condition brought about by car shortage was fruitful in stimulating the engineer to extend his resourcefulness in many new directions. The more extended use of local material and the easing off in requirements of high-grade material, especially where the construction is more or less in the nature of an emergency, were freely resorted to with gratifying success.

We are all well aware that the limits ordinarily fixed by engineers for the specification of materials do not necessarily mean that a reasonable departure under stress of emergency may not be justifiable. The extent of this departure, of course, must be governed by local conditions and possible results.

There need be no argument set forth that certain types of road when applied in a certain district will require much more transportation than will other types.

Almost immediately after the declaration of war by the United States, Camp Sherman was located at Chillicothe, Ohio, about 50 miles south of Columbus. The materials and supplies necessary for the construction of this great cantonment taxed to the limit every available means of transportation that could be provided. The city of Columbus, the capital of the State, with a population of more than 200,000, was naturally looked to as a source of supply not only for the camp construction, but for the supplies and equipment necessary to maintain this great army of from 40,000 to 50,000 men.

CLINTON COWEN

BUILT 33-MILE ROAD TO CAMP.

Although the camp and the city of Columbus are connected by railroad and trolley lines, every highway, direct or indirect, connecting these two points was used by the increased travel. Many influential people, prompted by patriotic duty or otherwise, became very much exercised in regard to our road conditions to the camp. The idea of constructing a brick road or concrete road or other high-type of improvement was strenuously advocated, which road, if the request made at the time had been acceded to, would no doubt have been under construction at the present time and perhaps far from being completed, with all the hardships of the detour incident to the construction of such roads.

Instead of pursuing this course, it was generally known that large supplies of good gravel existed at different places almost the entire length of the road to be improved, which was a link of 33 miles connecting improvements formerly made by the State highway department. The link as it existed was an old worn out macadam and gravel type of construction without drainage and with many places broken through to the clay. The deputy of maintenance prepared and submitted an approximate estimate of cost of a quick and economical but substantial improvement of this road with gravel. The estimate was about $3,300 a mile. This included all road drainage, widening of the shoulders and the surface of 16 feet of from 4 to 5 inches of water-bound gravel.

The work was undertaken and carried out, divided into a convenient number of sections, by force account under the immediate supervision of the deputy of maintenance. The total cost of the construction and of maintenance up to the present time is about $3,400 a mile. The exact cost of original construction can not be separated from the cost of maintenance because the maintenance commenced of course on portions of the road before the remainder had been completed. The whole work of constructing the 33 miles was finished in a period of about six months, and this was done without blocking the road against traffic and with very little inconvenience to the public. This was accomplished through the use of good bank gravel and motor-truck and horse-drawn wagons.

Immediately on the completion of this road the travel was so great that a double line of enormous passenger cars with a capacity of twenty-odd passengers was installed, making two round trips a day.

The work of maintenance is, of course, continuous, although not expensive, and on the whole, I regard this as one of the interesting pieces of work accomplished by the department, certainly one from which the public received immediate and large benefits.

I am stoutly of the opinion that where good gravel may be obtained and with the use of a motor truck, the construction and maintenance of rural highways in such localities should no longer be a serious problem.

MEETING DEMAND ON MOTOR ROUTES.

As a result of car shortage conditions in the country and the over-taxed capacity of railroads, enormous fleets of Army trucks, automobiles, and other

trucks passed over certain roads, especially those running east and west, destined to Atlantic ports. Among the most important of these was a road running through the northern part of the State, connecting Chicago, Detroit, and other points west, with Toledo, Cleveland, and Pittsburgh. This road was so heavily traveled by traffic of this character that much damage was done to it on types of road of almost every character.

Our ability to maintain this road was only made possible through the use of truck service. The spring of 1918 taught us a lesson in regard to road construction, that many of the roads we had previously constructed were not adequate to such conditions and to even greater strains that might be required in the future.

In order to relieve the northern route through Ohio of part of its heavy traffic and to provide for truck service that was growing constantly, we decided to fill in some links yet unimproved on the National Road, passing east and west through central Ohio. There was yet unimproved and not yet under contract as late as March, 1918, a section of 14 miles in Muskingum County. This section was in such condition that it practically prohibited the use of a road that millions of dollars had been expended on because of this unimproved portion.

Adopting rather heroic measures and brushing some legal technicalities aside, in April of this year we entered upon the construction of this road, subdivided into convenient working sections, under a cost-plus basis contract. We rallied to our assistance every available means at our command. The Government, realizing the importance of this work, lent us such assistance through railroad service as congested and restricted conditions of traffic would permit. Prison labor, free labor, auto trucks, and horse-drawn wagons were used on each section.

With much of the force inexperienced and with organizations more or less imperfect as must obtain on work of this magnitude and under such conditions, the entire stretch of road was completed and opened for travel on October 22, 1918, a period of a little more than six months.

The type of road was brick with mastic filler, 16 feet wide, upon a 6-inch rolled sandstone base with 6-inch cement curbs. The grading was rather heavy. The estimated cost of the 14 miles was $488,500, which was prepared in January, 1918. The actual cost of construction is not yet fully determined but will exceed the estimate in the neighborhood of 20 per cent, which may be largely accounted for in the increased freight rates and the amount of material used in the construction of a cost-plus job over that in a similar job under a straight contract.

To the use of convict labor on this work may be credited a large measure of our success. Although such labor did not exceed possibly 33⅓ per cent, the stabilizing effect it had on free labor was no doubt the means of preventing more or less unsettled conditions.

The above are some of the important instances of car shortage and how we met them.

PROPOSES BIG IOWA BOND ISSUE.

A bill has been introduced in the Iowa Legislature providing for a system of 17 cross-State paved highways, to be paid for by a bond issue of $50,000,000. The bonds are to be paid for by a combination of district taxation and the use of the funds from State automobile licenses, and the highways are to be durable, hard-surfaced roads which will, in the judgment of the highway commission, remain in good condition with reasonably low maintenance cost until after the bonds have matured. Many of the highways are now well known cross-State roads. The bill would do away with the present State highway commission and create a new commission of three, appointed by the governor, to administer road affairs.

COLORADO HIGHWAY TRAFFIC.

The Colorado State Highway Commission has completed a road traffic table for 3,827.6 miles of road out of the 7,000 miles of State routes for the year 1918. The table for the year is based on reports for traffic for the month of August. Chief Engineer Maloney states that the traffic is conservatively stated, particularly in regard to wagon haul, as the records were not taken when much produce or grain was being moved. The figures show the year's traffic in ton-miles as follows: Automobiles, 115,539,888; trucks, 28,576,262; wagons, 13,696,238; total, 162,926,098. The average ton-mile per mile of road was 42,566.

INDIANA LAW CONSTITUTIONAL.

Indiana has not heretofore been able to take advantage of the Federal aid law because of the contest in its courts over the validity of the State law of 1917 which enabled it to do so. The lower court pronounced the law unconstitutional and there was to be an attempt in the session of the legislature this winter to repeal it and enact a new law to take its place. The State supreme court has now reversed the decision of the lower court and pronounced the 1917 law constitutional and all that was done by the State highway commission appointed by Gov. Goodrich in 1917 has therefore become validated. Some amendments to the law may be made this winter.

FEDERAL AID IN OCTOBER–NOVEMBER

AN OUTSTANDING feature of the record of Federal aid projects considered in both October and November, 1918, was that the number of projects which went to final agreement exceeded in number those approved. In October 28 projects were approved while final agreements were signed for 42. The figures for November were 26 and 43.

In October the projects approved or which went to final agreement called for a total of 471.526 miles of road, for which the Federal aid allowance was $1,615,310.03 on an estimated cost of $4,646,225.20. In November the mileage was 636.9623, the estimated cost of all projects $4,557,507.68 and the allowance, $1,847,893.09.

The largest allowance for a single project made in October was $120,627.20 for 24 miles of gravel road in Missouri, estimated to cost $241,254. Another Missouri project approved was for 11.2 miles of asphalt and brick, with an estimated cost of $384,853.26 and an allowance asked for $96,213.31.

The next largest allowance for a single project was $100,200 on 10.02 miles of concrete road in Maryland, a part of the Washington-Baltimore highway, the improvement of which is estimated to cost $237,449.96. This road during the past year carried an especially heavy military traffic, as well as an unusually large commercial traffic. Another road built because of special military use is 6.52 miles of concrete highway in Georgia, leading to Camp Gordon, estimated to cost $169,560.88, for which an allowance of $47,500 was made.

Ohio received the second largest total allowance in October, $160,800, for concrete, brick, or macadam roads, to cost $523,779.83. Five projects in Iowa put that State in the lead in the mileage, amounting to 55.07 miles of earth and gravel roads, estimated to cost $268,856.50 and a total allowance of $100,939.96.

Wisconsin led in October in the number of projects considered, 12, all final agreements, with a mileage of 52.556, a cost of $437,175.30 and an allowance of $129,031.76. West Virginia came next with 8 projects going to final agreement, estimated cost $344,111.75 and an allowance of $90,751.

In November Pennsylvania projects considered have a total estimated cost of $766,362.34 and an allowance of $181,580. The mileage was only 18.152, concrete, bituminous concrete, and brick. The largest allowance to any one State for the month was $202,999.32 to Oklahoma for 25 miles of concrete road, estimated to cost $205,998.77, and a bridge over the Canadian River, estimated to cost $223,115.27.

Four projects from North Dakota, of gravel and earth roads, gave that State the largest total mileage, 83.7, while two roads in Minnesota with an aggregate length of 51.15 miles put that State second. The largest number of projects from a single State considered was 7, from Virginia, with a mileage of of 21.897, and estimated cost of $193,510.38 and an allowance of $91,105.31.

Federal Aid Projects in October, 1918.

State.	Project number.	County.	Length in miles.	Type of construction.	Project statement approved.	Project agreement signed.	Estimated cost.	Federal aid allowed.
Alabama	23	Coffee	9.305	Sand-clay		Oct. 18	$23,304.35	$11,652.18
	32	Conecuh	6.81	do		Oct. 25	35,625.04	17,812.52
Florida	8	Alachua	11.67	Top soil	Oct. 22		33,680.28	16,840.14
Georgia	14	Floyd	7.75	Gravel or topsoil	do		30,030.00	10,000.00
	27	Polk	14.70	do	Oct. 25		41,184.00	20,000.00
	40	Dekalb and Gwinnett	6.52	Concrete	Oct. 11	Oct. 24	169,560.88	47,500.00
Idaho	6	Idaho	21.77	4 mile macadam, 18 earth		Oct. 26	250,368.03	86,000.00
Iowa	24	Polk	7.75	Gravel	Oct. 18		67,721.50	23,041.07
	26	Adams	10.00	Earth	Oct. 8		47,795.00	16,507.60
	27	Appanoose	11.00	Graded earth	Oct. 7		46,750.00	19,832.33
	34	Keokuk	12.25	Earth	Oct. 9		45,100.00	22,345.19
	35	Chickasaw	13.07	Gravel	Oct. 22		61,490.00	19,213.70
Kansas	1	Mitchell	11.25	Concrete	Oct. 18		229,130.00	34,369.57
	16	Rice	3.00	Brick or concrete	Oct. 22		115,061.76	17,259.26
	17	Geary	.09	Brick	Oct. 24		39,947.16	9,000.00
Kentucky	9	Todd	2.95	Macadam	Oct. 18		23,428.00	11,714.00
Maryland	6	Prince George, Howard, Baltimore	10.02	Concrete		Oct. 19	237,449.96	100,200.00
Michigan	15	Livingston	4.232	Gravel		Oct. 31	[1] 44,555.98	22,277.99
Minnesota	15	Becker	19.96	do		Oct. 28	88,904.26	30,000.00
	34	McLeod	9.10	do	Oct. 26		33,333.94	15,000.00
Mississippi	11	Amite	6.92	do		Oct. 30	[1] 47,236.75	20,000.00
	36	Walthall	9.35	do	Oct. 18		63,129.00	30,000.00
Missouri	7	Mississippi	24.00	do	Oct. 14		241,254.00	120,627.10
	14	Buchanan	11.20	Asphaltic and brick	Oct. 7		384,853.26	96,213.31
Montana	13	Park	4.25	Gravel	Oct. 24		19,916.59	9,958.29
Nebraska	23	Burt and Washington	26.30	Earth	do		55,641.30	27,820.65
Nevada	9	Washoe	5.423	Concrete or bituminous	do		139,792.86	54,230.00
New Hampshire	12	Rockingham	1.75	Gravel		Oct. 24	12,358.94	6,179.47
	15	Merrimack	1.73	do		do	12,360.09	6,180.09
	16	Hillsborough	2.26	Modified asphalt surface		do	39,932.95	19,966.47
	17	Rockingham	1.29	Gravel		do	20,423.78	10,211.89
New Mexico	3	Santa Fe	9.32	do		Oct. 26	63,397.81	31,698.90
North Carolina	23	Burke	7.68	Top soil		Oct. 28	42,873.90	7,500.00
	29	Union	8.655	Top soil or gravel	Oct. 18		27,794.66	5,000.00
	30	Mecklenburg	6.304	Concrete or bituminous gravel		Oct. 31	102,551.35	26,900.00
	32	Edgecombe	3.10	Sand-clay or gravel	Oct. 9		14,080.70	7,000.00
North Dakota	6	Eddy	5.46	Gravel and earth		Oct. 9	12,816.86	6,408.43
	8	do	9.29	Gravel		do	[1] 24,306.57	11,767.59
Ohio	20	Richland	3.58	Brick or concrete	Oct. 10		143,017.87	30,000.00
	24	Madison	8.39	Concrete or asphalt	Oct. 8		284,000.00	83,900.00
	25	Highland	4.69	Macadam or concrete	do		96,761.96	46,900.00
Oregon	12	Yamhill	2.75	Macadam	Oct. 10		39,683.38	14,871.69
	13	Grant	7.40	Gravel	Oct. 19		145,051.50	72,525.75
South Carolina	8	Bamberg	12.17	Sand-clay		Oct. 16	23,922.38	10,771.14
Tennessee	5	Greene	2.64	Waterbound macadam		Oct. 24	38,321.91	19,160.95
Virginia	4	Pittsylvania	8.03	Top soil		Oct. 14	[1] 21,697.44	2,450.00
	13	Stafford and King George	6.932	Gravel		Oct. 30	59,263.28	29,631.64
	14	Augusta	4.012	Waterbound macadam		do	49,866.92	24,933.46

[1] Revision of previous agreement.

Federal Aid Projects in October, 1918—Continued.

State.	Project number.	County.	Length in miles.	Type of construction.	Project statement approved.	Project agreement signed.	Estimated cost.	Federal aid allowed.
West Virginia	4	Marion	2.40	Concrete		Oct. 26	$47,457.67	$13,000.00
	9	Jackson	0.977	....do		Oct. 8	20,200.00	9,770.00
	10	Mason	5.81	....do		Oct. 11	103,517.70	16,530.00
	13	Roane	1.00	....do		Oct. 19	13,552.00	6,776.00
	16	Barbour	3.24	Bituminous macadam		Oct. 16	33,334.00	8,075.00
	21	Lewis	.66	Brick or concrete		Oct. 11	20,000.00	6,600.00
	23	Kanawha	2.96	Asphaltic concrete		Oct. 5	69,971.48	20,000.00
	24	Preston	3.85	Bituminous macadam		Oct. 11	36,078.90	10,000.00
Wisconsin	14	Dunn	4.95	Graded earth		Oct. 28	15,043.53	5,014.51
	19	Price	6.84	....do		Oct. 22	16,775.20	5,585.06
	24	Jackson	2.18	Concrete		Oct. 11	44,980.28	14,993.43
	26	Wood	2.82	Gravel		...do....	17,156.10	5,718.70
	27	Washburn and Barron	9.02	Graded earth		Oct. 26	31,061.24	10,353.74
	33	Fond du Lac	3.69	Concrete		Oct. 31	74,864.59	24,954.86
	39	Racine	0.93	....do		...do....	23,929.17	7,956.39
	40	Sheboygan	2.41	Bituminous macadam		Oct. 28	25,907.57	8,635.86
	42	Rock	2.45	Concrete		Oct. 31	51,603.03	17,201.01
	43	Trempealeau	3.27	Graded earth		Oct. 11	17,121.51	5,707.17
	47	Richland	2.94	Earth		Oct. 28	23,793.59	7,931.20
	48	Monroe	11,056	....do		Oct. 31	44,939.49	14,979.83
Wyoming	22			Bridge	Oct. 10		24,310.00	12,155.00
Total			471.526				4,646,225.20	1,615,310.03

Federal Aid Projects in November, 1918.

Alabama	27	Lauderdale	4.00	Chert		Nov. 13	$33,936.43	$16,968.21
	38	Lawrence	7.38	Gravel	Nov. 13		34,067.82	17,033.91
Arkansas	20	Poinsett	6.05	....do		Nov. 30	59,885.65	29,942.82
	21	St. Francis	7.93	....do	Nov. 23		34,333.72	17,166.86
Florida	4	De Soto	3.05	Sand-clay		Nov. 20	66,005.98	30,000.00
	5	....do	2.50	Brick or asphaltic concrete		Nov. 2	46,879.17	20,000.00
	9	Holmes	5.11	Sand-clay	Nov. 7		22,254.11	11,127.05
Iowa	29	Wright	14.88	Gravel	Nov. 4		85,855.00	22,345.19
	31	Howard	10.50	....do	Nov. 1		51,425.00	18,092.65
Kansas	2	Labette	9.14	Gravel or macadam		Nov. 20	77,720.80	11,658.12
	18	Allen	1.00	Concrete	Nov. 30		32,015.15	4,702.27
	19	....do	4.25	Gravel or macadam	...do....		41,048.67	6,157.30
Louisiana	14	Caldwell	10.00	Sand-clay and gravel		Nov. 30	44,614.02	20,000.00
	15	Avoyelles	5.41	Gravel	Nov. 30		59,036.57	25,000.00
	16	East Baton Rouge	4.90	....do	...do....		35,913.90	17,956.95
	18	Caldwell	2.40	....do	...do....		11,462.99	5,000.00
Michigan	23	Berrien	2.53	Macadam		Nov. 1	44,676.02	22,338.00
Minnesota	31	Wright	23.37	Graded and drained earth		Nov. 20	59,383.41	15,000.00
	32	Kandiyohi	27.78	Gravel		...do....	58,545.43	25,000.00
Mississippi	10	Lincoln	6.875	....do		...do....	38,619.21	19,300.00
	12	Scott	5.62	....do		Nov. 23	30,002.61	15,000.00
	15	Wilkinson	9.00	Clay, gravel		...do....	50,096.28	25,000.00
	35	Pike	7.40	Gravel	Nov. 23		48,290.00	22,500.00
Missouri	1	Cole	26.39	....do		Nov. 30	141,776.67	35,444.17
Montana	2	Wibaux	7.00	....do	Nov. 7		21,631.28	10,815.64
	20	Missoula	7.00	....do	Nov. 4		21,985.26	10,992.63
	21	....do	7.00	....do	...do....		21,995.60	10,997.80
Nebraska	21	Box Butte and Sheridan	15.00	....do	Nov. 23		63,813.20	31,906.60
Nevada	5	Elko	18.73	....do		Nov. 1	98,066.56	49,033.28
	6	White Pine	12.46	Gravel or macadam		Nov. 20	63,846.20	31,923.10
New Mexico	12	Chaves	16.70	....do		Nov. 23	127,508.62	63,754.31
New York	13	Chautauqua	7.04	Concrete	Nov. 25		140,800.00	70,400.00
	15	Otsego	5.07	Macadam	...do....		101,400.00	50,700.00
North Carolina	24	Wake	4.24	Concrete		Nov. 13	67,760.00	25,000.00
	26	Davidson	12.88	Top soil or sand-clay		Nov. 23	22,856.68	10,000.00
	34	Wayne	.064	Bridge	Nov. 12		20,001.30	10,000.00
	38	Rockingham	10.928	Top soil	Nov. 30		47,000.00	12,100.00
North Dakota	3	Williams	30.50	Earth		Nov. 30	83,745.74	41,872.87
	10	Pierce	5.00	Gravel, sand, clay		Nov. 11	11,730.24	5,865.12
	15	Sargent	31.40	Earth		Nov. 13	54,384.08	27,192.04
	20	Wells	16.80	....do		...do....	[1] 26,495.98	13,247.99
Oklahoma	1	Cleveland and McClain	.3723	Bridge		Nov. 23	223,115.27	100,000.00
	2	McCurtain	25.00	Gravel		...do....	205,998.77	102,999.38
Oregon	10	Baker	17.80	Earth	Nov. 18		71,235.45	28,117.73
Pennsylvania	15	Beaver	1.006	Concrete, bituminous, or reinforced concrete.		Nov. 4	47,573.45	10,060.00
	17	Dauphin, Lebanon, and Berks	3.80	Concrete		Nov. 30	133,588.89	38,000.00
	18	Clarion	5.00	Brick	Nov. 30		220,000.00	50,000.00
	19	Montgomery and Bucks	8.352	Bituminous concrete	Nov. 25		365,200.00	83,520.00
South Carolina	17	Calhoun	.22	Sand-clay	Nov. 12		10,015.72	5,000.00
	18	Greenwood	7.29	Top soil		Nov. 20	19,997.98	9,988.99
Texas	12	McLennon	3.50	Bituminous gravel		Nov. 1	26,679.82	12,500.00
	20	Gregg	33.59	Gravel		...do....	115,317.52	50,000.00
	23	Dallas	2.167			...do....	14,985.44	7,000.00
	55	Camp	9.924	Gravel or macadam		...do....	65,664.52	17,454.00
Utah	2	Weber	9.28	Macadam		Nov. 11	61,340.44	30,670.00
Virginia	10	James City and York	2.462	Concrete		Nov. 4	69,014.44	24,620.00
	12	Franklin	6.16	Top soil	Nov. 23		56,936.44	23,468.22
	16	Botecourt and Rockbridge	5.398	Waterbound macadam		Nov. 4	61,575.83	30,787.93
	18	King William, Gloucester, and Middlesex.	13.777	Graded and drained		Nov. 13	44,193.30	22,096.65
	19	Fauquier	5.04	Macadam		...do....	64,437.05	32,218.54
	20	Southampton	8.31	Gravel	Nov. 23		67,902.34	33 951.34
	25	Surry and Prince George	4.05	Bituminous macadam	...do. ...		37,265.05	18,632.52
Washington	7	Lincoln	8.29	Gravel and macadam		Nov. 20	72,266.04	36,133.02
West Virginia	18	Tyler	1.00	Concrete		Nov. 11	27,754.43	10,000.00
Wisconsin	13	Clark	8.81	Graded earth		Nov. 20	26,987.07	8,995.69
	36	Milwaukee	.78	Concrete		...do....	21,473.68	7,157.89
	44	Juneau	11.905	Earth surface and sand-clay		...do....	30,633.01	10,211.00
Wyoming	2	Albany	10.41	Earth		...do....	10,321.63	5,160.81
	20	Sheridan	8.00	Concrete or asphaltic gravel		Nov. 14	183,188.75	85,944.50
Total			636.9623				4,557,507.68	1,847,893.09

[1] Revision of previous agreement.

STATE HIGHWAY MANAGEMENT, CONTROL, AND PROCEDURE

By M. O. ELDRIDGE, Assistant in Road Economics; G. G. CLARK and A. L. LUEDKE, Engineer Economists of the Bureau of Public Roads.

IN foregoing numbers appeared chapters on State highway management, control, and procedure. In this number are presented the chapters on two States. Each one takes up the development and results of State participation and control of road work and the relation of State to local control; organization, personnel, duties and powers of State and local road officials; classification of State and local roads with particular reference to control and basis of payment, including methods of selection, powers of State highway departments in granting aid, procedure in making surveys, letting contracts, and the control exercised by the State and local officials over road construction and maintenance; sources of State and local funds, basis of allotment and apportionment of State funds, and the relation of State to local funds, and the amount available for road purposes during the latest calendar or fiscal year.

MASSACHUSETTS.

Development.—State participation in road work in Massachusetts is of early origin and State-wide in extent. The State now exercises practically complete control over the construction and maintenance of 12 per cent of the rural roads and contributes approximately 54 per cent of all rural road expenditures.

Between 1794 and 1826 about 1,000 miles of turnpike or toll roads were established. These roads proved unremunerative to the stockholders and unsatisfactory to the public, and were gradually abandoned and turned over to the municipalities. The last turnpike was abandoned in 1868. From that time until 1893, when the State Highway Department was first established, complete control over practically all roads outside of cities was exercised by town selectmen.

The new State law provided for a continuous commission of three and established the policy of State aid to towns and State control of a system of roads to be known as State highways. Massachusetts, therefore, deserves the credit of having originated and given form to the idea of establishing a system of State highways constructed and maintained largely through the aid and control of the State. The form of the Massachusetts State highway organization has not materially changed since it was first established, although certain minor changes in policy and duties have been added from time to time.

The State funds available for State aid and for State highway construction and maintenance have increased from about $300,000 a year, when the work first started, to approximately $3,900,000 per annum at present. From 1893 to 1917, inclusive, the State expenditures have amounted to approximately $25,500,000. Local funds not under State control, exclusive of cities, now amount to about $3,350,000 per annum. During 1917 the total State and local expenditure amounted to $9,494,802.

The State has 18,681 miles of rural public roads, of which about 8,900 miles, or 47.6 per cent, have been surfaced. Of the surfaced roads about 2,270 miles have been constructed and are now being maintained under State supervision.

ORGANIZATION.

The highway organization of the State and the relation existing between the State and local forces is shown herewith.

State.—At the head of the State highway department is the State highway commission consisting of three salaried members. The commission is a continuous body, one member being appointed each year by the Governor. The commissioners devote their entire time to the work, about one-half of which is occupied with road matters and the other half with the conduct of the automobile department. All technical and clerical employees of the department are appointed by the commission from the civil service eligible list, and all employees must be citizens of the United States.

All engineering and technical work of the department is under the control of the chief engineer. He is assisted by the first assistant engineer, who has immediate charge of the designing engineers, draftsmen, and field parties, and an assistant engineer who is in immediate charge of specifications, contracts, and special work. The State is divided into four divisions, with a division engineer in charge of each, they reporting to the chief engineer. The division engineers are directly responsible for construction and maintenance work in their respective divisions. Each division engineer has a deputy and a corps of assistants and resident engineers to look after the details of construction and maintenance on each job.

The secretary of the commission has charge of records, accounts, and the automobile department. Under the secretary is an assistant secretary, a recording secretary, and a chief clerk, by whom the

accounts and records of the department are handled. There is also a chief clerk who has charge of the clerical force in the automobile department and a chief examiner who has charge of the investigators and examiners in that department. In this connection it should be stated that the commission registers all the motor vehicles in the State, licenses operators, and makes regulations for the operation of motor vehicles. It investigates automobile accidents and may suspend or revoke licenses for proper cause.

Local.—Each county has a board of county commissioners consisting of three members elected by qualified voters for terms of three years. Their authority over local roads is very limited. Upon petition and after due hearing, they have authority to order the layout of new roads or to improve existing roads, and to determine what part of the cost shall be paid by the city or town benefited. They also have authority over certain intercounty bridges and employ engineers when necessary to look after this work. Two counties have county engineers who serve under the orders of county commissioners.

Each town is governed by a board of from three to five selectmen elected by a majority vote of the voters at the annual town meetings. Cities and towns acting through their proper authorities, superintendents of streets, or highway surveyors, have authority to construct and maintain town roads and city streets and to raise and appropriate money therefor.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The public roads of Massachusetts, comprising 18,681 miles, exclusive of city streets, are, for the purpose of fixing responsibility for construction, control, and maintenance divided into two main groups, namely, State highways and town ways. In addition to this, there are 4,349 miles of city streets, of which 3,812 miles have been surfaced. Town ways which receive the aid of the State and which are constructed and maintained under State supervision may be classified as follows: Small town act roads, through routes (chapter 525), five western county roads, and special act roads.

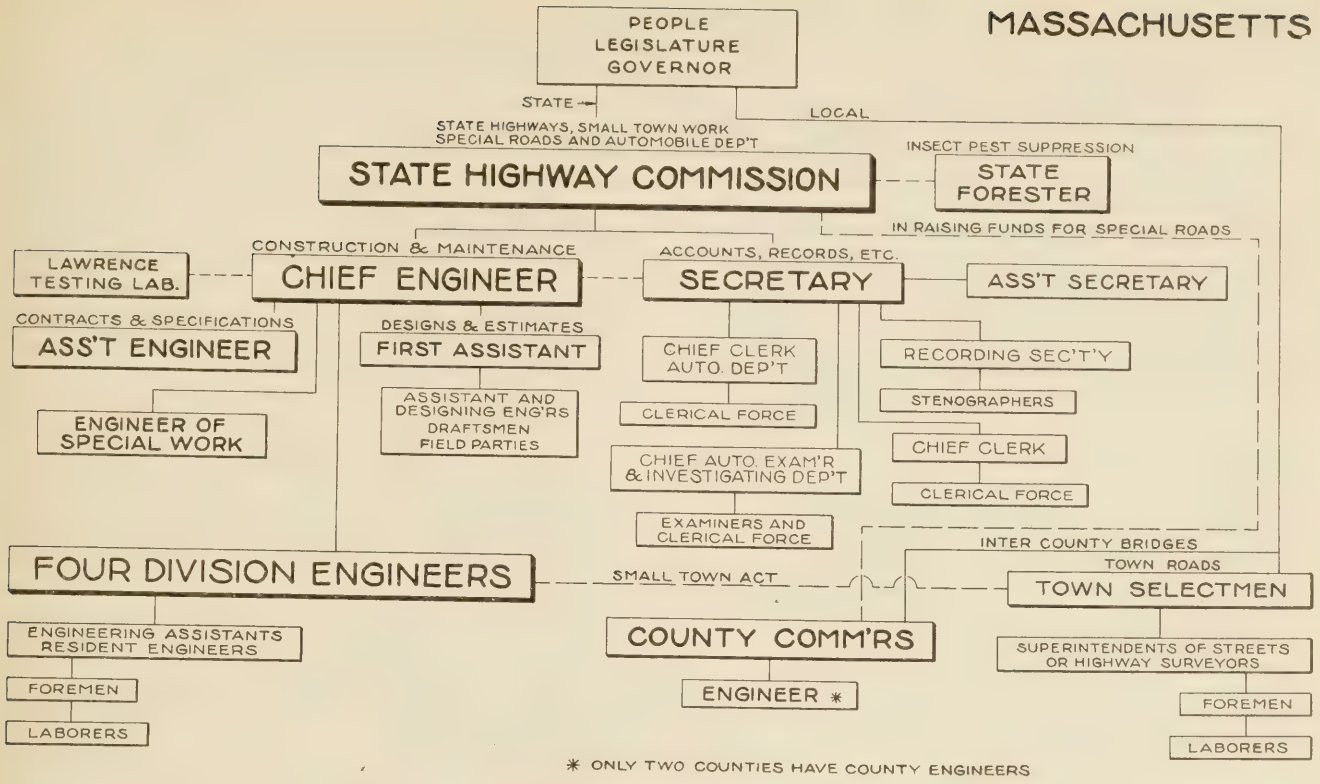
State highways.—The State highway commission has absolute control over construction and maintenance of State highways, which include at present about 1,200 miles. Petitions for construction originate with the county commissioners, town selectmen, or city officials. Surveys, plans, estimates, and description of layout are prepared and approved by the State highway commission and copies are filed with the county commissioners and with the clerk of the town or city in which the road is located. The road then becomes a State highway. Contracts may be awarded without advertisement to cities or towns for the work lying within their respective boundaries at a price agreed upon. If the city or town within 10 days does not elect to take the contract, the State may advertise and award the contract. Not more than 10 miles of State highway can be constructed in any one county in any one year without the approval of the governor and council.

Payments are made on monthly estimates, 15 per cent being deducted until final completion and acceptance. The State pays, from the State highway loan fund, 100 per cent of the cost of construction, but counties must repay within six years 25 per cent of the cost with interest at 3 per cent. On completion and acceptance the State maintains the roads, but the towns and cities in which such roads are located repay to the State from $50 to $500 per mile per annum on a valuation basis as follows:

In towns having less than $1,000,000 the basis of repayment is one-half the cost but not more than $50 per mile per annum; between $1,000,000 and $2,000,000 it is one-half the cost but not over $100 per mile; and between $2,000,000 and $5,000,000 it is one-half the cost but not over $200 per mile; and in cities and towns having a valuation of over $5,000,000, one-half of the cost but not to exceed $500 per mile in any one year. By this arrangement the State extends a greater amount of help to the poorer towns than to the richer ones. The amounts contributed by the towns and cities for this purpose may be levied and collected as a part of the State tax for the current or the three succeeding fiscal years, and when paid is added to the State highway fund. The State may upon presentation of sufficient reasons relieve the town from payment of any part of such repayment.

Small Town Act Roads.—The State highway commission may spend, subject to statutory restrictions, on town roads designated by town selectmen, 15 per cent of the amount appropriated for State highway construction, under the so-called small town act as follows: 5 per cent in towns having a valuation of less than $1,000,000, the towns making no contribution; 5 per cent in towns having a valuation of less than $1,000,000, the towns contributing an equal amount; and 5 per cent in towns having more than $1,000,000 provided the towns contribute an equal amount in addition to the average annual appropriation made by the towns for repairs for the preceding five-year period.

These roads are constructed under the direction of the State highway commission and the procedure for construction is practically the same as for State highways. The roads when completed remain town ways, and the town or city in which they are located assumes responsibility for maintenance. If after due notice by the commission repairs are not made within 60 days the State may do the work



and collect from the city or town in which the road is located from $50 to $200 per mile, depending upon valuation. The State may upon presentation of sufficient reasons exempt any town from the whole or any part of such repayment. There are 580 miles of road which have been improved under the so-called small town act.

Five Western County Roads.—The legislature of 1915 authorized the State highway commission to construct between 1915 and 1918, inclusive, 17 specially designated roads situated in 38 towns and one city in the five western counties of the State. The procedure for layout and construction of these roads is practically the same as for State highways. The construction costs are paid from a $2,000,000 State bond issue, and the counties return to the State 25 per cent of the cost within six years in the same manner as for State highways. The roads when completed do not, unless laid out as such, become a part of the State highway system, the towns being responsible to the highway commission for their proper maintenance. This system of roads includes approximately 160 miles.

Special Act Roads.—There are about 30 miles of town roads in the State which have been designated by the legislature and improved by the State from joint State and town funds. These roads remain under town jurisdiction for the purpose of maintenance.

Through Routes (Chap. 525).—The State highway commission is authorized to set apart 20 per cent of the net receipts from the automobile fees fund each year for constructing, improving, repairing, and maintaining town roads which may be used as through routes. These roads are designated by the local officials with the approval of the State highway commission. Petitions for improvement originate with town selectmen. Construction work is under State jurisdiction and maintenance work is handled by the State or the town under State supervision. The commission may spend any part of the above 20 per cent fund together with any money contributed by the towns on these through roads, and the roads remain town roads. About 300 miles of road are included in this system of through routes.

Town Ways.—All town roads except those indicated above are under the jurisdiction of town authorities both for construction and maintenance. The county commissioners do not build or repair roads except on petition, and only then if the town authorities fail when ordered by them to do so.

REVENUES.

State revenues.—Appropriations are made by the legislature usually for five-year periods for construction of State highways and for aid to towns under what is known as the small-town act, 85 per cent of the appropriation being used at the discretion of the State highway commission for State highway construction and 15 per cent for small-town work. The last appropriation was made in 1912 and provided $1,000,000 per annum for each of the years 1913 to 1917, inclusive. This money is derived from State bond issues, specially authorized for the purpose. Appropriations are made annually by the legislature for the administration of the

State highway department, for maintenance of State highways, for widening and reconstruction of State highways, and other purposes.

An appropriation of $2,000,000 was made in 1915 for improving 17 designated routes in the five western counties of the State during the years 1915–1918, inclusive, the funds being derived from a State bond issue. The automobile fees funds which were collected by the State highway commission are used for the maintenance of State highways and for the betterment of through routes; 80 per cent of the net receipts being used for the former and 20 per cent for the latter purpose. The State funds available for the fiscal year December 1, 1916, to November 30, 1917, were approximately as follows:

State highway construction	$850,000
Aid to small towns	150,000
Administration of State highway department, including $20,000 for care of machinery and $10,000 for insect extermination, and $27,500 for maintenance and operation of 2 bridges	117,000
Maintenance of State highways, including $194,547 from assessments of cities and towns for maintenance of State highways	254,547
Widening and reconstruction of State highways	150,000
Maintenance of State highways (80 per cent of auto money)	1,440,000
Betterment of through routes (20 per cent of auto money)	360,000
5 western county roads (17 routes)	500,000
Total of all State funds available	3,821,547

Local revenues.—Funds for the construction and maintenance of local roads are chiefly derived from appropriations by town meetings or governing bodies of cities and from local bond issues. Funds used to repay the State for one-fourth the cost of constructing State highways and the 17 designated routes in the five western counties are secured from towns and cities in which the roads are located as a part of the proceeds of the State tax. At the present time the total revenues annually applied to roads and bridges constructed by the towns, exclusive of cities, amount to approximately $3,350,000.

BONDS.

State.—Since 1894 State bonds have been issued from time to time to meet appropriations for the construction of State highways. State bonds issued between 1894 and 1904 were of the sinking-fund variety maturing 26 to 30 years from the date of issue. All State bonds issued since 1904, except the last two issues, were deferred serials with the first payment falling due from 3 to 11 years from the date of issue, and the last payments from 9 to 30 years from the date of issue. In 1912, a bond issue of $5,000,000 was authorized to meet appropriations for each of the years 1913–1917, inclusive. These bonds are of the serial type and the last payment must be made in 15 years from the date of issue. Another issue of $2,000,000 was made in 1915 for the improvement of 17 routes in the five western counties of the State during the years 1915–1918, inclusive. These are also 15-year serial bonds. Up to the present time the State has issued approximately $16,250,000 of bonds, of which $14,250,000 were for State highways and $2,000,000 for 17 routes in the five western counties.

Local.—Towns and cities may issue bonds for roads, bridges, and other purposes by a two-thirds majority of votes cast at annual town meetings, or by two-thirds vote of all members of city councils or other governing bodies. Bonds may be issued up to 2½ per cent of the valuation in cities and 3 per cent in towns, and must be paid off in equal annual installments, the terms being limited as follows: For construction of stone, concrete, or iron bridges, 20 years; for construction of streets or highways of stone, block, brick, or other permanent pavement of similar lasting character, 10 years; and for macadam pavement or other road material under specifications approved by the Massachusetts Highway Commission, 5 years. The total town bonds outstanding for roads and bridges, exclusive of cities, amounted to approximately $1,600,000 on January 1, 1915.

MICHIGAN.

Development.—State participation in road improvement in Michigan is state-wide in its scope, has been effective since 1905, consists of allotments of State funds to the various counties of the State for construction purposes, rewards paid to counties or townships improving roads in accordance with statutory standards, of technical advice relating to and supervision of the construction of work financed with local funds, and is extended through the State highway department.

A system of State highways comprising 6 per cent of the total road mileage of the State has been designated for improvement by or under State supervision as rapidly as funds are available.

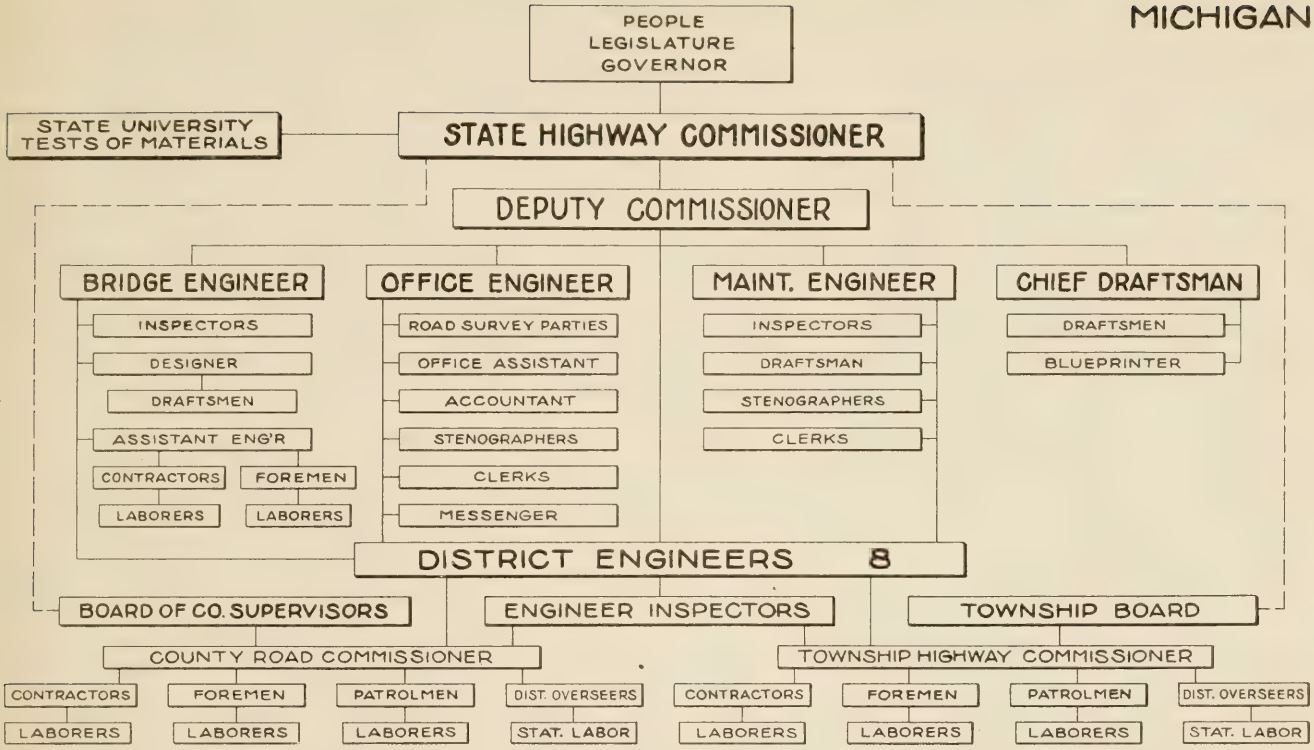
The "reward system" in effect in this State has induced local officials to improve their roads under State laws and general regulations provided by the State highway department, and as a result of this cooperation about 12 per cent of the entire road mileage of the State is now improved, most of the work having been done under this system.

During 1916, $9,082,939 was expended in the State for road and bridge purposes. Of this amount $3,332,939, or 36.7 per cent was expended by or under the supervision of the State highway department, the remainder, $6,750,000 being expended by local officials. The total expenditure from all sources during 1917 amounted to $11,190,153.

ORGANIZATION.

The organization of the road forces of the State and the relation between them is shown on the diagram.

State.—The State highway commissioner, elected by the qualified voters of the State for a term of four years, is the head of the State highway department. Such assistants and clerical force as may be required are appointed by him. He has charge of all phases of the construction of roads and bridges financed wholly or in part with State or Federal funds. He furnishes plans and specifications for and makes inspection of the construction and maintenance of the "reward" roads. He is required to present to the attention of and discuss at the annual meeting of the township commissioners of each county such matters of road improvement as may be deemed of special interest to them. He is also required to prepare a map of each township of the State showing all public roads, their condition, and the location of available road-building material. He is required to act as a technical adviser to all



road officials of the State and present a biennial report to the governor covering all operations of the State highway department. He is assisted in the discharge of his duties at the central office by a deputy commissioner, who is required to be a civil engineer, by a bridge engineer, an office engineer, a maintenance engineer, draftsman, and other employees, and in the field by eight district engineers, who have charge of supervision and inspection of State construction and State reward work.

County.—Fifty-eight counties have adopted the county-road system and control of the roads therein is vested in a board of three commissioners, generally elective. The county clerk is clerk of the board and the county treasurer is fiscal agent.

In counties containing 20 or more entire or fractional surveyed congressional townships the board of commissioners may be appointed by the county board of supervisors.

The board of commissioners of each county so organized is required on or before October 1 of each year to prepare a budget covering the estimated road expense and the tax levies for the coming year, and to present same to the county board of supervisors, who may make amendments therein, although they are required to provide sufficient funds for the proper maintenance of the roads in their jurisdiction.

Township.—Twenty-five counties exercise road control by means of township boards consisting of the township supervisor, the township clerk, and the two senior justices of the peace. This board appoints a township highway commissioner and an overseer of highways for each road district in the township.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The 94,100 miles of public road in Michigan are, for the purpose of fixing responsibility for construction, control, and maintenance, divided into three groups, viz, trunk-line highways, county roads, and town roads. As State reward may be granted under certain circumstances to roads of the various groups, a brief discussion of the State reward systems will be outlined at this time. State refunds are granted under the reward system authorized by the legislature and are applied to roads constructed in accordance with seven standard types. Class A roads are 20 feet wide between ditches, with a 9-foot traveled track of clean gravel or sand-clay, being the cheaper type of construction, while class G roads are 20 feet wide between ditches, with a brick-paved surface 9 feet wide laid on gravel, sand, broken stone, or slag, represent the highest type of construction. The rewards vary from $250 per mile for class A roads to $1,000 per mile for class G roads. These amounts are increased by 10 per cent for each additional foot in width of wearing surface up to and including 16 feet. These rewards are doubled on trunk-line or State roads if full control over construction is vested in the State highway department. The roads to be improved under the reward method are designated by joint agreement between the State highway department and county or township board. The State highway department furnishes the necessary plans and specifications and inspects the work when completed. The reward is paid to the county or township fiscal agent when the completed work has been accepted by the State highway department. Maintenance is executed by and at the expense of the local unit. State rewards may be withheld to compel proper maintenance.

The State builds and pays the cost of construction of all bridges greater than 30-foot spans on State rewards roads provided the local unit expended on road or roads including bridge sites, an amount not including State reward, equal to the cost of the bridge plus the State reward mentioned on the road or roads built.

In addition to the reward system, the laws of Michigan grant State or Federal aid for construction purposes when control over location and construction is vested in the State highway department.

When such aid is invoked the procedure is substantially as follows:

The county or township designates the road to be improved, pledges funds therefor, and requests Federal or State aid. The State highway department views the road, approves the project, prepares surveys, plans, specifications, and notifies the local board of the estimated cost and the amount it must deposit with the State treasurer to the credit of the State highway fund. The percentage of cost paid by the township or county board is fixed by statute and is computed as follows: The total assessed valuation of the county or township is divded by the number of miles of trunk line road allotted to the county or township. When the quotient is $100,000 or less, the local board pays 25 per cent of the total cost; as the valuation of the county increases, the percentage of cost borne by the local board is increased up to 50 per cent of the total cost, the State contributing the remainder. The cost of surveys and plans is paid from State funds.

Trunk-line highways; or State roads comprising about 4,500 miles are designated in a general way by the State legislature, the details of location being left to the State highway department. They are constructed and maintained by the State highway department with Federal, State and local funds. Local funds are contributed annually for maintenance purposes in an amount equal to 3 per cent of the local contribution to the cost of construction, provided, however, that this contribution may not exceed $100 per mile. The mileage of trunk-line highways in any county may not exceed 3 miles for each surveyed township.

Trunk-line highways may be constructed with local funds by local officials, the plans, specifications, and supervision being furnished by the State highway department. On satisfactory completion of the work, double rewards are paid to the local board. The maintenance of such roads may be carried out by the local boards subject to state supervision.

County roads.—These are designated, controlled, improved, and maintained by the county boards with local funds. Single rewards are paid for improved roads if constructed in accordance with State law, and the rules and regulations of the State highway department.

Township roads.—These comprise all other roads of the State not included in the preceding systems. They are constructed and maintained by township officials with township funds. Rewards may be paid for improved roads of this group, although it is the desire of the State highway department to give preference in construction to roads of the preceding groups.

Convict or reformatory labor may be utilized on trunk-line and county roads when requested by local officials, all expense being borne by the local board and an additional charge of 50 cents per day for each person employed. County prisoners may also be detailed to road work by the county board of supervisors.

Improvement of roads of the three groups may be executed under contract or force account. The State highway department may let contracts for work done by districts authorized to levy special assessments and located in two or more counties; for all bridges of 30-foot span or more located on State trunk-lines; for all work done by contract in counties having no county organization; and for all projects involving the expenditure of Federal and State aid funds. All other contracts are let by the board having jurisdiction over the roads.

Partial payments may be made at monthly intervals when based on estimates prepared and approved by the engineer in charge of the work. The approved estimate is then submitted to the executive official or board in charge of the funds provided for the work and payment may be made on his or their order. Final payment may not be made until the contractor has filed an affidavit showing that all accounts incurred by him on account of the work have been paid, and until the completed work has been inspected and approved by the proper authorities.

REVENUES.

For the year ended June 30, 1918, the State legislature provided the following amounts for the use of the State highway department.

For support of the State highway department	$30,000
For State aid on construction of Federal aid roads	225,000
For bridges and State reward on trunk line routes	550,000

In addition to these amounts the State highway department has at its disposal 50 per cent of the net automobile revenues which will produce it is estimated $1,272,246, which may be used for the payment of single State reward and maintenance rewards.

County and township funds.—These are raised by taxation or by bond issues. When by taxation, two levies are made consisting of (1) the road-repair tax laid on all property outside the limits of incorporated villages or cities, and may not exceed 50 cents on each $100 of valuation, except in townships having a valuation less than $200,000 where the tax may not exceed $1 on each $100 valuation; (2) the highway improvement tax laid on all property in the township at the same rates as given for the road repair tax.

Bonds.—Bonds may when authorized by a majority of the voters affected be issued for road purposes in an amount not to exceed 5 per cent of the assessed valuation of the township or three per cent of the assessed valuation of the county.

It is estimated that on January 1, 1915, $10,389,029.43 of county and township bonds were outstanding. These bonds bore interest at rates of 4 per cent and 5 per cent and had terms of 15 to 20 years.

NEW ARIZONA STATE ENGINEER.

State Engineer B. M. Atwood, of Arizona, resigned January 6, to go into the contracting business, with road work a specialty. F. N. Holmquist of Phoenix has been appointed to succeed him. Mr. Holmquist is a graduate of the University of Chicago, class of 1909. He has lived in Arizona most of the time since his graduation, has served as city engineer of Phoenix, and when appointed was in private practice in that city.

ALABAMA ROAD LEGISLATION.

The Alabama Good Roads Association is pushing road legislation wanted from the legislature now in session. It is advocating increased appropriations for highway building, the use of the automobile license tax in maintaining roads and a law to work convicts on the highways.

ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS.

NOTE.—Application for the free publications in this list should be made to the Chief of the Division of Publications, U. S. Department of Agriculture, Washington, D. C. 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. In applying for these publications the name of the series as well as the number of the publication should be given, as "Bureau of Public Roads Bulletin No. 32."

REPORTS.

Report of the Director of the Office of Public Roads for 1916.
Report of the Director of the Office of Public Roads for 1917.
Report of the Director of the Bureau of Public Roads for 1918.

OFFICE OF PUBLIC ROADS BULLETINS.

*Bul. 28. The Decomposition of the Feldspars (1907). 10c.
32. Public Road Mileage Revenues and Expenditures in the United States in 1904. 15c.
*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.
*48. Repair and Maintenance of Highways (1913). 15c.

DEPARTMENT BULLETINS.

Dept. Bul. *53. Object-Lesson and Experimental Roads and Bridge Construction of the U. S. Office of Public Roads, 1912–13. 5c.
105. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913.
136. Highway Bonds.
220. Descriptive Catalogue of Road Models of Office of Public Roads.
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.
*284. Construction and Maintenance of Roads and Bridges, from July 1, 1913, to December 31, 1914. 10c.
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.
387. Public Road Mileage and Revenues in the Southern States.
388. Public Road Mileage and Revenues in the New England States.
389. Public Road Mileage and Revenues in the Central, Mountain, and Pacific States, 1914.
390. Public Road Mileage in the United States. 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. Report 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.

*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. 5c.
52. State Highway Mileage and Expenditures to January 1, 1915.
59. Automobile Registrations, Licenses, and Revenues in the United States, 1915.
62. Factors of Apportionment to States under Federal Aid Road Act Appropriation for the Fiscal Year 1917.
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.

FARMERS' BULLETIN.

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

YEARBOOK SEPARATES.

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

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH.

Vol. 5, No. 17, D–2. Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements.
Vol. 5, No. 19, D–3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
Vol. 5, No. 20, D–4. Apparatus for Measuring the Wear of Concrete Roads.
Vol. 5, No. 24, D–6. A New Penetration Needle for Use in Testing Bituminous Materials.
Vol. 6, No. 6, D–8. Tests of Three Large-Sized Reinforced-Concrete Slabs under Concentrated Loading.
*Vol. 10, No. 5, D–12. Influence of Grading on the Value of Fine Aggregate Used in Portland Cement Concrete Road Construction. 15c.
Vol. 10, No. 7, D–13. Toughness of Bituminous Aggregates.
Vol. 11, No 10, D–15. Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.

*Department supply exhausted.

Stricken Europe Needs Our Help In Period of Recovery, Says Secretary

NOW, the great struggle has been won by the forces of civilization, and this Nation is free—at least temporarily free—to take up once more the tasks of peace. It has issued from the contest, comparatively speaking, untouched and unhampered. By reason of its shorter actual participation in the war and its freedom from such devastation as has swept Europe, its relative position—industrially, financially, socially, and governmentally—is stronger than it was five years ago. The world does not yet realize how stricken are the European countries and how long it will take them to recover and to make their former material contribution to the world's stock.

It is impossible yet for one to frame in his mind a complete picture of the disabilities under which all Europe labors. It has been estimated that the European belligerents, exclusive of the Balkan States and Turkey, lost more than seven millions of men killed and fourteen millions wounded, many of them permanently incapacitated, a total casualty list of over twenty millions. The impairment resulting from these losses and the burden imposed by great numbers of widows and orphans can not be calculated. And what of the destruction of property, the enormous losses of merchant ships, the disruption of industry?

We must think, too, of the immense upheaval in the social, economic, and political field, of the years of struggle that will ensue before Governments are reorganized and orderly political processes are restored. In Central Europe the old régime will not reappear. For the first time in their lives the masses of the people will have an opportunity to say something about their future and to take part in the direction of the Government. They will not be content with the restoration of former conditions and will demand things in the way of political participation, of standards of living, and of wages that will constitute a revolution.

Obviously, also, account must be taken of the enormous debts, the principal of which must be ultimately discharged and the interest paid. It is probable that the war debt of all the belligerents will range from $175,000,000,000 to $200,000,000,000. It is estimated that that of Great Britain will exceed 32 billions, 37 per cent of her estimated real wealth, and $700 per capita; that of France, more than 25 billions, 50 per cent of her wealth, and $600 per capita; that of Germany, 33 billions, 40 per cent of her wealth, and $560 per capita; that of Austria, 18 billions, 76 per cent of her wealth, and $346 per capita; that of Italy, 7 billions, 30 per cent of her wealth, and $200 per capita; while that of the United States may be 20 billions, only 11 per cent of her wealth, and $200 per capita.

And yet there are those who express alarm as to the future ability of this country to hold its due place in the trade of the world. There are doubtless others who may take smug satisfaction in the thought that Europe will be relatively handicapped. Many among us still entertain medieval notions of trade, and foolishly think that one nation can gain only at the expense of another or that it is possible for a nation to secure what it needs from others without giving an adequate return. It is incredible that any thinking man can gain satisfaction from an impairment of the capacity of any part of the world to contribute to the world's national dividend of goods and services.

Our thought, it seems to me, should be how, in the period of recovery, we may properly assist the desperately stricken people of Europe rather than of how we can take advantage of them in their present plight.—*From address by Secretary Houston.*