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A weekly paper for Canadian civil engineers and contractors

ROAD BUILDING AT THE FRONT

How the Good Roads of France are Helping to Win the War—Planks and Large Stone the Most Valuable Material—Address Delivered Last Week in Hamilton, Ont., at the Fifth Canadian Good Roads Congress

By LT.-COL. WILLIAM G. MACKENDRICK, D.S.O.
Director of Roads, Fifth British Army

MY first job of road-building in France was for the Canadians. I was put in charge of a thousand Belgian refugees—civilians—who were paid four francs each per day for working on the roads. I had not handled men for fifteen years, but I was puzzled to know why I could not put more vim into their work, until I found that these men had to walk from seven to twelve miles per day before they reached their work, and then walk that distance back home again in the evening. Was it any wonder that they had no energy left for their work?

Although I had considerable territory to cover, and a large number of workmen to watch, I could not get a motor or a horse. I simply was not on the list of army officers who were entitled to a horse or a motor, and that settled it. I did succeed, however, in arranging for motor lorries to collect my workmen, and within a month the work showed very satisfactory results.

Introducing Business Methods

These Belgians were divided into thirty-two gangs, with a foreman for each gang. At the end of the month, the paymaster handed in cash to each foreman the pay for his gang without any check whatever upon whether the cash reached its ultimate destination, and without any check on the number of men employed or the hours which they worked. We changed these methods and appointed soldiers as time-keepers, and saved John Bull & Co. something like 30,000 francs per month in the pay roll by cutting out the loafers, etc.

Moreover, modern methods of handling those men greatly increased their output. We had six gangs working in the woods getting out defence pickets, posts and other timber. We almost trebled their output. We had ten gangs in the quarries getting out stone and we trebled their output. The other sixteen gangs were on the actual road-making, and we doubled their output. The Belgians, when given proper superintendence, make excellent workmen.

"They Handed Me a Lemon"

Before the war the French roads were in good repair, but they were greatly overworked, even the routes Nationale. The heavy guns ground the stone to powder and the roads went to pieces fast, especially in the spring and fall. In the fall of 1915 the British army had to stop fighting because they could not carry the needed material over the roads. Sir Eric Geddes reported on the situation, and after he had made his report the British Cabinet asked him to carry on the work and take charge of all the transportation in the British armies, including standard railways, light railways and roads.

In 1916 I was sent to the Somme to make roads for the Fifth British Army. The job they handed to me was a "lemon." There were 250 miles of broken-down roads that they had been fighting over for months. The stuffing of these roads was gone, and they wanted them re-built so that they could fight over them again within three months. The centre of the road was often a ditch holding water and mud from 8 to 10 inches deep, of the consistency of pea soup.

No Crown, No Road

General H. P. Maybury, the chief engineer of the English Road Board, went over fifty miles of these bad roads with me in two days. I urged him to give me the men and materials to put a crown on them and then they would be alright. He said, "You seem to think that a crown is everything."

"Yes," I replied, "with it you have a road; without it, you have—not."

We gathered all the officers of the various corps and told them what we wanted done; nevertheless, we could not get sufficient stone. But for five miles of the road leading out from Acheux, we picked the stone off the outer 6 feet of each side of the road and threw it to the inner 6 feet, so that we had 12 feet of fairly good road in the middle. The director of roads gave us four and five times the quantity of stone we had before, and timber as required, so we never lacked material to work with after he took charge.

Making Roads With Material from Ruins

The army did not take kindly at first to the new department which had taken over the road work, but when they saw what it was accomplishing, we got their hearty co-operation.

They told me that for me, a lieutenant-colonel, to take a pick from a private's hand and show him what I wanted done, would prove ruinous to army discipline. But it didn't, and within a month we had 12,000 men working to the one idea and with the one policy, and doing fine work for the use of the fighting troops.

When "the big push" was on we could not get stone. As a result we canvassed the surrounding country for everything that could be put onto the roads. Consequently, there are many villages of which not a single brick, stick or stone is left. We took the bricks from the

houses and from the ruins and put them on the roads. We carted the stones from the broken walls. The army, as they advanced, used all the wood for fires to cook their meals, etc. We used the larger timbers, roof-rafters, etc., to fill up shell holes and to plank muddy places. It is a fact, therefore, that of many villages there is not a trace, virtually not one stone being left on top of another. One village of 2,000 inhabitants, that I have in mind, has disappeared absolutely with the exception of a piece of granite block which was laid where the centre of the village had been.

Used Planks on the Worst Roads

The road north from Albert to Bâpaume was for a time the only line of communication to the British front, and everything that went up to the army travelled over that road. At the end of the third day I drew attention to the fact that the road would not last two days more. It was built of four inches of gravel on sand foundation on clay. The caterpillars, weighing 17 tons, shook it to pieces with their incessant pounding. We had previously had 300 motor lorries on our road work, but they had taken away all but 23, and I had a strenuous time getting 200 more and stone to fix that road, but we finally got it rebuilt and in splendid condition.

Altogether, I had 764¾ miles of army roads under my care at that time. Besides the motor lorries, we had about 300 general service wagons, 56 road rollers and 12,000 men.

Many of these roads were blown to pieces by the Germans. When I first went to Flanders I saw that planks were the only thing that would save the situation, but I could not get the planks. "With five miles of plank, I will take the corps anywhere," I said, but there was no plank to be had. A plank road costs less, and can be built twenty times as fast, and over some kinds of ground will carry traffic that stone will not carry. The shell holes on some of the roads were from 5 ft. to 15 ft. in diameter. When it rained for a week, as it would, these holes would fill with water and stay full. I pointed out how impossible it was to build macadam roads under these circumstances, and asked for planks. When the new transportation department, under Major-General Sir Eric Geddes, got to work, they secured millions of railway sleepers for road-building; also 3-inch planks, which were used by all the armies in their advances on the western front. Sir Douglas Haig, in his despatches since then, has told of the value of those plank roads to the British army. At Vimy Ridge, Passchendaele and Messines, he said, the army could not possibly have advanced without them.

Road-Builders Saved Verdun

We found the method of building a Telford road in France, putting the stone on edge and then using small stone on top, did not carry the heavy lorry traffic. Even twenty or thirty inches of stone so placed did not hold the road up in place. We, therefore, changed the method and laid stones on their flattest side, then filled in 4-inch stone on top for a total depth of nine inches, putting a good crown on the stone and rolling where possible. Under these methods, we found that we were getting much better roads for one-third the cost, and that our roads would carry the heaviest kind of motor traffic.

The stone was mostly a soft limestone. In six weeks even 6 inches of this stone would be ground to powder and blown away. We found that 4, 5 and 6-inch stone were the best sizes to carry the motor traffic for soft spots. The 2-inch stone would "mush up" in wet weather, having too small a base and not enough bearing power to carry the traffic.

In this connection I may say that the French are, in my opinion, the finest road repairers in the world. They are economical in road-building, as they are in everything else. They make a barrow-load of stone go as far as we usually make a cart-load go. Their system of incessant vigilance and of patching of small holes effects great economies.

At Verdun the French road-builders undoubtedly saved the day. The Germans had totally interrupted their railway transportation on what was then the only railroad leading up to the French front at that point. A French road engineer organized regular schedules of motor freight trains. The trains left at definite intervals, just as on a railroad, and ran to schedule. If a motor broke down or was delayed, it was shoved to the side of the road. In this way supplies of materials of all sorts were kept up for three months, and this was undoubtedly the saving of Verdun, and thereby the saving of Paris,—and probably the saving of world civilization.

Open For Traffic Every Day

In the spring of 1916, army traffic was badly held up owing to the frost coming out of the ground. All traffic is kept off the roads for three days while the frost is coming out, and often it is necessary to keep the heavier traffic off for as much as ten days, but in the spring of 1917 we were able to keep all of the roads open for traffic every day.

We used all classes of labor, including German prisoners, Indian cavalry, West Indians, Chinese and English and Canadian labor battalions, but I found the Canadian labor best of all. It is more adaptable and keener to get on with the job, whether it be fighting, building roads, or the special work for which they are using the railway construction troops so much and so effectively on the fighting fronts.

[NOTE.—In order to avoid the publication of any military secrets, we submitted the full report of his speech to Col. MacKendrick for his revision. Unfortunately, Col. MacKendrick was too modest, we fear, and eliminated many of the most enjoyable parts of his address. As a result, the above abstract does not truly represent the witty and most interesting speech which he made at Hamilton, nor does it do justice to the splendid service which he has rendered at the Front and for which he was awarded the Distinguished Service Order.—EDITOR.]

The Brantford Board of Trade has indorsed a resolution calling for the immediate appointment of a town-planning commission for that city.

The industrial development section of the Vancouver Board of Trade is undertaking a special study of the problem of cheap housing of industrial employees.

The following utilities' estimates have been passed by the city council, Edmonton: Electric light, $46,890; telephone, $28,930; waterworks, $17,233; street railways, $1,541,439; total, $1,634,492.

At a meeting of the Ontario Railway and Municipal Board held this week, a letter was received from Bowman and Connor, who were the consulting engineers to the township concerned, approving the Toronto and Hamilton Highway Commission's plans for the Bronte bridge, provided that certain very minor changes be made. As the plans also have the approval of the Ontario Government, the contract will soon be let for the construction of this bridge. Action was deferred in regard to the Etobicoke, Port Credit and Mimico bridges pending report by Frank Barber, who is the consulting engineer for the municipalities interested in those bridges.

CANADIAN GOOD ROADS CONGRESS

At Fifth Annual Session, Held Last Week in Hamilton, Ont., War-Time Problems Were Discussed—General Report of the Proceedings—S. L. Squire Succeeds J. Duchastel as President

LAST week was "road week" in Canadian engineering circles. The fifth Canadian Good Roads Congress was held at Hamilton, Ont., and was attended by approximately 400 road enthusiasts (of whom, it is to be noted, only about 40 were from Hamilton), including the officials of the congress, speakers, exhibitors, motorists, municipal and highway engineers, road superintendents and road contractors.

Although the attendance was considerably smaller than in most previous years of the congress, the sessions were fully as interesting and the discussions even more general. From the standpoint of comfort, this congress was the best ever held in Canada, all who attended being unanimous in their approval of the idea of eliminating the heavier exhibits, which require the use of a large hall. Larger halls are generally cold and uncomfortable, whereas the ball-room of the Royal Connaught Hotel was an ideal place for the meetings. The room was attractively decorated, the exhibits being arranged along the two sides and across one end, with the stage at the other end.

Exhibitions Were Attractive and Educative

Following is a list of the exhibitors:—

Auto Road Construction Co., Niagara Falls, Ont.; The Barrett Co., Toronto; Hugh Cameron & Co., Toronto; Canada Cement Co., Montreal; Canadian Fairbanks-Morse Co., Montreal; Constructing and Paving Co., Toronto (in conjunction with the Godson Contracting Co., Toronto, joint exhibit); Dominion Good Roads Machinery Co., Goderich, Ont.; Imperial Oil Co., Toronto; Alfred Rogers, Ltd., Toronto; Sawyer-Massey Co., Hamilton; United States Steel Products Co., Toronto; and Warren Bituminous Paving Co., Toronto.

The booths were attractively furnished and decorated, the exhibitors distributing catalogues and samples and showing photographs of their products and factories. Various methods of testing materials were demonstrated, and sections of different kinds of roadway were shown.

The addresses by the various speakers were not entirely technical, but were intended to be informative for the general public, particularly for highway foremen and others actively interested in the improvement of roads and streets.

Opening of the Congress

Capt. J. Duchastel, city engineer of Outremont, who was president of the Canadian Good Roads Association for the past year, called the congress to order Tuesday afternoon, May 8th.

Mayor Booker, of Hamilton, extended the official civic welcome. He referred to the excellence of the Hamilton pavements, but deplored the practice of tearing up good pavements to lay water mains, sewers, etc., and he urged that a law be passed preventing the tearing up of new pavement, so as to make it necessary for cities to exercise foresight in installing water mains, sewers, gas mains, telephone conduits and other civic utilities.

W. A. McLean, deputy minister of highways for Ontario, and past-president of the Canadian Good Roads Association, addressed the meeting, stating that new traffic makes road construction an ever-changing subject. His speech in full will be found on page 436 of this issue.

James H. McDonald who until four years ago was state highway commissioner of Connecticut, extended greetings from the governor of his state.

B. Michaud, deputy minister of highways for the province of Quebec, spoke as follows:—

"I did not know that I had been selected to speak this afternoon, and I am somewhat tempted to blame the president, but I see this would be out of tune, as I think we owe a compliment to the president. I am glad to have this opportunity to congratulate him for the good work he has done in organizing the association on a legal basis, and also for having succeeded during these hard times in organizing this convention.

Would Pave With Roses

"I see there is a new feature—we have ladies amongst us, and I consider this a very favorable auspice for the convention of the roads. The first-class bituminous concrete road, the concrete road, the waterbound macadam with pot holes, the gravel roads with ruts, the trail made of clay and water,—all these roads will be dear things to us so long as they bring to us the loveliest and fairest half of the human family.

"On the other hand, I would assure them that we road men will always work to improve the roads and to maintain them in good order. If I were allowed a little sentiment, I would suggest that we should lay roses on the roads over which the ladies travel.

"Every time I have attended these conventions I have been called upon to speak of the work we have done in the province of Quebec as regards road construction, but I will refrain from it to-day. I was much embarrassed when I found that I had been selected to speak, and being in trouble, I looked for help and on the table in my room I found a Bible. I read that the great King Solomon said there is a time to cast stones away and there is a time to gather stones together. That is the secret of the road policy of the province of Quebec. Five or six years ago we made up our mind that the time had come to put stones together. Unfortunately the specification made by King Solomon was lacking in completeness, for he did not specify how we should keep the stones bound together. Of course, it has often been my lot to discuss and criticize specifications drawn up by people who knew more than I did, and so I would not venture to criticize those made up by King Solomon. I think perhaps he left that to the engineers of his time, but I must say that the construction of macadam roads should be a matter of discussion in this convention. I am sure all of you will discuss and criticize the various methods with care and in earnest.

"I hope you will upset the present methods, provided you can find better ones. At all events, I am sure that you all in this province and all the people of the Dominion of Canada will continue working hard toward the improvement of roads."

"Melting Pot of Public Opinion"

The Rt. Rev. Monsignor Mahony, of Hamilton, was on the programme for an address, but was unable to be present on account of an illness which later proved fatal. He died while the congress was in session, and suitable resolutions were passed in that connection.

Rev. Canon Daw, of Hamilton, who had also been asked to speak, was not able to be present.

Delivering the address of welcome on behalf of the Canadian Good Roads Association, of which he was vice-president for the past year, S. L. Squire, municipal adviser to the Ontario Government, said:—

"We look on these conventions as being the melting pots of public and private opinion in their relationship to highways. We find in conventions such as we are holding, men meeting who have diversified ideas, and although in some instances there seems to be no possible way of bringing all their ideas into harmony, still we believe that we can ultimately accomplish that which may now seem to be the impossible.

Opinions Differ, But All Welcome

"There may be men in this convention who would advocate the coast-to-coast highway, a highway which might bring the Atlantic and the Pacific together by a road over which traffic could be carried easier than by the railroads which we have. There are men who believe that the federal government should undertake that work as a public work, and we have the profoundest respect for the opinions of such men and welcome them to this convention. There are other men who are likely just as sincere as those who advocate this national transcontinental highway, who believe that we for a long time to come are, as a nation, not in a position to attempt any such public work. The men who do not agree with those whom I have first referred to, are welcomed also. We welcome them because we know that in each province they may have their own particular troubles and difficulties, and if they will bring their troubles and difficulties and cast them into this great melting pot, it is just possible that we will learn to know each other better and help each other to solve the difficulties which, after all, have a national aspect.

"There are those who consider the road from the standpoint of how we should legislate for the people, how we should undertake the work or what statutes we should place on our books. There are those who have a commercial interest in the highway. We welcome those. Perhaps some view it only as a means of pleasure, and shall we say that we have no use for those? Not at all. We look on every man interested in the improvement of roads as being with us. We welcome you all, whether your interests are commercial, national, provincial or local, with a personal and financial aspect or for the good of the whole people.

"If we all contribute our little bit, we hope that the dross shall be taken from that opinion and from it be drawn only the pure gold which shall make for the betterment of mankind. I am very glad we have such a representation from Quebec. Some people may have imagined that there is a difference of opinion in Canada between the French and the English. I want to say that after all there may be differences of opinion, but only such differences as we may find in families and communities, for while we may disagree in some little things, I am safe to say we agree in the things which go to make up a great nation."

Roads are Cheaper in California

C. R. Wheelock, president of the Ontario Good Roads Association, and Hon. Findlay Macdiarmid, minister of public works and highways of Ontario, both of whom had been scheduled to deliver addresses, sent messages of regret that they were unable to be present.

R. T. Kelley, president of the Hamilton Board of Trade, spoke about the importance of good roads as a factor in the campaign for increased production.

L. B. Howland, president of the Canadian Automobile Association, declared himself in favor of a Canadian transcontinental highway. "I have just returned from California," said Mr. Howland, "where I learned that they have spent $37,000,000 on good roads and intend to spend $20,000,000 more, but on account of better climatic conditions, they can build two miles of roads there for the cost of one mile here."

M. J. Overell, president of the Hamilton Automobile Club, said that the Toronto-Hamilton Highway is a good example of the benefit of good roads. It is already so popular that it is overcrowded. He hoped that the building of more roads like that highway would relieve the congestion there.

B. Michaud, of Quebec, presided at the morning session of the congress, Wednesday, May 8th. W. A. McLean, B. Michaud and S. L. Squire were unanimously elected as the members of the resolution and legislature committee.

Who Should Pay for the Roads?

In the absence of C. R. Wheelock, who had been scheduled to address the meeting on "Who Should Pay for the Roads?" Hugh Bertram, of Orangeville, Ont., who is a member of the Toronto-Hamilton Highway Commission, spoke on this subject. His address appears in full on page 438 of this issue.

The discussion on Mr. Bertram's speech was led by W. A. McLean, whose speech upon this subject is published on page 439 of this issue.

J. S. Sanderson, of Oxford Station, Ont.; James H. MacDonald, of Connecticut; and W. Findlay, of Ottawa, also took part in the discussion. Mr. Sanderson, who is president of the Dairymen's Association of Eastern Ontario, said that the people in the counties and townships believe that the federal and provincial governments should give more assistance in road building. He stated that the farmers are not satisfied with the help that the cities are extending, but that when the farmers feel that they have the city people earnestly behind them in the road movement, the farmers will become more enthusiastic.

Mr. MacDonald said that the eighteen years which he had spent as state highway commissioner of Connecticut, had shown him that the system of distributing the cost of roads which is being introduced in Ontario, is the only fair and satisfactory means of paying for roads. At the beginning of his commissionership, said Mr. MacDonald, his state spent $75,000 a year on roads. At present the average annual expenditure is $6,500,000.

Advocates High Types of Construction

Mr. Findlay, who is business manager of the Ottawa "Journal-Press" and also an alderman of the city of Ottawa, and who represented the Ottawa Motor Club, made a good speech on why and how the cities should assist in paying the cost of good roads. "The people are willing to pay for roads," said Mr. Findlay. "They will all help, notwithstanding where they come from,—country, city or town. We must raise sufficient money to build the roads of high types of construction. The state of New York lost millions by building roads that were too cheap. By means of automobile licenses and by direct votes of money, the cost of good roads can be secured."

At 11.35 a.m. the session was adjourned to give the delegates an opportunity to motor to the plant of the Sawyer-Massey Co., Limited, of Hamilton, where that firm's full line of road machinery was examined with much interest by the delegates.

(Continued on page 446)

ABATEMENT OF THE DUST NUISANCE*

By E. R. Gray
City Engineer, Hamilton, Ont.

THE abatement of the dust nuisance is a subject concerning which much has been written and in connection with which a considerable amount of valuable experimental work has been performed. The result of this study has been the establishment of certain well-recognized, standard principles in the application of the methods to which I shall refer. It is not my intention to deal with the subject in a formal way, but merely to outline something of our local experience.

The dust nuisance may, in varying degrees of efficiency, be dealt with by the following methods:—

(1) By removing the dust and loose material on the surface by the use of mechanical methods such as horse sweepers, scrapers, etc.

(2) By the application of a dust-layer in the form of (*a*) water from the ordinary sprinkler; (*b*) a deliquescent salt, such as calcium chloride, applied by hand; (*c*) a bituminous material, either as an asphaltic petroleum or a tar product (this method being the subject of this paper).

(3) By the construction of what is known as a dustless permanent road surface of some one of the many standard types (this, however, being outside of the scope of this discussion).

The application of any one of the above methods, or the combination of parts of each, depends upon the condition of the surface and the character of the roadway to be treated.

Horse sweeping, hand brooming and the removal of the dust by teams and wagons, does much to keep the roads free from the material which blows, after which the road may be further treated if it is so desired.

The second method, that of applying a dust-layer of some kind, is to-day perhaps the most generally adopted for dust abatement and road preservation. As ordinarily applied, however, this method is far from perfect, and we await with interest the discovery of some more effective and some less troublesome cure for the dust nuisance.

We easily see that road oiling has become a very efficient operation for dust prevention, but while we have tried many methods of varying our work here in Hamilton, I am free to say that as yet it has not developed that perfect state which you might be led to believe. The year before last we were using what is known as a light road oil. We were getting very good results from it, and in many cases were getting a pretty fair cover, and it was with the desire of securing a heavier cover that last year we used a quantity of medium road oil. You know what the season was like. It was cold and wet, and in fact we had to give up some of our oiling altogether because of the weather conditions. The oil being somewhat heavier than the oil that had been used in the previous seasons, we had much complaint from the people on the streets. We usually put screenings from our quarries on the oil after it has been distributed, but we found it impracticable to close our streets in order to keep the traffic off them for a sufficient length of time for the oil to harden. If we were doing a street at a time here and there, that might be arranged, but where we are doing miles of streets, and we have many miles of improved macadam roads in the city, it is not a feasible method of handling the situation.

Continued experiment over the past ten years has practically established the fact that the application of some kind of bituminous material to the surface of the road is the most efficacious method known to date. Salts, chiefly calcium chloride, have been used, but so far as I know these have never gone past the experimental stage or have been applicable only on small sections of road. Calcium chloride is obtained as a by-product in the manufacture of soda, and is distributed dry by sowing over the road surfact or spreading by shovel.

Calcium chloride is used in England to quite a large extent, the atmospheric conditions there lending themselves to the use of this particular material to a great deal better advantage than in this country. In fact, where it has been used here, around Boston, it was necessary, after the application, to water the roads in order to secure sufficient moisture to keep down the dust.

The salt, by its faculty of absorbingmoisture from the atmosphere, dampens the surrounding dust-layer, thereby reducing the tendency to blow.

An experiment of this character was carried out by the United States office of good roads, under the direction of Logan Walter Page, in Florida, by the application of 1½ pounds of chloride per square yard of surface. After several weeks of wear, the surface was always moist. No costs are given in connection with this method, so that comparison is impossible.

Holton Avenue, Hamilton, asphalt road oil on waterbound macadam. Photo at end of season, 1917

Inquiry as to the present price of calcium chloride in fairly large quantities shows that it is four cents a pound, so that for dust preventive purposes, on the present market prices, it is hardly an economic consideration.

The application of a bituminous material to the road surface is generally recognized as the method producing the most satisfactory results at an economic cost. The kinds of material used, and the different kinds of the same material, vary considerably. Certain principles, however, for the proper efficient use of these materials are outstanding if the best results are to be obtained.

The character of the road and the condition of the road surface are important considerations in deciding upon the particular treatment to be used.

It is generally conceded and results have proved, that as much of the loose material as is economically practicable should be removed from the surface of the road. I have read that under certain circumstances, some engineers have gone so far as to lightly sprinkle the road before the application of the oil, with the idea of removing

*Address delivered May 10th, 1918, at Canadian Good Roads Congress.

from the stone the thin film of dust which would prevent the proper adherence of the dust-layer to the macadam. I would think that was rather a dangerout procedure unless the road was given sufficient time to dry subsequent to the application of the oil.

Under such conditions, then, what is going to happen to this dust that lies on the road? It is going to be spread over the road, again, so it seems to me rather a superfluous procedure.

Any necessary repairs to the old macadam should be made in order to improve the conformation of the road, and provide for a free drainage to the gutter.

On country stone roads, where frequently the dust lies inches deep in layers, a horse sweeper could be used with great benefit and at very little added expense to remove this surface material to the side of the road, where it could be taken care of by different means, depending upon the environment. I have in mind many country roads where, regardless of the character of the surface of the road and the amount of dust and loose material on the road, the oil cart goes along and sprinkles the sand. It is only a short

Devonport Street, Hamilton, macadam treated with asphalt road oil in early Spring, 1917. Photo in Fall after season's traffic

time before that oil dust is blowing with every vehicle that passes, making the actual dust conditions much more disagreeable than the ordinary dry state of the dust.

Oiling performed after cleaning is much more effective, and I am of the opinion that the results warrant the small additional expense of such cleaning.

Having prepared the road surface, the next consideration is the character of the material which is to be used and the method of its application.

Asphaltic petroleums and tar products are the most common materials used for this purpose. Until recently they have been easily obtainable. They lend themselves readily to distribution, and prior to war prices were an economic material for this purpose.

The asphalt petroleum is sold commercially as a 40 per cent., 60 per cent. and 80 per cent. asphaltic oil, increasing in specific gravity in the order named. The tar products are sold under trade names which indicate varying degrees of specific gravity, the purchaser purchasing that particular product which is most suitable for his requirements.

Our experience in Hamilton has proved that what is known as a "light road oil" or a "medium road oil" for city work may be used with great effectiveness. In some cities a considerable lighter oil is used than the "light road oil," but this requires a more frequent application with a consequent increased cost.

Ordinarily, except under very heavy traffic, one application per season has been found to be sufficient of the 40 per cent. and 60 per cent. asphaltic petroleum. The lighter grades of oil may, however, be applied earlier in the season and without the necessity of heating in order to facilitate distribution. They are easily absorbed, dry out more quickly and reduce the dust nuisance during the late spring and early summer months. Light oils are applied also in smaller quantities than the heavier oils, as low as .085 gallons per square yard being found sufficient for good results. This is a very low figure. It is the Toronto figure. It is necessary to go over these roads two or three times a year, but they do away with that sticky condition which obtains in the use of heavier oils.

Oils are applied to road surface by several methods, depending upon the character of the road and the amount of oiling to be performed. In small communities it is sometimes distributed from the barrel by use of the ordinary hand sprinkling can. In such cases lighter oils are used and heating is obviated. In a larger way it is applied by gravity from tanks, either through a perforated pipe or nozzles specially adapted for the purpose, the oil being applied either hot or cold, depending upon its specific gravity.

Large motor-pressure distributors are now frequently used where the amount of work warrants it. This method of distribution being usually known as the penetration method. The material is applied hot, a heating device being used in conjunction with the distributor.

I have not the exact mileage of macadam in the city, but we have felt that we would not be justified in the purchase of a large distributing pressure sprinkler, for the reason that with our eight horse-drawn sprinklers, one in each district, we are able to cover so much more ground and are able to get our work done early in the season, earlier than if we were operating only one machine. We find, when we start oiling, that the people are very anxious to get their streets oiled, and it is a problem to know which street to oil first. We have had to make a rule that the streets with the greatest amount of traffic will be the streets that will first receive attention, regardless of how many friends a particular man has on any street, or how anxious they are to get their street oiled before their neighbors' street.

Much better results are obtained if the road surface is warm when the oil is applied, as diffusion through and over the surface then readily takes place before the oil congeals. This is especially applicable to the heavier bituminous materials. The surface should be free from moisture.

I was going to put it stronger and say it "must" be free from moisture. We have, however, been caught out in a rainstorm with a cart full of oil, and continued work. If the sun came out and dried things up quickly, it was not so bad. But we have had difficulty where the oiling was performed on damp surfaces, in getting proper drying and penetrating effect.

Heat is usually necessary in the application of the heavier road oils. In Hamilton, where last year and this year we are using a medium asphalt road oil, *i.e.*, an asphaltic oil which under certain conditions of test contains an average of 60 per cent. of the original asphaltic petroleum, the oil is first heated in large steel tanks by steam coils to a temperature of from 100 to 150 degrees, and pumped into ordinary oil carts, from which the oil is distributed by gravity on to the street.

The method of procedure is as follows: The street is first thoroughly swept by horse brooms and all the loose material that is practicable is cleaned from the surface of the street and removed. Oil, while hot, is then applied by a gravity sprinkler at the average rate of ⅛ gallon per square yard of road surface. Coarse rock screenings and stone dust are then distributed by hand over the surface of the oiled road in order more quickly to absorb the oil and prepare the road to receive traffic.

In calculating that figure of ⅛ of a gallon per square yard of road surface, we measured the road from curb to curb. The sprinkler does not sprinkle the whole width of the street, but the whole width is effectively oiled, in that a certain amount of the oil runs down the crown and effectively oils the portion next to the curb, so that I feel it is right and fair to consider that the whole road surface is oiled.

Ordinarily the street is not closed to traffic. Better results would be obtained here if the streets were closed from 24 to 36 hours after the oil application, in order to allow a certain amount of absorption and hardening of the oil to take place before traffic is allowed on the street. On busy city streets, however, this is hardly practicable.

When we are oiling up one street and down another, we would have a large section of the city completely ostracized from the rest of the town except by pedestrian traffic, and this would cause great inconvenience. We find it does not cause really serious difficulty to let the traffic go right over the street after it is oiled.

The amount of oil used depends altogether upon the character of the surface being treated and the extent of the coating desired. It varies from an eighth to a quarter of a gallon, and sometimes one-half gallon, per square yard.

I might say that last year in Hamilton a very accurate cost was kept in connection with street oiling as carried out in this city, the detailed statement of which was published in *The Canadian Engineer* for December 13th, 1917.

The average cost, without regard to overhead such as superintendence, engineering, repairs to plant, depreciation, insurance, etc., was $.01673 per square yard, or $1.673 per 100 square yards. This is equivalent to $235 per mile of 24-foot roadway, or a little less than 2¼c. per lineal foot of frontage.

I was surprised when we began to figure up our overhead in connection with our road oiling proposition. Our repairs to our little pump at the yard where we have our tanks, the cost of steaming, heating, the repairs to our tanks, the depreciation, insurance, etc., amounted to 31 per cent. of our total cost. I went into that very carefully. I was thunderstruck, but that is what keeping costs tells us.

Ordinarily, unless costs are very carefully analyzed, and a knowledge of conditions obtained, the figures are apt to be misleading rather than instructive. They vary, depending upon the price of labor, material and the methods adopted, so that real efficiency must be judged on a basis of these considerations. The following base prices were applicable to the above costs:—

Teams per hour	$ .75
Labor per hour	.35
Oil per gallon	.096
Screenings per ton	.85

The screenings were distributed by shovel from a wagon travelling slowly along the street.

CONCRETE ROADS*

By A. Lalonde, C.E.
Assistant Engineer, City of Outremont, P.Q.

WHEN a community decides to construct a road, the officials must find out first the amount of money available to pay for the initial cost; second, the amount of money available to pay for maintenance charges. The next step is to decide on the type of road which will best serve their purpose. Concrete will certainly be amongst the different types they will be called upon to consider.

In making a choice they have to bear in mind the essentials of the ideal road, which should be durable, sanitary and noiseless; thoroughly adapted to motor traffic; not slippery; and with low initial cost as well as low maintenance charges. Low maintenance naturally means easy repairs.

Data regarding the age and durability of the various concrete pavements, together with the future maintenance cost per year, are not yet established on a very sound basis, though the figures at hand are reliable enough for the sake of comparison. That is not the case with water-bound macadam, bituminous macadam or similar types. A considerable mileage of these roads have been laid during quite a number of years and accurate data kept on same.

The sanitary and noiseless state of a road especially applies to city pavements.

Motor vehicle traffic has come with us to stay. Humanity will profit by it, possibly more than it did with steam and electric transportation. It is the writer's opinion that we ought to take the difficulty as it stands, and not put out any law or any restrictions that would hamper the growth of that kind of transportation. If our roads are not fit for the new work, let us build roads that will stand this kind of traffic as well as other kinds.

Slipperiness should be dealt with very closely in Canada on account of our fall and spring conditions.

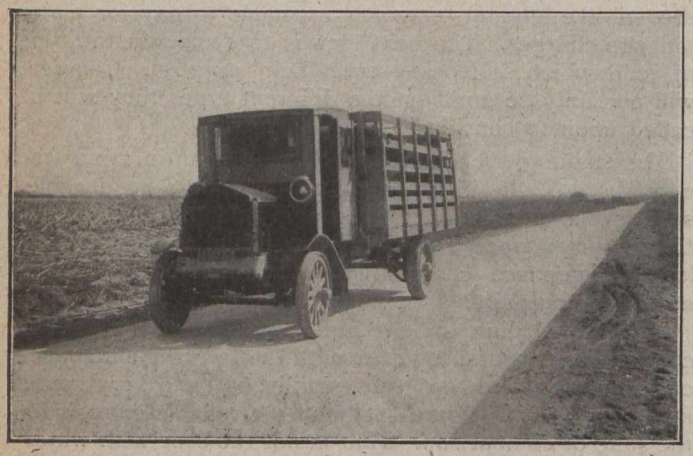
The demand throughout Canada to-day is for a long mileage of low-cost roads, but there is quite a difference between this statement and the belief so strongly entrenched in our different provinces that every time we ought to choose the cheapest road. It is an established fact that maintenance cost is much lower on hard surface roads than on any other types. The gross annual cost per square yard, which includes interest on initial cost, plus amortization, plus annual repairs, on different pavements, are, according to E. W. Sterns, chief engineer of highways, Borough of Manhattan, New York, as follows:—

Concrete	7.8	cts.
Asphaltic concrete on 6-inch base	11.0	"
Sheet asphalt on 6-inch concrete base	11.25	"
Brick on 6-inch concrete base	14.00	"
Bituminous macadam	15.70	"
Asphalt block	16.90	"
Water-bound macadam	17.75	"
Wood blocks	20.40	"
Granite blocks	21.00	"

Concrete roads will fulfill nearly all the above requirements of the ideal road. Though there are no very old concrete pavements in existence done under the present practice, the present condition of those which have stood quite a few years of service would be enough to satisfy

*Address delivered May 9th, 1918, at Canadian Good Roads Congress.

anyone who may doubt their durability. They offer very little resistance to traffic; they produce practically no dust and may be easily cleaned; they are not too slippery; and they are thoroughly adapted to motor traffic if well maintained. They can be constructed at a reasonable cost; as a matter of fact, I think they are the cheapest of all hard surface roads. It may also be noted



Livestock is Transported by Motor Truck Over Concrete Roads

that when considerably worn down by traffic they may be used as a very sound base for asphaltic concrete, sheet asphalt, brick or wood blocks pavement. They can be maintained at very small cost.

On the other hand, they are quite noisy, but this disadvantage should not be taken into account in the case of rural roads.

There is no method, to my knowledge, to prevent wear in the vicinity of joints. Cracks may appear even in places where joints are well constructed. Regarding difficulty in repairing, this objection is a valid one, but, sooner or later, will be found an easy method of making a first-class patch. Until then it would not be advisable to construct concrete pavements in a rapidly growing community if numerous street cuts are to be made in the surface.

There have been many pavements constructed with inferior materials, which accounts for a good deal of defective concrete pavement in Canada as well as in the United States. Only concrete materials of first-class quality for paving purposes should be used. The possible sources of supply of these materials are not quite developed and data regarding same are most generally not available. The investigations and reports made under the supervision of L. Reinecke, of the Geological Survey, will be of great help to road-builders in this country.

Any successful road requires a good deal of care as to details, and this is more true of concrete pavements than of any other. Cement is a wonderful material, but it has to be used properly. After a specification is adopted and the contract made, its terms and requirements should be followed rigidly. Some of these requirements may seem exaggerated to those paving contractors who do not understand their own interest. Often the engineer's or inspector's views are then overruled and the result is inferior construction. The inspectors should be very familiar with the specifications used and must look upon them as their reference library.

The specification of the Canadian Society of Civil Engineers for cement is commonly used. Good care should be taken that cement be stored in a dry shed where water will not leak through the roof or the walls.

Sand should be carefully chosen on account of being the controlling factor in the wearing properties of the surface. It should be free from clay, loam and vegetable matter. Careful instructions should be given to laborers shovelling same into wheelbarrows, that they do not shovel part of the soil on which the sand is deposited. Sand, the grains of which have natural coatings of limonite or other foreign matter, make a very friable mortar. So far as possible only washed sand ought to be used.

The coarse aggregate being called upon to take the wear and tear of the road, it should be hard, tough and durable. Its hardness should be at least equal to that of the mortar used. It must also be remembered that it has to sustain the shattering effects of the steel-shod traffic. So all soft stones, slates, shales and some limestones, etc., should be rejected. It should, of course, be clear of lumps of clay, pieces of wood and scales from uncleaned wheelbarrows. The presence of such matter will, sooner or later, produce local pitting and an increased wear on the surface. Long, flat stones should be picked up, first, because they produce scaling, and also they are very likely to come out, sooner or later, and leave a bad hole.

It is not a good policy to use crusher-run stone or pit-run gravel. These materials will not give to the concrete pavement the required uniformity of texture and hardness of surface. The dust which they contain in quite a large quantity will retard the hardening of the cement. These materials should be screened and separated into fine and coarse aggregates, even if it adds a certain amount to the cost of the work.

When building a two-course pavement the bottom course aggregate may be softer than in the one-course construction, but, on the other hand, the wearing, or top course, must be richer in cement than the one-course. The maximum size of aggregate should be smaller than the one-course, and also harder. To quote Messrs. Agg and McCulloch in their "Investigation on Concrete Roadways" for the Iowa State Commission:—

The Construction of Concrete Roads Brings New Business to the Truck Salesmen

"The life of a concrete pavement depends to a large degree, on the correctness and uniformity in the proportioning of the materials. Emphasis should be laid on the fact that the present methods of field proportioning are exceedingly crude. The development of the bituminous pavement surface has been characterized by the adoption of accurate methods of proportioning and grading the materials. Concrete as a surfacing material will never be used at its highest efficiency until the proportions are specified by weight, and these pro-

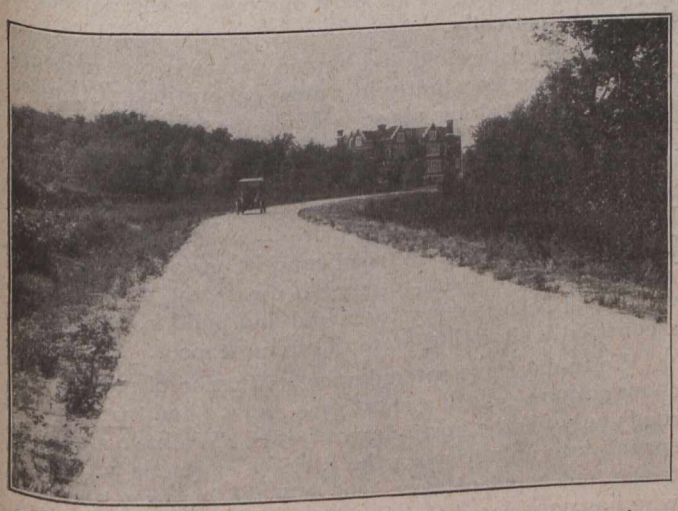
portions accurately maintained as the materials are placed in the mixer."

I would like now to say a few words regarding the general construction. Heavy stress should be laid on the making of subgrade and drainage. Unequal settlements should be avoided. No concrete should be laid over fills which are not thoroughly compacted or have not yet attained their ultimate settlement, which takes place at the end of about one year. A flat subgrade gives more concrete in the centre, where it is most needed, though one that is shaped to conform with the finished surface takes less concrete and gives better drainage. The subgrade should be rolled and reshaped until it has the specified shape and uniform firmness. This will not only prevent waste of concrete, but will also facilitate the movement of the pavement due to contraction and expansion, and, therefore, prevent the formation of cracks. It is a well-known fact that a rough and uneven subgrade renders the transverse joints about useless.

The system of drainage should be carefully studied and planned. It should not only take care of surface and underground waters, but provision should also be made for temporary drainage, so as to prevent the washing of green concrete by surface water. Such occurrences often necessitate the tearing up and removing of the entire pavement slab. The problem is to keep the subgrade dry by using the different resources or materials available. Were it not possible to do so, the design of the pavement, for such a length as may be found necessary, should be changed. In a poorly-drained subgrade there is a tendency for the edges to dry out quicker than the centre, with a consequent settlement and production of longitudinal cracks in the pavement surface, especially when the cold sets in or goes out of the ground. Nearly all engineers to-day are of the opinion that the unsightly cracks that one may notice in many concrete pavements are due to a very great extent to poor drainage.

Finishing

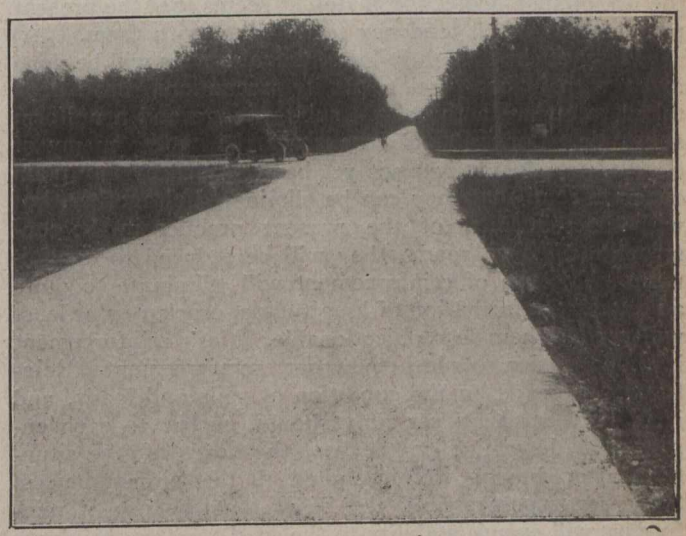
General practice seems to favor the wooden float for finishing. If handled by a skilled workman, it will give



Another Prettily Located Concrete Road Near Winnipeg that is Popular Among the Motorists

a satisfactory surface, sufficiently rough for all ordinary grades. The thinnest possible skin coat of cement should be brought to the surface so as not to cause scaling. Over-floating not only costs more money to the contractor, but does not give so good a surface.

It must be borne in mind that after concrete is deposited and floating done, the pavement is not finished. Good care should be taken that green concrete is not exposed to the hot rays of the sun. Canvas should be kept over the green concrete for about twenty-four hours, after which it can be sprinkled. No empty cement sacks should be allowed on the green concrete. Dirt can be used at the end of forty-eight hours, and should be kept wet for ten days. These precautions, if they are not overlooked,



Fort Garry Drive, Crossing Point Road, Near Winnipeg. Two of Manitoba's Oldest Concrete Roads

will prevent shrinkage cracks and conserve water, which will be needed for the chemical combination of the cement. Curing by ponding is also a very excellent method. The inspectors should see that all the dirt is completely removed and the surface well cleaned before the road is opened to traffic. As to the time of opening such roads to traffic, I would quote the following extract from the "National Conference on Concrete Roads for 1916":—

"The length of time necessary to keep the pavement closed to traffic will depend entirely upon weather conditions. During warm weather the pavement should be kept closed to traffic for at least fourteen days and preferably for three weeks. When the conditions are such that the temperature of concrete is less than 50° when placed, hardening takes place very slowly. As is well known, the hardening of concrete is a chemical action requiring heat. The hardening will take place in direct proportion to the amount of heat present, and takes place very slowly at a temperature of 35° Fahrenheit or below.

"When a concrete pavement has been laid in the late fall, it is sometimes difficult to determine when it will be safe to throw the road open to traffic. In rare cases it may be necessary, owing to peculiar local conditions, to open the road or street to traffic before it is absolutely safe to do so. Under such conditions, if about 3 inches of straw be placed on the pavement and this covered with several inches of earth, the surface of the pavement will be protected sufficiently against abrasion to allow the opening of the road sooner than could be safely done without such protection. This cover will, however, not minimize the danger of damage to the pavement by heavy loads, which will tend to crack pavement that has not developed its full strength. Concrete roads have been utterly ruined by opening to traffic too soon. Few people realize how slowly concrete hardens under unfavorable conditions, which will undoubtedly prevail on some jobs before the work is finished. All those in charge of concrete pavement work should have the necessity of adhering to the foregoing cold weather precautions strongly impressed upon them."

The recommended practice for transverse joints is that joints should be placed across the pavement, perpendicular to the centre line, about 50 feet apart. There seems to be a tendency to lengthen the distance between joints, and even to eliminate same entirely. Many en-

gineers advocate to-day the placing of a transverse joint only at the end of each day's work. The difference in the kinds of soil over which the pavement is laid should not be overlooked. A good practice, when metal protection plates are used, is to finish the pavement at least six inches on each side of the joint with the steel trowel. Though considerable difference of opinion exists as to the use of such protection plates, it seems that the present practice has much tendency to do away with them.

Many of the unsightly longitudinal cracks will be done away with in concrete roads if precautions have been taken to ensure a thorough sub-drainage and a uniform subgrade. Longitudinal cracks are the worst enemy of concrete roads. It has not yet been proved by any plain concrete road that they can be eliminated altogether, but with the refinement of the present practice in the construction of such roads, they will be reduced to a minimum. The use of reinforcement will eliminate to quite an extent the formation of longitudinal cracks, or at least will render them less objectionable. Mesh reinforcement is much easier to place than bar reinforcement. Reinforcing depends on the condition of soils and loads, and it is a matter that certainly should be left to each engineer to determine on the spot the needs of the situation, after having well weighed all the circumstances. Some engineers are of the belief that the use of reinforcing will ensure stability to the road, scatter shrinkage cracks and eliminate joints.

Regarding the thin, bituminous wearing surface for concrete pavements, the results obtained to date do not economically justify its use just at present. Maintenance of concrete pavements will be greatly simplified so soon as a satisfactory method of coating their surface can be devised.

After the road is completed and opened to traffic, it has to be maintained, and this is a point that should be clearly demonstrated to the officials of all communities who are planning good roads. An efficient, systematic and intelligent system of maintenance should be devised and enforced. I do not need to show here the full economic value of such a system. No municipality, province or country will ever realize the benefit and merit of a good road unless it is properly maintained. While the cost of systematic maintenance of concrete pavements is small, if we neglect to maintain same the cost may be very high and the taxpayer will not have received the greatest value for his money.

When an engineer makes the statement that a concrete road represents the minimum outlay for maintenance cost, highway officials should not derive from these words that when a concrete road is finished no care or attention whatever need be given to it. This would be a very grave mistake. It is inherent to human nature that everything will wear away in the course of time, and it is so with all pavements, even though they be called "permanent."

In their ninth annual report, the Board of County Road Commissioners of Wayne County, Michigan, say:—

"Recognizing that durability and low cost of maintenance, as mentioned in preceding reports, largely determine the success of any type of road, our preference, based on our past seven years' experience, continues to be for concrete construction. We believe in constant and systematic maintenance of all roads under our jurisdiction. As in past years, our gravel and macadam mileage continue to absorb the bulk of our maintenance moneys and energies. We have repaired and oiled all gravel roads and in addition thereto dragged them systematically in both the spring and fall.

"The wisdom of building of concrete, in our judgment, stands out conspicuously when maintenance cost involved in keeping all other types of roads under our jurisdiction in usable condition is compared with the actual cost of maintaining concrete. Yet, even the best concrete road will require some maintenance, consisting principally of cleaning out and refilling expansion joints, the repair of pockets which occasionally appear on the surface as a result of some foreign material such as clay getting into the concrete, some fragment of inferior pebble or stone, or defects in workmanship. Usually no maintenance is required on our concrete roads the first year of their life, but if we find that any is necessary, we do it promptly and thoroughly.

"Our concrete roads possess the special feature of presenting a surface that wears but slightly and uniformly; a surface that does not give away in any one spot and withstands traffic over its entire surface. This is made possible by careful selection of materials, careful methods of proportioning and mixing, and care in finishing and curing, resulting in a concrete having an uniform texture, which is a big factor in eliminating maintenance costs. We have over 125 miles of concrete road in Wayne County, some of it in its seventh year of service, all of it in good condition, and we have never taken up and replaced a 25-foot section since we have been building and developing this type of road, which, we think, speaks volumes for our low annual maintenance costs."

NEW TRAFFIC MAKES ROAD CONSTRUCTION AN EVER-CHANGING SUBJECT*

By W. A. McLean
Deputy Minister of Highways, Ontario

ROADS are as ancient as human history. I suppose that in the olden days the Greeks and the Romans must have had their congresses to create public feeling and interest in those organizations which were required by them to construct the ancient highways that are still so famous. And if roads are so old and highway conventions are so old, the question naturally occurs to us, why are we still talking about them? Haven't we reached the point when we should have good roads without talking about them? The answer is that history repeats itself, and that while roads are old, human nature is the same and we must all learn our own lesson painfully, slowly and patiently.

While roads are old and human nature is old, men are new. We are constantly in a new generation. Changes are constantly taking place. While there is nothing new under the sun, yet the combinations of the old things are infinite, and as we go on year by year, there are new combinations of vehicles and traffic which we all have to learn. If we could see three or four more thousand years into the future, we would still see road conventions and congresses just as we have them to-day, to create the organization which will be necessary to extend and build highways for a constantly changing state of circumstances.

We to-day have entered upon a situation of remarkable combinations. Until a short time ago we had to construct roads only for the horse-drawn traffic. We have suddenly sprung into an age when the gasoline engine is applied to traffic and transportation and only the highway engineer who has considered the problem of the new motor vehicle can understand and appreciate the intricacies of the question that is before us. We have not only had to construct for the present state of circumstances, but we have to see beyond the sky line and construct for the future. We have to create in our imagination that toward which we are tending, and if we are to leave a heritage for the future that will be for their good instead of for their injury, we

*Address delivered May 7th, 1918, at Canadian Good Roads Congress.

must see that our financial methods and our schemes of construction are such as will apply to the future as well as give to ourselves the pleasure of good roads.

Hamilton, from a geographical standpoint, is one of the most important hubs of highway traffic that we have in Canada. From Hamilton radiates the road to Toronto, the Toronto-Hamilton highway, and on through to Montreal; the road to Guelph and Owen Sound; the road to Galt, Kitchener and Stratford; the old Governor's Road straight to Paris, and beyond, the older provincial roads through Ancaster to Bradford and Woodstock; the road to Caledonia and Hagersville, where it joins the old Talbot Road; and the road to Stony Creek and Niagara. These are all old highways, laid out as direct roads in the early history of Ontario, and they all join here in Hamilton.

Highways in war time are a much-discussed problem. But war itself in Europe to-day is largely a problem of roads, roads leading up to the front lines bringing up supplies, and roads upon which to retire and save under certain circumstances the material and men which man the front trenches. It is a problem of roads all the time.

The past winter has shown us that to sustain these men overseas, we have our own highway problem and that of the steam roads behind them. The steam roads here are fed by the highways. Close the highways, the common roads, and all our steam roads would stand in idleness. The war, our men at the front, would cease to be sustained. The answer to me is a simple one. Good roads are a matter of efficiency in time of peace and they are as much a matter of efficiency in time of war as in peace, and they are more necessary in time of war than in time of peace because it is the time when every channel of commerce should be in its most efficient state.

I do not think that this is the time to undertake great plans of construction. It is impossible, unfortunately, even for our modest efforts to obtain the men we need. Our highway department would do much more if we could only get the men, and we have to move cautiously so that we will not disturb the essential functions of production. But while it is not a time to undertake great schemes of construction, it is a time when what we have should be maintained in the best possible state of repair. By careful management (and if we have the ideal scheme of conscription throughout Canada, turning each man to the point at which he could do the most for the country, to win the war), we would have the men to maintain our highways, with a small amount of time, so that there should not be a great deal of wasted time and effort in travelling over those highways.

That is always an answer to why we want good highways. We concentrate into their construction and repair what is a small amount of time and effort in order that we may conserve and develop a great deal of time. But we have something more to do. We cannot at home rest satisfied simply with seeking to secure a military success in France. We have every thought of winning the war, but we have to meet the necessity of being able to throw in the clutch as soon as the war is over, to sustain and maintain what we have, and to do justice to the men overseas who will return. We must prepare for the time of peace and for the time of reconstruction after the war, in order that as a country we may not sink beneath the load of taxation that will be thrust on every country in the world.

I am sure that in what follows this opening session, the practical questions of road construction will come under discussion, and I hope that the policy which Ontario has initiated will receive its full share of discussion. Ontario has sought to organize and prepare for after-the-war conditions. Ontario has sought to do what it can, under the stress of war, in taking care of the upkeep of her highways.

HIGHWAY WIDTHS*

By F. Howard Annes, Whitby, Ont.

WITH the passing this week of the by-law covering the agreement between the government and the town of Whitby, Ontario, as to allotment of the Kingston Road through that municipality to be maintained by each party, a stretch of some sixty miles (or as far east from Toronto as Port Hope) on this historic highway comes under the control of the Ontario Highways Department for development as the initial unit and an integral part of the projected system of provincial highways. It is, therefore, proper to consider the practical phases of the great problem offered for solution in this splendid enterprise upon which the people of Ontario are entering. One of prime importance is the width of the road allowance. At present the standard is 66 feet.

A careful analysis of present requirements in width of road allowance for a trunk highway like the Kingston Road discloses pitiable shortcomings. A fair apportionment of 66 feet between actual road surface, ditches and a place on either side of the road for telegraph, telephone and electric light and power lines, leaves nothing but butchering of trees planted along the boundaries between private properties and the public road. Nor does the 66-ft. width take any account of future demands for wider road surfaces on an artery for motor traffic that possibly is unique in that it is the only highway serving the most populous and wealthy portion of Canada—Toronto, Montreal, Ottawa and the intervening communities, aggregating more than a quarter of Canada's population, and perhaps one-third of her industrial and mercantile establishments—a portion of this great and growing country that never can have any other road than this for intercommunicating by means of vehicular traffic.

Is it wise, when now it is wholly practicable to widen this road sufficiently to provide for the indefinite future, that any chances should be taken in erring on the narrow side rather than provision based on a broad and enlightened outlook for the years to come? The opinion now is held by governmental authorities that the only certain way of fighting the fuel famine in this part of Canada is to plant trees on every available acre. Is there any more encouraging step in this direction that the government of the province could take, than to plant a line of trees on either side at the street boundary of a system of provincial highways?

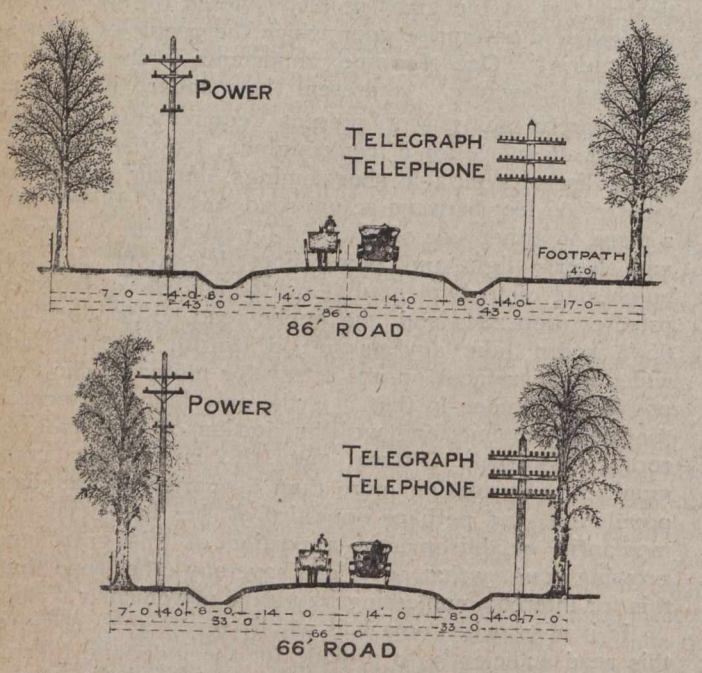
While these are some of the practical reasons for wider highways, there is the consideration of the æsthetic that is no less important. The element of width in a roadway is undoubtedly the one which most adds dignity and impressiveness. That is evidenced everywhere throughout the world in civic improvements by avenues, parkways, gores and other widenings of public roads. With the rigidity that comes to great centres of population in regard to such widening, it is only provident to prepare for a doubling or trebling of the population of this province already predicted by eminent public men.

What would Toronto not give if she could but widen Yonge and King Streets? The exact width of a new road

*Address delivered May 8th, 1918, at Canadian Good Roads Congress.

of this kind, fortunately, is yet to be determined. Already the principle is recognized in the Whitney Memorial Highway, running from Ottawa to Morrisburg, the native town of the distinguished statesman who best, and thus very fittingly, will be remembered as the man who made possible a road for electric current to be distributed all over Ontario under municipal ownership, and who, through his prescience and persistence, worked out the province-wide scheme since associated more with the name and fame of its successful protagonist, Sir Adam Beck. Adding ten feet to each side of a 66-foot road makes 86 feet, the width adopted for the Whitney Highway. My own idea is that, at least for the Kingston Road and its extension to Montreal, one hundred feet is better. That is the standard width adopted by the steam railways for a right-of-way. It means but seven feet more on each side, but will the more fully meet every need.

No name as yet has been proposed for this system of provincial highways. Why not one associated with



Sketch Showing Location of Trees and Pole Lines on Ontario Provincial Highways

the glory that has come to the sons of Ontario who sleep beneath the soil of France and Flanders? With triumphal arches at the Windsor, Niagara Falls and Montreal ends of the 500-mile trunk of the system, and at the entrance to the large cities, such a road system might well be made the finest memorial in the world. Is anything too good for those who have made the supreme sacrifice that civilization might not be destroyed?

Here is a suggestion for this purpose in devoting the provincial highways to the everlasting memory of those who have fallen fighting for us on the sainted soil of France:—

"ONTARIO GLORY ROADS, given, through their government, by the grateful people of that province, in honor of its sons, the Heroes of Canada, who freely gave man's greatest gift, Life, that liberty, freedom and justice might not perish throughout the world."

The New Westminster utilities' estimates for 1918 include: Light department, $37,246; water department, $17,462; board of works, $44,428.

WHO SHOULD PAY FOR THE ROADS?*

By Hugh Bertram
Member Toronto-Hamilton Highway Commission

IN trying to answer this question, one must first consider the service that roads in general give to the citizens of the country through which they pass.

Good schools and good roads are among a country's first and greatest assets, and, just as we find in the former the foundation of the educational and business life of the country, so do we find in the latter the foundation of the transportation system, which on this continent has had such far-reaching civilizing influences and has been the means of great development in a short space of time.

I mention schools purposely, for the one is handmaiden to the other, but until a common education became compulsory and free to one and all in a general way, we did not make the progress as a nation that we have since made, and not until toll roads were abolished did the people realize what it really meant to the general prosperity of the country to have roads free to be used by the rich and by the poor alike, with equal rights thereon. But the free use of roads by all who may or do use them, like freedom in many other things, as we know to our sorrow to-day, entails an expenditure that we must consider and be prepared to pay if we are to continue to enjoy them and receive the full benefit therefrom. It is here that the question thrusts itself before us, "Who should pay for the roads?" A simple answer would be the people, for they it is who in the end must pay. There are, however, various channels through which they can be reached without the expense being unduly burdensome on anyone.

First of all, I would mention the Federal Government which, in the past, has given such large sums of money toward developing the transportation system of our country as represented by railways, canals and waterways, but so little toward helping with the building of our roads, which after all is the real foundation on which the transportation system of our country must stand, and which has proven to be (next to man power) perhaps the most vital factor in the war. It may have been necessary in a country of such distances to have given the millions that have been given to the railways, but there is no reason why the roads should have come in for so little attention as has been given by the Federal Government. However, the time has now arrived when it becomes imperative to give some aid to the roads, the people's roads, in order that they may be able to sustain the transportation superstructure that we are now called upon the carry; for three years of war has shown the limitations of railways and the great possibilities of road transportation.

Federal aid should be given with the view of helping in the construction and maintenance of some of the main roads between cities, towns and market centres, relieving the municipalities interested to an extent that would allow them to devote more attention to the ordinary roads. The same argument holds good regarding aid from the provincial government, for while admitting that they are already assisting, there still remains very much that they could do, which would not alone be a helpful benefit to the municipalities, but would act as an impetus for them to make greater efforts to lift the outlying roads to a higher standard.

It is here probably that we should mention the amount collected from the automobile licenses by the provincial

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*Address delivered May 8th, 1918, at Canadian Good Roads Congress.

government. By many it is thought that this money rightly belongs to the roads, irrespective of any grants the province may make, being a tax supposedly for injury done, and as such properly returnable to the roads. This seems to be an ever-increasing source of revenue, and should help materially in the betterment of the roads if used for that purpose.

To this should also be added fees that may be collected from motor vehicles doing a freight or passenger business on any of our improved roads. Until very recently the cities have given little or no assistance to the roads outside of their own boundaries. However, it is recognized now by the government and by most cities that giving assistance towards the betterment of the roads lying adjacent to the city, not only facilitates transportation but brings the producer and consumer closer together to their mutual benefit; for this reason, cities should bear a share of the cost of the building and up-keep of those roads. In Ontario we find that nearly all the counties have now joined the good roads system, allowing them to partake of the provincial government grants. When roads are built to a certain standard, this is good so far as it goes, but there still remains a rather heavy burden for the ratepayers when we consider that they have to pay not only their share of county taxes for road purposes but must keep up all township roads as well.

I might mention here that most counties in going into the good roads system map out a program of road-building that requires considerable money. This is generally raised by a bond issue.

In the past, many counties have made the mistake of issuing bonds for too long a period, the roads being worn out before the bonds were retired. In issuing bonds for work of this nature, the maturity of the bonds should fall within the life of the improvement, thus insuring the taxpayer's value for money expended.

In the township roads we find the source of the major portion of rural traffic. They are without a doubt the most neglected part of the whole road system and yet the most important. At the present time the statute labor tax is the only source of revenue for this work unless a grant be made out of the general taxes. The township road system is so extensive that the statute labor tax is totally inadequate in most townships to keep the roads up to a proper standard. It is here that I contend the effects of federal aid would be felt most, for, in assisting with the building and maintenance of the main travelled highway, it would allow the provinces and the counties to give some much-needed aid to the townships' roads. When we stop to consider conditions as they exist to-day and as they are likely to exist after the war in regard to urban and rural population, it goes without saying that after-war conditions will find the cities and towns over-manned and the rural districts under-manned. One of the great problems will be to get the people back to the land, for our national recuperative powers will be largely governed by the manner in which we develop our natural resources.

The British premier, David Lloyd George, said in one of his great speeches, that never again would the farmers' interests be neglected as they had been in the past; so let us try to remember that neglected roads means jeopardizing the farming industry, the most essential industry in our country. While I would not go so far as to say that bad roads have been the cause of the depopulating of rural Ontario, I will say that it is one of the causes, just as I would say that good roads, and the benefits accruing therefrom, will prove to be one of the remedies for the repopulating of the rural districts.

There are some people who believe that where a more or less permanent road is built, thereby increasing the value of the property fronting it or adjacent to it, it should bear a part of the cost of the road. This is a debatable point, many believing that where a road has increased the value of adjoining property and increased the assessment (which in turn meant increased taxes on such property for all purposes), if the municipality as a whole benefit by the increased assessment and taxes, it should assume at least a part of any frontage tax that may be levied.

In conclusion let me say if we could only unite those different interests I have mentioned in a carefully-thought-out scheme for the betterment of our roads as a post-bellum measure, it would not only create a valuable asset to our country,—one that would bear interest in the progress and prosperity that would surely follow,—but it would be one sure way of providing useful employment for those who might need it in the period of readjustment which will no doubt follow after peace has been proclaimed.

WHO SHOULD PAY FOR THE ROADS?*

By W. A. McLean
Deputy Minister of Highways, Ontario

THE problem of paying for the roads is one to which naturally I have given some attention,—perhaps more to that phase of the subject than to any other. There is one thing that we may accept right at the outset, and it is no use blinding ourselves to any other phase or any other complexion of the situation: Roads must be paid for.

Through Spain and the southern countries of Europe, there are remains to-day of the old roads constructed centuries ago under the Roman Empire. The somewhat superstitious peasantry of those countries, having no information and no historical knowledge of how they were made, have the impression that they were a gift of the gods, created by some supernatural power. I am afraid that there are still people who have the idea that roads can be constructed in some such way.

I believe in the efficacy of prayer and I say it solemnly, but I have yet to find the road that has been constructed solely through the medium of prayer. It means work; it means material; and these have to be paid for, and the people of this country will have to pay. Now, there is no use saying that the Dominion government should give to this work, the province should give, some other organization should give. If they give it they must obtain it from the public, from the people, before they can give. There is no tap extending up to Heaven that the commissioners can turn on and expect the ducats to flow from any other source except the people. There is the fact we must face that the people of this country must pay for the roads. The only problem is to distribute that cost in an equitable manner, one which can reach the results without placing any excessive burden on the people.

In order to do that we must remember that road construction is a slow process. We cannot lay out a system to-day and employ an army on it and before the end of the year see a great completed system of highways throughout Canada. The Toronto-Hamilton highway was undertaken with every good purpose, was carried out as

*Address delivered May 8th, 1918, at Canadian Good Roads Congress, as discussion of Mr. Bertram's paper of the same title (see page 438).

efficiently as honest and sincere commissioners could be expected to carry it out, and with all possible speed, and yet in order to reasonably construct it, and part of it is not quite complete, it took three years from the time it was started to construct thirty-six miles of paved highway.

Our problem is not one which should discourage us. It looks to be a tremendous thing when we think of the extensive mileage that we have through Canada, some 250,000 miles of highways in the Dominion of Canada to-day. We should not let that problem discourage us. It is a slow process. The roads must be constructed by manual effort and can only be financed by an annual measure, so that when we start to construct a system of highways we don't have to have the entire sum in our pockets. We appropriate our money year by year for this purpose, and considering the time it will take and the means we have at our disposal, I am of the opinion that the people of this country are amply able to pay for and to construct a system of highways in every way adequate to our requirements, without any serious financial struggle.

Not a Shortage of Money

With us to-day, in order to carry out a good and adequate plan of construction for this year, we are not held up because the province has not the money, nor the county. I have yet to see the county that has not the means available to carry on a satisfactory scheme of construction this year, and certainly the province is not holding up because we have not the means. It is because, as you know, the men are not available. They are, perhaps, in a few localities, but throughout Ontario and Canada as a whole, the work is simply delayed because we know it is not expedient to undertake any great system of construction and so enter into competition with the labor market that is at the present time strained in order to take care of the essential, the most essential matters that we have in hand.

I have said that we should all pay for the roads. We must all pay for the roads. One serious situation that we have discovered in Ontario, and I think it pertains throughout Canada, is that in the past the farmers, the rural sections, have been expected to construct highways solely at their own expense.

Now we find that the townships are fairly well assessing themselves (not so much as they can, not as much as they will do) for ordinary township road purposes, but they have not had the means of setting apart, until the province took hold of this matter, a special system of highways on which to concentrate effort.

Suburban Road Systems

In order to separate the main arteries, the more important market highways, into a class which would receive immediate attention, the province established a scheme of county roads upon which the people of the townships, through the medium of their county councils, should concentrate their efforts. But we were still met with the serious condition of which I have spoken, that only the people within the county organization were called upon to pay for this work. And although these highways go right up to the entrance to the cities, although cities in every other country are helping to maintain and pay for such main arteries, through our scheme of municipal organization the cities were escaping entirely.

In Ontario we have established a plan of having suburban road systems. This creates somewhat of an offshoot from the city council and the county council, on which each are equally represented. A certain mileage of roads is selected adjacent to each of the cities, and on these the city and the county unite their efforts in what I would call the metropolitan area surrounding each city, and just as the province aids the county or gives its contribution to the county, so it is extended to the suburban area, with the result that within the suburban areas the province estimates that it will contribute twice as much to the roads within those areas as to the ordinary county roads. The cities will join equally with the counties which makes the associated townships. That is, we have established a plan by which the cities can co-operate in constructing the more heavily travelled of the country roads, and it is an axiom of road construction that roads must be constructed and maintained and consequently paid for practically in proportion to the amount of traffic over them.

It has been said that the province should give more than the fees from automobiles. I have no doubt whatever that the province, so soon as it finds that the available funds from automobiles are absorbed through the channels that have been established, will find other means of supplementing that expenditure sufficiently to meet the needs of our annual plan or scheme of construction. Ontario has accomplished a good deal in road construction. I have talked with quite a few from the United States and elsewhere who have been on our highways. I have been over quite a few highways in the United States. I have seen highways much more expensively built than any we have here, but I have taken as much comfort out of our own particular type of highway as I have out of some of the more expensive types, for the reason, after all, that maintenance is the only permanent part of any highway and some of those expensive highways are not properly maintained and certainly are some of the most uncomfortable highways one can drive over.

A Few Main Arteries Urgently Needed

Cheaply constructed highways, where traffic is not heavy, will serve every purpose if they are maintained. As traffic increases, the highways should be constructed in proportion, and maintained in proportion, and consequently the area of payment must be extended, and so we extend it to the county and the province joins in. A considerable proportion of the counties have for some time been constructing their market roads with excellent results.

What Ontario needs more than anything else is a few main arteries in order to develop what we have. You know that you can get from Hamilton in reasonable comfort over quite a series of old county roads. Close to Hamilton these roads are worse and in poorer shape than they are some miles out. Why? Because they are not a strong enough type to support the heavier traffic concentrating itself close to the larger centre of population, entering the city of Hamilton or going out from the city of Hamilton. As you leave the hub the traffic diffuses itself and in a remarkably short area it is astonishing how you will pass from the section in which expensively constructed highways are required, to the area where comparatively cheap roads will serve the traffic equally well.

But, as I have said, what we need are certain main arteries, and we are planing for them. What I have said as to the diffusion of traffic hardly applies to those main arteries, because the traffic there is from city to city and town to town and is fairly well concentrated between important terminal points. The province has created an organization for a provincial system of highways. We have started that organization, have taken over a section from Toronto to Port Hope, and it will be extended as fast as it seems expedient. When such a system of con-

nected roads exist,—that is, when the main highways, a series of sections connecting up the county roads, are constructed,—when these main arteries are constructed, I promise you that in Ontario we will have a system of highways that will be equal to any on this continent, because we will be able to go from one end of Ontario to the other, get out on the county roads constructed by the counties, carrying the market traffic, and from those to pass onto the township roads, maintained at the expense of the township, but upon which they will be able, after the county has created its system, to concentrate all of their efforts.

The average township road, under favorable circumstances of material, can be maintained in very good condition with the ordinary township expenditure, and the townships can carry their own financial burden. The county roads require a heavier expenditure of funds. For the present the township, the county and the province will have all that their financial effort will perhaps enable them to meet. But here you have a scheme of distributing the cost. The city joins in the area of the county, and the township looks after minor roadways or arteries. By minor arteries I mean such roads as have perhaps ten or twelve vehicles a day. Such roads require comparatively light construction. When you get up to 25 and 50 or 100 a day, according to circumstances, or 200, 300 or 500, you have to extend your type of construction and spread the cost over the people.

Roads as Costly as Railways

The question of drawing the cities together is the main point to-day. I sometimes illustrate the equity of it by saying we cannot have the county road pass every farm and yet the farmer on the township road has to pay for his share of the construction of that county road, because he drives two or three miles, gets on it and goes to his market point or into the city.

In the city you have an area of two, three or six thousand acres, with a population of ten, twenty or a hundred thousand. Why should that area and population escape from the cost of those main arteries that serve the country any more than the farmer whose property is not even on the county road? In the city you have an area and a population, in the individual farm you have an area and population, they are all part of the country.

Roads, main arteries, cost as much to construct and proportionately to maintain as the steam railway does. A good main artery costs fifteen, twenty or thirty thousand dollars per mile to construct. That is what the steam railway costs. It is an expensive undertaking. Everyone must share in the cost in Canada, as they are sharing in the United States, as they have shared in the past in England and in France. I have always held the view in Ontario that until the cities and towns come wholeheartedly into our scheme, the construction of highways would be proportionately slow in development. In Ontario and throughout Canada the construction of main arteries, our main channels of traffic, is as important to the country as the steam railway. The city and the township must join equally in the cost. The cities were slow in entering the field during the era of the horse-drawn traffic. With the growth of the automobile, the interest of the city has been stimulated, their people have been going out on the country roads and they see the state of those roads. They have been discovering that certain roads are good and that certain roads are of the other description, and they have been asking why. And we have been seeking to tell them why,—that certain roads carry the concentrated traffic upon which all join, and for which all must in equity expect to pay.

The automobile has increased the carrying capacity of the main highway how many fold? Two, three, ten fold, it is impossible perhaps to estimate, but we do know that the automobile can go five or ten times as far in a day as could the old horse-drawn vehicle, and it can carry four or five and perhaps ten times the load that the horse-drawn vehicle was able to carry. If roads were important to the civilization of the past, and to the people of the past, with horse-drawn vehicles, how much more important are they to the people of to-day with the carrying capacity that has come to them through the introduction of the automobile?

Yet Roads Will Not Be Financial Burden

If the cities of the past have been expected to pay their share, surely the cities of to-day must join in and meet this heavy outlay. Heavy in a sense, yes, but in carrying on this present war we have discovered that what seems a heavy financial undertaking is purely an attitude of mind. If we want good roads, we can pay for them. The financial cost that we have undertaken through this war would have previously seemed impossible to the most efficient of our financiers. To-day we see how it was accomplished. To-day the road problem payment seems heavy. When it is paid for, we will discover that we only had to do a day's work at a time and a year's work was finally accomplished, and we paid for it through our daily earnings at the end of the year, and it was not such a heavy burden after all.

I don't consider that the cost of the highways is going to stagger us at all. It will be immense, but our resources are adequate and the construction of those good roads will pay for themselves in the greater development of our country. All we need is faith and courage to go ahead, knowing that that will be the result. Past history has shown that it is. I believe that Ontario to-day has the foundation of one of the most equitable financial schemes of any country in the world, and I have studied them all. I don't think there is anything to surpass it. If there are any angles to be cut off, we can cut them off as they appear. If there is any filing or sandpapering to do, we can look after that, but we have the foundation of it, and all we need to do is to go ahead and use what we have and perfect it as we see that it ought to be perfected. We have a perfect foundation to work on. That is all we need to concern ourselves with to-day. If there are any inequalities, they will be taken care of as the work develops.

Equitable Distribution of Expense

We have an organization for taking care of the heavily travelled arteries and distributing the cost, and so on to the ordinary township road. I admit that in certain parts of Ontario, some special arrangement would seem desirable in connection with the ordinary township road, but that seems to me to be a matter for the future rather than for the immediate present when we have our main arteries to attend to and our systems of county roads, which will give the townships and the counties and the cities and the province perhaps all we should undertake at this stage of the work.

What we have is not at all final in the way of organization. It is simply the stage from which we must start to use what we have, and I believe that under it the cost will be equitably distributed without any heavy undertaking on the part of any individual or municipality.

HOT-MIX BITUMINOUS CONSTRUCTION, USING ASPHALTIC BINDER*

By E. Drinkwater
Municipal Engineer, St. Lambert, P.Q.

I PROPOSE to deal with this subject in a general way that will give the salient features and entirely leave the technical matters to the authorities of standard specifications now so easily procurable, and which can be obtained from any reliable manufacturer of paving materials.

First I propose to give a synopsis of the various methods employed by the writer during a period of from

Jarvis Street, Toronto, hot-mix asphalt, surfaced 1901, photo 1917. Repairs negligible

twenty to thirty years. I have been more or less the whole of my life actively connected with pavement construction, and previous to 1910 had always had to make use of that which was locally procurable and economically purchased, and had always adopted the mixed method for bituminous construction; that is to say, the fine or coarse stone aggregate was always coated with the bituminous binder before being placed in its pavement position.

In the early days of my work I may say that we used gas tar procured directly from the gas works, at a very nominal cost. We coated the stone in dry, warm weather, without any heating. The tar was heated in what we called tar boilers, some of which were of a very large size and portable. In cold or damp weather we dried out and warmed the stone on plate floors heated by steam or hot air flues, such as we also used in brick-making. After coating, the stone was stored in the various sizes, separate and under cover until required for use on the work, and when laid was designated as tar macadam. It was laid in courses of 3-inch, 2-inch, and 1-inch stone to a total depth of 6 inches on either old macadam or a well-laid Telford base, and after many years of use these pavements would compare favorably with other more costly types of construction. These results were due, to a large extent, to the excellent quality of coal-gas tar which was available.

In 1909 I was called upon to construct pavement by the mixing method to a specification which called for the coating of stone first with hot tar and then with a second coat of hot asphaltic cement, and laid into position before the binder cooled. The mixing was done by hand on the site. When the weather was continuously fine and hot, this method gave a very satisfactory pavement, and after nine years' wear may be found in good condition to-day. But when the weather was unfavorable it was impossible to carry on the work satisfactorily, and any work done under unfavorable conditions as to weather, never proved good, and entailed considerable maintenance expenditure annually, due to the high cost of the sheet asphalt and other such manufactured pavement. We decided to adopt the penetration method. This was in 1911, and I laid a considerable mileage on old macadam and on new, well-laid and well-drained Telford base. For a time these pavements were seemingly satisfactory and economical to construct. It was not very long, however, before it was demonstrated that in accordance with the dry weather during construction, so was the quality of the pavement, and those sections that did not have the most favorable conditions began to disintegrate in fall, and the surface in the hot weather became out of shape.

It became manifest that the method could not give continuous good service and that the hot-mix method was the proper way in which the right gauging and mixing of materials could be obtained, and by the use of improvised plant I proved to my employers that better results could be obtained by its adoption, as it eliminated the bleeding in hot weather and was less slippery in cold weather on grades.

Since 1911 I have laid no pavement other than the hot-mix type, and according to the requirements used for city pavement,—sheet asphalt, where grade was flat, on concrete base, varying from 5 to 10 inches thick, according to the amount and class of traffic. On the same grade I have used asphaltic concrete (Topeka mix) on concrete

Quebec-St. Augustine Highway, hot-mix asphalt, now under construction. Laid on old macadam

base, which requires 4 per cent. to 5 per cent. less asphaltic cement than sheet asphalt, and is therefore lower in initial cost.

On grades upward of 5 per cent. it is necessary that larger stone should be employed in the aggregate. This can only be done with the consent and under the Warren Brothers' patent covering Bithulitic and Warrenite pavements.

These pavements all entail a costly and immobile plant and considerable area to carry out the work of preparation of paving materials, and I propose to deal with the con-

*Address delivered May 10th, 1918, at Canadian Good Roads Congress.

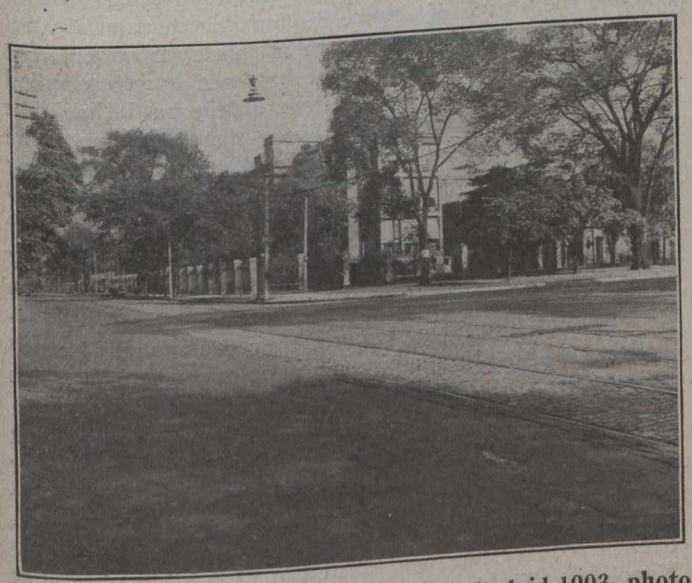
struction method that may be used to build a fairly well-proportioned and thoroughly mixed pavement that will carry any class of traffic, and be constructed as continuously as any other type, and regardless of water supply, by machinery of low cost, and mobile, *viz.*, the ordinary concrete mixer with the heating attachment, traction wheel and distribution arm, that can be obtained from the many manufacturers of contractors' plant. After the base has been prepared in the maner decided upon and ready to receive the wearing surface, the machine can be placed on the travelled way or pavement area, and the material distributed along the line of work. It is preferable, however, if there is space available on the side of roadway, to place the machine there and protect the base; the construction to be carried out as follows:—

Mixing

Stone aggregate to be of a size that will pass a 2½-inch ring and retained by a 1½-inch ring, to be placed in the mixing drum and the hot blast applied. When the stone is heated to a temperature of approximately 250 degrees Fahrenheit, the asphaltic binder, previously heated in a portable heater to a temperature of not less than 200 and not more than 275 degrees Fahrenheit, is then added to the already heated stone, the quantity to be within the limits of 12 per cent. to 13 per cent. by weight of the total quantity of the stone in the mix.

Laying

When the stone is thoroughly coated, the batch should be emptied as soon as possible, and carried by the distribution arm, or any other means convenient to use, to the dumping platform if macadam base be used; if concrete base, on the base within spading distance of the laying



College Street, Toronto, hot-mix asphalt, laid 1903, photo 1917. Heavy traffic, repairs negligible

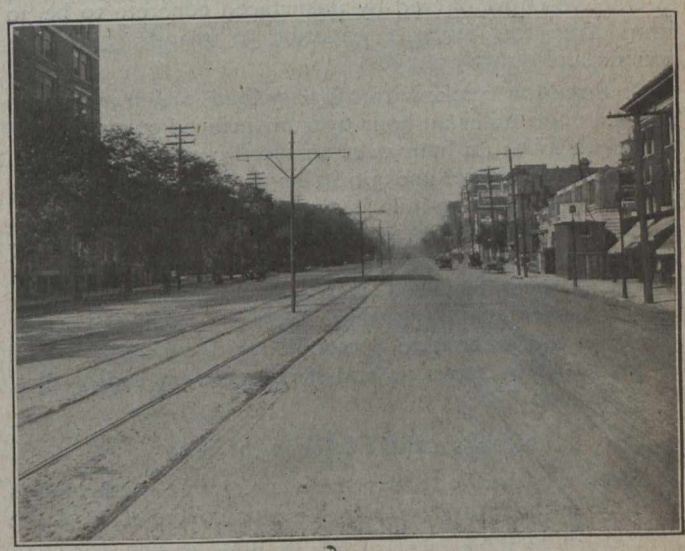
point, the mixture to be laid either by spade or fork, level and even to a depth of 3 inches loose, and well packed into position.

Rolling

When slightly cooled off, the rolling is done by a 12-ton macadam roller, care to be taken that the line and camber are maintained. Any hollow spots must be immediately levelled up during the rolling, and the roller kept moving until the pavement is thoroughly compacted. When this is done, and before the pavement is cooled, the mix in the machine should be changed.

Surface Coat

This consists of a mixture of three parts of stone, one part of rough sand, heated as the stone, and mixed with 12 per cent. to 13 per cent. asphalt cement, heated to the temperature of not less than 225 or over 275 degrees Fahrenheit. The stone and sand are thoroughly coated. When the mixing is completed, a surface treatment is given to the already laid and still warm pavement to a depth evenly laid of approximately ½ to ¾ inches in thickness, and as soon as laid the roller started again to drive this coat into the voids that may exist between the previously laid stone and here care should be taken to watch that any parts of the surface needing extra material



Spadina Ave., Toronto, hot-mix asphalt, after 16 years' heavy traffic. Repairs on asphalt less than one-fifth cent per square yard per annum

should receive it during the first rolling, when it will manifest itself. When sufficiently rolled, the whole pavement should be then just covered with a coat of warm stone chips of ¼ inch down, and as soon as cooled off, the pavement may be used for traffic.

Asphaltic Cement

Any well-known brand that will fulfil the standard specification requirements of a penetration of from 60 to 90 at 77 degrees Fahrenheit, will be a satisfactory material to use for this class of work.

Mixer

A standard mixer of ¾ yard capacity will turn out 800 to 1,000 yards per day, or 200 yards of 16-foot roadway per day, and can be operated either by steam or gasoline power, and the heater be provided with crude oil burners. The traction attachment makes it possible to eliminate considerable haulage delay and the machine can always be kept alongside the work being laid.

In conclusion I beg to say that I find the asphaltic cement binder a satisfactory material to use, due to the fact that its natural ductility allows ample time for compacting before setting up. It is less subject to variation of temperature than any other material, and climatic changes have no effect. In spring and fall it does not get excessively hard and slippery, and in summer the heat does not have any appreciable effect, and at all times it will carry any load that the foundation will carry. It will give good service, easy to repair and low in maintenance cost.

THE EFFICIENCY OF THE HIGHWAY IN THE PRESENT TRANSPORTATION DIFFICULTIES*

By Col. William D. Sohier
Chairman, Massachusetts Highway Commission

EFFICIENCY is the ability to accomplish work with a minimum of time or energy. The efficiency of good highways is well shown by a report which I received on April 19th, 1918, on road tests with motor trucks, by R. E. Chamberlain, of the Packard Motor Company. Mr. Chamberlain made some elaborate tests to determine the relative value of different road surfaces under operation of motor trucks. Results of these tests show the resistance to tractive effort offered by unsurfaced concrete to be 30 pounds per ton, surfaced concrete 50 pounds, gravel 82 pounds and dirt 99 pounds.

A three-ton truck, with capacity load, which maintains a speed of 12 miles an hour over unsurfaced concrete, will make 7.2 miles an hour over surfaced concrete, 4.8 miles an hour over gravel and 3.6 miles an hour on dirt roads. relative cost per ton-mile is $.167 on surfaced concrete, $.194 on gravel, and $.207 on dirt roads. Mr. Chamberlain in his report states that "a computation would show that if all roads travelled were gravel instead of dirt, annual savings in operating America's 400,000 motor trucks would amount to $70,200,000; if concrete instead of gravel, $167,400,000; and if concrete instead of dirt, $237,600,000."

Roads a Big Factor in the War

The fact that the tractive resistance of an earth road is 306 lbs. as compared with 83 lbs. for concrete, is of the utmost importance at the present time, as the results of the war will depend fully as much upon roads and highways as upon any other one factor, because it is manifest that if you cannot feed your men, move your guns, supply them with artillery and ammunition, you cannot maintain an army in an existing location. While the railroads and steamships are vitally necessary to bring the supplies and men, ammunition to the artillery, and everything needed for modern war, to the country, and from the large storehouses to the railheads, the soldiers in the trenches, and more particularly the soldiers back of the trenches, have to be almost entirely supplied over the roads.

The whole battle of Verdun was really fought, so far as the French were concerned, with soldiers, ammunition, guns, and supplies that were transported over the roads, because the one railroad which originally supplied that region was cut by the Germans, and the other one was dominated by their artillery. The consequence was that the army was supplied with ammunition, guns and men that came over the roads.

All Important Roads are Military

From one point of view, all roads which are of any importance are military; to wit, any roads which have to be used for the transportation of any of the products which are necessary for the conduct of the war or the feeding of the people with the articles that are necessary to sustain life. It is a question of relative importance, but under existing conditions we should certainly confine our efforts to those roads which are of the most importance from this point of view.

Practically all of the roads in France were military roads. The French road system was admirably adapted to be used for military purposes. This can be illustrated by a few figures.

France, with a population of ten times that of Massachusetts, and an area of about twenty-five times the area of Massachusetts, had, when the war started, over 371,000 miles of macadam road. These roads had been built for many years; they were all graded, with foundations where necessary, and all had adequate drainage. Virtually all had a hardened surface of waterbound macadam, though a certain percentage had been built with a bituminous surface.

There were about 32,000 miles of national or departmental highways, or about 10 per cent. of the whole. These main arteries connected all the more important cities and villages with a network of main highways through the whole of France.

The width of the "Route Nationale," including ditches, was 60 ft.; the macadam surface was usually 24 ft. wide, with about 15 ft. of graded road on each side and then a ditch. The "Route Departmentale" was about 42 ft. in width, with a macadam surface usually about 18 ft. wide.

French Roads Helped to Save Paris

There were also over 107,000 miles of road of secondary importance, what might be called county roads, connecting all the little towns, villages and hamlets. There were 47,500 miles of road that were perhaps of interest to two or more towns. These roads were graded about 30 ft. in width, including ditches. Then there were about 184,000 miles of what might be called ordinary country roads. The roads of the least importance had a macadam surface about 9 ft. in width, but were graded 27 ft. in width.

So far as I can learn, it was this road system which enabled the armies of France to stem the German armies' rush on Paris, and to throw them back to where the trenches were first dug. France has been so well supplied with roads in most of the sections on the battle line that it has been unnecessary to build very many new ones. The big problem has been to keep up and maintain what they had, with the tremendous traffic that had to go continuously over them.

By way of comparison with the French mileage, I may say that Massachusetts has about 23,000 miles of roads, of which about 6,000 miles are village, town or city streets.

I tried an interesting experiment recently with a French map. I could not put a pin on any point on the map which was further than one mile from a macadamized road.

The French roads are not accidental. They have not happened. They are well designed and built to better plans, better grades and better alignment than is the practice anywhere on this continent,—but even those roads could not stand the pounding by army traffic. The French road system was started in 1826 by a decree of Napoleon. The location, width, alignment and grade of the whole system as originally planned has been very largely adhered to, so that their policy has been continuous.

Planned in Napoleon's Time

Some time ago I asked a high French road official how many miles there were of macadamized roads in France. He replied that there were 400,000 miles. Later I wrote for further information and secured the names and mileages of the various roads. Upon adding these, I discovered a total of only 371,000 miles, or nearly 30,000 less than the figure originally given. I wrote again enquiring where the error had been, and received a most gracious apology and explanation that only 371,000 had really been built,

*Abstract of address delivered May 8th, 1918, at Canadian Good Roads Congress.

but that 400,000 had been planned, and that as an engineer he considered the system as planned, as a whole, rather than the part that had been completed. The remainder did not matter; it had been planned, ergo it would be built, someday, even though it had been planned since 1826 and was not yet built. But there is not the faintest doubt that those other 29,000 miles will be built and exactly as planned. We can learn much from far-sighted and clear planning for the future such as practised by the French road engineers.

Knowing the tremendous traffic that any road directly used for army purposes will be required to carry, we must build our bridges and roads accordingly.

Trucks Increasing, Better Foundations Needed

The main thing that our roads must be made to stand is the continuous pound and wear of the 3 to 5-ton trucks and of the heavy wagons on iron tires with 4 to 6-in. wheels, the weight of which will not exceed, probably, 3 tons. Each of us in our own locality must see that we use materials, if possible, that are capable of withstanding this traffic.

I think we should all pay a great deal more attention to the foundations of our roads than we have done in the past, when the traffic was lighter. In my own State there is a tremendous commercial traffic in motor trucks. They are constantly on the increase. Most of our main roads have to carry 100 to 150 a day, and some of them have a much larger number. This is going to require stronger roads, thicker macadam, and a foundation in a great many places where the old macadam or gravel road would have held under the traffic of a few years ago without such foundations.

To do this, we must have federal government co-operation and support. I have some roads in Massachusetts that are perfectly alright for the traffic which they would normally experience, but if the government trucks keep pounding over them for another three or four months, I won't have any roads left at all in certain localities unless the government provides the money to maintain them in the unusual manner necessary.

We are getting 1,000 vehicles a day and from one hundred to two hundred trucks on old macadam that is fast being ruined. I know of one road in Maryland and Virginia over which the government has been running 150 trucks a day and it simply went to pieces. Our roads were built too poorly, most of them, for this sort of traffic, but the government is now beginning to co-operate properly and no doubt the Canadian government will do the same sooner or later.

Auto Trucks Will Carry Most Freight

If money be very limited, spend it first of all on drainage. Build the ditches, provide your drains, form your surface. Then put in a good foundation if you can take another step.

The motor traffic of France and England is nothing compared to the motor traffic in Ontario or in the United States. All the autos in France do not number as many as the taxicabs in New York City alone.

England does not expect to be invaded, and yet as a war measure the British parliament has voted something like $5,000,000 a year for the up-keep of roads in Great Britain.

Our government is working at cross purposes in dealing with the question of supplementing our railroads with truck traffic.

In the past we failed to look far enough ahead in building roads. The time is coming when most of our freight carrying will be done by auto trucks. We must build our roads heavy enough to carry trucks.

The United States government is using trucks to deliver army contract goods, for in such cases it is time, not money, that counts.

The cost of the road must not be looked upon too seriously as it will generally be more than offset by the savings it will effect. I could cite innumerable instances where improvements in highways have more than paid for themselves. In one case three-ton loads are being hauled where three-quarter-ton loads were previously the maximum. In another instance milk is being trucked over a new highway to an adjacent city for a half cent a gallon, where the railroad formerly charged one cent. In addition, the farmers are also saved the cost of hauling to the railroad station and the cost (one cent) of carting from the station in the city to the distributor's plant. The farmers along that highway are saving $71,000 a year as a result. The road is 13 miles long and cost about $260,000. The saving far more than pays the interest, sinking fund and maintenance. One farmer saves $150 in the hauling to market of his cabbages alone.

Roads Pay For Themselves

Suburban roads increase land values to such an extent that the extra taxes more than remunerate the municipality for the expense. One road near Boston is 1½ miles long. It goes partly through what was a market garden and partly along a hardly passable hillside. Within eighteen months of the start of construction on that road, twenty-six new houses have been built averaging about $2,500 each. Four sideroads join the new road. These have been partly developed and four houses are going up along them. The farm land was worth $500 an acre and the hillside land $200 an acre. The building lots are selling at $750 each, 8 lots to the acre. The road cost about $45,000 and the municipality is already collecting over $1,000 annually more taxes than previously owing to increased valuation. It will soon collect a sufficient increase to meet the interest, sinking fund and maintenance of the road, without any doubt. The bonds were issued at 4¼ per cent, I believe, and the required annual sinking fund is about 1¾ per cent., so that they are already collecting a substantial portion of the interest and sinking fund charges. The road is bituminous macadam, penetration method, with a concrete base where necessary. It is 18 ft. wide, with a 3-inch gravel shoulder along each side.

People have said to me, "Why don't you stop the road building during the war, and let the labor go onto the farms?" Well, we employed more men and reduced their working hours, and when they finished their eight-hour day, they were still willing to help the farmer.

W. A. McLean, deputy minister of highways for Ontario, in discussing the above address, said: "We surely will have to reconstruct roads between towns and cities strongly and heavily enough for the motor truck traffic. It means that we must put in foundations strong enough to take care of heavy concentrated wheel loads.

"I believe that all our highways are military highways. If the highway which saves the farmers' time is not a military highway, I don't know what is."

The Toronto Harbor Commission has moved from its leased offices, on Bay St., to its own new building on the waterfront at the foot of Bay St.

CANADIAN GOOD ROADS CONGRESS

(Continued from page 430)

At 1 p.m. the annual meeting of the Canadian Automobile Association was held, with L. B. Howland in the chair. Mr. Howland stated that since the last annual meeting, the number of automobiles in use in Canada had increased by 100 per cent. With over 200,000 cars in operation, Canada to-day ranks third among all the countries in the world in regard to the number of motor vehicles owned and operated.

Col. William D. Sohier, chairman of the Massachusetts Highway Commission, said that he had found the co-operation of the automobile associations the greatest single asset in making progress in the road movement.

May Establish Auto Freight Depots

Arthur H. Blanchard, consulting highway engineer of New York City, urged that in making traffic regulations in Canada, there should be kept in mind the importance of the problem of motor freight traffic on the highways. "That," said Mr. Blanchard, "is an even more difficult question than the regulations for the passenger traffic. We have in New York State a committee which is composed of some of the most prominent authorities on highway work, who are planning uniform regulations for all cities for motor freight traffic.

"We in New York are also deeply interested in what is called 'the return load guarantee,' whereby arrangements can be made that freight autos can be assured a return load from the point of delivery of the original load. This guarantee reduces the cost of freight traffic. For this purpose we would have to have auto freight depots where loads can be called for and delivered. At present, however, we have not gone beyond the stage of investigation and plans."

W. A. McLean stated that there are about 80,000 automobiles in Ontario to-day, of which number approximately 5,000 are trucks and lorries. The business men of Ontario are using 14,000 cars and about 20,000 are used by the skilled tradesmen, carpenters, plumbers, etc. Therefore fully 39,000 of the 80,000 motors in Ontario to-day are used at least in part for business, and no doubt a great many of the other 41,000 also are frequently used for business purposes.

Predicts Main Trunk Lines for Freight

"Among the cities in Ontario which have been neglected so far as good roads are concerned," said Mr. McLean, "is Ottawa." He promised that Ottawa will be one of the first cities to receive consideration when the provincial programme for an extensive good roads system is carried out.

James H. MacDonald predicted that in time we will require main trunk lines reserved solely for carrying freight. "Therefore, in constructing roads like the Toronto-Hamilton Highway," said Mr. MacDonald, "you are building better than you know."

Col. William D. Sohier, chairman of the Massachusetts Highway Commission, was the first speaker of the Wednesday afternoon session. An abstract of his address on "The Efficiency of the Highways in the Present Transportation Difficulties," appears on page 444 of this issue.

Col. Sohier was followed by Lieut.-Col. W. G. MacKendrick, D.S.O., president of the Warren Bituminous Paving Co. of Ontario, who delivered an address on "How the Good Roads of France are Helping to Win the War." Col. MacKendrick is the director of roads of the Fifth British Army. He is in Canada for a short time on special furlough. An abstract of Col. MacKendrick's address appears as the leading article of this issue.

"English and American Practice in the Construction of Tar Surfaces and Pavements" was the subject of an informative address by Prof. Arthur H. Blanchard, consulting engineer of New York City. Mr. Blanchard's lecture was illustrated by a large number of lantern slides. He said that the people of the United States now realize that the solution of their transportation problems depends upon the highways. He expressed regret that chaos reigns in the United States in respect to highway transportation, construction and maintenance, but stated that the efforts of the various semi-public organizations are now bearing fruit, and Congress will no doubt place the control of this part of the country's war work in charge of one department.

F. Howard Annes, of Whitby, Ont., spoke on "Highway Widths." Mr. Annes' speech is published on page 437 of this issue.

"The Border Is Still There"

The annual dinner of the association was held Wednesday evening at the Royal Connaught Hotel. The vice-president, S. L. Squire, who was later elected president for the ensuing year, acted as toastmaster.

W. A. McLean proposed the toast to "Our Guests." James H. MacDonald replied in a most eloquent, patriotic and inspiring address. Mr. MacDonald incidentally complimented the city of Hamilton upon its drainage system, which he said is most modern. Mr. MacDonald is an accomplished orator and he was called upon to speak upon every possible occasion, as his talks were all much enjoyed.

B. Michaud, deputy minister of Highways for Quebec, explained how the road policy of his province differs from that of Ontario. "We built the trunk roads and supplied the money for the local roads," said Mr. Michaud. "Perhaps a beter way is the way which the people of Ontario have chosen. Here you have studied the conditions, prepared the assessments, etc. That is, you have first consulted your resources. We could not do that. We could not classify the roads upon a scientific basis. We had no time to do so, as we wanted the roads at once. We built five trunk roads amounting to 300 miles, and we have a sixth one under construction which will be completed this fall. During the past few years we have spent about $18,000,000 on roads. In making this expenditure, our thought was not only of Quebec, but of all Canada. We thought of the Canadian transcontinental highway. Even our municipalities built roads which are ready to form a part of such a transcontinental highway. We have built roads to the boundary of Ontario. We are at your door, at the border of your province, but so far as roads are concerned, the border is still there."

"Old Dammit" Back Again

Lieut.-Col. W. G. MacKendrick explained the engineering vocabulary which is necessary in handling 12,000 men in constructing military roads. He said that he started out early every morning inspecting his road work, making upwards of forty calls a morning, and that he frequently had occasion to use an expression that he had learned some years ago when on railway construction work. Last summer he was ordered for a time to the Ypres salient. While walking along a railway track the first morning after his return to his former section, he passed two privates of his old labor battalion. "Hi say, 'Arry," called the one to the other, "'eres old Dammit back again."

George Henry, M.P.P., representing the Ontario Good Roads Association, said that when we get back to normal conditions we will need every agency for the development of the country, and that no agency would be so important to mankind generally as the public highway. Mr. Henry explained that the reason for the absence of Mr. Wheelock, the president of the Good Roads Association, was that the latter had but recently lost his eldest son, a member of the Royal Flying Corps.

Difficult to Maintain Roads in U.S.A.

Col. Sohier explained the difficulties of maintaining roads in the United States under war traffic. He said that he had made the suggestion that all the highway commissioners get together and decide what roads are the important ones, what roads should be built and what roads maintained. At present there are ten different departments in Washington which have to be considered in connection with any road work. He needs a large quantity of road oil very urgently, and so far has been able to get only fifteen carloads. His roads will be ruined if he does not get the oil, he said. Sixty-eight men from his department have enlisted or have been drafted for the army and navy.

L. B. Howland, who was re-elected president of the Canadian Automobile Association, and R. T. Kelley, president of the Board of Trade of Hamilton, also spoke very briefly.

Moving pictures of the Columbia Highway were shown Thursday morning, followed by an illustrated lecture on drainage by Jas. H. MacDonald. Ninety per cent. of all the trouble with roads to-day is due to the lack of intelligent drainage, said Mr. MacDonald. Countless evils result from the lack of proper knowledge of this subject. He showed a number of views of the roadways in his state under spring-time flood conditions. The photographs proved conclusively that road building in Connecticut requires a knowledge of drainage. The speaker dealt briefly with the various salient features of the subject. Certain principles of road building had been standardized and were the best to follow. With the aid of the slides, he illustrated the primary steps in road-building. The hog-back road was shown to be dangerous and expensive. The old-fashioned, rubble centre drain had been found by the speaker to be unequalled for all practical purposes. Blind drains, in his judgment, were very inefficient. Proper water breaks, the prevention of warts, and the most effective methods of widening narrow and uneven roads, were among the matters he discussed. The practical value of the rim-edge, cobble gutter was shown.

The three great ideas in drainage, said the speaker, are to get the water off the roads, to get it out of the roads, and to keep it away from the roads. Lack of proper drainage of the subgrade caused much damage, being responsible for cracks and other evils. Mr. MacDonald described in detail the building of a Telford roadbed, which, he claimed, is in his opinion the best type of construction, and one which would last for centuries.

The discussion of Mr. MacDonald's paper was adjourned until the afternoon session in order to permit the executive of the association to motor over the Toronto-Hamilton highway to Burlington, and to be the guests of the Hamilton Board of Trade at luncheon.

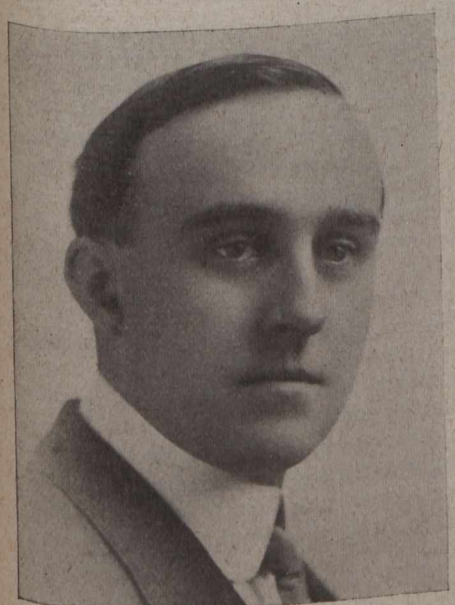
B. Michaud opened the discussion on Mr. MacDonald's paper at the afternoon session. He asked whether there is any road so good as the Telford, but cheaper. Mr. MacDonald advised making use of the material nearest the district in which the road is to be constructed.

Canada Should Benefit by U.S. Mistakes

Mr. Fraser, of Quebec, asked which is the better, the side or the base drains. Mr. MacDonald replied that the base had proven to be the better.

Mr. MacDonald stated that of all the roads and bridges in the United States, there are not 10 per cent.

Executive of the Canadian Good Roads Association



GEO. A. McNAMEE
Secretary-Treasurer

S. L. SQUIRE
President

JULES DUCHASTEL
Honorary Past President

that can carry 15-ton motor trucks. Canada should benefit by the mistakes of the United States.

Extended discussion arose in regard to the relative merits of cement and clay pipes. It was decided that both have their merits.

B. Michaud extended an invitation from the city of Quebec, and urged that the next convention be held in that city. W. P. Near, city engineer of St. Catharines, Ont., presented a letter from the mayor of that city, asking for the 1919 congress. The executive decided to go to Quebec next year, but may meet in St. Catharines in 1920.

L. B. Howland spoke on what motorists can do to help the good roads movement and relieve the transportation congestion. Motor trucks are in their infancy, said Mr. Howland. In the United States, 1,300,000,000 tons of material were hauled by motor trucks during 1917, at an average of 18c. per ton, a saving of 10c. over horse-drawn vehicles. The motor truck will abolish the short railway.

Discussion on Concrete Roads

W. H. Connell, consulting engineer, of Philadelphia, who was on the programme for a paper on the result of tests of various types of pavements, was unable to be present.

A. Lalonde, C.E., assistant engineer of Outremont, P.Q., spoke on concrete roads. His paper is published in full on page 433 of this issue.

Mr. Cadwell, of Windsor, Ont., said that he did not think it necessary to keep the traffic off new concrete roads for so long a time as is now the practice. "I have seen a three-ton truck taken over a concrete road twenty-four hours after its construction," said Mr. Cadwell, "and not a mark of the wheels was left on the road." The general opinion was that the engineer who permitted the truck to go over the road, had taken a great risk, and that the road might have been injured, even though unmarked.

The question box was cleared and a brief general discussion took place on the questions which had been submitted. The various types of machinery for snow cleaning were discussed as the result of one question. Mr. Duchastel said that his municipality, Outremont, P.Q., cleaned its streets last winter by the use of a new machine with a saving of fully one-third of the cost by cleaning with wagons and sleighs.

Following the afternoon session, the delegates and guests were taken on a motor trip around the city by members of the Hamilton Automobile Club.

The works department of the city of Hamilton tendered a dinner to the executive of the association and their guests early Thursday evening, and at 9 p.m. the annual meeting of the association was held.

Directorate Increased to Twenty

A. A. Dion, of Ottawa, was elected as chairman of the meeting. An advisory board of all past-presidents was formed, and the following officers elected for the year 1918-19:—

Hon. past-president, Capt. J. A. Duchastel de Montrouge, Outremont, P.Q.; president, S. L. Squire, Toronto; first vice-president, A. F. Macallum, Ottawa; second vice-president, P. E. Mercier, Montreal; secretary-treasurer, Geo. A. McNamee, Montreal. Directors:—The officers and A. L. Caron, Montreal; Dr. E. M. Desaulniers, St. Lambert; R. S. Henderson, Winnipeg; L. W. Levesque, Montreal; J. A. Sanderson, Oxford Station; L. B. Howland, Toronto; C. R. Wheelock, Orangeville; W. G. Yorston, Halifax; Wm. Findlay, Ottawa; R. T. Kelley, Hamilton.

Upon motion of Capt. Duchastel, the directorate was increased to twenty, the additions to be chosen by the present board from the deputy ministers of the provinces.

Several amendments to the constitution were passed in order to make the constitution conform with the federal charter which had been obtained during the year. Advisory boards were formed for the province of Quebec and the province of Ontario, and separate meetings of the Quebec and Ontario executives will be held. A number of votes of thanks were unanimously adopted.

The last session of the congress was held on Friday morning, May 10th.

E. Drinkwater, municipal and highway engineer of St. Lambert, P.Q., delivered an address on the hot-mix method of bituminous construction, using asphaltic binder. His paper will be found in full on page 442 of this issue.

C. A. Mullen, director of the paving department of the Milton Hersey Co., Ltd., Montreal, was on the programme for a paper on asphalt pavements. Mr. Mullen was unable to attend, but he forwarded his paper, and this paper was also read by Mr. Drinkwater. It is published in part on page 449 of this issue.

E. R. Gray, city engineer of Hamilton, read a paper on the abatement of the dust nuisance. This paper will be found on page 431 of this issue. The chairman, Capt. Duchastel, in discussing Mr. Gray's paper, said that the cost of applying tar last year to the streets in Outremont, was about 2½c. per square yard, which was somewhat higher than the cost of oiling in Hamilton. A general discussion on oiling followed Mr. Gray's paper. Capt. Duchastel considered oiling to be the most economical and sanitary way of dealing with the dust problem.

Paul S. Sargent, engineer of the state highway commission of Maine, who was on the programme for a paper on gravel and macadam roads, did not arrive, so after the discussion of Mr. Gray's paper had been finished, the chairman declared the congress adjourned.

COST OF OILING IN TORONTO

"It is costing this year 35 per cent. more for oil and 11 per cent. more for labor than was paid last year," says Street Commissioner Wilson, of Toronto, in a report to the city council, "so that to treat the same mileage of streets as last year, on the basis of 3.5 applications, would cost approximately $31,694.24, or $6,694.24 more than has been provided in the estimates. It will be obvious, therefore, that we cannot, without overdrawing or appropriation, treat the same mileage as was treated in 1917."

The commissioner points out that "there are 176.89 miles of macadam, Rocmac, and unimproved roadways in Toronto. The policy is to oil only such of these streets as it is absolutely necessary to oil, having regard to traffic conditions and the density of the population.

"To oil one mile of roadway, 24 feet wide, or 14,080 square yards, applying one-tenth gallon per yard, at 12.5c. per gallon, costs the department $176, plus $5.11 for labor, or a total of $181.11 for one application."

Geo. F. Porter, designing engineer of the St. Lawrence Bridge Co., will read a paper on the Quebec Bridge next Monday evening at a meeting of the Manitoba Branch of the Canadian Society of Civil Engineers.

ASPHALT PAVEMENTS*

By Charles A. Mullen
Director of Paving Dept., Milton Hersey Co., Ltd., Montreal

THE broad subject assigned to me is far too comprehensive to fall within the scope of a single paper. We will therefore brief those parts which are of historical or general interest, and pass on as quickly as possible to the consideration of the phases of the subject that are of present-day interest to the modern road-builders of North America.

The sheet asphalt pavement is not a modern invention. This material was used for street covering purposes by the ancients, and sections of it have been dug up with the other evidences of past civilizations. Having in mind the centuries that have elapsed since its first employment as a street pavement, the surprising thing is that so little progress has been made in its development, and practically none until recent years.

American Asphalt Introduced About 1870

The European asphalt pavement is the rock asphalt, it being prepared from native bitumen-impregnated rocks. The natural substance is ground to a powder, heated, spread and then compacted by tamping or very slow rolling. To secure the best results, two or more rock powders from different sources and having different characteristics are combined to produce a better grading of mineral aggregate and a more satisfactory bitumen content. Many very good asphalt pavements have been laid with this material in Europe, and some on this side of the Atlantic.

The American asphalt pavement was first produced by E. J. De Smedt about 1870, and may be considered as an attempt on his part to imitate, at a less cost in this country, the rock asphalt pavements of Europe. The Europeans still term rock asphalt pavements as natural and the American product as an artificial asphalt pavement. As has happened in many other cases, the substitute leaves nothing to be desired of the original.

The first asphalt pavement of the American or artificial type to attract wide attention was that laid on Pennsylvania Avenue in the city of Washington, D.C., about 1876. Congress provided that this national thoroughfare should be paved with sheet asphalt from the Capitol to the White House, that section east of Sixth Street to be rock asphalt and the section west thereof to be artificial asphalt. Previous sections of pavements laid in other cities had been of but small yardage and of an experimental nature.

Mineral Aggregate Most Important

The modern asphalt pavement consists of a mineral aggregate of specially graded sand and impalpable dust, thoroughly mixed, and bound together with asphalt cement. Roughly speaking, the mineral aggregate is 90 per cent. by weight or 75 per cent. by volume, the specific gravity of the bitumen in the asphalt paving cement being but slightly more than that of water. The grit mixtures and the "stone-filled" sheet asphalts are the same with a small proportion of fine stone chips added, not usually over 30 per cent.

The asphalt paving cement is, of course, a vital matter, since we could not have an asphalt pavement without it. More pavements fail to-day, however, because of the lack of an understanding of the necessary requirements for the mineral aggregate, or carelessness or ignorance in the making of the paving mixture. Our public officials frequently go to great lengths to make sure that the materials furnished are what they should be, and then permit those materials to be spoiled at the asphalt mixing plant.

Many good asphalt cements are on the market to-day. They are manufactured from crudes found in Mexico, California, Trinidad, Bermudez in Venezuela, and elsewhere. All are of so nearly equal value that only the uniformed or specially interested will to-day pay a great difference per square yard for asphalt pavement in which one or the other has been properly used. The per square yard competitive basis, under carefully drawn specifications crude materials they are made nor by whom. Some public in wholesome communities.

Penetrations of Asphalt Cements

Asphalt cements need testing no matter from what crude materials they are made nor by whom. Some public officials do not seem to think so; but could they know how well they are spotted by the supply houses, and how carefully this frame of mind is cultivated for them, they would very soon change these views. Doubtful material, or material that has been condemned by some careful official who does have his deliveries tested, is always shipped to the other man.

The consistency or penetration of the asphalt paving cement is the first point to which we look. In a material that is pure, and with a mineral aggregate that is properly graded, it is customary to use the following classes of material for the different conditions of traffic in this climate:—

Heavy traffic	45 to 55 penetration
Medium traffic	55 to 65 penetration
Light traffic	65 to 75 penetration

Unless otherwise specified, all penetration tests are made with a No. 2 standard needle acting for five seconds under a load of one hundred grams at 77 deg. Fahr.

The ductility and other tests are of great importance in determining the quality of the asphalt cement, but they are more particularly the concern of the asphalt chemist, and must receive close attention at the laboratory. The field engineer should be in close touch with the chemist and know the general characteristics of the asphalt cement he is using, but we will pass these points for the present to discuss others that are of more immediate importance to the greater number of us.

Cut-Back Asphalts

Fluxed or cut-back asphalts are so little used to-day that they no longer present a serious problem,—at least, not in Canada. It is much easier to manufacture asphalt paving mixtures from cement that is delivered at the mixing plant at the desired consistency than when the cement must first be manufactured from crude or refined asphalt and flux oil. As a general proposition, the promiscuous cutting-back or fluxing of oil asphalts that have been refined to a hardness greater than that desired, should be discouraged. While it is not necessarily harmful, and might even be beneficial, it is always at least a subject for close question. The native asphalts are naturally so hard that they require fluxing with some other suitable material before they are usable in asphalt paving at all, so the foregoing remarks do not refer to these materials.

The inorganic dust or filler is a factor of prime importance. The material most commonly used is limestone dust pulverized in a grinding mill to such fineness that at least 75 per cent. will pass a standard 200-mesh testing

*Paper prepared for the Canadian Road Congress, May 7th to 10th, 1918, at Hamilton, Ont.

sieve. When the material is less fine, more must be used to secure a given result; and, as the inorganic dust is usually introduced cold at the mixer into the hot sand of the bulk of the mineral aggregate, the result of using too much of this cold material is obvious. Such mixtures, in that they approach the aggregate of rock asphalt pavements, are also harder to lay in the manner usually employed in the construction of the artificial or American pavement.

Stone dust and Portland cement are the most widely used filler materials, the former being the more common because the lower in cost, but the latter being preferred by some on the ground that it is thought to make a superior mixture. When Portland cement is employed, the difference in specific gravity between that material and the remainder of the mineral aggregate should be taken into consideration, as the mixtures are usually figured by weight instead of by volume, though the latter would seem a more logical method if it could be used with reasonable convenience.

Filler Materials

Other filler materials are pulverized clay, marl, shale, silica, etc. Many materials have been tried and found satisfactory, but a few have produced disastrous results. "Safety first" demands that a new material be thoroughly investigated before it is used extensively as an asphalt pavement filler. These investigations can only be conducted in a properly equipped laboratory, and by those with comparative experience to draw upon.

The 200-mesh sieve is not a sufficient test for an inorganic dust filler, except for routine work on a known material. The particles of dust that are of the most value are those that would pass a 500-mesh sieve, were one of such fineness of practical value for laboratory testing.

Two-hundred-mesh fine sand was offered to the city of Montreal as a filler material last season. A deposit of this material, practically all of which would pass the 200-mesh sieve, had been uncovered in a local sand pit, and it was offered to the municipal purchasing department at a fancy sand price as a substitute for the more expensive stone dust. It had to be rejected on the ground that, though it passed the specifications under which bids had been received, it was not a proper filler material at all, there being practically none of the finer material for the separation of which no laboratory sieve is practical, and which is the really important factor in a dust filler.

Photomicrographs of Sand

Photomicrographs saved the day in this instance. It was a rather difficult matter to advise a city purchasing department that the material which passed their specifications better and was about 50 per cent. cheaper than stone dust, should not be bought and used; but when we submitted comparative photomicrographs of the part of each material that had passed the 200-mesh sieve, and it was seen that the sand grains looked like rocks under the same magnification that still left the stone dust grains the appearance of fine powder, even the low bidder who was offering the fine sand was satisfied that his material would not serve the purpose.

The air separation dust test is by far the most satisfactory that we have yet found for making comparisons of materials. Water separation gave some good results, but the air method seems more practical. Neither is sufficiently simple to be used on routine work, so the 200-mesh sieve must still be relied upon for much of the checking of deliveries with samples submitted. As we do not know of any other air or water separators of the type we are using in Canada, they being especially constructed by us, it is hardly worth while at this time to use these tests in specifications.

The specially graded sand that forms about 75 per cent of the weight of a standard sheet asphalt pavement surface is a very simple matter if one fully understands and appreciates what is necessary. To fully comprehend the very great difference in an asphalt pavement mixture that the grading of the sand will make, one has but to follow daily on the street the work turned out by a mixing plant where the man in charge is careless of detail, or thinks that any old sand grading at all is good enough.

Sand Must Be Watched

We have seen a mixture produced by an asphalt paving plant at one o'clock that was all that could be desired, and at four o'clock of the same afternoon that plant was turning out, under the same formula of batch weights, a mixture that was not even third-rate. The reason was that no attention was being paid to the sand. At one o'clock, the supply was being drawn from a section of the pile that by chance happened to be of a very good grading, but by four o'clock the laborers had worked into a large pocket where the sand was very coarse.

The result of this carelessness was a poorly graded, sloppy mixture, that could not be expected to give good service under heavy traffic, and that cost as much as the better mixture even for light traffic. It will mark badly in warm weather, and probably shove, whether it has a binder course or not. The quantity of asphalt cement that is correct for a mixture having the standard grading of mineral aggregate is far too much for a mixture in which the sand is coarse. A plant crew that was not well enough organized and trained to watch the sand pile could not be expected to know when the proportion of asphalt cement should have been reduced to prevent a sloppy mixture.

Three grades of sand are needed in most cases to approximate sufficiently the standard or model sand grading. These may, for convenience, be termed fine, medium and coarse grade sands for asphalt paving purposes. It may assist the layman to an understanding of the matter if we say that the fine is of that size which is sometimes spoken of as blow sand, the medium a good plasterer's sand, and the coarse a sand of the type we all recognize as suitable for Portland cement concrete work.

The Various Grades of Sand

One sand is occasionally found that is in itself a sufficient approximation of the standard grading; but such cases are rare, and, even then, it is a good precaution to have on hand small stocks of fine and coarse sands for tempering purposes in case the main supply does not at all times prove sufficiently uniform. Sometimes a well-graded sand may be secured from a stratified bank by working a face to a certain depth that will take in layers the mixture of which in falling and handling will give a satisfactory approximation of the model. This we succeeded in doing with good effect last season at Woodstock, Ont.

Fine sand for asphalt paving is one in which there is a decided predominance above the percent. required in the model grading of those sized grains that will pass a standard 80-mesh and be held on a standard 200-mesh sieve. The requirement of the model sand grading is 34 per cent. of the total sand.

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Principal Contents of this Issue

BRITISH COLUMBIA "INSTITUTE"

ONE HUNDRED civil and mechanical engineers, draftsmen, surveyors and architects in British Columbia recently sought provincial incorporation under the name of the "Engineering and Technical Institute of British Columbia." Their bill was disallowed on a technicality when first introduced, and by payment of double fees the promoters secured permission to reintroduce it. But the legislature prorogued on April 23rd without having discussed the bill, as the private bills committee had reported against it; consequently the proposed legislation is dead for this year at least and probably for all time.

Now that the Canadian Society of Civil Engineers has broadened, and has changed its name to the Engineering Institute of Canada, it would have been unfortunate had the British Columbia legislature allowed the use of so similar a name as the "Engineering and Technical Institute of British Columbia."

The bill was sought upon wrong premises. The reason for the bill, as outlined therein, was as follows:—

"Whereas it was deemed expedient for the better protection of the public interests, and for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which has special reference to the profession of engineers, architects and technical professions, and to encourage investigation in connection with said profession, and in order to enable persons requiring professional aid in any work to which such knowledge of engineering, architecture and technical knowledge is applicable or necessary, to distinguish between qualified and unqualified members of such professions. Therefore, His Majesty enacts as follows," etc.

"Persons requiring professional aid in any work" are now partly able "to distinguish between qualified and unqualified members of such professions" by ascertaining the engineering degrees held by the engineer under consideration, or by consulting the lists of members of the Engineering Institute of Canada, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and other Canadian technical organizations or Canadian branches of American engineering societies.

It is true that some of these societies contain members who are not well qualified engineers, so that membership in any one of them is not a sure sign of ability, but surely it indicates a probability of ability, as at least nine-tenths of the membership of any such society, at a conservative estimate, are technically qualified for some kind of engineering work. There was no guarantee that the Engineering and Technical Institute of British Columbia would be more Simon pure with regard to its membership, or that its members would be of any higher grade than those of any other society or institute. As a matter of fact, the secretary of one of the other Canadian technical societies alleges that the contrary proposition is more correct.

One phase of the object of the bill is being met by the present change in the Engineering Institute of Canada. Undoubtedly the public now finds its difficult to determine just who are the qualified engineers. The man in the street often finds the same difficulty, perhaps in lessened degree, in selecting a "qualified" doctor or lawyer. Leaving out of consideration the house-cleaning that would have to be done by any society which might want membership therein to be regarded as *prima facie* evidence of engineering ability, the public does not know what membership list or lists to consult. Injustice would be done to many well-qualified engineers by consulting only one or two lists. It would be obviously unfair, for example, to assume that an individual—because his name does not appear in the list of members of, say, the Engineering Institute of Canada—is not a qualified engineer. He may be a member of any one or more of a dozen other technical societies, and he may be fully qualified. But to make it easier for the public to distinguish in this regard, the idea actuating the men who are behind the broadening out of the Engineering Institute of Canada, is to widen the Institute to such an extent that it will include all qualified engineers in Canada, in whatever branch of the profession they may practice, and to weed out the few men now in the Institute who are not well qualified, so that ultimately a reference to the membership list of the Engineering Institute of Canada would be sufficient for all "persons requiring professional aid."

The committee of the British Columbia legislature showed good judgment in reporting against the bill. The best interests of the British Columbia public will be served by the growth of the Vancouver and Victoria branches of the Engineering Institute of Canada.

TO THOSE NOT INTERESTED IN ROADS

"EVERY engineer is, or should be, interested in every other engineer's problems, whether they are his own at the immediate moment or not," recently said H. H. Vaughan, president of the Canadian Society of Civil Engineers. Perhaps we are depending too much upon Mr. Vaughan's theory in devoting this whole issue to the Canadian Good Roads Congress, but we appreciate the advisability of presenting these road speeches to our

readers while they are still warm and pulsing. We trust that those engineers who are mainly interested in water-works, structural or other problems, and but incidentally interested in roads, will be indulgent this week. Their turn to monopolize an issue with their particular specialty soon may come again as in the past.

PERSONALS

J. W. SHACKLETON has been appointed city engineer of Chatham, Ont.

ALEX. MCKINNON, town engineer of Glace Bay, N.S., has resigned to accept a position in the State of Ohio.

STACEY H. OPDYKE has been appointed manager of the water sterilization department of the Northern Electric Co., Limited, Montreal. Mr. Opdyke has been in touch for a number of years with the treatment of water for various purposes. He is a graduate of Purdue University, and was formerly with the sales and engineering departments of the Dearborn Chemical Co. Mr. Opdyke's connection with the Northern Electric Co. is the result of that company's having recently secured the sole agency for Canada for the R.U.V. Co., New York. The latter concern are manufacturers of ultra-violet-ray water sterilizers, of which a few small installations have already been made in Canada for industrial purposes. Mr. Opdyke intends to endeavor to introduce the R.U.V. system for municipal water sterilization in Canada, a fairly large municipal plant having been recently installed at Henderson, Kentucky, with good bacteriological results.

D. DARRACH, Schomberg, Ont., has been appointed engineer on grading work for the county roads in York County, Ont.

Col. C. N. MONSARRAT, chairman of the board of engineers, Quebec Bridge, has been appointed consulting railway engineer to the Dominion Government, succeeding the late Sir Collingwood Schrieber. The offices of the board of engineers, Quebec Bridge, will be removed from Montreal to Ottawa, where its work will be completed.

A. B. MANSON, city engineer of Stratford, Ont., has received an appointment as lieutenant in the C.E.F. Engineering Corps. Mr. Mason, after graduating, spent a year in land survey work in the Northwest and a year and a half in railway construction with the Canadian Northern and the Mond Nickel Co. He has been in charge of the city engineering department in Stratford for the past six years.

Captain FRED. HARCOURT, formerly harbor engineer at Port Arthur, has been appointed assistant commander of labor units in France. Captain Harcourt, who is a son of Hon. Richard Harcourt, of Welland, graduated with honors from the University of Toronto in 1900. He went overseas in December, 1915, with the 94th Battalion and was promoted captain and adjutant prior to leaving for England. After acting as adjutant of the Canadian pioneer training depot for a time, he went to France in January, 1917.

GEO. A. MCNAMEE, of Montreal, who is secretary-treasurer of the Canadian Good Roads Association, which held its annual meeting last week, was born August 20th, 1884, at Montreal. He was educated at the Archbishop's Commercial Academy and the Montreal Business College. After four years' clerical work in the traffic manager's office of the Richelieu & Ontario Navigation Co., he entered the employ of the Montreal Tramways Co., later becoming assistant to the secretary-treasurer. He was elected secretary-treasurer of the Automobile Club of Canada at its inception in 1905, and resigned from the Tramways Co. in 1912 to give more time to the club's affairs, as a million-dollar club house, garage and office building was contemplated. This scheme was abandoned, however, owing to the war, but may be taken up again after the war. He has organized two road congresses in Montreal and one each in Toronto, Ottawa and Hamilton.

ASPHALT PAVEMENTS

(Continued from page 450)

Medium sand for asphalt paving is one in which there is a decided predominance above the percent. required in the model grading of those sized grains that will pass a standard 40-mesh and be held on a standard 80-mesh sieve. The requirement of the model grading for medium sand is 43 per cent.

Coarse sand for asphalt paving is one in which there is a decided predominance above the percent. required in the model grading of those sized grains that will pass a standard 10-mesh and be held on a standard 40-mesh sieve. The requirement of the model grading for coarse sand is 23 per cent.

Medium-fine and medium-coarse are the terms applied to sands in which there is a decided predominance above the percentums required in the model sand grading for two of the sand grades. This quite frequently occurs, and it is in such cases that the standard grading is sometimes sufficiently approximated by the mixing of two instead of three separate sands.

Very fine sand is objected to by many on the ground that it usually makes an unstable mixture. In asphalt paving parlance, very fine sand is that which will pass a 200-mesh sieve but which is not fine enough to be considered dust or filler material. With some of the very finely pulverized fillers that are available to-day, we doubt if this objection is good.

Very fine sand is not filler, however, which was pointed out in a paragraph above, and it must not be allowed to be considered as such in meeting the standard or model grading for sheet asphalt paving mixture. If there is a serious amount of this 200-mesh sand in the sand aggregate, it should be added to the fine or passing-80-mesh-held-on-200-mesh material and deducted from the 200-mesh material in the mixture to make sure that the model requirement for 200-mesh material is properly met with inorganic dust filler material. Some specifications, very unfortunately, do not provide for this contingency.

(To be concluded in the next issue.)