

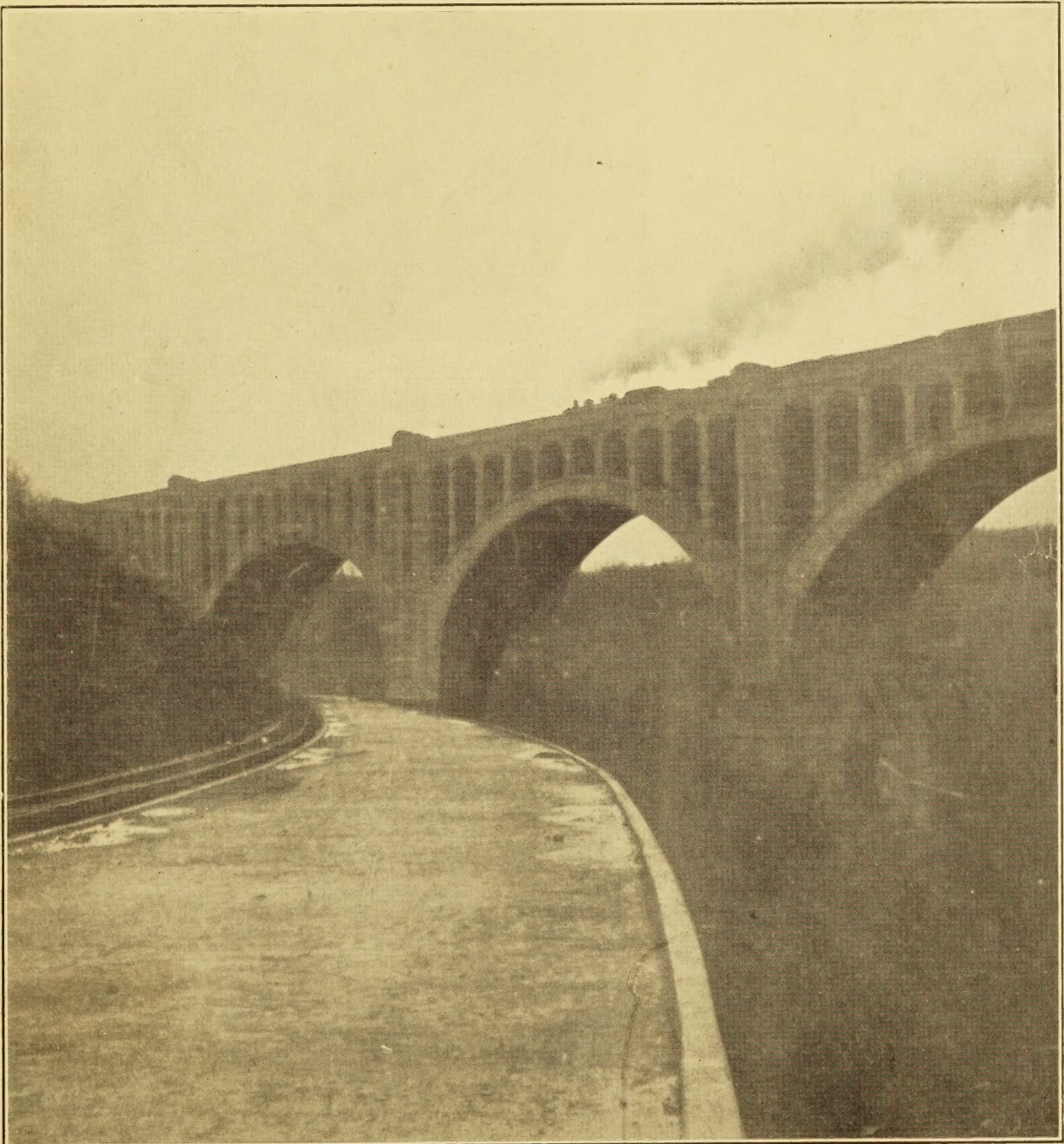
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

Public Roads

VOL. 2, NO. 20

WASHINGTON, D. C.

DECEMBER, 1919



SUNSET ON THE LACKAWANNA TRAIL, PENNSYLVANIA

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 a single number to the Superintendent of Documents, Government Printing Office, Washington, D. C.

U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

PUBLIC ROADS

TABLE OF CONTENTS

	Page
Convention of American Association of State Highway Officials	3
The American Highway Problem	6
<i>A. R. Hirst</i>	
Survey of Southern States Highway Situation	11
<i>W. S. Keller</i>	
Highway Situation in Pacific Coast States	12
<i>Herbert Nunn</i>	
New England Conditions, 1919 and 1920	13
<i>Wm. D. Sohler</i>	
The Situation in the Middle Atlantic States	15
<i>Samuel Knopf</i>	
Highway Situation in the Central West	19
<i>F. R. White</i>	
The Motor Vehicle's Share of Construction and Maintenance Cost	21
<i>S. E. Bradt</i>	
Problems of Administration	24
<i>Arthur H. Blanchard</i>	
Is State Supervision of Construction and Maintenance of all Highways Desirable	29
<i>B. H. Piepmeyer</i>	
Proper Inspection in the Development of Material Supplies for Heavy Programs	31
<i>A. B. Fletcher</i>	
Highway Department and Railroad Cooperation for Transportation of Materials	33
<i>A. G. Gutheim</i>	
Statement by the Highway Division of the Associated General Contractors of America	37
<i>R. G. Collins</i>	
Surveys and Plans and Suggested Changes to Meet the Shortage of Engineers	42
<i>P. St. J. Wilson</i>	
Relations with the Contractor, Influence of Fair Specifications and Inspection	50
<i>H. S. Mattimore</i>	
Pennsylvania's Lackawanna Trail	53
<i>A. C. Rapelje</i>	
Federal Aid Record	54

THOMAS H. MacDONALD	Chief of Bureau
P. ST. J. WILSON	Chief Engineer

DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS
PUBLIC ROADS

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
15 CENTS PER COPY

PAPERS AND DISCUSSIONS AT THE HIGHWAY OFFICIALS' CONVENTION.

THE annual convention of the American Association of State Highway Officials, held at Louisville, Ky., December 8-11, 1919, was very largely attended and was one of the most important in the history of the association. The subjects discussed and the resolutions adopted bore directly upon the problems affecting the road building activities of the country and especially upon the carrying out of the present extensive program of highway construction.

Because of the importance of the meeting and the various subjects discussed Public Roads presents to its readers just as complete a report of the papers and discussions as is possible. The length of the program and the variety of topics makes it necessary to devote two issues to the convention. It has not been found possible to print every paper in full, but there has been as little condensation as possible.

It has been necessary to give, in most cases, only the more important ideas and facts brought out in the discussions.

Resolutions adopted by the convention were as follows:

PARTICIPATION OF PUBLIC LAND STATES IN FEDERAL AID.

Whereas, The Federal aid road act provides for financial cooperation between the States and the Federal Government whereby the Government may contribute not more than 50 per cent of the cost of any Federal aid project; and

Whereas, This basis of cooperation is manifestly unfair to the so-called public land States, where vast areas exist in which the titles still rest in the Government, and such lands are not subject to taxation by said States; and

Whereas, On this account said States in many cases are unable to raise the funds necessary to meet the Government on a 50-50 basis, and thus complete their main trunk-line roads which are an integral part of the interstate road system; therefore, be it

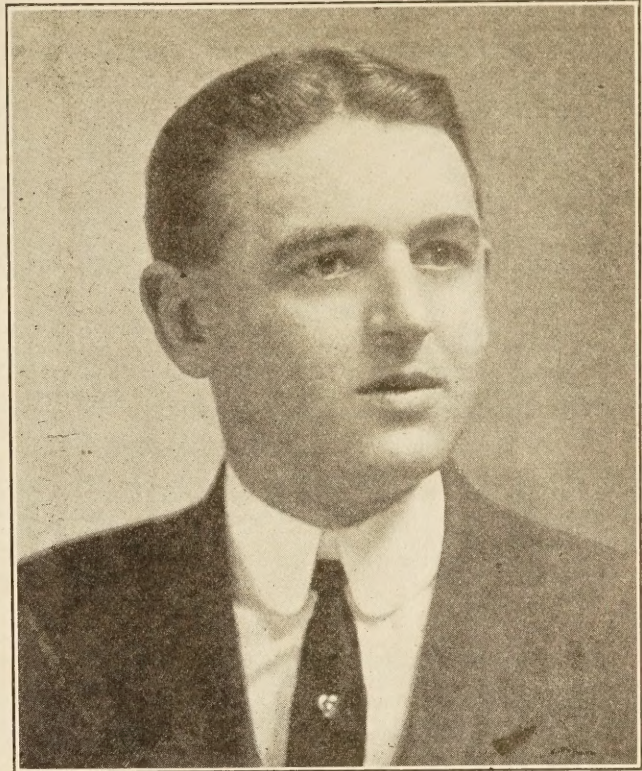
Resolved, By the Association of State Highway Officials in convention assembled at Louisville, Ky., on December 11, 1919, that the factors determining the total allotments of Federal aid moneys to each State, as now fixed by law, be not disturbed; however, in determining the percentage of cooperation required of each public land State, the following plan should be followed:

The percentage which the patented land area bears to the total area of such State, shall be determined by the Secretary of Agriculture, the 50 per cent now required as such State's portion of cooperation shall be multiplied by the resultant percentage as above determined, and the figure obtained will be the minimum percentage which such State shall be required to furnish of the total of any Federal aid project.

Be it further resolved, That nothing in the above resolution shall prevent any public land State from participating in a larger percentage than that above determined, on any Federal aid project.

Be it further resolved, That this new basis of cooperation in public land States may apply to projects, now under project agreement, between such States and the Government, and on any project agreements that may hereafter be entered into between the same.

Be it further resolved, That a copy of these resolutions be addressed to the Senators and Representatives in Congress at the earliest possible moment, and that a copy be addressed to the honorable Chief of Bureau of Public Roads, and that legislation



A. R. HIRST, PRESIDENT.

be urged at the present term of Congress to put the above provisions into effect.

REVISION OF SALARIES.

Whereas, The Federal and State Governments of our country have entered upon a program of improving the highways of the nation on a scale that makes this the greatest engineering project ever undertaken in the history of the world, at a cost to the taxpayers of many billions of dollars in the next decade; and

Whereas, To expend these vast sums efficiently and without waste, to get a dollar's worth of road for every dollar of tax, most urgently demands that the best engineering executive talent of the country be drawn into this work at once; and

Whereas, In order to draw the best talent into this work our State and National Governments must offer conditions of employment much more favorable than generally prevail at present both in the line of financial reward, in the permanency of the positions offered, and in freedom from political interference; and

Whereas, Wise provision for the future demands that the financial rewards offered should be such as to attract the best young men in the engineering colleges to prepare themselves for a life work in highway engineering; and

Whereas, A policy of niggardliness in this matter is one that can only bring disaster and waste in this great undertaking, and is, therefore, the most short-sighted economy.

Be resolved, By this association of State highway officials in convention assembled at Louisville, Ky., December 11, 1919, that our executive committee be instructed to present these facts with every proper urgency to the President and the Congress of the United States, and to the governors and legislative bodies of each State as soon as next they are in session; and that the executive committee be instructed to call to the attention of the various executives and legislative bodies and impress upon them the necessity of revising the salaries of engineers upward in substantial accordance with the appended schedule and impress upon them that provision for its adoption is a measure of wisest public economy.

RECOMMENDATIONS FOR SALARIES FOR ENGINEERS IN STATE HIGHWAY SERVICE.

<i>Administrative and executive positions.</i>			
Chief engineer	\$8,000	\$15,000	
Engineer of construction	6,000	10,000	
Engineer of maintenance	6,000	10,000	
Engineer of bridges	5,000	8,000	
Office engineer	5,000	8,000	
Engineer of tests	4,000	7,000	
District engineer	5,000	8,000	

Senior engineering positions involving some administrative duties in the higher grades

Advisory and consulting engineer to the chief engineer	\$5,000	\$10,000	
First assistant engineer	3,600	5,000	
First assistant bridge engineer	3,600	5,000	
Assistant construction engineer	2,400	4,000	
Assistant maintenance engineer	2,400	4,000	
Assistant bridge engineer	2,400	4,000	
Assistant office engineer	2,400	4,000	
Chief chemist	3,500	5,000	
Assistant division engineer	2,400	4,000	
Assistant testing engineer	2,400	4,000	
Assistant chemists	2,000	4,000	
Chief draftsmen	2,400	4,000	
Chiefs of survey parties	2,400	4,000	

Inspection service.

Confidential inspectors	\$4,000	\$5,000	
General inspectors of maintenance	2,400	4,000	
Inspectors of bridge construction	2,400	4,000	
Field inspector of materials	2,400	4,000	
Inspectors of construction	2,400	3,000	
Inspectors not employed in working season, per month	250	300	

Junior engineering positions concerned with routine work only.

Engineering, draftsman, computers, checkers	\$1,800	\$2,400	
Computers, checkers	1,800	2,400	
Engineer draftsmen	1,800	2,400	
Instrument men	1,800	2,400	
Instrument men employed, per month	200	250	
Rodmen, chainmen, and tracers	1,200	1,500	
Laboratory assistants	1,800	2,400	

THANKS TO MR. A. N. JOHNSON.

Resolved, That the thanks of the American Association of State Highway Officials be extended to Mr. A. N. Johnson, of Chicago, for the presentation of his paper on "A Proposed Scale of Salaries for All Classes of Highway Engineers in Public Service."

IN RE CONFERENCE WITH ASSOCIATED GENERAL CONTRACTORS.

Be it resolved, By the American Association of State Highway Officials, in convention assembled at Louisville, Kentucky, December 11, 1919, that its executive committee appoint a subcommittee to confer with a committee appointed by the associated general contractors to discuss matters of mutual interest and importance, and that the report of the conference be sent to the various State highway departments.

IN RE INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES.

Resolved, That the American Association of State Highway Officials, in convention assembled at Louisville, Kentucky, December 11, 1919, through its executive committee, urge on the Congress, the importance of taking the necessary steps for the United States to become a Government member of the International Association of Road Congresses, and that appropriation be made therefore,

Resolved further, That his action be taken at once in order that necessary arrangements may be made for holding the next meeting of the international congress (May, 1921) in this country.

THANKS TO THE HOTEL SEELBACH.

Be it resolved, That the American Association of State Highway Officials, express to the management of the Hotel Seelbach its appreciation of the many courtesies extended to both the association and the individual members during the convention assembled at Louisville, Kentucky, December 8th to 11th, 1919, and,

Be it further resolved, That the secretary of the association be requested to mail to the Hotel Seelbach a copy of this resolution.

THANKS TO LOUISVILLE CONVENTION AND PUBLICITY LEAGUE.

Resolved, That the secretary be instructed to extend to the Louisville Convention and Publicity League and its managing director, Mr. T. R. Maas, the thanks of the Association of State Highway Officials for the hospitality and pleasant features which they have provided during our meeting in their city.

AMENDMENT TO ABOLISH HONORARY MEMBERSHIP.

Whereas, The American Association of State Highway Officials was organized for the purpose of providing mutual cooperation and assistance to the State highway departments of the several States and Federal Government, as well as for the discussion of legislative, economic, and technical subjects pertaining to the administration of such departments; and,

Whereas, Many of the subjects to be discussed are of more or less confidential or personal nature and relate only to the affairs of one or more of the departments forming the association:

Therefore, be it resolved, By the American Association of State Highway Officials in convention assembled at Louisville, Kentucky, December 11, 1919, that the constitution and by-laws be so amended that honorary membership in the association be abolished and the meetings of the association be open only to such persons as are eligible for full membership, provided, however, that the program committee appointed to prepare the program for any meeting may, with the approval of the president, extend to persons not eligible for membership, special invitation to attend such meeting and address the association on some specific subject, or such persons as may be invited by the executive committee or association in session.

KAHN BILL, DISTRIBUTION OF WAR SUPPLIES.

Whereas, The War Department has an abundance of surplus war materials, equipment, and supplies, including motor vehicles, suitable for use in highway construction, and

Whereas, The Secretary of War has authority under the provisions of section 7 of the Post-Office appropriation act to transfer such surplus war material, equipment, and supplies to the Department of Agriculture for distribution to the highway departments of the various States, and,

Whereas, The Secretary of War is disposing of and offering for disposition said war materials, equipment, and supplies instead of making the transfer to the Department of Agriculture as authorized and contemplated by law, and,

Whereas, Economic returns to the people would be greater if the surplus material were used in highway construction than if sold at private sales,

Be it resolved, That it is the sense of the American Association of State Highway Officials in convention assembled at Louisville, Ky., on December 11, 1919, that H. B. 9412, generally referred to as the Kahn bill, including the amendments recommended in a letter written by Mr. Thomas H. McDonald, Chief of the Bureau of Public Roads, dated September 20, 1919, and which appears as a part of the record of the hearing on the Kahn bill before the House Military Affairs Committee, be immediately enacted into law and made effective, and,

Be it further resolved, That copies of this resolution be transmitted immediately to the House of Representatives of the United States.

KAHN BILL.

Be it resolved, That it is the sense of the American Association of State Highway Officials in convention assembled at Louisville, Ky., December 11, 1919, that the State highway department of each State be requested to call upon influential citizens of their respective States to urge upon their congressional delegation the immediate passage of H. R. 9412 and the amendments recommended by Mr. Thomas H. McDonald, Chief of Bureau of Public Roads, in a letter dated September 20, 1919, and addressed to the Secretary of the War Department.

ADVOCATING TOPOGRAPHIC MAPS.

Whereas, The vast program of highway construction now undertaken by the Federal and State Governments has great need of adequate topographic maps such as the Federal Government is now making, and,

Whereas, These maps are now completed for only a small part of the area of the country, and,

Whereas, The saving in the expenditure of the highway funds, intrusted to our supervision, if these maps are made available for our use will be much greater than the cost of making these topographic maps, and,

Whereas, At a conference recently held in Washington between the various Federal and State agencies interested, a plan was developed whereby the whole country could be completely mapped by 1932 by proper cooperation between the State and the Federal Governments,

Be it resolved, By the Association of State Highway Officials in convention assembled at Louisville, Ky., December 11, 1919, that our executive committee be instructed to bring this matter to the attention of the President and Congress of the United States and the governors and legislative bodies of our respective States, and urge upon them as a measure of economy that the Federal

Government provide adequately for completing the topographic map of the United States by 1932, by appropriating the necessary sums to the Coast and Geodetic Survey and the Geological Survey; and that the State governments likewise be urged for the same reasons to provide for paying their share of the cost; and be it further

Resolved, That the executive committee be instructed to appoint a special committee whose duty it shall be to carry forward the work.

OPEN-TOP CARS.

Whereas, The Federal Congress and the legislative bodies of the several States have made available for highway construction during the years 1920 and 1921, funds generally exceeding appropriations made for previous years; and,

Whereas, If these increased appropriations are to be efficiently and economically expended, adequate transportation facilities must be provided for the delivery of road-building materials; and,

Whereas, During the past working season the supply of open-top cars available for the hauling of road aggregates was far short of the requirements for the carrying out of the road program of 1919 and if the number of open-top cars is not materially increased there will be a still greater shortage which will prevent the carrying out of the proposed program for the coming year; Therefore

Be it resolved, That the American Association of State Highway Officials in convention assembled at Louisville, Ky., December 11, 1919, hereby directs its executive committee to use every means possible to impress upon Congress the necessity for making provision for an adequate number of open-top cars to be added to the equipment of the several railroad lines before the beginning of the next construction season.

PUBLIC LANDS AND APPROPRIATION.

Whereas the States within whose boundaries are included large National Forest reserves have expended, during the last five years, millions of dollars in the improvement of State and county highway systems and;

Whereas the majority of these States have issued bonds in large amounts in order to finance modern highway construction; and

Whereas there are within the boundaries of these States approximately 150,000,000 acres of National Forest reserves; and

Whereas State and county highways of national importance traverse these reserves through areas involving the most difficult construction in the West; and

Whereas the forests are a great national asset which should be preserved, and the construction of roads traversing them facilitates the control of forest fires which have in the past caused tremendous losses; and

Whereas the amount involved in road construction would represent but a small percentage of the value of the timber resources which could be preserved from destruction by fire, and the value of such national timber resources would be greatly increased by reason of the construction of an adequate highway system through and adjacent to the National Forests; and

Whereas appropriations heretofore made by Congress have been inadequate to permit of sufficient road construction, within the National Forests, to keep pace with State and county highway systems or to provide for a standard of construction equal to that of the several States and counties; and

Whereas the withdrawal of large areas has decreased the taxable resources of such States and counties, and has also operated to reduce their bonding capacity; and

Whereas it is the duty of the National Government to provide sufficient funds to develop its national resources according to the same rate and standards as that of the States and counties concerned. Now, therefore, be it

Resolved, That the American Association of State Highway Officials, in convention assembled at Louisville, Ky., on December 11, 1919, urge upon Congress the necessity of appropriating at least \$10,000,000 per year for the next 10 years, at least 75 per cent of which would be for expenditure in the construction of primary State and county highway systems within and adjacent to the National Forests.

Whereas most of the conditions hereinbefore stated apply also to Indian and other Federal reservations and to reserve and unappropriated lands of the United States. Now, therefore, be it

Resolved, That the American Association of State Highway Officials in convention assembled at Louisville, Ky., on December 11, 1919, urge upon Congress the necessity of appropriation of at least \$2,500,000 for the fiscal year ending June 30, 1921, and thereafter \$5,000,000 per year for the next nine years, for the purpose of constructing highways in said areas.

Further resolved, That copies of this resolution be transmitted to the House of Representatives and United States Senate, and that the highway department of each State be requested to urge

upon its congressional delegations the passage of suitable bills making such appropriations available.

FEDERAL AID APPROPRIATIONS.

Whereas there have been introduced in Congress various bills contemplating or affecting Federal participation in highway work, which bills represent a wide divergence of policies; and

Whereas we believe that it is necessary that Congress should take action on this matter during the present session in order to enable the States to more completely outline their program of highway building; now, therefore,

Be it resolved, by the Association of State Highway Officials in convention assembled at Louisville, Ky., on December 11, 1919:

1. That we urge the continuance of Federal operation with the States in the building of roads under the terms of existing law and under the direction of present agencies. To this end we recommend and urge that Congress appropriate the following sums:

The sum of \$100,000,000 for the fiscal year ending June 30, 1921.
The sum of \$100,000,000 for the fiscal year ending June 30, 1922.
The sum of \$100,000,000 for the fiscal year ending June 30, 1923.
The sum of \$100,000,000 for the fiscal year ending June 30, 1924.

2. That all of said appropriation allotted to the several States shall be available for said States until one year after the expiration of the last appropriation.

3. That we favor an adequate national highway system upon which the Federal aid funds will be concentrated. This system shall be selected by the various States in cooperation with the Bureau of Public Roads, and connected at the State lines by the Federal department in cases where connections are not made by the adjoining States.

4. Realizing that the improvement of a system of national highways will be brought about in much shorter time through the cooperation of the Federal Government and the States under the plan proposed by this resolution, we favor the passage at this time of only such appropriations as will insure the continuation of the Federal aid as provided for in this resolution.

5. That a copy of this statement be sent to each Member of Congress.

ASSOCIATION OFFICERS FOR 1920.

The American Association of State Highway Officials at the Louisville meeting elected the following officers:

President, Paul D. Sargent, chief engineer, Maine State highway commission;

Vice president, W. S. Keller, State highway engineer, Alabama;

Secretary, Joseph Hyde Pratt, State highway commission, North Carolina;

Treasurer, J. H. Mullen, deputy State highway commissioner, Minnesota;

Executive committee:

Thos. H. MacDonald, chief, Bureau of Public Roads, 1924;

Geo. E. Johnson, State engineer, Nebraska, 1924;

A. B. Fletcher, State highway engineer, California, 1924;

S. E. Bradt, superintendent of highways, Illinois, 1922;

E. R. Neel, State highway engineer, Georgia, 1921.

Members of the executive committee whose terms hold over are Geo. P. Coleman, chairman, State highway commissioner, Virginia; W. G. Thompson, State highway engineer, New Jersey, 1923; Ira R. Browning, State road engineer, Utah, 1923; W. D. Uhler, chief engineer, State highway department, Pennsylvania, 1921; W. F. Coker, assistant State highway commissioner, Virginia, 1921; C. J. Bennett, State highway commissioner, Connecticut, 1921.

The American Highway Problem.

A. R. Hirst, President American Association of State Highway Officials.

WE commence to-day, in this our annual meeting, what I sincerely feel is the most momentous highway gathering ever held in America. For the past few years the overwhelming shadow of the World war has hung over all our deliberations. Everything else was so secondary to the issues fought for and won in that great struggle that even those of us who most implicitly believed in the importance of highway work in America felt that highways and work upon them should be subordinated to the other and greater world purposes.

We did, however, fight and fight successfully in order that the great highway movement be not utterly crushed in the midst of the manifold demands of war, because we felt that by keeping together the nucleus of a highway organization, despite many short-sighted attacks, we were doing the American people a real service. It was not pleasant work, nor profitable, to those of us who were in the midst of the storm. But it was worth while, and the fight was won, even though for a time the production of ukuleles was ruled by the powers that be as more important than the production of highways.

THE NEW ERA.

But now all is changed. The American people, almost as one man, are demanding, and that instantly, a modern and comprehensive system of highways and are willing to pay the price. They have at last realized that the price of building highways which will serve the needs of the present and of the logically-to-be-expected traffic is far less than the price they must pay if the present embargo of mud continues. Never, I believe, since the days of early railroad development have the American people been so determined to change instantly their means of transport and not even then were they so willing to pay the cost, provided they could get the results.

What are the results they are now demanding and what are some of the problems that grow from these demands?

They are expecting the States which had no highway organizations three or even two years ago, which had done no preliminary work and in some of which hardly a mile of modern rural highway had ever been built, to create an organization full sprung from the earth (like our imaginary defensive and aggressive army was to spring) and to build instantly hundreds of miles of modern roads costing millions upon millions of dollars. In the older States in the highway game, better prepared with organizations and contractors, and with some knowledge of materials and

construction conditions, they are asking us to double, triple, or quadruple our annual output of roads. It is probably fair to estimate that the expenditure for modern highways in rural America in 1919 was about \$200,000,000, and that the sum desired to be expended for them in 1920 exceeds \$600,000,000. In other words, the people of America desire to approximately triple their highway expenditures and to do it in one year.

We are wont to think of the era of railroad building in America as presenting the greatest of engineering problems and that its solution was an astounding exhibition of the capacity of American engineering genius. However, the problem confronting American highway engineers to-day far exceeds the old one in magnitude. In the record five years of railroad development (1879 to 1883, inclusive) there were built 40,000 miles of railroad costing, as nearly as I can ascertain, about \$20,000 a mile on the average, or \$800,000,000 in all. In the five years from 1920 to 1925, inclusive, the American highway engineer will be expected to build probably 100,000 miles of highway costing not less than \$3,000,000,000. Even allowing for the depreciated dollar, the yardage of earth to be moved, the amount of materials to be furnished and transported, and the labor required is probably at least double that required in the former enterprise.

It may be of interest to list some of the tremendous problems facing the executives of State highway departments in this work of speeding up the national highway program to meet the American demand.

THE PROBLEM OF TRAINED ENGINEERING HELP.

This is a problem largely for American educators, but with the present shortage and the very restricted output of young engineers, due to the war, it is an acute one demanding immediate attention. I might add that, in my opinion, a four-year course is longer than is necessary for the preparation of much of the help that is needed, and a solution should be sought along the lines of the winter short courses of our agricultural colleges. We must have hundreds, yes thousands, of trained men at the earliest possible date and four or five years hence will not do.

MATERIALS OF CONSTRUCTION.

Nothing is more certain than that there will be an acute shortage of materials in 1920 and thereafter, unless there is substituted in place of the present hit and miss methods an intensive study of all available road materials in every State, and unless the most strenuous methods are used to develop every available source of supply. The extensive production

and delivery of road materials during the winter season is going to be necessary, especially in the northern States with short construction seasons. Every State must establish a road materials department, the sole function of which will be to locate, test, develop, and arrange for the proper delivery of all available materials. Already there are rumors of combinations of material men to purchase and control all sources of highway materials. It is up to the States to protect their people by getting sufficient material sources in State and county hands before it is too late.

THE PROBLEM OF CEMENT.

It seems obvious that much, if not all of the so-called permanent surfacing will be either cement concrete or other surfacings on a cement concrete base, and that practically all drainage structures will be built of concrete. Unless there can be had the most absolute and fair Federal control of the price of cement the bidding between municipalities and States and between contractors for cement is apt to drive the price up to the point of impossibility. In lack of Federal control, the erection or purchase by the States of cement mills or State control of the output of certain mills would seem to be only a rudimentary conception of the duty of protecting the public against unduly inflated prices. The present unfair arrangement between manufacturers and dealers whereby dealers who never see or handle the cement must be paid hundreds of dollars for every mile of road built of concrete or with a concrete base must also be controlled effectively. States which buy millions of barrels of cement annually and pay always (no bad accounts) must get at least the dealer's price.

PROBLEM OF CAR SERVICE.

Car service has been execrable on practically every railroad. We have been handicapped day after day and month after month by the neglect of the present railroad officials to recognize the fact that highway building is a great American industry. If construction is to be carried on with materials delivered by rail, better car service and, in the Northern States, a longer season for shipments is necessary. Possibly the time will soon return when freight revenues will mean something to American railroads and when it will not be an insult to a railroad man to offer his company freight business. I sincerely hope so. Until then we ought not depend on materials involving a railroad haul except where no other source of supply is humanly possible. If the railroads are allowed to come out of their present state of coma and will give us the proper type of cars, enough of them, and reasonable service at fair prices in the installation of unloading sidings conveniently near

the work, their revenues can be very materially increased, our costs decreased, and our work speeded up.

CONSTRUCTION ORGANIZATIONS AND PRICES.

The contracting problem we always have with us. We need every competent highway builder available and we need to immediately multiply his number two to five times in the various States. We must encourage those good contractors who are now available and develop many new ones. To do this good prices will have to be paid and fair treatment given. On the other hand, we must not hand over our clients' pocketbooks to the contractors with the injunction "take what you think is right, but please return us the cover." Unless some restraint is exercised, with the amount of work there is to be done and with the universal feeling existing that "my road must be built no matter what it costs," prices will be driven up and up without regard to proper cost, values, or profits.

In this connection it is my belief that each State should immediately develop a moderately large construction organization fully equipped to do a portion of all classes of its work. Then in case prices on certain work are extortionate, the work may be done by force account. This plan has the advantage of developing and training the nucleus of a larger day-labor organization, if one should later prove necessary. It also gives at all times a true index of the cost of various kinds of work on the basis of actual and recent State experience.

Every State has availed itself, I believe, of the offer of war equipment from the Federal Government. Large supplies of many things useful in highway work, especially motor trucks, have been or will be received. The organization of a proper department to receive, fit for use, and handle this equipment is no mean problem. The States should carefully consider whether this equipment should not be made the basis of building up a permanent thoroughly well-equipped day-labor organization as a means of protecting itself now and in the years to come.

I also believe it necessary for adjoining States to cooperate with a view of keeping prices for work fair and uniform under the same conditions. If adjoining States are going to bid against each other the cost of work in all of them will be sent up to the prohibitive point without any ultimate advantage to any State. It should be possible for the States to get together on this matter. Costs are quite figurable for each job and with a uniform system of allowances for the use of machinery, profits, and contingencies it should be possible to put work in all States on an approximately equal basis of

attractiveness. These allowances must be generous, because we must attract the best contractors, but they need not, and should not, be wasteful. This problem is the most acute of all our problems and should be given immediate and serious attention by every State. I can think of no way in which more millions can be unnecessarily spent in the next few years than by allowing unbridled and useless competition for contractors and materials to prevail between municipalities.

THE PROBLEM OF LABOR.

We speak blithely of millions of dollars for the construction of thousands of miles of road. This program means men, far more men than have ever been employed in this work before. But men are scarce, and other productive labor must not be raided. Our farms, our mines, our factories, and our mills must be allowed to produce largely and at a reasonable cost. We should not pay our labor, or allow such prices to contractors as will enable them to pay their labor, a sum per day greatly in excess of the going wage for like work in that vicinity. Whether we pay high prices for labor or whether the contractor does, it is our responsibility, because the prices we pay for work determines the prices which can be paid for labor. In other words, we must not bull the labor market to the disadvantage of other production. This is public work, its continuance depends upon the support of the whole public, and we must be careful not to alienate this support by forcing our work at undue prices, thus upsetting local labor situations. This policy is not only right from the standpoint of expediency, but is also economically sound.

IMPROVED LOCATION AND ALIGNMENT.

We have, in the past, been too prone to build along the old established lines of highways. This has been the easy course and it has been taken. But the new traffic conditions are so different and so intense that in considering the construction of a main trunk highway all of the old governing considerations, such as saving the buying of new lands for right of way, utilizing old cuts and fills, saving an existing bridge or a few good culverts no longer bind us to the old locations. We must connect the centers of population because they are the points from which things and persons come and to which they wish to go. In building a modern highway between these fixed points we can feel free to exercise our untrammled judgment and build where the road will ultimately cost the public the least. Shortness of distance, freedom from dangerous curves and from railroad grade crossings, and reasonable grades are now the principal ends to be sought and practically nothing else counts.

Cost of construction has become secondary. If the very conservative sum of 10 cents per mile is allowed for each mile of travel saved, the saving of a mile in distance on highways carrying the following average number of vehicles per day will save the traveling public the given amount per year, which is the interest at 5 per cent on the amount given in the third column.

VALUE OF A MILE IN HIGHWAY DISTANCE SAVED.

Average number of vehicles per day.	Saving to owners per year.	Saving capitalized at 5 per cent.
100.....	\$3, 650	\$73, 000
250.....	9, 125	182, 500
500.....	18, 250	365, 000
750.....	27, 375	547, 500
1,000.....	36, 500	730, 000
2,000.....	73, 000	1, 460, 000
5,000.....	182, 500	3, 650, 000
10,000.....	365, 000	7, 300, 000

I believe that these figures are unassailable and that they demonstrate that when building our main highways for all years to come, saving in distance in the layouts is the supreme consideration and should be given much more attention.

SOME OTHER IMPORTANT PROBLEMS.

Many other important problems could be named and briefly commented on but this paper will be too long if continued along these lines. I can not, however, resist naming without comment some of the other things with which an efficient State highway department must also concern itself.

A proper system of records of the cost of all construction and of accounting for all funds available.

Proper publicity of plans and results, not only in the local press, but in the national press.

Proper care of traffic during reconstruction.

Proper touring maps for the information of the people of the State and of other States.

Proper marking of the main traveled roads, keyed to the State maps.

Proper accommodations for the traveling public in the way of garages, hotels, public parking places, and comfort stations.

Complete knowledge and study of, and, if necessary, the design of labor and time saving devices and equipment.

A study of plant layouts and equipment for various types of construction under varying conditions.

A study of the grade crossing situation and a strong campaign for improved conditions.

The holding of road schools and short courses for the instruction and inspiration of all classes engaged in supervising and constructing highways.

Helping to formulate and pass adequate highway legislation so that the State may keep pace with other States.

THE COMING BATTLE.

It may readily be seen from this hasty survey of some of the attendant problems that these changed highway conditions and this spirit of getting hitherto unheard-of results have, instead of making our task easier, but served to tremendously increase our problems and responsibilities. We are on the threshold of a new epoch in highway construction in America, but instead of congratulating ourselves to-day that the long fight for highways is won, we should rather gird our loins for the impending battle. Added responsibilities bring added fears to the executive who thinks and spur him on to new efforts and new devices for developing himself and his organization to meet the new conditions.

The coming battle is all the more serious because from time immemorial the American people, while always willing to pay the price for the work they desire, have never been willing to pay the price of the proper supervision of it. "Millions for public works, but a pittance for those who must design and supervise the building of them" seems to be the American spirit. Our National and State legislative halls are filled with men who appropriate millions and tens of millions with very little thought of the organizations necessary to properly expend them, and with much less desire to provide proper supervision than to further the prestige of themselves or of their political party.

FEDERAL POLICY.

As a case in point: It was with the greatest difficulty that the present Congress could be induced to fix the salary of the very competent present head of the Federal Bureau of Roads at \$6,000 a year, although this bureau will in the years 1919 to 1922, inclusive, supervise from the Federal standpoint and protect the Federal interest in the expenditure of probably two hundred millions of Federal money and with it the expenditure of three hundred millions more from the States and local units. The National Congress is probably the most niggardly employer in America, unless some of the States bear off the unenviable palm. It seems hopeless to expect a continuously efficient organization in any Federal bureau unless Congress shall see a new light and fix public salaries to fit the imposed responsibilities.

It is interesting, although disconcerting, to note the almost total lack of interest on the part of road-promoting organizations in the fundamental problem of getting proper administrative bodies to control the highway programs. We have good-roads associations, trail associations, highway councils, etc., ad infinitum, all seeking to promote the construction of roads in detail or in mass, and urging the Nation, the States, and the counties to spend millions or

billions on highways of all kinds, classes, sorts, and conditions.

The sole idea seems to be to get money and more money to build highways. It does not appear to matter to them what kind of highways, who builds them, or whether the people get a dollar's worth or a dime's worth for a dollar. Men are in these associations who make millions every year, who control organizations which are solely designed to get efficient dollar-for-dollar results, and who pay their executives what they are worth. Yet when they get into the field of public service they seemingly forget all the rules which made their own business a success, and expect a thousand-dollar man to be the eighth wonder of the world and world-beating organizations to grow overnight with no possible financial encouragement. Unless business men of this class wake up and devote more thought to the basic problem of getting efficient organizations to spend the money, I fear a real disaster to our highway programs.

POLITICS AND SALARIES.

All of us have probably in the past derided the possibility of getting effective results out of town and county highway efforts because (we said) politics had too great a part in road work in those units and that they would never pay the salaries necessary to get competent planning and supervision of the work. And yet in 34 of the 48 States which now have State highway departments, the Governor may change the personnel of the State highway department so as to control it during his term of office. In many of these States the highway law is deliberately so framed that a new governor may make a clean sweep of the State highway department the minute he assumes office, if he so desires. In most cases he seems to have desired it. There have been at least 127 different executive highway officials in these 34 politically organized State highway departments in the grand total of 296 years of their existence, or a change every $2\frac{1}{3}$ years (on an average) in each State. The oldest executive officer in charge of highway work in any American State has served his State 9 years in that capacity.

A State highway department is not right or it is not wrong just because it has a Republican or a Democrat at its head, or because one brand of Republican or Democrat is in control when another brand of the same political party comes into power. A State highway department is right when it is well organized to get efficient and economical results and is wrong when it is organized or unorganized to produce inefficient and uneconomical results.

Let us consider the salaries paid the executive officers of the State highway departments. There is

one who is paid \$20,000 per annum; two, \$10,000; one, \$8,000; two, \$7,000; two, \$6,000; and eight, \$5,000, while 32 of them are paid less than \$5,000 and 20 of them receive \$3,600 or less. In this connection it should be remembered that the highway work expected to be supervised by a State highway department is now in few cases less than \$3,000,000 a year and in many States it has reached, or will soon reach, as much as \$15,000,000, \$20,000,000, or \$25,000,000. What business organization in the world would pay on a similar scale for similar responsibilities or would expect to receive adequate results under such conditions?

I speak of these matters not in a spirit of fault finding, but in order to interest you in the great problem of building up public opinion to the point where, for its own protection, it will insist upon the proper organization of every agency which deals with the expenditure of these great aggregations of highway funds.

CLEAN-CUT EFFICIENCY.

We must, by every means in our power, by precept and example, preach the doctrine of clean-cut business efficiency in American highway administration. In doing so we will go up against the age-long prejudice of the American people against paying their public servants a living or a proper wage. From top to bottom the scale of public salaries is wrong. The constitutional and other officers of the Nation, of the States, of the counties, and of all other municipalities are, practically without exception, being paid not on the basis of what their services are or should be worth, but on a basis fixed (in most cases long years ago) with due regard to the "honor" which must accrue to the holder of a public office.

There is or should be an honor in being selected for public service—and worthy public servants appreciate and feel that honor. It may be, although I doubt it, worth while for the American people to consistently penalize those who work for them by paying them less than a living wage or less than the work would command if done for a corporation, or if done for the individual citizen in his private capacity. But the trouble with the system is that when the American people have before them a piece of really constructive work, like their present highway program, the policy falls down absolutely.

We must help the American people by making them realize that with hundreds of millions, even billions, to be expended in the next few years the building of highways is a profession and a business and not a political football to be kicked around like the proverbial pup. This is not selfishness. Most of us are in this highway business because we love

the work and because we want to help build up the States and the Nation. I doubt if there is one man here who has made good or who is capable of making good who can not leave his present State position and make more money working for himself or in employment in commercial lines. But the work must go on well and we must feel an interest above a mere financial interest in the jobs we hold, if we are worthy of them. * * *

I trust that nothing I have said in regard to State highway organizations will be wrongly construed. The present organizations, with very few exceptions, are, and have been doing effective work with limited opportunities. Where there is trouble it is in most cases due principally to the political obsession of our American Commonwealths. * * *

In fairness to my home State, Wisconsin, it should be stated that we have a nonpolitical highway commission, the operations of which have been entirely free from political interference by the governor or anyone else. I state this because there may be some idea that my remarks originate from dissatisfaction with conditions in my own State, which is not the case. Conditions, laws, and public sentiment there are good and improving fast. * * *

The professions of highway engineering and of highway building must be dignified so that they attract the best engineers and the best construction men in America. This is important, not only for the immediate future, but especially so for the years to come. Not only must we strive to attract and keep the best we have but we must get the coming men. We need all the brains and all the talent we can muster. To attract the best young men good working conditions, a clean atmosphere in public service, adequate compensation, and a reasonable chance of advancement must be offered. Less than this will not serve.

Let us dedicate ourselves to this work of helping to make all highway organizations efficient instruments, able and competent to carry out the American purpose of building a highway system befitting the greatness of the American nation. Than this, we can do the American people no greater service

INTEREST OF BONDS TOO LOW.

California is finding it difficult to dispose of highway bonds on account of the low rate of interest, $4\frac{1}{2}$ per cent, fixed by legislative enactment. In November the State offered the last \$3,000,000 of the second \$15,000,000 issue authorized some time ago, but there was not a single bid. The first sale under the \$40,000,000 issue voted last year is scheduled for an early date, but officials think the sale extremely doubtful.

Survey of Southern States Highway Situation.

W. S. Keller, State Highway Engineer of Alabama.

JUST what States should be included in this report is doubtful. I have not attempted to communicate with all really Southern States, concluding that several such States are included in the territory assigned to others. Questionnaires were mailed to North Carolina, South Carolina, Tennessee, Arkansas, Louisiana, Mississippi, Florida, Georgia, and Alabama. Replies were received from all of the States with the exception of North Carolina and Louisiana, and on the basis of these replies, I am able to give you the following information.

CONSTRUCTION AND EXPENDITURE, 1919.

Arkansas.—This mileage and cost can not be divided upon a yearly basis.

Georgia.—Two hundred miles constructed with an expenditure of \$2,500,000.

South Carolina.—Ninety miles, with two bridges completed and five other bridges under construction. Total estimated cost for work done this year, about \$1,100,000.

Tennessee.—Federal aid, 67.8 miles, cost, \$854,837; State aid, 38.66 miles, cost, \$209,153.30; total, 106.46 miles, cost \$1,063,990.30.

Alabama.—One hundred miles, \$600,000.

As a large number of contracts extend from one year into the next and are in various stages of construction it is manifestly impossible for a State to give accurate approximation of miles of road constructed and expenditures for the year.

PRICES AND SUPPLIES OF LABOR AND MATERIALS, 1919.

Arkansas.—Prices very high for both labor and materials; freight rates high. Labor scarce and inefficient.

Georgia.—Convict labor scarce. Free labor plentiful at \$3.50 per day. Materials plentiful at source of supply but scarce and expensive because of lack of transportation and high freight rates.

South Carolina.—Prices about two and one-quarter times those of 1916.

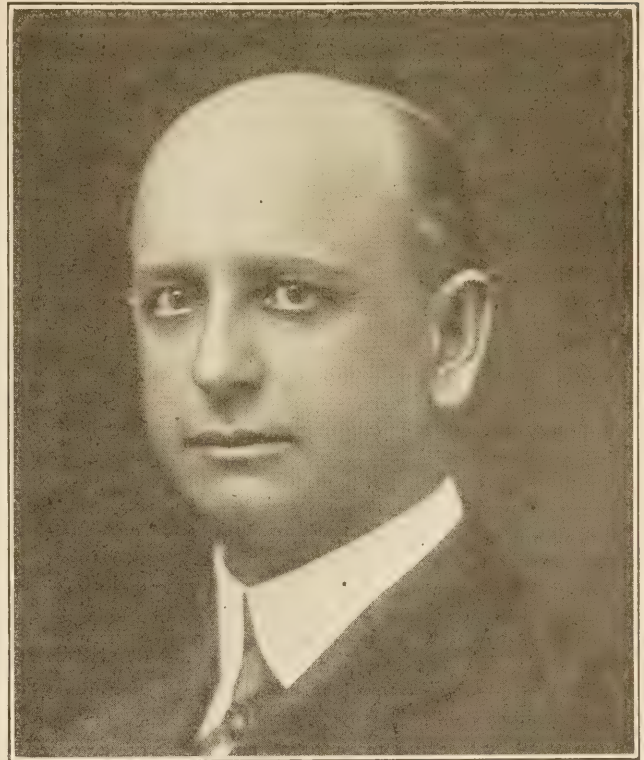
Tennessee.—Materials satisfactory. Labor and transportation the problems.

Alabama.—Prices very high with labor hard to get and very unsatisfactory.

NEW OR PROPOSED STATE LEGISLATION.

Arkansas.—The 1919 legislature in regular and special session created special road improvement districts to build more than 6,000 miles of good roads.

Georgia.—An act of the Georgia Legislature, approved August 18, 1919, reorganizing the State highway department; and an act approved August 16,



W. S. KELLER

1919, amending "Georgia motor vehicle law," which will provide approximately \$2,000,000 per annum for highway construction and to liquidate the bonded indebtedness which, by vote of the people of Georgia, may be created to build and maintain roads of this State.

South Carolina.—Proposed doubling of auto tax which will raise about \$1,250,000 and a 2-mill tax which would raise about \$750,000.

Tennessee.—None.

Alabama.—A new State highway law was passed by the legislature in September enlarging the power and authority of the State highway commission and increasing the State appropriation. There was also passed a bill authorizing a vote of the people, election to be held next February, to amend the State constitution so that \$25,000,000 in State road bonds may be issued. If passed favorably the law becomes self-acting and will be put into effect immediately.

BOND ISSUES PASSED AND PENDING.

Arkansas.—No State or county bonds can be voted in Arkansas.

Georgia.—Counties have voted \$17,000,000 in bonds. An issue of \$40,000,000 in bonds by the State is pending.

South Carolina.—No State bond issues. Previous county and township bond issues total about

\$7,250,000, proposed county bond issues about \$3,000,000.

Tennessee.—County bond issues \$11,832,250.

Alabama.—One county has voted a bond issue of \$150,000, the proceeds to be used in conjunction with State and Federal aid. A constitutional provision prevents any county from having a bonded indebtedness greater than 3½ per cent of its tax valuation. Most of the Alabama counties are up to this small debt limit.

CONSTRUCTION AND EXPENDITURES 1920.

Arkansas.—See answers above.

Georgia.—Proposed mileage of construction in 1920, 400 miles with an approximate expenditure of \$6,000,000.

South Carolina.—Four hundred miles and about \$4,000,000.

Tennessee.—189 miles bituminous road, at \$25,000, \$4,725,000; 427 miles waterbound macadam, at \$16,500, \$7,045,500; total, 616 miles at \$11,770,500. All under survey will be in shape for contract by spring.

Alabama.—If bond issue fails \$1,000,000 will be spent. If bond issue is successful the expenditure will be \$2,000,000. These amounts are exclusive of Federal and county funds.

1920 LABOR AND MATERIALS PRICES AND SUPPLIES.

Arkansas.—In view of large amount of work contemplated, scarcity of contractors and men,

car shortage, lack of local materials, etc., prices will probably remain high.

Georgia.—It is anticipated that convict labor will diminish. Price of free labor and materials will remain the same, but supply will be deficient.

South Carolina.—About the same as 1919. No material change anticipated.

Tennessee.—Situation as to labor and material very discouraging.

Alabama.—No change anticipated.

WHAT THE REPLIES SHOW.

The information gathered from these five States establishes the following facts which can not be disputed:

1. That the South is awake to the necessity for the construction of high-class roads.

2. That despite the enormous increase in the cost of road-building materials and labor, funds are being provided and road construction is decidedly on the increase.

3. That if the enormous amount of work proposed by some of the States for the year 1920 is advertised to the world the psychological effect will greatly increase prices. It would appear that an underestimate of work to be done is decidedly better than an overestimate.

4. That road construction is no longer the sole duty of counties, but with the generous aid of the Government, the States are assuming their share of such duty.

Highway Situation in the Pacific Coast States.

Herbert Nunn, State Highway Engineer of Oregon.

THE Pacific coast is only particularly interested in one National highway; that is the Pacific Coast Highway extending from California to Oregon and Washington. This when completed will have an approximate length of some 1,400 miles, and the large part of it is now completed or nearing completion.

Mr. Fletcher, of California, stated to me this morning his State had completed 525 miles, extending from Los Angeles north to Sacramento, and we are now under contract to complete the road. Oregon now has under contract on this road some 400 miles of construction, all of which will be completed by the middle of next year, 200 miles of which will be paved and the rest macadam or gravel. Washington has completed this road to Seattle, and next year its entire length will be complete.

I am unable to say at this time just how much money was expended during the year 1919 in the three States, but in Oregon approximately \$7,000,000 was expended. The three States, however, are pretty well fixed financially.

California has a new bond issue for \$40,000,000 and previously has expended some \$33,000,000. Oregon has some \$32,000,000 available and roads to cost \$19,000,000 to \$20,000,000 under construction. Washington has less money. They failed to carry the bond issue there this year, but have between \$8,000,000 and \$9,000,000 available for next year.

The eastern connections with the Pacific Highway are the Santa Fe Trail, the Lincoln Highway, and the Midland Road. I think the Santa Fe is pretty well cared for. It connects with Southern California. In Oregon we are connecting with the Southern Highway and with the Columbia River Highway.

Labor conditions on the Pacific coast are about the same as in the East. The pay is about \$4.50 with \$7.50 for teams. We don't expect better labor conditions next year. Material conditions are better. In Oregon we have sufficient local material and don't require much rail transportation. Washington is fixed similarly. So is Northern California. Southern California is in worse condition as to transportation.

New England Road Conditions, 1919 and 1920.

Col. Wm. D. Sohier, formerly 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.

IMPROVED HIGHWAYS.

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 that New Jersey was the only other State to begin a comprehensive State or State-aid system of improved highways 26 or 27 years ago. The results accomplished in New England show clearly the advantages of such a system.

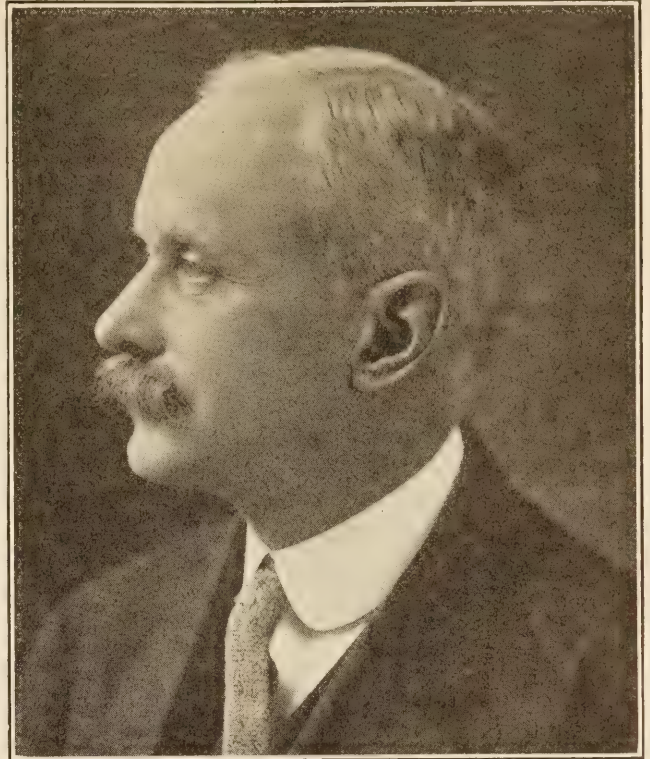
I am using the figures published by the United States Bureau of Public Roads, to January 1, 1917, allowing for recent improvements. Out of about 75,000 miles of improved rural highways in the United States, maintained under the State or State-aid system, 11,589 miles, or 15½ per cent, were in New England.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

MILEAGE OF IMPROVED HIGHWAY.

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.



WILLIAM D. SOHIER

Since those statistics were made in my home State, Massachusetts, the mileage of road improved as State highway or State-aid road has increased from 1,100 miles credited to us by the Government, to over 2,400 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.

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, are very thickly populated, and their roads carry 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 road, 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. The roads have had to be considerably widened; many of them have had to be resurfaced. It has been found everywhere 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 foundation, withstand heavy trucks and truck traffic, especially when the frost is coming out of the ground in the spring.

THE HIGHWAY RECORD OF 1919.

During the year 1919 there were approximately 300 miles of State highway constructed in the New England States, at a cost of about \$2,300,000, and 225 miles of State-aid road constructed at a cost of about \$2,700,000. I could not secure accurate figures for all the States.

There were approximately 15,500 miles of road maintained by the States or under State supervision, either State highways or State-aid roads. I have not the figures for Connecticut, but \$4,300,000 was spent on this maintenance and reconstruction work in the other five States.

I have not the number of men employed in all the States, but there were 515 employed in Maine, and from 300 to 600 a day in Massachusetts not including 400 town employees who actually did maintenance work.

The figures I secured are shown in the following table:

State.	1919			
	Miles maintenance.	Cost of maintenance and reconstruction.	Miles of State highway and State-aid constructed.	Cost.
Maine.....	4,400	\$700,000	145	\$1,500,000
New Hampshire.....	1,425	750,000	120	.....
Vermont.....	1,518	98,670	115	412,000
Massachusetts:				
State Highway and State aid.....	2,286	2,211,000	.....	.....
73 towns.....	4,000	225,000	140	2,400,000
Rhode Island.....	333	1,000,000	.....	.....
Connecticut.....	1,627	.....	.....	.....
Total.....	15,589	4,984,670	520	4,312,000

Maine has voted 5 to 1 in favor of authorizing the State to issue \$8,000,000 in bonds to be used in constructing State highways and State-aid roads, also to meet Federal aid of which she secures \$2,648,000.

AVAILABLE FUNDS AND WORK IN 1920.

I am showing the amounts probably to be available in the various States during 1920 (the amount available in Connecticut is given as for two years, 1920 and 1921, this including Government aid, \$9,640,000 for construction and maintenance; I have divided that amount to get an average for one year):

State.	Miles of State highway construction and reconstruction.	Cost.	Miles maintenance.	Cost.
Maine.....	150	\$4,500,000	4,500	\$800,000
State aid.....	100-125	1,250,000	.....	.....
New Hampshire.....	100	1,250,000	1,500	750,000
Vermont.....	75	1,323,000	1,518	98,670
Massachusetts:				
State highway and Federal aid.....	100-125	3,300,000	2,286	1,200,000
State aid.....	100	1,500,000	.....	.....
Reconstruction.....	60	1,250,000	.....	.....
Poor town roads.....	.....	.....	5,500	450,000
Rhode Island.....	30-40	1,300,000	333	350,000
Connecticut, average 2 years.....	140	3,845,000	1,627	.....
	855-915	19,518,000	17,264	3,648,670

¹ Estimated.

PROGRESS IN MASSACHUSETTS.

In Massachusetts under an act passed two years ago, the highway commission was authorized to aid the poorer towns of under \$3,000,000 valuation, to maintain and improve their rural highways. This work has only commenced.

The State gives to the towns from the motor vehicle fees, \$50 a mile a year, and the town appropriates an average of a 3-mill tax to go with the State's money—all the money to be spent under the supervision of the State engineers. Last year the legislature made available from the motor vehicle fees \$200,000, and the towns had to appropriate about \$100,000 to go with it.

Work was done in 73 towns and 4,000 miles of road were dragged. Next year we have asked for an appropriation of \$300,000, and we think the towns will probably have to put up \$150,000 for the work and that this maintenance work will cover about 5,500 miles of road.

This is the greatest advance in road improvement that we have undertaken in Massachusetts, and it promises most splendid results within a few years when the towns are properly grouped and proper machinery is secured, the plan being that a number of towns may be grouped and use the same machinery, the laborers also working in a number of adjoining towns.

It is expected that within a very few years the State will be helping over 160 towns, containing over

8,000 miles of road, to improve their roads, and maintain them, all the work being done under the supervision of the State, and that at that time the commission will have available at least \$500,000 a year for the work, and the towns in which the work is done will have to make available \$500,000, or about \$1,000,000 in all for this maintenance work.

Certainly at the end of five years, if the present program is carried out, there will be 3,500 miles of State highway and State-aid road on the main routes in the rural districts which will have been constructed in a permanent way and be constantly maintained. There will be 8,000 miles more of dirt and gravel country road, well drained and constantly maintained and many miles of it oiled on the main lines, making about 11,500 miles of road constantly maintained in the country districts, or 67 per cent of the total of 17,000 miles in the whole State of Massachusetts. Of course, you must realize that a good many miles of this 17,000 are merely bypaths and wood roads, although they are called public highways.

CREDIT DUE MAINE FOR IMPROVED ROADS.

I wish at this point to say a word for Maine, because I think Maine and its State highway commissioners have accomplished so much in Maine during the last 6 years, including the terribly difficult period of the war.

Some of the other New England States started sometime ago, and they have been at it ever since. Connecticut and Massachusetts began 27 years ago; Rhode Island had a State highway system constructed and improved at least 5 years ago. New Hampshire and Vermont have been at work for a good many years on their trunk-line systems and State-aid roads.

Maine, however, until 6 years ago, had practically no road system whatever. As you know, during the war, particularly the last year of the war, conditions were extremely difficult. Consider, then, what

Maine has accomplished during these 6 years. She made a new start in 1913 with a State highway commission and State engineer. Since that time she has constructed 391 miles of State highway, 1,393 miles of State-aid road, and several miles under special acts, the total constructed mileage being 7 per cent of the entire mileage of road in the State. She has expended for construction, \$3,231,000 for State highways, and \$3,242,000 for State-aid roads.

And what is more significant than this: Starting only 6 years ago, Maine, with a total mileage of over 25,500 miles of road, has now under maintenance 1,400 miles of State highways and about 3,000 miles of State-aid road.

In 1914 they were maintaining under State supervision 688 miles of road. In 1919 they were maintaining over 4,500 miles under more than 500 patrolmen, and 88 more miles maintained that were not under patrol.

NEW ENGLAND CONSTRUCTION 1920.

During the year 1920 we expect to construct about 900 miles of improved highway in New England at an expenditure of over \$9,500,000. Much more important than this is the fact that we shall have, under State-supervised maintenance, over 42 per cent or more than 17,000 miles of the total of 40,000 miles of improved and surfaced highway in the country districts. We shall have available for this maintenance over \$4,500,000, if I include my estimate of the expenditures in Connecticut.

We are much prouder in New England of what we have accomplished in establishing a patrol system or the constant maintenance of our highways, than we are of all the miles that we have constructed since the beginning.

Construction is easy, involves but few miles, few years, few places in any one year; but maintenance—that is different—is constantly with us year after year, day by day, and every day and every minute of the day.

The Situation in the Middle Atlantic States.

Samuel Knopf, Assistant Engineer, Delaware State Highway Department.

REPORTS from highway departments of the Middle Atlantic States, comprising New York, New Jersey, Pennsylvania, Delaware, and Maryland, indicate a total mileage of highways under construction during the calendar year 1919 of approximately 1,900 miles. The moneys expended to carry on this work amounts to a sum of nearly \$75,000,000. This total is made up of the actual cash expenditures for such items as labor, materials, supervision, and administration directly connected with the construction, improvement, and upkeep of the public roads and bridges outside the limits of

incorporated towns and cities, and does not include any items for the sinking fund payments or the redemption and interest on road and bridge bonds.

Of all kinds of construction undertaken in these States during the year, either public or semipublic, no work resumed operations so quickly or on so large a scale as the highway work.

THE STIMULUS TO ROAD BUILDING.

This new impetus of road building, attributed to the tremendous development and increase of the heavy motor truck to a great degree, is a by-product

of the war. During the war the almost complete paralysis of railroad facilities by war-time transportation stimulated the use of motor trucks on public highways. Particularly has this been true in the Middle Atlantic States, where the production of war materials was largely centered, and through which passed nearly all troops, materials, and equipment for war purposes. In this district their increase, due to their successful operation in spite of the bad roads and weather conditions, has been little short of phenomenal, and they are to be found wherever traffic conditions permit their profitable use.

Very few of our present roads were designed to carry this class of traffic. In many places, the damage due to the incessant pounding of these fast and heavy vehicles was so great that the cost of adequate maintenance overbalanced the bond charges required for complete reconstruction. New and unforeseen problems in road building had to be solved.

It is significant that the road building program of 1919 in these States was enlarged and designed primarily to cope with this traffic. The money for the construction program was immediately available, and with few exceptions, work began in full swing. Indications pointed to great records in construction. To date, with the working season over, only approximately 40 per cent of this program is completed. Failure to complete the program has been primarily due to labor conditions, shortage of materials, brought about by lack of equipment available for transportation, and a poor working season due to bad weather.

DELAY FROM LABOR CONDITIONS.

Labor conditions in this district were never more unsatisfactory. It was first thought labor would be plentiful owing to the fact that our soldiers now returning from war would be more than ample to carry on road work. Sympathetic propaganda urging that the soldiers be given first preference was spread broadcast. As the returned soldier did not take kindly to this kind of work, labor obtained to carry on road work in this district was recruited largely from foreigners formerly engaged as munition workers. Accustomed to a higher rate of pay during the war, they became restless when they were obliged to accept wages averaging 45 cents per hour. Their war savings made regular employment unnecessary. During the year in certain districts of Pennsylvania and New Jersey, thousands of this class of labor migrated to Europe. This had quite an effect on the visible amount of common labor available for road work. Contractors and others engaged on road work did not anticipate this instability of labor. In some localities, there was not sufficient labor to carry on road work under construction and the other business of the vicinity. An actual shortage existed. In other localities, labor

was plentiful, but disinclined to work regularly. As the season progressed labor became more unreliable. Some contractors imported labor from cities 75 miles distant. As an instance of this drifting labor: On one job 2½ miles long, requiring an outfit of 50 men, which was completed in about three months, an examination of the payroll showed it to contain at least 500 different names. This labor turnover, besides delaying the progress of the work, influenced bidding prices and quality of workmanship.

THE SHORTAGE OF SUPPLIES.

Relative to supplies of materials, an actual shortage existed. Plants supplying materials were confronted with a large production program, larger than they had anticipated. With no chance to provide additional equipment, with labor uncertain as in other lines, and with present equipment in bad shape due to wear and tear of war work they could not keep up production. Part of the time this was due to lack of transportation facilities, but, generally speaking, to an actual shortage, or the fact that the territory was, so to speak, "over-jobbed."

Equipment for transportation was in bad shape. This directly affected the actual supply of materials. Even now, there is a distinct shortage of cars for the movement of coal, drain and other commodities, which are being given first preference when any emergency arises. This condition became so acute during the last few months of the working season that it almost put a stop to the construction program. Contrary to expectations, material prices did not drop. It was thought that with the war over there would be a gradual decline, but the unusual demand for the limited supply of materials coupled with the high cost of production and the supply of transportation facilities kept prices within narrow limits—actually there was a general increase in prices of all materials.

A poor working season was experienced by all engaged on road work during the past year. Particularly has this been true in this district. The average number of working days fit for laying roadway were as follows: May, 11 days; June, 19 days; July, 19 days; August, 15 days; September, 20 days; October, 11 days; November, 12 days.

Usually the number of working days per month will average 22 days. Although this delayed the progress of the work, it helped the material shortage by making the situation seem better than it was actually.

The lateness and hesitancy of awarding some of the contracts naturally delayed the program. Contractors looking for prospective work marked time, and did not arrange for needed plant. Consequently equipment orders piled up as the season progressed and deliveries came too late for the working season.

That all these factors have had an influence in the bids submitted for road work let out late in the season, is shown by the fact that in some instances these bids received ranged 10 to 15 per cent higher than those submitted earlier, when every indication then pointed to "straight sailing" road building.

During the year legislation affecting highways was passed in several of the States. These laws affected the weights and tonnage carried by motor trucks and the use of traction engines on improved highways. Their use upon improved types of roads have been restricted. Others passed were headlight laws modifications and ones requiring all vehicles to carry lights. New legislation, empowering her highway commissioner to acquire land containing stone for road building purposes, has been passed in Pennsylvania. This stone may be used by the State or furnished and sold to contractors engaged on highway contracts under the State's jurisdiction.

THE YEAR'S GREAT PROGRAM.

The magnitude of the highway program did not become apparent until the early part of 1919, when the State and county governments began to make provisions for road funds to an extent before unknown.

Besides the annual revenue derived by taxation for road purposes, bond issues authorized or pending and other sources of money in the States were as follows:

Pennsylvania:

\$50,000,000 in State bond issues authorized.

\$17,000,000 in county bond issues authorized.

\$8,500,000 in county bond issues proposed.

New Jersey:

\$5,000,000 in State bond issues authorized.

\$1,000,000 in county bond issues authorized.

\$4,500,000 in county bond issues pending.

New York:

\$12,000,000 of the bond issue of 1912 authorized.

County bond issues approximately \$7,500,000 authorized, with a proposed State bond issue to be introduced to the legislature for \$100,000,000.

Delaware:

\$2,000,000 in State bond issues authorized.

\$1,750,000 county bond issues authorized.

\$1,500,000 private fund.

Maryland:

Program was carried on by State appropriations.

No State bonds have been passed or pending.

To these amounts of money must be added the considerable increase of funds available under the Federal aid act and the Post Office appropriations act, which provided an additional appropriation for Federal cooperation in the improvement of rural post and forest roads during 1919, 1920 and 1921.

The money allotted to these five States under these acts amounts to \$32,400,000, of which \$5,500,000 was applied to road building during 1919.

Notwithstanding the fact that this year's road building program has been a disappointment, preparation for road building for 1920 is even larger than that undertaken this year.

The program calls for the construction of about 2,100 miles of hard-surfaced highways, at an expenditure in the neighborhood of \$100,000,000. Just what amount of this will be completed is problematical. Funds will not be the limiting factor. The limiting factors will be the same as those which held back this year's construction, namely, the amount of labor and materials available, including the ability of getting the materials on the ground, and the lack of experienced and fully equipped contractors' organizations.

WHAT THE 1920 PROGRAM MEANS.

The program to be carried out requires the moving of 12,500,000 tons of aggregates, which include the tonnage required to complete the projects carried over from this year's work. To this also must be added the tonnage of aggregates required in the resumption of building operations, railroad improvements, street work, maintenance of roads, etc., which has been seriously curtailed during the war and the year of 1919 waiting for a decrease in prices. Realizing that no decrease in prices is probable, and, because of the urgent demand for these improvements, it is safe to predict that they will be made. It is evident that a material shortage will exist unless some means are taken to improve the situation.

To successfully meet this tremendous demand for materials, transportation facilities must be improved, plant capacities enlarged, and production increased. Each is supplementary to the other. The development of one without the corresponding development of the others would tend to increase rather than to minimize a difficult situation.

The fact that materials producers were unable to secure transportation for their capacity production this year has led them to curtail their output as a means of self-protection. The coal shortage is also at present closing down some plants. As an instance, in the Lehigh Valley districts supplying cement to these States, there is nominally on hand 15,000,000 barrels of cement in stock. Reports indicate that now there are but 2,000,000 barrels on hand. Shortage of coal has closed down several of the plants, and the others are running below capacity. How serious a factor this coal crisis will become is not apparent, but is a general indication that production will be lower and prices higher.

The labor condition existing in this country is at a critical stage. Although labor seems plentiful,

there is nothing in the present situation to indicate that it will be more efficient or more willing to work next year than this year, and, unless there is a full resumption of united effort, there is no chance for a larger production. Until the unorganized common laborer on road work realizes that he is no longer employed on "war work," and that no "war profits" and "war wages" exist in honest road building, he will always remain the same unreliable workman. Not until he has spent his war savings will he become more efficient. Any increase in wages does not seem to remedy the position. During the past year increases to common labor were given to help rush the program, but the general effects with regards to production remained the same. Contractors to cope with this labor are turning favorably to labor-saving devices, and wherever men can be replaced by machines the chances are they will.

COOPERATION TO COPE WITH CRISIS.

Industrial managers and concerns have begun to realize that to cope with this crisis more efficient cooperation between all parties is necessary. It is apparent that there must be the greatest degree of cooperation between the contractors, the highway department officials, material producers, and the railroads, if delivery of materials to carry on this huge construction program is to be possible. Labor for the road work and existing transportation facilities must be employed in the most efficient manner.

To this end the Delaware highway department has issued prospectuses of next year's work. These contracts are to be advertised during the months of December, January, February, March, and April of 1920. It is thought by this early announcement of the construction program that contractors will be given full opportunity to look over the roads, locate sources of materials, investigate terminals, etc. They will then be in a position to assemble plant and materials on the work, make financial and preliminary arrangements in advance of actual operations, and make it more nearly possible to complete a majority of the contracts during one working season.

Several highway departments, to help the material situation, have also carried on extensive material surveys and propaganda campaigns for the establishment of small local material plants, as well as securing available local supplies for contractors with crushing equipment.

Pennsylvania, as noted previously, has empowered her highway commissioner to purchase and acquire lands containing stone suitable for highway purposes; to purchase machinery and equipment to operate such quarries; and to use such stone for their own highways; besides power to sell, furnish, and supply stone to contractors engaged in building or main-

taining roads under the department's jurisdiction. To increase the available supply of stone the States in this district have revised their specifications on stone used in concrete. The ranges now are from five-eighths inch to 2 $\frac{3}{4}$ inches. This will increase the amount available by 20 per cent.

If possible, material estimates should be allowed. To arrange for early and regular deliveries of materials in advance of actual operations is a considerable financial burden to a contractor, unless material estimates are allowed. Delaware's highway department, organized during the war of 1917, found it difficult to secure bids on her road work. With the announcement that substantial materials estimates would be allowed, her entire program was put under construction. Materials estimates are still allowed and during the past season when shipments were "spotty" and irregular, enough materials were on hand to tide them over, causing no delay in the work. The result has been an increase in mileage, made possible by the allowance of these materials estimates.

Contractors can assist by perfecting adequate organizations and employing labor-saving machines to replace some of their labor. Investigation and adoption in every practical instance should be encouraged, and orders placed early enough to insure their delivery for the present working season.

FACTORS IN THE SITUATION.

Producers of materials have organized an association and are making preparations to keep their plants in repair in order to keep up production. Cars will be loaded to their maximum capacity and traced to their destination. Their prompt unloading will be asked for.

But it is obvious that the controlling factor is transportation. To cooperate, the railroads must place in service all existing equipment, and keep it repaired to the fullest extent. If possible, new equipment should be purchased. Plants should be rated in accordance with their capacity and the distribution of cars made on such a basis without discrimination.

It is impossible to predict just what portion of this huge road building program will be built next year and what will be the course of prices. There is just enough uncertainty in labor and transportation, available material supplies, impending railroad strikes, and freight rate increases to make conditions seem actually worse for road building next year than they were this year. Perhaps the plan for efficient cooperation as outlined may be a remedy, but, as long as these disturbances continue, in face of the heavy demands for materials, there will be an underproduction rather than an overproduction. Due to this fact the general consensus of opinion is that

prices will be no lower but rather higher during the coming year.

As to the expected exodus of labor to Europe, the United States Immigration Bureau reports that this is about normal. It is also reported that there will be a return influx of labor during the winter and early spring. This will have a tendency to stabilize labor conditions, and prevent any further increase of wages for common labor during the coming year.

But this is not going to deter or discourage the efforts to complete the program outlined. Since the war the public in this district has sensed seriously the commercial value of improved highways, and has generously backed up the program financially. In spite of the various and intricate difficulties, every effort and means will be exerted by the State highway departments to see it through.

Highway Situation in Central Western States.

F. R. White, Chief Engineer, Iowa State Highway Commission.

THIS summary of the highway situation covers nine States: North Dakota, South Dakota, Nebraska, Kansas, Missouri, Minnesota, Wisconsin, Illinois, and Iowa. The results of the survey have been grouped as nearly as possible under the six headings outlined by the chairman of the program committee, as follows:

APPROXIMATE CONSTRUCTION IN 1919.

Mileage of work contracted or placed under construction: During the past year, the several States of this group placed under contract approximately 7,400 miles of road. On nearly 75 per cent of this mileage, or approximately 5,000 miles, the improvement proposed consisted of constructing the roads to finished grades and providing the necessary drainage, but did not contemplate paving or other form of surfacing. On approximately 1,400 miles the improvement consisted of graveling or other similar form of surfacing. On the remaining portion, or about 1,000 miles, the improvement contemplated the paving of the roads. Illinois leads the list in mileage of pavement placed under contract, with approximately 575 miles. Wisconsin is second. In some of the States very little paving was contracted for.

Approximate cost: The approximate total cost of the work contracted or placed under construction was \$48,000,000.

Work completed: In none of the States was the program of construction outlined for this year completed. The amount of work completed ranges from 20 to 85 per cent of the work contracted or placed under construction, the average being about 53 per cent. It will thus be seen that the Central Western States will carry over into 1920 a considerable amount of uncompleted work. This uncompleted work added to the program outlined for the year 1920 will make the accomplishment of the program for that year all the more difficult.

PRICES AND SUPPLIES OF LABOR AND MATERIALS, 1919.

Labor: One State, North Dakota, reports the supply of labor in 1919 better than in 1918. The prices, however, were 60 to 100 per cent higher than

in 1918. One other State, Illinois, reports that labor was fairly plentiful, but very independent and, therefore, inefficient and not dependable. All the other States report a scarcity of labor during at least a portion of the year. In some States this scarcity was very pronounced. The prices of common labor varied from 35 to 60 cents an hour. The prices of teams varied from 60 cents to \$1 per hour. As illustrating some of the difficulties with which the contractors have had to contend, one of the States reports that labor increased from 40 cents at the beginning of the season to 52 cents at the end of the season, while teams increased from 80 cents at the beginning of the season to \$1 at the end, an increase of 25 to 30 per cent in labor and team costs.

Materials: Apparently in the majority of the States a sufficient supply of materials has been available. The main difficulty has been to get the materials transported from the point of production to the construction operations. In a number of the States there was a rise in the price of materials toward the close of the season, due no doubt to the poor transportation facilities which tended to restrict the available supply.

NEW OR PROPOSED STATE LEGISLATION.

North Dakota: A special session of the legislature is now in session. A bill has been introduced to amend the constitution so that the State may issue \$50,000,000 in bonds for road purposes.

South Dakota: It is expected that new legislation will be enacted, making it easier to authorize hard surfacing road projects.

Nebraska: A new law which takes effect January 1, 1920, creates a State highway system of 4,500 miles and an automobile license fund of \$2,500,000 for maintenance.

Kansas: A number of minor changes were made in the road laws to permit a better operation thereof. Also more stringent regulations were provided for the elimination of railroad crossings. The most important piece of legislation was the submission to a vote of the people of a constitutional amendment for State aid in the construction of highways.

Missouri: A law was passed at the last session of the legislature, giving more authority to the State highway department in the making of surveys and the preparation of plans for road construction.

Minnesota: New legislation proposed consists of an amendment to the constitution, providing for the construction of a trunk line system of highways of approximately 7,000 miles.

Wisconsin: State laws were amended so that the cost of surveys and right of way on Federal-aid projects can be charged to the project, thus very materially relieving the State highway department's administration fund. A new law was passed providing that advertising signs along the highways shall be removed.

Illinois: A new law was passed limiting the maximum axle loads permitted on any motor-propelled vehicles, to 8 tons. This law also places motor trucks and similar vehicles in a separate classification as regards license fees, the character of tires, etc. A law went into effect July 1, requiring that all highway bridges built in the State and costing over \$200, shall be subject to the approval of the county engineer, who is a deputy of the State highway department. Another law provides that all bridges built in the State must conform to the structural requirements of the State highway department.

Iowa: A new law was passed creating a primary road system of approximately 6,000 miles, providing for the construction and maintenance of such system, creating an annual fund therefor, and providing for the issuance of bonds in anticipation of such fund. The motor-vehicle law was revised and the registration fees increased, so that it is anticipated that this law will produce approximately \$8,000,000 annually, which fund will be used in connection with Federal aid in the improvement of the primary road system.

It will be noted from this brief summary of legislation that the trend is very strongly toward an enlargement of the program of highway construction, making provision for the better types of roads, providing for funds therefor, and placing more power in the hands of the State highway departments. The tendency also in this section is very strongly toward placing the major costs of a trunk line highway system on the motor vehicle rather than on real property.

One bit of legislation to which I would call special attention is that reported by Wisconsin with reference to the removing of signs along the highways. Personally, I do not see the necessity of permitting our highways to be lined with every kind of advertising sign as is now the case in most States. These signs, in addition to their generally unsightly appearance, often render the highway dangerous by cutting off the view at sharp turns. I hope to see the day when such signs will have entirely disappeared from our public highways.

BOND ISSUES PASSED AND PENDING.

Approximately \$462,000,000 in bond issues have been passed or are now proposed, as follows:

Bond issues passed: Approximately \$138,000,000 worth of bonds have been authorized. Principal of

these is the \$60,000,000 bond issue authorized by the State of Illinois, none of which has yet been expended. The next largest bond issue authorized is in the State of Iowa, where 13 counties have voted \$18,500,000 in bonds.

Bond issues proposed: Approximately \$300,000,000 in bond issues are proposed. Principal among the State bond issues proposed is the \$75,000,000 bond issue proposed in the State of Minnesota. Wisconsin stands first in the amount of county bond issues proposed, these proposals running between \$50,000,000 and \$60,000,000.

Considering the vast amount of bonds passed, and the still greater amount proposed, it is apparent that the difficulty of the State highway departments of the Central Western States has shifted from one of finances to one of construction. It appears safe to say that no State highway department will be able, within the next two or three years, to spend the funds that are now actually available, or that it seems very probable will be made available in the near future.

PROPOSED CONSTRUCTION IN 1920.

It is rather early in the season for the State highway departments to give a definite statement of the mileage of each type of road proposed to be constructed during the coming year. Also from the way prices have been rising, it is difficult to give an estimate with any degree of accuracy as to what the cost of the work will be. Reports indicate that approximately 9,500 miles are included in the programs of the several States included in this group. Probably 60 to 75 per cent of this mileage will be improved by grading and draining only. The probable cost of this work will be about \$102,000,000. These figures include only the primary, State, or trunk line highway programs. They do not include the construction or maintenance work which must be done by the various counties and townships. From experience in the State of Iowa as to the volume of expenditures by the counties and townships, it seems safe to say that at least another \$100,000,000 will be spent on county and township work.

LABOR AND MATERIALS IN 1920.

It is anticipated that prices during 1920 will be at least as high, and possibly 10 to 20 per cent in excess of those prevailing in 1919. It is anticipated that the supply of labor will be about the same as in 1919. In some places there will be a shortage of labor, while in other places there will be a reasonably plentiful supply of labor, but it is expected to be independent and inefficient. The question of materials depends largely upon the railroad situation. It is believed that if assurance could be had that railroad facilities can be provided, additional capital would be interested and the supply of materials would be assured. With the present very great uncertainty with reference to rail transportation, it can not be expected that there will be a very great extension in the production of materials or in the capital invested therein. In order to avoid the very acute shortage of rail transportation facilities, many of the States are using every effort to produce materials locally.

The Motor Vehicle's Share in Highway Construction and Maintenance Cost.

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

THE question propounded in the topic assigned to me is one calling for the judgment of each individual; and his answer will be governed to a certain extent by conditions existing in his own State; therefore, what I shall say may not exactly apply to all States, but will serve, nevertheless, as a basis for discussion.

The underlying principles of taxation are that taxes shall be levied, as far as possible in proportion to the benefits received, upon those who have the money with which to pay, and in a manner that will meet the approval of those who are to pay. The extent to which these principles are embodied in any plan of taxation, will be the measure of the equity and the success of the plan.

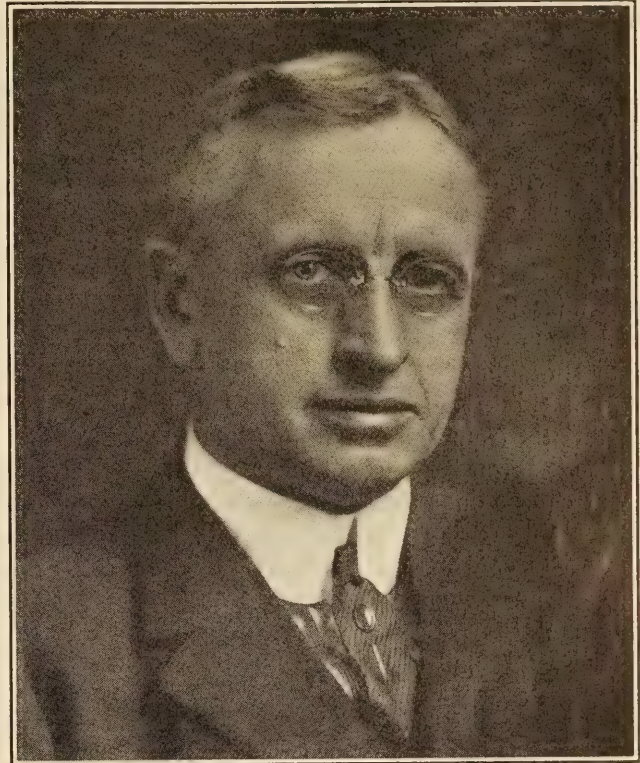
WHO BENEFIT FROM GOOD ROADS.

We naturally come back to the oft discussed question as to who receives the benefits from road improvement. That there is a general public benefit to our entire citizenship, applying equally to those who do not use the roads as well as to those who do, is beyond question. We are well aware of the fact that cheaper distribution provided by good roads will mean cheaper farm products for all the people, that more readily accessible schools and churches and places of amusement will bring about a general betterment of society, that the free movement of fresh foods to the centers of population will bring better health to the communities, that better roads bring better farm conditions and more intelligent farming, which will mean increased production.

In addition to these general, indirect benefits, there are direct and pecuniary benefits accruing to the users of the road. These, as you well know, arise from a saving of time to the car owner, a saving in wear of tires, a saving in repairs and in gasoline consumption, as well as in added life of the car itself.

What these direct benefits to each car owner will average annually is a question over which there may be considerable difference of opinion. I think I am safe in saying, however, that there are very few people who will not place these benefits greatly in excess of the license fees charged at the present time by any of the States. So long as these fees do not exceed these direct benefits the tax is just and the motorist is not being harmed.

The motor license fees in Illinois averaged approximately \$5 per car in 1917. In 1918 the fees were increased to an average of about \$7 per car,



S. E. BRADT

and in 1919 the fees will average \$10 per car. This fee will produce about \$5,000,000 in 1920, which has already been appropriated as follows: For maintenance, \$200,000, and the remainder to be expended on Federal aid roads in connection with Federal money. This, however, is not all that is provided for road work in Illinois. During the same period there will be raised by general taxation through county and township levies about \$15,000,000, or three times the amount received from motor license fees. In other words, the motorist, because of the direct benefits he receives, will be called upon to pay \$5,000,000 because of these direct benefits. I do not believe this represents the correct ratio between the direct and indirect benefits of road improvement, and am of the opinion that there is considerable room for further increase in motor fees before we reach the right proportion. The above increases, however, serve to show the evolution in legislation and the change in public sentiment toward levying a larger tax on the motor vehicle.

CAR OWNERS WILLINGLY PAY TAX.

Let us come back to the two practical factors in the problem of taxation mentioned above, namely,

getting the money from the people who have it and getting it with their consent. The motorist not only has the small amount of money with which to pay his annual motor license fee, but is willing, even anxious, to approve any reasonable license fee that will bring about highway improvement. More than this, he is willing to pledge the payment of these fees over a long period of years as a basis for the payment of bond issues to be used for highway improvement. As evidence of this I would call attention to the fact that in Illinois the voters approved a \$60,000,000 bond issue for highway improvement by a vote of 661,815 to 154,396, with the provision that the bonds and interest would be paid entirely from the motor license fees, which required a 100 per cent increase in those fees. Approximately one-third of the voters were motorists, and the most enthusiastic supporters of the proposition throughout the State were these motorists. I do not think that the people of Illinois differ very materially from the people of other States in their attitude toward questions of this kind. Therefore, what can be done in Illinois can be done anywhere.

For this reason I do not hesitate to say that if motorists can be assured that the money is to be properly expended they stand ready to give their approval to any reasonable, direct tax on motor vehicles for highway improvement.

PROPER USE OF MOTOR FEES.

There has been much discussion over the question "whether motor license fees should be used for construction," some people holding to the view that they should be used for maintenance only. In Illinois, we believe that the use of the funds, after they are raised, whether it be for one purpose or the other, or both, is a matter to be determined by local conditions. Maintenance is absolutely essential, and if a State requires for maintenance of its roads the entire amount derived from motor license fees, it is perfectly proper to devote it entirely to that end. If it requires only a part of the fees for maintenance then why not devote the remainder to construction? Our policy should be to charge reasonable fees somewhat in proportion to the direct benefit received and then use the money to the best advantage and where it will do the most good.

Ultimately the tax on motor vehicles reaches a very large percentage of the tax-paying population. Several of the States at the present time have an average of one vehicle to every 6 or 8 of the population. Illinois at the present time has one car to about every 12 people; but the present increase indicates that by 1923 we shall have one car to every 8 people. This means an average of nearly one car to a family. Therefore, while the motor license fee taxation will not be uniform as to the

valuation of property, it will be fairly equivalent to a general taxation on the basis of the population.

PRESENT FEE BASIS NOT EQUITABLE.

Before closing I wish to say that it is generally recognized that horsepower rating as a basis for motor license fees is not equitable. The man who drives his Ford car 1,000 miles in a year pays the same fee as the man who drives the same car 20,000 miles in the same length of time. The man driving the thousand miles should undoubtedly pay more per mile than the man driving the 20,000 miles, but his total annual tax should not be the same.

We are all waiting for some ingenious individual to work out a more equitable plan, such as a graduated gasoline tax, whereby each vehicle owner would pay a fee in proportion to the weight of his car and the distance he drives it; that is, in proportion to his actual use of the road.

In conclusion, the demand which we are now facing for highway improvement, calling for a volume of money never before dreamed of in any scheme of internal improvement, places us in a position where we shall be obliged not only to use the old established methods of raising money, but to resort to any other equitable plan which may be devised. The raising of funds for this work by a license fee, to be paid by the individual who uses these highways and receives a large direct benefit from this improvement, is surely an equitable and proper source of revenue, and the benefit is so pronounced that the motorist stands ready to offer this assistance.

As has been indicated, the proportion which the motorist should pay toward highway improvement and maintenance will differ in almost every instance because of varying conditions. If fees are based on benefits to the motorist, it is apparent that the greater the mileage improved or maintained the greater the benefits; that is, the broader the scale of your plans the larger should be your license fees. These matters are for local determination in accordance with local conditions and local public sentiment.

DISCUSSION OF MR. BRADT'S PAPER.

R. E. Nornell, highway commissioner of Colorado: We, of Colorado, have a law, which was passed in the last legislature, which allows a tax of 1 cent a gallon on gasoline sold—a very appreciable amount each month. I think it is a very equitable tax, especially in Colorado or any western State, because we have so many foreign cars that come in and pay no tax whatever. In the collection of this tax I think we have received from \$30,000 to \$40,000 a month. A very large proportion of that comes from the foreign cars, as we term them. Our tax on foreign cars is a minimum amount, something like 25 cents for regis-

tration, and by the collection of the gasoline tax we get an appreciable amount for every vehicle that motors over our roads.

L. A. Gillett, State highway engineer, New Mexico: We have a law passed in the last legislature assessing gasoline 2 cents a gallon. We have received no money under this, for the simple reason that it is now before the Supreme Court of the United States on the question of constitutionality. That may happen in Colorado.

Herbert Nunn, State highway engineer, Oregon: It is pretty well conceded, I think, through all the States, that a fixed tax on any type of motor vehicle is unjust. It should be based on the consumption of gasoline, I think, and for that reason Oregon has been working on a proposition for the last 4 years, and succeeded last year in getting 1 cent a gallon tax. At this time we are clearing \$300,000 or \$400,000 a year, but the four oil companies are paying without question. We think it is an equitable way of taxing vehicles as each one pays according to weight and speed and the numbers of miles run. It is quite likely that in the next legislature an attempt will be made in Oregon to place another tax on the gasoline. The automobile in Oregon is exempted from direct taxation.

THE PLAN ADOPTED IN IOWA.

Senator N. Balkema of Iowa: In listening to this road discussion and to the taxation discussion, and the question of raising funds for road-building purposes, it seems to me that the legislature of Iowa at its last session struck the happy medium in placing a part of the burden upon the motor vehicle which it already had placed upon the driver or owner of the automobile.

I will speak of what we call the primary road system upon which we are placing the Federal aid, which comprises about 6 per cent of the road mileage of our State. The legislature, particularly the committee which had to do with the drafting of the bills that provided for this fund, believed in the theory that the road user should also pay the expenses of the road building, and upon that theory we proceeded. We found that about 85 per cent of the users of the road were motorists. This was determined through statistics of road users compiled by the commission, and by that it was determined that about 85 per cent of the vehicles used upon the road were automobiles.

Our automobiles are not taxed for general purposes. They are taxed only for road purposes and a license fee is placed upon them, based upon the weight of the car and upon the factory cost. I

mean by factory cost the retail cost that the factory places upon its cars. This runs for a period of 5 years until it is diminished as the car reduces its usefulness upon the highways.

In addition to this, we feel also that the property owner along the highway has an interest in this matter of the road, and in the building of the road, and we have established a graduated scale, starting with the property that is located upon the highway itself, and running down to the property a mile and a half distant on either side of the road.

This explains our method of raising the automobile vehicle tax that goes toward the building of the primary roads. We have established upon motor trucks a similar provision. Our motor trucks are taxed in accordance with the weight of load they are supposed to carry, and in addition to that the weight of the motor vehicle itself.

We have other roads besides the primary roads, and the revenue for the building of these roads is raised by direct taxation upon all properties in the State.

THE GEORGIA LAW.

W. R. Neel, State highway engineer, of Georgia: The property of the man who owns a farm is benefited through increased valuation of the property. Now, if the farm land is increased in value, the taxes are certainly increased. And, thinking over the fairness of this question and in arguing it, I have been unable to find in our State anyone who has not benefited by the construction of these roads, and I have been unable to find any automobile owner who is taxed unjustly. We have a tax there of 60 cents per horsepower on all cars. That gives about \$13.75, I think, for a Ford, and on up for the heavier cars.

I agree that the flat rate for the horsepower is unjust, because some cars use the road less than others, but that is the tax for the construction of the road. In addition to that there should be a tax on gasoline for a maintenance fund. I think that will be the next question that will come up in the State of Georgia.

In asking for the passage of this bill we appealed to the automobile owners. Committees from every county in the State appeared before the legislature and requested the passage of that bill, committees from owners of automobiles. They were the owners who were demanding this tax. I think if anyone should complain of the injustice of the tax it should be the owner. I know in one trip I spent \$40 or \$50 in repairing the tires and wheels because of the bad roads.

Problems of Administration—Proper Cooperation Between Adjoining States.

Arthur H. Blanchard, Professor of Highway Engineering, University of Michigan.

THE discussion of this subject should be handled without kid gloves. In any remarks which I may make there will be no intention of discussing technical features, of specification, of materials, or methods of construction. In order, however, to handle the subject intelligently it will be necessary to point out differences which actually exist.

The reasons for the many differences which exist in specifications for materials and methods of construction in a given geographical section may be legitimate. Such differences may be based upon the differences in the character of materials available and other local conditions. But many of the differences I believe have grown up, like Topsy. It therefore is of the utmost importance that we should not camouflage differences which exist by using that very favored expression of highway officials, that the difference is due purely to local conditions.

In consideration of the cost of materials and methods of construction there is a certain economic fundamental principle: Standardization of materials, methods of construction and machinery, clear and definite specifications, a maximum equitable competition among producers and contractors will reduce the cost of materials and the cost of highway improvements. Upon that basic principle will be based the remarks which will follow.

This subject may be considered under various heads. Naturally, the first head deals with the necessity for considering cooperation among the States in a definite geographical section. It should be realized that the time is approaching when the spotlight of public opinion will be brought to bear upon the work of every highway department, and the responsibility of the men in this audience should be fully realized, for the billion of dollars to be expended next year on highway improvements will depend in a great part upon the work of the men represented here. It therefore is of the utmost importance that everything be done which will reduce the cost, at the same time maintaining the efficiency of the highway work.

We do not need to take much time in considering the conditions which will exist if we can not have cooperation. All of us know, for example, that a group of brick companies are able to produce one size of brick at a much lower cost than those companies could produce any one brick if they were required to manufacture 10 sizes. This point was well appreciated in France back in 1910 when it was found that the 57 proverbial varieties of stone

block were being employed in the various municipalities of France, and after they got to work on that problem, following a second International Road Congress in 1910 at Brussels, the sizes were practically reduced to 5, with resultant saving. The reduction of cost of production is well illustrated by the thousands of articles of merchandise sold for 5 and 10 cents in the Woolworth chain of stores. The principle there involved need not be expanded. The necessity is self-evident.

What should we endeavor to accomplish? Before considering that phase it will be advisable to look into the situation which exists; and, of course, to take the whole United States it would be impracticable to cover the problem in the brief period assigned to me. I have therefore selected a given geographical section, including Wisconsin, Michigan, Illinois, Indiana, Ohio, western New York, western Pennsylvania, and Kentucky.

SOME EXISTING DIFFERENCES.

Some of the differences found in the specifications of those States will be brought to your attention. Please bear in mind that these points are brought to your attention not in the spirit of criticism but to show you that in a great many instances it will be practicable, through a cooperative effort, materially to reduce differences which now exist in specifications for materials and methods of construction. Take, for example, as the first illustration, the water-bound gravel road. In this connection, a great many plants of considerable size are supplying gravel. It is self-evident that in the case of gravel and broken stone the greater reduction we can make in the number of sizes required the lower will be the cost of production. And in this connection it is a basic principle that whenever specifications require special sizes, or special machinery, or complex methods the public pays the cost.

In the case of gravel for the top course of the water-bound gravel road we find, running through these various States enumerated, sizes ranging anywhere from a maximum of 3 inches down to a minimum of gravel passing a 1-inch screen.

In the case of broken stone for the water-bound broken-stone roads we find as many differences, running from a maximum (and this is for the same kind of rock as far as the specifications are concerned) of 3½ down to 1½ inches.

Of the seven States having specifications for water-bound broken-stone roads no two call for the same product. And yet it is well known that the same

commercial plant is required to supply broken stone for many of the States in that group.

THESE SPECIFICATIONS ARE OUTLAWED.

In connection with specifications for broken stone, it should be borne in mind that the time is past when we can call for sizes by the old worn-out nomenclature of "nut" or "egg" or size "1½" or "2½," etc.; that the time is past when we can follow the practice (which was an improvement on the old practice, I will admit) of calling for the size of broken stone by the usual specification that it shall pass over a screen having a certain size hole and through a screen of the next size hole. That method of specifying broken stone may work out satisfactorily in the matter of water-bound broken-stone roads, but when we come to dealing with the higher forms of pavements in which broken stone is used it doesn't prove satisfactory. If I could read to you a number of analyses of products complying with a given specification I think some of you would be astounded at the difference which exists.

Now, in the specifications which I have before me (and they are scientific specifications) there has been included for the sizes of screen the following: Passing a ¾-inch not less than 95 per cent; passing a $\frac{1}{100}$ -inch not more than 15 per cent; passing a $\frac{1}{10}$ -inch, 30 per cent to 70 per cent. Those limits are based on the experience of the engineers in that particular State who desire to have a certain product furnished them for use.

In that same specification there is found for the base course that the size of stone shall be: Passing a 3-inch screen not less than 95 per cent (that is definite, of course); passing a 1½-inch screen not over 10 per cent. That last specification, gentlemen, I do not consider a definite specification, and I want to say now that you can bank on it (and this is based upon experience as a consulting engineer to many contractors during the last eight years) that if your specifications are not definite the contractors are going to put a figure on their bids that will cover any questions of which they are not sure.

The point is, in regard to this specification for broken stone, which I find is being used in a great many States, that the clause, "passing a 1½-inch screen not over 10 per cent," in my opinion will not hold in any litigation as meaning that there must be present some stone which will pass a 1½-inch screen. I am not sure exactly what some engineers mean by it. There is no definite requirement there. It simply says "not over 10 per cent." You will find that characteristic of a great many specifications where it is of the utmost importance that a certain per cent should pass through the 1½-inch screen. It is simple, of course, to remedy a specification of that kind and make it definite, so the contractor or pro-

ducer will know exactly what is required, by simply inserting "not more than a certain per cent and not less than a certain per cent."

Another example: In the specifications covering one kind of bituminous concrete pavement, where it is of the utmost importance that a desired size should be obtained, the specification reads like this: "All of the broken stone shall pass a 1¼-inch screen." That absolutely settles the maximum size. "Not more than 10 per cent nor less than 1 per cent shall be retained on a 1-inch screen." That fixes the amount of the maximum particles in that product.

This is for one product of a crushing plant: "Not more than 10 per cent nor less than 3 per cent shall pass a 1¼-inch screen." That fixes absolutely the minimum size in that product and the producer and contractor know exactly what is expected of them.

In the case of cement concrete pavements we reach a type in connection with which there is a material used which stands by itself, namely, cement. We have there the uniformity which is desired on the basis of having all the specifications simply refer to the standard requirements of the American Society for Testing Materials.

When we come to the coarse aggregates, however, we have all sorts of combinations, and it must be remembered that the broken stone and gravel employed for these coarse aggregates in many cases serve a given area which laps over various States. For instance, the Chicago commercial plants serve in some cases parts of Wisconsin, Illinois, Indiana, and Michigan. Whether they get down into Ohio or not I do not know. But in the case of those four States the specifications are entirely different.

INDEFINITENESS IN SPECIFICATIONS.

Branching off from materials for a moment and coming to the matter of the distributor used in the production of bituminous macadam pavements, for the distribution of bituminous materials, here we run into that extremely indefinite clause so often found in specifications: "A type will be satisfactory which is approved by the engineer."

The time has arrived when such clauses should be eliminated from specifications. If a man knows enough to go to a distributor or a roller or mixing machine and pass on it after the contract is awarded, he should know enough to be able to put into the specifications an intelligent description covering the points which he considers essential.

Now for the definite illustration to which I referred a few moments ago. In 1914 that specification occurred in the specifications of New York State. Mr. Hubbard and myself were investigating conditions in that State for one of the State departments. At that time there were 9 divisions. The highway commissioner, when this matter was discussed with him,

said that the approval was up to the division engineer. In investigating the work of the 9 divisions we made a point to take up with the division engineer his ideas in regard to what an approved distributor should be. We found that in the State of New York there were 9 distinct ideas in regard to an approved distributor.

Now, a contractor was in this position: That he must, through some means (underground or otherwise) find what were the ideas held by that division engineer before he could intelligently bid on a job. I have in mind two contractors whom I have served, both of whom added to their contract price for bituminous macadam pavement \$2,000. Furthermore, they got the jobs. That \$2,000 was put on because they were going into a State where they had not before worked, and they were not familiar with the ideas of the engineers in that particular State in regard to what an approved distributor was, and they were not going to take any chances. They intended to have an item in their bids covering the overhead for the purchase of a new distributor. And that thing crops up time and time again wherever this clause of "approved type" of machine or method is included.

In connection with bituminous macadam pavements we furthermore find quite remarkable differences in the specifications for the bituminous cements to be employed. It is perfectly true that, depending upon the geographical location of the work, a difference in penetration is necessary. In this particular case, however, it is not sufficient to account for the wide difference in penetration of the asphaltic cements which exist except in the case of (let us say) Kentucky on the one hand and northern Michigan on the other, or northern New York, or Wisconsin.

If a bituminous material company has to manufacture a great many concretes, and keep all of those concretes in stock, you are paying for it. Don't forget that. That must be a fundamental consideration. The same thing exists in regard to the other properties, physical and chemical, of the bituminous cements employed.

AS TO ROLLER REQUIRED.

I have alluded to materials heretofore. I will not allude specifically to the differences which exist, but I do want to refer to the matter of rollers required. The rollers vary anywhere from 5 tons to 10 tons. I don't say that the engineers of this State are not entirely justified, because I am not taking up the technical features to any extent. But let me read you this: "The initial compression shall be effected with a tandem power roller, weighing approximately 8 tons, having a roll of such width as to give a compression of approximately 250 pounds per inch width of spread."

As far as it goes, that is excellent—a very admirable specification. But here is the point: "Final compression shall be effected with a power roller weighing not less than 10 tons." In other words, two rollers are going to be required on that job, specifically requiring an 8 ton and a 10 ton.

A contracting company which makes a practice of constructing sheet asphalt and Topeka bituminous concrete in all probability will not have a 10-ton roller. It means then that the results obtained must justify that added cost. It happens that that is the only State in this group that requires a 10-ton roller; therefore contractors who are used to the work in the other States, in providing their equipment before going into this State, must take care of that overhead of the 10-ton roller in making their bid.

A rather interesting technical detail is, that as far as the compression secured is concerned it does not make a bit of difference, because there is nothing specified here in regard to the weight per linear inch of tread for this 10-ton roller, and those who have made an examination of rollers know there are some 10-ton rollers that only have a 250-pound limit.

Furthermore, in this specification, for the binder course an 8-ton roller is allowed. The practice of using two rollers on a job is as old as the hills. It has been followed in New England for a great many years, but there is considerable difference in the weight of rollers used. If a 5-ton roller is used for the initial compression, then 8 or 10 tons may be used for final compression on certain classes of work. But such requirements as that should only be put in after it is determined that the results will warrant the additional cost of construction.

THE BITUMINOUS CEMENTS.

In the case of the bituminous cements employed for Topeka bituminous concrete we find as many differences as we do in the specifications for bituminous cements for bituminous macadam pavements. Let us take just one example. Take ductility. We find "less than 15 centimeters," "not less than 30," "not less than 60," "not less than 100." I believe you can get together on such requirements as that, because those differences mean that the asphaltic cements for those various States have to be manufactured some time before in a good many cases.

In regard to the size of brick the various States mentioned differ to quite an extent, so that if one company proposes to supply all of them it must manufacture several sizes.

There is one specification which appealed to me as being extremely definite. It reads: "The length shall be between 8 and 9 inches, variation $\frac{1}{2}$ inch; width, $3\frac{3}{8}$ to $3\frac{5}{8}$ inches, variation $\frac{1}{8}$ inch; depth, $3\frac{3}{4}$ to 4 inches, variation $\frac{1}{8}$ inch." That is a specification which gives a producer and contractor the exact idea of what is required.

THE SOLUTION OF THE PROBLEM.

In dealing with the matter of brick specifications my previous remarks were based upon the belief that it must be true that a great many engineers have more or less blindly followed the recommendations of certain associations of engineers. I think the time has come when every engineer must think for himself and adopt no method in connection with any type of pavement unless he is fully satisfied that that method contains inherent merit.

Now, the solution of this problem seems to me very simple, provided that those who hold the purse strings in our several States will realize the ultimate economic advantages resulting from uniformity in specifications of materials and methods of construction in adjoining States. It would seem simple that for a given geographical section a committee representing engineers from the several States could meet—meet often, and in some cases for long periods—and thresh out these differences and decide which differences are dependent upon local conditions, which differences are based upon legitimate differences of opinion among the engineers in regard to the proper materials and methods to employ, and which differences are of such a character that they may be eliminated.

DISCUSSION OF MR. BLANCHARD'S PAPER.

C. P. Fortney, chief engineer West Virginia State Road Commission. The question was handled by Prof. Blanchard, apparently, from the standpoint of specifications and standardization of material.

Our State is very peculiarly situated, especially in regard to costs. In the northern end, for instance—we have a panhandle extending into Pennsylvania between Pennsylvania and Ohio—we have one price up there. Then over in the eastern panhandle, which is affected by Virginia and Maryland, we have another set of costs. Down in the southern end, which is affected by Virginia and Kentucky, we find something still different. Then we have a county system. We have 55 counties, and the State road commission acts in a supervisory capacity, so in effect we have 55 free States.

But from the standpoint of specifications we have a State standard; so the question of difference in standards would not necessarily affect this difference in cost.

I notice that, to the north, where the road building is going on very intensively, the costs are higher. Over in the southern part, we are paying, say, \$1.25 a yard for excavation; in the center of the State, where little construction work is going on, we are only paying about 56 cents. So something else comes in there.

It is the same way with material. Take the question of brick, for instance. We have the Mack block manufactured in the northern Panhandle, and we put that in our specifications. Transportation of material enters into the question here, and labor also. The question of transportation may modify or influence conditions somehow.

When we come to the standardization of the specifications West Virginia is somewhat of a small United States in itself.

Then we are confronted with getting contractors, and several other things, and we have these 55 counties bidding against one another. That runs the prices up. We try to eliminate that as much as we can. We have to pay twice as much in one section of the State as in another. That is due partly to the disposition of some of our neighbors. Frankly, I don't know what Col. Uhler is doing up in Pennsylvania except through what I learn from the bonding companies when we get bids. I know in a general way what Mr. Coleman is doing in Virginia; also what Kentucky is doing. But I do know that the people in Pennsylvania must want them as much as we do in West Virginia. That puts us bidding against one another.

I wonder sometimes if we are not forcing prices up ourselves. The contractors know we want the roads and just boost the prices, and it is a question of how badly we want them, how much we want to pay for them. They balance one against the other. I think I voice the sentiment of our commission when I say that if any of our bordering States want to cooperate with us we will tell them exactly what we wish to do, give them next year's program, say how much we are going to spend, and they can say what they are going to do. We may help one another that way.

The tendency is for prices to keep going up because we can not, as I said a moment ago, influence labor. As to the question of material, West Virginia is not troubled so much by that, for it is superabundant. There are only one or two countries where we are troubled with the question of transportation. The next thing that is going to concern us next year is whether we can not do a little bit more by getting away from labor and getting machinery instead.

DIFFICULTIES IN GEORGIA.

W. R. Neel, State Highway Engineer of Georgia: In thinking over this very important subject I am like Mr. Fortney, though I have not been able to arrive at a solution, I have found a great many of the difficulties. As I see it in my section of the country, the principal difficulty that has confronted me has been the short supply of road building materials, the limited number of contractors, and the inadequate service from the railroads.

In looking for a solution of these principal problems, I have thought of the advisability of the State's opening quarries, not to compete with the people who are already in that business but to encourage the contractor. Now, the contractor bids, and he admits he is taking a big gamble. And you all know that, under our present system of letting contracts, the contractor is a gambler, and right now the odds are pretty heavy against him. With the possibility and probability of railroad rates going up month by month, and the labor situation just about as bad as the railroad situation, and the short supply of materials, the contractor must bid a very high price. There is such a great amount of work that he does not have to bid low in order to get work; it is just a question, as I see it, of his conscience—and my experience in attending the lettings for the last 6 or 8 months has been that his conscience is growing less sensitive at each letting.

I am sure it is not from experience that the contractor has raised his prices steadily, because I have seen the same contractor bid from week to week and get 4 or 5 contracts, and none of the work which he had bid on had commenced, so it was not from experience that he found he had to bid higher. It was because he saw he could get the work at the higher price.

I think that maybe we can help solve the problem before having the committee (following out the suggestion of Prof. Blanchard) representing the different States as they would be affected in each group, meet and work out the standardization of specifications. I think that is a very important point. I admit it is a point I had not thought of. But that feature of the possibilities of reducing the cost of the work I think can be worked out very satisfactorily.

Then, if we could find means of specifying as nearly as possible local materials, we might not only find a solution of the transportation difficulties but also leave for our neighbor States the materials that they have available locally.

It might be that we would have to experiment some and use materials that are as yet of unknown value. But in order to advance science I think a certain amount of experimenting is necessary.

I do not believe we have yet arrived at the point when we can standardize all features of road construction. I do not think we have yet arrived at the point where we can standardize road-building equipment. I think, as Prof. Blanchard has suggested, that we can cover in our specifications certain essential features that we now retain, as necessary; but I think we should leave other features for future development, because I am satisfied that we all agree that we have not yet arrived at the ideal road. We must meet the changed conditions from day to day

and we must allow people's ideas to be put into effect as much as possible. Of course where such ideas are radical those in authority should confine them to a limited expenditure. Working along these sane lines, we might get to a point where the benefit of cooperation would tell in the cost of our roads.

Another point that has occurred to me that might reduce the cost of roads would be careful study of our present system of letting contracts. I believe that the bidding of a fixed sum is all wrong. In Georgia we have such a small number of contractors to do this great amount of work that there is absolutely no competition, and I think if we were to work out a form of contract that would be more business-like and in which there would be less of the gamble, we would get more business men, and the use of larger amounts of capital employed in the construction of our roads.

MIDDLE STATES UNITE ON SIZES.

W. G. Thompson, State highway engineer of New Jersey: I would like to inform the association of a movement started which is quite in line with Mr. Blanchard's suggestion. At the instance of Col. Uhler, of Pennsylvania, a meeting was called in Philadelphia, about three weeks ago, of the highway officials of the States of Pennsylvania, New York, New Jersey, Delaware, and Maryland, with the stone producers. Col. Uhler's idea was that in order to increase the output of the quarries, which in our locality is almost up to its limit now under the present system of working, some change should be made which will enable the quarries to increase it.

We discussed the proposition of agreeing on minimum and maximum sizes of stone to be used for concrete work, for example, and for such macadam pavements as may be built hereafter. It was found that the maximum and minimum sizes used or specified for use in each of the States was different for each State. We finally agreed upon sizes which will be used hereafter in these States (with slight exceptions possibly) which will increase the output of the quarries about 20 per cent in some cases.

In other words, by agreeing upon the maximum size (which I think was passing through a $2\frac{3}{4}$ -inch sieve and retained upon a $2\frac{1}{2}$) for concrete, we were able to get together with the producers. All agreed upon that and it will have a tendency to lower the price where a large output is used because heretofore the quarries have had to comply with different requirements for each community and that of course restricted the output, because of the many sizes required, and the many bins or storage houses required to take care of the surplus product. The movement, I think, will become more widespread. The same method may be applied to all of the products used in road construction.

UNIFORM SPECIFICATIONS BENEFIT.

Clifford Older, chief highway engineer of Illinois: About a year ago the engineers of the Northern Mississippi Valley States (11 in number) met in conference to determine this question as to the sizes for concrete road construction that would be adopted as uniform (if it were possible) for the 11 States.

We adopted such specifications and recently I made a visit to 16 gravel aggregate producing plants in northern Illinois to determine something about how this thing was working out. I found, to my great satisfaction, that in these 16 plants, which produce about 4,000,000 tons of coarse aggregate per year, that the answer to my question as to what was the demand for road construction aggregate was practically the same, and that was, that the demand was in accordance with the specifications adopted by this Mississippi Valley conference. There were very few exceptions and those came from small villages and cities where miscellaneous engineers handled the work. But for large city and State construction the same size of aggregate was in demand. The only difficulty outlined by these gravel producers was their trouble in handling the orders of cities where smaller aggregate is required

for reinforced concrete building construction. However, they all agreed that the new schedule of aggregate for road construction purposes had simplified and lowered the cost of producing gravel.

I believe the same answer would have been given by the stone producers, although I have not yet been able to visit those plants. I am just giving this as an example of what has been done along this line.

A. R. Hirst, State highway engineer of Wisconsin: Apropos of this discussion and of the point made by Mr. Older, I wish to say that in these 11 western States we have an association of State highway officials devoted to specific problems of road affairs. I believe it is the oldest organization of the kind in America and the forerunner of this larger organization. As far as Wisconsin is concerned, and I believe the other States join us in this, we would not know how to do business without the association. We get together at least once a year and if we can not wind up the business at that time we establish a committee, such as this aggregate committee, and it is a fact, that in that group of 11 States we are practically uniform in our requirements and we are getting more so every year. I recommend to other States the formation of similar associations.

Is State Supervision of Construction and Maintenance of all Highways Desirable?

B. H. Piepmeier, Construction Engineer of Illinois Department of Public Works and Buildings.

BEFORE this question can be answered intelligently, it is necessary first to investigate the general location of the public highways, the purpose for which they were established, and the source from which the funds are received to pay for their construction and maintenance.

On account of the nature of our traffic on the public highways, all roads within the boundaries of a State do not serve their purpose in the same way. Some roads accommodate primarily local or community traffic, some intercommunity or county traffic, others intercounty or State traffic, and a few interstate or through traffic. In view of the varied purposes for which public highways are used it would not seem to be economical nor desirable for any one political unit to have complete control of their construction and maintenance.

In a few of our States and portions of other States the majority of the roads are located, primarily, to serve villages or community centers. Many of the villages are widely separated and frequently in different counties. Under these conditions it might be economical and desirable for the State as a unit to

have complete control over the construction and maintenance of all roads.

In our agricultural States we have a much different condition. Here we have a very large mileage of roads in comparison to the population or area served. The difference between the two classes of States is illustrated by data published by the United States Bureau of Public Roads, which shows that Rhode Island has 250 people to every mile of public road, or $1\frac{3}{4}$ miles to every square mile of area, while in Iowa there are 21 people to every mile of road and about 2 miles to every square mile of territory. It is very evident that the road problem in these States is somewhat different and while State control over all construction and maintenance in some States might be desirable, it would not be in others.

In the agricultural States a very large mileage of the public highways is of value, principally, to local communities. Such highways are of interest, primarily, to the people who live within the immediate communities; hence, their construction and maintenance should naturally be under the control of local officials.

CONTROL OF STATE AND LOCAL ROADS.

Inasmuch as all road and bridge construction and maintenance involves engineering principles and skill which can be obtained only by experience, it is advisable to have all local road officials report and be responsible to a competent county commissioner or engineer who should in turn be responsible to and under the general supervision of the State department.

In every State there are a number of highways which should be termed strictly county roads, as a large percentage of the traffic upon them extends from one community to another. Their construction and maintenance might be logically come under the control of a county commissioner or engineer, thus making such roads serve as main feeders to a State system.

The residents of every State are increasing their fields of social and commercial activities annually until to-day it is apparent that no local or county unit should be required to bear the burden of the construction and maintenance of all of its roads. Practically every State in the Union has realized the economy which is inherent in State control over a number of its roads. The exact mileage of roads the State should control is perhaps a debatable question and will be as long as traffic conditions are changing yearly. It is evident that the thickly populated States should have more roads under their control than the sparsely settled States.

Experience has proved to practically all State road officials that partnership with political subdivisions of the State in the construction and maintenance of roads is very unsatisfactory. It seems desirable, therefore, that all roads within the boundaries of each State should be divided equitably between the individual communities, the county, and the State, and each unit have the direct responsibility of the construction and maintenance with such general engineering supervision from the State department as is necessary to control irregularities.

FEDERAL AID AND THE STATES.

During the past few years there has been considerable argument advanced favoring an independent Federal system of roads with the Federal Government controlling all construction and maintenance. There is no argument against an interstate system of improved highways, as traffic is demanding such a system and all road enthusiasts are looking forward to its realization. In my opinion the public is not demanding a Federal system of roads with complete Federal control, but it is demanding a connected system of improved trunk-line highways. Any method or plan, therefore, that will secure such a system, in the least possible time and in the most

economical way, will meet with the unanimous approval of the public. There is no question but that the recent Federal-aid plan has met with approval and has induced many States to take up road construction that would not have done so without this aid. It is reasonable to believe, therefore, that under a Federal-aid law there will be a greater mileage of improved roads constructed and a trunk line or Federal system of roads secured in less time and in a more economical way than under any other plan.

Present conditions would indicate that it would be more desirable to all concerned if the respective States had complete control of all State and Federal highways with such general supervision from the Government on all Federal highways to insure that the roads in each State would connect at the State lines, and to see that the Federal money was actually spent on roads which are generally recognized as suitable for the traffic that might be expected. Where the State has a highway department and furnishes any portion of the money in a Federal road, its engineering department should be, and generally is, competent to supervise all construction and maintenance work within the boundaries of the State. In Illinois the present plan of Federal supervision has proved to be very desirable.

WHERE CONTROL SHOULD LIE.

When proper engineering supervision is supplied, it is generally more satisfactory for the political unit which is financing the work to control the construction and maintenance. It is apparent that the local unit as well as the county unit must depend upon direct taxes to finance its road improvement; hence, should control the work, providing that proper engineering supervision from the State department is assured.

On account of the large territory which is covered by the average motor vehicle, it seems equitable that all fees derived therefrom should be used exclusively by the State and on intercounty or State roads.

In conclusion, therefore, I would deem it desirable for all road construction and maintenance under existing conditions to be divided as follows:

All district or township road work to be under the direct supervision of local road officials.

All county roads to be under the direct supervision of the county officials, and all State and Federal road work under the direct supervision of the State. The Federal Government should have general engineering supervision over Federal-aid construction, the State general engineering supervision over all county and township or district road construction and maintenance.

Proper Inspection in Development of Material Supplies for Heavy Programs.

A. B. Fletcher, State Highway Engineer of California.

IT IS indeed a day of heavy highway programs; we talk as glibly of forty, sixty, or a hundred millions of State highway bonds as we did a few years ago of five or ten millions. We talk now of annual programs of highway construction of from ten to twenty-five millions without particular difficulty.

But talking about such programs is one thing and getting experienced engineers and assistants, finding enough contractors of sufficient ability and financial responsibility and securing the huge quantities of proper materials of construction promptly is quite another story.

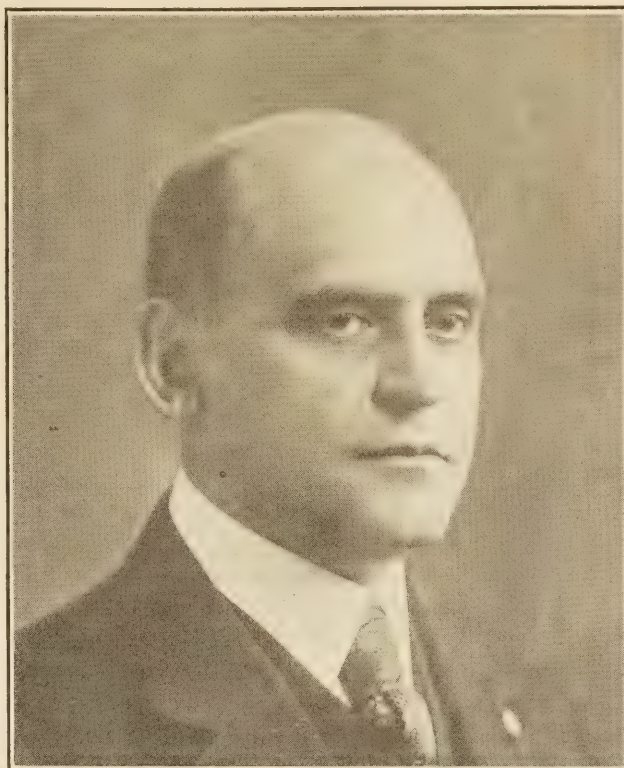
Hardly any two States of the Union have the same problem to solve. In some of the States where State highway activities are of very recent date the troubles with respect to the supply of materials of construction must be acute and hardly any State has been accustomed heretofore to thinking of the supplies in terms of the enormous volumes we are now facing.

The public now in thinking of or speaking of a State highway has in mind an expensively paved road. In general it may be said that the days of gravel or waterbound macadam roads are no more. In most of the States the location of the principal supplies of gravel, sand, and broken stone is fairly well known, but for extensive paving operations these supplies must be increased greatly and new deposits located, if the highway work is to proceed with the dispatch desired by the public.

Often the engineer must decide whether he can or must use materials of somewhat inferior quality or whether materials of better quality can be shipped to the work by rail. These decisions often require nice judgment and no highway department can consider itself well organized without a geologist competent to assist the engineer in such matters, nor unless it have a well-equipped testing laboratory with trained assistants to operate it.

SUPPLY OF MATERIALS.

In many instances the material supply difficulty is not so much the lack of material as it is the failure of the railroads to ship it promptly and as ordered. In some States it is notorious that the railroads do not have enough suitable cars to give the needed service and this is true particularly at the crop-moving periods. Hardly anything will do more to disrupt a highway contract than the failure of the railroad to furnish the materials of construction as they are needed.



A. B. FLETCHER.

This failure of the railroads unless it can be corrected otherwise would, doubtless, in some States with heavy programs, justify the purchase of railroad cars by the State department for highway use.

If the railroad may be depended upon, the economical way of handling the materials, particularly such stuff as broken stone, sand, and gravel, is to unload from the cars and place the materials on the road where they are to be used without unnecessary rehandling, which is always a costly performance.

Failing prompt railroad service, and in these days we rarely expect regular deliveries, one remedy is to stock pile the materials at convenient points. Sometimes, but not often, it is possible to haul the materials and place them in small piles within the right-of-way, but more often they have to be placed in large piles near the railroad sidings.

The use of portable derricks or cranes with clam-shell buckets to a large extent lessens the rehandling expense but whether machinery is used or not it seems obvious that the materials must be available when the contractor needs them.

Doubtless it will also be found that because of the extraordinary number of motor trucks supplied by the Government to the States at an almost

negligible cost much material may be hauled in these trucks for long distances. The ton-mile cost of hauling in trucks which cost the States practically nothing is greatly reduced if the factor of original cost of the trucks does not have to appear in the figuring.

SUPPLY OF MATERIALS BY STATES.

Some of the States have adopted the practice of furnishing the materials of construction or most of them to the contractors. The writer does not know of any State which has gone so far as to own cement plants and rock quarries and to operate them, but that such a policy may have to be adopted by some States is by no means unthinkable. Indeed the statutes of some States provide for such a contingency. For such States as have become accustomed to supplying the contractor with construction materials it would be a simple extension of their operations.

There is little doubt that heavy road building programs will be in fashion for a long time to come, so that the plant construction cost may be distributed over a huge quantity of the product. If the cement companies are unreasonable in their prices, this policy would afford a means of curbing them. However the money involved in such undertakings would be in large figures and could be allotted only with difficulty in some cases. "We want the money spent on the roads" is still the slogan of many of the thoughtless voters of State highway bonds. It must be confessed, too, that under normal conditions no State-operated cement plant can hope to compete with a privately operated plant on the cost basis. There are many advantages and few objections to the State highway department furnishing materials to the contractor. A contractor with little capital is enabled to bid on work since he has little to finance outside of the labor and equipment items. The contractor has no incentive to skimp on quantity or quality of the materials. Indeed he must be watched to prevent him from wasting them. All disputes with the contractor as to the quality of the materials are eliminated.

Because of the larger volume of materials in which it deals, the State can usually secure lower prices per unit than can the individual contractor. The contractor will insist of course on prompt deliveries. He will be much more critical in this respect than if he were doing the purchasing himself, and he may claim for damages due to faulty deliveries, but the State should and can operate better than the contractor in this respect.

It costs something to handle the business end of course, for purchasing agents and clerical people to buy and route the materials and for this service the contractor, when he furnishes his own materials,

charges from 5 to 10 per cent of the value of the materials. This cost is reflected, necessarily, in the administrative costs of the State highway department and there is much bother connected with the supply of materials to the contractor. The advantages, however, seem to outweigh the disadvantages.

STATE TESTING LABORATORY NEEDED.

So much costly paving is involved in modern State highway construction that the testing of the materials used becomes an important division of the work. The geological work and the testing may be combined in one department without difficulty and a highly trained geologist may be placed in charge of both branches of the work.

It is hardly possible to make up cost estimates until the sources of the materials are known and the geologist and the testing engineer often settle the matter for the engineer. After construction work begins, it is necessary from time to time to test concrete mixtures, both asphaltic and Portland cement in order to get the best results, since although the ingredients have all passed the specification satisfactorily, the limitations of the specifications for the combinations nearly always permit some latitude. It is also interesting to know, for instance, the compressive strength of the concrete in the pavement slab after the road is completed.

A testing laboratory can be set up at no great cost, probably in no case exceeding \$10,000, which will do all the testing required in the general line of work. The United States Bureau of Public Roads requires the tests to be made and it seems to be advantageous to have the work done by the State highway department rather than to rely on private firms of testing engineers.

DISCUSSION OF MR. FLETCHER'S PAPER.

By F. E. Everett, State Highway Commissioner of New Hampshire: During the last three years highway engineers throughout the country have had forced upon them the realization that in order to carry out a program of construction or maintenance, some means must be devised to insure the delivery of material.

To arrive at the solution of the problem, it is necessary, of course, first to consider the cause. We are told by every material concern that there is a car shortage, that the railroads do not furnish them enough cars to take care of their output. Investigation of a few commercial plants in New Hampshire has shown this to be a fact. Road builders everywhere have been busy for the last two years attempting to impress upon the proper authorities the necessities of alleviating this evil. Some results have been accomplished, but not enough. Neither have we any assurances that this improvement will

continue. If we are unable to get relief from the railroads, it is evident that we must devise some scheme that will entail the minimum use of railroads. By doing this, we will help not only ourselves, but also the railroads, which we are told are badly congested.

The development of local natural resources, if they are of value, will answer this problem. With this end in view the New Hampshire Highway Department during the seasons of 1917 and 1919 conducted a rather extensive geological survey of the State. The results obtained have greatly exceeded expectations. Trap-rock dikes have been located in nearly every section of the State. Native granites have been located and classified as to resistance to wear. Gravel deposits have been tested and classified as to their availability and quality, and the limits of the bedrock strata have been located and a study made of the effect of the bed of rock on gravel deposits.

Laboratory tests of the trap rock which have been located show it, in every instance, to be of better quality than that which we have been importing. Several trap dikes are located within easy truck-hauling distances of proposed heavy construction. Practically all of them could be used to take care of some work within reasonable hauling distance. Of course it is necessary in order to accomplish our purpose to expend a large amount of money in plant equipment. Taking into account the large amounts which have been thrown away waiting for material to be delivered by rail, is not this expenditure for plant equipment warranted?

Gravel roads constitute approximately 75 per cent of New Hampshire's total State road mileage. It is therefore evident that we are dependent in a large degree on our gravel deposits. This being the case it is imperative that we know exactly how we are situated regarding this valuable material. Our geological survey had given us this information in detail.

SURVEYS LOCATE VALUABLE MATERIAL.

By means of the survey deposits of inestimable value have been uncovered and good gravel has been located in sections where before it was not supposed

to exist. This has, therefore, helped, in large measure, to solve the transportation problem, as it was necessary to import material into these sections before. Where a particularly good bank has been located, the State has taken steps to purchase, thereby insuring the use of the material without hindrance and also its conservation for road purposes. With this information at hand it seems that the material used in construction can be placed on the work at the time planned. Also it is likely that our estimates conform more closely to the actual cost.

The development of material supplies is not the only result realized from the geological survey. The testing of material to be used in road construction has been greatly facilitated. Hundreds of samples from every section of the State have been tested, and the data obtained has made it possible for us to make up a map of the State showing the quantity and quality of all materials. Also a map has been plotted showing the location of the different bedrocks. It is surprising to note the uniformity of effect of the glacial action over the bedrock on the adjacent deposits. It is possible by an analysis of bedrock and direction of glacial drift to determine the nature of the adjacent deposits with a goodly degree of accuracy. This is a great help in the matter of future tests, as it gives a good idea of what can reasonably be expected from samples of material submitted from different sections. If construction is contemplated at a certain place we are able by means of tests made in conjunction with our survey to locate satisfactory deposits without further tests. We have also taken samples of sand from all sections of the State and tested them for their strength in cement concrete.

This acts as a great relief to our laboratory during the season of the year when it is busy making tests on asphalts, tars, Portland cement, etc.

Taken all in all, this survey has been of inestimable value. In consequence of it we are better able to plan our work, both as to the nature of material to be used and its availability. The work of the laboratory during rush seasons has been lessened and the conservation of road materials has been promoted.

Highway Department and Railroad Cooperation for Transportation of Materials.

A. G. Gutheim, Car Service Section, U. S. Railroad Administration.

THERE is perhaps no line of industry which, in the aggregate, suffered so much as a result of the curtailment of commercial transportation service during the war as did the road building industry and the industries naturally associated with it. This curtailment of transportation for road building was practiced from the very beginning of the war. In the latter part of April,

1917, when the carriers revised their car service rules in order to gain greater efficiency, they provided that open top cars should be furnished primarily for the transportation of coal, coke, and ore. The result of this was practically a prohibition of open top car service for stone, sand and gravel on many railroads, and this prohibition precipitated a complaint that brought the stone, sand, and gravel

people to Washington and gave me my first insight into their side of the question.

That first difficulty in the early days of the war was patched up sufficiently to take care of the coal situation and the blast furnace situation, and at the same time give reasonable service to construction materials, and this continued throughout that summer. With the advent of fall weather, and with the greater war activity on the part of the country's industries in general, the pressure for coal became so strong that we had to face again the agitation for the prohibition of open top car supply for road building materials. This prohibition was counseled by the National Coal Association, then newly formed, which openly advocated and urged upon the Washington authorities that there should be no open top cars suitable for coal transportation furnished for any commodities other than coal until coal mines had first received all the empty cars they could load. Action along this line was held off, but in the fall of 1917 the situation became such that Judge Lovett, then Commissioner of Transportation Priority for the President, finally found himself in the position where it was necessary to cut off car supply for road building materials. Thereafter, and practically throughout the war, transportation for road building materials was greatly curtailed and the road building industry itself necessarily curtailed in consequence.

RULE WHICH GUIDES CAR SERVICE.

I recite these facts of history merely to preface the statement that the result seems to have been an impression gained among shippers of other commodities that whenever the open top car supply becomes short it is the perfectly proper thing to cut off car supply for road building materials. I want to say at this point, and to make it very definite and clear, that that has never been the viewpoint of the Railroad Administration, nor that of any individual railroad officials, so far as I know. It has been our rule in the commission on car service, and in the administration generally, to proceed always in full accord with the requirements of the Act to Regulate Commerce, that there shall be no unjust discrimination between commodities. Unfortunately, however, the present state of industrial unrest in the country has precipitated situations which have made it necessary to deviate somewhat from this principle. The point to be borne in mind now, however, is this: That we are practically in a state of peace, although, to be sure, in a somewhat disturbed state in our domestic industrial condition, and under these circumstances it is no more than just and fair that all commodities should share in the available transportation facilities upon a just, reasonable, and nondiscriminatory basis. That, I

feel sure, is the rule which guides the Car Service Section and the Railroad Administration in their handling of the various problems that came before it, and I feel equally sure that that is the attitude which railroad men generally take in the disposition of their available car supply.

Coming now to the future, I think that the road building people should insist first, last, and all the time, that they propose to get this just, reasonable, and nondiscriminatory distribution of cars which is guaranteed them by law. That should be the basis of all your relations with the individual railroads and with any other organizations, Government or other, which have to do with the problem hereafter.

CENTRALIZED CONTROL OF SERVICE.

I had hoped that by the time of this meeting the railroad situation would have been so far settled as to enable us to know just what arrangements would be made by the carriers as to the future for centralized control of cars. By that I refer to the proposal which is still under consideration, that there shall be reestablished the commission on car service which handled car control in conjunction with the Interstate Commerce Commission for about a year preceding Federal control of railroads, and which, after Federal control, was taken over by the Railroad Administration as the car service section. Final decision of this proposition has not been rendered, but I think that I can say here that there is every indication that with the termination of Federal control, there will be in Washington some central organization of the railroads which will handle car supply generally throughout the country for the purpose of effecting the most efficient utilization of the equipment available, and for the benefit of the entire country. Certainly, if some such organization is not maintained by the railroads to work as did the old commission on car service with the Interstate Commerce Commission, then the Interstate Commerce Commission itself will undoubtedly have to handle the situation under the car service provision of section 1 of the act to regulate commerce, commonly known as the Esch car service bill.

I feel, therefore, that you can look forward with confidence to the opportunity of dealing on this general question with some central organization in Washington which shall have some control over the equipment which, according to all the information that comes to me, will in the next few years be in greater demand than ever before for the transportation of road-building materials. The particular point about this centralized control of cars is this: A great deal of your road building work is to be performed in one way or another in conjunction with the Federal authorities and through the administra-

tion of the Bureau of Public Roads of the Department of Agriculture. I take it, therefore, that henceforth we can look to the Bureau of Public Roads as a sort of liaison office between the road building projects and the State commissions and others, most intimately interested therein, and the central organization which controls car supply.

If the tonnage of road building materials to be handled in the next few years is anything like what is expected, it is my guess that there will be considerable advantage in having such a recognized point of contact, and I have not the slightest doubt that it will be conducive to a more efficient utilization of transportation facilities and better transportation service for the road-building people.

THE SUPPLY OF CARS.

Last July, when the Director General answered a resolution of the Senate with respect to the coal car situation, he pointed out that there were about 775,000 cars on Federal-controlled railroads of this country available for the transportation of coal. There have been some additions since, and when it is considered that some light capacity cars, not strictly suitable for coal transportation, are suitable for transportation of stone, sand, and gravel, it is probably fair to say that at the present time the cars available for the transportation of stone, sand, and gravel number in the neighborhood of 800,000. This does not mean, of course, that all those cars could be turned to the transportation of road-building materials, no more than it means that they could all be turned to the transportation of coal. They must, of necessity, be used indiscriminately for the transportation of that very heavy tonnage of bulk commodities which must necessarily be transported all over the country at all times. Principal among these are ore, limestone, and other commodities utilized in blast furnace operation.

This large number of cars, however, while it includes some increase during the past year from the number in operation previously, does not include much in the way of increase commensurate with the general increase of business over the past few years. That is the inevitable result of the restrictions upon car purchase necessary during the war for one or another reason, and the fact that many cars have gone out of service during the past few years incident to the very heavy use which was made of them on account of war necessity.

The opinion of most men conversant with the situation is that when a well stabilized condition of industry again develops there will be an extraordinary resumption of business, and a very heavy demand upon the railroads in consequence. Your extraordinary road-building program is, in part, one element of this increased tonnage that may be

expected from the endeavor of the country to catch up with postponed peace-time employment. All in all, I think that you may look forward to the necessity, during the next few years, of railroads, shippers and consignees combines, making the most effective use of all equipment units available if the demand for the same is to be met.

EFFECTIVE USE OF EQUIPMENT.

You will observe that I put the obligation of making effective use of equipment upon the railroads just as much as on the shippers and the consignees. This is entirely proper. It is no more than right that the railroads, urging as they constantly do that shippers and consignee by every means shall utilize cars with the greatest efficiency, should do the same themselves. You should not hesitate, in your relations with the various carriers, where you find that they are wasting car days by neglecting to pull loads or to dispose of empties, to direct their attention to the fact and to follow it up until corrected. At the same time you should make every effort yourselves to make every car go the farthest. In a time of car shortage it is practically nothing less than a crime, regardless of shippers' rights under tariff provisions, to ship out cars which are not fully loaded to their carrying capacity. Likewise, it is nothing short of waste of the rankest kind to take two days to load or unload a car if you can do it in a day or less. We have seen numerous instances during the war period of consignees permitting cars to remain loaded on their tracks because they were short of labor and it was cheaper to pay demurrage than to take men from other lines of employment to put them to unloading the cars. Such consignees overlook the fact that every day's delay of that kind reduces the capacity of the railroad plant just that much, and inevitably, in the aggregate, tends in a material way to produce or increase a car shortage. That has been adequately proved to our satisfaction during the past few months when we have made a particular effort to cut down the detention of cars for unloading. A detailed record was kept of all cars of coal which remained on consignee's tracks longer than the 48 hours free time permitted by the demurrage tariffs, and it was not unusual to find on one railroad that the car days lost in this way were enough to have produced an additional 1,000 tons of coal on that railroad that day had the cars been released and put back to the mines, and this, you must bear in mind, at a time when the railroads were being criticized severely because of their inability to furnish car supply at the mines.

That brings me to another phase of the subject which is akin to what I have no doubt all of you men here have given much thought to, and that is the regularization of industry and its effect upon

car supply. We in the railroad game have looked upon road building as a seasonal industry. One of the difficulties of railroading, as I see it, is that a good deal of the tonnage is seasonal tonnage, and the seasons run too much together. For instance, take this last year: Your road-building projects, through no fault of your own, so far as I can understand, were rather late in getting started. You had no more than started than the demand for coal started. We were then faced, in August, September, and October, with a demand for cars for both coal and road-building materials that was in excess of the available supply. Only a few months before, however, there had been weeks when the railroads were carrying 200,000 open-top cars a day in excess of all demands for them.

Our problem is to equalize that demand throughout the year and spread it over the whole twelve months. That is where the theory of regularization of industry will help the railroads, and, conversely, the regularization of industry will help industry itself by giving it more regular transportation. I am, therefore, an ardent supporter of the campaign to regularize industry, because I know that thereby we can regularize transportation demand, and the railroads can give better service than ever before and perhaps with less relative investment in equipment than has heretofore been necessary.

KEEP BUILDING PROJECTS GOING.

Along this line let me suggest that you should do your utmost to keep your building projects going, wherever possible, throughout the year. You should give the railroads which you expect to serve those projects all the advance notice possible, of what tonnage you expect to offer them, the points from which it will move, the average number of cars per day you expect to load, and the points to which it must be moved. Assemble this information and give it to the railroads at the earliest possible date in advance of the movement. You will probably find yourselves more certain of service if you are able to utilize what would otherwise be a return empty movement of cars to mines. I appreciate that it is not always possible to draw your raw materials from localities that will permit movement in that way, but where it can be done it will probably tend to assist you in car supply, should car shortage conditions develop.

You should load your cars as rapidly as possible, and to capacity, and you should urge upon your consignees that they should unload the cars and see that they are pulled out empty with the greatest rapidity. I feel sure that if all get together and each recognizes the obligation upon him to avoid transportation waste, that the job before us all can be met and met successfully

There will undoubtedly come times, however, when in some sections, because of the lack of sufficient open top cars on certain railroads, or because of an extraordinary road-building project in a community that does not ordinarily need open top cars, you will find a shortage developing which can not be cured by the individual railroad. You should handle this in the first instance with the individual railroad as far as possible. If that fails, however, I would suggest that the officials in charge of the project will probably be able, through communication with the Bureau of Public Roads, of the Department of Agriculture, or directly, if that is preferred by them, to obtain some assistance if assistance is in any way obtainable, through the medium of the central organization which will control cars in Washington. But the big point is to handle your difficulties to a conclusion, wherever possible, with your individual railroad, for in the last analysis your help must come from the men who handled the cars.

DISCUSSION OF MR. GUTHEIM'S PAPER.

Thos. H. MacDonald, Chief of Bureau of Public Roads: Without going too deeply into the questions raised by this paper, it seems to me that this association should take note of the fact that we are very likely to be faced with an increase in freight rates on road-building materials before we are in session again. And this question, as well as that of car service, seem to me to justify the establishment (within the executive committee perhaps), of a subcommittee that will deal with questions of that character. I don't know whether that is the way the association would wish to handle it, but whatever individuals are delegated to handle questions of this character for the association during the next year, in my opinion, will have to figure that as part of their public service.

G. P. Coleman, commissioner, Virginia: I agree with Mr. MacDonald that this question of transportation and freight rates is the most important question that is confronting the highway builders to-day, and that we must of necessity to protect the work which we have in hand, have some representatives from this association appear, or be in position to appear when necessary, before the proper bodies in Washington to represent our interests. I think all of us realize the importance of this question, but I am free to tell you, as a member of the executive committee, whether it is the wish of this association that it shall handle it, or whether it is the association's wish that the matter be handled by a special committee, we will do our best to see that it is taken care of.

Statement Submitted by the Highway Division of the Associated General Contractors.

Presented by R. G. Collins.

ACCORDING to Mr. Thomas H. Macdonald, Chief of the Bureau of Public Roads, there will be available for highway work during 1920, \$633,000,000. This is more than four times the amount of money that has ever been expended during any previous year for like purposes.

This enormous highway program is the direct result of the demand for better highways which has been made by the people throughout the United States. The responsibility for carrying through this program and obtaining these results rests primarily with you gentlemen as State highway commissioners and engineers to administer and design, and secondarily with us as highway contractors to execute the work. We shall both be held to account if we do not produce a large and substantial mileage of highway in response to the enormous bond issues which have been voted by the public.

Although the production during the past year has exceeded all previous records, it is evident that if the mileage to be built during 1920 is to be even greater than that, careful consideration must be given to the experiences encountered during this last year of unusual performance.

In his very able letter to the State highway departments, dated October 27, 1919, Mr. Macdonald, Chief of the Bureau of Public Roads, points out four principal factors which must be taken into consideration if the production of highways is to be increased. These are: (1) Material supplies; (2) Shipping facilities; (3) labor supplies; and (4) contractors' organizations.

MATERIAL SUPPLIES.

1. Early letting of contracts: The first and most important consideration affecting the highway program for 1920 is an early letting of contracts. While this affects particularly the question of transportation and contractors' organization, it has its most significant bearing upon the question of material supplies. An early letting of contracts will enable the contractor to place his order for materials with the manufacturer at once and thus enable the manufacturer in turn to take advantage of all available seasonable weather in which to operate his plant. Again, contractors can take advantage of the supply of open-top car equipments during the months of February, March, and April, when, as pointed out by Mr. MacDonald, there is a large supply of idle equipment.

2. Estimating materials in stock piles.—But the advantage which thus accrues from an early letting is frequently offset by the heavy expenses and the

large capital investment which contractors have been under because of the provision in most highway contracts that materials shall not be paid for until they are in place. The result is that the contractor aims to minimize the amount of time between the receipt of his materials and their actual use in highway construction as much as possible. This means that he is obliged to postpone the delivery of the materials until ready to use them, with the result that production and transportation of them is also postponed until the last minute. The obvious result of all this is a serious shortage of materials with consequent waste of time and loss of mileage during the very best days of the year. This whole difficulty could be avoided if county, State, and Federal authorities would estimate to the contractor aggregates stored in quantities on account of contracts let, including the cost of material and handling of all aggregates stored in stock piles. Some States have already included such a provision in the contracts. In attempting to meet this situation another State, however, is planning to adopt a method of procedure, which is most unsatisfactory to contractors. In this case, the State has agreed to pay the manufacturer for all materials delivered to the contractor on presentation by the contractor of the proper evidence and details of their delivery and cost; but several general contractors, who have highway contracts in this State have refused to take advantage of this method, which disclosed to public use details of their contracts with the manufacturers which they consider private. Others consider such a step only one removed from the situation where the State will furnish the material, a proceeding to which they are unalterably opposed.

To quote from a recent editorial in the American Contractor:

One of the most valuable assets that a contractor has is his ability to purchase and secure delivery of materials. Expert purchasing ability is just as important a part of the contractors' organization as labor and methods of handling work. The contractor through experience, becomes an expert buyer and his ability in this respect is reflected in his bid. The contractor who can control the shipments and the delivery of his materials will submit a more attractive bid than he would if this control were to be taken out of his hands.

If purchases of materials are controlled by the State, the people of the State will have to pay more for the roads and highways that are to be constructed. There is no question about that. The matter of control is the vital thing. The control of delivery which enables the contractor to obtain the materials when and as he wants them is absolutely

essential if we are going to have a sufficient highway construction. When the State furnishes the material it assumes a measure of responsibility for the delivery of that material, but if a shortage should occur, it would be an easy matter to show favoritism in allocating the supply. The State would also have to be prepared to meet a measure of financial responsibility for delayed deliveries. If the State furnishes aggregate the contractor will be forced to add from 10 to 25 per cent to his labor cost to provide for losses which he may incur in connection with the delivery of materials.

3. Use of local aggregates.—A third means of greatly increasing the supply of material for highway construction may be found by the adoption of the policy of using local aggregates wherever possible, and the encouragement of opening local pits and quarries. Such a policy will not only materially increase the supply of materials available for highway work, but will help relieve railroad congestion, reduce the cost of construction, and greatly expedite the work. We believe that such a policy should be followed even to the extent of modifying specifications as to tests of materials where necessary.

4. Inspection of materials at source.—Another consideration which should be given attention in discussing material supplies is the inspection of materials at the source. It not infrequently happens that materials taken from a source from which samples have been approved by those in charge of the work have been rejected when delivered to the job. While the engineer, or inspector, is justified in refusing materials which are not up to standard specifications, the contractor on the other hand is hardly to be penalized for delivering materials from a source already approved by the same engineer or inspector. The contractor is, however, forced to stand the loss which such a procedure entails in time and money. It also frequently happens that materials, such as cement, which is delivered to the contractor in carload lots, is held up for days awaiting the approval of the inspector. Both of these contingencies could be avoided, and the progress of the work expedited, if the materials for use on a contract were inspected at the source of production.

As has already been pointed out, the problem of insuring an adequate supply of materials is closely related to that of providing adequate shipping facilities. The real solution of this problem will come about if a proper supply of cars is maintained by the railroads. Measures which will reduce the demand for cars, or which will distribute the demand over slack seasons will help materially, but the solution of the problem is to have the cars available when they are needed. This does not necessarily mean that the number of cars available must in all cases be increased, but rather that the supply shall be used with the most intelligent regard for economical service. Both State and Federal highway engineers can do much to help the contractors secure

increased car supply and better car service in particular instances, if they will recognize the importance of their positions in the State or Federal administration in securing proper action in regard to transportation facilities as it relates to road work.

CONTRACTORS' ORGANIZATION.

The problem of carrying through the tremendous highway program which has been outlined depends even more upon the contractors' organization than it does upon material supplies. Material will ultimately arrive at the job, but without the adequate organization to put them into place and to get the work done, no great advance over the highwater record of 1919 can be expected. Until very recently, it has been an outstanding characteristic of highway construction that large contractors have not been particularly interested in highway contracts. Unless these men, with their large organization and capital, with their adequate equipment and well organized force of men to handle big projects, are encouraged to take part and find a share in that program attractive to them, large parts of work are bound to remain uncompleted.

To bring these men into the work the following suggestions are offered:

1. Let contracts in longer sections in one contract extending over longer periods of time than one season; and let such contracts include all the work on any section, including grading, paving, bridges, culverts, etc.

2. Let contracts only to responsible contractors who will show the qualifications sufficient to perform the contract as stated, careful consideration being given to the contractors' organization, equipment, past performance and financial responsibility.

3. Safeguard highway contracts from unnecessary risks, such as forced increases in freight rates, time lost bidding on jobs which do not go ahead, tying up of proposal guarantees and other losses incident upon delay in awarding contracts, unlimited responsibility on the part of contractors, unreasonable provisions of maintenance of highway after completion, retention of unnecessarily large percentage of payments, lack of specific information in plans and specifications, and inadequate amount of time allowed for studying them, needless refinement insisted upon by inexperienced inspectors, etc., etc.

If our conference could result in providing some adequate consideration of these three considerations, the problem of contractors' organizations to handle the enormous highway program would be solved.

AN ADEQUATE SUPPLY OF LABOR.

When the problem of attracting sufficient able contractors' organizations to undertake highway work is solved, the question of adequate labor sup-

ply will solve itself, for with better equipment, and an able organization, forces of labor can be quickly brought together and utilized to greater efficiency. The right sort of contractors' organizations can also supply and keep the right kind of labor, because they will maintain the right sort of conditions to help good labor on the job.

SCOPE OF CONTRACT.

The chief reason which has deterred the majority of large contractors from undertaking highway work is the scope of the contract. Adequate equipment for highway construction undertaken on a scale which would be attractive to a large organization is too expensive an investment for a single season's contract on a small stretch of road.

In view of the unprecedented shortage of labor it is obvious that the construction program which has been outlined can only be carried through by substituting machinery for labor. When it is recognized that the special equipment necessary to construct 8 to 10 miles of concrete highway in one season will cost from \$75,000 to \$100,000, you will realize the enormous investment which will have to be made to carry out under existing conditions the program which the public demands.

These factors should be given a great consideration in determining the scope of the contracts and the fitness of the concern to whom the contract is to be awarded. If each contract were let in larger sections, extending over longer periods of time than a single season, larger contractors would find it worth while to devote their organizations and equipment investment necessary to large scale highway construction.

In this connection it seems almost unnecessary to point out the effect of the tendency in some States to let different parts of the work in the same section to different contractors. Large contractors with large organizations are not interested in highway work where the grading is let to one man, the paving to another, and the bridge and culvert work to still others. He is equipped and organized to handle a job from start to finish, and his whole force is coordinated with that end in view. To engage one part of it only is to enforce idleness on the others and to disrupt his organization. Again, the responsibility for coordinating his organization and work with that of other contractors frequently involves greater risks and losses in time and money than these contractors care to bother with. Especially is this true where there is a separation of such parts of the work as grading and paving. General contractors are organized to handle large contracts as a whole and if the advantage of their large scale organization is to be had in highway work, highway contracts must be let as a whole. The saving to the

State in better highways and in greater mileage produced will more than offset the apparent saving which appears on paper in totaling up separate bids.

RECOGNIZING RELIABILITY IN AWARDING CONTRACTS.

There is, however, a second consideration which has almost as great a bearing on the question of interesting large and able contractors' organizations in highway work and that is the elimination of the unreliable and irresponsible contractor as a factor of comparison in awarding contracts. Reliable and competent contractors will not waste time submitting bids in highway work when they realize that no consideration will be given to their organization, equipment, past performance, financial responsibility, and general ability to perform the contract. Of all types of construction, highway work offers greater possibilities for the "fly-by-night" contractor to compete on an apparently equal footing with the responsible man, than almost any other kind. The characteristics of public work enhance these possibilities. As a result, unless some of the obvious factors such as have been mentioned are given greater work with the actual price figures, first-class men will not bid on highway work. Some method must be developed for giving contractors assurance that those factors will be considered if the ablest men are to be attracted to highway work. The obvious saving of a few dollars as between the low bidder who does not know his business and can not perform the work satisfactorily and the contractor who knows his costs and guarantees an A-1 performance in reality exists only on paper. It can be set down as fundamental that more mileage and better highways can be produced by better contractors, and better contractors will be interested in highways only when the quality which enables them to produce such results is given weight in comparison with men who can bid but can not perform.

ELIMINATING UNNECESSARY RISKS.

It is probable, if contractors could be assured of contracts whose scope would interest large organizations and capital investment and a due recognition of quality and performance as well as bidding price, that the main obstacle to interesting large contractors in highway construction would be overcome. But even then highway construction would not be all smooth sailing. There exists at present in highway work, due to the fact that it has practically grown up overnight, various risks and undeveloped elements which make contracting in this field less attractive than in the more developed lines of construction. While individually these are of less importance, together they have a very important bearing on the interest which contractors with large and capable organizations take in highway work.

The procedure and practice surrounding the letting of highway work is in some States still in the stage of development. Proposals for highway work are frequently requested when the details of financing have not been taken care of. As a result the letting is delayed if not indefinitely postponed, and the proposal guarantees held up and time lost all around. Bids are rejected in highway work for any reason under the sun, and the contract let to some one else who will cut under the figures announced.

Sometimes plans are not delivered on the work to be let until a few days before bids are asked for, and then frequently the plans give only the most meager information. On the other hand, needless refinements in the specifications are sometimes insisted upon by inexperienced inspectors when the progress of the work demands a reasonable interpretation.

According to some contracts the contractor's responsibility for all easements or for the maintenance of the highway, even after it is turned over to the public, seem almost unlimited. At the same time the retained percentage on highway work is frequently away out of proportion to the actual necessity for safeguarding the State, to the serious inconvenience and loss on the part of the contractor.

In all these points, the contractor is not asking the highway departments to relieve him of the risks for which he is paid to assume, but rather to relieve him of those risks for which he is not by any right responsible.

One of the most obvious of these details which have served to keep conservative contractors away from road construction is the uncertainty of freight rates. Fortunately some State highway departments have already made provision to allow for such increases in freight rates, but the majority have still to make adequate provisions for reimbursing the contractor for increases in freight rates which are ordered after he has signed his contract.

Where bids are rejected due to difficulties in financing or for other good and sufficient reasons, the low bidders should be reimbursed at least one-half of 1 per cent of the average of their bids toward their expense.

PLANS AND SPECIFICATIONS.

In order to secure responsible contractors who will make responsible bids on highway work, time to make up an intelligent bid must be allowed. A reasonable length of time, say 3 weeks, can be established as the minimum time between the date plans and specifications are furnished and the date bids are to be submitted.

It is surely not an unreasonable request also to ask that plans and specifications show the limits of the right of way, the amount of grading to be done, the location and size of culverts, bridges, etc., with a reasonable amount of accuracy; and, furthermore,

it seems reasonable also to suggest that if there are any material changes in the plans furnished to the contractor after the contract is awarded, that the contractor be compensated for the extra cost and delay on account of making changes. Such suggestions as these provide no special favors for the contractor; they are simply checks which probably safeguard the contractor against loss of time and money due to lack of reasonable consideration for his interests on the part of the officials in charge of the work.

If refinements in specifications are shown to be unreasonable, joint consideration by contractors and engineers in conferences like this should remove them. Both contractors and engineers should urge the proper authorities to appropriate sufficient funds to secure the services of competent inspectors by paying them a wage equal to that paid the same class of men in other industries.

LIMIT THE RESPONSIBILITY.

We do not think it unreasonable to ask that the contractor's responsibility and liability be limited in several respects on highway work, and we believe that to do so will help encourage responsible contractors to undertake it. The practice adopted in some States of providing easements to contractors for special roads and bypaths maintained for public convenience might be adopted to advantage by other highway departments. Again, to ask contractors to be responsible for the maintenance of roads after they have been opened to public use is to make them responsible for the plans, specifications, and inspection which it is the highway department's duty to assume. If the plans and specifications are sufficient to get a satisfactory road, and if the inspection is properly done, it can be rightly assumed that a good road has been constructed. To extend the contractor's responsibility, as in some States, to a year after the completion is sufficient to drive any reasonable contractor from highway construction. Each section of highway work, as it is opened for public use, should be accepted at the time paid for in full.

PAYMENTS.

The question of payments, beginning with the return of the proposal guarantee and including the payment for work done, is a problem which warrants more consideration if highway contracts are to be developed to their greatest efficiency. The recent clause adopted in Minnesota solves some of these difficulties. According to its provisions, all contracts are to be awarded within 10 days after the date of the proposal, and all proposal guarantees, except that of the successful bidder, will be returned within 3 days following the award of the contract. Should no award be made within 10 days, all proposals will be rejected and all guarantees returned.

In making progress payments on work, we believe that monthly or semimonthly estimates should be based on 100 per cent of the work done, with a sufficient percentage retained to protect the owner. This retained percentage should never exceed 10 per cent and should stop when it amounts to 5 per cent of the total estimated amount of the contract. Large contracts soon run into big money and partial payments based on estimates that are reduced at every step as they go down the line, and retained percentages which exceed reasonable limits soon find the contractor with large investments, not only in organization and equipment but also in State highways, perhaps the last place in the world he wants it invested. The Engineer Corps of the United States Army follows such a plan of retained percentage on their work and finds it very satisfactory. Similarly, the same plan may be applied to the reduction of the amount of bond necessary as the work is completed.

FORCE ACCOUNT WORK.

Payment for force account work frequently is a cause of friction in highway work. The clause recently adopted by the State highway department of Minnesota is worth consideration in this connection. Paragraph 33 of the Minnesota specifications entitled "Force account work" has been changed to read as follows:

All work done on force account basis will be paid for in the following manner:

(a) For all labor, teams, and foremen in direct charge of the specific operation, and such other expense as is directly a part of the cost of the work, the contractor shall receive the current local rate of wage, to be agreed upon in writing before starting such work, for each and every hour that said labor, teams, and foremen are actually engaged in such work, to which shall be added an amount equal to 15 per cent of the sum thereof.

(b) For all materials used the contractor shall receive the actual cost of such material, including freight charges as shown by original receipted bills, to which cost shall be added a sum equal to 15 per cent thereof.

(c) For any machine, power, tools, or equipment, including fuel, lubricants, which may be deemed desirable or necessary to use, the engineer shall allow the contractor a reasonable rental price, to be agreed upon in writing before such work is done, for each and every hour that said tools or equipment are in use on such work, to which sum no percentage shall be added.

ENGINEER'S ESTIMATES.

With the question of payments is closely connected the subject of the engineer's estimate. When highway contracts are let at unit prices, the engineer directly in charge of the work feels, nevertheless,

that the total cost should correspond as nearly as possible with the costs shown on his original estimates. While both contractors and engineers recognize the fact that it is almost impossible to prepare plans and specifications that are so perfect that they do not have to be altered after the work is started, thus affecting the original estimate, county boards and other officials who are not experienced in engineering and contracting are not so ready to acknowledge the engineer's estimate as an approximate figure. In making adjustments on cost plus work frequently the result is that basing his stand on this estimate the local engineer attempts to make a lump-sum contract out of a unit-price job. State highway officials can do much toward educating local engineers in regard to this subject and help secure much more reasonable consideration of work done on a cost-plus basis.

We strongly recommend that your association take definite action by authorizing your executive committee to appoint a permanent committee to act jointly with us in improving existing conditions and unite our efforts to fulfill the expectation of the public.

The best evidence that these suggestions are within the realm of possibility lies in the very fact that in response to the invitation of your association the Associated General Contractors, representing the ablest contractors in the country, have called highway contractors together from all parts of the country to discuss these problems and are present here to-night in large numbers as evidence of their good faith in talking them.

DISCUSSION OF PAPER BY MR. COLLINS.

A Member: I would like to ask Mr. Collins what size contract he would consider best for the contractors to figure on. I am asking for this reason: If the contracts are large, there are very few contractors who will bid on the work. Certain work we have on hand now is made up almost entirely of large contracts; very few of them as they stand today figure at less than \$200,000. The question in my mind is whether we shall cut them into smaller projects, say of \$100,000 each, or leave them as they are. We have one nearly \$500,000. What I want to get at is what the contractor would consider an inviting project for bidding.

Mr. Collins: Well, I don't think any large contracting organization would want to go down there for anything less than \$200,000. I think the question of the handling of contracts depends largely on the locality in which it is to be built. The 4-mile contract for one section is pretty big, and the 20-mile contract in another section is no bigger. I think it depends on that and the quickness and manner in which local organizations are kept and the

quickness with which you can get through the job. It is not so much a matter of cost as of quality.

F. F. Rogers, State Highway Commissioner, Michigan: If I might supplement, I might suggest a plan in use in some States now—that is, taking bids in short sections of, say, 10 miles, and accepting combination bids for three or four sections. In this manner the contractor of a large organization can bid on the larger section and the small individual contractor can bid on the smaller section. That would give a chance to compare the bids, and, as has been found to be the case in a number of instances, the bid of the larger contractor on the combined sections may be less than the bid of the small contractor on the small sections.

Mr. Collins: Right there I would like to add to one point I tried to make plain in the paper. People want roads, and the total of small bids on paper may be less than the total of a larger contractor's bid. The question is, which is the better bid for the peo-

ple, in view of the fact that they want roads. I think such things ought to be taken into consideration equally with the mere figures.

Mr. Rogers: Our experience in Michigan is that even our best contractors are unable to finish more than 5 or 6 miles in the season. If we have 25 miles in one project and we don't split it up into 5 or 6 sections we have either got to have a contractor who will put on 5 or 6 entities or have 5 or 6 contractors on the job to get it done in the season. There is some tendency sometimes with the larger fellows to sublet the grading, the culverts, and some of the other work, so that in reality we have just as many irresponsible fellows to deal with carrying our construction as we would have if the other men got on the job who could guarantee to complete 5 or 6 miles a year. As a matter of fact we have only had two contractors who have completed 5 miles and upwards of roads this year, where we have about half a dozen that have fallen down on that much.

Surveys and Plans and Suggested Changes to Meet the Shortage of Engineers.

P. St. J. Wilson, Chief Engineer, U. S. Bureau of Public Roads.

THE pamphlet issued April 28, 1917, from the Office of the Secretary of Agriculture and entitled, "Standards Governing the Form and Arrangements of Plans, Specifications, and Estimates for Federal Aid Projects," by implication presents the ideas of the Bureau of Public Roads as to how surveys and plans should be made, although the word "surveys" does not occur in the title. This pamphlet was prepared by the Bureau of Public Roads in cooperation with a committee of this organization. At the end of the first season's work these requirements were discussed at some length at the Richmond meeting of the association and as a result amendments Nos. 1 and 2 were promulgated. At the end of the second year the State highway departments were requested to criticize certain amendments to the rules and regulations and to the standards, and as a result amendment No. 3 to those standards, approved March 18, 1919, was promulgated, and at that time it met as far as possible all of the major criticisms made by the State highway departments. Some of the criticisms made by individual States were so conflicting as to make it impossible to meet them all.

EXISTING STANDARDS SATISFACTORY.

Upon the assignment of the present subject for my presentation to you at this meeting, and with the thought in mind that the experience of the present season might have clearly developed further suggestions for modification of the existing stand-

ards, a circular letter was addressed to the State highway departments of the several States, asking for an expression of opinion as to the probable shortage of engineers and for suggestions as to further modifications of the requirements for plans and specifications, having such probable shortage of engineers in view. Replies have been received from 30 States. From these replies it is gratifying to report to you that the present standards are apparently satisfactory to a great majority of the States, and it will be a pleasure later to support this by quotations from the letters received.

Six States—Arizona, Michigan, Idaho, South Dakota, Oklahoma, and Wyoming—make suggestions that the plotting of cross sections might be omitted. Otherwise, there are few suggestions for reduction of the standards, except in minor details. It is felt that a thorough study of the amendment of March, 1919, to regulation 5, section 8, particularly of the amendments regarding the scale of plans and profiles, and of the requirements under cross section will convince those who object to plotting cross sections that considerable relief is possible under the existing regulations. For instance, it seems to be the impression of some of the above-mentioned States that cross sections must be taken every 100 feet, whereas the regulations reads: "For original plans, cross sections shall be taken at such intervals as may be necessary to show accurately the character and extent of the intended work." This makes no arbitrary limit of distance between cross sections.

Sixteen of the 30 State departments replying to the above-mentioned inquiry stated emphatically that they desire no changes in the existing standards.

SUGGESTED CHANGES CONSIDERED.

From the discussion submitted by several States, two definite minor points in the preparation of plans deserve consideration. First, that some relief is desirable in the regulation with respect to the ratio of the horizontal to the vertical scales on profiles. The regulation, as it now stands, requires the ratio to be 1 to 5 or 1 to 10, and in the case of 200 or 400 foot horizontal scales it is now suggested that 5 feet or 10 feet to the inch vertical be permitted. This suggestion from Arkansas is a good one and will be immediately taken under consideration for adoption.

Ohio suggests that where the stationing of both ends of the vertical curve is shown the length of vertical curves be not required on the profiles. This seems an unnecessary duplication and might be omitted. Another suggestion comes from several States that temporary obstructions like wire poles, fences, etc., may be omitted. While the Bureau of Public Roads has found this information very useful in some of its own work, it may not be in all cases, and the requirement might be made optional.

In regard to the criticism of Minnesota, I feel that we are not yet ready to concede that what is known as a preliminary plan is all that is necessary at the time of awarding the contract on a unit basis. Information in reasonable detail as to requirements, as well as a close approximation of quantities, are necessary to the contractor in order to enable him to bid intelligently, and I gather from a number of the letters recently received that the cost of acquiring such detail is more than compensated for in resulting prices. I should be interested in a development of his method should Mr. Mullen do that in his discussion of this paper.

EXPRESSION FROM STATE DEPARTMENTS.

As you will doubtless be interested in the opinions of the several States replying to my letter of October 28, I quote the opinions expressed regarding the present standards.

Arizona.—* * * Considerable reduction in the work * * * might be secured if the platting of cross sections were eliminated from the plans necessary to submit with the project agreement.

We believe that estimates would be much closer from slopes and center readings or from actual computation than by use of the planimeter, and that this work could best be done by the engineers overseeing construction rather than the location.

Arkansas.—* * * In our opinion the requirements as to the details to be shown upon the plans are probably too strict, and among the points that may be mentioned are the requirements for showing property owners, the location of unimportant fea-

tures, such as telephone poles, fence lines, and high and low water marks of small culverts where ruled profile paper is used.

In regard to scales, we still have many requests for scales other than those permissible at present, and it is true that in our State where more than one-third of our area is very flat, the scale of 200 or 400 feet to 1 inch horizontal and 5 or 10 feet to 1 inch vertical would be preferable, as the topography is such that frequently we find a fall of only 1 foot to the mile in our grades. Where the standard scale is now used many of the engineers are forced to make a set of working drawings for the contractor to a 400-foot scale in order to show the information in a condensed form for use in the field. This, of course, would not apply to closely built up sections, such as we find nearer the larger cities, but it should be remembered that nine-tenths of our roads are in the rural sections and on these roads there are very few topographical features to be shown.

Connecticut.—With reference to the suggestions concerning the general subject of Federal aid, much might be said regarding the duplication of work now performed by the State departments and the Bureau of Public Roads. If it were possible for your district engineers to pass finally and at once upon the surveys made by the State highway departments, without making it necessary to have a reinvestigation at Washington, it would seem to me, it would be of great value.

SALARY INCREASES THE SOLUTION.

Colorado.—An increase in road work as well as in railroad and irrigation projects I believe may be looked for during the coming year and will undoubtedly call for a large amount of engineering assistance. I believe it will be absolutely necessary that schedule of salaries paid for the different positions be increased substantially in order that men may be attracted to this line of work. As far as the best method of making our surveys and plans is concerned I have no radical changes to recommend.

Georgia.—* * * It is doubtful if anything could be omitted without in the long run causing some additional work to the project engineer.

Idaho.—I have one suggestion in regard to the preparation of plans which would materially cut down the time and cost in their preparation for Federal aid projects and that is the method of furnishing the department with plotted cross-sections with each and every 100-foot station on the line.

Illinois.—We are very much pleased in this department with the form of plans specified by your office. We are convinced after having tried the size of sheet, scales, and general practice that it is much superior to that which was formerly in use generally throughout the States.

I am convinced that no expense should be spared to make the surveys and the resulting plans carefully in order that difficulties during construction may be avoided.

Indiana.—We are experiencing very little difficulty with our plans in so far as the Bureau of Public Roads is concerned. I doubt if any modifications can be made that would materially help us. Since the rules and regulations have been revised, I believe there is very little called for that is nonessential.

Iowa.—In reply we wish to say that we have no criticisms to make of the requirements of the Bureau of Public Roads with reference to surveys and plans.

Kentucky.—I seriously question whether it would be advisable to curtail the amount of information that we now require on our plans.

Maine.—I do not know how satisfactory surveys and plans can be made except as already outlined by the bureau.

Massachusetts.—So far as making changes to meet a possible shortage of engineers is concerned, I would say that I do not see how we could make any material changes where it is necessary to make definite lines of location for the taking of land for layout.

Michigan.—It might be possible to leave off from the plans, cross-section at every station using only typical cross-sections, say every thousand feet or more where there is very little change in the contour of the land.

With this exception the Federal Aid plans are not more complete than we are making for all of our State trunk-line roads.

MINNESOTA'S SUGGESTION.

Minnesota.—I have your letter of the 28th instant, and replying would say that in my judgment the engineering work could be made less expensive and more progress accomplished in the starting of work, if your office would modify requirements as to perfection of detail on the preliminary plans. As a basis for consideration of this matter, you will first have to come to a conclusion that the preliminary plans, at best, are only made for the purpose of determining the general layout, and in the construction of substantial improvements as are being built in this section of the country, it is expected that plans will be revised by the resident engineer on construction as the work proceeds. This being granted, it is a waste of time for the engineer to spend a great deal of effort in trying to arrive at perfection in the preliminary plans, so long as his general layout is correct. In this State our work is let on a unit-price basis, the contractor being paid for grading on the actual excavation measured by the engineer at time of construction. When this is done the detailed accuracy of figuring quantities on the preliminaries is practically lost. If, however, we are to continue in the endeavor to have a perfect set of plans prepared before the letting of the work, it would then be better to let the work on a lump-sum basis and place an instrument man on the work instead of a resident engineer, forcing the contractor to build according to plans, regardless of local conditions, as they develop. To sum this matter up, I would say that a great deal of time could be saved and the engineer's situation relieved considerably, if your office would omit the detailed checking of plans, excepting as to general layout of the work, leaving it to the State highway department to execute the work according to the general plans and return to you a final plan and profile showing what was actually accomplished on the project. This is the method which is followed on State work in Minnesota and is very satisfactory.

New Mexico.—There is one hardship imposed by the Bureau of Public Roads which possibly could be eliminated and that is that the bureau demands the State highway department advise them of any

changes to be made on contracts which incur an increase in cost before work is started. This could be eliminated if such increases or decreases (changes) were put on the final plans and estimate at the time they are sent to the Bureau of Public Roads.

USE STANDARD ROADWAY SECTIONS.

New York.—The more extensive use of standard roadway sections and structures are to be encouraged to accompany contract plans as they tend to eliminate repetition and by the use of same necessary quantities become familiar to the designer.

North Dakota.—* * * having quite completely discarded the idea of machine or turnpike work, we have no special fault to find with the standards governing the execution and arrangement of plans and estimates as required by your department.

Ohio.—In answer permit me to say that in general the requirements for State aid are the same as for Federal aid projects and I can see few changes which could be made tending toward simplifying the preparation of plans.

Oklahoma.—* * * I have advocated from the start the preparation of simpler plans occupying much less space than the standards of your bureau and using symbolic alignment and other methods of shortening such preliminary work and reducing plans to more compact size.

COMPLETE INFORMATION IN PLANS.

Pennsylvania.—From my viewpoint, it would seem undesirable at this time to make any changes in your requirements which might lead to the preparation of plans which would not give complete information to the contractors. In view of the present high prices, I do not think it desirable to consider simplifying requirements. I believe that if our road plans contain full and concise information, not only as to location, grade line, cuts, fills, bridges, suitable material supplies, railroad sidings, streams, etc., that we will get more reasonable and lower bid prices.

Rhode Island.—We have plans and surveys complete for a considerable mileage of construction and reconstruction to be done next year.

South Carolina.—At various times during the year we have kicked among ourselves on the amount of detail required by the Bureau of Public Roads, yet after going over the entire methods and processes now being used we found that we were unable to devise a better scheme than is now being required by the Bureau of Public Roads. This is specially true in view of the fact that we are finding it necessary to use many young, inexperienced engineers. I, therefore, say that we are unable to make any recommendations toward the improvement of the present method of handling surveys and plans.

South Dakota.—Careful analysis of the present requirements of the Bureau of Public Roads for preparation of plans will convince anyone well informed on these matters that the requirements, on the whole, are no more than the same should be * * *.

There is just one requirement regarding which we feel like offering any suggestion, and this suggestion probably will apply with more force for a State new in road work like South Dakota, * * * than for older States where their principal efforts and expenditures are centered on surfacing.

We believe it would greatly accelerate the preparation of plans if the earthwork quantities could be based on estimates made from a center line survey.

Tennessee.—* * * I can really think of no changes to be made at this time. I believe that the surveys and plans should be as complete in every detail as possible and that the requirements now made are not in any sense excessive.

Washington.—In reply I wish to advise that we have experienced no difficulty whatever on this account nor on account of the requirements of your bureau, as they now stand. In fact we have secured the fullest cooperation on the part of your district office in Portland, Oreg., as well as the bureau at Washington, D. C., in all matters pertaining to the initiation and execution of Federal aid contracts.

West Virginia.—It is believed that the present requirements of surveys and plans, demanded by the Bureau of Public Roads, are as simple as they possibly could be, and yet meet the requirements which should be embodied in any such plans. It is believed that the present arrangement of plans in some respects even falls short of its purpose. The plans should show the balance, with respect to cuts and fills. It is believed that more time should be spent in surveys than we are able to at present. It has been found by experience that where the surveys have been made more carefully, that the subsequent construction of the road has been materially cheapened. This statement is more especially true in the mountainous State of West Virginia.

INDORSE REQUIREMENTS IN PLANS.

Wisconsin.—The Wisconsin Highway Commission endeavors each fall to secure a large mileage of surveys in order that the plans might be worked up during the winter months when it is impossible to carry on field work. I note that you state in the last paragraph of your letter that "it is believed a large amount of survey work should be completed before the next working season begins * * * ." This has always been our policy and due to that fact alone we are able to maintain the same force of engineers from one end of the year to the other and in that way are not bothered with the necessary engaging of a large force of engineers at the beginning of the season and the subsequent laying off of those same forces at the end of the season.

* * * I believe that the standards embodied in your standard plan are of such value that none of them can be eliminated. I have felt at times in the past two years' experience with Federal work that some of the requirements were perhaps unnecessary, but after working under your standards for two years I have changed my conclusions on this point, and even though I have sat down and made a study of the plans with a view to cutting down all the work, I have been able to find nothing that could be omitted without affecting the value of the plan.

Wyoming.—* * * I believe that our work on plans for Federal aid projects has been so developed as to keep the costs of this work as low as could be expected under the present regulations.

The cost can be reduced and consequently the number of draftsmen required be reduced by less rigid requirements as to cross sections and estimates. The cost of platting cross sections for every

station or oftener, is high in comparison with the rest of the work. If the bureau would not require us to furnish cross sections, but depend on the highway departments to furnish satisfactory estimates, using whatever method that they should see fit, to make these estimates, a very material saving will result, and I desire to strongly urge that this change in your requirements be made.

THE SUPPLY OF ENGINEERS.

With reference now to the question of the apprehended shortage of highway engineers and surveyors, replies to my letter of October 28 from 29 States present interesting data. Seven States, Arizona, Colorado, and New Mexico in the far West; Kentucky, Ohio, and South Dakota in the Mississippi Valley; and New York in the North Atlantic States, report an anticipated shortage. Arkansas, Michigan and North Dakota in the Mississippi Valley indicate a probable shortage, as also does Wyoming. Four States, Alabama, Illinois, South Carolina, and West Virginia, are either silent or undecided, and eight States reply that no shortage is indicated. Iowa, Maine, Minnesota, Oklahoma, Pennsylvania, Washington, and Wisconsin indicate that there will probably be no shortage. So that of the 30 States, less than one-half indicate any anticipated shortage of engineers.

In general, the sentiment reflected is that the real shortage exists in the class of resident or constructing engineers and in some cases in the class of designing engineers. It is admitted that the better and more experienced men in general should receive larger salaries than now prevail. New York submits a schedule of salaries revised upward and effective November 1. Idaho regrets its inability to pay sufficient salaries under the law.

Notable results are reported from several States in the matter of accumulating sufficient surveys in the late fall to carry a considerable force through the winter on design work. It is quite apparent that a distinct effort has been made to prepare for the coming season's construction by the expediting of surveys in many States. Some of the States report that they will endeavor to do a considerable amount of surveying during the winter. A number of States indicate that their difficulties in securing engineers have been largely solved by the planning of their work so as to keep a permanent force throughout the year. From the far West reports from our district engineers and two of the State highway departments indicate that should a resumption of railroad construction occur an acute shortage of highway surveyors may result, since at present a considerable number of railroad engineers are engaged in highway work.

Apparently, in general, there will be a supply of highway engineers sufficient to handle the work for which contractors can be found in a large propor-

tion of the States. It is apparent from several replies that a shortage of contracting strength and of material supplies is more feared than a shortage of personnel.

A good suggestion comes from New York in the matter of making the maximum use of computing machines, tables, etc., in all calculations for highway design. There is no disposition evident to try to meet any anticipated shortage by a reduction in the quality or present standard of plans and surveys. It is recognized that highway work now costs nearly twice as much as it did four years ago and that now more than ever the plans must be complete in every detail to clearly set forth to the contractor for what he is to be paid. There is evidenced a desire to emphasize that we should not try and economize on the 10 per cent engineering item of the cost and take chances with the 90 per cent item of the total bill for the highway.

DISCUSSION OF CAPT. WILSON'S PAPER.

J. H. Mullen, chief engineer, Minnesota: I think perhaps a wrong impression may have been obtained—not intentionally—from the paper, in which Capt. Wilson stated that what is known as a preliminary plan is all that is necessary at the time of awarding the contract.

Minnesota doesn't advocate only what is known as the preliminary plan. On the contrary we have for the past six years used practically the same method of preparing our plans as that required by the Bureau of Public Roads at the present time. It is somewhat different in form but in general it is the same. We found several years ago that on the large grading work that we had in our State it was necessary to give the contractors very complete information as to the basis of their bidding. We have a bond law that permitted us to lay out our work in long sections. On two different roads the contracts were 70 miles long in each case and on many roads they were some 40 to 60 miles. That was a special assessment law. When we started in we found we had to have some really definite basis for awarding the contracts. So we made very complete cross sections of the work, drew up the cross sections, and furnished them to the contractors; and I believe that is absolutely right. I wouldn't recommend that the requirements in that respect be waived at all or that the wires be let down in that respect.

There is a little different method used in our State in preparing the cross sections. We draw the cross sections of the working profile. That is, it is not the actual profile that is submitted as part of the plans,

but we draw the profile on the upper half of the cross section, with the cross sections below in that particular location, which we think is a very good thing because it gives the man who is working on the design an opportunity to compare right before him the profile with the cross section. Of course the profile is not inked in; it is just a pencil profile used as a working profile. But we prefer to submit those cross-section sheets in that form with that temporary profile in pencil. We think it is somewhat a saving and we believe it works out to advantage on the job.

We go perhaps a little farther in some of our design work than is required. This is said just to clear the impression that we might want to cut down the plan requirements. We use a small-scale profile and require all our resident engineers to submit progress profiles on these small-scale profiles. Every month we receive a progress profile on every job showing what was accomplished. We use a color system to do that. That is, for the various months we use yellow, blue, green, red, and so on to show the progress of the work. It is mighty convenient, doesn't take a great deal of time, and gives us a good check.

CHECKING OF THE QUANTITIES.

The point that I tried to make in my letter to Capt. Wilson is that we do not consider that it is to the interest of the job to put too much refinement into the checking of the quantities. That is really the point. We believe that work should be checked as to the design, the grades, balancing of quantities in general, and the alignment of course should be checked; and we are very glad to have any suggestions that will better our layout as to grades and alignment.

But I believe there is a danger in the Bureau of Public Roads (the same as in our own departments in dealing with county engineers), to build up a little organization inside. I know we have had that to fight in our own department. You start checking work, put some one in charge of it, and that becomes the all-important feature of that work to that man, and he immediately begins to build up on it. As long as the quantities on the preliminary plan are reasonably accurate and are accurate enough to base your grade lines on, that is all that is really required, because all the State highway departments make their pay quantities on actual measurement of quantities moved, instead of on the preliminary.

So my point was, when the quantities reasonably check the plans should be approved without sending them back for remeasurement when perhaps the difference may be in a personal equation, the difference in the way of measuring the sections.

That doesn't seem to be very important, but it does gum up the work, especially in the spring when we all have more or less work hanging over us. We try to organize our work in such a way that we can use the survey organization for designing in the winter time, but that can not be done as well in practice as in theory. We find every spring we have a whole lot of work to jam through, make the surveys and plans and let the contracts after the snow leaves, really after the construction season opens. So that on that work it is very difficult to get the plans precisely according to requirements.

The requirement that changes of design be submitted to the department for approval I think should be omitted. Of course I imagine a good many States do make changes and then submit them to the district engineer without saying whether they have been made or not, asking for approval after changes. But really the intent is to have all changes approved before being made, which I don't think is practicable when we have a great deal of grade work.

I don't know of any other way that we can meet the shortage of engineers which is claimed to exist. We do not find there is a shortage of engineers up in Minnesota. We have a large number of railroad engineers up in that locality and we can draw from that source, but we will have to increase the salaries. The only danger we have is that they will enter other lines. It reverts back to the same situation that has been expressed here several times, and that is, we will have to pay more money if we are to interest the best kind of men in the work; and if we so interest the best kind of men there will be no shortage of engineers.

MUST MAINTAIN THE STANDARDS.

Col. W. D. Uhler, chief engineer, Pennsylvania: In reference to the remarks I have heard relative to doing away with some of these standards, I might say that if we attempt to do that and at the same time carry out a large program of construction we are bound to run up against a wall. We have been through times where we had a hundred miles of work and we did finely. Now that we have 3,200 miles of construction work on our hands, we find we can not take too much care in the preparation of plans and specifications.

As an illustration: If we attempt to do what some States are talking about, putting \$30,000,000 or \$40,000,000 worth of work under contract, if we don't make proper preliminary estimates on contracts how will we take care of our finances? What I mean is this: If you are simply making preliminary estimates of quantities, and your estimates overrun 15 to 20 per cent, there is going to be a day of reckoning. Take \$30,000,000 worth of work, if you overrun that by 20 to 25 per cent somebody is going to be up against it good and hard and proper. I

want to say to you, when you make your detailed estimates, try to get as near to the point as possible.

I know we double check everything. Some people may think the precautions we take are unnecessary, but there is not a single plan that goes out that is not checked in the central office. Notwithstanding the fact that you may term that unnecessary, we are carrying on the work this year and our cost will be less than 6 per cent. Had we had a fair working season we would have been under the 5 per cent limit in handling all our work.

I think any big business organization that can do business and expend \$25,000,000 or \$30,000,000 on a 5 per cent basis is to be congratulated. But the point I am trying to drive home is the fact that you can not be too careful in the preparation of plans, in getting out details. I have given considerable thought and study to the matter and do not see where there is any way you can better that. If we could save a nickel on every plan we would like to do it. And we are trying to do it, and at the same time trying to protect the interests of the State.

TRAINING THE ORGANIZATION.

As far as the shortage of engineers is concerned, I want to say to some of these States that are getting ready for large programs, you must train your own organizations. There is no use going out and loading yourself up with a lot of lame ducks. There are plenty of lame ducks floating around. You will get into trouble. Pick your own men, the bright prospects, train them, then you will have something to build on. We follow that policy and absolutely will not fill any of our higher positions from outside the organization. We pick up what we consider the brightest prospects we can find, put them through various lines of work, make them feel they have something to work for. We take the attitude that a man is worth more to us than he is to the other fellow. We have to make him feel he has something to work for, that there is a prospect ahead of him. We must keep him satisfied, and there is only one way, that is to increase his salary as he earns it.

We have a commissioner who believes in paying a man just what he is worth. He is opposed to any fixed salary for any one position. But you must train your organization. We have at the present time 286 inspectors. They are not all good men, by any means. But every man that has made good during the past working season will be carried this winter at his full inspector's salary, no matter whether he is assigned to survey work or field work. We expect to bring into our central office this January those fellows we think are bright prospects and put them through a course of training. In other words, we shall run a regular two weeks'

school or college course. We believe that after that two weeks' course (which will cost us in the neighborhood of \$15,000 or \$18,000) we shall have the nucleus of a real live organization to build on for next year.

The results obtained depend entirely upon the inspection. I don't care how good the engineer or supervisor or executive manager is, if you haven't proper inspection you are going to fail. And you can not go out and find a trained inspector. Why not spend a little money in training your own men?

EXPERIENCE WITH PROJECT ENGINEERS.

Thomas H. MacDonald, Chief of Bureau of Public Roads: It is perhaps not very fortunate, in the interests of harmony, to inject such a topic into this meeting, but it seems to me that we would not be taking the position that we should take if we did not state that up to the present time our experience with so-called project engineers on Federal projects has not been satisfactory. We do not believe that we can obtain the right kind of engineer from without the organization. Naturally, we expect that newly established highway departments and rapidly expanding highway departments will have to take on men and train them as rapidly as possible, and we will assist and sympathize in that development. But I do not believe, and this is personal and final, that we shall be able to obtain satisfactory highway engineers when project engineers are chosen outside the organization itself.

I suppose there are few departments which have made more miles of survey within the last few months than the Iowa department. I will call on Mr. White to tell us something of the methods they are using to get a large mileage of roads under survey.

F. R. White, chief engineer, Iowa: When we started out last spring we had three survey parties. They had a very small program before them. Of course we had to expand to handle the large amount of work that was thrown upon us under the new law, and we wound up the season with 30 parties. We were doing about 225 miles a month.

We may say that we have no complaints to make about the requirements of the Bureau of Public Roads with reference to the details of the survey or the details of the plans. In fact, I think we are putting more detail on the plans than the Bureau of Public Roads calls for, because we believe it is labor well spent.

I can heartily agree with the statement that if we do not get our preliminary plans right we are going to come to grief. We check all our quantities, and double check them, so we know within reasonable limits that they are right.

As to getting your plans in good shape, I wish to mention a little instance on one of our Federal

projects that came to my attention this fall. It was one of our early projects, in which there was an offset in the alignment. In the original survey the engineer had been just a little too economical of the right of way. He made too sharp a jog. Mr. Jones, who had charge of our plans, and I were going over them, and the matter was mentioned at that time. We said we will take care of that in the spring. This fall I went over the construction, and found that we had not taken care of it. The jog is there. It is not bad, but it just is not good. We ought to have held up the plans, even though it did mean delay, until we had got that straightened up and had made that original plan what it should be. If we had done that our construction would now be right. With a large mileage of road work going on, as Col. Uhler says, you will have to depend to a large extent on the man on the job; and if you give that man a plan that is not right he is going to give you a road that is not right. And the chief engineer, or supervising engineer, will not come around until something is done that is not right; all he can do is to swear about it.

CARE WITH PRELIMINARY PLANS.

H. K. Bishop, chief engineer, Indiana: I want to stress what Col. Uhler has said about preparation of plans. Two years ago, at Richmond, I was with the Bureau of Public Roads, and I was more or less under fire, with the rest of the officials of the bureau, on account of this same subject.

Some of the States thought we were requiring altogether too much in the plans. I believe there can not be too much care taken with the preliminary plans, and I believe that every dollar you spend in getting the preliminary plans right and in checking quantities is coming back to you two or three fold when you come to construction. When you have to change the plan after the contract is let it costs money. Not only that, but your contractors in bidding on the work soon learn whether or not the plans that you will put out are reliable.

There is another point that was brought out, and that is the fact that our men in charge of the contract work (and especially in the State of Indiana) are more or less inexperienced. We must, as Col. Uhler says, train our organization and must put out plans that those men will take and follow. We have found that where our plans are not properly prepared the men will follow the plans blindly without making the changes more experienced men will make.

I am rather inclined to feel that the Bureau of Public Roads is not making requirements enough. In Indiana, for our own convenience, we are putting on the plans a lot of things that are not required

by the Bureau of Public Roads. During this past season we have had to make a great many changes that could have been eliminated by more careful preparation of plans. I went to Indiana in June. We had to hurry in order to get the work under construction this year. We were not as careful as we are going to be next year. We hope to improve, and to go even farther than the bureau requires.

Fortunately we had a good district engineer. I want to say that where we have had to make changes, and we have had to make several of them, we have found our district engineer very reasonable; he will let us go ahead and make changes and submit the changes to him, and he has approved them. We have explained the circumstances to him, telling him we were really up against it, and he has made the changes and has always been agreeable. I think he recognized the changes were good and should be made.

THE COST OF SURVEYS.

Alex. W. Graham, State Highway Engineer, Missouri. In this survey problem you have touched every problem but one. That point is, how much is it right to pay for surveys? Our last legislature gave us the right to make a survey. But our State is young in highway construction, and very young indeed in using engineers on highways construction. We could not quote as high a figure for the surveys as is seemingly necessary, and I would like to know what is proper.

I succeeded in getting our legislature to consent to \$100 a mile, and we are getting the bulk of our work done for that price. We have 2,500 miles now under survey and should have the plans ready for rejection or approval in the early spring. We are using the county engineers and we are employing all of the private engineering firms in the State who care to take up the work, and to date I think \$135 a mile is the highest we have had to pay.

But engineers in the counties bordering Kansas have tasted blood and are wanting considerably more money. I would like to know what it costs in other States to do this work.

J. Roy Pennell, State Highway Engineer, South Carolina: I think I can answer that question. Put into the cost of the surveys and plans whatever is necessary to properly locate your routes. It is not a matter of cost. That is a secondary consideration. The chiefs of the surveying parties are probably the most important men we have on road work in South Carolina. We are not paying them enough, but we are trying to pay them more than the resident engineers on the work because theirs is the more important work. The cost of surveys in some instances runs as low as \$40 a mile. The average has been around \$40 to \$50 a mile for surveys. Plans cost about \$50 a mile, surveys and plans, somewhere

between \$100 and \$110. We supply a chief of party, an instrument man, and a rod man. The counties are furnishing all of the other help.

PERMANENT IMPROVEMENTS ONLY.

State Highway Commissioner Sadler of Pennsylvania has ruled that money derived from the sale of long-term bonds may not be used for the building of short-lived roads. The Pennsylvania law gives the commissioner control over county expenditures for highways. The ruling was brought out by a proposal from Venango County to use the proceeds of a bond issue of \$1,000,000 in the construction of cinder roads. In his ruling the commissioner said:

“Our studies clearly demonstrate that a cinder road is not serviceable under modern conditions of transportation. Upkeep of such a road would be continuous and costly. Long-time bonds should not and must not be used to build short-time roads. We can not consent to any improvement paid for with borrowed money—money borrowed for a long period of time—that is not an improvement of a durable type. Any other plan would be extravagant and waste. To put down cinder roads would mean annual rebuilding. The continuing cost prohibits this type of construction; long before the maturity of the bonds issued to pay for the cinders the roads would have disappeared.”

MUCH CRUSHED ROCK NEEDED.

It is estimated that the proposed road-building program in Minnesota this year will require about 667,000 tons of crushed rock or gravel, or nearly 20,000 carloads of aggregate. Largely on account of a shortage of crushed stone or gravel 58 miles of road which were to have been built in 1919 were not completed. These roads are to be completed this year, while about 180 miles of new construction requiring crushed rock or gravel has been authorized. This makes a mileage of 250 scheduled for 1920.

ROADS IN A MICHIGAN COUNTY.

According to the annual report of the road commission 258.08 miles of State-reward roads have been completed in Shiawassee County, Mich. During the past year 89.74 miles were built or were under construction, at a cost of \$506,975, of which the State will pay one-quarter. At present 191.24 miles of graveled road and 6 miles of dirt road are under maintenance by the county. The average cost of maintenance per year is \$128 a mile.

Relations with the Contractor, Influence of Fair Specifications and Inspection.

H. S. Mattimore, Engineer of Tests, State Highway Department of Pennsylvania.

THE subject assigned me by your committee is to my mind very important. There are many serious problems confronting highway officials at the present time. One of the main factors on which the accomplishment of this work depends is the securing of reputable contractors to undertake construction of these highways. It is a pure business proposition with these companies, and there is no reason why they will not seek it providing the highway officials make it attractive. This does not necessarily mean exorbitant prices. Fair prices with fair treatment and intelligent, clear specifications, with competent enforcement, generally proves to be a greater incentive than high prices coupled with extensive delays caused by incompetent inspection, indecision, and indefinite specifications.

Just what do we mean by friendly relations between State and contractor? Theoretically, it is a relation between the engineer and the contractor where both parties have the same views regarding the performance of a contract, and where the work is accomplished with little or no friction during its progress. We will have to admit that such a relationship is a Utopian one. In the first place we have one party interested mainly for financial gain, while the other being the purchaser, or his representative, is naturally interested in seeing that the article paid for is in his judgment equal to that which was agreed to.

Now, do not misunderstand me, I do not assume that as a class contractors, although seeking financial gain, are not willing to live up to their agreement. In fact, I really think otherwise. With very few exceptions our modern contractor is a big business man anxious to do good work and maintain friendly relations and thereby establish a good reputation. On the other hand, our engineers are fair minded, or at least try to be, and their decisions are influenced only from the standpoint of obtaining what in their judgment is a good quality of work.

SOME CAUSES OF CONFLICTS.

The causes of conflicts between the engineers and contractors are many and varied, but broadly they can be summed up as differences in viewpoint. These are bound to exist so long as individuals are of different character and mind, and in fact the stronger the character the more the argument necessary to change the viewpoint. Do not confuse this with ignorant stubbornness. We must be broad enough to realize that there are many problems in highway work that have more than one correct solution.

The highway official has full power to specify the character of work that the contractor must perform, and in justice to the State he must see that this work is performed according to these specifications. Now, to my mind, this is the source of many of the troubles arising during the progress of the work. The contract is taken by the contractor and he agrees to perform the necessary work in accordance with certain specifications. These specifications are written by the engineers and supposedly understood by the contractor. But are they always so understood? Are all specifications clear? As an answer consult articles in current numbers of engineering and contracting journals, also examine court records of State versus contractor on highway cases. In the latter you will find judge, jury, and many legal authorities trying to interpret various clauses in specifications. This in itself should convince us that the specifications must be clear. Make them concise if possible, but do not sacrifice clearness.

POINTS AS TO SPECIFICATIONS.

There is much to be said regarding specifications. In the first place they must not be a product of one mind. A clear and concise specification, if written by an individual, should be so written only after ideas are obtained from men directly connected with the details of construction. Good practice must be adhered to and all methods must be described as definitely as possible.

Do not specify better quality or more detail than you expect to obtain. We have all seen specifications with many paragraphs or phrases which were apparently written to act as a club over the contractor. They were supposedly intended as an insurance against a dishonest contractor. Such insurance leads to high bids, and large, reputable contracting companies will hesitate before bidding under such specifications, and when they do bid it will be high enough to play safe.

Occasionally another type of specification is encountered which is so open and broad that it is dangerous. I refer to specifications which, instead of definitely specifying qualities and describing methods, will call for work being done to the satisfaction of the engineers. This type is a survival of the days when the chief engineer or competent assistants could give much time to details. I doubt if such specifications proved satisfactory even then. At any rate, in the present days they would be hazardous for both State and contractor. No man can satisfactorily handle all details in super-

vising the large amount of work being done at present, and much supervision has to be left to subordinates. It is a careless and unnecessary procedure to place the responsibility of deciding broad questions on men of limited experience. Furthermore a reader of such specifications is impressed with the idea that the State presenting them was in ignorance of just what they did want.

The main factors affecting the relationship between the contractor and the State therefore might be enumerated as first, the type of specification under which the work is done; next, the interpretation of these specifications and finally their enforcement.

INTERPRETING SPECIFICATIONS.

I have briefly discussed two general types of specification to be avoided, and too much emphasis can not be placed on these points. In order to play fair, the engineers or other officials responsible on the part of the State must see that their specifications are clear, and that methods are definitely stated as far as it is practical to do so. If we expect to avoid friction during the progress of the work, we must have a proper understanding of what is expected, and this information should be conveyed in the specification. We can not expect a better class of materials and workmanship than is available. If we call for them the result will be that if the contract is ever completed we will find that we have not met the specification requirement but will probably be faced with the fact that we paid the price for them. A reputable contractor will take the specifications in good faith and assume they will be enforced. If they are impractical or not properly enforced the State is the loser, as a successful contractor prepares for the worst condition and bids accordingly.

Now, all specifications must be interpreted in many points, and as it is within their authority, this is entirely controlled by the State representatives. The type of man invested with this authority is a large factor in determining the relationship with the contractor, and also has a great influence on future prices. A broad minded man of experience insists upon an excellent quality of work, but he is reasonable enough to insist on this being obtained in the most expensive way.

RESPONSIBILITY OF INSPECTORS.

A certain amount of responsibility and some authority has to be given to the inspector on the contract. The experience of this man and his general character has a great influence on the work and the relationship maintained. This is the State employe who is most intimately associated with the contractor; and his decisions, although in many cases of a minor nature, are bound to have their effect on the subject under discussion. It is true that a good specification leaves little to the decision

of the inspector, but we must realize that there are still many points on which he has very little to guide him except past experience and good practice.

The first duty of an inspector is to inspect and insist on quality and compliance with specifications. Any failure on his part, in this regard, is an absolute neglect of duty. It can be said in praise of the engineer or inspector, from a moral standpoint, that a very small proportion deliberately err on the side of neglect of duty so far as their understanding of the specifications are concerned. In fact, their main faults are improper interpretation of the specifications; insufficient detailed knowledge of the different phases of the work, thereby making them uncertain in making decisions; inexperience, thereby unfitting them to determine between a major or minor cause for complaint; and finally a lack of cooperation with the contractor. This latter, and inexperience, are probably the main causes of delays on many contracts. The inspector should always see that the contract is performed in accordance with specifications, but instead of constantly complaining he should suggest methods for rectifying poor conditions. His aim should be to secure results and cooperate with the contractor in getting them. For example, in working local materials the inspector is, or should be, informed as to what is required, and having facilities for determining this he can guide the contractor in working deposits, so as to insure the delivery of acceptable material to the site of the work. Here I wish to emphasize that there is no intention to interfere with the contractors methods of working. The inspector should cooperate to the extent that no large amount of material will have to be rejected after hauling to the roadside. You can readily see how such cooperation on the part of the inspector will reduce costs to the contractor which in the end results in lower bids, and at the same time maintain a high standard of quality in the work.

An inspector should avoid indecision; a firm positive attitude on his part will command respect and maintain friendly relations to a greater extent than will the apparent indecision encountered on many contracts. The complaints from contractors because of indecision on the part of the engineer or inspector far outnumber those in regard to positive directions, even though the latter are at time somewhat severe.

AIDING THE CONTRACTOR.

All highway departments should aim to furnish competent, reliable information when calling for bids. This gives some definite knowledge to the contractor and allows him to bid with intelligence and thereby reduce his so-called contingency or safety item. Under this head might be mentioned sources of approved materials for construction. It is expected that a contractor will inspect the highway before bidding, but having no facilities for

determining quality he must figure on sources of known quality regardless of economy. All available material sources should be investigated by the State and full information furnished with the proposal or bidding sheet. This investigation of materials should be made as complete as possible. So far as I know no attempt has ever been made to guarantee these sources in quality and quantity. It is a question for thought whether it may not pay in the end to do so, but regardless of this I know from past experience that furnishing information on material sources, without guarantee, has proved economical. These sources, although not guaranteed, must be reliable, and great care and pains taken in their investigation, or otherwise very little benefit will result.

Highway officials desire to be fair and hope to impress this sense of their fairness on the contractor, not only to attract bidders, but from the general idea of fairness itself. In order to do this we must impress the contractor with the fact that in giving due consideration to the legal side of a contract we also know and consider the moral side.

DISCUSSION OF MR. MATTIMORE'S PAPER.

Paul D. Sargent, chief engineer of Maine: There are one or two points in connection with this topic which come to my mind. It seems to me that if contractors are intelligent and fair and honest, and engineers are intelligent and fair, there will not be anything but fair relations between them.

But, as we were told by our friend from Washington this morning, the doctors, lawyers, and bankers want to tell the engineers how to build the roads, and in this line of work, I don't know why it is, practically every man you meet thinks it is the easiest thing in the world to build a road. We have had the experience in our State shared by others, I suppose, of having a lot of inexperienced men bid on highway work, though they had no suspicion of what it meant to build an improved road. We have had men bid on our work, (and we have been forced to let the contract to one such) who could not read or write. Now that is an extreme sample of one class of men we have to deal with. There is not anything you can do to help men of that class that they will say is fair.

I think most engineers are disposed to be fair, and it has never been my observation that the engineer has tried to crowd the contractor if he had a fair man who wanted to do a fair job. Many times we have had contractors who would give us suggestions that would save them money and make the work just exactly as good, and we have always been glad to meet them half way.

I remember an experience I had five or six years ago with one of the best contractors we ever have had on our work. The first time I visited his work

I had never seen the superintendent and he never had seen me. I found him reprimanding the foreman who was laying a side drain and covering it with improper material. He made him take the material up and substitute good porous gravel. I immediately said, "I guess this fellow and I can get along all right." He has been doing work six years and we have never had a difference. He always does first class work, simply because he wants to, and he follows his specifications with intelligence. When you have a man like that to deal with it is not necessary to have a lot of hard and fast specifications, but when you have an ignorant fellow, you must draw specifications that he can not depart from.

When the honest fellow reads the specifications, he makes up his mind to bid against the worst contingency that may arise, fearing, of course, a rigid and arbitrary interpretation. I have always felt, when letting a job by contract, that we were paying even the good men for all that very minute detailed description we put into the specifications. They all bid on the worst possible contingency and then get away with a reasonably fair and honest job. Consequently we pay more than we should. But I don't know how to protect ourselves against the unscrupulous fellow unless we do have a rigid specification.

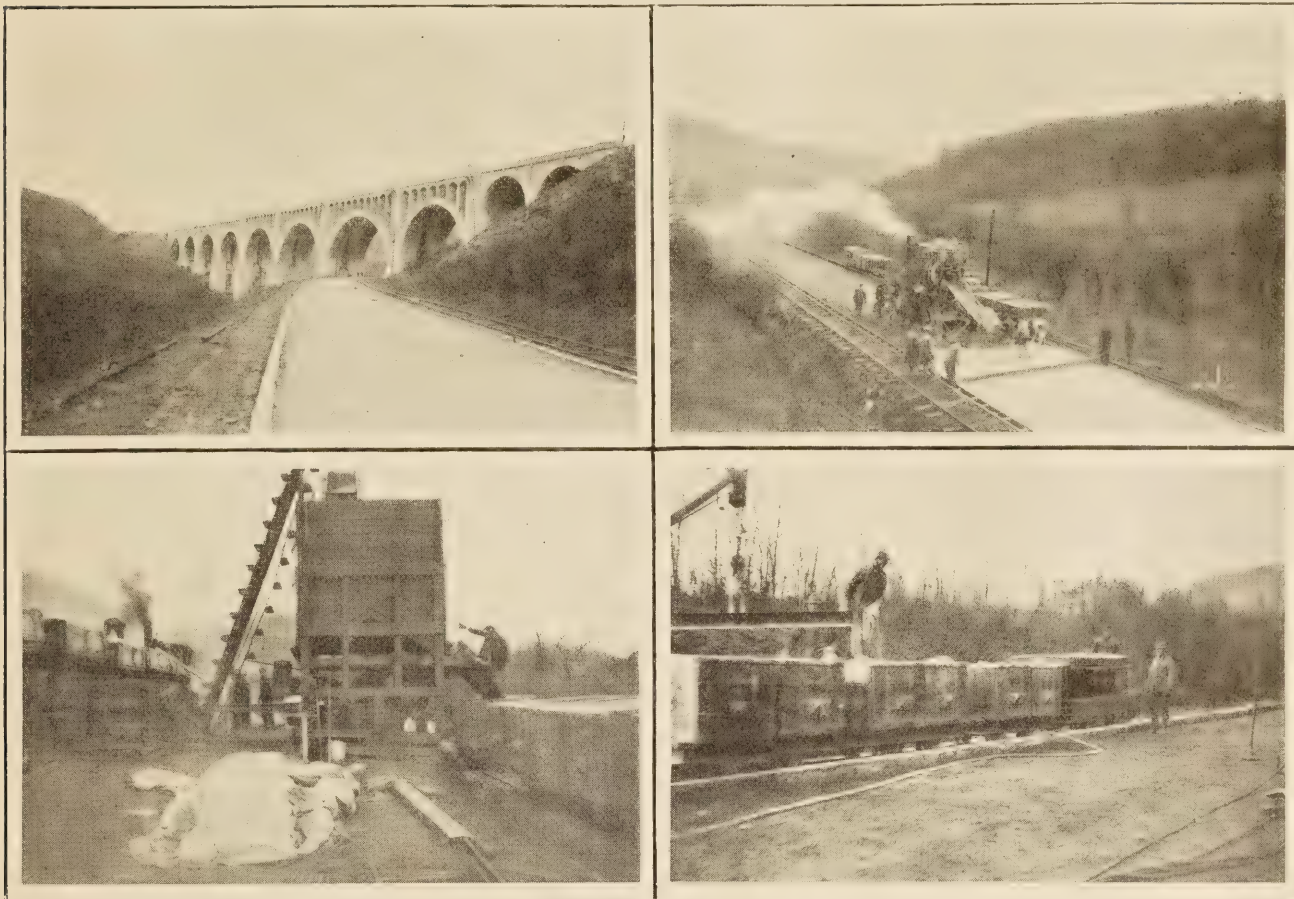
I have had new contractors come to our office to bid on work. They would come around and ask who was going to be the inspector. "Is he around here, can I see him? I would like to talk with him about five minutes, I would just like to get acquainted with the fellow and see what he looks like, and then determine whether I want to bid on the job or not." I have had that happen frequently. The contractor simply wants to see if he is going to have a fair man for an inspector. He wants to know if he is going to have a man to work under that he can get along with in a good and fairly reasonable way. It seems to me very much more depends on securing intelligent contractors and fair engineers than on the technicalities and the details of the specifications.

UTAH ROAD BUILDING.

For the year ending November 30, 1919, the State highway department spent \$3,238,566.21 for road construction and maintenance. This is in addition to the funds expended in the State by local authorities on roads which are not a part of the State road system and that spent in the State by the Federal Government on forest roads, either independently or in cooperation with the State and local authorities. The largest monthly disbursements in the history of the State's road work was \$586,399.94 in October.

PENNSYLVANIA'S LACKAWANNA TRAIL.

By A. C. Rapelje, Senior Highway Engineer, Bureau of Public Roads.



On the Lackawanna Trail. Above, left, Trail passing under one of the new viaducts of the Lackawanna Railroad; right, Double system of industrial railway used for transporting materials on the State's section. Contractor uses 10 miles of 60-pound, 36-inch gauge, main line track carrying locomotive, and 2,000 feet of 24 gauge light industrial track for locally supplying two mixers. Below, left, Semi-portable transfer and batch gauging bin accompanying each mixer outfit, batch gauging box being discharged into cars on industrial track; right, 3-ton Plymouth gas locomotive operating local train of batch cars.

THIS highway project as its name implies runs through the central portion of Lackawanna County, from Scranton, Pa., northerly through Susquehanna County to a connection with the New York State Trunk Line route to Binghamton, N. Y. Just whether the name comes from the county or whether it is a compliment to the laying of the project on the abandoned double track roadbed of the Delaware, Lackawanna & Western Railroad, commonly called the "Lackawanna Railroad," I am unable to state; but in either case or in combination it matters little, for though the Lackawanna Trail in name may have reached back over a period of centuries, its future is of what I have to write. It is quite probable, were we to trace back and go over the years, history would reveal this route originating with the Indians, and with the advance of civilization, the cows, then the bridle path, then the ordinary earth road too tap the rich anthracite mines of Lackawanna County, and lastly, the double-track steam railroad recently abandoned for a more direct route, meaning a saving in distance, time,

grades, and alignment. This, however, is not the end. The State highway department, automobile associations, and local interests sensed the desirability of putting this abandoned tract of railroad property to highway use and the Delaware, Lackawanna & Western Railroad philanthropically deeded this right of way for such use without cost to the State. This act on the part of a railroad corporation rather upsets the old-time theory of getting "something for nothing" from a railroad corporation. The project thus unfolds itself into one of unusual interest, based on the possibilities of highway construction on a basic foundation, embodying light curvatures and gradients with ample width without additional cost, on a subgrade prepared and pounded down by heavy rail traffic for years. Here is the ideal in "preparedness," drainage, and all of the minor essentials that go toward making the perfect highway.

The State highway department has planned and is now placing under contract, sections of 18-foot width standard concrete base, 6 inches in thickness

with 6-inch curbing; and for the wearing surface a 2-inch bituminous surface, specification A (sheet asphalt pavement) will be used. This work is carefully laid out by transit to fit the roadway width to the best advantage; curves are to be elevated and where necessary widened, as are the easements at points of beginning and ending of the sharper curves, which are infrequent. The work is to embody all of the high-grade standards now used throughout the State, and due to its importance as a connecting route between two large industrial cities and the beauty of its mountain scenery it is assumed that the route will meet with popular favor with summer tourists throughout the United States. The project when completed will be about 36 miles in length.

Two sections are already let to contract, the first being at the Scranton end covering 13.204 miles, for \$525,563.47, of which Federal aid has been authorized for \$289,059.91. This section of the project is known as Federal aid project No. 66. Of the

amount, \$83,092.87 of the bid price is for the construction of bridges. At another point somewhat removed from this work, a contract has been let for 10.19 miles at the bid price of \$342,637.46. This work was also planned as a Federal aid project, but it was found that the State had taken up about the full Federal aid allotment on the 76 other Federal aid projects now being constructed throughout Pennsylvania, leaving an insufficient amount remaining to be applied to this project. With the 1921 apportionment of Federal aid, the projects yet to be let on the Lackawanna Trail will doubtless be under Federal aid.

With the completion of this road and its opening to traffic it is expected that the automobilists, if not generally in a few instances, will realize they have a very tempting stretch of highway and distance to negotiate with, the long tangent and easy curvatures with grades of no resistance, and this will cause those of a certain turn of mind to "step on her" and step hard.

FEDERAL-AID PROJECT APPROVALS AND AGREEMENTS NOVEMBER, 1919.

Project.		Length in miles.	Material.	Project state- ment ap- proved.	Project agree- ment signed.	Estimated cost.	Federal aid.
State.	No. County.						
Alabama	14 Talladega		Chert and gravel		Nov. 4	\$18,590.00	\$9,295.09
	71 Dallas	4.166	Gravel	Nov. 18		16,217.68	8,108.84
Arizona	18 Pina and Cochise	28.00	Sand-clay and gravel	Nov. 8		283,469.00	119,234.50
Arkansas	24 Ashley, Desha, Drew, Chicot, and Lincoln	152.99	Asphalt and macadam		Nov. 18	2,684,177.10	332,000.00
	27 Columbia	14.03	Macadam		do	53,807.60	23,046.05
	28 St. Francis	18.58	Gravel		Nov. 3	238,262.72	50,000.00
	38 Howard and Sevier	9.84	do	Nov. 8		55,461.28	24,000.00
	46 Grant	12.48	do	Nov. 3		24,110.90	12,000.00
	58 Hempstead	5.02	do	Nov. 28		34,897.98	12,500.00
California	24 Orange	9.37	Bituminous		Nov. 19	139,889.31	69,944.65
	25 Santa Barbara	3.56	Concrete		Nov. 18	85,373.97	42,686.98
	26 Kern	10.73	do		do	329,598.61	164,799.30
	32 Siskiyou	17.64	do	Nov. 8		390,775.00	195,387.50
	33 San Bernardino and Riverside	7.10	Earth	Nov. 5		108,438.00	54,219.00
	34 San Diego	6.61	do	do		79,876.50	39,938.25
	35 do	13.80	do	do		226,105.03	113,052.50
	36 Humboldt	7.34	Concrete	Nov. 24		131,587.50	65,793.75
	37 Fresno	11.99	do	Nov. 19		306,061.25	153,030.62
	38 Mariposa	7.84	Earth	Nov. 24		171,600.00	85,800.00
Colorado	4 Garfield and Rio Blanco		Gravel or stone and graded earth		Nov. 26	122,494.89	11,247.45
	18 Pueblo		do		Nov. 3	12,318.79	6,159.40
	24 Castilla	5.844	Earth and gravel		do	20,044.39	10,022.19
	28 Summit	2.03	Earth	Nov. 18		34,376.59	17,188.29
	50 Elbert	16.88	do	do		48,446.75	24,223.37
	57 Prowers	1.409	Concrete		Nov. 3	39,725.95	19,862.97
	65 Ouray	1.155	Earth	Nov. 4		68,432.59	24,750.00
	77 Mesa	2.477	Concrete	Nov. 19		99,798.60	49,540.00
	78 Eagle	2.759	Earth	Nov. 3		114,503.27	55,180.00
Georgia	25 Candler	14.66	Sand-clay		Nov. 18	46,486.16	23,243.08
	26 Bullock		6 bridges		Nov. 24	57,157.06	28,578.53
	30 Cobb	16.815	Topsoil		Nov. 3	75,120.91	37,560.45
	59 Jackson	4.259	Sand-clay		do	38,477.27	19,238.63
	75 Gilmer	.56	Concrete	Nov. 15		20,652.50	10,326.25
	104 Jasper		Bridge		do	9,295.90	4,647.95
	105 Coweta	4.88	Sand-clay	Nov. 29		40,603.75	20,301.87
	106 Sumter	3.00	Bituminous	Nov. 26		58,759.58	20,015.92
	107 Worth	3.98	do	Nov. 26		118,702.92	50,000.00
	108 Merriwether	12.00	Sand-clay	Nov. 24		70,240.06	30,000.00
	111 Union	6.50	Gravel or macadam	do		53,154.75	26,577.37
	112 Laurens		4 bridges	do		66,435.60	27,194.90
	113 Pulaski		3 bridges	Nov. 29		84,270.96	30,000.00
	114 Ware	7.00	Bituminous, brick or concrete	do		240,625.00	50,000.00
	115 Chattooga		Bridge	do		17,379.30	5,000.00
Idaho	23 Twin Falls	27.00	Bituminous	Nov. 5		664,290.00	332,145.00
	24 do	8.82	Bituminous or concrete	Nov. 6		279,621.76	139,810.88
	29 Kootenai	12.50	Gravel	Nov. 24		197,990.76	98,995.38

¹ Modified agreements. Amounts given are increases over those in the original agreements.

Project.			Length in miles.	Material.	Project state- ment approved.	Project agree- ment signed.	Estimated cost.	Federal aid.
State.	No.	County.						
Illinois	1	DuPage, DeKalb, Kane, Ogle, Lee, Whiteside.	13.311	Concrete and bituminous macadam resurfacing.		Nov. 19	\$418,400.63	\$209,200.31
	2	do.		do.		do.	2 10,742.97	2 5,376.48
	3	Sangamon, Menard, Mason, Tazewell, Peoria.	4.37	Concrete.		Nov. 3	181,812.98	90,906.49
	3	do.	10.503	do.		Nov. 19	386,498.92	193,249.45
	3	do.	38.855	do.		do.	1,460,126.23	724,034.41
	4	do.	29.151	Brick or concrete.		do.	1,008,292.87	504,146.41
Indiana	9A	Bartholomew and Johnson.	8.452	Asphalt, brick, or concrete.		Nov. 24	317,237.19	158,618.59
	12B	Jackson.	6.135	Concrete, brick, or bituminous.		Nov. 18	231,415.36	115,707.68
	14	Vigo.	4.661	Asphalt, brick, or concrete.		Nov. 24	162,698.91	81,349.45
	17A	Lake, Porter, and Laporte.	11.382	Asphalt, brick, or concrete.		Nov. 24	410,472.01	205,236.00
	18AB	Tipton and Howard.	9.981	Brick, concrete, or bituminous.		do.	375,387.77	187,693.88
Iowa	14	Harrison.	15.60	Earth.		Nov. 3	94,487.14	47,200.00
	17	Dubuque.	21.89	do.		Nov. 1	142,428.00	71,200.00
	48	Humboldt.	1.87	Concrete or brick and gravel.		Nov. 24	78,324.12	37,400.00
	61	Cerro Gordo.	6.05	Brick or concrete.		Nov. 24	241,706.08	120,000.00
	67	Hamilton.	20.90	Earth.		Nov. 24	70,455.00	35,200.00
	69	Monona.	39.40	do.		do.	168,861.00	84,400.00
	71	Washington.	22.00	do.		Nov. 19	154,550.00	77,200.00
	75	Marion.	23.20	do.		do.	123,921.60	61,900.00
	76	Chickasaw.	13.50	Gravel.		Nov. 4	86,847.75	43,400.00
	85	Butler.	15.62	Earth.		Nov. 29	162,410.38	81,300.00
	88	Bremer.	16.40	do.		Nov. 6	51,636.20	25,800.00
	91	Wayne.	17.80	do.		Nov. 26	110,836.00	55,400.00
Kansas	27	Reno.	35.00	Brick or concrete.		Nov. 18	1,563,661.55	525,000.00
	28	Ford.	16.60	do.		do.	920,856.20	249,000.00
Kentucky	19	Mercer.	7.50	Macadam.		Nov. 29	74,993.60	37,496.80
Louisiana	16	East Baton Rouge.		Gravel.		Nov. 19	23,062.44	7,043.05
	46	Red River.	8.05	do.		Nov. 3	77,048.01	38,524.00
	52	Rapides.	13.30	Sand-clay and gravel.		Nov. 19	163,803.58	81,901.79
	57	Grant and LaSalle.		Bridge.		do.	16,991.15	8,495.52
Maine	5	Washington.	5,184	Gravel.		Nov. 6	89,617.10	44,808.50
Maryland	9A	Frederick.	2.00	Concrete.		Nov. 26	60,700.53	30,350.25
	12B	Carroll.	2.60	do.		do.	63,526.65	31,763.32
	16A	Howard.	6 1.18	do.		Nov. 25	6 57,664.75	6 24,880.53
Massachusetts	7	Hampshire.	4.659	Macadam.		Nov. 19	173,633.07	86,816.53
Michigan	41	Oakland.	10.058	Bituminous.		Nov. 19	556,847.59	201,160.00
Minnesota	48	Swift.	19.575	Pavement and gravel.		Nov. 5	266,499.67	129,000.00
	64	Rice.	12.90	Asphalt, brick, or concrete.		Nov. 19	420,563.51	150,000.00
	66	Big Stone.	10.42	Gravel.		Nov. 24	82,472.80	40,000.00
	68	Rice.	4.61	do.		do.	27,320.28	13,000.00
	71	Martin.	5.02	do.		do.	55,237.89	25,000.00
	72	do.	4.54	do.		Nov. 19	51,394.75	25,000.00
	74	Sibley.	21.74	do.		Nov. 19	189,992.00	94,996.00
	77	Rice.	5.51	do.		Nov. 24	46,212.48	23,000.00
	81	Marshall.	26.67	do.		do.	139,333.59	55,000.00
	91	Kanebec.	16.50	do.		Nov. 5	148,225.00	74,112.50
	92	Anoka.	26.35	Concrete and gravel.		Nov. 19	310,750.00	155,375.00
	99	Todd.	17.38	Gravel.		Nov. 24	112,985.40	56,492.70
Mississippi	24	Marshall.		Slag or gravel.		Nov. 10	6 15,436.25	6 17,435.62
	30	Lauderdale.		Gravel.		Nov. 3	6 13,964.16	6 7,111.67
	41	Wilkinson.	17.90	do.		Nov. 19	142,758.00	71,379.00
	46	Montgomery.	4.18	do.		Nov. 18	78,287.00	39,143.50
	47	Holmes.	3.71	do.		Nov. 19	22,844.25	11,422.12
	65	Yazoo.	6.80	do.		Nov. 3	49,142.50	24,571.25
	86	Lincoln.	3.61	do.		Nov. 18	55,815.65	27,907.82
Missouri	23	Pettis.	5.31	Bituminous.		Nov. 26	60,759.66	30,379.83
	28	St. Charles.	1.66	do.		do.	22,714.07	11,357.03
	38	Lewis.	8.50	Gravel.		Nov. 18	88,977.37	44,488.68
	43	Montgomery.	8.241	Macadam.		do.	62,043.41	31,021.70
	44	Randolph.	8.50	Earth.		Nov. 24	49,555.00	24,777.50
	45	Hickory.	7.50	Gravel.		do.	26,837.80	13,418.90
	46	do.	4.50	do.		Nov. 25	15,548.28	7,774.14
	47	Cedar.	9.73	do.		Nov. 24	43,666.02	21,833.01
Montana	4	Carbon.	3.43	do.		Nov. 18	33,243.05	16,621.52
	26	Fergus.	1.13	Earth.		Nov. 19	21,976.98	10,988.99
	54	Cascade.	.86	Gravel.		Nov. 19	5,868.50	2,934.25
	62	Toole.	29.00	do.		Nov. 29	134,816.00	67,408.00
Nebraska	38	Frontier.		Earth.		Nov. 3	6 2,071.52	6 1,039.76
	70	Stanton, Cumming, and Wayne.	39.20	do.		Nov. 19	126,324.00	63,162.00
	75	Fillmore and Thayer.	17.87	do.		Nov. 26	70,000.19	35,000.00
	90	Merrick.	22.20	do.		Nov. 24	55,825.00	27,912.50
	102	Dawes and Sioux.	31.70	Sand-clay.		Nov. 19	132,550.00	66,275.00
	105	Dawson.	13.45	Gravel.		Nov. 19	57,096.60	28,548.30
	106	Gage.	1.15	Brick or concrete.		Nov. 26	59,691.04	23,000.00
	110	Knox and Boyd.	40.10	Sand-clay.		Nov. 18	130,928.60	65,464.30
	112	Douglas.	16.80	Earth.		Nov. 24	70,950.00	35,475.00
	113	Knox.	16.70	do.		do.	62,260.00	31,130.00
	114	Dundy and Hitchcock.	20.80	Sand-clay.		Nov. 5	85,558.00	42,778.00
	116	Johnson.	21.00	Earth.		Nov. 19	76,670.00	38,335.00
	117	Garden.	13.10	do.		do.	40,777.00	20,388.50
	123	Richardson.	1.36	do.		Nov. 24	5,445.00	2,722.50
	125	Brown.	29.50	Sand-clay and earth.		do.	64,699.80	32,349.90
	133	Otoe and Lincoln.	54.90	Earth.		do.	176,253.00	88,126.50
Nevada	11	Esmeralda.		do.		Nov. 26	6 5,914.63	6 2,957.32
New Hampshire	22	Grafton and Merrimack.	1.00	Gravel.		Nov. 24	10,071.27	5,035.63
	29	Merrimack.	.538	do.		do.	5,989.83	2,994.91
	36	Cheshire.	1.13	do.		do.	12,065.95	6,032.97
	40	Merrimack.	.909	do.		Nov. 24	10,004.94	5,002.47
	54	Strafford.	2.04	do.		do.	21,135.07	10,567.53
	65	Hillsborough.		do.		Nov. 3	6 4,643.10	6 2,321.55
	68	do.	.833	do.		Nov. 24	15,043.60	7,521.80
	70	Coos.	.568	Macadam.		do.	12,343.87	6,171.93
	71	Strafford.	1.08	Gravel.		do.	16,542.94	8,271.47
	79	Rockingham.	1.136	do.		do.	8,299.06	4,149.53
	88	Hillsborough.	2.00	do.		Nov. 15	25,036.00	12,518.00

¹ Includes sections 10, 11, and 16 of project.

² Modification of agreement, for section 12 of the project. Amounts given are increases over those of the original agreement.

³ Separate agreements for portion of project. The first includes sections C-15d and F-15d, the second sections A, G, M, and O-15d, and the third sections, A, B, C, D, E, F, H, J, and L-15d.

⁴ Includes sections C, D, E, G-15d, H-15d, K, Q, X.

⁵ Statement previously approved withdrawn.

⁶ Modified agreements. Amounts given are increases over those in original agreements.

Project.		Length in miles.	Material.	Project statement approved.	Project agreement signed.	Estimated cost.	Federal aid.
State.	No. County.						
New Jersey	10 Hunterdon	2.03	Concrete		Nov. 19	\$138,472.42	\$50,047.07
	12 Atlantic	9.87	do		Nov. 3	346,843.22	173,421.61
New Mexico	37 Union	11.00	Gravel	Nov. 3		93,269.00	46,634.50
North Carolina	9 Polk	12.52	do		Nov. 24	42,617.74	21,308.87
	44 Granville	4.57	Sand-clay		do	45,513.63	15,500.00
	45 Buncombe	7.80	Macadam		do	185,345.25	92,672.62
	68 Harnett and Simpson	28.00	Sand-clay or gravel	Nov. 24		173,077.96	86,538.98
	75 Columbus	7.06	Sand-clay	Nov. 3		24,631.20	12,315.60
	87 Hyde	4.00	Gravel	Nov. 19		56,716.00	28,358.00
	88 do	17.50	Sand-clay	Nov. 25		242,660.00	121,330.00
	97 Macon	8.50	Sand-clay or gravel	Nov. 12		74,806.82	37,403.41
North Dakota	14 Stark		Earth		Nov. 19	¹ 3,565.50	¹ 1,782.75
	15 Sargent		do		do	¹ 51,744.59	¹ 25,872.79
	19 Ramsey		Graded earth		do	¹ 23,178.79	¹ 11,589.39
	33 McIntosh	² 3.00	Earth	Nov. 24		² 29,520.00	² 14,760.00
	42 Pembina	6.00	do	Nov. 6		23,000.00	11,500.00
	46 Traill	4.02	do		Nov. 12	11,847.42	5,923.71
	61 do	12.50	do	Nov. 24		38,500.00	19,250.00
	69 Richland	18.50	do	Nov. 19		54,000.00	27,000.00
	71 do	13.00	do	Nov. 8		36,330.00	18,165.00
	73 Williams	18.50	do	Nov. 19		56,980.00	28,490.00
	74 Mountrail	8.00	do	do		22,880.00	11,440.00
	76 Burke	20.00	do	Nov. 25		52,800.00	26,400.00
	77 do	18.00	do	do		49,500.00	24,750.00
	78 Divide	10.00	do	Nov. 19		27,500.00	13,750.00
	79 do	10.00	do	Nov. 24		40,040.00	20,020.00
	80 Williams	19.00	do	Nov. 19		60,610.00	30,305.00
	81 Ward	13.00	Gravel	Nov. 25		63,206.00	31,603.00
	82 do	15.00	do	Nov. 19		70,950.00	35,475.00
	84 do	25.00	do	Nov. 24		130,130.00	65,065.00
	87 Bottineau	15.00	Earth	Nov. 19		52,800.00	26,400.00
	88 Wells	11.00	do	Nov. 26		39,600.00	19,800.00
	89 Sargent	11.50	do	Nov. 25		43,700.00	21,850.00
	90 Wells	10.00	do	Nov. 26		33,000.00	16,500.00
Ohio	57 Shelby	3.065	Concrete		Nov. 8	100,000.00	35,000.00
	58 do	3.521	do		do	100,000.00	35,000.00
	68R Perry	3.068	Bituminous or concrete		Nov. 19	81,600.00	40,800.00
	70 Allen	4.43	Bituminous	Nov. 25		123,000.00	43,600.00
	89 Madison	2.42	do	do		73,300.00	24,200.00
	94 Lawrence	4.386	do		Nov. 24	94,000.00	47,000.00
	104 Vinton	4.583	Earth	Nov. 5		46,000.00	18,000.00
Oregon	26 Klamath	8.92	Macadam	Nov. 3		160,806.80	84,403.40
	30 do	13.90	do	do		108,341.75	54,170.87
	31 do	14.70	do	do		173,860.50	86,930.25
	32 Lake	11.00	Gravel	do		125,829.00	62,914.50
	34 Klamath	13.15	Macadam	do		146,234.00	73,117.00
Pennsylvania	8G Erie	3.617	Cement concrete or bituminous concrete or concrete base		Nov. 26	264,532.21	107,459.78
	56 Center	2.23	Bituminous or concrete		Nov. 19	133,975.11	46,600.00
	66 Lackawanna and Wyoming	13.204	do		do	578,119.81	289,059.90
South Carolina	41 Hampton	15.625	Sand-clay	Nov. 19		148,859.02	74,429.51
	46 Kershaw	2.129	Gravel	Nov. 24		23,614.45	10,000.00
South Dakota	15 Lawrence	22.94	Earth and gravel		Nov. 19	183,166.56	91,583.28
Texas	52 Callahan	34.85	Gravel		Nov. 18	232,152.87	75,000.00
	94 Baylor	4.313	Sand-clay		Nov. 19	24,641.04	10,692.22
	107 Runnels		Bridge	Nov. 19		61,423.36	24,482.50
	111 Scurry	21.521	Gravel	do		92,301.00	46,150.50
	112 Bexar	7.27	Bituminous	Nov. 28		76,057.22	35,802.33
	115 Smith	8.72	Concrete or gravel	Nov. 19		174,481.49	87,240.74
	116 Tom Green	26.542	Macadam	Nov. 28		340,952.16	100,000.00
	117 Denton	10.055	Gravel	Nov. 25		164,896.71	41,224.18
	118 Webb	17.55	do	Nov. 19		116,028.50	41,567.12
Utah	12 Iron and Washington	56.00	Concrete		Nov. 3	¹ 274,911.56	637,455.88
	15 Iron	47.00	do		Nov. 3	829,237.20	414,618.60
Vermont	1 Chittenden		Gravel		Nov. 18	¹ 4,506.08	¹ 2,253.05
Virginia	37 Bedford and Campbell	6.61	Bituminous		Nov. 5	139,786.68	69,893.34
	54 Rockbridge	2.05	Macadam	Nov. 19		41,085.00	20,542.50
	58 Prince George	11.26	Gravel		Nov. 19	70,952.03	35,476.01
	59 Nansemond	5.40	Concrete	Nov. 18		155,485.00	77,742.50
	62 Roanoke	.72	do		Nov. 5	24,904.00	12,452.00
Washington	46 Garfield	10.81	Macadam	Nov. 19		211,085.66	105,542.83
	47 Columbia	6.57	do	do		112,647.15	56,323.52
	48 Ferry	1.19	Earth	do		26,460.61	6,622.00
West Virginia	47 Wetzel	4.88	Concrete		Nov. 18	106,820.00	53,410.00
	49 Marion	1.42	Brick		Nov. 22	50,850.00	25,165.00
Wisconsin	2 Manitowoc	² 2.59	Concrete or brick		Nov. 19	² 21,380.48	7,126.83
	14 Menominee	³ -4.95	Gravel		Nov. 20	³ -15,043.53	³ -5,014.51
	39 Racine		Concrete		Nov. 18	³ 7,509.71	¹ 2,503.24
	51 Columbia	4.934	Gravel or macadam	Nov. 19		74,964.51	24,988.17
	62 Washington		Concrete		Nov. 24	¹ 11,988.32	³ 3,996.11
	67 Monroe	2.82	Earth		do	30,446.68	10,148.89
	97 Sauk	² 4.30	Gravel	Nov. 1		² 30,708.00	² 10,236.00
	99 Douglas and Washburn	7.04	do		Nov. 18	62,954.43	20,984.81
	101 Barron	4.253	Earth		Nov. 26	44,793.77	14,931.26
	102 Waukesha	2.31	Concrete	Nov. 19		60,123.69	20,041.23
Wyoming	5 Sweetwater	14.04	Earth		do	28,249.18	14,124.59
	37A Goshen	9.195	Gravel		do	68,195.60	34,097.80
	38 Hot Springs	3.381	do		do	34,081.36	17,040.68
	44 Carbon	12.217	Earth	Nov. 19		36,300.00	18,150.00
	53 Hot Springs	.627	Gravel or macadam	Nov. 25		24,805.00	12,402.50
	54 Big Horn	6.922	Gravel	do		57,139.50	28,569.75
Total	225	2,427.771				31,774,219.65	14,447,863.46

¹ Modified agreements. Amounts given are increases over those in the original agreements.
² Revised statement. Amounts given are increases over those in the original statement.
³ Agreement previously signed canceled.



ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS.

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

REPORTS.

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

DEPARTMENT BULLETINS.

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

OFFICE OF PUBLIC ROADS BULLETINS.

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

OFFICE OF PUBLIC ROADS CIRCULARS.

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

OFFICE OF THE SECRETARY CIRCULARS.

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

FARMERS' BULLETINS.

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

SEPARATE REPRINTS FROM THE YEARBOOK.

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

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH.

- Vol. 5, No. 17, D-2. Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements.
- Vol. 5, No. 19, D-3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
- 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.
- 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.
- Vol. 17, No. 4, D-16. Ultra-Microscopic Examination of Disperse Colloids Present in Bituminous Road Materials.

* Department supply exhausted.

* Department supply exhausted.

