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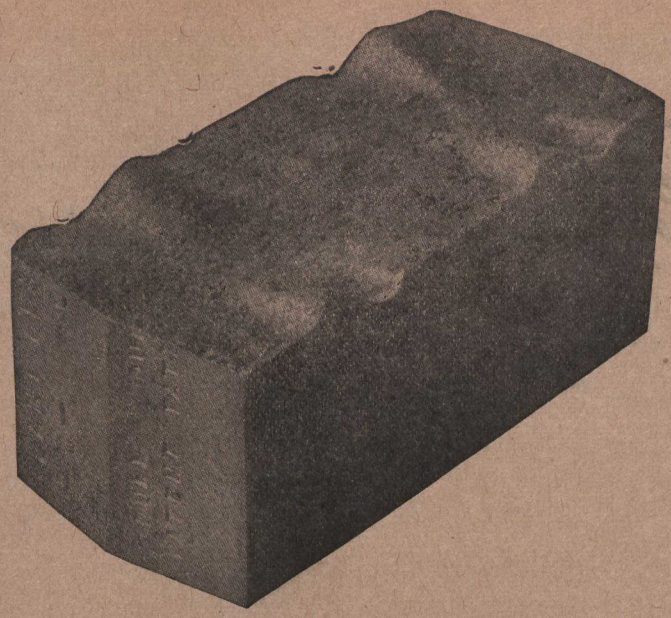

When the Board of Water Supply of New York decided to build 40 miles of Boulevard around the great ASHOKEN RESERVOIR, in the Catskills, the engineers, after investigating several leading types of pavement, decided upon brick.

After further investigation, the engineers specified WIRE-CUT BRICK.

The municipal authorities decided upon cheaper construction for part of the roadway, as the city of New York would have to build the roads.

But the engineers insisted upon brick for the most important section, and wire-cut lug brick were used thereon.

Deputy Chief Engineer Alfred D. Flinn, M. M. E. N. Y. of the New York Board of Water Supply, said in a meeting of the Municipal Engineers of New York in February, 1915, that he had examined many pavements and he concluded:

> "WIRE-CUT LUG BRICKS ARE PREFERRED to repressed blocks; all the samples I examined showed a more perfect pavement wherever square-edged blocks had been used than where repressed blocks with rounded edges had been chosen."

The road over the great Ashoken dam is being paved with wire-cut lug brick.

The following independent, competing companies, operating 47 plants, make wire-cut lug brick:

Corry Brick & Tile Company, Corry, Pa.
United Brick Company, Greensburg, Pa.
Plant at Conneaut, Ohio.
Sterling Brick Company, Olean, N. Y.
Reynoldsville Brick & Tile Company, Reynoldsville, Pa.
Danville Brick Company, Danville, Ill.
Clinton Paving Brick Company, Clinton, Ind.
Alton Brick Company, Alton, Ill.
Medal Paving Brick Company, Cleveland, Ohio.
Plants at Cleveland, Carrollton, Malvern and Wooster, Ohio.
Metropolitan Paving Brick Company, Canton, Ohio.
Four Plants at Canton, Ohio and One at Willow, Ohio.
Bessemer Limestone Company, Youngstown, Ohio.
Three Plants at Bessemer, Pa.
Peebles Paving Brick Company Portsmouth, Ohio.
Two Plants at Portsmouth, Ohio and One at Firebrick, Ky.
Murphysboro Paving Brick Company, Murphysboro, Ill.
Southern Clay Manufacturing Co., Chattanooga, Tenn.
Plants at Robbins, Tenn., and Coaldale, Alta.
McAvoy Vitrified Brick Company, Philadelphia, Pa.
Plant at Perkiomen Junction, Pa.
Windsor Brick Company, Akron, Ohio.
Hocking Valley Brick Company, Columbus, Ohio.
Plant at Logan, Ohio.
Veedersberg Paver Company, Veedersberg, Ind.
Springfield Paving Brick Company, Springfield, Ill.
Terre Haute Vitrified Brick Company, Terre Haute, Ind.
Albion Vitrified Brick Company, Albion, Ill.
Alliance Clay Product Company, Alliance, Ohio.
Westport Paving Brick Company, Baltimore, Md.
Mack Manufacturing Co., New Cumberland, W. Va.
Four Plants at New Cumberland, W. Va.
Hydraulic-Press Brick Company, St. Louis, Mo.
Barr Clay Company, Streator, Ill.
Burton-Townsend Company, Dayton, Ohio.
Two Plants at Zanesville, Ohio.
Trimble Paving Brick Company, Dayton, Ohio.
One Plant at Trimble, Ohio. One Plant at Glouster.
Thornton Fire Brick Company, Clarksburg, W. Va.
One Plant at Thornton, W. Va.
Indian Paving Brick & Block Co., Brazil, Ind.

THE DUNN WIRE-CUT LUG BRICK CO.

(LICENSORS)

CONNEAUT, - - OHIO.

THE CANADIAN MUNICIPAL JOURNAL

A REVIEW OF CANADIAN CITIZENSHIP

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Official Organ of the Union of Canadian Municipalities

"Municipal from cover to cover" *Circulates in every city, town and village*

Vol. XII MAY, 1916 No 5

CONTENTS.

RETURNED SOLDIERS.

We congratulate the Alberta Association of Rural Municipalities on the following resolution which was passed at its recent convention at Calgary:

"That all vacancies for paid officials, whenever they occur in rural municipalities, should be offered to returned soldiers. Also in the formation of new rural municipalities the same procedure should be adopted."

This journal has time and again urged the recogni tion by municipal councils of returned soldiers, and the above resolution is strong evidence of Alberta's determination to do the right thing to its sons now "somewhere in France". Again the resolutions of both the Alberta and Saskatchewan rural associations urging a tax on farmers for the benefit of the Patriotic Red Cross Funds indicate that the splendid spirit of the West is not by any means confined to the urban municipalities.

BERLIN, ONT.

The application to change the name of Berlin, Ont., has been refused by the Ontario Legislature largely because of the city council's objection. This was a wise decision for not only would such a change at this time bring out all the bitterness of racial differences but would create suspicion between neighbors and friends. To our mind the change of a name—even that of Berlin—is a question of choice that should concern the local citizens only. It is no business to outsiders what the name of a municipality is, provided the inhabitants are loyal, and Berlin since the war commenced has given every evidence of the patriotism of its people in recruiting and contributions to the different war funds. There are thousands of Canadian citizens—Canadian born—with German names, and of German parentage, who are just as loyal to Canadian citizenship and what it means, as those whose forefathers first saw the light on English, Scottish or Irish soil. It would be just as logical and stupid to ask these citizens to change their name as to have a city change its name because of misplaced ultra-loyalty on the part of some extremists. The whole idea is based on false premises. The Ontario city of Berlin has raised itself by that name to a high position amongst Canadian municipalities, and we would be sorry to see the name changed. Indeed, we would say that Berlin, Ont., is a standing, and it is to be hoped permanent, example to the world of the benign influence of the British constitution as against the evil spirit of Prussian militarism under which Berlin, Germany, exists .

Municipal Preparedness

When this war is over things will not be as they were. New conditions will arise of which no man has any conception, least of all the citizens of the British Empire, whether their home be in the Motherland or in the Britains beyond the seas. The spontaneous outburst of loyalty from every part of the Empire, which has been put into practice in the continuous sacrifice of their many sons, has convinced the world of the unity of thought that prevails in the minds of its peoples. But this spirit of sacrifice has made Britishers think as they never did before of the awful responsibilities as well as the great privileges of Empire citizenship. In our minds we contrast the workings of the two nations —Germany and our own. In the one we see a people driven by a military autocracy to deeds of damnable rapacity which stink in the nostrils of humanity; in the other we see, and know, a nation controlled by the will of the people, meaning that the people of Greater Britain entered this war on their own initiative. They willed it so.

But we also know something of the state of preparedness of Germany for what was to be a war of aggression and domination. We know too of the long, long fight that Germany made for the trade of the world, and her success even in the markets of the British Empire, often by means none too scrupulous, and we now wonder since that trade has been crushed by the British fleet, if the componant parts of the empire, at least, so far as their own bounderies are concerned, will see to it that after the war our enemies are barred from getting back in a commercial war that which they will have lost because of their ego in assuming that the world could be conquered by the sword — and such a sword.

The answering of such questionings by the powers that be is due to those millions of men, aye and women, who have and are offering themselves on the alter of right and all that British nationhood stands for. It is true that Great Britain (and the Dominions) went into the bloodiest war in her long history for a principle, BUT THAT PRINCIPLE MEANS THE RIGHT TO ONE'S OWN PEOPLE AS WELL AS TO THOSE FOR WHOM WE ARE FIGHTING.

What then is to be the outcome of it all?

Is the Empire — which means Canada — going to take advantage of the lessons taught by the war, or is it to sink back to the same state of divided responsibility — we might say irresponsibility — that prevailed before. The answer will concern every Empire citizen.

The question comes then what is Canada doing now to bring about the proper state of preparedness to meet the new conditions, and in particular what of the municipalities for surely no economic progress can be made in Canada without the co-operation of the local authorities. In fact, we go so far as to say that municipal councils, being not only elected by the people but by the exigencies of their office in daily touch with the electorate, are more thoroughly representative of current thought and ideas and ambitions, than either the provincial or federal representatives, so that in the local councils of this country we have in practice the strongest force for progress, or retrogression. But that force is too divided to be the really effective factor it should be, in the putting of our national house in order.

This to a large extent is because of the lack of continuity in our municipal councils and the foolish want of confidence in our municipal officials. How this is to be remedied is not part of this article; suffice it to say that we are stating the facts as we understand them. It is true that the urban and rural municipal associations, and the father of them all, the Union of Canadian Municipalities, have done much in the drawing together of the councils, but all the conferences in the past have been principally given to the discussion of the material side of municipal affairs, which though very essential in the business management of corporation work, does not meet the ethical and larger side of municipal life. Now in the larger responsibility of preparedness that we would commend to municipal councils of this country we are confident that it would receive the unqualified approbation of the electors who in reality are specially desirous that Canada should not only be prepared to take her proper place in the councils of the Empire, but should reap the harvest of her large part in the war. But confidence in either the provincial or federal parliaments to rise to the opportunity has been somewhat rudely shaken by the political bickerings that would seem to underly their works. In the municipal field — with few exceptions — politics are barred; hence the opportunity of real national building.

One great problem we must meet when the war is over is immigration, which will be heavy despite what the Minister of Labor and others say, particularly from the Old Country. Over four million Britishers are now fighting their country's battles and these men are experiencing an outdoor life. They won't go back to the office or workshop — indeed they could not if they so desired, for when peace comes the only present industry, that of munitions, will be stopped — and so they will look beyond the seas for their home. This is recognized by the Imperial authorities who are naturally anxious for British immigration to be directed to British dominions. Even at the present moment Sir Rider Haggard is on an unofficial visit — but who is coming as Lord Curzon says, as a servant of state — to South Africa, New Zealand, Australia and Canada, with the object of gathering data and opportunities for the placing of returned soldiers on the land. Of course, these men will not be penniless by any means, and Canada will be all the better for their presence. But, and here comes one of our points, material success alone is not going to satisfy them. They will want a fairly decent social life and if the country won't give it they will migrate to the cities where they can get it. And who can blame them?

Now it seems to us that this is a special opportunity for our rural municipalities to show what they are made of in creating the nucleus of a country social life. We understand that the Grain Growers' Association has already done much to make living in the country pleasanter by the starting of country clubs in the school houses, and this movement should be spread to every part of rural Canada, and who so well equipped for the work as the rural councils?

The municipal councils of Canada, as governing bodies, have probably done more than any other authority in rising to their responsibilities in this present war — in the leading of recruiting, taking care of returned soldiers, in contributions to war funds, in the placing of the public buildings and often the staffs at the disposal of the country. Why not after? But preparations must be made now.

We could give many suggestions as to how the municipal councils could prepare for the new conditions, but two more will suffice for the moment. Why not the municipalities on our seaboards, and the lakes for that matter, seeing that little encouragement is given by the federal authorities, get together with the idea of encouraging ship-building, which should be one of the great industries of this country. Canada has the iron, the coal and the timber, and her manufacturers have convinced the world that they indeed know how to make steel. She is, or was before the war seventh on the list of mercantile nations, and no doubt would have been nearer to the top had she have built her own ships. We hear of croakers condemning the restarting of the ship building industry, but they are mostly interested parties and no notice should be paid to them. Canada has a glorious opportunity to build her own mercantile marine and the municipalities on the coasts should start the ball rolling.

Then, too, there is another aspect of national progress which naturally comes under the term municipal responsibility — namely, education, and especially technical education. There is no doubt that Canada is behind most countries in her educational facilities. The ordinary school education, in most provinces, is almost useless in fitting future citizens for their part in the great battle of life and higher education is too expensive by far for the pocket of the ordinary citizen. The very best education should be within reach of every boy, or girl, who has got the brains. Canada will need them all. The part that municipal councils seem to have to-day is the raising of the money. They should see that better results accrue.

There are many other features of the broader and fuller municipal life which we might mention, but these we will leave for another occasion. If in these utterances we have set municipal heads thinking we are satisfied. They will do the rest. Municipal Canada to-day has the opportunity of its life in taking the lead to perpetuate the amity and unity, so spontaneously created by this terrible world catastrophe, and thus bring about in a very practical way the hopes of those great pioneers of Empire, of whom we are so proud, and also prove that the sacrifices of our sons are not being made in vain.

But Municipal Canada must get together.

Good Roads Congress at Montreal

Canada, with her splendid railroad and canal systems, has transportation facilities, so far as long distances are concerned, equal to any country in the world, but because of the proper lack of feeders in the shape of well built roads, much valuable energy is wasted, accentuated very largely, particularly in the West, by the sectional laying out of the farms. This lack of properly constructed roads has isolated many of the cities and towns from the surrounding country, inasmuch as the produce is kept away from the local markets. Some municipalities, such as Toronto, have remedied the evil by the appointment of highway boards in conjunction with the provincial authorities, which have jurisdiction over the roads in the vicinities. But there is much to be done in this respect, and it was with the idea of bringing before the municipal councils of Canada—both urban and rural—all the information available on road building and maintenance, that this journal made arrangements wtih the Canadian Good Roads Association to publish their official report of the proceedings of the GOOD ROADS CONGRESS which was held in Montreal in March.

This is the third congress held by this association (Montreal, 1914; Toronto, 1915 Montreal, 1916), and the next congress will be held in Winnipeg, March, 1917, at the invitation of the Manitoba Government and the Council of the city of Winnipeg. It will be noted that the papers, every one given by an expert, do not deal so much with the value of good roads—that stage has been passed—but rather with the best and cheapest means of building them; and it would be impossible to conceive in any series of addresses in which so much concentrated knowledge, begotten of experience, can be secured by the perusal of those given in these pages.

Much of the success of the three congresses is due to such men as Deputy Minister Michaud of Quebec, Deputy Minister McLean of Ontario, and Mr. George McNamee, the secretary of the Good Roads Association. These men took up the tremendous and sometimes thankless task of educating public opinion to the necessity of well built roads to the community, and Canada indeed owes a debt of gratitude to them for their untiring confidence in the common sense of the people to ultimately recognize, as they themselves realized, the enormous advantage of good roads in the development of this country.

It would seem appropriate, too, that the third con gress should be held in Montreal, if only to crown the splendid efforts of the Government of Quebec in the building of fifteen million dollars worth of roads throughout the Province. Already results are seen in the wonderful progress made in the country districts of Quebec during the last three years, due in no small part to the building of hundreds of miles of well constructed roads, where before mud prevailed.

¶AS THIS NUMBER IS ESSENTIALLY A GOOD ROADS NUMBER A GREAT DEAL OF VALUABLE MATTER HAS BEEN HELD OVER UNTIL JUNE. ::

George Bernard Shaw and German Local Government

George Bernard Shaw in a recent article, which appeared in the New York Times, under the title of "The German Case against Germany," has out-Shawed himself. This clever dilettante in the English language is passionately fond of notoriety, even at the expense of his fellow Britishers. In the article in question he dilates on the superiority of everything German over anything British — with the exception of Shaw—and he professes to write from first hand knowledge. Shaw's experience of Germany was essentially a money making one. Not trusting, or afraid, of the English critics, and because of the bigger royalties offered, he produced his latter plays in Berlin, instead of London or New York. Had the Berlin producers turned down this lover of every other country but his own, his Germanism would no doubt have been expressed somewhat differently.

Our reason for referring to the article at all is because of the following statement: "German local government is very superior to English local government. Its organization, its foresight, its public spirit, all due to its skillful combination of educated, well-to-do municipal statesmanship with the primitive criticism of the poorer common vestryman, who knows where the shoe pinches, put us to shame." In the April issue of this journal we dealt with the German system of local government and showed something of its bad effects on the public life of the people. We do claim that we wrote from first hand knowledge, and when Shaw rants of an educated well-to-do municipal statesmanship, in a country where professionalism is at a premium, the least we can say is it is Shaw speaking. Of course, with his love for paradoxes he goes on to say, "But the infant mortality of Germany is higher than that of England," which happens to be true.

But the gem of the contrariness and absurdity of Shaw is in the following paragraph: "The German system of selecting and training men seems far more thorough than ours; but the result is not convincing; the men who secure the commanding posts are not those born to command." If the German system of training and selecting municipal officials is so thorough, why cannot it evolve men capable of holding the higher positions, or again what becomes of the so-called highly trained men?

The truth is as we stated last month, the German system produces puppets, not men. And Shaw knows it, or should. He is now laughing at those who take him seriously. We don't. But there are many good men who do, and it is to warn these of the inconsistency and spuriousness of the article in question, particularly that part of it referring to municipal government, that we have taken up the matter.

The letter on this page from the City Clerk of Outremont well indicates the official mind on the subject, and which coincides with our own.

City of Outremont

City Hall, Outremont,
4th May, 1916.

To the Editor:—

As a Municipal Official I beg to enter an appearance, as it were in the Courts of the minds of your many readers who have read the article appearing in the New York Times by Mr. George Bernard Shaw.

What I would particularly urge upon your readers is to suspend their opinions upon the relative merits and demerits of the Local Government Systems of Britain and Germany until a proper competent expert or authority can decide the difficult and highly debatable question, viz., the New York Bureau of Municipal Research, or, say, Professor Powers, of Washington, D.C.

The assertion to which I take particular exception is:—

> "I have admitted that German Local Government is very superior to English Local Government. Its organization, its foresight, its public spirit, all due to its skilful combination of educated, well-to-do municipal statesmanship with the primitive criticism of the poorer, common vestryman, who knows where the shoe pinches and puts us to shame."

Now I personally know nothing of German Local Government, but with that of the British I have had a deal of experience, and while I would not like to elect myself as a defender of this well established system before a court of experts for the reason that there are older and abler men than myself who have devoted their lives to its service, I yet claim I am entitled to refute the irresponsible assertion of a man who lightly passes judgment upon matters and subjects of which he can, at the best, have only an elementary knowledge. This great playwright and writer undoubtedly excels in many literary matters, abstract socialism, women's rights, etc.; but when he asserts, and without a tittle of evidence, in support, the vaunted superiority of the German Local Government, he overreaches himself, and thus, like the tragedian who has based his plot upon an impossible incisent, he descends from the sublime to the ridiculous.

Much discussion has taken place among Local Government Experts of the two countries, and I have often read opinions of our experienced English City Treasurers, who, while admiring the wonderful progress of German methods, yet express greater satisfaction at the progress of their own Local Government, which is, they considered, more autonomous.

Again, Mr. Shaw gives no credit to the Municipal Government of all the large British cities, who have secured the ownership and control of all their public utilities, and operate same (without any accusation whatever of graft), economically devoting their surplus generally to reducing the cost of utility furnished, or to the relief of rates. Again, Municipal Officials, have in many respects improved their various professions, (I say various advisedly, because the scope of municipal enterprise in Britain, embraces practically sections of all the liberal professions) to such an extent as to command the admiration and respect of all the distinguished and official societies or institutions of each of the liberal professions, (viz.: Law, Medicine, Engineering and Accountancy.

I could easily lengthen this reply into a long article, but time forbids. However, I would crave, Mr. Editor, that you give it as much publicity as possible, to counteract the evil influence of the baseless accusations of Mr. Shaw.

Yours very truly,
E. T. SAMPSON,
City Clerk.

P.S.—I remember reading in the English Municipal Journal several years ago, a statement that the company operating the Tramways in the City of Berlin had been able to obtain an official assurance from the German Government that the franchise then unexpired, would be renewed for another long term of years, in spite of he notice given by the Berlin Municipal Council, that it was the intention of the City to operate the Tramways undertaking after the expiration of the franchise given to the company.

Organizing The Community Resources

(By J. S. WOODSWORTH, Director, Bureau of Social Research.)

Organization is the key to efficiency in modern industry and in the social order in which we live and which is so largely a development of modern industry. Our industrial and commercial interests have recognized this and adapted their methods much more quickly than have our social institutions. The result is, that where there is a conflict, the organized interests, however self-centered their nature, easily defeat the potentially great but unorganized social forces.

The great task of to-day is not the securing of greater individual efficiency but of mobilizing the forces. Social efficiency is not to be estimated as the sum of the various units of individual efficiency, but these units as organized into an effective fighting machine. In Canada, in every community we have plenty of good and able men, and yet our public and social life is corrupt and inefficient. The imperative need is that of organization.

"But," it may be objected, "we have numerous organizations already—too many of them." That is true; but the "organizations" need organizing. The community is the unit. Institutions and societies—as individuals—must learn to work not in their own immediate interests, but for the welfare of the community at large. So with all our machinery, we have not yet a machine. We have wheels, cogs, shafts, levers to no end. These must be "assembled," "set-up," "started running." The call is for master mechanics!

The organization of the social life of our towns has hitherto received scant attention. The city, and more recently the rural districts, have been studied with some care, but the town has been left to work out its own problems. Generally the problems are still there. But here and there successful experiments are being carried on that are well worth the consideration of other communities.

Among the larger prairie towns Yorkton is one of the most progressive. It cannot be called a boom-town though it has participated in the very doubtful benefits of the land speculation wave that swept the West. But Yorkton can boast some social developments that are not found in many towns of its size.

Among these is a small community organization known as "The Social Welfare League." How far this League is responsible for the various progressive social movements is a question that is not worrying its members. They will tell you that the League itself is simply an indication of the community spirit that is increasingly present in the whole life of the place and which is finding expression in all kinds of co-operative enterprises.

The League was an outgrowth of a study-class on social conditions which three years ago held regular weekly meetings in the Methodist Church. At the close of the class the members, who belonged to various denominations, asked themselves, and others, the practical question, "What can we do?" What can we do, not to be saved, but to save and enrich the life of our community? Surely that is the question which more and more will express the innermost yearnings of the souls of to-day!

Various things began to happen. Things always do "happen" when a few people get together with a purpose and a vision!

The foreigners, of whom there were a number in the town, had been sadly neglected. A number of people became interested in the situation—among others the School Inspector—and within a few weeks there was opened a night school for teaching English to foreigners. This was the first, we understand, in Saskatchewan and set an example which was soon followed by other towns. The School Board engaged a special teacher for this work. She was assisted by volunteer workers, some of whom had been members of the study class. This year, owing to the financial stringency, the School Board could not see its way to maintain a special teacher, but the Normal Students have come to the rescue. Now the work is not only continued, but the Normal Students are receiving a special training that will enable them to carry on a similar work in the various little communities to which they will go as teachers.

Next came the formation of the Social Welfare League, or as it was called The Social Service League. This was composed of a little group who, without formally representing any church or society, were really representative of the best citizenship of the town. They helped to link up existing agencies. They supported and broadened the work of the Social Reform Council. They secured speakers on Social Welfare topics for the Canadian Club. They helped to draw together the churches and the various women's organizations.

The League itself undertook only one piece of work. It appointed a "Benevolent Committee" to organize and supervise the relief work of the town. The various churches and societies were associated in the work. The Committee was recognized and subsidized by the Town Council and became a thoroughly community institution, the town dealing with all "charity cases" through the Committee.

This co-operative spirit is manifesting itself in various enterprises. The ladies of the W. C. T. U., sinking denominational differences and getting away from conventional lines of work have been holding Mothers' Meetings among the non-English immigrants. They are now arranging to employ a Social Worker to give her time to visiting the homes and carrying on classes and clubs.

The latest development has been the formation of a Peoples' Forum. The Canadian Club took the initiative and its officers are largely responsible for the new undertaking. It was felt that something should be done to interest and educate the foreign men in Canadian citizenship, and to draw together the English speaking and foreign residents of the town. Meetings are held on Sunday afternoons in the Town Hall and several of the leading ministers are backing the scheme.

The better day is dawning. Out of chaos is emerging order and efficiency and good-will.

TELEPHONES IN CANADA.

A good perspective relating to the telephone interests of Canada since 1913 can be gained in the following table:

	1913.	1914.	1915.
Capitalization	$59,847,004	$70,291,884	$74,284,991
Cost	69,214,971	80,258,356	83,792,583
Revenue	14,879,278	17,297,268	17,601,672
Operating expenses ..	11,175,689	12,882,402	12,836,715
Remuneration	6,839,308	8,250,253	8,357,029
No. of telephone companies	1,075	1,136	1,396
Wire mileage	1,092,586	1,343,090	1,452,360
Telephones	463,671	521,144	533,090
Employes	12,867	16,799	15,072
Persons pere telephone	16.2	15.5	15,1
Persons per mile of wire	6.8	6.0	5.6

Telephone companies' net earnings, as represented by the difference between total receipts and operating cost, were $4,764,957. This was better by $350,091 than the result for 1914. From the foregoing figures prepared by Mr. J. L. Payne, comptroller of statistics, it is seen that there were 533,090 telephones reported as being in use in Canada in 1915, as compared with 521,144 in 1914. The increase was 11,946.

On the basis of population, as estimated by the census office, there was an average of one telephone in use to every 15.1 persons.

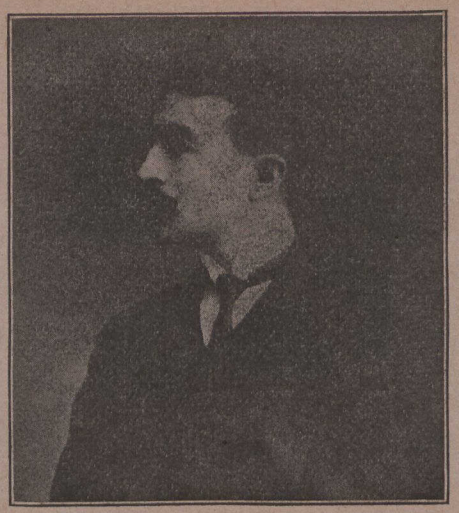
Of the 533,090 telephones in service, 313,225 were classified as being operated by central energy; and 219,865 by magneto. The latter are to be found in villages and rural districts.

There were 1,452,359.82 miles of wire in use in 1915, as against 1,343,090.07 in 1914. The 1915 wire mileage was divided as follows: Urban, 1,009,146.79; rural, 443,213.03. The principal growth, as will be seen later, was in rural mileage.

There was one mile of telephone wire in service for every 5.6 persons constituting the total population. The ratio was 6.8 in 1914.

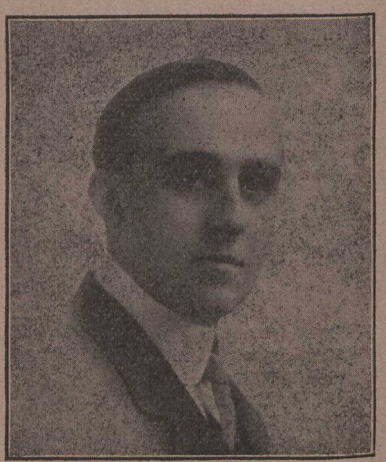
The following are the different classes of organization: Government, 4; municipal, 62; stock, 584; co-operative, 601; partnership, 28; private, 117; total, 1,396.

In Manitoba and Alberta practically all telephone interests are in the hands of the local governments. In Saskatchewan the provincial government operates in all the large centres, but has not taken over the 520 small units which spread their wires over the rural sections of the province. In all the provinces there is a growing tendency toward consolidation.



B. MICHAUD
Deputy Minister of Roads, Quebec.
President Dominion Good Roads Association.

J. DUCHASTEL,
City Engineer, Outremont,
New President.



GEO. A. McNAMEE,
Sec. Dominion Good Roads Association.

ONE OF QUEBEC'S NEW ROADS

Proceedings of the Third Canadian and International Good Roads Congress, March 6, 7, 8, 9, 10, 1916.

OPENING SESSION—MARCH 6.

Under the auspices of the Dominion Good Roads Association, the third Canadian and International Good Roads Congress was opened in Sohmer Park, Montreal, on March 6, under the presidency of Mr. B. Michaud (Deputy Minister of Roads for the Province of Quebec). The guest of honor was the Lieutenant Governor of Quebec (Hon. P. E. Leblanc), who was accompanied by Mon. Roy (representing Archbishop Bruchesi), Bishop Farthing; Hon. E. Decarie (representing the Premier); Hon. J. E. Caron, Minister of Agriculture; Hon. J. E. Lessier, ,Minister of Roads; Messrs. G. L. Squire, President Ontario Good Roads Association; Controller Cote (representing the Mayor of Montreal); Thomas Adams (Commission of Conservation; Dr. E. M. Desaulniers, M.L.A.; A. C. Emmett (representing Government of Manitoba and City of Winnipeg); E. A. Cunningham (representing Government of Alberta); H. W. Pillow, Pres. Automobile Club of Canada; W. H. Dandurand; J. Duchastil, etc. ...

The President, Mr. Michaud: (Addressing the Lieut. Governor of the Province of Quebec.)

Your Excellency,—On behalf of the delegates of this Convention, I beg to tender their respectful homage and to welcome you most cordially here to-day. Your presence at this meeting and the interest you have shown in our work are such as to justify its importance. Your presence shows us that you are not only with us, but that you are a collaborator in our work. Your long experience of public affairs, where you have been for more than 30 years in contact with the people, enables you to get at the secret of popular aspirations, too, tell in what direction they should be guided. and what measures should be taken to satisfy them in a legitimate way. Good roads are indispensable to practical agriculture, they are like streams which spread their riches from one point to another, and they must necessarily have created a favourable state of mind in you towards the ideas we are working for.

Is there any one in this province who is not interested in them? It also seems as if the greater part of our people were talking Good Roads, working to get them; and as many of them as possible. This is an obsession which has taken hold even of the most lazy amongst us. A long and easy road,—because sometimes, the straight road is not successful—shines in our imagination like a work of art, or else like a far-off country. We are trying to bring this thing a little nearer. It seemed as if only it were to be got in the Old Country, or in our sister republic, or our sister provinces; but we have really accomplished it by a combined and vigorous effort, using all the forces at our disposal; of the Government, of the press, of the automobile (an unconscious, but ever-growing force), the force of the will of the people, which made itself clearly heard, and finally the force of certain individual energies deserving of special note, and that your Excellency will allow me to mention here and to greet, the Premier of the Province, the Minister of Agriculture and the Minister of Highways, three pioneers to whom our roads owe their regeneration.

Many comments have been made, and many more will be made on the salutary effect that this improvement of our highways will have on special intercourse on the beautifying of life, and on agricultural and industrial progress. We have great hopes on one point. The farmer, and especially the young one, is not as fond of the land as he used to be; country life is tedious and slow to him, and there are a thousand ways to-day, whereby he is led to realize the doubtful attractions and the pleasures of the city, and this in his own restricted and monotonous environment.

If we had built highways only, they would have tended still more to draw the life-blood of our villages towards the towns, but by constructing roads on all sides, by bringing the remotest districts within their net-work, and so allowing our country population to make an environment for themselves, we flatter ourselves that we have been building a dam against the tide of this disastrous exodus. When the auto will have reached our farmers, and it will do that in a very short time with our improved roads, the tide will not always flow towards the towns without any ebb; it will be a life-giving one that will return to the depths whence it came after having watered the shore.

We are discussing and studying problems of great public interest, but even these cannot throw into the shade the greater events which occupy so large a part of our national life to-day. On the contrary, I think it is when men must get together on an occasion like this, that the idea of our country should be uppermost. We shall all carry away with us some sadness; we are here in perfect safety, while our dear ones, and if your Excellency will follow me to be still more precise, your dear ones, are fighting for that peace which we ourselves are enjoying here. It is easy to prove that works of peace are also works of war. When the country is in danger, then it can use the work done in peace-time. It is owing to the energy the soldier accumulated in peace time that he beomes a hero in the fight. We want to send a message of admiration and gratitude to our men fighting out there with France and our Allies, for it is because of them that we are going to take our place in history.

The Committee of the Congress is happy to extend to all a cordial welcome. I would like to pay a special compliment to our friends from Ontario, and our friends from across the border. They have given their support. They sent to us their men of knowledge, and may I say that such an evidence of sympathy is bound to be instrumental in carrying out one of the most important objects of good roads, which is to link together not only towns or cities, but also the citizens of this Dominion who have a common love for justice and true civilization. We are acquainted with their methods, we have benefited by their experience. We are aware of the good work they had been carrying on in their own country, and I may say that to a certain extent this had been the incentive for us to undertake in our turn very considerable and comprehensive road improvement. It is my duty to voice the feelings of this Congress in conveying the thanks of the members to the clergy, to the Government, ,to the Legislature, to the prominent financial and business men, and above all to the very distinguished representative of His Majesty, the Lieutenant Governor, for honoring us with their presence. I shall now respectfully ask his Honour to open the Congress.

LIEUT.-GOVERNOR LEBLANC:—

The Lieut.-Governor, Hon. L. Leblanc: Mr. President, Your Reverence, Gentlemen:

I have the honor to wish you all welcome to this Third Annual Congress of the Canadian and International Good Roads Association. The programme of the subjects for discussion has been distributed, and you will have noticed that some very important questions are to be studied, and I feel sure you will give them all the consideration they deserve.

It has given me great pleasure to hear that we have amongst us to-day many distinguished visitors from our sister- provinces and from the States.

Good roads and good schools are the best signs of progress; the school teacher tells our little ones how to get along on the path of life, and a good road is at the basis of all progress, and of the welfare of the entire country.

The magnificent roads of ancient Rome remain as an eloquent witness of her greatness; the Flaminian Way and the Appian Way have resisted the onslaught of more than twelve centuries. We can say the same of the great Napoleon; the masterpieces for which he is celebrated, are with us still; the Napoleonic Code, and the great Imperial roads of France.

The Provincial Government is at present engaged in studying a wider policy for the improvement of our highways; we trust we shall have the co-operation of all in this enterprise. We hope to get from this Congress a great deal of information that will help us in furthering this movement in the best interests of our Province.

Mr. President, Your Reverence, Gentleman, It gives me great pleasure to say that this Congress is now open.

Monseigneur Roy:—

The President: Archbishop Bruchesi has kindly sent Monseigneur Roy to represent him here to-day. We shall now have the pleasure of listening to Mgr. Roy.

Mgr. Roy: I am very pleased to bring you the good wishes of Archbishop Bruchesi, and I wish to say that you have the thorough sympathy and cordial wishes of all the clergy in this splendid work. The Church's duty is to insure your happiness in the other world, but the Church has always given her support to the innumerable achievements of applied science, industry and commerce.

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Good roads are the best means of communication between men; the better they are, the more mankind can learn to know and love his neighbour, and the civilizing influences of the Church will be spread more and more. Give us good roads for our pioneers, and our missionaries will be able to follow in their tracks. Give us good roads in our parishes, and our priests can carry the consolations of religion to any of our sick; and our people will be able to come to church without the fear of dirty and muddy roads. Long ago, the Church founded an Order of Monks Bridge-Builders, and they built that famous bridge at Avignon, and many of the highways in Italy and France.

I might remind you that the Sulpician Fathers dug the first waterway here, the Lachine Canal. In the course of his visits through the Province, the Archbishop never fails to exhort his people to do all they can to improve the roads, and get rid of some of those terrible mud holes and swamps, where a poor priest nearly lost his life a little while ago.

I wish you all success, and I beg to assure you again that you can count on the help and assistance of the clergy.

Bishop Farthing.

BISHOP FARTHING OF MONTREAL: It may be a mystery for some to connect the interest which the clergy may have in Good Roads, beyond the general fact that we are all interested in what concerns the people of the nation. After all the church is not composed of the clergy only but also of the laity. It would be a pretty poor looking church if we had not any laity round about, and therefore what concerns us concerns you, and I think also what concerns you concerns us, we are very much concerned sometimes about you. But I am particularly interested in the question for which your Congress has gathered together, good roads, because I don't suppose there are many men in this Congress who travel more over the country roads of the western portion of the Province of Quebec than I do. And I could tell a good many of the places where I would like the attention of the Government, and those concerned with the good road movement, to pay particular attention to. You know good roads have always been a matter of great importance to a nation, of great importance for the purposes of a nation itself in the way of commerce, and also in the way of war, of which we are hearing necessarily so much today. And not only is it in the way of commerce that roads are important, but also with regard to all movements, even of art itself, of education and of religion, because the communication which is necessary for the furtherance of every good cause is only made possible by the means of transportation. It is well-known to all students of history that one of the signs which we feel indicated the controlling power for good in the coming of Christ and the propagation of His Gospel was the fact that not only the nations of the world were uneasy and expecting some great event, not only that there was one great language of communication throughout the then Roman Empires, but also that there were the magnificent roads which the Roman Empire had provided for trade purposes, which rendered the possibility of the propagation of the Gospel so rapidly throughout that Empire in Apostolic days. So that the roads are a matter of importance commercially, economically, and a necessity for the furtherance, of every movement that requires communication between man and man I only desire to say that the roads, like everything else, need a great foundation, I am not an expert in road making, though I am somewhat an expert on the roads when they are made. But when one sees the scratching of the surface and the throwing of mud from the ditch to the centre and then you have to beat it down by the traffic, one feels they have a good deal to learn through the medium of a Congress of this sort. When one sees also the wasting of valuable time and money, thrown upon the centre of the road when there is no proper foundation, then one realizses that they are not all wise men who are in authority and who are supposed to be experts guiding these matters. All men of business you know are not business men. Far from it. I think some of the most unbusinesslike men I have ever met have been men in business, and all the men who are experts in road-making, or professedly, so don't seem to put their expert knowledge into practice, because they don't go down far enough to get a foundation on which to build, and a road like a man's character, unless it has a good foundation, is not worth much. A surface character, you know, is not worth anything at all. We cannot rely on a man who is all on the surface, but the man who is solid right through, with solid principles of honor and truth in the very centre of his being is the man whom we can rely upon. May I say therefore that I trust that your congress will do a great deal, as it has done in the past, in furthering the good roads movement. For the last seven years I have been a resident of the Province of Quebec, having come from that province which I understand many of you still belong to, you are therefore to be congratulated. I can say that it has been simply marvellous to see the wonderful improvement that has taken place in the public roads of this Province, since the Government of Quebec threw themselves so heartily into the movement a few short years ago. And I think we ought to feel indeed most grateful for what they have done in this connection in this province. I used to think, when I first came here, that all the bad roads were those I had to travel over, and I used to long for the roads of the glorious province of Ontario. But I don't long for that any more. I had occasion last November, to visit my old province, the scenes of my former work, I had a service in the city of Brantford on a Sunday morning and had to motor over to Woodstock for the evening. I will never forget that wonderful ride last November, from Brantford to Woodstock. Going along we were oftentimes uncertain just where we might come down when we went up and I know on one occasion, in going up, the most prominent feature of my face came in contact with the rim of the cover of the motor and I was not quite sure whether I had any face left or not for some time after I came down. And since then, my fellow citizens of Ontario, let me assure you I never sigh for the good roads of Ontario, I hope they are better than those I had to travel over last November. But all through Canada we have good roads and bad roads, and I hope you will be guided in this convention to make the good roads better, more solid in their foundation, and that we shall have nothing but passable roads in the Dominion of Canada in years to come. We cannot expect, and I think it is unreasonable for people to expect, we who come from the Old Country especially, that we should find here, in this Dominion of Canada as good roads as they have in the old country. Why, it would take up the whole value of the property along those roads to do that, in all probability in many parts of the country. You cannot expect it in a sparsely settled population like ours. You cannot expect that the sparsely-settled people will be able to maintain roads of such magnificence as those in the thickly settled parts of the Old Land, especially when they have had 1800 years or more to build them, and we have only had, in some places, forty or fifty years. But we are doing well, the roads are improving wondrously, and I trust your convention this year, as in former years, will make great strides to improve them still further. I wish you every success in the work of your convention.

The President: I wish to thank Bishop Farthing for his particularly kind words; I only regret one thing, and that is that the Premier of this Province was not here; the session is a very busy one, and he was unable to get away. We are now going to listen to the Hon. J. A. Tessier, Minister of Highways, Quebec.

Hon. J. A. Tessier, Minister of Roads Quebec

Hon. J. A. Tessier: Mr. President, Gentlemen—I had great pleasure in accepting the invitation sent me by the Good Roads Association to attend this Congress; no one more than myself has this movement more at heart. I was exceedingly touched by the kind words given us by the proceedings speakers, and I wish t othank the clergy, not only for their promise of support in the future, but also for a continuance of the very generous help they have always given in this matter.

I am perfectly sure that this Congress, meeting to-day in this Province of Quebec, will be most successful, and that we may soon see some good results from it in our Province. I am especially anxious to welcome the strangers from other Provinces and from the States; we are proud to have these distinguished men amongst us, and we are glad to be able to say that we have also been doing our share to get some improved highways, and to better our country roads.

It is practically a new thing in our province. In fact, people used to say we were terribly behind-hand; but we are making up for it now, and we think our Province can compare favorably with any other in the Dominion.

In starting this Good Roads policy, the Government began to do it for economic and philanthropic reasons, because the industrial and commercial life really depends up-

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on quick communication; the farmer can get his produce to market quicker, and the town merchant can sell his wares easier in the country. It also helps to reduce the cost of living.

On the other hand, those who have studied this question thoroughly, tell us that good roads are the greatest civilizing influence in the world; as soon as nations could communicate with each other, they exchanged commodities, ideas and principles, thereby becoming much happier, for we are happy if we are on good terms with our neighbours. In trying to improve our roads, we are trying to help each other. Good roads are the arteries of the world, in trying to promote them, we are doing a great humanitarian work. We want them for our own Province, and for the other parts of the Dominion. It has been said that the 19th century was the century of railroads; we want it said, that the 20th century was the Good Roads century. Quebec has not been backward in this movement; all possible efforts are being made by the government to support and further this policy, and we know that we are working for the economic and industrial development of the Province.

The President: The Minister of Agriculture has kindly consented to say a few words. I may add that I was his collaborator when this policy was first started, a few years ago.

Hon. A. Caron, Minister of Agriculture, P. Q.—

Hon. A. Caron: Mr. President, Gentlemen—Good roads and agriculture go together; and I fancy that it was in my department that the good roads idea started. The Hon. B. Allard was then Minister of Agriculture, and we owe it really to him. I took charge of the department after him, and with the valuable help of your president, Mr. Michaud, we organized the Department of Highways, which now looks after the construction and maintenance of the roads in this Province.

The beginning was very difficult; first of all we had to educate the people; we sent a lot of lecturers around to try and interest the farmers in this new idea. Sometimes it was pretty hard to make them see any possible advantage in it. We did not succeed at once, but we managed to get 45 municipalities interested the first year; the second year we went ahead and since then our propaganda has been very fruitful; it spread all over the Province, and there's no necessity now for us to do any preaching about good roads. Now the farmers simply inundate us with requests for funds for road making and repairing.

We want to keep up this movement, we want to go on, but it must be done cautiously and prudently, knowing exactly where we are going; it has got to be the basis of progress and of prosperity.

I said that good roads and agriculture go together; so many people are going to talk about roads in the next few days, that you must allow me to say something about agriculture. In starting this movement of good roads, I did it with the idea of helping our farmers first of all, for those who do their best to cultivate the land, not at all for tourists and owners of automobiles.

I heard of a congress in the States some years ago, where a statement wa smade that wherever the Good Roasd Movement had spread, cultivation of the soil had also increased; after the opening of an improved highway in any agricultural section of the States the tonnage of the traffic immediately increased from fifty to a hundred per cent. A good road is the first factor of agricultural progress and prosperity. Our farmers can raise more crops, can diversify their products, go in for more intensive culture, which is just what we need. In fact, I know they are making more money to-day than ever before. They were marking formerly about twenty or thirty per cent of what they are making to-day, and that is owing to the improvement we have made in our highways.

I said at the beginning that we were principally occupied with the agricultural prosperity of the Province of Quebec, but that does not mean that our Province was behind the others of the Dominion. We are next door to the beautiful Province of Ontario, which is quite as wealthy as ours; but I think that I may safely say that if Ontario is wealthier than we are, Quebec has made more progress than her neighbour, and that she is actually at the head of the Dominion by the progress she has accomplished.

In the last ten years we have considerably increased our production in all lines; we have doubled it in some points; the percentage of our crops is much greater now than it was in 1900; land has increased in value, and improvements all through the Province have simply done wonders for our farmers.

We have had to educate our people on the question of good roads, but we have also started a fresh line of agricultural education. Our three agricultural colleges, Oka, Macdonald and Ste. Anne have shown our young people that they can make a career in an agricultural profession equal to any other career in the world. There are one hundred and twenty pupils studying at Macdonald College, seventeen at Oka, and one hundred and fifty-five at Ste. Anne. In the last six years fifteen of these pupils have completed their studies in addition to their classical studies, and later on they will be professors and demonstrators capable of rivalling the best agricultural experts of Europe.

In all this, however, we need a good deal more than just help from the Government; we want the help of all good citizens, whatever class they may belong to, in order to help along the farmer; to let him feel that he is as good as anybody else in this country. The farmer needs encouragement, and, perhaps, with our sympathy, he will be more interested in his task, and on that sentiment we can base the future prosperity of the country. The future of the Province of Quebec is based on Commerce, Industry and Agriculture, and not only the future of our own province, but that of our whole Dominion.

The President: A few moments ago His Honour the Lieutenant Governor said that the two principal sources of prosperity were good schools and good roads. The Minister of Highways has spoken to us of the latter. I am sure you will be glad to hear now from the Secretary of the Province, who has done so much for education of this Province.

Hon. J. Decarie, Provincial Secretary, P. Q.—

The Hon. Jeremie Decarie, Provincial Secretary: I am proud to be here this afternoon. I am glad to see that all those who are willing that their country should be prosperous, should be free, have cordially answered the invitation of the Province of Quebec to discuss one of the most intimate problems connected with the development of the country, of its citizens, and of its freedom. I have to apologize, by his own request, for the Prime Minister not being here. Truly, as you have said, his Parliamentary duties at the end of the session, would perhaps require his presence at the capital, but that is not the reason. The only reason he is not to feel the pride that I feel myself, not to be in touch with those builders of every country and every continent, is because disease and sickness keeps him at home. The same thing with the Hon. Walter Mitchell, our Provincial Treasurer, the one who has been wise enough to provide for all the ratepayers of this province the moneys to build the roads that citizens of this country have been good enough to subscribe towards the maintenance of our borrowing fund to pay the interest on it without extra heavy charge. He would have been glad to tell the delegates of all the other provinces, of all the other states on the south side of us, how he does it. Many may think that the Province is borrowing, he would have explained to you that he is merely acting as an intermediary between the farmer and the onew ho lends the money, and for his own administration, his budget. If he borrows he borrows in order that the people may save money. That they may get the advantage of free capital, we are charging ourselves all the capital, and only half the interest. Gentlemen, I hope you will come to this free province of Quebec, the most tolerant of all the provinces of the Dominion, the most broad-minded of all the provinces of this Dominion, and perhaps of many other States. Feel at home, I do pray, in the name of my province. Give us the best of your advice, in order to help us—we will give you the results of our experience with the same spirit, the same mind, trying to help each other. The road is the great artery to freedom. When we can communicate either by word, wire, or travelling, then we can understand better each other, and this is why we are working on that great principle and why we urge the co-operation of everyone of you. Give us the benefit of your experience, we will give you ours in the most broadminded sense, and together we will gain the great blessing of true freedom and true independence.

The President: The Mayor of Montreal is unfortunately not able to be with us to-day, and he has asked Mr. Cote to represent him.

Controller Cote, Montreal:—

Mr. Cote: Mr. President, Gentlemen—My first duty is to express to you the regret of His Worship, the Mayor of Montreal, for his absence this afternoon, and also to wish you all the most cordial welcome to the City of Montreal. We all know that the Good Roads Policy, started a few years ago by our Provincial Government, is destined to unite our agricultural classes as well as our commercial and industrial ones. We know that this policy will contribute largely to the development and prosperity of our country.

The Municipal Authorities have also realized their duty in this matter. We have some fine roads between Quebec and Montreal, and between Montreal and other centres of the Province, and what would you have said if you had not found within the limits of the city itself streets and roads, at least as fine and as well built as the highways of the province.

Notwithstanding the financial crisis of the last two years we have built about ninety miles of new streets in our city. We hope to continue this during the season of 1916 and 1917, so as not to arrest the material progress of the metropolis of Canada. We shall go on with this policy as long as the present capital lasts which we have at our disposal. Later on we shall have to do things in another way; we shall go on with the maintenance of our streets, but we shall have to ask the people to pay the cost, as it is done in all other towns of Canada and the United States.

We shall follow your discussions with the greatest interest; we shall try to profit by the suggestions that you make to our engineers, so that we can build our streets more economically, if it is possible, and more permanently. You can see the exhibition we are showing of all kinds of road machines in use in our city; perhaps our engineers will also be able to give you some useful information, thanks to special studies they have made, and investigations in different towns in the States.

Gentlemen, I thank you again, and I wish you a most cordial welcome.

The President: Mr. McLean, that enthusiastic devotee of good roads, was to have been with us to-day. Circumstances have prevented this, and I will read you his telegram.

The following telegram was read from W. A. McLean, Deputy Minister of Highways for the Province of Ontario: "Toronto. To George A. McNamee, Secretary Good Roads Congress, Sohmer Park. Am confined to house by severe cold, and was compelled to cancel arrangements for trip to Montreal last night. Please express regrets to the President of the Congress. To make Canada famous for good roads is a work of patriotism worth all necessary efforts, and requires the earnest co-operation of every Province and Municipality, from the Atlantic to the Pacific. To that end the Good Roads Congress has my best wishes for success. If possible, will attend later in week. W. A. McLean."

Ex-Alderman U. H. Dandurand:—

U. H. Dandurand, Honorary President of the Dominion Good Roads Association: It is with great pleasure as Honorary President of the Dominion Good Roads Association that I welcome you here this afternoon, at the opening of this Third Annual Congress. It is with pride I have to acknowledge that I was the one to propose, two years ago, after the first Congress, that we should form a permanent Dominion Association. And it is with pleasure that I notice that the work has been appreciated to the extent that every Congress seems to be better attended. Your Lordship was at our first Congress two years ago; we had not half the attendance that we have this afternoon, and we have now the promise of nearly two thousand delegates attending this Congress. All that is required is education, and as soon as the question is understood there is enthusiasm. I have heard it said that the road is a fad for the motorist, but as soon as they understand the value of good roads they have built them. I have been told of a representative of a rural constituency, not far from the city, who managed to bring his whole council to a Congress. There was one man especially who had that old idea, that the roads were good enough for his forefathers, and therefore he did not see why they should not be good enough for him. He came to the Congress, and now he is the most enthusiastic member of that Council, and if you listened to him there would be no money spent except on good roads. Naturally I am very enthusiastic. Last year I said the question of good roads was the best medium of civilization. A Montreal paper said I was too enthusiastic and went too far. I don't believe it. Notice the change between here and the boundary line. I passed on that road years ago as the pioneer automobilist, when it was quite an effort, between bad automobiles and bad roads, to get to the boundary. I notice the change now. You notice the same old houses, but the whole aspect of things is changed. You have nice roads, and everything is improved. I have noticed it in passing through on a Sunday, the children can afford to dress up clean, because the roads are clean. They can dress up because they can go to church. Heretobefore it was only in rigs that you could go to church, and the children went to school, when they could get there, dirty and badly clothed, because the roads were bad. Now you see the little boys with ribbons round their collars, because the roads are clean, there is a nice path for him to the school, there is proper attendance at church. And so the question of good roads goes hand in hand with civilization. It is with pride that I notice the ecclesiastical authorities are joining hands to help us in this great movement. After hearing the representative of Archbishop Bruchesi, and Bishop Farthing, I am quite contented with this work which we have tried to do. We are only commencing, and it is quite encouraging—when we have the support of such high authorities we feel we can work more enthusiastically on the question of good roads. Allow me to thank you on behalf of the Good Roads Association, and to give you an enthusiastic welcome to our city, the representatives of the Provinces of Quebec, of Ontario and other provinces in the Dominion, and especially to our friends from across the boundary, who have done so much to make our visits not only pleasant, but interesting at any congress that I have had the good fortune to attend in the United States.

Last year, we had the warmest of welcomes in Toronto, where I had the honour of presiding; I notice that the attendance is larger this year than ever before. I am delighted to see my friend, Mr. Michaud, in the chair, as he was such a worthy representative of Quebec at our last meeting.

In the name of the Dominion Good Roads Association, I welcome you all most heartily to-day. We noticed last year that the work done on our Quebec highways had been so appreciated that it was decided to hold the next congress in Montreal; I was present at the last great congress held in Worcester, and I heard that the work done by use in Quebec was spoken of most appreciatively at that convention. We want to thank the Government of this Province for the splendid work they have accomplished. They were surprised in Worcester to hear of our many and difficult problems; they were astonished to hear that with a population of two millions only, we had to keep up 45,000 miles of roadway. They could not believe that the Province of Quebec was as large as England and Germany put together. We can learn a good deal from our friends, the Americans, how to build roads, but we can teach them how to finance the work, and that is no small problem.

I shall not say anything more at present, as I have to speak again to-morrow.

The first session was then closed.

Dinner at the Hotel Place Viger

On the evening of March 6 a banquet was held in the Place Viger Hotel under the Chairmanship of Mr. B. Michaud, the President of the Dominion Good Roads Association. The company which was composed principally of delegates to the Congress, after drinking the toast of the King, had the pleasure of listening to some enspiring addresses.

THE SPEECHES

The President: Gentlemen, Montreal is a progressive town; Montreal takes an intense interest in everything that concerns the development of our rsources, and of our highways. Therefore, if we meet in Montreal to-day, it is under the most favorable auspices possible.

We have many business men with us, we can consult them about our different ideas, and we shall derive a lot of benefit from this inter-communication. We are perfectly sure that if the Province of Quebec is to play a greater part in the history of the Dominion, it will be due in great measure to the collaboration of the business men of Montreal, and of the government of Quebec. It was quite flattering to hear from several men of this association their cordial and spontaneous tribute to the work accomplished by the government. I shall only be too pleased, on my return to Quebec, to tell our Premier of your sympathy and encouragement.

Speaking in English, Mr. Michaud said: I have spoken this afternoon, and I am beginning to be afraid I speak too often. This is because, unfortunately, or fortunately, we have to speak both languages, and I am glad to do so. I just want to repeat what I have said in French, that I am happy here to-night to meet all the distinguished members of this Congress who honor us with their presence, those who come here to help us to carry out the great problem of road improvement which we have undertaken in the Province of Quebec. I have referred to the business men of Montreal, and I have referred to Montreal as the centre of business, and the financial city which does all the business in the Dominion of Canada. We have the co-operation of all the engineers of the country in the undertaking of the road improvements. We have often seen them at our offices in Quebec; we have had the pleasure of meeting those who want their own welfare and the welfare of the Province. It comes to the same thing. When a man wants to be a good business man for his country he has to be a good business man for himself, so we have nothing to say against those who come to our offices and make a little canvassing in favor of new roads. We hear them with pleasure, we are exceedingly happy to have had this occasion of telling them how we appreciate the work they are doing, together with us, for the movement of good roads in the Province of Quebec.

Hon. M. Tessier:—

I shall now call on the Hon. M. Tessier, to say a few words.

Hon. M. Tessier: I remember, two years ago, at the first meeting of the Dominion Good Roads Association, Mr. McLean said that France was the first among modern nations to build permanent highways, and he drew the conclusion that French ought to be the official language for any Good Roads Congress, and so he went on to speak in French; you will allow me to do the same.

As your president has already said, the organizers of this Congress may well be proud to see such a distinguished gathering here to-night. We have representatives from our sister Provinces, from the States, men distinguished in politics, in the professions, in industry, in commerce, delegates from municipalities of our own provinces, and from all classes of society.

As I said this afternoon, the problem of good roads is quite a recent one for us. But, really, the laws relating to the highways date from the time of the founding of the colony. Under the French regime it was very simple; it was all under the control of one man, called the "Grand Voyer.' After the conquest, nothing was done till 1840; with the forming of the parishes, decentralization set in; in 1870, the municipal code gave over the administration of the roads to the different municipalities; since the Confederation, the various governments in Quebec paid no attention whatever to the improvement of our highways; everything was left to private initiative or to statute labor.

I need not go into any discussion as to this state of affairs; I need only add, that the government helped the railroads liberally, but did nothing for the roads. The communication between the large centres was good, but the rural districts, with their terrible roads, were almost cut off from each other. In 1907, it was decided to get to work and accomplish something to remedy this state of affairs; a law was passed allowing a certain sum to each county which would undertake to improve the roads; this law was again amended from year to year; in 1911, the 50 per cent bill was passed, and that gave to all those who were willing to improve their roads, 50 per cent of the cost. In 1912, the present system of loans to municipalities was started.

That revolutionized the question in our Province; to satisfy all demands, we shall have to provide, not five millions, but twenty millions for this purpose. In 1907, only 21 municipalities took advantage of the government's offer of help, whereas in 1915, over 475 municipalities took advantage of the government's offer of help, whereas in 1915, over 475 municipalities profited by it.

We have been sharply criticized by the press, but I like criticism; it has helped, in this case, to stimulate the policy we have adopted. Since 1912, we have spent on improved highways, the sum of 13 million dollars, over 3 millions a year.

I know you want to ask me, what we have done with all this money. Well, we have constructed and improved over 1,700 miles of macadam and gravel roads. Since 1909 2,000 miles of such roads have been made; I am sure you will acknowledge that we have not been idle.

The entire province quickly realized the importance of the question, and the demand is practically unanimous today that this policy be continued. We shall do so, because we are convinced that, in pursuing it, we are working for the best economic interests of this province, and of the whole country.

I am delighted to see so many delegates here to-night; I wish especially to welcome the representatives from over the border, from the most flourishing states of the Republic to the south of us; they are bringing us the result of their studies, and of their experience; I trust that the good relations which exist between us will never be broken, and that our mutual frontiers will never have to be guarded by cannons and machine guns.

I expect the very best results from this Congress; as I said a little while ago, we have been backward in our efforts in this matter, but we are trying to make up for lost time, and soon the Province of Quebec will compare favorably with any other portion of the Dominion.

Hon. J. Decarie:—

The Hon. Jeremie Decarie, Provincial Secretary: You have gathered by your own will in this large metropolis of Canada to talk of one of the best ways and methods of improving our welfare. It is communication through the roads, with the pedestrian, with the cart or with the new fast moving carriage, but it is communication. I understand that the Association has extended its invitation to all the Provinces, and even more, to our good friends of the United States. We have had to practice on their roads. I only hope that they will come into this country and come to us and explain the ways and means, the methods they have used to make their most beautiful roads, that we enjoy, when we go into their own territory, in absolute freedom. If we could only retaliate not in freedom, because we are just as free and generous as they are, and we are trying to give them the material way of coming to us. Probably most of you heard what I said this afternoon, when speaking at the more than memorable, the historic, assembly, in Sohmer Park, about the regrets of the Prime Minister. When we talk of progress, when we talk of political economy, when we talk of

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advancing the welfare of all classes, we think of the Premier, who appreciates the destiny of this province, and who is hailed by our friends as the greatest Premier the Province has ever had. Education, agriculture—he is master of them all. Let us talk roads. I have explained to you why the Provincial Treasurer is not here. His Parliamentary duties are occupying him more intensely than mine are, and that is why I want you to believe that if they are not here they are sorry not to be. I do not want to speak at any length, you have more interesting speakers to hear. But let us be sincere, let us be honest, each, all and everyone of us. When we are building roads we are building up the country, every one, whatever part we are from. I would like to see on the Orders of the day, that there should be a paper read on honesty in public contracts. We need workers, every public administration needs workers. We need experts, but pray that those whom we are asking to do the work are honest, that the conscience of the contractor shall be equal to the task he has got to do for the public. Make it for roads, make it for public buildings, and more especially make it for the national security. Why should I live behind a gun which has not been made honestly? Why should I throw a shell which has been laden with sand and salt? We are all interested in our country, our patriotism, our security, our territory knows no boundary, why should I, with my good money, lie behind the treachery of a dishonest contractor. In roads we have something in common, something that we each will have to travel on; let us be honest, let us be fair, to the country that awards us the contract, and with your minds and brains and your experience give us the best that is in you, and Mr. Michaud, the president of this Congress; Mr. Tessier, the Minister of Roads; Mr. Dandurand, one of the pioneers, all of us, will give the best that lies in us to promote the welfare between brethren in mankind.

Alderman Leslie Boyd, Montreal:—

Alderman Leslie Boyd, on being called on to speak, said: This is a surprise to me. I did not come here to represent the Mayor of Montreal, but to get some information, on my own behalf, in reference to good roads. Now I am glad to have the opportunity and privilege of representing the metropolis of the Dominion of Canada as such an important congress. I had the privilege of attending your first Congress in the Arena, and I can say that after that important Congress the results have been most fruitful. We have seen a tremendous improvement for the good as far as the roads are concerned, in the Province of Quebec, and I was pleased at that time to see the Premier, Sir Lomer Gouin, present, also our good friends the Minister of Roads, and some of the other ministers. It showed the interest that the Government of the Province was taking in the question of good roads. We have listened with interest to the very eloquent address of our good friend the Provincial Secretary, and I think we all agree with him in his remarks, when he says that the Government is doing all it possibly can to make the Province of Quebec the premier province of the Dominion so far as good roads are concerned. But, as the Minister has said, we can go farther than that. The Government does its part in lending the money, but that is only the commencement of the work, and it is up to the Government to appoint inspectors to see that that money is well spent, and that the public get the roads they are paying for. We all know what communication means as regards progress between communities, and it has been marvellous the results that have been obtained since these good roads have been made in the greater part of the Province of Quebec. The city of Montreal is the largest city in the Dominion of Canada, but, as the representative of that city, I wish to state that Montreal, if it wishes to progress, must have the lines of communication improved to such an extent that the people of the other provinces, and of this province, will have proper facilities to come into the city of Montreal. Those of us in the city who have the privilege of enjoying automobiles, when we start out to take our trips for pleasure, where do we go? We make across the river, through the southern portion of the Province to Plattsburg, and down through the Adirondacks. Now I think the time has come when the Province of Quebec should be opened up and its beauty-spots should be accessible by not only the people of the province, but by those tourists and good friends to the south of us. I ventured at the last Congress in Montreal, to mention to the Ministers who were present that when they had finished providing the people of the province with proper facilities, as far as good roads were concerned in the way of inter-communication from one town and village to another, that I felt it was their duty to open up the Laurentian Mountains, not only to our own people of the Province of Quebec, but to our good friends to the south of us. You all know the mountains, the valleys, and lakes in the Laurentians, and I am satisfied that if they can build the roads they have built through the Adirondacks, we can build the same kind of roads through our own Laurentians, and open them up to the tourists, and to those people who care to enjoy the beauties of our scenery. I want to say that the city of Montreal is delighted that this important congress should have selected this place to hold its third annual congress, and I want to add a word about our good roads in the city of Montreal, because I think I can say now that Montreal is fast becoming a city which can claim to having good roads. Our estimable engineer, Mr. Paul Mercier, whom the city has only had the privilege of having as its chief engineer for the past two years, is indeed an engineer who has the interests of the city at heart, and he is using his best efforts and great ability in seeing that when the roads are laid. We are getting good roads, and that the contractors are not making a bad job of it. Good roads are an essential to any community, for good roads mean intercourse and increased trade between one city and another. It enables the peoples of one town to meet and know the people of another town, and, in that way, I think the advantages to the whole community are enormous. I am glad to see that the good roads policy of the Province of Quebec has opened up to the people of that province great advantages, and I only hope that you will continue that good work, and not only will you increase you roads where they are most necessary, but that you will go to the length of opening up roads through our beautiful country districts. We enjoyed and appreciated the remarks of the Hon. Mr. Decarie, and I am sure you all endorsed what he said, that we must get our money's worth when roads are built. Good roads are no use to the community if at the end of one year they have got to be replaced, because that means a higher expense to those people who have got to pay for it. I believe that the Government feels its duty is to appoint such inspectors to see that the roads are properly made, that the surfaces are put down properly, and will not be washed away in the course of one season. I may say also that the city of Montreal appreciates what the Automobile Club of Canada particularly has done for this good roads cause. I believe by the coming of the automobile came the good roads. Those of us who have had the opportunity of visiting La Belle France know what good roads mean, and I am sure that those gentlemen who are instrumental in building these good roads to-day have had an opportunity of using those roads, not only in England and France, but in the United States. I think, if we follow the example of those great countries, that the Province of Quebec will rapidly take its place as the premier province of the Dominion. On behalf of the city I wish you heartily welcome; I hope your congress will be successful, and that, before parting, your ideas will have been exchanged, and that all the delegates here will feel they have attended this congress to their mutual advantage, and they will only take away with them the most pleasant recollections of the city of Montreal.

S. L. Squire, Ontario Good Roads Association:—

S. L. Squire: President Ontario Good Roads Association: I wish to express my appreciation of the opportunity that you have given me, to add my testimony to the democracy of the subject that we are considering. I fancy that there is no question which comes so close to all of us and brings us to such a common plane, as does the question of roads. We have to-night with us the Government of Quebec represented by a number of its ministers. We have on the other hand, those who are interested in the construction of those roads from an engineering standpoint, and there are some of us, perhaps in the minority, who enjoy the roads simply for the uses that we may make of them. This, however, shows us at once the breadth of the subject, and no wonder that we often hear the remark that the subject of good roads is an intricate question and has a great many angles. I believe that, if there is any real good reason why good roads present so many difficult subjects or angles, it is because when the Creator made man he made everyone

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of us a builder of roads. The sense of this suggestion will only be thought out when you consider that whether you may come from rural districts, where pathways have been in vogue or in the city, you will find that those who are working under the pathmaster know more about the road than the man himself, and those who are not working at all are able to criticise. And if the Government of Quebec is not vastly different from the governments of other provinces, there are many people who have not made a study of the question, who are ready to give splendid advice on this matter. I would not do my duty to Ontario if I did not extend to the Province of Quebec our congratulations on the splendid advance you have made in this great national question. I believe that the most prosperous product of every country is its men, and I believe that, if Quebec has shown an advancement in this particular feature more than the other provinces, it is because of the splendid calibre of men that you have had associated with this work. We in Ontario consider the questions perhaps in as large a measure as you, and yet we have not as yet been able to interest those men of large calibre to the same degree that you have in the Province of Quebec. For that reason I believe that we should take off our hats to you, and give you the credit which is you due for the premier place that you have taken in this great question. It may be, however, that there is another reason why you are leading us. Geographically the province of Quebec is, undoubtedly, the front door of the Dominion of Canada, and I am not sure but what it is a matter of practice that we take a good deal more care with our front doors than we do with our back yards. But, if the Province of Quebec is the front door of the Dominion, we want to remind them that there is a garden just behind the front door, and fields behind the garden, and if we agree roads and paths are necessary in the front, they are equally necessary in the garden and the back yard, which are behind the front door of the Dominion. And so, while we meet with you to-night, it is with the hope that this Congress may be to all of us, an incentive to do better in our various professions, that we may weld this grand Dominion into one continuous system of roads, reaching from one end of the country to the other. I thank you for giving me this opportunity to speak for the Province of Ontario.

Mr. Levesque:—

Mr. Levesque, M.P., for Laval: I feel quite flattered at being called upon to propose the toast of the Press, because, if this policy of improved highways has made any headway at all, it is owing to the strenuous efforts o four government, but still more so, to the energetic and generous collaboration of the Press.

It has been said to-day, that good schools and good roads go hand in hand; I endorse this statement with all my heart, and I want to call your attention to the fact, that if the son of one of our humblest farmers could become one of the most distinguished men in our province, then we cannot help but build the best sort of roads to our schools, if they lead in the end to Spencer Wood.

I am pleased to see Mr. Adams here as representative of the Federal Government; at the last convention in Toronto, he stated that the Province of Quebec was the only one with a definite road policy. I heard the same thing said in Worcester.

But all this is not enough; we must go on, and to do that, we need the help of the Press. When I say that, I mean the Press of both languages, all over the Dominion, but especially of this city, for the Montreal Press has always most generously seconded the efforts of the Government to carry out their mission.

Together with this homage I am paying to the Press in general, I should like to mention the name of one man, whose early death was such a loss to us all, and whose whole life was consecrated to the welfare of his country. He often said, in speaking of the Goods Roads Movement, "You can count on the patriotism and the co-operation of my paper," meaning La Presse; of course you have realized I am speaking of Mr. Berthiaume.

Every one will admit that the Hon. Berthiaume gave a tremendous impetus to the movement, when he promised the staunch help of his paper; it ensured the education of the masses on this matter. That is why I wish to render this tribute to his memory; he helped me more than any one else in the work of my own county, and I know of no more devoted patriot and citizen than he was.

I see in one paper to-day a reproach which was levied at the Senate at the time of our last convention. The Canadian Senate is accused of having refused to sanction a bill of the Federal Government which was intended to help the different provinces in the construction and the maintenance of our national highways. When this reproach was made in Toronto, I answered that the Canadian Senate had never refused to sanction any measure of the Government as far as helping the Provinces was concerned. The only thing the Senate insisted upon was, that the Good Roads policy should be a national one, and not a red or blue one. The Senate wished the money distributed at a pro rata of the population of each province, and not according to the fancy or inclination of any single individual. The bill was to allow 30 millions to be paid out for this work all over the country; it was not fair that that should have been left to one man's discernment. Last spring, I said in Toronto, "We know that the population of Ontario is larger than that of Quebec, therefore you will get a larger part of this grant; we have no objection to that, because you have a right to it; we are also sure that we are going to get what is coming to us."

And when I said that ,all the delegates declared: "That's all right. That is what we all want. We don't want this road policy to be a petty one, we want it to be a national one." For this reason, the Press is now asking the Government to divide this grant according to the pro rata of the population. That is all we ask, and I think we shall get it, and the result will be most beneficial for the interests of the whole country.

There is another thing I want to mention. As representative of a rural county, I want to pay my tribute to our farmers, who have not been afraid to impose a heavy tax upon themselves in order to improve their roadways; and I want to add another thing; may I ask the owners of automobiles, who run round through our country districts, to have a little more regard for the people who live in the country. As I came from the country, I can tell you exactly what they are thinking and saying there. These good farmers are saying to themselves: after all, we made a mistake in spending so much of our money on these roads, we thought it was for our benefit alone; instead it was for these motorists, and for their amusement; our wives and children are no longer able to go out for fear of being run over. I have seen some disgraceful scenes myself, motorists abusing country people because they did not get out of the way quick enough; after all, it was those people who had paid for their construction.

I am making this appeal to the Automobile Club, to ask them to see that this state of affairs is put a stop to; the Press can also help us in this matter; I am very much concerned in this matter, because if things go on as they have done lately, our farmers will start up the old mudholes and ruts again, in order to get rid of the motorist. There is a little education to be done here as well.

Perhaps I have said enough about the valuable services the Press has rendered; especially in its efforts to advertise as widely as possible this Congress, which we owe to the untiring energy of my friend, Mr. Dandurand. But I must mention one more name; we never call him "Mr."—it is always George McNamee, who has done so much for this cause. He works always very quietly in his office, but we know that his sole ambition for the last few years has been to secure good roads for this Province of ours. We owe him a tremendous debt of gratitude, and we are going to ask the Press to give him first credit for this Good Roads Association.

Gentlemen, I now ask you to drink the health of the Press, and of all our newspaper men, to whom we owe so much.

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H. M. Boland:—

H. M. Boland, City Editor, Montreal Daily Star: Had I known I was going to be called on I might have looked up some statistics, and been able to prove it was far better to spend money on good roads than railways. Mr. Tessier made reference to what good roads could do to foster the friendly spirit between Canada and the nation to the south of us across the border. Why go as far as that, across the border. I know a good roads congress is not supposed to be local, but why not foster a little friendly spirit between Quebec and Ontario for example. Who can tell what might not be the good results if some person would only build a bridge across Ile Perrot? At the present time there is quite a discussion going on between the two provinces, and the only way to get from one to the other is take a train or swim. If you want to go by automobile, and looking around at this prosperous gathering every person owns one, the only way is to go through Rouse's Point, or swing round by Ogdensburg, or, if you want to risk your life, take the two ferries across Ile Perrot and get into Ontario. That is just one little suggestion coming from the Press. Our good friend, Mr. Levesque, I can assure you, has, in the county of Laval and Isle Jesus, better roads than I have travelled on in any other part of Quebec, or Ontario, or elsewhere, but how are you going to get to them. Aeroplanes are not the common property of every person to-day. We have our Mr. Mercier here, and if he can fix up St. Denis street or Lajeunnesse Avenue, he would earn the gratitude of thousands. Why not build a new way out, and call it Levesque Avenue? Mr. Levesque has been good enough to thank the Press for what they have done to boost good roads. Why should not they? Good roads mean prosperity to everybody, prosperity to everybody means prosperity to the newspaper—there is the answer, there is nothing else to it. Mr. Levesque also has been kind enough to refer to our good friend, and my good friend, Mr. McNamee. I can assure you that while the Press may be given a little bit of credit for the enthusiasm, and the crowds that this Good Roads Congress has brought here, I think Mr. McNamee is the man who deserves most of the credit, if not all of it, and if there is any gentleman here who knows any County Council or City Council that is wavering on whether to spend five thousand or ten thousand dollars on a good road, he might send a little note to Mr. McNamee, and he will come up, and I guarantee he will win them over, because, when a gentleman can come into a newspaper office, and get the amount of stuff past the city editor that Mr. McNamee can do, I will leave it to your imagination to figure out what he could do elsewhere. Whatever little efforts the Press has done to boost good roads has been done most willingly, and the only regret I have is that we were not able to do more.

Thomas Adams, Commision of Conservation:—

Mr. Thomas Adams, Town Planning Adviser, Conservation Commission: I might say that, if I were not an old countryman, I should be ashamed not to speak so as to get in close touch with the French people as well as those who speak English. You have a very rapidly growing population in the Province of Quebec, and the future of the Dominion rests very largely on the health of that population, and the question of good roads is very much bound up with the question of the prosperity of the people. I notice that this is a Dominion Good Roads Congress, and I should like to say, although I don't wish to be misunderstood—it is a great pleasure to be here—that to some extent as a Dominion representative, I feel somewhat out of it. I feel I am here rather on sufferance, because Dominion officials and Dominion organizations do not seem to be in it. I do not think any Federal department which is concerned, should be left out of this question of good roads. They should be encouraged and stimulated to take an interest in it. It is not a question of whether the Federal Government will vote money towards good roads. I suppose they might, as this is a question above politics, and the time will come when we will have spent enough on railways, if it has not already come, and when we must devote a good deal more attention to building roads that will connect our farmers with the markets, and increase the population of our rural districts as well as the prosperity of our cities. This is a national question, as it is a provincial question, as it is a city question, a question for the farmer, and the rural municipality. The Commission of Conservation are interested in this question of good roads, and we are anxious to join with you in considering that question. What are the problems that interest us most? There are the problems of getting at the comparisons of standards or road construction. We want to get comparisons between the different methods of constructing roads; to consider the different width of roads, and the planning of roads. There are three kinds of road enthusiasts—there is, the man who is fond of a wide road, the man who accepts any kind of road so long as he keeps the taxes down—he is for the narrow way that leads to votes—and the third the man who wants roads on a proper plan, a sensible plan, with proper consideration to the purposes to which they are to be put. The latter consider the economic question and the efficiency of the industries to be served by these roads. I compliment the Province of Quebec on the spirit of enterprise it has shown on this good roads question. But I venture to say even here you are spending a considerable amount of that money without having properly considered schemes for the planning of those roads. We are spending money in Canada according to no settled principles, in the same way as if we were spending money in extending our factories without paying some regard to its connection with future extension. We are somewhat haphazard in our methods of development, and in considering which are the main roads, which are the secondary roads, and which are the lesser roads. I venture to say that among the most important things that will have to be considered in the near future, in connection with the conservation of our resources, is how we can make the largest amount of superficial area of road serve the largest agricultural territory. In Ontario and other provinces we have as much roads shown on a thirty-six square mile township as might serve five or six times the area. We go on laying out a large amount of roads without considering the cost to the community. The farmer cannot possibly bear the cost of making proper roads over that territory. We should consider more carefully the amount of road we can profitably make of a suitable character to bear our traffic. And when you come to consider that you have to have good main arteries even though you have to put up with poor secondary roads, there is a very important question to be settled in connection with good roads in connection with the matter of planning. The chief difficulty is not in the remote country districts, but at that point of contact between the city and the rural municipality, and between the towns and the rural municipalities where the congestion is the greatest, that the question of good roads is the most serious, because there is dual control, because there is the overlapping of interests, and because there is the difficulty of determining the apportionment of cost and responsibility in keeping up these main arteries leading out of great cities. Montreal has responsibilities outside of Montreal in regard to keeping up main arteries, just as other towns have, and the question of the cost apportionment is a serious matter for the farmer. He has to consider how proper planning of these man arteries out of cities and towns can be carried out, in such a way that he can afford to pay for them, and yet get the benefit of good roads. The farmer is not so conservative as some people make out, but he does recognize he has but a limited use of the road compared with industries having a large volume of traffic. The question of main roads radiating from big cities and towns is largely a question for the whole province, and the matter can only be settled by planning. I think that is a question that deserves to come more and more to the front. We in this country have to suffer from bad roads because we are a new country. But Canadian roads, considering the age of Canada as a commercial country, are comparatively as good as they are in the States. They are a little further in advance there because they have been a little longer at it, just as they are still further in advance in England, because they have been building roads and road making for so many years. I sometimes feel that those who are interested in good roads look on town planning as a sort of fad, a sort of joke, and sometimes they forget that the most practical people in the world have been town planners. Town planning in Paris and Washington were planned by men interested in great roads. In Scotland they are practical enough to plan their cities, and they do plan them, as they did Edinburgh and it one of the most beautiful cities in the world. We could make Montreal the real metroppolis of Canada, if we could set to and plan it with some regard to the future and to the great site on which it stands, but we allow it to grow "anyhow," with the result that the sub-division artist is allowed a free hand to plan the city as he likes.

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President Michaud:—

The President: I would like to point out that Mr. Adams' remark as regards the lack of system in road building and road selection according to their importance is not precisely a fault with us. I have explained, in Toronto last year, that first we had to get out of the slough, we had no roads at all in the province of Quebec. Now Mr. Adams has given to this Dominion the benefit of science in town planning and road making. When you have to answer the first necessity of life, often you have to overlook science. In fact, when a child comes on earth, very often, in a new country, science has very little to do with it. It is the case to some extent with this country, which is a very young country. Road-making was an entirely new thing in the Province of Quebec, and I may say that although the classification of the roads has not been made according to a scientific system, there has been some classification. As I pointed out we had to face necessities, the immediate needs, and we had no time to go into the scientific side of the matter, and calculate the importance of roads according to traffic, population, and so forth. First we had to give roads to those who wanted to make them, and so we did. Nevertheless we did obey a certain system in our policy of road building. We have provided trunk roads between cities. This is the classification: First, roads for big traffic between cities, and, second, secondary roads in the municipalities. And through that system, which I confess is not purely scientific, but which is worth something, we have been able to comply with the first requirements of this province—to provide roads for the automobile people who have a very great influence on the development of roads and of industry, and at the same time to provide roads for all parts of remote villages, and townships, and parishes of the province, which were asking for roads to get to the station, to carry the produce of the farm, and for their local needs. This is merely explanatory—you hear a speaker and you always think he is speaking of you. I don't want to think such was the intention of Mr. Adams, because I know he is a good friend to our road policy, and has approved it, but I thought it was necessary, on account of the very representative attendance we have here of business men and newspaper men, that I should give some explanation.

Mr. Adams: Having given voice to the expression which has led to the misunderstanding I must explain myself. I had in mind, and I intended to emphasize, the difference between the province and the city. It is true the province, as a province, has a plan, and I should have said so, but what I was alluding to was the congested area of cities in the province. If the province has a plan how very much more necessary is it that the cities should have a plan in the congested areas.

Mr. Levesque:—

Mr. Levesque: Gentlemen, Before we leave this evening, I wish to drink to the health of our President, Mr. Michaud. All those who have had the privilege of meeting Mr. Michaud, will concur with me in saying that few public men have done their duty as conscientiously as Mr. Michaud. After the splendid send-off they gave him last year in Toronto, where he was unanimously chosen president of our Association, it is only right that we should drink his health here to-night.

After the President's health was drunk a short entertainment was given.

The singing of the National Anthem brought the evening to a close.

PROVINCIAL LEGISLATURE AND THE MAINTENANCE OF ROADS.

SECON SESSION, MARCH 7th.

The President, Mr. Michaud, announces the forming of certain committees.

The President: So as to enable everybody to profit by the work of this Congress, we have arranged to have alternately French and English papers. Mr. Levesque will give us a lecture on "Legislation in Quebec and Road-Making."

Mr. Levesque: I feel I must crave your indulgence in presenting this subject before you, because it is a very dry one. I am going to treat of legislature with regard to road-making. I think this paper of mine contains practically all the legislative measures of this Province on that subject.

J. W. LEVESQUE, M.L.A.

The improvement in our roads in the last lew years has been wonderful. People have begun to understand the great importance of the subject; hundreds of municipalities have adopted new methods in order to develop and maintain their roads. Many highways have been constructed, many others are in course of construction, old prejudices are disappearing, and we are marching bravely along the great highway of progress. What is the cause of this change? What influences have been brought to bear upon it, to bring about such a remarkable turn-about? I think it is mainly the assistance we have received from the Provincial Government—without the help and encouragement of the present administration, we should still be where we were 15 years ago.

If we look back upon the history of road-making in our country, and particularly in this Province, we notice a striking contrast between the past and the present. Civilization began here three hundred years ago ,and yet what has been done in the way of building roads, has been done in the last few years. The first laws with regard to the subject take us back to the first days of the Colony. During the French rule, the roads were under the control of a State officer, the Grand Voyer. His duties consisted in seeing to the construction and repairs of roads and bridges, the cost of their maintenance being paid by the tax-payers, on whom he had the right to levy. After the conquest, in 1796, a law was passed entitled: Law relative to the construction, maintenance and improvement of the roads and bridges of the Province. This law ordained that all the King's roads and bridges, open to the public, should be built and kept up under the supervision of the Grand Voyer, or his assistant, in each district of the Province. It was a system of absolute centralization. It was only slightly modified later and lasted till 1841.

In that year, the decentralization of the road laws began, with the creation of municipal councils. This law of 1841, and a few other modifications subsequently added to the municipal code, in 1845, 1847, 1855, and 1860, form the basis of our system to-day. From this time on, we notice that the building and maintenance of the roads belongs entirely to the municipality. The government does not grant any concessions except for new roads to be built in districts that were being colonized.

A few miles of macadam roads were laid out by some independent companies near the larger towns; with this exception, nothing has been done to improve our roads in any way until the last few years. The first step towards the establishment of a definite system of road-making, was the construction of iron bridges at the expense of the government. In 1911 and 1912, two different measures were passed which placed Quebec definitely in line with other countries, which have adopted modern methods in road building. Co-operation was the key-note of these two measures.

Before these laws were passed, a great many tentative efforts were made to put the question of the improvement of our highways on a right basis. In the last twenty years, the cost of the improvement of the roads has risen from $75.00 to $4,069,307.68. The first figures represent the Provincial concession voted for the improvement of rural roads in 1895; the second figures are the sum total of the cost of all road building and maintenance executed by the Government in 1914. You can see by those figures

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the progress we have made. The following table gives you the list of credits voted at each session of the Legislature, for the last 20 years.

1894-95	$ 75.00
1895-96	30.20
1896-97	5,953.34
1897-98	7,795.56
1898-99	10,203.29
1899-1900	14,510.00
1900-01	13,000.00
1901-02	6,000.00
1902-03	17,572.79
1903-04	11,000.00
1904-05	18,250.58
1905-06	9,661.88
1906-07	15,404.56
1907-08	20,117.85
1908-09	60,146.92
1909-10	60,000.00
1910-11	95,000.00
1911-12	494,277.66
1912-13	1,069,810.35
1913-14	4,069,308.68

In these columns, you have the history of the Government's efforts for the improvement of the roads in the Province. In 1897, for instance, $5,953.34 went towards the purchase of road machines; the expenditure was not great, but we don't see that any improvement resulted from their use.

Later on, in 1908, a new bill was passed, authorizing the Department of Agriculture to make three grants: $125, $100 and $65, respectively, to the three first municipalities of a county buying a road machine, and further a special grant of $1,200.00 to any county buying a stone crusher. This effort of the Government was not all appreciated; some municipal councils said they would never use those road machines, and the stone crushers were laid on one side.

It was merely a question now of educating the people. The Government did their best to persuade the municipal councils to take over the maintenance of the roads. In 1907, a law was passed to make a grant of $800 to all municipalities adopting this system. This measure had some success, and that was the beginning of the present good roads policy. It was amended several times, giving the municipalities further inducements to improve their roads, but very little was done practically, as our rural population is not very fond of innovations.

Something more attractive was wanted; in 1911, the 50 per cent bill was passed. According to this law, the Minister of Highways can make three separate grants to the rural municipalities, for the up-keep, macadamizing and gravelling of their roads. The following are the principal features of this measure:

Maintenance: Any rural municipality can secure an annual grant of $400.00 for the maintenance of all their roads.

Any rural municipality can secure an annual grant of $200.00 towards the maintenance of their roads.

The first two municipalities in a county which undertake to look after all their roads, shall be entitled to a grant equal to three-fourths of their expenditure, and this during 2 years.

Any village municipality can obtain an annual grant equal to 40 per cent of its expenses, so long as it does not exceed $200; and this so long as they take over the maintenance of all their roads; if they only undertake the care of the main road, the grant shall be the same, provided it does not exceed $100.

No village shall be entitled to this grant, if the roads mentioned are not in good repair.

About 400 municipalities agreed to this arrangement; in that way, it did away with the repair of "parts" or roads, and it placed them under a central control, emanating from the municipal council.

Macadam: Any rural municipality can secure an annual grant of $1,000.00, equal to 50 per cent of the expenditure of a macadam road; if the road is only gravelled, the grant shall consist of $500.00; if the two are done, the total shall not exceed $1,000.00.

Any municipality building a macadam road right through its territory, can secure an extra grant, besides the above.

Any rural municipality, not wishing to build a macadam er gravel road at its own expense, can pass a bye-law directing that this work shall be undertaken at the expense of certain tax-payers, provided the latter ask for it by petition signed by a majority of them; said macadam road shall be the principal street in the village.

All such grants for macadam or gravel roads, shall be over and above the grants made for maintenance.

Those were the advantages presented by the law of 1911; it is known as the 50 per cent Act, as the Government pays half; and the municipality the other half.

It produced very good results; a large number of municipalities took advantage of it. The municipality has to meet its own expenditure by the levying of special direct taxes. Many rural districts, however, do not wish to go to the expense of very costly works.

If the Government had simply stuck to this 1911 Act, the gravel and macadam roads would probably have been built in the course of time, but it was very slow. The Government, realizing how urgent the question was, drew up a new plan which was submitted to the Legislature in 1912, and passed at once. This is the Good Roads Act, so-called of "loans," whereby the Government undertakes to find the money for all expenditure made by the municipalities for improved roads; in other words, the Government lends the money. The municipalities pay 2 per cent interest on the loan, for 41 years, and the Government looks after the sinking fund.

As a result of this Act, the Government has already borrowed $15,000,000 for this purpose, and more than 300 municipalities have taken advantage of this measure to build either gravel or macadam roads. The whole Province welcomed this measure as most satisfactory. In order to popularize it and educate the people, the Government sent out lecturers in all counties and parishes of the Province. The farmers soon grasped the impoprtanec of the thing, and very soon the Government was besieged with requests for a loan.

Once the movement was started, a regular staff of engineers had to be found, road machines had to be bought, and competent workmen found. A new department was formed, to distribute and look after the different sums paid out to the rural municipalities. It was hard work, but it was done. The men in charge were competent and most conscientious; the organizing of the department was slow but sure; our road laws and regulations were studied and explained to the town councils; by degrees, the new mechanism was working wonderfully. The President of this Congress knows something about it. He was the right hand of the Hon. Mr. Caron, then Minister of Agriculture and Highways, whose untiring energy has contributed so much to the success of the Good Roads policy in the Province of Quebec. Together with the Hon. J. A. Tessier, the present Minister of Highways, Mr. Michaud continued to work very hard to further this policy. I am sure you all recognize the splendid work he has done in this respect.

I must now try and give you some account of further work done by the Government, as regards the construction of main roads, and the abolishing of tolls.

By Art. 9 of the Good Roads measure of 1912, the Government was empowered to construct provincial highways, to serve as inter-communication between the great centres of the Province, and this over and above the credits voted for the improvement of roads. The total cost of this construction is paid by the Government, either by giving the work out to contractors, or doing the job themselves. By this law, the Government has the right to levy a contribution of not over $1,000 per mile for macadam roads; and $30 per mile for gravel roads. The average cost per mileage of macadam and gravel for these provincial highways cannot be compared to the cost of the work if it were carried out by the municipality. These main arteries of communication are most important, and the Government has to see that the work is done as permanently as possible, avoiding steep banks and slopes and dangerous curves.

The expenditure, of course, is very high on account of indemnities, purchase of land, constructing bridges, grading, altering telephone and telegraph poles, and other special works in connection with the location.

On the provincial highroads the width of the macadam is, as a rule, sixteen feet; with four feet of embankments on each side it makes a total width of 24 feet for the road.

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Up to the present moment, the Government of the Province of Quebec has built as a provincial highway, the King Edward Highway from Montreal to Rouse's Point, 37, miles, which is intended to link the metropolis of Canada with the State of New York. Unfortunately, the Federal Government were going to build a jetty of about 8,000 feet along the bank of the St. Lawrence, in the parish of Laprairie, and that work has not yet been done. A temporary road made of planks is all there is on the spot at present. We should have had a jetty long ago.

Besides the King Edward Highway, another one has been undertaken by the Government, the Sherbrooke-Derby Line, 32 miles long, to connect Sherbrooke with Vermont. This new country highway was finished last summer, and it is one of the finest in the Province.

The main road, Montreal to Quebec, was begun in 1913, and is nearly completed. It will unite the two principal centres of the Province, and will be one of the finest on the American continent. The road from Levis to Jackson, 93 miles, is three-fourths done; it opens up communication right through an agricultural country and connects Quebec with Maine.

Several other routes have been projected: Montreal to Hull; Three Rivers to Grand 'Mere; Levis to Nicolet; Nicolet to Rimouski, and many others. In about 15 years, Quebec will have a large number of main highways, interlaced by all the local roads built by the municipalities.

I need hardly say that the Government is doing its best to get rid of the tolls, both on roads and bridges. Those on Viau and Lachapelle bridges, as well as at Three Rivers, and in the eastern counties, have been abolished. Last week, a bill was introduced to take over all the toll gates on the roads north of Quebec. This is no easy or inexpensive task; we have to remember that in 1910 there were not less than 20 toll gate companies doing business in the province, and controlling 236 miles of roads.

These toll-gates have been a great advantage to the people of the Province; they gave us fairly good roads at a time when it was impossible to get them in any other way; they certainly helped in the development of the country; they are quite out of date to-day; the increase in population, the expansion of industry and commerce and the great distances between the various centres of trade all demand that these old-fashioned obstacles be done away with.

I should like to give you some idea of the mileage of construction done during the administration of Sir Lomer Gouin. There are at the present time no less than 15,000 miles of improved roadway which are kept in repair by the Roads Department; since 1908, about 416 miles of gravel roads have been laid; 910 miles of macadam roads; 9,665 wooden bridges have been replaced by solid concrete bridges; several provincial highways have been constructed; more than 300 municipalities have asked for grants under the Good Roads Act; more than 1,000 lectures have been given in various parts, illustrating the advantages of improved roadways; 143 complete plants have been bought by the municipalities engaged in building their own roads, the Government owning 58 similar plants; from the 1st of July, 1914, to the 10th of March, 1915, we spent the round sum of $5,087,094.22 for the improvement of roads in the Province, and finally, we have a Department of Highways composed of experts on the question. That is what the Government of Quebec has done for the great and laudable object, **Good Roads.**

The President: I wish to thank Mr. Levesque for his most interesting paper, and also for the compliments he has showered upon me. I expect he will soon apply to me for more money for his county. I think I must add that if the Government has done its share in this question, the members of the different counties have not been behindhand in helping us. Mr. Levesque is one of these; his county has a quantity of splendid roads, and there are bye-laws which provide for the building of macadam roads in nearly all parts of the county.

However, we did not come here only to get compliments; we have tried to adapt our legislation to the needs of the country; but we do not pretend that it is perfect; we are open to any kind of criticism or suggestions. Sometimes the people on the spot know the local needs better than we do; and we shall only be too happy to listen to them.

ROAD LEGISLATION IN ONTARIO.

M. S. L. Squire: I appreciate very much the opportunity of speaking at this time in defence, perhaps of legislation as we have it in Ontario. As you may know the manner of handling roads from a legislative standpoint in Ontario differs somewhat from the lines of the Province of Quebec. Until recently, we did not have a good roads department. However, the good roads problem is becoming so vital in the province that the Minister of Public Works, Mr. McDiarmid, under the advice of his colleagues, has already got Mr. W. A. McLean, as Deputy Minister of Public Works, as far as it appertains to highways. And as you know the McDiarmid Bill, which was passed at the last Legislative Assembly, became operative on the 18th of January. And now we in OOntario have aid to the extent of 40 per cent, if districts go into what we call the county system. No aid is given to municipalities in Ontario in any unit smaller than a county. I understand in Quebec you deal with parishes. We, in the Province of Ontario, deal with counties, and while there has been some criticism from some of the larger townships, who were desirous that a Government aid might be given to them, yet we find that the county unit is plenty small enough, for after all the question of good roads is not a local question, but must be viewed in its entirety, as it appertains to the nation. The McDiarmid Bill not only pays forty per cent towards construction of roads, but it also contributes twenty per cent to the maintenance or upkeep. The balance of the money is provided by the municipalities, so that while we do not have the opportunity in Ontario of borrowing our money, or getting our money from the Government in the same advantageous way you have in Quebec, still it is an absolute gift from the province to the people of forty per cent, without any repayment clause whatever, and I think if the two systems are figured out it may be that there is very little difference when it comes down to the question of advantage. However, the fact that we have now a Deputy Minister who has charge of this department, means that we are looking forward to Ontario coming to its place in the Sun so far as good roads are concerned. We have, in the department, those who are sympathetic, we have an energetic engineer and there is a general awakening among the people working towards the necessity of improving our highways. So that while I perhaps am not in a position to make a comparative statement as to the advantages of the law as you have it in Quebec, and the law we have in Ontario, from the fact that the new law has not been operative long enough to show its direct advantage, I hope, when we meet next year, or the year after we may be able to make a comparative statement from which we will be able to discover whether your system is better than ours, or ours is better than yours. It is only by comparison, by inviting criticism, by co-operation, that we can hope to obtain that which is best in your system and in our system, for after all, it is a case of shoulder to shoulder in order that the ultimate object of good roads may be furthered not only throughout the Provinces of Quebec and Ontario, but throughout the Dominion of Canada.

Macadam Road Maintenance

W. H. HUBER, C.E.
Engineer, Ontario Highways Department.

The revolution in the character of highway traffic within recent years has resulted in a demand for road surfaces very different from those which have heretofore been considered quite satisfactory. This change in character, and increased intensity, of traffic has also brought about a marked change in the methods of maintenance, and has advanced the question of maintenance from a position of importance second to that of construction to one at least of equality. Whereas formerly, a properly constructed road was looked upon as built almost for all time, the present tendency is to consider no road or pavement permanent, much less that type composed of crushed stone bound with its own dust and known as macadam. Formerly, the road-builder looked at the completion of the road as the end of his work; to-day it is only the beginning; for no builder of highways would not claim the ability to construct a road or pavement that will withstand the severe strain imposed on it by present-day traffic. True, one may read and hear extravagant claims for almost any of the expensive types of pavement, some of which are protected by patents, but how many of them will live up to these representations? In the case of water-bound macadam, and even bituminous macadam roads, which are to carry even only moderate traffic, the scheme of highway improvement is considered incomplete if it does not at the beginning provide for constant and efficient maintenance of the roads to be constructed.

Almost every treatise on the maintenance of macadam roads has for one of its first sentences the statement that "Maintenance should begin on the day the road is opened for traffic," or "The proper time to commence maintenance is immediately after the completion of the road" or words of like import. The truth of these exhortations is admitted, and acted on by the municipal official, who would preserve his investment. The day on which the road is completed is the proper time to commence systematic maintenance, but many of the plans should be laid long before this. Realizing that a well-built road will require much less expenditure to keep it in good condition than one built to a lower standard, it will be well, before commencing construction, to consider carefully the relation between original cost and the cost of subsequent maintenance.

The annual cost of maintenance on macadam roads may be quoted roughly as from one to ten cents per square yard, depending on many conditions, such as the nature and intensity of traffic, qualtiy of material and standard of work originally employed, character of the sub-grade, excellence of the drainage facilities, and efficiency of the maintenance organization, with much emphasis on the last named. While we have come to the conclusion that roads carrying heavy concentrated traffic must be something more than ordinary water-bound macadam if they are to be maintained in good condition at reasonable cost, financial considerations in many instances decree that the expenditure on construction must be limited as nearly as possible to the cost of the ordinary type. In such cases it is well to remember that a moderate increase in the cost of construction may materially lower the annual maintenance charge. For example, if an increased outlay of 20 cents per square yard will give a road surface on which the yearly maintenance cost will be reduced 1½ cents per square yard, the saving in maintenance will repay the increment in 20 years, and the expenditure will be justified. And 20 cents per square yard added to the cost of the average water-bound macadam road will make a vastly better road. It will, for instance, permit an increase of from two to three inches in the depth of stone, and a corresponding increase in the strength of the road. Or it will provide an extra inch or two or stone, and in addition a bituminous carpet coat to protect the surface and prevent dust. The latter will result in an improved road, both top and bottom, and it cannot be denied that the annual maintenance cost of such a road surface will be reduced by at least 1½ cents per square yard. Or, in the case of a 12-foot road costing $1.00 per square yard, the equivalent of 20 cents per square yard on this width, added to the cost, would allow for an increased width of from two to three feet, and would permit of a wider distribution of traffic over the metalled surface.

To first-class construction must be added contant care in maintenance, in order that the cost of the latter may be kept down. The less attention a road receives, the more it will require in the end, and the greater will be the cost of eventually bringing the surface back to its original good condition. Efficient maintenance consists in more than keeping the travelled roadway smooth; it must include careful protection of the metalled surface, and also the earth shoulders and sub-grade from the numerous agencies which tend to destroy them. Such a programme will include careful attention to the drainage facilities, and the improvement of these wherever possible. The growth of grass and weeds on the earth shoulders is one of the most effective enemies of surface drainage, and should always be discouraged. Not only does the vegetation prevent the rapid draining off of all surface water, but the accumulation of the remains of successive years' growth will before many seasons have passed, raise the shoulder above the metal, and form a basin for the retention of water to soften the stone surface and subgrade, and hasten wear and rutting. The use of the log-drag is being emphasized in connection with the maintenance of earth roads. It may also be used with profit on the earth shoulders of macadam roads, both in keeping them smooth and maintaining a proper chamber, and in preventing the growth of weeds.

By improving the conditions under which a road performs its work of supporting traffic, and by taking such precautions as are practicable to decrease wear and deterioration, and the consequent necessity for maintenance and repair, much expense may be saved, and the annual charges materially reduced. Some of the destructive agencies to which the road is subjected are almost entirely preventible, and may with proper construction be almost eliminated. Of these the chief is probably the action of water and frost in the sub-grade. With proper drainage there will be no water under the road, and where there is no water, there is no danger of damage from frost. Internal movement and attrition may also be prevented by precautions to secure a solid subgrade and thorough consolidation and binding of the stone. Other agencies, however, such as the abrasion and pulverization caused by horses' feet and vehicle wheels, the shearing action of fast-moving automobile tires, and the chemical action set up on the weathering of the stone, cannot be entirely prevented, and protection against them consists mainly in minimizing their effects.

While effective maintenance will depend largely on the attention given the road and the labor expended on it, there are influences which may be exerted to reduce the effects of some of the foregoing destructive agencies. Much of the wear and damage sustained by roads subjected to increasingly heavy traffic are due to the inconsideration of the users of the road. To counteract this negligence educative steps will in some cases be necessary, while in others legislation has been brought into play, and further steps along similar lines would be justified. In the former class may be mentioned the tendency to drive in a single track, thereby hastening the formation of ruts. This is frequently encouraged by building narrow roads with high crowns, and a partial remedy is found in widening the metalled portion and reducing the crown. Prevention of abuses of the latter class, which can usually be achiev-

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ed only with the assistance of the law, includes limiting the speed of automobiles and the weight and speed of motor trucks. The advantage attending the use of wider tires for heavy horse-drawn traffic has frequently been discussed, but the only hope of securing their adoption appears to be in legislation prohibiting the use of narrow-tired vehicles carrying heavy loads on improved roads. The same remarks apply to the question of having front and rear wagon-axles of different lengths.

But when all is said on the causes of road deterioration and methods of preventing it, the fact remains that road maintenance consists largely of labor expended on the road surface itself. The question of how the road may be best maintained in the good condition which, we shall assume, followed construction, is the vital question on thousands of miles of road at the present moment. Not only must the maintenance be effective, but it must be carried on at a cost commensurate with the original cost of the road, the nature and amount of traffic using it, and the financial capabilities of the municipality on whose shoulders rests the burden of meeting the cost.

No matter how good the construction, wear will occur, and it is the chief object of maintenance to take care of this wear before it goes so far as to require heavy repair work. Ruts and depressions will form, especially in a newly built road which has been laid on an earth sub-grade. The second season is usually the road's worst time. Ruts, caused by the sinking of the stone into the sub-grade must be filled, the occasional ravelled spots found on almost any road must be re-rolled, and the contour of the surface restored if necessary.

It is frequently desirable to repair ruts which have been formed in the foregoing manner, or which are caused directly by the concentration of traffic in one line. Two courses are open, either of which will be found effective and inexpensive. The first consists of spiking up the ruts with the roller, and filling with new stone. It will be found that the rear roller wheels just cover the ruts, which may be picked without moving the roller from its tracks, and without loosening the remainder of the road. Short spikes should be used in this operation. Two to three round trips over a given section will usually loosen the stone sufficiently to permit a bond with the new material. In the ruts thus loosened, fresh stone from one inch to one and one-half inch in size is carefully placed, in quantity sufficient to restore, after consolidation, the old cross-section. This is then rolled and bound with screenings and water, as in the case of the original road. The second plan eliminates the loosening of the road surface, and depends on the use of tar or asphalt to keep the new stone in place. The ruts or depressions are first thoroughly swept out till the bare stone is exposed over their entire area. The surface of the hollow is then painted with bituminous material, usually a heavy asphaltic oil, or medium grade refined tar. New stone is next placed over the bitumen in the quantity mentioned, and rolled. A small amount of bituminous binder is applied to the surface and the whole finished with stone chips and rolling. This process is an application of the penetration method of bituminous road construction on a small scale, and possesses the advantage of providing a bituminous bound surface on that part of the road which receives the greatest wear.

Experience has shown that the surface of a water-bound macadam road cannot be expected to withstand the effects of rapidly moving motor traffic. While still the mainstay in the body of thousands of miles of the country's main roads, stone screenings as a binder for wearing surfaces subjected to much of this class of traffic has reached the end of its usefulness, and substitutes must be, and are being, provided.

The use of oils on road surfaces is usually considered in connection with the prevention of dust, but systematic treatment with a good asphaltic oil ranks with the most efficient methods of road maintenance. If a good grade of asphalt oil, say, 40 per cent, is applied regularly to a properly prepared surface, the effects are soon seen to be in a measure permanent, the asphaltic base remaining on, and penetrating into, the road after the volatile constituents have evaporated, and forming a permanent binder for the surface. The same penetration may be obtained from the use of a light refined tar, the grade known as Tarvia B, being generally used for this purpose. In either of these cases, sand sprinkled on the road after the application of the bitumen will furnish a wearing surface which will effectively protect the stone during the life of the treatment.

The most lasting and generally the most satisfactory treatment of a macadam surface, particularly when subjected to much motor traffic, is found in what has been termed the "carpet coat." This consists of a thin covering of bitumen, filled with stone chips, pea gravel, or coarse sand. The result is a surface from one-eighth to one-half inch thick composed of stone and a bituminous binder, the former taking the wear of the traffic and the latter binding the stone together and holding it on the road.

While more expensive than treatment with light oils, a bituminous carpet coat is usually cheaper in the end, owing to the greater durability of a single application, and the better condition in which the road is preserved. When properly applied a carpet coat may last, with a small amount of maintenance, for from two to five seasons, and the road thus treated has many advantages equal to those of a bituminous macadam road. In some respects a well-built water-bound road with a bituminous carpet coat is to be preferred to one with several inches of a bituminous bound surface. The cost is less, being equal to that of an ordinary water-bound road plus eight to ten cents per square yard. The body of the road, if built on a firm sub-grade, is perhaps more rigid than the bituminous macadam, owing to the danger in the construction of the latter type of using an excessive quantity of bitumen. This is especially true in the case of country roads, where experience in the use of bituminous binders is not so general as in city street paving. If a suitable system of maintenance is organized, the only work necessary is that required for keeping the carpet coat in good conditon, correct practice being to repair any defects in the surface before the body of the stone is injured. This follows the principle of maintenance of city streets, where the concrete base is considered permanent, and the wearing surface, of whatever character, is renewed as occasion requires.

The successful application of a carpet coat depends on a number of details, neglect of which may result in partial or total failure.

(1) All dust must be thoroughly swept off the road in order to secure adhesion between the carpet coat and the body of the road. For economy this should be done by a horse-drawn rotary sweeper, dust being removed from ruts and depressions, if necessary, by hand brooms. The bare stone must be exposed over the entire area.

(2) All bitumen which does not penetrate the road must be taken up with stone chips to take the wear of traffic and to prevent creeping of the carpet coat and the consequent formation of lumps.

(3) Bitumen must not be applied in quantities greater than just sufficient to cover the road. For a heavy carpet coat, an application of from one-third to one-half gallon per square yard is usually made of 80 per cent or 90 per cent asphaltic oil, or medium grade refined tar.

(4) Care must be taken that it is heated to the correct temperature, else its viscosity will require the use of more than is necessary or advisable. The temperature mentioned in the specifications covering work with any given material must be rigidly adhered to.

(5) Sufficient stone must be used to take up all the bitumen, and extra chips added wherever "bleeding" occurs.

(6) In order to prevent creeping and to insure the success of the treatment the stone must be consolidated by rolling. During this operation the stone is forced into the bitumen which comes to or near the surface. The principle on which the rolling is considered of such importance is that the voids in the stone chips must be reduced to a minimum, and these voids be filled with bitumen. If they are not reduced to the limit, there is an excess of bitumen which will come to the surface and cause "bleeding" in hot weather, when, assisted by the crown of the road, it will tend to run toward the sides and couse lumps. The roller should make several passages over each portion of the road, and fresh chips be applied wherever the tar or oil comes to the surface.

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Results of the treatment described are to a large extent dependent on the degree of penetration, or at least on the adhesion between the bitumen and the stone surface. It should therefore be left undisturbed for some time after being applied. A warm day assists materially, keeping the bitumen in a more liquid state. If applied in cool weather it will become cold and thick before penetration or adhesion has commenced, and peeling will probably occur soon after. Also, the stone chips used in covering will not enter the bitumen as they should, and bleeding and movement on ensuing hot days will result. On no account should any traffic be allowed on the road between the applications of bitumen and stone chips. The bitumen will adhere to wheels and horses' feet, and results may usually be seen in the subsequent peeling of that part of the coat which ha sbeen disturbed.

The cost of a heavy carpet coat such as described will usually be from eight to ten cents per square yard, and the life of such a coat with careful, though not necessarily expensive maintenance is estimated at from two to five years. Including the cost of upkeep, the annual cost of this form of road protection in ordinary cases will be from two to four cents per square yard. The cost will be somewhat increased on main travelled and suburban roads, in which case it may be as high as six or eight cents per square yard per annum.

Since one of the greatest objections to the carpet coat as a form of road preservation lies in its tendency to creep, and as this tendency depends largely on the thickness of the coat, recent practice has changed somewhat to a preference for a thinner coat, composed of a lighter grade of asphaltic oil or tar, filled with smaller stone chips or coarse sand. The durability of such a treatment is not nearly equal to that of the heavier coat, but the lower cost at which it can be applied will permit more frequent resurfacing. It possesses the additional advantage that rolling is not absolutely necessary, and the cost of this item may be eliminated. The same care must be taken, however, as regards cleaning the road surface prior to the application of the bitumen and the prevention of disturbance by traffic before the sand has been applied. The cost of this treatment, using approximately one-quarter gallon per square yard and covering with sand, is ordinarily from three to four cents per square yard. With ordinary country road traffic it will last a full season, and in most cases a moderate amount of repair work will make it good for a second, making an average cost of from one and one-half to three cents per square yard per season.

The size of stone chips required will vary, with the grade of bitumen used, from coarse sand to half inch. Whichever size is used it must be free from dust. Since it is to constitute the actual wearing surface of the road it should be carefully selected, and as carefully applied. Trap or granite chips should be used wherever obtainable at a reasonable price. First quality limestone is next in preference, while pea gravel and coarse sand may also be used.

In order that the benefits of a carpet coat as described may be continued, and in order that the body of the road may suffer no deterioration, great care must be taken to keep the surface completely covered. Bare spots must not be allowed to develop or pits will form. Experience has shown that where the stone becomes bare, disintegration will rapidly set in, due to the fact that the bitumen has prevented the penetration of moisture to the road. In the case of an untreated road, the surface will absorb a certain amount of moisture, which is necessary to maintain the bond. Proof of this is seen in the ravelling of many macadam roads during continued hot dry weather. When oil or tar is applied it replaces the moisture, and the surface bond is maintained, and even improved. When the bitumen has worn or peeled off the surface, the stone beneath, robbed of its bond, will ravel, and a pit is the result. The scheme of maintenance should provide for a frequent and systematic inspection of all treated roads, and the application of a small quantity of bitumen and stone chips, of the same grades as those originally used, to any spots where bare stone is showing.

The mention of constant attention naturally introduces the subject of patrol work in connection with road maintenance. There is now no question of the economy of small repairs continuously made, as opposed to periodic resurfacing amounting practically to reconstruction. The employment of patrolmen on the main roads is now quite general, and it remains to have this system extended to cover the less important roads which must also, in the interests of economy, be kept in a state of first-class repair.

The length of road which a single patrolman can properly cover will depend on the original condition of the road and the intensity of traffic. Briefly put, his duty will be principally to keep the road in as good condition as when it was built. At the first sign of wear or deterioration steps must be taken to repair it in order that the work may be done as cheaply and expeditiously as possible.

Attention to the travelled roadway, while perhaps the most important, is not his only duty, and the care of the entire road allowance from fence to fence will be entrusted to him. The maintaining of the drainage, and its improvement where practicable, are of vital importance. All side ditches and culverts must be kept open and free from rubbish. No water must be allowed to stand in any ditch or culvert, but must be carried to its proper outlet. A patrolman's instructions should include a positive order to traverse his entire section immediately after each rain to see that all ditches and culverts are working properly, and that water is not being held back in any place; also to look through each culvert at least once a week.

Weeds on any part of the road allowance should be cut and burned before going to seed. On the earth shoulders, they may be kept far from the seed stage with a log drag, which will at the same time keep the shoulder smooth. Broken guard rails should be immediately repaired. Approaches to bridges and other embankments should be watched in order that any shifting of earth may be promptly arrested. Damage to bridges or other property on the section, repair of which does not lie within the patrolman's field, should be immediately reported to his superior officer.

For purposes of patrol work, a man with a single horse and wagon, and heating kettle, is generally employed. For social reasons it might be preferable to have two men with a wagon, and to double the length of the section patrolled. This would double the amount of work done per outfit, and reduce the cost to somewhat less than twice that of a single man. In the wagon are carried the necessary tools for the work, a quantity of stone chips for repairing the bituminous surface, and a supply of fuel for the heating kettle. The outfit can start from headquarters in the morning fully equipped with tools and materials for any repair or maintenance work which will be encountered during the day, and lost time, usually spent in going for supplies for a particular job, is eliminated. In efficiency the patrol system has already proved its worth, and the organization of such a system, suited in detail to local conditions, will result in better kept roads at less cost.

In conclusion, macadam roads form the greater percentage of the heavily travelled roads in this country; they represent an expenditure of millions of dollars, and it is our duty, as engineers and roadbuilders, to see that this investment is preserved to as great an extent as possible.

The President: We have built many miles of macadam in the province, and we will probably build many more. And therefore the question is of importance to us, and we are indebted to Mr. Huber for his valuable paper on the matter.

Town Planning and Good Roads

THOMAS ADAMS.

The Chairman:—

We have with us an expert of the Commission on Conservation, who deals with the matters pertaining to town planning, which is a very expansive subject.

Mr. Adams: I want to take your attention for a little while this morning away from the construction and maintenance of roads, which are of great importance, to the question of planning and general policy. The good roads movement in Canada is chiefly concerned with the rural municipalities, and I think something more might be done to interest the cities and towns in this Congress. There are a great many cities and towns interested here, but at the same time one always has in mind the idea that the good roads movement, as it is at present advanced in Canada, arouses most interest in rural areas. We have in Quebec, and in Ontario, Deputy Ministers of Roads, but I think these Ministers have not a great deal to do with the roads within the boundaries of cities, and their chief concern is with the roads in the rural municipalities. Now the question of good roads is not a question solely confined to rural municipalities. We want good roads within the cities and towns, and particularly in regard to the approaches to the cities and towns. As traffic comes in from the outside district towards the centres it is there that it becomes congested. You may do with a light gravel or a clay road out in the farming districts, but when you come towards the town you want a road of better material, well planned, well constructed, well drained, with a good grade, because there the question of industrial efficiency is affected by the extent to which you have high-grade roads. There is no well defined boundary between the city and the rural municipality. The city is spreading out into the country in long strips and in isolated spots. Manufacturers are spreading out from big cities into the surroundding country districts. All over the American continent there is a tendency for manufacturers to get out of the big cities and to build their works in the country just outside. The cost of land in large cities and the cost of taxation is accelerating that movement. The great manufacturer is not building in Chicago or New York, he is building on farm land, outside, where he can get the land, at agricultural rates, build cheap houses for his workpeople, lay down his own systems of sewers and water supply—in fact, the big manufacturer has become the competitor with the existing city. He is no longer prepared to pay for the conditions which the city provides; he has become a competitor by creating his own conditions. That means we have to plan for the population spread over wider areas.

TOWN PLANNING AND GOOD ROADS IN RURAL MUNICIPALITIES.

The time seems to have come when consideration should be given to the need for extending scope so as to include all authorities and municipalities interested in road transportation in any class of area. Perhaps the city roads are not so primitive in character as those in the country, but they have to meet the needs of a greater amount of traffic—which means that in so far as they are bad, they are relatively more injurious to industry.

My subjetc requires me to give attention primarly to the rural municipality, but I will endeavour to show that the tax payers in rural municipalities are very much concerned in the question of planning the suburban areas round cities and towns.

The rural municipality is the domain of the farmer. It is his interests that are dominant in the areas outside the cities and towns. In certain districts, such as those within ten or fifteen miles of Montreal, where building sites are obtainable within easy reach of the railway stations, the sovereignty of the farmer is encroached upon by private residents and sub-division artists and in other districts there are residential villages and summer resorts where the interests are not solely agricultural. But generally speaking it is the farmer and the interests of the farmer that we have to recognize and provide for in the rural municipalities.

The farmer is the creator and producer of the first necessities of life, and it is upon his activity and his success that we have to depend most in times of stress. But the cities need the rural districts not only to provide food, the sources of capital, etc., but also to provide the young, healthy recruits that are constantly required to keep up the average strength of the army of citizens crowded together in the comparatively unhealthy conditions of the city.

The city relies more on the farmer than the farmer on the city, although in the apportionment of the fruits of the soil it often happens that the farmer is left with the least reward for his labour. He is not altogether blameless himself for this, for he has been slow to appreciate the value of co-operation and of such luxuries—to him—as good roads. His fear of increased taxation has always been a sore trouble to him. In spite of his usually intelligent grasp of affairs, he appears to have failed to appreciate that the success of his business depends on the net profits he earns, no matter what the taxes are.

But the farmer is awakening to the fact that it is how he spdends his money, and not the amount he spends, that is the important thing. Undoubtedly more must be spent in the future in getting good roads, and the farmer will have to bear his share of the cost. We have to see that he gets fair play in the apportionment of that cost. Up to the present, our fault has largely been in the direction of providing too many roads. It has seemed as if we thought by putting road reservations on the map and calling them roads, they would become roads without artificial aid. That we have too many reservations and that we have not planned them properly are two of our difficulties in getting some of them made good. The farmer will have to look at this question from a broad point of view, and consider the general welfare of his district rather than his personal interest—what is best for his municipality as a whole will in the end be best for himself.

The real efficiency of a road system depends, however, on its being considered in relation to an area comprising many districts—and no one district can be satisfactorily dealt with alone. That is where the aid of the Provincial Department of Highways is so valuable. Provincial planning must precede town planning. On these things we are mostly all agreed, but I can imagine the question being put—what business has the rural municipality with town planning? What interest can the farmer have in town planning anyway?

Unfortunately the term "town planning" is misleading, as a description of the movement to which it relates. It means the planning and regulating of the use and development of land for all building purposes. Every farmer has certain rules which govern the use of his land, the rotation of his crops, etc., and he will be the first to recognize the need for even greater consideration being given to the "planting" of buildings on the land. When permanent buildings are erected, they are capable of standing—or should be—for 100 or more years. In considering their erection we should surely have regard to the development that may take place in the intervening period. We cannot tell precisely what the extent of the building "crop" will be in any given period, or how many acres of land "will be spoilt by being covered by stone and lime," as a Scottish farmer put it. But the farmer also, does not know what his apple crop will yield when he is planting his young trees. None of us can accurately see into the future, but we have certain principles and experience to guide us, and we require to use them in regard to building development, as well as in regard to farming. We also should have regard to the expensive and permanent nature of the "crop" we are dealing with. We go on every year destroying building values by our indiscriminate way of allowing bulidngs to grow up. This means a loss of capital and waste, and the man who feels most the result of national waste is the farmer. The more we waste money in the cities on inefficient and inconvenient methods of transportation, on unnecessary fire risks, on extravagant local improvements, on the consequences of bad local government, the les capital is available to help the development of our rural areas, the making of good roads, and to purchasing the necessities and luxuries which the farmer produces.

The good government of the city is as necessary for the welfare of the farmer as it is for the welfare of the city dweller. You cannot separate the problem of the town from the problem of the country. It is in the rural municipalities that the beginnings of bad development take place, and it is only during and before these beginnings

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take place that you can properly plan and regulate development. The healthy development of Montreal depends as much on the control of development in the rural areas outside, as on the control inside the city boundaries. We must have the co-operation of the farmers in preventing that development going on in such a way as to burden the future taxpayers with the great losses we have now to bear—as a result of neglected sanitation, bad suburban roads, want of planning ,and destruction of natural features in the past. All round the small towns and the villages, there are areas which are in process of being used for building purposes, or are so situate that they are likely to be so used. It is to the farmer's interest as a producer and as a taxpayer that there should be regulations to control that development, and get good roads made where the traffic is greatest and the profit obtained from the land is highest.

Sometimes one farmer will sell his farm for the purposes of sub-division. He goes out of business at a good profit. Later on, the other farmers in that district have to put their hands in their pockets to pay for improvements from which they enjoy no benefits—or perhaps they have to bear the heavy cost of educating the children of large bodies of workmen brought into a rural district by a manufacturer. The high price obtained by the one farmer who sells out, has to be paid for out of the increased taxes, which have utimately to be paid by the other farmers. They cannot prevent that sort of development, but they can assist in getting it controlled in such a way that the burden will be more fairly apportioned, and that the making of good roads will be borne by those who have to use them. In Great Britain, the prime movers in many town planning schemes are the farmers in rural districts who want good roads, and who have to protect themselves from the encroachment of building development of an undesirable kind.

This short paper is merely an introduction to some of the elementary phases of a big subject. The farmer in Canada has not yet begun to interest himself in town planning, because he has not seen how it affects him. When he is prepared to take more interest in it, and sees its relation to good roads, I hope there will be many opportunities for discussing details. Meanwhile, the following are a few suggestions regarding the points of connection between town planning and good roads in rural areas. There are many other questions of interest to rural municipalities in connection with town planning, but I will confine attention to road matters only.

(1) The planning of road widths is required so as to secure that more importance will be attached to the principal radial thoroughfares and less space given and money spent on minor roads in sub-divided areas. We cannot afford to give up a greater average width to streets than 60 to 66 feet, but we can arrange so that more width will be thrown into main thoroughfares and less width into streets of short length not required for through traffic. Nor do we want too many main thoroughfares. What is important is that they should be sufficient, in the right place, and that place determined on scientific principles of planning by unbiassed experts. The question of width should have relation to the traffic purposes of a street, and farmers will gain as much as any other class from the proper planning of our roads. Perhaps it may not be practicable to get more than 60 or 66 feet in main thoroughfares as part of the actual area dedicated to public use, but there are certain things we can do in a town planning scheme which will give us a result which is nearly as good. Whatever standard of width we may have fixed in a given area, we can vary the width of our building lines to secure that no buildings shall be erected nearer to each other on a main thoroughfare than, say, 100 feet, without any cost to the community, thus enabling us to widen such a thoroughfare in the future if ever it becomes necessary to do so.

In most rural municipalities, however, sub-divisions have not taken place over large areas, and there is still time to plan so as to secure a more sensible adjustment of road widths to our needs and our ability to pay. If 60 or 66 feet is a sound minimum for minor streets, it is an absurd width for main thoroughfares. It seems to be a good average, and there is no reason why it should be greatly lowered as an average, but there is good reason why we should increase it in main highways. To enable us to do so, we must be prepared to allow narrower widths in short, minor streets. Air space should be obtained by fixing building lines, and not by fixing width of streets.

(2) The use of road frontage for different classes of building should be considered with more care. Manufacturers select sites in rural areas without regard to the effect of their traffic on roads or the increased burden of taxation they will put on the community. In other instances, expensive streets are sometimes made to provide access to a few scattered dwellings. That means that the general taxpayers have to pay for unnecessary and wasteful improvements. In proportion as the individual can throw the burden of cost of construction and maintenance on the community, the method of developing land is usually carried out in an extravagant way. The need of avoiding this waste and securing a more reasonable apportionment of cost is very great, but it cannot be determined satisfactorily without proper planning.

(3) The extension of railway systems and the growth of radial transportation will increase the tendency of building development to spread into rural areas, it will cause consideration to be given to securing good access by road to stations. The improvement of the road system should be planned as far as practicable before new lines or stations are fixed, and should at least be considered in co-operation with the railway interests when they are fixing their lines or stations. Although we have difixed lines already laid down for most roads, we should have a scheme of improvement prepared, or at any rate we should have machinery ready to deal with it as soon as developments come along.

(4) The fixing of certain areas for residence and others for manufacturing is even more important in rural areas than in cities. It has a bearing on the good roads problem. We should have heavier roads to accommodate the traffic of factories and lighter and cheaper roads for residential areas. Unless we separate the two classes of development to a certain extent, we cannot make economical roads.

(5) Our roads should be designed to make the most of natural scenery and there should be control of bill-boards. If the districts through which roads are made are protected from injury, visitors and business will be attracted.

(6) Traffic concentrates rapidly as it nears the city or town. It is the main approaches to the average city or town that needs most attention to-day. The problem in the country is as a rule the comparatively simple one of providing a reasonably good surface for a small volume of traffic without any regard to building development taking place on the road frontage. Near the town the position is much more difficult and complicated. In the first place these roads lie on both sides of an artificial boundary between two different classes of district—the city or town and the rural municipality—with somewhat conflicting interests. There you have the evils of what amounts to dual control without, in most cases, any real co-operation. Secondly, it is where the road approaches the city or town that roads require to be both good and wide. The volume of the country traffic increases greatly as it radiates towards the centre, and here is added the local traffic. In an area where building operations are proceeding, this local traffic is ruinous to the roads. It is along the main arteries that building proceeds most rapidly and needs most control. We cannot have a system of good roads leading to our towns without regulating the building development along their frontages in a better way than we do now.

These and other questions require urgent consideration by rural municipalities in town planning schemes. By preparing such schemes, they will be able to get the foundation laid for a satisfactory method of apportioning costs of road construction or maintenance. The need for this is very great in the interests of the farmer, but the practical difficulties are almost insuperable under present conditions. As already stated, the border line between the city and the country is very indefinite, and it is becoming less definite as cities expand. It is along this border line on both sides that regulation is most urgent in the interests of good roads and healthy living conditions. The rural municipalities have a great responsibil-

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ity to see that the overflow of the city will be well taken care of under their jurisdiction and will not, on the other hand, add unduly to the burdens of the rural community, and especially of those engaged in agriculture.

We want two things in Quebec. We want to copy Nova Scotia in regard to one, and to formulate a policy for ourselves in regard to the other. Nova Scotia has a compulsory town planning act for the whole of the province, that covers the rural municipality as well as the big city, and under that act within three years every city and town and rural municipality in Nova Scotia have to agree on a combined scheme of development. What I suggest is we should try to get the government of Quebec to give the cities and towns and rural municipalities power to prepare town planning schemes to fit in with the general road scheme of the province. We have at Quebec a Ministry of Roads. They have prepared a skeleton scheme for the roads of the province, and we want in addition to that, to have powers given to every authority, whether city, or town, or municipality, so that they can prepare a scheme, and link it up with the scheme of the Minister of Roads. In that way you get the whole province under one considered scheme.

We ought also to have a Department of Municipal Affairs in the Province of Quebec. We have no means of considering questions of standards of value, standards of planning, and standards of construction. We need a Deputy Minister giving his attention to local government problems and to municipal questions to join and co-operate with the Deputy Minister of Roads in considering questions of local government. One or two reasons for that. If we are going to have any periods of unemployment in the future you cannot deal with unemployment as a purely local question. You must deal with it as a provincial question. Yet it is the municipality that has got to find the money, and administer the expenditure of it. Therefore it is a question in which you want the co-operation of the province with the local authority. That is so far as unemployment is concerned. On the question of finance, there is nothing we spend more money on than on roads and maintenance, and we want to regulate that more carefully, under the administration of a department of municipal affairs. I appeal to those interested to get some literature from the Commission of Conservation, which will explain the meaning of what I have been urging—a Town Planning Act, which would give powers to the local authorities to consider the planning of their areas for the next twenty or thirty years, and a Department of Municipal Affairs giving attention to unemployment, finance and other local problems.

We pay far too much interest on the money we want because we have no sound co-operative policy in regard to the borrowing of money. Cities and towns are are competing with each other to raise money, and officials at Ottawa are often asked about the standing of municipalities in different parts of Canada. People come to Government Departments in Ottawa and ask what is the standing of such-and-such a city. There is no proper answer that can be given to that question because you have no proper system of controlling finance and securing the money that can be raised at the lowest rate of interest. These questions ought to be considered, as well as the question of road construction, because they are of the utmost importance, and, before we get much further in spending millions and millions of dollars in making roads, we ought to apply business principles to financing them. You should always consider how extensions are going to affect further extensions, and if you apply the same principle as you apply to your farm or factory, to the planning of your towns you will get very much better results and be able to defeat the Germans after this war; there is no question about it, and we will have to fight a country that has been trained, to the last ounce, how to economize their energies, and how to sacrifice themselves in the matter of food. We are not having to deny ourselves now as they are having to do, and therefore they will be all the better equipped to fight us. Let us prepare to fight them and let us have co-operation between the French and English in Canada, because I believe the future of the country depends on that co-operation as much as on anything else. Let us have an entente cordial on the question of planning, and local government, so that we shall be not only allies in the trenches, but allies in the battle for the industrial supremacy of Canada.

The president voiced the feelings of the meeting in congratulating Mr. Adams for his able speech, and asked Mr. Francis to take up the discussion on the paper read by Mr. Huber.

ROAD MAINTENANCE.

Mr. Francis: This question of highways maintenance is of the greatest importance to the whole world to-day. Those who left the banquet hall last night did not dream of the monumental efforts that the street railway were going to put forth in order to get us here this morning. And if there are any congratulations to be paid out it is to the street railway for the way it got its maintenance system to work for us bright and early, this morning. In France, where the fate of the nation depends on the question of highway maintenance, on the ocean where Britain, Mistress of the Seas, is maintaining highway commerce for the liberty of the world, everywhere, highway maintenance is the most important subject in the whole world to-day. I want to congratulate Mr. Huber on the very able presentation of his paper on the subject of highway maintenance. When I was asked if I would lead the discussion naturally I started to look around for something to fight about. But I was bitterly disappointed for the reason that Mr. Huber had covered the very points that it seemed to me were most essential in this very important subject. Last night, at the banquet, the Hon. Mr. Decarie made a reference to the honesty of building roads. I should like to say that he should have made a reference to the honesty of the upkeep of roads, for one of the most important things in connection with all highways is to see that they are kept up, from the moment they are finished, or, as he put it, kept up before they are finished. So it is up to the authorities everywhere to see that there is honesty in the upkeep of the roads. Now the things that force this upkeep upon us are largely two of the great forces of nature, water and frost. If you are going to keep roads right, get your foundations drained, and you will have little or no trouble. And here we have the marked difference between the roads of Canada, and the roads of Europe, and the Roman roads, and the roads in the Southern States, where they have not the enemy frost. The next thing that occurs to me as being of importance is the reference to the effect of the bituminous carpet, which is probably the greatest advance in road making to-day. The introduction of the bituminous carpet keeps the water out of the road, and if it is properly drained underneath it gives you no trouble, and as Mr. Huber outlined in his paper, the very best method of keeping that carpet in order is the patrol system.

END OF MORNING SESSION.

The Hot Mix Method of Bituminous Construction Using an Asphaltic Binder

By FRANCIS P. SMITH, Ph.B., M.A.S.C.E., M.A.I.C.E.

THIRD SESSION **Tuesday Afternoon**

Mr. Emmett: Owing to the unavoidable absence of Mr. Dandurand, who has an important business engagement, I have been asked to preside at the third session of this Congress, as representative of the Province of Manitoba. I greatly appreciate the honor that has been done that province in asking me to preside, and whilst I have the opportunity I wish to extend the congratulations of the Province to the Province of Quebec for the excellent results which they are achieving through the good roads movement, that is being so efficiently carried on by the government of this province.

Paper by Francis P. Smith, New York, on "Hot Mix Method of Bituminous Construction, using asphaltic binder."

THE HOT MIX METHOD OF BITUMINOUS CONSTRUCTION USING AN ASPHALTIC BINDER.

From among the wide variety of bituminous pavements known at the present time it is almost always possible to select one type which will satisfactorily answer any given set of climatic and traffic conditions. Bituminous pavements therefore come nearer to being the universal and ideal type of pavment than any other which has yet been devised by man.

Bituminous pavements, especially those with fine mineral aggregates, are smooth, non-productive of dust, almost noiseless, waterproof, non-absorbent and easy to clean. They are capable of sustaining very heavy traffic and also last well under light traffic. They are therefore well adapted for business and residence, streets and the facility with which they may be kept clean makes them especially desirable in tenement districts. They are easy to repair and offer but slight resistance to traffic. They are somewhat softer in summer than in winter but when properly laid never become too soft for use even in the hottest weather. When dry and clean they are not slippery and their slipperiness in moist or drizzly weather is largely due to the presence of a thin film of mud caused by the collection of street detritus and this can be greatly reduced by washing or keeping them clean. For this reason they are less slippery in a heavy rain than in a drizzle. Horses accustomed to granite block pavements put their hoofs down and slide them until they obtain a foothold in the crevices of the pavement. As there are no such crevices in a bituminous pavement, it takes a little time for them to become acccustomed to it but they soon learn to adapt themselves to a smooth surface.

While sheet asphalt will sustain a very heavy traffic, this statement applies more especially to a traffic largely composed of quick moving, light to medium loaded vehicles, such, for instance, as prevails on Fifth Avenue, New York. It is not the most suitable type of pavement for a very dense, slow moving, heavily loaded traffic. Wood block and granite block will outlast it under these conditions. It will not give satisfaction where there is practically a total absence of traffic, as it then is liable to develop cracks, apparently requiring the kneading action of traffic to equalize the stresses set up by contraction and expansion and to keep it in proper condition. It is entirely suitable, however, for traffic varying from the light delivery traffic of residence streets to the dense but quick moving traffic of Fifth Avenue, New York, or the Thames Embankment, London.

On account of their smoothness, sheet asphalt pavements are not suitable for use on excesive grades. Generally speaking streets carrying a fair amount of traffic can be paved with asphalt if the grade does not exceed 6 per cent. In some cases where the traffic was very light and a smooth pavement was considered essential, it has been laid on grades running up to 10 per cent and 12 per cent, but this is rather exceptional. Where the traffic is heavy, a 3 per cent to 4 per cent grade is usually considered as the limit. In most of the largest cities of the United States the maximum grades on which this type of pavement is laid very from 4 1-2 per cent to 8 per cent, regulated largely by the traffic and climatic conditions.

Depending upon the size of the mineral aggregate used, they may be considered as bituminous mortars or bituminous concretes differing from ordinary mortars and concretes, in having a cementing material which is plastic and which may be classed as a semi-fluid or a semi-solid. For this reason greater care must be taken in the selection of the mineral aggregate and its grading than if a rigid cementing material were employed.

The pavements produced by these mixtures are to a certain extent malleable and yielding, thus minimizing the wear of the mineral particles and making them more acceptable to horse drawn traffic. In summer these qualities are more noticeable than in winter for at very low temperatures the asphaltic binder becomes practically rigid. This very quality of flexibility makes it necessary to provide a stable foundation. If the foundation is unstable and sinks after the pavement has been put down, the pavement will gradually sink with the foundation, thus forming a depression in which water will collect and eventually destroy it. The wheels of vehicles passing over such depresions will drop into them, the force of the blow depending upon the weight of the load, and this will still further exaggerate the depression by forcing up a portion of the pavement immediately in front of it. It will also set up a vribration in the springs of the vehicle which will cause successive blows to be dealt to the pavement until the spring vibration returns to the normal. This action, especially in commercial vehicles where the springs are short and stiff, results sooner or later in wave formation which is unpleasant to ride over and which, when it once sets in to any considerable extent, rapidly increases until it becomes necessary to re-surface the street or road.

Hot mixed bituminous pavements differ from each other chiefly in the size and kind of the mineral aggregate, the bituminous cement or binder being substantially the same in each case. Sheet asphalt pavements have a mineral aggregate which contains no particles which would be retained on a one-quarter inch sieve. Topeka mixture pavements consist of a standard sheet asphalt mixture to which has been added from 15 per cent to 25 per cent of stones passing a one-quarter inch screen and setained on a ten mesh screen and 10 per cent or less of stone passing a half inch screen and retained on a one-quarter inch screen. It is really a type of bituminous concrete pavement although in certain sections this term is only applied to pavements having a mineral aggregate consisting wholly or largely of stone of varying sizes from 1 1-2 inches down. The coarser the aggregate used the rougher will be the surface of the finished pavement. On grades, therefore, where the traffic is not excessively heavy, coarse aggregates are to be preferred. Generally speaking, the heavier the traffic the finer should be the mineral aggregate used owing to the fact that the coarse particles are more liable to fracture than the smaller particles. Where fracture takes place to any considerable extent rapid deterioration of the pavement will ensure, as the bituminous cement ordinarily used is not sufficiently fluid at atmospheric temperatures to rebond and re-coat the fractured particles.

This brief consideration of some of the characteristics of bituminous pavements is necessary in order to intelligently discuss the question of proper foundation and the selection of the mineral aggregate to be used.

The character of the foundation required will depend upon the traffic, climate, character of subsoil and drainage conditions. The heavier the traffic the stronger must the foundation be. In cold climates where the ground freezes to considerable depth in winter, the spring thaws produce a very unstable condition of the subsoil and in such cases the foundation must be stronger than is required in climates where there is little or no frost. A well drained sandy soil is much less affected by these temperature changes than is a heavy clayey soil.

A number of different types of foundations have been successfully employed, such as old macadam; broken stone rolled dry or cemented together with some form

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of bituminous cement; old cobblestone, Belgian Block or granite set pavements; old brick or asphalt block pavements; bituminous concrete; natural cement and Portland cement concrete. Where the traffic is light, as on country roads which are not main arteries from or between large cities and in some residential streets, old macadam roads have proved to be suitable foundations for bituminous surface mixtures.

In some cases, notably the Thames Embankment in London, a foundation of this kind covered with an asphalt pavement has successfully carried very heavy traffic but the layer of stone has been built up during many years and is very thick. Under severe conditions the use of macadam as a foundation is to be deprecated and more failures than successes have resulted from it.

Many roads are classified as macadam which contain no base course of large stone and are in reality old dirt roads which have never been properly drained and on which fine stone has been dumped and consolidated by traffic. Before using any macadam road as a foundation, its history, and more particularly its condition in the spring of the year, should be investigated. A sufficient number of test holes should be put down to determine the character and depth of the stone and provision made for proper under and side drainage. It will usually be necessary to rebuild the road in a number of places and in most instances the crown must be reduced. Wherever possible this should be done by filling up the depressions and building up to the shoulders. Traffic will compact a road far better than will a roller and a road surface which has been scarified and rolled will not be as hard and firm as one which has been compacted by years of traffic. Where depressions are to be filled the road bed should be cleaned and slightly loosened to insure proper binding of the new stone which should be of the same size as would be employed in building up the corresponding portion of a new macadam road. It should be thoroughly wetted and rolled with a 10 ton road roller with the addition of sufficient screenings until vehicles passing over it do not cause displacement.

Unless this work is thoroughly and conscientiously done, the foundation will not be of uniform strength throughout, and settlements will occur where the new stone was put. If it is necessary to scarify the road surface this should be done to the minimum possible depth, after which the surface should be built up exactly as if constructing a new macadam road and rolled until the utmost compaction is obtained. Wherever possible traffic should then be turned upon the road for a few months to develop any weak spots in it, and to secure still better compaction.

Old pavements of brick, granite, etc., should not be used as a base if it is first necessary to re-set them. In their original condition they are satisfactory if the traffic is not too heavy. Relaid blocks, until bedded by traffic, are not rigid, and have a tendency to rock ,and asphalt pavements laid on such foundations in New York City have rapidly disintegrated wherever they were exposed to heavy traffic.

Concrete foundations vary according to conditions from 4 to 9 inches in depth, and in every case before laying them the subsoil should be thoroughly compacted. In certain localities in the north-western portion of the U. S. and Canada very heavy clay soils are found, which in winter frequently develop cracks 4 to 5 inches in width, and heave very badly. In such cases cross trenches should be dug every twenty-five or thirty feet, and filled with coarse broken stone and connected with longitudinal trenches at the side of the street, similarly filled and draining to catch basins. Concrete should not be laid directly on such a soil. Sand or gravel should first be spread upon it to such a depth that when rolled it will form a layer 3 to 4 inches in thickness and the concrete should be placed on this.

The mineral aggregate constitutes from 75 to 90 per cent of the pavement, and takes practically all the wear resulting from traffic. It must therefore be selected with great care. It must be hard enough to carry the traffic; il must have clean grains or particles, and these grains or particles must be graded from coarse to fine so as to make a pavement of the maximum density, with the smallest sized voids obtainable and with sufficient inherent stability to resist displacement under the shoving action of traffic. The surfaces of the grains or particles must be of such a character that the bituminous cement will adhere satisfactorily to them. Sand, gravel, broken stone or slag, or combinations of them, are the materials used in the type of pavements under discussion.

Sand should be clean grained, hard and moderately sharp. The grains should be chiefly quartz and should have rough pitted surfaces. Where necessary the proper grading of the different sized grains must be obtained by mixing several sands or in certain cases by the addition of unweathered crusher screenings. When using the ordinary type of bituminous mixing plants the presence of clay is undesirable, either as a coating to the grains or disseminated throughout the mass. For medium or heavy traffic pavements all particles retained on a 10 mesh screen should be discarded. For light traffic, three to five percent of 8 mesh particles can be incorporated in the pavement with advantage or broken stone of the sizes and in the amounts described under "Topeka Mixture." Sands containing a large amount of flinty grains should be avoided.

Gravel should be clean grained, hard and free from adhering clayey particles. It is lacking in stability owing to its roundness and is usually considerably improved by passing it through a crusher. Gravel with a rough pitted surface is to be preferred and gravel containing a large percentage of flinty particles is to be avoided. It is unsuitable for the construction of pavements carrying heavy traffic and inferior in all respects to crushed stone.

Broken stone should be freshly crushed, preferably in cubical shaped particles. The size and hardness required depend upon the traffic which the pavement is to carry. Dense hard limestone will carry medium and light traffic satisfactorily. Where the traffic, even though comparatively light in volume, is composed of heavy iron-tired units, a dense hard trap is required. Trap is now commonly used in the manufacture of asphalt block, although in the past a large number of asphalt blocks made from limestone gave excellent service under light traffic. Granite is not usually satisfactory as it is too coarse and uneven in texture and much of it is friable and it is liable to shatter in crushing. Mesh composition or grading of the various sized particles is just as important as with sand. It is not suitable for use in pavements carrying very heavy traffic.

Slag: Hard, dense basic slag is to be preferred. It should be stable when exposed to the weather and not show any tendency to slack or disintegrate. It is only suitable for light traffic and should preferably be coated with a very fluid bitumen.

The filler should be finely ground limestone or Portland cment, the latter being preferable for mixture designated to carry extremely heavy traffic. For light traffic the speaker prefers the limestone dust as it does not have such a marked drying effect. Whichever is used, it should be ground so that at least 65 per cent of it will pass a 200 mesh sieve. Pulverized clay also makes an excellent filler but is difficult to handle owing to its tendency to ball and cake if it becomes the least bit damp.

The bituminous binder, or asphalt cement as it is termed in the sheet asphalt industry, must possess such properties that it will firmly bind together the mineral particles and resist the disintegrating action of trafic and the elements. The necessary tests for determining whether or not it is possessed of these properties are fairly well standardized and are embodied in most standard specifications. The time allotted to the speaker will not permit of a detailed discussion of them.

The plant used in the manufacture of the paving mixture is a very important element in the success of the pavement. A uniformly good mixture can not be turned out by an imperfect plant. The standard type of plant first developed in the sheet asphalt industry has for a long time been recognized as the best for the purpose. In it the sand or stone, or both, are heated in revolving driers and fed by means of elevators into a storage bin. The bituminous cement is heated in properly designed melting kettles.

Measured or weighed (preferably the latter) amounts of the various ingredients are then mixed together in a twin shaft mixer of the pugmill type. This mixer should have a speed of from 65 to 85 revolutions per minute and for ordinary work each batch should receive a full minute's mixing. Where the service conditions are very severe it may be necessary to increase the time allowed for mixing and also raise the temperature at which the mixing is done in order to insure a thorough coating of the surface of all particles with a firmly adherent film of bituminous cement. Great care must always be taken not to overheat either the mineral aggregate or the bituminous cement, as this will injure and harden the latter. Too low a heat will result in imperfect coating of the mineral particles. Certain asphalts are fluid at much lower temperatures than others and certain asphalts are very readily injured by overheat-

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ing while others are not. In the type of plant which we have been considering clay or clayey particles are objectionable owing to the fact that they either become partly baked on the grains of sand or pieces of stone or form into lumps which do not detach themselves or break up under action of the mixer blades. This prevents the bitumen from adhering to the grains or else results iln coating the outside only of the clay balls. Under traffic these balls break up and the bitumen becomes detached from the coated grains, tending toward more or less rapid deterioration of the pavement.

In certain types of plants the grains after heating are subjected to pulverisation which breaks up any clay balls which may have been formed and which cleans the sand grains or small stone particles. With this type of plant practically any desired amount of fine material may be produced from the mineral aggregate and clay, owing to its great absorbent power and affinity for bitumen, is a distinct advantage.

Plants of the concrete mixer type, in which the heating and mixing are done in one revolving chamber, are not to be recommended. As usually arranged, they are inefficient driers and very inefficient mixers and are liable to burn the bituminous cement if the flame is permitted to come in contact with it. The only way to avoid this source of danger is to heat the bitumen and the mineral aggregate separately and not to heat them in any way during the mixing process.

The construction of the bituminous portion of the pavement is not the same for all types. Where coarse aggregates are used, from two to three inches of the surface mixture are usually laid directly on the foundation. It is very difficult to completely close up such a mixture by rolling. It is usually therefore given a squeegee coat of hot bituminous cement after which stone chips are spread over the surface and rolled in, the excess being left to be ground away by traffic.

Topeka mixture pavements are laid from two to three inches thick and are frequently placed directly on the foundation. Much better results are obtained by using a binder course one and one half inches thick next to the foundation with a one and one half or two inches wearing surface. This greatly reduces the tendency of the finished pavement to shove. With a well graded mixture a squeegee coat is unnecssary although it is frequently employed.

The bitumen contents of coarse aggregate mixtures must be very closely watched and kept within much closer limits than are necessary with sheet asphalt mixtures. One half percent above or below normal is about the permissible variation. Too little bitumen will make a pavement which is too open and porous and too much bitumen will render the pavement very liable to shoving.

The standard sheet asphalt construction of the present day is one and one half inches of binder and one and one half inches of wearing surface. The binder should be of the "close" type; i.s., should contain approximately twenty-five percent of material passing an 8 mesh sieve.

A close binder properly made and laid will be superior in many respects to the mixtures which have been laid on a large number of country highways and will carry a fair amount of traffic for a considerable time without suffering any serious damage. Poor binder will break up very easily —sometimes it can be kicked up— and the hauling of the hot surface mixture over it will damage it very seriously. Surface mixture laid on a binder of this kind which has been badly broken up might almost as well be laid on loose broken stone and will not give satisfactory service under heavy traffic. The binder should, of course, be thoroughly compressed with a steam roller before laying the wearing surface on it. Lack of compression will produce an unsatisfactory foundation for the wearing surface, and binder which is too cold or made with too hard an asphalt cement or an unsufficient quantity of asphalt cement can not be properly compressed into a dense, tough mass. In hauling the binder to the street over long distances or in very cold weather, it may become chilled below the danger point. During the hauling process a certain amount of surplus asphalt cement usually drains off of the stone and accumulates on the bottom of the cart or wagon. If these excessively rich portions be laid on the street, what are called rich or fat spots in the binder course will be produced. As the name implies, these are places carrying an excess of asphalt cement. If these are permitted to remain, the surplus asphalt cement will be absorbed by the hot surface mixture when it is placed over them. This will make a soft spot in the finished pavement which will be displaced by traffic and eventually produce a hole or depression in the pavement. They should, therefore be cut out and replaced with normal binder.

Before laying the surface mixture on the finished binder course the latter should be dry and swept clean of dirt; otherwise the layer of wearing surface will not adhere properly to it. Binder should be covered with surface mixture as soon as practicable after laying it. In many large cities it is required that all binder laid should be covered the same day with surface mixture.

When delivered upon the street the surface mixture should be of such a temperature that it can be properly compressed and should be evenly spread by means of hot iron rakes. In many cases the loads of hot surface mixture are dumped directly upon the spot over which they are to be spread. This is bad practice as the men trample upon it while shovelling and raking it and the rakes do not thoroughly loosen up this trampled material when passing over and through it. Although the mixture is raked to a uniform surface and apparently even thickness before it is rolled, those portions which have been trampled on before and during raking are really covered with a greater quantity of surface mixture than those portions which have not been trampled on and which are covered wholly with what might be termed loose or fluffy mixture. When the roller has completed its work there will, therefore, be a slight uneveness in the finished surface. Under light traffic this would make no appreciable difference, but under very heavy traffic the slight pounding action resulting from this condition would be detrimental and lead to uneven wear of the pavement. Proper and thorough compression of the finished mixture is very essential as this produces a pavement which in its earliest stages is fit to sustain the heaviest traffic. It is always questionable whether portions which are very lacking in compression will be ground out or eventually consolidated. Under unfavorable conditions the chances are strongly in favor of their being ground out. In those portions of the pavement which are inaccessible to the roller, compression is effected by the use of hot smooothers or tampers, or both. If properly handled, the desired results will be obtained, but if used too hot they will burn the pavement and cause it to scale or grind out. Hot smoothers particularly are dangerous tools to put in the hands of incompetent or careless workmen.

Extreme care should be taken to insure a proper union between the surface laid on successive days. The first loads laid in the morning at the termination of the previous day's work should be a little hotter than normal so that the hot mixture may soften the cold edge of the pavement and bond perfectly to it. The joint should be bevelled and freshly cut away unless the rope joint or a similar method is employed.

The practice of painting the edge of the joint with hot asphalt cement is not to be recommended, as unless extreme care is exercised, too much asphalt cement will be used and that portion of the pavement will be too rich in bitumen and consequently softer than the rest, which will result in uneven wear and possibly shoving. Great care should be taken not to leave any hump or depression where the joint is made.

The following are typical analyses of the various types of pavements which have been discussed in this paper:

	Sheet Asphalt Heavy Traffic	Sheet Asphalt Light Traffic	Topeka Mixture	Bituminous Concrete
Bitumen	11.0%	10.5%	8.5%	7.0%
Passing 200 mesh.....	14.0	10.5	8.5	5.0
" 100 "	14.0	10.0	6.0	4.0
" 80 "	13.0	10.0	6.0	2.0
" 50 "	19.0	14.0	6.0	5.0
" 40 "	11.0	14.0	10.0	4.0
" 30 "	10.0	13.0	10.0	4.0
" 20 "	5.0	10.0	9.0	3.0
" 10 "	3.0	8.0	6.0	5.0
" 8 "	....	....	6.0	3.0
" 4 "	....	....	14.0	7.0
" 2 "	....	....	10.0	20.0
" ¾" "	....	....	....	14.0
" 1" "	....	....	....	12.0
" 1½" "	....	....	....	5.0
	100.0%	100.0%	100.0%	100.0%

DISCUSSION.

The Chairman, after thanking Mr. Smith, said that as the essence of a good roads congress was to endeavor as far as possible to get mutual ideas worked out, the papers were open for discussion, and Mr. Smith and all the other speakers were willing, in the event of their wishing to

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discuss any features that arose from the papers, to take the matter up with them.

Mr. Belanger: First. with reference to painting cuts, I don't know if you do it in New York, but the experience we have in Montreal is that, very often, we are required to repair cuts made by different companies. Would you recommend in these cases that painting should be done?

Mr. Smith: That would depend very much on the age of the pavement. If the pavement is an old one, has dried out and become very hard, it is impossible to soften that sufficiently to get a good and proper bond for your new mixture. If comparatively recent, and more especially if made in hot weather, I should recommend not painting the edges of thec ut, but laying adjacent to the new surface mixture, which was fully up to 325 degres Fahr., pulling that up a little above the edge of the cut, and back on the old pavement, leave it rest there a short time, and then pulling it back and working in with the rake, and you get a joint which will be a perfect one, and you don't run the danger of having a soft spot right at the juncture of the new and the old. It it very difficult to take hot asphalt paint in a pail and apply it with a brush or piece of stick. It usually results in a bit here and there, and is not satisfactory.

Mr. Belanger: In regard to grades on sheet asphalt. Do I understand by your paper, that you would recommend a higher grade than six per cent?

Mr. Smith: No, six per cent I regard as a feasible maximum, except under exceptional circumstances.

Mr. Belanger: But for the ordinary bituminum mixture you would recommend higher grade?

Mr. Smith: You can go higher.

Mr. Belanger: Do you think twelve per cent would be too much?

Mr. Smith: Twelve per cent is an excessive grade, if you have any amount of horse drawn traffic, for any kind of bituminous pavement. But where you approach a maximum grade, and your traffic is not heavy, you should make a mixture that is as coarse and as rough on the surface as possible.

Mr. Belanger: I want to thank Mr. Smith, the well-known New York expert, for his paper. Every one who has had anything to do with asphalt, knows Mr. Smith's name; and they know the name of his associate, Mr. Dow. The latter was employed for a long time by the city of Washington, for Washington is the pioneer asphalt city in America. Mr. Smith is consulting engineer in New York City, and we often see his reports on asphalt, and I can assure you, if you see a report signed by him or by his partner, Mr. Dow, you may be sure that yau can put the utmost reliance in it. Allow me to thank him again for his very clever paper, where he told us so many interesting things in such an impartial way.

Mr. Drinkwater, St. Lambert: Having in view the fact that recent prices for asphalt pavement laid on concrete have been very little above the actual cost of laying a well laid macadamised road, and having in view the possibilities of it being used in rural municipalities, do you think that corporations are comparatively secure in regard to their maintenance when the pavement is made to expert specification and with expert advice, with the usual ten per cent guarantee? Is it sufficient to cover any chance of any maintenance the municipality may be called upon to make? There are sometimes pavements laid by contractors who are not staple in their financial standing, and also sometimes we get spots on pavements which make us feel inclined to wonder if ten per cent is a sufficient guarantee.

Mr. Smith: There is no doubt about it that bituminous and asphaltic pavements, properly laid under proper specifications and proper inspection, have passed so far beyond the experimental stage that there should be no doubt in the minds of a municipality but what they were going to get value for their money, and not be subjected to undue maintenance cost or an undue amount of repairs, even if they are covered by guarantee. There are, of course, in every industry, the road building as in others, contractors who have taken up the business as a new business, who are not familiar with it, and whose only idea is to lay their yardage and get through as soon as they can, and do not realise the vital points that must be paid attention to in order to secure the successful laying and wearing of a pevement afterwards. But with proper specifications and supervision there should be no reason why any municipality should fear for the results they were to obtain.

Mr. Drinkwater: You stated that in certain kinds of mixtures the clay made an ideal filler, for I presume the sheet asphalt. Would that have reference to the National Paving?

Mr. Smith: The National Paving is of that type, and is practically the only one of that type developed up to the present time. Attempts have been made to use clay as a filler in sheet asphalt construction to a limited extent. The trouble has been that when the material was dry and pulverised sufficiently fine to act as a filler and then put in bags, that with the slightest dampness in the air the clay would absorb it, and tend to form in balls, and when it was in the mixed you would have balls of clay loosely adherent and only coated on the outside with bitumen. With the plants that are in use at the present day it is very difficult, if not impossible, to use clay. Recently changes have been made in certain types of machinery for manufacturing bituminous pavements, which, broadly, consists in the introduction of a pulveriser between the exit end of the hot sand drum or drier and the bin from which the materials are drawn directly into the mixer. If you take, with such a type of machinery, a sand containing clay, or a soil composed largely of clay, pass that through the drum, in its passage through the drum it balls up, and half-baked balls result. The action of the pulveriser reduces it to dust again, and that produces a mineral aggregate which more closely resembles the type of asphalt pavement which was first in the field, the French rock asphalt pavement. The French limestone rock of Paris, and the older cities in France, are composed of 200 and 100 mesh particles impregnated with a very fluid bitumin, and the wear that can be gotten from such a pavement is at least as good, and in a number of cases better, than you can obtain from the highest type of sheet asphalt pavement as manufactured under the previous methods and with the previous types of machinery, but you can regulate with great ease the percentage of fine material in your pavement, and in a number of cases it reduced its cost very much, because you can find or take almost any material available at or near the plant site for manufacturing your pavement, instead of, as in the case of many cities, having to haul their sand by rail over a hundred miles in order to get a suitable sand. Where the sand mixture is used the type of pavement produced by the new type of plant under discussion is very similar to that produced by the ordinary methods of sheet asphalt manufacture. Where clay or clay soil is used the type more closely resembles that of the French rock, although it is less slippery in this respect, that it does not polish under traffic. The limestone particles take a very high polish under traffic, and the pavement is less malleable than the pavement which is made with the clay base.

Mr. Cadieux, St. Hyacinthe: You have talked about the use of small grade machines with heating attachments, where it was dangerous that the flame would hurt the mixture. Do you absolutely condemn those machines when the stone is very well selected and the asphalt melted in a separate kettle and mixed after the flame was shut off, or the flame could not touch it?

Mr. Smith: That is a question which is a little difficult to answer, for this reason. I would be prepared to take a plant of that type and with what knowledge and experience I have collected through a good many years I could turn out a successful and reasonably uniform pavement. But to put that type of plant into the hands of the average contractor I consider one of the most dangerous practices that can be permitted. And another thing that makes it more dangerous to the man, is that the manufacturers of that type of plant have, unfortunately, advertised and spread the idea broadcast that with that type of plant you do not require as much skilled labor as you do with the other type. Whereas, as a matter of fact, in order to get good results, your labor must be more skilled and experienced than with the ordinary type. As a mixing plant with small aggregates the mixing effect with the revolving drum is nothing like as good as with the twin shaft pug mill type of mixer. Where you have stone to mix you get a better result than with sand, but the difficulty with mixers of that type is that it is difficult to get a good temperature of the stone in the mixing drum. It is difficult to get at it, and when you get at it it is difficult to obtain the temperature of broken stone of very large size. The thermometer does not come into sufficiently close contact with the large particles to give you the temperature, so there are many dangers attendant on that type of plant.

Handling and Care of Road Machinery

By E. FAFARD
Superintendent of Road Plants and Construction, P. Q.

The Department of Roads owns 57 complete macadamizing plants, besides a special plant for gravel and earth roads. These plants are placed at the disposal of municipalities, upon request. This allows municipalities, who do not wish to purchase a plant, to macadamize their roads without spending a considerable amount for the purchase of a road plant.

With each plant, the Department sends an instructor, whose duties consist in having the work done in accordance with the specifications. He must look after the plant, be in daily communication with the Department and make a weekly report, showing the work done during the week. He must show in detail what each man did, the length of the haul, the number of trips made by the carters, and the amount spent for labours for each of these operations. These reports are looked into and classified by a civil engineer. The instructor must also look after all purchases and repairs to the plant and tools. All purchases and repairs must be asked for, on special requisition forms signed by him, which are given to the merchants or to those making repairs. Such requisitions must correspond with the accounts which must be sent, each month, to the Department to be audited; otherwise, the accounts are refused. The instructor must also keep the Department posted on the state of the plant and of the repairs made or to be made. The advantage given to the municipality of either renting or borrowing the Government plants obliges the department to move many plants from one municipality to another, every year.

Repairs and Maintenance.

The method followed at present has been studied and modified, and gives entire satisfaction. We have a head machine-repairer, who formerly built plants and road machines, and he has with him another machine-repairer of experience. They each have a tool-box containing all the necessary tools to make the repairs on the spot. They also each have a portable smith's forge, because in most cases, the plants are far from villages and workshops. They also have the necessary utensils for melting metals, and casting babbitt bearings. The larger parts, which cannot be repaired on the spot, are sent to the Department's store of spare parts, which attends to the repairs to be made. The repairers work all season, following instructions of the Department, repairing road plants. They must go only where the Department orders them to go; they must report daily; every Saturday, they must, on a special form, report to the department for each day of the week, the use of their time, the places where they worked, the work done each day in each place, the distance covered daily, whether on a railroad or in a waggon; they must inform the Department, by telephone, on Wednesday of each week of the place where they are what they have done, and what remains to be done to the plant; they must telephone to the Department as soon as repairs are finished, so that they may receive instructions to go elsewhere. At the beginning of the season, before work is started, and in the fall after work is stopped, they are accompanied by four men who have experience in repairing. They are given an itinerary to repair the plants which have suffered the most damage, and to put them in good working order, because each in their turn, all these plants have to be examined and overhauled. The head machine-repairer, in the Fall, inspects the plants which he did not see during the summer, and reports to the Department the parts which will have to be repaired during the winter, and he, himself ships to the Department's store of spare parts, in Quebec, all the parts which will have to be repaired. Linen tags are attached to each part, and the number of the plant from which they come, is written in ink, as well as the name of the municipality. These tags remain attached, as much as possible, to the parts while they are being repaired; thus, there is no confusion in shipping the parts of the plants from which they were sent. At the end of the season, on a special form, the instructor must make a complete inventory of the machinery and spare parts which he has on hand. Moreover, he must explain in detail, for each machine, the repairs necessary, in order that should the head machine-repairer be unable to inspect all the machines, or should the plant be too far, or the travelling expenses are thought to be too high, the Department knows what repairs have to be made to each machine and to each plant. The spare parts which can be repaired are sent to the store. Before they arrive, a new part is shipped to the plant, and the Department only charges the municipality with the cost of repairs. This is very economical and also prevents work being stopped, very often, in the best part of the season. To obtain this result, we compel the instructor to telephone to the Department every time that the plant is in bad order and he is unable to repair it himself; it is his duty, before telephoning, to find out exactly the number of the part, if it should have no number, he must be able to describe it, give its size, etc., so that we may find it in and be sure of sending the right part. If he is unable to give the information above mentioned, he has to pay for the telephone or the telegram, and is liable to be dismissed, and this denotes on his part, carelesness or a lack of competence.

Our store of spare parts carries a stock of the parts most in use, as we know the parts which wear out the quickest and which are liable to break often: jaws, metals, packing, fittings, oil, etc., are specially chosen. The store has over $20,000.00 worth of stock. Three employees receive and ship goods. By means of a system of accounts, each part sent from the store, from the shop, or by the manufacturers, is charged to the plant which has asked for said parts. They must also keep a record of everything coming into the store, and deliver nothing unless they have a written order on a special requisition form from the office.

Shipping of Plants on Cars.

I will here briefly explain the instructions given to our instructors when it is necessary to ship a plant on cars, to another municipality. The first thing to do is to order the cars in advance, generally three flat cars. While waiting on the cars, all the machines, spare parts, etc., are taken to the station. When the time has come to load the machinery on the cars, first of all, the wheels of each car must be blocked very carefully, after which a strong platform is built long enough to facilitate the loading of the heavy machines. Too much care cannot be taken in the construction of this platform which will have to carry loads varying between 6,000 and 25,000 lbs. Besides the roller which goes on the platform under its own steam, the other machinery is hauled on the car by means of a tackle solidly attached to the car and to the machinery, and the cable is drawn by horses. While loading machinery, two men must follow the hind wheels of each machine with good blocks which they slide behind the wheels during all the time that the machinery is going up the platform. This precaution has certainly avoided serious accidents, both to men and to machinery; in fact, if the cable of the tackle should break when a machine weighing from 6,000 to 8,000 lbs. is on the top of the inclined platform, I will leave you to suppose what would happen if we did not take the necessary means to prevent its coming down. When all the parts are loaded on the cars, every wheel of all machines loaded on the cars must be solidly blocked. The best way is to place good blocks nailed solid on the floor of the car, in front, behind and on each silde of the wheels; special care must be taken for the bin on account of its great weight and the excess of weight it has on top. The same instructions apply to the unloading of the machinery.

Installation.

The first thing to do, is to look over the ground where the plant is to be placed, choose the driest spot, see to it that the water is not too far away and is abundant, not to place the crusher too far from the stone piles and quite a distance from buildings, on account of the danger by fire and the inconvenience from the dust and the noise of the machinery. To set the machinery in place, we have spruce deals from 10" to 12" square, which belong to the plant and are used for supporting the plant. These deals are much preferable to planks placed on top of each other.

First of all the ground must be levelled, the deals are set down and the portable engine placed on top of them. The machinery is all set plumb with a level, and in a straight line by means of a string. In order to avoid all trouble, it is wise to see that the machines are set plumb very often; that is to say that if they are not perfectly plumb, there will be trouble. When the machines are not plumb, this can easily be remedied to, by means of wooden wedges. Afterwards all the wheels must be blocked.

Care of Boilers.

For the care of the boilers of the portable engine and of the roller, we give the following instructions which are illustrated. As this is the most important part of the machinery, we insist upon having these instructions carried out to the letter, and the result obtained, since we have in-

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augurated this system, are surprising, in so far as repairs are concerned, and saving in the fuel. It is the instructor's duty to watch and also help in the washing and cleaning of the boilers every week. He must also be familiar with the working of the machines, he must help to cast babbitt bearings if necessary, help to tighten the bolts of the boiler, and to block all leaks through which steam is escaping. While the work is going on, he must be able to know if the machines are in good order by the noise they make; he must be familiar with the working of the pumps, of the injectors, etc.

The portable engine and steam roller engineers must have a certificate of competence; they must carry out to the letter, written instructions given them by the Department in reference to, besides the care of the boilers, the most economical way of heating the boilers (heating too quickly a boiler full of cold water would be sure to cause its destruction very quickly), that it has sufficient water, (that the provision be regular and constant), of the care of monometers, test at least once a day the safety valves, how to put out the fire should the water become low in the boiler, the care to be taken in emptying the boiler: that is to say, see that the fires are put out and not empty it by means of steam pressure.

The portable engine is always under shelter of a shed which can be taken to pieces, built large enough to be able to place in it, oil, straps, belts, spare parts, etc., This shed is also used as a shelter for the men during showers, but it is used especially in keeping the machines free from the dust coming from the crushing of the stones. This dust very rapidly damages the bearings and the shafts.

Steam Roller.

To keep a roller in good order, the roller engineer has more work to do than the portable engine engineer, because the roller is always going. He must specially look after the pipes of the boiler; if they leak, he is given by the Department a tube expander which enables him to repair them very quickly. He must, like the portable engine engineer, clean his machine every morning, while making steam, all the mechanical parts, the oilers, the grease cups, etc., see that the bolts are tightened, see that there is no part worn out, see that the exhaust which is in the smoke stack, is working well. This exhaust is sometimes blocked by rust and trouble results, but they look everywhere for it except there. He must look after the excentrics, pistons and packings. When the spikes are attached to the larger wheels of the roller, the instructor must not forget to remove the scrapers from the wheels. This is very often overlooked; then, the scrapers are broken and have to be replaced at great expense. The tubes of the boiler must be cleaned every day, A roller should never be placed in the hands of a man without experience. In changing speeds, it should not be done only when the roller is stopped; by proceeding in this manner, it will prevent the slide of the excentric from spreading.

The Stone-Crusher.

After having levelled off the ground, deals are set down, in exactly the same manner as for the locomotor. It is placed perfectly level. Owing to the vibration of this machine, it should be set down solid and be levelled very often. Under the bottom part of the elevator, a hole must be dug in the ground large enough to facilitate the removal of stones which might fall out of the buckets. It is preferable to surround this hole with wood so as to prevent the earth from sliding into it. This machine requires special attention, specially so far as oiling and greasing are concerned. The grease cups especially must be cleaned with gasoline, as this machine is always working in a cloud of dust from the stone crushed which makes the grease cups and oil-cans dirty very quickly, and prevents the oil and grease from reaching the bearings. The bearings of the connecting rod must be well connected with the crank and require to be renewed in a proper manner. The Department gives written instructions with plant and sketch, and all explanations about the way to do it (copy of instructions and plan, etc., hereto annexed).

When the crusher is in operation, the instructor must strictly forbid the men from using sledge-hammers on stones which are a little too big to go in between the jaws. It sometimes happens that by using these hammers, the jaws are broken or else the hammer drops in, between the jaws, which might cause the jaws to be broken or to break the frame of the crusher.

Elevator.

The elevator is a wooden frame attached to the bottom of the crusher and to the top of the bin. It supports a chain of buckets which carry the stone from the crusher to the screen which is operated by chains on a shaft above the bin. The chain which holds the buckets must be greased often with a special oil. If this is neglected it will wear out quickly and cut the teeth of the sprocket wheels. The grease cups on the bearings of the shaft of the screen must be cleaned and filled with oil every day as well as the teeth of the gears. The bin, like the other machines, must be set on deals, very plumb. The screen when in operation sorts out the different sizes of stone, according to the specifications. During that time all the stone and dust, in the screen, is mixed the same as in a concrete mixer. A large quantity of fine dust is taken up by the wind, and sometimes spoils neighbouring properties. To avoid this loss, a light frame is put up on top of the bin, and it is covered with cotton or linen. It is economical to build a large platform close to the crusher so as to enable the waggons to haul the stone up to a level with the opening of the crusher. This system reduces the cost of handling and does away with laborers to supply the stone crusher.

Sprinkler.

The sprinkler is used for carrying the water necessary for cementing the stones during the last operation of the construction of macadam. There is a pump attached to this waggon which is used to fill it when it is empty. As this work is long and tiresome, it is preferrable to have a gasoline engine, with a pump and tank. Moreover this is more economical. The tank is placed on a solid frame 6 or 7 feet high near that part of the road under construction and it is fed by means of a pipe which is attached or taken off whenever the gang goes further away. At the bottom of the tank, there is a connection with valve. This connection is three inches in diameter. With this system the sprinkling waggon is filled in a few minutes, and there is always enough water on the road to do good work, and the roller is never behind. A plant which is not organized to have plenty of water always does poor and expensive work. If there is plenty of water and it is close to the machines, it would be cheaper to take the pump off the sprinkler and put it on the locomotor; the latter, by means of wheels and straps can set it going and it will only be necessary to have a tank. We have adopted a new system for that part of the sprinkler which distributes the water. The old systems were too heavy and were subject to breaking often and the cost of repairs each time was very high. The new system is much ligter, cost much less and does not break. Iron wheels are replaced by wooden wheels; they are very much preferable. The gear of the front wheel is disposed in such a way that it can turn completely under the water tank. In this way the sprinkler can turn in a very limited space without destroying the macadam.

Road Machines.

With each plant there is a road machine which is drawn by horses; but it is used cheap and advantageously when attached to the steam roller. It is hard to find in municipalities three teams which can give the continued and regular effort required for this kind of work. With these machines the road can be put in form, the roadbed made, the shoulders bevelled and in some places, the ditches cleaned, much cheaper and quicker than with a shovel or an ordinary plough, and the work is done much better. It is necessary to have had experience to be able to use this machine, and we therefore recommend choosing a good man and always take the same man, so as to give him more experience, and he can render great services to the municipality, for the maintenance of their earth roads The department gives to municipalities instructions in how to make earth roads with the machine and illustrations showing how to use the split log drag which should be used after the road has been put in form with the machines. During the construction of the Levis-Jackman road, a split log drag was used to spread the gravel dumped from the waggons and to keep the form of the road which is being rolled. It was also used to advantage for the maintenance of the road which was divided into sections from 4 to 5 miles in length. A patrol sectionman was appointed to look after each section. When the Department deemed it advisable, after a rain storm especially, it gave instructions, by telephone to the patrol sectionman, to pass the split log drag over the section of which he was in charge; in this manner the drag was passed over the whole road on the same day. The superintendent would go over the road in an automobile, see that every one is on the job, etc. The instructions given by the Department to the patrolmen were to pass first on the side, close to the ditch, to level the shoulder, and on the second

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turn to pass the drag towards the center, so as to bring the loose gravel on the road towards the center. This caused the surface of the road to be kept very evenly, to fill in small ruts made by the wheels and the tracks by the horses ruts or holes, to facilitate drainage in rainy weather. The are scraped off, the latter not always passing in the same place the wear of the road is more evenly divided. Genarally, a gravel road well rolled and cemented is so hard that it is impossible for the drag to give it a crown when it has been broken up. In that case, the road machine must be used early in the spring; that is to say as the earth begins to thaw and before it hardens up. Despite the rolling, certain qualities of gravel take a long time to bind. In this case, the use of the drag is necessary, so as to keep the crown of the road until it is completely cemented. The patrolman must bring a shovel with him, and if he runs across a rut or a hole which the drag cannot fill, he must use his shovel to fill it. During the years 1914 and 1915 split log drags were used for the maintenance of the Levis-Jackman road. One man and two horses weighing 1300 lbs. each, can scrape, in one day, a section 4½ to 5 miles long.

The Department has already distributed to municipalities an illustrated circular showing how to build and how to use the split log drag (a copy of this circular is attached to this document).

On the road going to Valcartier, at the request of the Federal Government, in 1914, the Department had taken charge of the maintenance of a portion of the road, over a length of nearly 5 miles. The soil was composed of sand which it was impossible to bind and of the hardest variety for an earth road. After having put the road in form with the road machine, this road was kept in good order by using the split log drag, although there was a heavy traffic of automobiles, trucks and other vehicles. All the heavy artillery passed over this road to be loaded on steamers going across to Europe. I passed a few minutes after them, having met them taking down the heavy loads at a gallop, and the road was not in too bad a condition; there was at the most 5 or 6 ruts. Generally it is thought that when the drag has gone over the road once, that it has been repaired for the whole season. This is a serious error, because in order to obtain the best result, the drag must be used often, especially when the weather conditions are most favorable, that is to say after a rain storm, not when the earth is all wet and muddy, but just as it begins to dry and before it becomes hard.

Pick Plow.

The plant has also a pick plow. This plow is used to tear up the old macadam or to break up the ground.

Instructions for Casting on the Spot, Bearings for the Connecting Rod of the Henry Stone Crusher.

Cut a planed board very plumb, of hard and dry wood, corresponding to the measurements of the small plan (Fig. 1) and on this board, (fig. 1), attach a pivot of dry and hard wood, which you must have prepared in advance. This pivot must be turned in such a way that its diameter will be very regular; the diameter must be 1-64 of an inch larger than the crank-pin which is one of the crusher; attach it to the board as shown on the plan (fig. 2), making sure before sawing and planing it that the ends of the pivot are squared so that, when resting on the board, it will be very vertical. This pivot must be attached to the board as in fig. 2, by means of a long screw.

You will see that the covers on each side of the bearings of the connecting rod are planed. Use a file to remove all seams and dirt, if there is any. Roll some wire 3-16", crossways, around the pivot, as shown in figure 2. Place a wooden plug in the grease hole of the connecting rod and let it exceed slightly so that it will touch the crank pin; in this way, the canals for the oil will be made through the mouth and the grease hole will be made by casting babbitt through the plug in the connecting rod. Place the conecting rod on the board, as shown on fig. 3, leaving on side "F" a larger space, because the babbitt must be 1-16 of an inch thicker on the side of the connecting rod than on the side of the cover, on account of there being more pressure on the side of the connecting rod. Place on the block (1) at the end of the connecting rod, as shown in figure "4" on part "E" so that the planed part at the big end of the connecting rod will rest plumb on the board. Place the dry wooden strips 3-16 of an inch thick between joints "K' 'and "L" between the cover "H" and the connecting rod "F" wide enough so that they will touch the crank-pin. Tighten the bolts by hand only, and cast the babbitt not too hot so as not to burn the wood. After it has been cast, scrape the inside of it with a sharp blade or a file, on the side, and try to put it back in place of the crank pin; scrape until the adjustment is perfect after which put the connecting rod back in place in the crusher, making sure not to put anything but the liners, tin packing, and in sufficient quantity to allow the bolts to be put on, very tight, and so that the bearing will just touch the crank pin without tightening it. The adjustment of the bearings of the greasing shaft, at the smaller end of the connecting rod, must be done in the same way. Do not use other babbitt than the "Imperial", which you will obtain from the store of the Road Department, at Quebec. In carrying out these instructions, you will understand that it is an easy practical and quick way of casting bearings yourself. The board and wooden pivot which were used for this, should be handled with care, and should be kept in a very dry place. If you take care of them, you can use them during the whole year.

Care to be Given to the Interior of the Boiler of the Roller.

As it is the engineer's duty to know how the boiler of the roller of which he is in charge, is built, a sketch is added to the book of instructions, which you must study, as to know every part which it is necessary to clean and to keep free for the circulation of the water.

You should proceed in the following manner:

1.—Place the roller on a piece of dry road, raise the back part of it with a jack, block the boiler under the parts "A" which are the extension of the side of the boiler, just high enough to take off the big wheels; one inch high is sufficient. Take off the wheels and roll them backwards, so as to have the sides of the boiler perfectly free. This operation is not necessary for the locomotor.

2.—Take off the mud ports marked "B" on each side, not one or two, but four of them; take off also those at the ends, marked "C" as well as the plug marked "D". Take scrapers and place them in the mud ports "C" and scrape thoroughly the fire box marked "E", the top of the tubes marked "F", and everything that you can scrape off through the tubes, between "F" and "G" ;then, the bottom of the tubes marked "G", by the hole "D", and all that will have been taken off, will go down in the sides "H". To clean both sides and the top of the boiler, introduce pieces of wire into the four mud parts "B" or, what is better for this kind of work, strips of steel 3-8 or 1-2 inch by 1-32 inch thick, and use them in all directions shown by the arrows on the sketch. The earth and dirt must be taken out by these same mud ports "B". When you have done this several times, proceed with the washing beginning by the top, and be sure to pass the pieces of wire or strips of steel in all the mud ports and in every direction. Set the big wheels back in place and fill the boiler immediately. Pour into the boiler 1-4 of gallon of Crest Crown composition, which will be supplied to you by the Department. Make use of this composition every fortnight. Have the water boiling for two hours, put the fire out completely and when there are 10 lbs. steam pressure, then blow out the boiler in the ordinary way. Let the boiler cool off and fill it up again. The work of cleaning the boiler is now finished. By following this method you will obtain good results; the boilers will not be so overheated, which will prevent leaks and repairs resulting from a boiler not properly kept clean, and you will produce steam much easier, more quickly and you will use less fuel.

Every moring when water is boiling, it is advisable to blow through the "stop cock" during three or four seconds so that any accumulation will blow out.

Road Maintenance, Materials and Methods

by WILLIAM H. CONNELL,
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A good organization is essential, particularly in so far as maintenance is concerned, as it is practically impossible to continuously and systematically maintain pavements and roads in first class condition in an economical manner, without a good working organization built up along the lines best adapted to cope with the conditions involved in this important branch of work coming under the jurisdiction of a highway department. By this it is not intended to give the impression that the maintenance organization should be separated from the construction, as separate organizations are apt to result in an overlapping of jurisdiction and a tendency to shift responsibility, and open up a field for unlimited excuses, as to whether the construction or maintenance division is responsible for any unsatisfactory conditions that may arise relative to the pavements. Furthermore, it is obvious that the logical organization to maintain the pavements is the one that saw them laid and is familiar with every detail of the construction, as very often a knowledge of apparently trivial conditions in connection with the construction bears an important part in the future maintenance.

It is the intimate knowledge of the details of both construction and maintenance, not considered separately but in their relation to one another, that is so desirable as a future guide in highway engineering; consequently the combination of the two organizations in one will accomplish far better results than they would working more or less independently of one another, each with a limited responsibility. Highway engineering may be considered a specialty, but further specializing in construction and maintenance is not logical, as the two are dove-tailed and cannot be considered separately. Every engineer engaged in highway work appreciates the fact that there is no such thing as a permanent pavement for either city streets or country roads, consequently, in addition to the cost of construction, the maintenance repair charges during its life must be included in the final cost, and is a most important factor in the selection of a pavement.

The main and most perplexing problem of a highway department, no matter whether the department be a State, Municipal, County or Town Department, is, or eventually will be, that of maintenance. If a large percentage of the roads or pavements are constructed, which is usually the case, then the maintenance predominates, and in fact it is only in localities where there are practically no roads or pavements, that the maintenance is subordinated to the construction.

The activities coming under the jurisdiction of the Municipal and State Highway Departments are not similar in every respect, but the principal functions do not differ sufficiently to affect the problem in the main.

A large Municipal Department embracing street cleaning, collection and disposal of ashes, garbage and rubbish, and snow removal, together with the general problems, such as construction and maintenance of pavements, etc., embraces a greater variety of work than does a State Department, but principally of a nature that is essentially maintenance work. Likewise in a large State Department with an active organization controlling a large area of improved highways, the maintenance problem is more involved and complicated than in a County or State Department with a less mileage of pavements or roads under its care, so that the perplexity of the problem increases not only with the number and variety of activities, but with the area of the territory and the mileage of roads and pavements coming under the jurisdiction of the department. It is, of course, a much simpler matter to cope with this problem where the work involved is such that it can be controlled from a central office, without delegating the responsibility to divisions and subdivisions of the organization. This is especially true in maintenance work, as there is always a tendency among engineers to be lax in attention to details of an apparently simple and routine nature. They are apt to overlook the fact that it is no trick to construct a pavement, as in supervising this work they are simply following more or less standard, and well defined principles, where, in maintenance work, there is no set specification to follow, the success depending upon attention, to a certain degree, to daily routine and principally to petty details that present themselves in the actual physical work, and in this there is an unlimited field for initiative. Personal experience in observations of the wear and peculiarities of the different types of pavements and road surfaces is invaluable as a guide in research work, as there is not a pavement to-day that cannot and should not be improved upon. The difficulty of impressing upon the supervising force the importance of this close personal attention to detail in connection with the care of the pavements is probably the most important single factor in the operation of a large highway department, and must be reckoned with, and especially in these times when the public are becoming more and more exacting and virtually demanding that the roads and pavements be kept continuously in good repair. This should be obvious to all engineers in charge of highway organizations.

For convenience the different branches of maintenance work will be grouped under the following classifications:

1.—Routine Maintenance.
2.—General Maintenance.
3.—Emergency Maintenance.

Routine maintenance includes such work as the regular street cleaning in municipalities, and the cleaning of country roads and gutters, and any other work of this character that is more or less routine, and should be performed under a definite schedule. The streets in the thickly populated sections of the city should be cleaned every day; in less thickly populated sections, every other day; every third, and so on until we come to the country roads, which should be cleaned once a week, once every two weeks, and some only once a month, depending upon the amount and character of the traffic which largely governs the frequency with which the cleaning should be done. The amount and schedule of work and the force necessary to perform it can be determined upon in advance and carried on in a systematic manner under a regular organization, more or less military.

General maintenance includes repairs to streets and roads, and involves different characters of work, each requiring special knowledge on the part of those engaged in the actual performance of the physical work for which special gangs have to be organized. Stone block, wood block and brick repairs, for example, require skilled laborers who have made a specialty of this work, and are employed under the title of pavers and rammers; while repairs to asphalt and bituminous pavements must be performed by men specially trained in this line of work, in addition to the necessary force engaged at the mixing plants. Macadam road repairs, the care of earth roads, the bituminous surface treatments, also require men specially trained, and while it is desirable to train the gangs for each particular branch of this work, such, for example, as bituminous macadam built by the penetration method, waterbound macadam, bituminous surface treatments, and the care of earth roads, the three classifications, namely:

1.—Block pavement repairs.
2.—Bituminous pavement repairs (mixing method), sheet asphalt, bituminous concrete, etc.,
3.—Country roads, macadam, gravel, etc.; bituminous surface treatments, and earth road repairs,

represent the three branches into which the organization is usually divided. Further sub-divisions can be handled by those directly in charge of the different classes of work coming under these divisions by training the laborers for the particular character of work to which they are assigned.

This illustrates the difficulty of handling the work coming under the heading of general maintenance, which not only requires separate organizations made up of men specially trained in the different branches of the work, but the character and amount of the work itself is of such an indefinite quantity that it is very hard to control, and, furthermore, can only be performed in seasons of the year when weather conditions are suitable, all of which tends to make it difficult to maintain a good working organization, as is always the case when men are not regularly employed all year round.

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The principal element leading to success in this work is the application of the theory that "a stitch in time saves nine." This not only applies to the patching of different characters of pavements, but to bituminous surface treatments, particularly when the treatment only consists of a paint-coat lightly covered with washed gravel or chips, which is only intended to last for a year or two. Very often when a treatment is required on a road, and the performance of the work is postponed for a couple of weeks, the road will deteriorate and require resurfacing, so that it not only necessitates a more or less flexible organization for the actual performance of the work, but a very thorough study of the probable amount of material required, which should be purchased sufficiently in advance to avoid any delay in furnishing the material. This requires in addition to an efficient overhead organization, composed of engineers well versed in the art of carrying on the work, a thoroughly systematized procedure suited to bring about the best results under the conditions to be met.

The third classification, or Emergency Maintenance, consists of such work as snow removal and taking care of extensive washouts, both of which require an emergency force, as work of this character must be performed at once, and necessitates putting on an indefinite number of men, depending upon the volume of work, usually for only a short period of time. This makes it necessary for the organization to keep in touch with all available sources where men can be employed on short notice.

These are some of the reasons why the maintenance problem is the most difficult one in a highway department. Construction work, in the first place, is usually carried on under contract, and all the cares and troubles relative to the labor situation are up to the contractor, the department requires the contractor to perform a specific piece of work under definite conditions, and is only charged with the inspection, and the responsibility of seeing that it is performed in accordance with the requirements of the specifications. While, in the maintenance work the burden of the responsibility is up to the officials of the department not only in so far as the character of the work is concerned, but for the control of the organizations engaged in its performance.

The details of the different characters of repair work including the methods and materials used are, of course, very important, but nothing like as important as the length of time that elapses between the origination of the necessity for the repairs and the performance of the work. Repairs should be made as soon as the defects, no matter how slight, present themselves, and not weeks afterward. The secret of success in highway work is continuous and systematic maintenance. The upkeep is the real problem. The highways should be patrolled every week, and oftener if necessary, and all defects reported and repairs made at once.

The general methods employed to maintain a system of highways in good condition are the patrol method and the gang method. The patrol method usually consists in having a man with a team and the repair equipment patrol, and be responsible for making repairs to a certain, definite length of highway. The gang method consists in sufficient gangs being employed, equipped with all the materials to make repairs where ordered, the difference between the two methods being that in the first method the man who makes the repairs also patrols the highways, while the gang method is dependent upon the reporting of defects being made by special patrolmen, who may be inspectors, engineers, etc. There is some difference of opinion as to the better method, but it would seem that the reporting of the necessity for repairs by a special patrol inspector and the making of these repairs by a specially trained gang would be the better method. A detailed description of the methods of making repairs to the various types of roads and pavements would constitute quite a voluminous document. Consequently, it will only be possible to discuss the fundamental principles.

Dirt roads should be well crowned and drained. The shoulders should be kept clear, and the drainage ditches open. Road drags and road scrapers must also be used from time to time in order to keep dirt roads in good condition. An application of about a 20 Beaume gravity road oil once a year will not only lay the dust, but will help to compact the road surface under travel and form a sort of crust.

Gravel and waterbound macadam roads should be well crowned, well drained, and the shoulders and drainage ditches kept clear. The most effective method of maintaining gravel and macadam roads is through the use of bituminous surface treatments. The method and type of treatment used, however, will depend upon whether it is to be used for a gravel or macadam road, and the character of gravel and stone used in the construction of the respective types of roads. On other classes of roads and pavements, such as bituminous pavements by the mixing and penetration methods, cement, concrete brick and stone block pavements, it is also important to keep the roads well drained, the shoulders clear, and the drains and ditches open. The methods of bituminous surface treatments used on the city of Philadelphia suburban and country macadam and dirt roads are as follows:

The suburban and country streets and roads receive bituminous surface treatments of the character best suited to the respective roads, which are selected only after making a study of the type of construction, the traffic and social and local conditions in each instance. Generally speaking, two methods of treatment are used on the roads. For convenience they are divided, first, into bituminous surface treatments, intended to eliminate the dust nuisance and preserve the roads, and secondly a cheaper method of bituminous surface treatment, used simply for the purpose of laying the dust on macadam, cinder and dirt roads, and not intended to preserve the road to any great extent.

The first method of treatment is used only on macadam roads that have been put in good condition, as it is a waste of money to put a high class bituminous surface treatment on a road that is full of ruts and pot holes, and not properly shaped up. The bituminous materials used in the city of Philadelphia consist of coal tar treatment, hot application, known as Tarvia A., coal tar treatment, cold application, known as Tarvia B, water gas tar treatment, hot application, known as Ugite No. 2, water gas tar treatment, cold application, known as Ugite No. 1, and asphalt cut-back treatments which consist of a mixture of 60 to 65 per cent of 80 to 100 penetration asphalt, conforming to specifications adopted by the Association for Standardizing Paving Specifications at Pittsburgh in 1913, and 35 to 40 per cent of 53 to 60 commercial naptha. All of these materials are applied in quantities just sufficient to paint the road and to avoid possibilities of building up a pad. In other words, the purpose is simply to have a film coat of bituminous material on the surface of the road and to re-treat the road as often as is necessary to maintain the film cost, and in this way eliminate the pushing and rolling under traffic, which occurs with bituminous pads.

The method of applying these bituminous materials, when the road is in proper condition to receive such a treatment and the material to be used on the respective roads has been selected, is as follows: The roads are first lightly sprinkled with water and then swept with a horse-drawn broom. They are then swept with hand brooms until the surfaces of the stone are free from dust. This sweeping, however, should not be done in such a manner that the stone dust or binder will be removed from between the stones. The bituminous material is then applied with a pressure distributor at a certain rate per gallon, which varies on different roads, depending upon their condition, and also whether it be a first, second or third treatment. The bituminous material is then allowed to remain on the road for about twelve hours, or over night, after which fine washed gravel—

Passing ½-inch screen .. .. 100 per cent.
Passing No. 4 Screen .. .. 50 to 60 per cent.
Passing No. 6 Screen .. .. 20 to 30 per cent.
Passing No. 10 Screen, not over.....10 per cent.

is spread over the road at the rate of 13 to 18 pounds to the square yard, depending upon the amount of bituminous material applied. In some cases clean trap rock chips passing a ⅝-inch ring and maintained on a ⅛-inch ring are used.

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The theory of using fine washed gravel in place of stone chips is two-fold; first, to provide a covering that will not grind up and pulverize before the bituminous material has set up, and thus incorporate with it and build up a pad, such as is the case with the stone chips as they pulverize very quickly under any appreciable amount of traffic; second, it only contains 10 per cent of the fine sand and the pebbles constituting the rest of the material are so hard that they do not grind up and pulverize for from three weeks to two months, depending upon the traffic. The process of pulverizing is so slow that the fine material is washed off the road after each rain, thus doing away with the necessity of sweeping the road to eliminate the dust, which is necessary where stone chips are used.

These treatments last for a year and have proved to be not only the most economical method of preserving roads of this character, but the cost is less than the cost of sprinkling with water, provided the roads are sprinkled three times a day and this, by the way, is not sufficient to lay the dust, and, of course, it must also be understood that the sprinkling with water will not preserve the roads under automobile traffic.

The second class of treatment generally used consists of asphaltic road oil from 18 deg. to 23 deg. Beaume gravity. This material is applied to all of the macadam roads that are not in fit condition for the first-class bituminous surface treatment, and to all dirt roads, and is applied at the rate of 2-10 to ¼ gallon to the square yard. On some roads, depending upon the amount of traffic and whether or not the road is shaded, it is necessary to treat the road in May and treat it again in September. Such roads, however, are the exception. In most cases this method of treatment will last for one season. The roads as a rule are not swept before the application, nor is any covering put over this bituminous material, as it is applied in such small quantities that there is scarcely any necessity for covering. The purpose in putting on this small quantity is to insure its disappearing from the road before the winter sets in, in order to avoid the mushy condition that prevails when there is too much oil on the road in this season of the year.

The paint coat method of tar bituminous surface treatments on first-class macadam roads has been a success for seven or eight years in this country, and it has also been used to a very great extent for a number of years in England.

The asphalt cut-back paint coat treatments are somewhat new, and have been largely developed in Philadelphia during the last four years. The successful results in Philadelphia have led to its use in other localities in the east this year, notably by the Highway Department of the State of Pennsylvania, where a large mileage of roads have been treated using this method.

The asphalt cut-back bituminous surface treatment, was evolved through research work carried on with a view to finding some way to utilize an asphalt in the paint coat method of treatment which had been so successful with the tars. In order to do this, it was necessary to use a comparatively stiff asphalt so that it would set up quickly on the road. This necessitated cutting back an asphalt of about 100 per cent penetration with from 35 to 40 per cent: of naptha. The purpose of the naptha is to make the material of such a consistency that it can be applied to the road when it is moderately warm. In other words, the naptha simply acts as a carrying agent, and after it has done its work, it evaporates and leaves the paint coat of asphalt on the road.

This material has proved to be a success under a four-year test, retreating, of course, every year or two, or as often as is necessary, as is also the case with the tars.

The methods of bituminous treatments described, however, are not applicable to all conditions. The roads treated must be built of comparatively hard stone, and the traffic conditions must be taken into consideration.

The method of bituminous surface treatment described for macadam roads built of hard stone and in good condition can also be used on gravel roads constructed of materials similar to what is commonly called Poughkeepsie gravel, which consists of large and small sized stones with fine gravel for a binder. Where the gravel is composed of any appreciable amount of clay, this method of treatment would not give very satisfactory results. The dust layer referred to, however, would benefit such roads to a considerable extent. In discussing these bituminous surface treatments it will be noted that great stress has been laid on a paint coat or film coat to be renewed each year or so, or as often as necessary. The object of this paint coat or film coat is to avoid the formation of a pad, but where the road is built of soft stone that would naturally be affected more by traffic than would the hard stone, this point coat or film coat would not be satisfactory. In such cases, it would be necessary to use a larger amount of bituminous material and build up a ⅜ to ½ inch pad. It is practically impossible to give any general description for bituminous surface treatment work that will apply to all conditions, but there is no road that cannot be benefited by the application of bituminous surface treatments. It is, however, very important that all the details of the cleaning, etc., previously described, should be given very careful attention, and the roads should be re-treated before they have gone into a condition of bad repair. After these re-treatments have been applied, that does not mean that they will not require any attention until the following year. Some roads, of course, will not require any attention until the time for the re-treatment, but a great many of the roads where the traffic is heavy will require patching all through the winter. The methods used in patching these bituminous surface treated roads in Philadelphia are as follows: Where the surface treatment has worn off in spots and there is likelihood of a pot-hole forming, the road is painted with tar used for cold treatments or asphalt cut-back, depending upon the character of material the road was originally treated with, and chips or gravel spread over the area of the surface that has been painted. Where pot holes have formed a mixture of ¾-inch stones and a heavy tar somewhat similar to Tarvia A or an asphalt of about 100 penetration is placed in the hole and tamped, and dry gravel or chips spread over the surface. This can be done by heating the tar or asphalt on the road and mixing it with the stone, but a more effective and better way to handle this kind of patching is to make up a mixture of the tar and stone, and asphalt and stone and place it at different locations along the line of the system of highways. By the use of a suitable mixture of asphalt or tar cut back with naptha, it is possible to prepare large quantities of patching material which will not set up so that it cannot be rehandled and used for repair work during the winter, without the necessity of reheating. This is known and the cold mixing method of patching bituminous macadam and bituminous surface treated roads. Such materials as Amiesite and Bicomac are also adapted for winter patching, and have given very satisfactory results. The main point that should be, and has been, brought out in connection with repairs to roads and pavements of all descriptions is to make the repairs promptly when there is the slightest indication of the necessity for repairs, and thus avoid pot holes in the country roads and necessity for making extensive repairs to roads and pavements of all descriptions. The table on page 258 gives the detailed costs of the materials and labor and unit cost per sq. yd. in connection with the bituminous surface treatment work in the city of Philadelphia.

Now that you are building a large mileage of highways in Canada, it will not be long before your maintenance problem predominate as it will be looming up larger each year, and you have a splendid opportunity to avail yourself of the experience gained by the failures in other localities where there has been a great deal of highway construction. In conclusion, it will not be an unfair statement to say that the failures in highway construction have been very much exaggerated. The troubel has been principally, however, the failure to maintain the roads and pavements after their having been constructed.

Cost of Maintaining New York State Highways

By Deputy Commissioner Fred W. Sarr, New York State Highway Department.

Upon receiving your kind invitation to be with you today and address you on the subject of highways, I was at first reluctant to accept same owing to the voluminous and important work which has been before the Commission during the past few months. In finally accepting, however, I did so with the idea in mind of addressing you on the subject of the maintenance and repair of improved highways in the State of New York, which end of highway engineering in that State, I am at present associated with.

The proposition of maintenance of improved highways in New York State is an enormous one, practically ninety millions of dollars having been spent by the State for the construction of roads in the past seventeen years, and yet with this huge expenditure, the experience gained and the system now in force, the maintenance of highways, even in our great State, is, I might say, still in its infancy. The evolution in the kind of traffic to which our roads are subjected, particularly the adoption of the use of motor trucks carrying very heavy loads, and the general increased traffic necessitates a continuous study of individual cases.

General maintenance is comprised of keeping the paved roadway surfaces in as nearly uniform condition as possible, due regard being had for the relative importance of each particular road and the character of traffic it bears; keeping the earth shoulders smooth and safe for traffic; the drainage system free from obstructions; all structures in good repair and removing obstacles to vision, as brush or overhanging branches.

If the work of maintenance of improved highways is consistently performed throughout successive years, it is certain that the efficient life of such roads will be lengthened, and it would appear as though it could be prolonged almost indefinitely, if year by year the material added to the paved surface be equal or a little in excess of the material which has worn away during the same interval of time. This applies to the macadam type of construction which constitutes the vast bulk of the mileage under maintenance.

Maintenance should commence when construction leaves off, because in order to effectively and economically maintain improved roads it is necessary that the roadway be in a good state of repair at the time the maintenance work begins.

As an illustration of the magnitude of highway construction and maintenance in New York State, there were on April 1, 1915, 5,345 miles of improved and accepted state and county highways, and this mileage was increased as the season advanced, and on December 31, 1915, there were 5,926 miles of improved and accepted highways which has been maintained and repaired.

The following is a summary of the maintenance and repair work performed during the past season, including sums obligated on uncompleted contracts:

276 miles of highway resurfaced or reconstructed at an average cost of approximately $5,471 per mile; total expenditures and obligations under this item	$1,510,112
2,086 miles of highway given a surface treatment of bituminous material and cover of sand, fine gravel, iron ore tailings or fine crushed stone, at an average cost of $419 per mile; total expenditure and obligations under this item	874,137
728 patrolmen employed in the work of maintenance and minor repairs, at a total cost for labor	403,047
Expended for material and temporary labor in making miscellaneous repairs and supplying material to patrolmen for maintenance	998,462
Expended for rentals of large units of repair equipment	58,135
Expended for purchase of equipment and tools	31,958
Expended for engineering, supervision, inspection and expenses incidental thereto	334,724
Total amount expended and obligated for all purposes, approximately	$4,210,575

The State Highway Law, or our authority, provides for the maintenance and repair of improved highways either by contract or departmental forces, and all work which can be properly anticipated and foreseen, is incorporated into contracts which are awarded to the lowest responsible bidder, and emergency work and work of a minor nature, particularly such repairs as cannot be definitely measured or expressed in contract units, is performed by departmental forces.

During our past working season there were 230 maintenance contracts prepared, advertised and awarded to the lowest responsible bidder for a sum aggregating $2,271,566.59, or 61 per cent of the total amount expended.

There was expended directly by the department for materials, labor, rental and purchase of equipment and tools, the sum of $1,604,285.

A study of the experience of our Maintenance Department in maintaining and repairing highways during the past year indicated that the expenditures are divided into three groups:

First. Maintenance, or the act of maintaining and preserving the various features of the highway in the same or uniform condition; the cost of such maintenance of all the improved highways of all types was approximately $350 per mile, which involves the cost of the patrol system and the material used by the patrolmen, together with the cost of the surface treaements with bituminous materials and cover and supervision.

Second. Repair, or the act of restoring the highway to its former condition after more or less extensive deterioration during the winter season with the contingent freezing, thawing, unstable foundation, obstructed drainage, floods, washouts, sliding banks, etc., and that the cost of such emergency repairs was approximately $140 per mile for roads of all types.

Third. Reconstruction and resurfacing. While on many of the improved highways it appears possible, with efficient maintenance, to preserve a standard of improvement from year to year, there are those that show marked deterioration in spite of efforts at maintenance and extensive repairs from time to time. This deterioration is generally due to peculiar traffic conditions, combined with unsuitable materials used in the original improvements, and is often the result of insufficient foundation material in the roadbed.

The total amount expended and obligated for all purposes in the year will average $750 per mile when distributed over the entire mileage of improved highways.

This statement is misleading in that a large percentage of the total improved mileage is of recent construction.

The first highways improved by the State under the Higbie-Armstrong Act were completed in 1899, and in thirteen years, or to the end of 1911, there had been completed and accepted but about 2,600 miles, while in the last four years there have been completed and accepted 3,226 miles. In other words, 55 per cent of the improved mileage has been constructed an average of two years, while the 45 per cent has been improved an average of ten years.

Assuming that no pavements should require resurfacing for a period of four years after construction, it is necessary to eliminate the 3,226 miles which have been improved during the past four years from the consideration of the cost per mile for resurfacing and reconstruction. Therefore, the total expenditure for this subdivision of the work should be distributed only on such mileage as has been constructed or improved for a period of four years, and when so distributed the cost per mile for this subdivision during the past year is approximately $560 per mile.

It would seem, however, that the average life of a pavement after reconstruction would be greater than that of the first improvement, as foundational weakness that has developed would be provided for in the reconstruction. Also the maintenance and repairs for the first five years after the original improvement are greatly increased by heavy items which are properly chargeable to improvement, and are really a completion of the improvement, such as removal of slides from banks which have been cut into at the time of improvement; the construction of retaining walls to sustain such banks, and for the pro-

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tection of the highway from the erosion of streams. Also the drainage conditions, as provided in the original improvement, are often the subject of much complaint from the abutting owners and necessitate modifications and construction of storm water sewers, all of which develop and are taken care of in the first few years, after the original improvement. It can, therefore, reasonably be expected that the cost of maintenance repairs and reconstructions will decrease in some proportion to the age of the improvement and that the high cost of $560 per mile for resurfacing and reconstruction, when applied to all the improved highways would never be attained, and that the reduction in the item of repair would offset the increase in reconstruction as the improvements increased in age owing to the gradual elimination of weakness, together with the effect of efficient maintenance.

It would accordingly seem by this manner of reasoning that the improved State and county highways of all types could be perpetually maintained for about $750 per mile.

Our expenditures for the past have been segregated into groups to determine the expense of maintaining the roads of various types, the expenditures in each instance being charged to the type in which the highway was classed at the beginning of the season or before reconstruction.

There were under maintenance during the season 192 miles of gravel roads, upon which the average expenditure, including reconstruction to a different type, was $955 per mile, and the average expenditure, exclusive of reconstruction, was $577 per mile. Gravel roads, while most susceptible to deterioration under heavy traffic, are most easily and readily repaired. Said repairs are generally accomplished by scraping and honing in the spring and the addition of new material from gravel banks in the vicinity.

Surface treatments have been given to gravel roads, but are not generally satisfactory where any considerable traffic prevails. The treated gravel surface is soon converted into longitudinal ruts and ridges by displacement, and this condition is not as easily repaired after the surface has been treated. Where medium to heavy traffic prevails it appears preferable to lay a new macadam surface over the existing gravel, and this practice for the past season results in the heavy expense for reconstruction of this type.

There were under maintenance during the past season 2,298 miles of so-called waterbound macadam highways, upon which the average expenditure, including resurfacing and reconstruction, was $1,055 per mile, and the average expenditure, exclusive of resurfacing and reconstruction, was $564 per mile.

The expenditures on this type of pavement are larger than on any other type, both for maintenance and reconstruction. This is partially due to the fact that the average age of this type is greater than that of any other type. The maintenance is more expensive owing to the necessity of more frequent surface treatments and to the necessity for constant patching. The large charge for resurfacing is due to the large number of miles of pavement resurfaced, and not to the cost per pile of the highways thus treated.

There were under maintenance during the past season 2,387 miles of bituminous macadam penetration method pavement, upon which the average expenditure, including resurfacing and reconstruction, was $510 per mile, and the average expenditure, exclusive of resurfacing and reconstruction, was $448 per mile. A much larger percentage of this type of macadam is located on the main trunk lines than that of the waterbound macadam and, in general, the motor vehicle traffic over this type is very much larger, in spite of which fact the maintenance is less than for the waterbound macadam pavement.

Of the bituminous macadam mixing method type, there were 63 miles under maintenance during the past season, upon which the average expenditure for maintenance was $181 per mile.

The expenditures on highways of this type during the past season have, in general,, been for labor on the shoulders and gutters and other work outside of the pavement proper, although in a few instances it was necessary to do considerable patching to the pavement, but, in general, little or no repairs were required to the pavements.

The most unsatisfactory type of pavement, from the maintenance standpoint, is that of concrete bituminous type, and the construction of this type has been abandoned by our state.

The body of this pavement is formed of a low grade of cement concrete which was given a light surface treatment of bituminous material and fine stone chips at the time of construction. This thin surface treatment does not adhere to the concrete, is readily removed by traffic, which then wears into the concrete, necessitating frequent and constant patching. Numerous experiments have been tried out with surface treatment of varying depths, and the concensus of opinion of those who have endeavored to maintain this class of pavement is that any surfacing to be satisfactory must be thick enough to have stability in itself and not less than two inches in depth.

There were under maintenance during the past season 295 miles of this type of pavement, and the average expenditure, including new surfaces, was $1,050 per mile, and the average expenditure, exclusive of resurfacing, was $532 per mile.

There were under maintenance during the past season 84 miles of first-class concrete pavement, and the average expenditure on highways of this class wac $129 per mile.

These pavements are of recent construction, the average age being one year, and the expenditures were nearly all for labor and materials on the shoulders and gutters, a small expenditure only being required on the pavement for filling the frost cracks with pitch.

From the limited experience in the maintenance of this type of pavement, it would seem that an expression in regard to the efficiency of the type should be reserved for at least another year.

Under the heading of "Block Pavement" have been grouped the expenditures for all brick, stone block and asphalt block pavements.

There were under maintenance during the past season 291 miles of these types of pavements, and there was an average expenditure on highways of this type of $190 per mile, including the reconstruction of one section about one-third of a mile in extent, and the expenditure for maintenance was $176 per mile.

This expenditure is, perhaps, about evenly divided between the pavement and the shoulders. The expense of the maintenance of the shoulders is much heavier with the rigid pavements, such as concrete and block, than with the macadam types. This is due to the smooth, rigid edge which catches and holds the traffic parallel thereto for short distances, similar to the effect of street car rails. A rut is soon formed along the edge of the pavement which is generally filled with crushed stone, increasing the cost of shoulder maintenance.

On the older brick pavements there has been expended a considerable amount during the past season for taking u pand relaying small areas that have broken down. In the western section of the state, wherein is located the greatest mileage of brick pavement, some 102 miles, the average cost of maintenance of this type was $245 per mile.

Summarizing the mileage and the average expenditure for maintenance, repair and construction per mile per year for each of the different types, we have:

193 miles of gravel roads cost $955 per mile.
2,298 miles of waterbound macadam roads cost $1,055 per mile.
2,387 miles of bituminous macadam, penetration method roads cost $510 per mile.
63 miles of bituminous macadam, mixing method roads, cost $181 per mile.
295 miles of concrete bituminous roads cost $1,050 per mile.
84 miles of first class concrete roads cost $129 per mile.
291 miles of block pavement roads cost $190 per mile.
5,611 miles of all types cost $750 per mile.

A review of the above summary would indicate that the various types could be grouped in three classes, namely, low, medium and high maintenance types, and when so grouped we have 438 miles of low maintenance type, including bituminous macadam, mixing method, first-class concrete and block pavement, upon which the average expenditure for maintenance was but $177 per mile per year; 2,387 miles of medium maintenance type, including bituminous macadam, penetration method, upon which the average expenditure was $510 per mile per year; 2,786 miles of high maintenance type, including gravel, waterbound macadam and concrete bituminous, upon which the average expenditure was $1,059 per mile per year.

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If the low and medium maintenance types are grouped in one class, we have slightl yover half the improved highways upon which the expenditure for maintenance is about $440 per mile per year, and slightly under one-half the total mileage upon which the expenditure for maintenance and repairs was $1,060 per mile per year.

It is contended that with the present system of maintenance in many cases the life of a pavement may be extended indefinitely. The method referred to is that of treating the surface of the pavement with a light application of asphaltic oil or refined tar, and a cover of fine crushed stone, sand or gravel. This treatment consists of spraying on the surface of the pavement about one-quarter of a gallon of oil or tar and covering the same with from ten to fifteen pounds of cover material per square yard of pavement. These materials are worked and kneaded into the existing pavement by the traffic, and most efficiently by rubber tire traffic, and results in filling up the small interstices between the larger fragments of the existing pavement and increasing the thickness of the pavement from an eighth to a quarter of an inch. This increase in thickness should more than offset the constant wearing away of the surface by th abrasion caused by the pounding of the iron-shod feet of the horses and the iront-ire vehicles. The repetition of this treatment from year to year will gradually increase the thickness of the existing pavement. The ideal condition being where this treatment approximately maintains the pavement at its original thickness, as it has been found that where the treatment has been too heavy or too frequently applied and the oil and stone mat is built up to a greater thickness than one-half inch, it is liable to creep and become displaced by traffic, particularly in hot weather.

The experience in our state would indicate that a waterbound macadam pavement under the average condition of two years, after construction, then perhaps the treatment rubber-tire traffic, should be treated once each year for may be omitted the third year, and in subsequent years treatment is required two years out of three.

With the penetration type of bituminous macadam, a surface treatment is not generally required until the second or third year after improvement, and thereafter a treatment every second or third year. The advantage of this type of treatment is the ability to thereby incorporate a thin layer of new material with the existing pavement at a minimum cost and restore, at more or less frequent intervals, the part which has been worn away by traffic.

The most efficient material seems to be one that carries 65 to 70 percentum of bitumen or pitch and which can be applied in a spray under pressure at a temperature of from 80 to 100 degrees F. This grade of material is sufficiently liquid for several days after being applied that it may be worked and kneaded into the porous surface of the pavement by the rubber-tire traffic.

A heavier material that requires heating to a temperature higher than 130 degrees F. in order that it may be applied, cools after application and before receiving traffic, and assumes a consistency of rubber gum, and while it may be united with the stone chips by rolling, it cannot be as thoroughly worked into the body of the pavement, and simply lies on the surface as a mat which shifts around under traffic and is worked into waves and hollows. An example of the principle is the painting and varnishing of wood surfaces. A thin paint or varnish is applied and is worked into the pores of the wood by brushing and rubbing and a more desirable and permanent surface is obtained than by using a heavier or thicker varnish applied by pouring the same on the wood surface. The varnish being so heavy it is necessary to heat the material to make it sufficiently liquid to be poured over the surface. No one would expect such a finish to a hard wood floor to be very desirable or lasting. The floor could be opened to use very much quicker, but permanent results. This would not be expected. This simile is set—— an explanation for the necessity of the disagreeable condition of the road surface for a few days after the bituminous rteatment is applied, during which period the traffic is working and kneading the more or less liquid material into the existing pavement.

There is also the necessity for the use of the light material in the subsequent treatments in that the light carrier oils soften the hardened material of the former treatments and allow new material to unite and combine therewith.

The best results are also obtained where the least amount of cover material permissible, is used. This can best be explained by comparing the bituminous material to portland cement when used with sand in mortar. A surplus of sand weakens the cementing qualities of the cement. The same results are obtained by using a surplus quantity of sand to cover the application sufficiently to eliminate the disagreeable condition of the freshly-treated pavement. Where the pavement is not open requiring a filler for the interstices and where previous treatments have been given, better results will be obtained where no cover is used, but a freshly-treated surface with no cover is dangerous to fast-moving vehicles and such treatment is seldom resorted to in the country districts.

While the best results with surface treatments are obtained with a semi-liquid bituminous product and a minimum amount of cover, the disagreeable features of this treatment from a traffic standpoint have been given serious consideration, and changes have been made in the specifications for surface treatments, which it is hoped will materially reduce the period during which the treated surface is objectionable from a traffic standpoint.

The light surface treatment with bituminous material and cover does not appear to be suited to pavements where horse-drawn iron-tire traffic largely predominates. The iron-tire traffic appears to grind the bituminous material with the mineral aggregate and keep the surface roughened and loosened, allowing the volatile oils to more readily evaporate. The bituminous material then loses its adhesive qualities, and is ultimately ground to dust and is washed or blown away.

The bituminous mat tends to make the surface waterproof, and as the moisture in the macadam leaches away through the foundation and not being renewed from the surface the so-called waterbound macadam is no longer waterbound and is simply dustbound and is ready to be loosened by traffic in any spot wheer theb ituminous surface mat is worn through and it is necessary to either provide a heavy mat or constant patching of the areas where the mat has worn through. The tendency is therefore with the waterbound type to give a general treatment more often than should be necessary, which results in building up a heavy mat which finally creeps and displaces under traffic in hot weather, and it is then necessary to remove the entire mat and start over with the light surface treatments.

With the bituminous bound macadam this precaution is not as necessary. While the bituminous carpet sheds off the surface water and the madacam dries out, the individual fragments are bound together with a bituminous material and are not susceptible to the loosening effect of traffic as they are in the dried out, waterbound type. The results being that a much thinner bituminous surface can be maintained without constant patching, which results in less frequent treatments being required, and the expense of maintenance of the surface by light bituminout treatments on bituminous bound macadam roads is not much over half of that for waterbound roads.

The bituminous macadam, however, being of a more plastic nature, is more easily displaced by swift moving traffic, resulting in transverse waves developing in the body of the macadam, and are not as pleasing to ride over as the more rigid waterbound.

With reference to the cost figures submitted herewith, while they are the result of but one year's experience, it would seem that the large mileage represented would make the data of some value, this can be better appreciated when it is stated that the improved highways of New York, if laid down in a continuous line, would provide an improved highway from Boston to San Francisco, and from Maine to Florida, and thence to New Orleans.

With reference to the cost as expressed in units of miles, I would state that the standard width of pavement on our state and county highways is 16 feet with earth shoulders of four to eight feet on each side of the pavement.

Referring to any statements which I have made which are contradictory to those of some of the other speakers, I wish to qualify my statements to the effect that they are simply the opinion of the speaker as gained by the observation of the maintenance of some 5,600 miles of improved highways.

As can readily be seen from the above data, the problem of maintenance has not as yet been mastered, but I believe, however, that the assembling in Congress and conventions of this character, of men engaged in road work, where a free discussion of experience and ideas is permissible, will tend to and eventually be resultant in perfecting to a very large extent, the matter of road construction and the maintenance of same, and finally reducing it to a practical and economical basis.

The Attitude of Legislature to the Good Roads Movement

(A. C. EMMETT, Sec. Manitoba Motor League.)

The session on Wednesday morning was presided over by L. R. Howland, of Toronto, in the unavoidable absence of O. Hezzelwood.

Paper read by A. C. Emmett, Secretary, Winnipeg Automobile Club, on "The legislative aspect regarding road construction."

The attitude of the Provincial Legislatures toward the important question of road building, is becoming more favorable as the economic value of good roads in the development of our great Dominion is better realized. The Province of Quebec is to be especially congratulated on the wide awake policy that has been adopted by the Provincial Government, and which is being so successfully carried out.

For many years the granting of aid from the Provincial Treasuries toward the construction of good roads was of the most meagre character, and it is only in recent years that the Provincial Governments have passed Good Roads Acts under which the various municipalities can obtain substantial grants toward the carrying out of a definite and well defined plan of road improvement in the country districts.

Under the present Good Roads Act of the Province of Manitoba, the government on petition from a province gives a grant of fifty per cent of the total cost of construction of all roads of a permanent character, including all bridges, culverts, drainage, etc., necessary to place the highway in perfect condition.

No provision is, however, made for after maintenance, and this to me would appear to be a weak spot in the Act, as unless roads are properly maintained, the money expended in their construction is to all intents and purposes wasted, and there should be a provision in the Act, compelling municipalities to make some provision for after maintenance for a period of time equal to that of the bonds which are issued in payment of the construction work, such bonds being guaranteed by the Government.

The present system of road construction throughout the entire Dominion, is not one that is conducive to the best results being obtained, as the work is generally carried out by the municipal councils, who although interested in the construction of good roads, have not the expert knowledge necessary to see that the best results are being obtained from the expenditure of the ratepayers' money. In order to remedy this state of affairs, it would appear that the system of road building would be improved by the placing of all the main highways throughout the Dominion, under the charge of the Dominion Government, whose engineers should construct the roads, take care of the maintenance and the cost of the work be borne from the consolidated revenues of the Dominion.

The second class main roads should come under the control of the Provincial Governments, who would be responsible for their construction and maintenance, and the cost covered from the consolidated revenues of the Province, or in a similar manner to that provided for under Section 20 of the Road Laws of the Province of Quebec, by which the Government may construct or reconstruct roads connecting central points of importance and levy the cost on a mileage basis on municipalities benefited.

The third class of road would come under the heading of Municipal Roads and would consist of the local market roads and feeders forming the connecting links between the main highways. The cost of such municipal roads would come under the present system of construction and maintenance by local taxation.

The encouragement of Split Log Drag competitions throughout the Province will also be found of the greatest benefit to the good roads movement. In the Province of Manitoba, a Split Log Drag competition has been carried on for several years past by the Manitoba Good Roads Association, and has been so successful that the government has decided to help along the movement this year by a special grant towards the cost of the work. Such a grant will probably take the form of a percentage on the number of miles kept by each municipality under the dragging competition, which will commence with the spring break up and last until freeze up. By extending the competition in this manner it will ensure the roads being left in good condition for the winter which, as everyone will agree, is a most desirable condition, as the smoothness of a road when winter sets in, guarantees it being in good condition for shedding the surface water when the spring break up comes.

The Split Log Drag competitions conducted by the Manitoba Good Roads Association are governed by rules which have been carefully thought out and are the result of several years experience gained in the conduct of previous competitions.

The competition is divided into two classes, gravel roads and dirt roads. With the gravel roads competitors have to enter one mile and for dirt roads two miles.

When all the entries have been received and tabulated, the secretary sends out cards bearing the words "Competition Stretch Split Log Drag Contest, Manitoba Good Roads Association." These cards have to be placed at half mile intervals and kept in position by the competitor throughout the competition for the purpose of drawing attention to the work being done and allowing comparisons to be made by the general public on the road condition during the contest.

Score cards are also issued to each competitor and a duplicate set provided for the use of the judges who commence their duties by making a first inspection of the road before the work is commenced and follow this with a second examination when the competition period is about midway and a final inspection during the last two weeks.

These cards provide space for marking conditions at each inspection and allowing points according to a fixed scale for condition of road, contour, provision of good shoulder for drainage, cutting of weeds at side, etc.

The municipalities in which competition stretches are situated, make their own arrangements for payment to competitors for actual work done and the competitors are encouraged to carry out the work in the best possible manner by the provision of prizes by the Good Roads Association. Such prizes, in the province of Manitoba, are $100 in cash and a silver challenge shield for the first prize winner in the gravel class, $50 cash, and a special prize for second man and $20 cash for third man.

The winner in the dirt class receives $100 cash and is entitled to hold the beautiful "Banfield" Challenge Trophy until such time as he loses it to another competitor. The second man receives $50 cash and a prize of goods, and the third man $20 and an extra prize. Special prizes for extra good work and consolation prizes are also provided by local merchants.

The period of time over which the competition is in progress, lasts from June 1 to October 31, or until the roads freeze up and further work is prevented.

In order to cover the province thoroughly, it is divided into Good Roads Districts in each of which individual competitions are carried on and judged by local men or judges from other localities who may be willing to volunteer their services. Such districts may consist of a single municipality or a combination of two or three municipalities and the latter arrangement is recommended as providing disinterested judges to cover the districts by interchange between the municipalities.

The Provincial Government is this year assisting the Split Log Drag movement by giving a grant toward the cost of the work based on mileage so that the municipality having a large mileage in the competition is assisted to a greater extent than those which only enter a few miles.

Owing to changes necessary by the extension of the competition period this year it is not possible at the present time to give absolutely definite particulars regarding the work, but the details given will provide a general outline of the methods adopted in carrying on the annual Split Log Drag competitions in Manitoba.

It may be said that it is almost impossible to get work done on the roads when the farmers are busy harvesting their crop or hauling grain to the elevators, but this only makes a strong argument for the suggested revision of our road system, as, if the farmer cannot be depended on to do the work when it is most necessary and of the greatest benefit to the agricultural communities, then the work should be done by means that will assure a continuance of work at all times.

I do not wish to offer any suggestions as to the best way of bringing about such a radical change as I have suggested, as there are many delegates to this conference who are more fitted to deal with this question than I am, and I simply desire to see this question discussed by the Congress with a view to improvement of our present road system, which if only considered from the viewpoint of military necessity, should receive the attention of the Dominion Government as far as the main highways are concerned.

In conclusion I would thank the officers of the convention for affording me the opportunity of placing these suggestions before you, and trust that the Congress will meet with the success which such a laudable object deserves.

Gravelled Roads

GABRIEL HENRY, Chief Engineer of Highways, P.Q.

The nature of the top course to be adopted for a road depends, more than anything else, upon the traffic which it is destined to accommodate. It is useless to insist upon this fact, so well established by experience and now so generally admitted.

The cost of top courses varies according to their qualities and powers of resistance, and the more solid and durable they are made, the more expensive, as a general rule, they are. In cities, it is usual to employ a series of paving having the greatest powers of resistance and of duration but which are too expensive for the country districts.

On the trunk roads connecting the different cities and forming the country's principal arteries of circulation, resort is had to pavings or top courses of concrete, brick, bituminous macadam, water-bound macadam with or without a bituminous carpet. The choice of these different top courses depends upon the nature and the importance of the existing and future traffic, as far as the latter can be forseen. These top courses are also all of them relatively costly and require careful maintenance. They are only used where absolutely necessary. But outside of the cities and of the trunk roads there are a number of less important roads. The total length of these latter is generally much greater than that of the principal arteries above mentioned. They are really local roads, connecting different villages and giving communication with these villages and with railway stations, factories and trunk roads to the farmers scattered throughout the country districts. The traffic on these roads is much less important than on the trunk roads and in the cities, and from the economical point of view costly top courses are not to be recommended for them.

They are generally known under the name of earth roads, gravelled roads and—the most important of them—stone or macadamized roads, according to the nature of the top courses employed.

When the soil is of good quality and gravelly, they are maintained as earth roads. But when there is good gravel, as frequently happens, it is sometimes preferable to make use of it. And it is the utilization of this gravel for improving earth roads, that we are now about to consider. Even when stone is abundant it may be advantageous in some cases to prefer gravel, provided of course that the volume of traffic does not exceed certain limits.

It is necessary to remark however that this refers only to good earth roads covered with a top course of bank's run gravel and not what is generally called gravel macadam roads. The gravel macadam is constructed like ordinary macadam, but with certain special precautions.

As this lecture treats only of ordinary gravelled roads, macadam will not be dealt with.

Surface Drainage and Underground Drains.

One of the advantages of well constructed gravelled roads is that they can be made to serve later as foundations for a more costly top course and one of greater resistance, if traffic increases and if circumstances demand it. This fact is worthy of special attention.

Just as gravelled roads may serve as foundations for water-bound macadam or for a top course of still greater resistance, so earth roads serve as a base for gravelled roads. That is to say that in order to construct a gravelled road it is first necessary to establish a good earth road; in other words to prepare first of all a suitable substruction.

Before gravelling a road and when all the principal earthworks have been made and the road straightened, the curves improved and the bridges and culverts constructed it is necessary to be assured:

1st—of a perfect drainage of surface water.

2nd—of a suitable drainage of subterranean waters.

These two conditions are indispensable for any road no matter what covering may be chosen for it.

To attain this end, it is necessary:

1st—To create a complete system of ditches so as to rapidly drain the water from the heaviest rains and from the melting of the snow in the spring. The grade of the different ditches of this system, their dimensions and their form, should be such that no stagnant water remains a few hours after rain and that this rapid drainage causes no erosion at any point.

2nd—To inspect all places where subterranean waters soak into the sub-soil and remain there, and to drain them off by means of subterranean drains emptying into the ditches or by other means; to lower the highest level to which water rises and remains in the substructure of the road, to at least twelve or eighteen inches below the surface of the road before it is gravelled.

There are many means of obtaining this result, but the study of these means does not enter into the program of this lecture.

The large earth works, the bridges and culverts, ditches and drains once completed, the levelling of the surface and slope of the road should be proceeded with. A large part of this work may be advantageously done with the road machine.

If a steam roller or horse roller can be obtained for this purpose it may be employed to consolidate the surface of the road and to ascertain that there remain no soft spots or places not properly drained.

It must be remarked here that it takes some time for the drains to give the expected result.. In certain soils it is sometimes necessary to wait many months before the effect is felt.

If by means of the roller, soft damp spots are found, they must be drained and hardened before the gravel is laid.

It is as necessary to insist on this question of surface and subterranean drainage for gravelled roads as it is for earth roads and even more so. Just as an earth road may be called upon to receive a covering of gravel or other top course so a gravelled road may later be called upon to bear a covering of macadam. It is therefore necessary that this covering should be protected from accidents caused by the lack of resistance of the substructure without its being necessary to proceed, before laying said covering with preliminary works of consolidation which should have been made at the time of the first improvement of the earth road or at the time of the placing of the gravel.

Yet a covering of gravel placed on a solid substructure costs very much less for maintenance than another covering on a damp and badly prepared ground.

Laying The Gravel Covering.

There are two principal ways of laying the gravel.

1st—Covering the entire width of the road between the ditches with one layer. Then it is given a fixed thickness in the centre which gradually diminishes towards the sides where it is reduced to one or two inches.

2nd—Spreading a layer of gravel over the centre of the road for a determined width (ten, twelve or sixteen feet for example according to the importance of the road) with earthern shoulders three to four feet wide at each side to keep the gravel in place. In this case the thickness of the layer is uniform over all its width or only slightly deeper in the middle, and the roadbed may be crowned from a half to three quarters of an inch per foot.

In this second method a slight layer of gravel may also extend over the shoulders allowing it to spread as far as the ditches. This gives the road a better appearance, makes the shoulders more practicable for vehicles and prevents the growth of weeds, facilitating also the maintenance of the roads and also the surface drainage of rains from the centre of the road towards the ditches. In the first method it is also a good thing to give a slight crown to the substructure before placing the gravel.

For heavy traffic the system with trenches is best.

The system without trenches which is not quite so costly is generally employed for light traffic.

The average thickness of the layer of gravel depends upon the resistance of the soil and upon the importance of the traffic.

A good gravel on good solid ground may be reduced to an average thickness of four or five inches measured after settlement. In the case of grounds with less power of resistance the gravel may be as thick as twelve inches or more. The spreading of the gravel on the road may be done by first dumping it in heaps close together, which may then be spread with shovels, rakes or a horse scraper.

Pebbles exceeding two inches in size are carefully raked ahead of the gravel, so that they will be spread on the bottom of the trench and be overlaid by the gravel, in such a manner that when the road is completed none will be found within three inches of the surface. Roads so gravelled may be rolled with a steam or horse roller if it can be easily procured. The rolling accelerates the settling of the road, and it consolidates more quickly under the influence of traffic.

An energetic harrowing of the layer of gravel before rolling acts in the same manner and is to be recommended.

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When gravel is very sandy it may be laid in two layers by interlacing between the two a third layer of half an inch to an inch of clay, marl or earth. The whole is carefully harrowed and then rolled.

The dry rolling of a bed of gravel, is generally difficult, especially if the roller is heavy. If water can be had it is preferable to sprinkle the layer of gravel before rolling.

When the road has been completely crowned it should have a crown of an inch to an inch and a half per foot. If the crowming is left to traffic it is necessary to give a little more crowning when laying the gravel, two inches per foot for instance, because vehicles have the tendency to push gravel towards the sides. If a gravel road is not rolled at once it will take season or two to completely settle and harden and sometimes more according to the quality of the gravel and of the soil and the nature of the traffic. During this time it is frequently necessary to employ the split log drag to fill in the ruts, to level the surface and to re-establish the crown until the road is completely consolidated.

Gravelling on Stone Foundation.

When stone of good quality and of moderate size, say 4" to 6", is plentiful in the fields, and when it is difficult to advantageously procure good gravel, a foundation of stone may be interlaced between the bed of gravel and the prepared surface of the road. When the traffic is light and moderate this system gives good results and will prove a good foundation for future macadam. It is economical and permits municipalities to await the development of traffic before going to the expense of water bound macadam or of other more costly top courses, while enjoying meanwhile the advantages of a good gravel road.

Qualities of Gravel.

The gravel to be employed should not contain too large a proportion of sand, 20% to 25% is sufficient. Sand is here understood to be that part of the gravel which will pass through a screen of a quarter inch mesh. Is should not be too earthy. The little pebbles of which it is composed should be hard and of good quality.

Certain gravels contain too large a proportion of sand or earth. In this case, it is necessary to resort to screening not leaving any more sand or earth than can be avoided, or else to employ a much heavier layer of the gravel than usual.

In this last case the rain transforms the sand and earth into mud which may be got rid off by the frequent use of the split log drag, and through the drying up of the mud into dust which is gradually scattered by the wind or scraped or swept from the road. At the end of one or two seasons there remains upon the surface of the road a layer of small, hard and well cemented pebbles.

Some gravels contain a certain proportion of very soft pebbles which crush under the wheels of vehicles. When the proportion of them is large the result is the same as in the two preceding cases. Between these extremes occur all the intermediaries. All gravel which contains soft pebbles should be completely rejected. It is not worth its transportation even for short distances.

Certain gravels bind with difficulty; others easily. Quartz gravel from the beds of rivers belonging to the first category. However, some silicions gravels coming from banks outside of water courses bind well with time, notwithstanding their freedom from earthy matter,. The same thing naturally applies to those containing a certain proportion of such matter.

Some river gravel and some unwashed sandy gravel, which contain a proportion of soft pebbles, often bind very well. These soft pebbles, crushing under the wheels of vehicles, help to cement the union.

When a hard gravel does not bind well, a certain portion of clay or marl or limestone dust may be employed by incorporating it with the layer by the use of the harrow or by other economical means. This use of clay or earthy matters with the gravel has been severely criticised, but I believe that this criticism referred to gravel macadam only and not to banks run gravelled roads.

It is not the same thing in regard to economical roads in which we are interested here. The average distance that it pays to transport gravel depends upon its quality. First quality gravel, which makes a well-resisting wearing surface without too much loss is worth hauling three miles. For poorer qualities this distance must be reduced. Sandy and earthy gravel for example, requiring screening or an increased thickness of covering, which adds to its cost, belongs to this category.

The cost of labor and of horses have also an influence on the minimum haul, to be adopted.

Each case should be studied separately and it is impossible to give general rules.

The Employment of Oiled and Other Bituminous Products on Gravel Coverings.

To give more resistance to gravel coverings and to render them more suitable for soft tires, oils and other bituminous products have been tried, spread hot or cold as the case may be, on "Banks run" gravel coverings like those which we have been considering. In this province at least the results have not as yet been sufficiently satisfactory and there is little probability that they will ever be for this category of gravel coverings.

It is not a question here of course of gravel macadam coverings for which this oiling may be recommended.

Maintenance of Gravel Roads.

The permanent part of gravel roads, that is to say the ditches, the drains, the foundations when there are any, the slopes of the fills and excavations the bridges and culverts are to be maintained in the same manner as in the case of all other roads. They should have the same care.

The covering is kept in repair by use of the split log drag which must often be used especially during the first years to fill in the ruts, to level the surface and to re-establish the crown. The split log drag is used as it is in the case of earth roads, and preferably after rain. When for one reason or another depressions occur, it is necessary to add some gravel where these depressions are only due to uneven settling or to irregular wear. In these two cases the road machine may also be employed to put the surface in good condition again. But if the depressions are caused by humidity of the soil it is necessary to resort to subterranean drainage.

When the covering becomes thin and commences to break up from long usage it is necessary to recover it with a sufficient layer of gravel to support traffic without injury.

Coverings constructed with hard gravel of good quality will last a long time without the addition of new material, but those which are constructed with sandy or earthy gravel wear more quickly and require more frequent additions.

Resume and Conclusions.

Coverings of unscreened gravel are a special type.

They must not be confounded with macadam or gravel coverings, that is to say with those made of screened gravel. They may be utilized in a large measure, and very economically, to improve earth roads, at the same time diminishing the cost of their maintenance.

They are very suitable for local roads where the traffic is not very important.

Made with or without a stone foundation, when they are well built and well kept, they may themselves serve later as foundations for more costly coverings, thus permitting municipalities to await the increase of traffic on certain of their roads before resorting to macadam which is more costly, and have the benefit in the meanwhile of a good rolling surface.

The gravels of which they are composed are unscreened gravel, generally of little value from the viewpoint of the composition of top coures of great resistance. It is therefore important to submit them to as little manipulation as possible.

All attempts to work these materials, or to complicate the employment of them for the purpose of adding to the resisting power of the surface which they are destined to form generally add to the cost of these top courses of unscreened gravel in such a proportion, that it would be better to resort to water bound macadam composed of screened gravel or of broken stone, with a bituminous carpet or bituminous macadam or concrete, but in doing so we depart from the type which we are considering and of which the first characteristic is its economy.

The maintenance of these coverings is very easy and inexpensive. It does not call for the use of costly machines or special labour. The materials are close at hand. However, they support an active automobile traffic badly, they are generally dusty in dry weather, and if the scraping of them is neglected they become muddy in wet weather. Oils and other bituminous applications do not suit them unless the unscreened gravel of which they are composed is of the very best quality. They are suitable only for local roads. In the Province of Quebec they have so far given good results. The government recommends their use everywhere where they may be successfully employed. In view of the results already obtained the government

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has established a branch in the roads department which is specially occupied with these roads.

Some municipalities having first decided to employ waterbound macadam and having with the aid of the inspectors of this branch discovered beds of gravel, have afterwards changed their mind and substituted with great economy, gravelling to macadamizing.

In a general manner these roads may play an important part in the improvement of the roadways of the country.

DEPARTMENT OF ROADS.

Province of Quebec

Letter sent out to rural municipalities.

MAINTENANCE OF GRAVELLED ROADS

Dear Sir,

The by-laws adopted by our corporation to order the construction of gravelled roads contain a clause providing for their maintenance. In order to facilitate the putting into execution of this obligation, we give here below certain directions to be followed for the maintenance of gravelled roads. (The same directions apply to the maintenance of earth roads).

The ditches, pipes and culverts must be kept in good order, in such a manner as to insure a complete and easy flowing of the rain waters and especially of the water resulting from the melting of the snow, in spring time.

Pipe sand Culverts.—All mud that is liable to accumulate in the pipes and culverts shall be removed.

Ditches.—Stones and earth that fall into the ditches through the caving in of their side slopes shall be removed so that they will not incumber the ditches.

Shoulders.—The shoulders should be mown and they shall never be higher than the edge of the gravel proper, in order that all water falling in the road can run off directly into the ditches. These shoulders shall always have a sufficient slope.

Caving in of side slopes.—All caving in that occurs in the side slopes of the ditches shall be immediately repaired and the side slopes must always be kept in good shape.

Discharges.—All the discharges from the ditches shall be kept in good order, otherwise the water running in the ditches cannot find an outlet.

Draining of Subgrade. In all wet spots where it is found necessary to underdrain the road with transversal drains of dry stone, with concrete or clay pipes, it shall be done. The foregoing refer to the road bed.

Organic Matters.—As regards the gravel proper, care must be taken not to throw on its surface organic matters such as sod, roots, etc.: all such material deteriorates the gravel.

Split Log Drag.—During the summer time, the split log drag must be run over the road now and then in order to fill in the ruts and maintain the crown of the road. When running over the road with the split log drag, it is obligatory to always begin by the sides in such a manner as to draw the gravel to the middle of the road.

It is absolutely necessary to have a split log drag for the maintenance of gravel and earth roads.

Specifications for the Construction of a Split Log Drag.

To construct a split log drag, select a light and sound wood. Spruce or cedar is excellent. Do not use hickory ash or oak if any other wood is available; they are entirely too heavy. The most important quality of a split log drag is lightness. The sketch attached hereto indicates the form and dimensions of such a drag. This drag is made of a round cedar post not over ten inches through. The cutting steel of the front slab at the ditch end shall have a length comprised between three and a half and four feet. With steel running the full length of the slab, the drag develops a tendency to ridge the centre of the road over much and will be found entirely too heavy for the average team and with such a length of steel it is very difficult to correctly shape a road. The half part of the front slab at the ditch end only shall scrape the surface of the road. The other half of the front slab is pushing the earth towards the centre of the road and in order to attain this result, center line of the drag shall make with the centre line of the road an appropriate angle. In each special case the experience indicates the best angle to be adopted. The object of the rear slab is to fill the ruts, the holes and depressions and to level and harden the surface of the ground. It shall not be shoed with steel. This object is also to keep the plan of the split log drag parallel to the surface of the road. That is, the ditch been supposed at the left side (see the sketch) if the right end of the front slab meets a depression the rear slab shall prevent this right end to thrust into it. It is the reason why the rear slab shall be longer, as indicated by the sketch.

The lower edge of this slab shall not be sharp but on the contrary shall be two inches or more thick as indicated. The steel bar used to shoe the front slab shall be three inches wide and one quarter of an inch thick.

A hole shall be bored close to the ditch end of the front slab. An eye bolt shall not be used and, at the other end, the chain shall be attached to the cross stake. The drag shall be safely and completely covered with a platform which shall present no opening wide enough for the foot. Such openings are dangerous when the drag meets a boulder or a stump.

The front and rear slab are framed by using cross bars having a diameter of two and a half inches. The distance between the two slabs shall be two and a half feet. The cross bars and the slabs shall be framed together as firmly as possible, using hard wood edges well driven. With such a slab, use a chain fourteen feet long with links made of three eights inch wire.

Each municipality should have a certain umber of these split log drags along each road. They can be put in care of the farmers and left at the disposal of those who will be named to use them.

Reloading.—When the depth of the gravel course becomes too thin, the road must be resurfaced, that is the road shall be recovered with a new course of gravel to a depth varying with circumstances. The road shall never be allowed to lose its normal crown of one inch to the foot when rolled.

Hills.—On the hills, a more pronounced crown shall be given, and that in proportion to the incline.

When the Split Log Drag shall be Used.—The most favourable time to use the split log drag is after a rain storm, when the ground begins to dry. However, if there happens to be too long a spell of dry weather, the split log drag shall be used all the same.

Wide Tires.—It must not be forgotten that the use of wide rimmed wheels diminishes the cost of maintenance to a great extent.

How To Use a Split Log Drag.

1.—The drag must be placed on the road at an angle of about 45° or, at such an angle as will permit to carry, towards the center of the road, a small quantity of dirt or gravel so as to fill up the ruts and the rolls.

2.—Keep the team at the ordinary pace; a greater speed is useless.

3.—Stand on the drag. Loading the drag with stone and walking along side of the drag will give a poor result. The best result will be obtained if the teamster changes his place quickly, accordingly to circumstances for instance, to fill up a hole or to scrape off a greater thickness, or to increase or decrease the quantity of dirt or gravel to be deposited in the center of the road.

4.—First, scrape one side of the road, at the edge, close to the ditch; continue the same way on one whole section, and then, take the opposite side going up towards the centre.

5.—See that a little dirt or gravel be carried to the center of the road, in order that such center be 10" or 12" higher than the edges and that the crown be maintained.

6.—Should too great a quantity of dirt or gravel be scraped off by the blade, this will be remedied by shortening the chain of the drag. The reverse will be done if the blade does not carry enough material.

7.—It is the position of the teamster, on thed rag, that determines the quantity of dirt or gravel shifted ahead of the blade. The teamster should always be standing up. If he stands near the sharpened part of the blade, the blade will be driven deeper; this will cause the dirt or gravel to shift easily to the other end of the blade and the quantity of dirt or gravel will be distributed more evenly.

You are requisted to communicate this letter to your municipal council at its next meeting and to acknowledge receipt of it.

I have the honour to be,

Yours very truly,

J. A. TESSIER,
Minister of roads.

The Human Dynamics of National Development

MISS ST. JOHN WILEMAN.

The War Civilized Humanity is now engaged in is so stupendous it overshadows and conditions every phase of our life, and for its aftermath history offers no precedure or analogies. We therefore felt justification in asking your Hon. President and Executive if they would afford the opportunity for bringing to the attention of this representative, cosmopolitan Congress, a constructive reformbearing directly upon the after results of the war, and at the same time bearing distinctly upon the object of your Congress, inasmuch as it will furnish invaluable machinery for aiding the practical work of securing the construction of Good Roads throughout the Dominion. May we tender sincere thanks for the invitation so cordially extended to plead our case.

In dealing first with what takes the foremost place in all our minds, the war, I venture to state, that when it ends, as matters now stand, the Dominion will be absolutely lacking in any well organised efficient system for coping with the following vital and complex problems.

(a). Providing permanent suitable occupation for the hundreds of thousands of able-bodied soldiers who will return when Peace is declared. Above all others they deserve the best of your hands—they have freely given their bodies as a defence against the Hun wild beast. Posterity in the future will owe to them freedom from the Prussian thrall—an unbounded debt of gratitude is their due—expressed by deeds, not words.

(b). The transference of thousands of war equipment workers to normal peace industry.

(c). Better methods for dealing with immigration and distribution of labour.

(e). Publication of regular business-like bulletins as to industrial conditions and openings in employment from coast to coast.

(f). The stimulation of manual and technical training, and co-operation with the public schools in placing children in suitable openings in industrial life.

These six great questions vitally affect the very core of your national economic and industrial expansion, and your ability to reap to the full the results of victory; but as yet, no organization has been created to deal with them, not in a perfunctory peacemeal manner, but in a comprehensive national spirit. No problems affecting a whole nation can be dealt with in water-tight compartments, by either individual municipalities or provincial governments. There must be homogenity and activity of principle and method and close co-operation informing and guiding the whole process.

To turn to the object of your congress, good roads, have you not often found differences in politics, provincial boundaries and jurisdiction as hampering barriers in the progress of your work.? Your efforts would be considerably lightened if a national non-political organization were in existence, having a keen interest in stimulating beneficial public works and in keeping the working population as far as possible a regular wage-earning population engaged in productive work of the highest usefulness in the development of the state.

You are invited to take no wild leap in the dark, to essay no untried experiment but you are asked to endorse and secure the establishment here of a reform first born in 1865, which has been accepted by all the nations in the vanguard of civilization, and endorsed unanimously at an international congress held in Belgium of glorious fame in 1913. The statistics reports of the progress of the British, New Zealand, Australian and French labor bureaus systems show they have realised expectations in the primary work of acting as clearing houses and of placing employer and worker in touch with the minimum of delay, the minimum of efficiency, without one cent of cost to either parties. The government reports from the previously mentioned show preparations have already been made to place a giant's share of the work of reconstruction, re-adjustment of labor conditions and replacement of soldiers and war equipment workers, upon the respective National Government Labor Bureau systems.

I submit to you gentlemen, that the early appointment of a permanent commission empowered to organise and administrate a chain of free public labor bureaus from coast to coast, co-operating with all the provincial governments, municipalities, and other public bodies, as well as with employers and laborer, delegating to the districts where local labor bureaus are established, a reasonable autonomy and share in administration, preserving strict neutrality during strikes and lockouts staffed by officials chosen for vocational fitness, as well as business ability, would be a potent factor in developing the country industrially and economically and in promoting the highest standards of citizenship.

Mayor Ballantyne: Allow me on behalf of the town of Montreal West, and the Council to thank you for the invitation to attend these meetings. There is no doubt but what we are going to get good instruction here. I have with me from our town council, Alderman Elder, chairman of the Road Committee, and you have the hearty support of our municipality and all other municipalities in the island of Montreal, in the good work that you are doing and are still going to do. There is no question about it that good roads mean prosperity to cities, municipalities and the farmers throughout the country. With the advent, in late years, of the automobile and good roads added to that, the isolated districts are brought into closer touch with large cities and centres throughout the whole country, which means business and prosperity to everybody. We have now practically a new road from Montreal to Quebec, and the chairman wants one from Montreal to Niagara. Miss Wildman has explained what thist esolution is for, and I am sure you will all agree with what she says. For four years she has been working strnuously in the province of Alberta for labor bureaus throughout the province. I have very much pleasure in submitting this resolution to the Good Roads Congress:

RESOLUTION.

The Good Roads Congress endorses the establishment of a Dominion Labour Bureaux system administered permanently by a non-political Commission, as a National organization indispensable to the adjustment of post-War conditions, and the replacing of thousands of able-bodied soldiers in civilian Employment when Peace is declared. It further believes the system will be invaluable machinery for aiding the development of Good Roads generally through the Dominion.

Alderman Munro, Outremont, seconded, saying:I think that the proposition that has been explained to you by Miss Wildman is one of the most important questions occupying public attention today. It is estimated that at the present time, there are in the country over a hundred thousand men working on munitions. At the close of the war these men will have to look for employment elsewhere. In addition to that at the expiration of the war, we will have probably over 250,000 of our own men come back to this country. These men will have to be provided for in some way, employment will have to be found for them, and experience has proven in the past, during the last decade when we had such a large influx of immigration into this country, that they congregated at certain points—Montreal, Winnipeg, Vancouver and so on. While at these points there is always a congestion of labor, at other points throughout the Dominion it is very hard to find sufficient men to carry on the different works that are in progress. The idea of this national labor bureau is to have one establishment under the Dominion Government, non-political, so that the main bureau would be at Ottawa, and there they would be in touch with every part of the Dominion where labor is wanted, and they would have the machinery to direct labor to wherever it is wanted. In that way strangers coming into the country would not be at the mercy of quite a number of the local labor bureaus whose sole aim, I am sorry to say, has been to get the registration fee, and when they have got that their interest ceases. These bureaus would be under one control, that of the Dominion Parliament. Such a system has been in operation in New Zealand for twenty-four years; run under the Federal Government, in Australia for seventeen years and since 1911 in Great Britain. The benefit to the community at large has been very great. This movement is endorsed by all the large employers of labor in the country. It is one that every municipality, from the Atlantic to the Pacific will have to deal with in the future and I would like to see every municipality endorse this movement, and soon, when the time comes to send delegations to Ottawa to press the importance of it on the Dominion Government, every part of the country will be represented. It is the one question allied closely with the good roads movement, and a resolution from this congress would carry very great weight.

The resolution was carried unanimously.

Construction and Maintenance of Brick Roads and Streets

J. DUCHASTEL, M. Can. Soc. C. E.

One of the principal aims of Road Conventions of this nature should be, in my mind, the education of the public to the general details of the construction and maintenance of some of the principal standard pavements. This can only be obtained by honest talks in the simplest terms possible, devoid of all the exaggerated statements and impossible claims which are frequently advanced by parties interested solely in the selling of some kind of paving material.

The common man on the street should be made to take some interest in the cause we are all trying to advance here today, and demand good roads and still better roads, knowing that he can get them if he has a good knowledge of what he wants.

Since the last fifteen or twenty years, or to be more precise, since the advent of the automobile as a real factor in traffic problems, the engineers have been eagerly at work trying to meet in an efficient manner the very serious and new problems as they arose in rapid succession.

Hundreds of mistakes have been made through this period, but we must be very thankful that many thousand roads builders have profited by these same mistakes, and today the fertile profession of engineering has seen some of its members branch off in a new specialty as highway engineers. Some o fthese distinguished highway engineers are here gathered at this meeting. The paper I am presenting today is not for their benefit, but I will be most satisfied if it meets with their approval. My only object, in complying with the wishes of our worthy president, Mr. Michaud, is to do my little bit and give to every day man who follows these Road Conventions, or read their proceedings, the results of my experience in the matter.

Before going any further I want it distinctly understood that I am not to be classed as a crank on brick pavements, and that I firmly believe that the merits of all types of pavements for any special locality should be carefully considered before any decision is arrived at, so that my judgment on the matter must be accepted as an unbiassed one.

The main principles governing the construction of a brick pavement are as follows:—

1—The proper and efficient drainage of the sub-soil, most important in our climate;
2—The careful compacting of the sub-soil and the shaping of same to a grade to correspond with that of the finished pavement;
3—The construction of a proper concrete foundation. Most necessary in cold climates and in localities where the drainage of the sub-soil is sluggish;
4—The adoption of a cushion layer between the concrete foundation and the bricks.
5—The careful laying of the bricks with the smoothest surface up and lugs laying in the same direction;
6—The thorough rolling of the ungrouted bricks to an even surface.
7—The thorough application of a proper cement filler;
8—The protection of the filler from rapid setting;
9—The prevention of traffic over the new pavement for a period of two to three weeks;
10—The competent supervision of the whole work by efficient men.

Allow me to discuss these important items in detail in describing to you the manner in which a Wire Cut Lug Brick Pavement was constructed on Laurier Avenue, in Outremont, last year, under my supervision, by day labor.

Laurier Avenue is the main commercial street in Outremont; it runs in a South-Westerly direction from Hutchison Street to Cote St. Catherine Road. The distance between the curb lines is 57 ft. 6 in. and its length is 1092 ft. The grades of this street vary from 2.65 per cent to 4.52 per cent. A double line of car tracts occupies its centre.

The paving work was carried out in the folowing manner:

The old macadam pavement on the North-West side was first excavated and both car tracks were pulled over to this side overnight; then the Tramway Company installed new 115 lb. groved rails on new cedar ties on a concrete stab 18 feet wide by an average thickness of 8 inches constructed by the City. The pavement between the tracks was then completed, and after a period of fifteen days the street cars were allowed to run over the new tracks. After the old rails had been removed from the North-West side, the paving operations were immediately started. Traffic was allowed to circulate throughout these operations on the opposite side, and as soon as the pavement on the North-West side had properly set it was transferred over to this side and the pacing operations began on the South-East side.

I shall describe only the construction of the pavement on the two sections between rail and curb line, the paving between the tracks being carried out somewhat differently on account of the presence of the rails themselves.

1—DRAINAGE—The sub-soil encountered in the excavation was quite varied; bed rock at one end and common dirt excavation at the other with rock underlaying. This sub-soil has been many times disturbed by the construction of sewer, water and gas services in separate cuts as well as the connections to same from the dwellings along this street. Three lines of porous drain pipe 4 in. in diameter were laid; two at the curbs at an average depth of 12 inches below their level and connected to the catch basins; the third line was laid in the centre of the street below the concrete slab under the ties and connected to the manholes. The shallow trenches of these tile pipes were carefully filled in with 1 1-2 in. broken stone, insuring thereby the proper drainage of any ground water.

2—COMPACTING OF SUB-SOIL—The sub-soil was carefully shaped and thoroughly rolled with a fifteen ton roller until it was well compacted and its shape corresponded as closely as possible to that determined for the pavement itself. Special attention was given to freshly opened cuts, and quite a number of the old ones were also thoroughly rolled. We observed that many of these old cuts settled down considerably under the roller, demonstrating the necessity of this rolling before construction of any type of pavement.

3—CONCRETE FOUNDATIONS—A concrete foundation was then laid to a depth of 6 ins. at least; the following proportions were used—one of cement, two and one-half of sand, and five of stone. Reinforcing rods 1 in. by 12 ft., spaced 12 inches apart, were laid in the concrete over all freshly made cuts as a precautionary measure in case of further settlement. Twice a day, this concrete foundation was thoroughly watered, and no traffic whatever was allowed over it.

4—CUSHION LAYER—When the concrete foundation had properly set, two guide timbers 1 1-2 in. thick by 4 in. wide were laid directly on the concrete, one on the curb line and parrallel to it, and the other along the rail, then the sand and cement cushion, which had previously been mixed dry, in the proportions of one of sand to four of cement, was spread evenly over the concrete foundation to a depth of about 2 inches. A heavy templet having the exact cross section of the finished roadway was then drawn over this on the wooden rails levelling down the cushion and compacting it to a thickness of about 1 3-4 inch. This operation was carried on in stretches of about twenty to thirty feet in length, when found necessary, more of the cement and sand cushion was distributed and the templet drawn over again until an even surface was obtained. Then, a hand roller weighing about 250 pounds was rolled up and down the cushion until it was thoroughly compacted. After this the templet was again put in use, but this time the 1-4 in. iron shoes at each end being removed, thus allowing the templet to shape and compact the cushion to a thickness of 1 1-2 in. When these operations were completed, the wooden guide timbers were removed and the cushion materials placed and compacted in the depressions they had occupied. The importance of properly shaping the sand cushion will be readily seen, as the final shape of the pavement depends entirely upon its success. The addition of cement in the cushion adds but little to the final cost of the full work, and affords a stable foundation for the bricks, which cannot be disturbed by any ordinary cause.

It affords me great pleasure to bring to the attention of this convention, the details of the construction of a new bedding course described above, and which is being rapidly adopted by quite a number of leading engineers across the line.

I am also pleased to state that Outremont is probably one of the first Cities in Canada, if not the first one, to adopt this new type of construction.

It is well recognized today that many failures in brick pavements can be traced to the non-uniformity of the sand cushion or the lack of proper compactness of same. It is claimed by some that a brick pavement should have a cushion so as to keep its resiliency under heavy traffic. It

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is very doubtful in my mind if the sand contained between concrete foundations and the brick pavement has really any elasticity, and my opinion is that this plain sand cushion can shift or be compacted by heavy traffic, and that the brick pavement itself may spring somewhat under this heavy traffic, but the sand cushion will not follow and small air spaces between the sand and the brick pavement may be formed introducing weak spots which may cause serious trouble later. It has also been claimed that the sand cushion prevents the crushing of the brick pavement under heavy traffic; this idea, in my mind, is not well founded. If bricks well grouted are not able to sustain the load of modern pavement, the sooner they are discarded as paving materials, the better it will be.

The advantages now claimed in using a cement and sand bedding are as follows:

Elimination of the hazard to the sand cushion during construction as the pavement will not be injured at any time by rain, the wearing surface, with the exception of the filler, being completed each day. If a rainstorm intervenes no damage is done, as there is no sand to become saturated and cause to worry about rolling the brick surface.

Each brick in the wearing surface will be assured a cement bond its entire depth, for if the cement sand should work up in the joints, it will set up and prevent the shearing action which tends to crush the top of the brick.

There is no chance for the bed to shrink or shift away from the bottom of the brick wearing surface, as the brick is firmly bedded in the cement sand or held in the mortar of the concrete base.

Where these pavements have been laid there seems to be a total absence of any rumble under traffic.

Slight settlements and breaking of bonds due to non-uniformity of sand cushion are eliminated.

One striking example of grouted brick pavements laid on cement sand bedding can well be described here, and that is — the approaches to the Pennsylvania Railroad Terminal in New York City paved in 1910, the bricks being laid on a sand and cement bedding course mixed one to three. This pavement shows no signs of deterioration except along the curbs where the wheels of the heavy loaded waggons skidding down the inclines have cut somewhat into the bricks; the traffic on these approaches it must be remembered, is very heavy.

5—LAYING OF BRICKS—The bricks, which had been neatly piled on the sidewalk edge or any convenient points, were carried over to the droppers or pavers on wooden pallets, five at a time, and placed behind them in piles, five bricks high and in such position that each brick could be handled so as to bring its lugs always in the same direction with its best edge up. The droppers on dropping the bricks down in place could proceed with their work by standing on the newly laid bricks and dropping the bricks ahead with the lugs away from them on the sand cushion, the brick joints were broken at least three inches, and nothing but whole bricks were used, except in starting and finishing courses. Every fourth or fifth course, where it was found necessary to straighten up or close up the courses, this was done by tapping them slightly with a sledge using 4 by 4 timber, three or four feet long. At all times the bricks were clean and entirely free from chips, dirt or other foreign matter.

6—ROLLING—After a certain stretch of bricks had been laid, and the surface thoroughly swept, a small three ton steam roller was used to roll them down. This was done in the following manner: The rolling was commenced near the curb at a slow pace and continued back and forth up to the rail, then the operation was repeated at a quicker pace; then the rolling was done transversely at an angle of 45 degrees with the axis of the pavement and then repeated in the opposite direction; then the bricks were rolled again parallel to the curb lines. During the rolling the bricks were carefully inspected and all broken or chipped ones were immediately removed and replaced. Those bricks having settled too much as well as those sticking up were removed and replaced by other ones. The rolling operation was really a very attractive one to watch as the smoothing out of the brick surface was very noticeable after the first trip of the roller. The rolling of all the bricks laid in one day was completed every night, so that if the weather became rainy there was no chance of the cushion setting before the bricks had been properly rolled. It is useless to say that we did not mix any more cushion materials than was required for one da'ys work.

7—CEMENT GROUTING. — The grouting was done as soon as possible after the bricks had been rolled down. These bricks were first thoroughly sprinkled with the double object of supplying enough water to the cushion for setting purposes, and the thorough wetting of the bricks themselves. The sand and cement of the grouting were mixed dry in equal proportion, one to one, and to an uniform color. Batches of about two cubic feet were placed in specially constructed portable mixing boxes, having one corner lower than the others, and the water was added very slowly and the mass thoroughly mixed with a hose until its consistency was liquid enough to allow it to flow without separation of the ingredients. This grout was then poured on the bricks with large scoop shovels and spread well into the joints with hand squeegees, and the operation gone over until the joints were completely filled. The grout was always sufficiently fluid to thoroughly fill the lower part of all joints and flow several joints ahead of the squeegees, oozing up to the surface as more grout was pushed ahead. I am perfectly sure that every joint was filled up with the grouting from top to bottom, and that none of fthe cushion material partly filled the joints.

8—After the grouting operations were finished, the pavement was well covered with tarpaulins or cement bags, and kept moist for several days, thus insuring the slow settling of the grout.

9—Vehicular and pedestrian traffic was kept off the freshly made pavement for a period of at least fifteen days, according to the weather and temperature. When pedestrian traffic had to cross a section of the freshly made pavement, a thick layer of sand was spread over it and heavy planks laid over this sand, so in no manner did the pavement receive directly any traffic.

10.—I personally gave this considerable attention, and aided by my assistants, every detail of the work was carefully supervised. No Highway Engineer can expect to have good results with brick pavement without the most minute supervision of every detail of the construction.

The bricks specified for this pavement were of the type known as the "Wire Cut Lug Brick." The main advantage in using these bricks are that the joints are all uniform in width on account of the presence of the lugs which maintain the bricks at an equal distance from one another, and also the fact that the bricks have square corners, and that the joints can be filled from top to bottom at a uniform width without any danger of the grouting being chipped at the surface, as in the case of bricks with chamfer corners. These bricks had to comply with the general clauses adopted by the American Society of Municipal Improvements.

The wire-cut lug bricks that were used were tested as follows:

Abresion Test, averaged thin blocks;

	Per Cent.
at 600 revolutions	8.55
at 1200 revolutions	12.00
at 1800 revolutions	14.21

Absorption Test; 1.21 per cent.

In conclusion I must state that the advantages of brick roadways are as follows:

1—When properly constructed with the right materials they will wear without being slippery;

2—They are the most sanitary pavements known, being easily cleaned and absolutely dust-proof;

3—They are practically noiseless;

4—They are economic in the long run as they require very little attention and maintenance.

5—They can be cut through when required and easily repaired at small cost without any cumb rsome plant

Details of Cost.

	per sq. yd.
Excavation and Carting	$0.490
Sub-drainage at curb line	0.042
—$0.43 per lin. yard.	
Concreting	
Labor	$0.2383
Sand	0.1383
Stone	0.2687
Cement	0.3353
Reinforcing	0.0169
Miscellaneous	0.0009
Forms	0.0060
Depreciation on Mixer	0.0036
	1.058

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Plastering of Rails (both sides):		
Labor.	0.050 per lin. yd. of rail	
Material.	0.065 per lin. yd. of rail	0.023
Brick work:		
Bricks	$1.418	
	$1.418	
Cement	0.179	
Sand	0.063	
Hauling brick and piling along road..	0.117	
Laying, rolling, making sand cushion, grouting, expansion joint, culling and replacing.	0.341	
Half-inch expansion joint.	0.015	
Miscellaneous	0.015	
		2.148
Sundries (including Accident Fund, Lumber, damage to trolley wires, and maintenance of lanterns, etc.)		0.080
		$3.841

The Chairman: An important point is the characteristic of the brick and its density. You take the ordinary bricks we get from the general run of brickmakers. They vary intensely in their wearing strength. They may be alright for rubber tyred vehicles, but for iron tyres I don't think they are as good.

F. S. Snyder: I think the Congress is very much to be congratulated on this excellent paper of Mr. Duchastel. It is very lucid and gives almost every detail that a man wants to know about a brick pavement. But there are one or two things I would like to ask and that is how he has taken care of expansion and contraction. I have not built any pavement this far north, but I have built a great many brick pavements in Pennsylvania and have also indirectly had charge of pavements in Cuba. There of course we did not have the same climatic condition, we had practically a uniform heat, but in Pennsylvania we had a temperature as low as ten or fifteen below zero, and in the summer we have temperatures on the pavements over 100°, so that we found that with our brick pavements—there they were put on a cement grade, I have never used any of this wire cut brick, it was the old matt joint with the lugs—we had to put in expansion joints along the gutter of about half to a quarter of an inch, and if the pavement was wide we had to put one along through the centre. Transversely we had to put in joints about 25 feet, if we did not we found that our pavements cracked in the winter time in about 25 feet blocks. I would like to ask how he is handling this expansion and contraction?

Mr. Duchastel: We did use longitudinal expansion joints along curb line. They were prepared asphaltic expansion joints, four inches high by half an inch thick. In the centre of the roadway, naturally, we could not place any expansion joint, the car lines having to be there. As far as transverse expansions go they were not put in at all. The experience, I understand, of paving engineers in the States is that these cross joints, or transverse expansion joints are a source of great trouble and worry, they are really the weak part of the pavement, and it is very hard to prevent the bricks from crumbling away at these joints which are of a very soft material as compared to grouting all through. We may have a few cracks, the pavement has not been laid long enough to test that, but I am not anticipating any trouble about expansion simply because this pavement was laid in the hotseason. But we may have a little contraction trouble which I think can be well cooked after and filled up with proper material when they develop. But seeing that the whole pavement is one and that the base forms really part of the concrete base, I think any excessive variation in temperature will be disseminated clean through. I base this statement on the fact that the concrete sidewalks we have in Outremont have indicated troubles of this nature. For instance on the old type of concrete sidewalks built fifteen years ago the top surfacing was placed two or three days, and sometimes longer after the foundation had been laid, with the result that two layers existed, the foundation course and the top wearing course of one and a half inches, absolutely distinct. And in many cases, especially in the spring time, we had trouble with the wearing course lifting up completely off the foundation. With the new type construction of concrete sidewalk, where we are very particular to have the top surfacing course placed within an hour of the foundation being laid in place, with the result of having the whole properly bonded together, we have had none whatever of this trouble, and probably we have ten times as many of the new as of the old sidewalks. I think a great deal of trouble due to contraction in the old pavements, where the bricks rested on a damp or moist sand cushion, which probably would not transmit temperature as well as concrete, clean through to the base, will not occur in this modern pavement. I must frankly admit that my experience in that class of construction is very limited, but this pavement laid by the Pennsylvania railway company goes to prove that no trouble of that sort has been found. This pavement has been laid five and a half years, and I have seen it several times while in New York, and I have never seen anything very important in the way of cracks.

Mr. Snyder: My experience is practically more with contraction than expansion and there is one thing I am glad to hear and that is that reference to sub drainage of the foundations. At one time I was assistant supervisor on the Reading railroad. We have a big bed of springs under our railroad and I tried to get the superintendent to put in drainage under, and he was going to fire me as a damned fool. But the man is a damned fool who does not put proper provision under his roadway to get the ground water out and I think that is going to solve half the trouble.

Mr. L. Hurtubise: About the approximate cost per yard and the durability of it. I understand he mentioned the Pennsylvania road which seens to have been built a few years only. But is it in the knowledge of Mr. Duchastel that there are some other towns where they have built the same kind of pavement with the same material. And thirdly, about the brick.—It must be a brick absolutely different from the brick we use for building of course, but what would be the cost of the brick?

Mr. Duchastel: The cost is the great drawback of that brick in this country. We paid $40,00 a thousand F.O.B. cars, the price of that pavement if I remember well was $3.80, exclusive of the heavy concrete slab, which was laid under the brick, that is the pavement alone. I have an itemised detail of cost of this construction, and will be only too pleased to send any member present a copy of it. As far as the brick that is being used, it is most extensively used in the western states. There is quite a lot of it used in New York. The brick we used is named the Dunwire lug brick—that is not the name of any company making it, it is simply the patents covering the machine to cut the brick with, but the great advantage is that the joints are perfectly square and there are no chafing edges and no chances of the grouting being broken down to the depth of a quarter of an inch or more, thereby collecting dirt and dust and making it disagreeable to ride over in a carriage. It renders it absolutely noiseless, because the surface is as smooth as an asphalt surface would be.

Mr. Cunningham: I express my personal appreciation for this paper for the excellent information given. Would it be asking too much if you would add to the paper the detail of the cost which you have undertaken to send to anyone asking it. I understand all the papers are to be published in a book which can be used as a text book and if this information were included I am certain it would be appreciated by all who take an interest in the question of brick pavements. The information given is one of particular interest to those in Western Canada where there is one thing we have in quantity, that is clay. We can convert that into brick. The density mentioned by you is remarkably good. One point is the six per cent of absorption. It is very very low indeed, that is one point we will have to overcome in the manufacturing of the brick. But if you could publish the cost of the road in detail it would be of great value.

Mr. Duchastel: I will do that, with pleasure.

Mr. Edwards, Sherbrooke: You will be surprised to know that in that interesting city we have not one yard of paved streets, but this year we are anticipating paving our leading business street, and our committee has made up its mind to use asphalt. What considerations led the speaker to use brick instead of asphalt or other material?

Mr. Duchastel: In the first place this street, Laurier Avenue, is the main business street of Outremont. We had a double line of cars in the centre, which had to be paved with some type of block pavement and the advantages of qualities I mentioned in the conclusion of my paper are the ones that governed us in the selection of that kind of pavement We make it a practice in Outremont to do all our work by day labor, and so far we have no asphalt plant. All these reasons combined are those that decided us to use this type of pavement.

Mr. Hurtubise: I wish to thank Mr. Duchastel for his most interesting paper on Brick Pavements; it seems to me this type of pavement could be used more frequently, as it appears to be cheaper in the end than many

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other kinds. Mr. Duchastel must have given a lot of time to the study of this paving, as well as to that of gutters and sidewalks. I want to ask a question about the binder of cement and sand; this is something quite new to me; were the bricks directly on the binder while it was damp?

Mr. Duchastel: I don't know exactly what you mean by the binder; do you mean the cushion?

Mr. Hurtubise: Yes, the cushion.

Mr. Duchastel: No, when it was dry, perfectly dry.

Mr. Hurtubise: You said you noticed the bricks sank a little after rolling.

Mr. Duchastel: Yes.

Mr. Hurtubise: If the cushion was dry, how could the bricks sink?

Mr. Duchastel: Because it was simply sand and cement mixed; the thickness of the bricks varies a little, the under surface is uneven, and the rolling presses them down.

Mr. Hurtubise: What was the proportion of the cement and the sand?

Mr. Duchastel: Four to one.

(End of Fourth Session).

FIFTH SESSION - WEDNESDAY AFTERNOON.

U. H. Dandurand in the chair: As honorary president of the Dominion Good Roads Association, I wish to tender the hearty welcome of the Congress to those of you who were not present at the opening. It is very gratifying to us to notice that the attendance is so large and so representative. Our first Congress, two years ago, was well attended, at least we thought it was, but we find we were mistaken as it is increasing every year. Last year in Toronto it was very gratifying and we find as the necessity and importance of the good roads movement is being understood throughout Canada, that these good roads conventions are being appreciated and better attended every year. I am rather proud of the fact of my foresight, because the first year I thought it such a success that I made bold to propose that a Dominion Association be formed, in order to carry on the good work. I find I am not mistaken by your appreciation so it is a great pleasure for me to wish you a very hearty welcome, all those of you from Ontario and from other provinces. We have several friends from way out west, Manitoba, and the north west, and it is a pleasure to see the importance of the movement is appreciated by men travelling a couple of thousand miles to attend the convention. Naturally we had to choose a season when people could travel, when the farmers could attend easier, but we regret, notwithstanding, that we cannot show them what we have done in the province of Quebec. You may say we can boast all we like and cannot show the goods. But we have certainly made a great deal of progress since the first Congress. Some of our delegates who attended two years ago, when we took them over the King Edward highway, were astonished to see the work we were doing. Since that time we have gone on notwithstanding the war. We have now practically completed the Montreal-Quebec highway, 147 miles nearly finished of beautiful roads, we have changed since then thousands of wooden bridges for cement bridges and culverts, we have also finished a very nice bit of road, thirty-one miles, from Sherbrooke to the Derby line. Now when we tell our American friends that we welcome them, we know that we are able to tell them that they are welcome both by rail and road. They can visit us with their automobiles, a man can start from New York, and through the King Edward highway, and down from Montreal, to Quebec, and from Quebec across to Levis back to Nieuport by the Jackman road, do a continuous tour of seven hundred miles on splendid road. Very little of it remains to be done. I took the trouble, when I was in the States, to get a report from the American engineers as to the amount to be completed in Maine, and I found they are fairly well advanced, and no one can hesitate to undertake that trip to Montreal and to go back via Maine. I believe these meetings have done a great deal of good to Quebec, and our province certainly deserves credit for they had a great handicap. When people understand the size of the province of Quebec with a population of only two million people, and forty-five thousand miles of roads to maintain, you can understand that the financial end of it is no small problem. But our ministers are confident in the public spirit of its citizens and also in the natural resources of the province, and have not hesitated a minute to undertake this vast undertaking and it is being carried through with every haste.

I am sorry to say that Mayor Church of Toronto, who honored us with his presence at the first Congress, when he was then Controller Church, is unable to be with us as he hoped. When I was in Toronto last year, and they did me the honor to ask me to address a few words in the City Council of Toronto, I was telling them that I knew he was a fit Canadian to be the mayor of even Toronto because he was a great good roads enthusiast. When he came to Montreal he put in a strong bid for the city of Toronto, and any man who devotes a great deal of time to good roads is certainly a good citizen and deserves to be Mayor. He was to have addressed this meeting this afternoon, but owing to some military function—the presentation of colors to battalions going overseas—he was unable to come down. But we hope he will find his way to Montreal before the end of the Congress. We all regret his absence, becasue we all know what a good speaker he is and one who knows a great deal about good roads. Mr. Hezzelwood was to have presided this afternoon, and I request Mr. A. C. Emmett, the secretary of the Winnipeg Automobile Club to read a letter from Mr. Hezzelwood. Mr. Emmett was very handy around here yesterday, I had an engagement and Mr. Emmett was good enough to preside in my stead. This afternoon it is turned about and Mr. Pillow being unable to be present I take his place.

TORONTO, MARCH 6TH, 1916.

MR. MCNAMEE, Secy. Good Roads Association,

MONTREAL, P. Q.

Dear Sir:

I regret that the pressure of engagements here will prevent me from being in attendance at the Good Roads Convention in Montreal. I wish you every success and hope that the Convention will result in an added impetus to good road making, but really I must confess that unless we obtain aggressive action on the part of our various legislatures, that I am afraid our present plans will prove as hap-hasardous and capricious as the voluntary enlistment has been. More and more every day the writer is beginning to believe in the conscription principle for all public weal. Just as in the matter of enlistment, many localities are failing to realize their reponsibilities and some provinces are not doing their share, so in the matter of good roads, the same thing prevails.

My own opinion is that every effort should be made on the part of the whole of Canada to enable the Allies to overcome the German peril, for now and all time and immediately that is achieved, then our Government should proceed vigorously with Provincial-wide or even Dominion-wide schemes for improving the roads and thus developing the resources of the Dominion. In the meantime, road making could be carried on by interned enemies who might be compensated for their work. I do not think it is wise to promote great public undertakings now to employ our manhood to the detriment of enlistment. The 500,000 men necessary from Canada will take every available ounce of man-power that is physically fit. The remaining human potential factor will be needed in the carrying on of all essential industries and production. For instance, I think it would be folly to divert the energies of a farm laborer to road making at the present time, but with hundreds of aliens interned in Canada I see no reason why they should not be used in road making.

It has occured to me from reading over the Parliamentary returns of enlistment that there are sections of our Dominion that for some cause or other are failing lamentably in realizing the responsibilities imposed upon them by this war which was not of our Empire's seeking. Whether is it an indication that they would prefer the German flag to the Union Jack, I am unable to express an opinion, but the result of voluntary effort in connection with road making and enlistment have combined to convert me to favor some form of National Service that will impose upon every community and every individual, the task of assuming his or her fair share of community responsibilities and it seems to me the sooner we recognize this and County Councils and small Municipal Councils turn the matter of roads over to the central governing bodies, the better it will be for us and in time every community will be served with roads that will not only be a pleasure to the users but will be a boon and a means of economy to all the people of the Dominion.

Yours sincerely,

OLIVER HEZZELWOOD.

The Construction of Highway Bridges

LUCIUS E. ALLEN, C.E., Engineer County of Hastings.

A consideration of any scheme of highway development must include as a component part of such system its highway bridges, which in many highways bears no small part of the total cost of the road. In view of this fact, a careful study on the part of highway officials and engineers should be given to the designing and construction of bridges that in point of cost and durability combined with the utmost safety will best conform to present and future conditions upon our highways.

While the wearing surface of the roadway will wear out and require renewal from time to time, the bridge structure should be so constructed as to be practically permanent. To attain permanancy in bridges as in other structures requires not only careful designing at the start, but also the judicious selection of those materials best adapted for that particular bridge, and finally experienced workmanship in combining the materials at hand into a finished structure.

It would be of little interest to many attending this Congress to enter into a technical discussion of the engineering of bridge design, but there are certain facts common to almost every bridge that is to be constructed, which have an important relation to the life of a bridge, which should be of interest to everyone connected with highway work. One common error often made in the construction of a bridge is the lack of attention paid to securing a good foundation. It matters not what the superstructure may be, whether of steel or reinforced concrete, unless the foundation is sound, the superstructure may be damaged beyond repair. Accurate and careful soundings should always be taken to determine the character of the bottom upon which the abutments or bridge piers will rest. This may be done by the use of steel rods driven until either solid rock or a sound foundation is found. In some cases a wash drill outfit may be used consisting of a drill point attached to short sections of iron pipe which may be connected together as the drill penetrates into the soil Water is forced through this pipe by means of a force pump and in this way the character of the subsoil can be determined. In rivers or streams where ice conditions are severe, it is usually necessary to trench into the rock bottom so that the pier will have proper and secure footing to withstand ice jams. This also prevents underwashing of the pier from the currents existing in the stream.

As a general rule it is not advisable to construct the arch type of reinforced concrete bridges upon anything less than a good rock foundation or its equivalent. Where the foundation conditions are not suitable for the use of the arch type of bridge, the girder-beam type of reinforced concrete may be used. In this type should settlement subsequently occur in the abutments, the concrete slab would still be intact, the reinforced-concrete beams acting in a similar capacity to the steel girders in the girder type of steel bridge.

Due attention should also be given to the size and type of piers and abutments. In some cases it is economy to use reinforcement in the piers and abutments, thereby reducing the size of the pier of abutment and adding to its strength and ability to withstand heavy lateral strains. The wing or reventment walls connected with the abutments should be constructed of such height and length as to prevent backwashing of the abutment, and also retain to a proper slope the earth approaches to the bridge. In some cases it is advantagous to start the growth of willows along the edge of the stream adjoining the wing walls to further restrict washing, etc. It is important to remember that as in many sections of this country, the forests are being depleted, the watersheds of many rivers and streams while not being changed in area, yet the spring runoff of water is much quicker than formerly, thereby increasing the danger of washouts to bridge foundations. It is therefore good practice to anticipate such conditions, and so construct the foundations of our bridges as to withstand the test of time.

Selection of Type of Bridge.

Unlike highway construction there can be no standard type of bridge that will be adapted for every locality. Local conditions should in every case govern the choice or selection of the type of bridge. This will in most cases resolve itself into a consideration of three points: length of span and head room; character of river or stream as well as traffic conditions; and the character of the foundation available.

The length of span will depend largely on calculating the relative cost of long spans with fewer piers, or shorter spans with an increase in the cost of the foundation. The cost of the superstructure should be made to balance as near as possible the cost of the substructure. In some cases the lack of head room or elevation of the approaches to the bridge will prevent the adoption of the reinforced concrete arch type, in which case the girder-beam type may be used to advantage.

If steel is selected as the best material to use for a bridge, the length of span will determine the type of truss. Usually in bridges with spans up to 75 to 80 feet the low truss type is the most economical, above 80 foot span length the high truss type is usually used. The use of pin connected truss bridges is being displaced to a large extent to the use of riveted sections, either singly or made up of angles, channels and plates.

The girder-beam type of reinforced concrete bridge above 45 foot span is not usually as economical as the arch type. In the construction of reinforced-concrete bridges too great care cannot be exercised in the selection of the best materials entering into the concrete. Many concrete bridges have been made failures simply from the use of poor material or inexperienced workmanship. The work of pouring the concrete should be as continuous as possible, especially in the slab or rib of the arch. A careful check should be made during construction to see that every piece of steel reinforcement is placed in its proper location in the bridge. Many times a careless workmen, not realizing the importance of the location of a steel reinforcing bar, will displace it from its proper location, thereby weakening for all time the strength of the bridge. Sufficient camber and grade should be given the concrete floor slab to drain the water from the bridge floor. If solid concrete side walls are used, short sections of iron pipe may be placed at the bottom of the floor and through the side wall to drain the water quickly away from the floor.

As before stated the character of the river or stream will in many cases determine the best type of bridge adapted for the locality, but the character and amount of traffic passing over a bridge should always be taken into consideration in determining the character and width of the bridge. While it is difficult in all cases to anticipate future traffic conditions on a given highway, on main connecting roads or roads leading into large cities or towns, the traffic is very likely to increase. For ordinary country roads, a clear roadway of sixteen feet is sufficient for ordinary traffic. For main roads, where the motor traffic is heavy a bridge width of twenty feet is not too great. In England many of the old masonry arch bridges have in recent years been widened to accommodate the large increase in traffic.

It may be of interest to note that in a report presented by Mr. H. Howard Humphreys and Mr. W. J. Taylor, County Surveyor, Southampton, England, at the Third International Road Congress in London, it is stated that of thirty-three engineers of county councils, who furnished information regarding the use of reinforced-concrete for bridge work, eighteen reported that reinforced concrete had been used for the construction of bridges and culverts carrying main roads within their respective counties, while others were considering its use.

The reasons chiefly advanced by these County Engineers in favor of reinforced concrete bridges, as compared with steel and masonry were "economy in first cost" and "economy in maintenance." If the floor slabs of reinforced concrete bridges are kept properly covered with from five to six inches of gravel or crushed stone, there will be little wear on the concrete surface of the slab itself.

The artistic design and finish of a reinforced concrete bridge should also not be neglected. With little if any additional expense artistic effects may be given to the concrete side walls by panels or open balustrades and suitable panelled end posts. If surfaced lumber is used for forms and the forms are removed before the concrete is too hard, the surface can be brushed and given a uniform appearance which will add much to the general effect of the bridge structure.

If steel has been chosen as the best material suited to the locality, the Engineer for the municipality should prepare suitable plans and specifications which may be submitted to the various bridge builders for tender. The old practice of allowing each bridge builder to submit its own plans should be avoided, as in this way there is no uniformity of design, and many times price was the main consideration. The fabrication of the steel work should also be inspected, especially the riveted connections. While ordinary shop riveting is usually well done, the riveting done in the field in erecting the bridge is often poorly done. All rivets after being driven and inspected should be im-

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mediately painted in the field, previous to the painting of the entire bridge. Two coats of paint in the field in addition to the shop coat should be given the steel work each successive coat being of a different color to insure every portion being covered.

Too much stress cannot be put upon the matter of painting steel bridges. Many steel bridges in Canada which when constructed were first class bridges, through neglect to properly repaint them have practically been destroyed. The speaker has examined some steel highway bridges which were constructed from 12 to 15 years ago, which have had to be replaced by new bridges owing largely to the lack of proper painting. Steel is not often put to a more severe test than when used in bridge work, the action of moisture, water, the acids from the bridge floor, etc., all tending to contribute to rapid corrosion unless protected by paint.

The matter of the best type of floor covering for a given bridge is also of great importance. While the use of concrete as a floor covering adds greatly to the weight of the floor system, and thereby increases the size of the trusses, etc. It is generally considered to be better than wood floors on account of the lower cost of maintenance. On main highways, or in cities a combination of concrete and wood blocks makes a very durable bridge floor. The wood blocks should be creosoted, and the joints filled with pitch or asphalt to seal the joints. One advantage of wood block bridge floors is a reduction of vibration due to traffic as well as being noiseless.

The capacity or safe load that a steel bridge is designed to carry is an important factor, and should be given attention before designing the structure. The future traffic requirements should again be borne in mind, as it is much easier to design a bridge for a 20-ton moving load than after having been constructed to reinforce or strengthen it for increased loads. Owing to the increased use of heavy road making machinery, such as traction road rollers, etc., which pass over bridges, it is necessary to design the bridge to safely take a maximum load equivalent to the weight of this machinery.

The load capacity for different highway bridges may very conveniently be divided into two or more classes, depending upon traffic, and ranging from bridges capable of carrying 10 tons up to 20 tons or more, which will ordinarily be sufficient for any heavy moving load as above mentioned. Allowance should also be made for decrease in strength due to age, so that at the end of say 50 years what was originally designed as a 20 ton capacity bridge, may have fallen to 15 tons loaded capacity.

There are many other details which time will not allow me to mention that must be considered in selecting and constructing a highway bridge that combines economy of design with permanancy. It is however a source of much gratification to Highway Engineers, that more careful attention is being given to this important branch of Highway work than formerly, and great advancement has been made within the past few years in methods of construction, so that when the construction of a great Canadian National Highway from east to west is commenced, as we believe it will be, the construction of its bridges will conform in beauty and permanency with that of the highway itself.

DISCUSSION.

D. D. Gray, Experimental farm superintendent, Ottawa: I would like to ask Mr. Allen, what he thinks the depreciation of value would be of a well built concrete bridge per year?

Mr. Allen: I always estimate that a properly constructed reinforced concrete bridge, assuming that your foundations are good, is practically a permanent structure, the only depreciation will be in your floor slab. If that is kept properly covered with gravel or stone even that will be practically nil. I may say there is an instance of one bridge in France, which is now probably fifty years of age which is in just as good a condition today as when it was built, and the materials of that time, such as cement, were not as good as the cement which is made today.

Mr. Gray: That is a question I wanted answered because a great many of us, making roads and bridges, forget permanency in the jobs we are doing, and I think that one of the prime things we should consider is whether it is going to last for ever.

Mr. Allen: That is the great advantage of reinforced concrete for bridges, they may cost more, but, if properly built, they are established for all time.

Highway Culverts

ALEX. FRASER, Highway's Dept., P.Q.

Mr. Duchastel read the paper of Mr. Fraser, Quebec, on "Hughway Culverts."

The limit of application of the word culvert is not exactly established. In the following few remarks I will apply the word somewhat arbitrarily to all work of whatever type, from the circular culvert of 12" diameter to the bridge or culvert of 8 feet span. In the province of Quebec these culverts are considered as an integral part of our roads and their permanent improvement is made in accordance with the plans and specifications furnished or approved by the Department of Roads. The construction of bridge of greater dimensions is generally carried out under the control of the Department of Public Works. But here again naturally when the question arises of making a work of a permanent character on the probable line of a proposed provincial road, there is an understanding between the engineers of the two Departments as to the location of the bridge in view of securing the best possible alignment.

As the culverts constitute a permanent part of the improvement of our roads and their cost forms an important item in the total cost of that improvement, special attention to them is therefore necessary together with method and economy.

On our provincial roads in the province of Quebec, the average cost of the permanent culverts from 12" diameter to 8 feet span has varied from $800 to $1,500 per mile.

Circular Culverts.

In the province of Quebec we make circular culverts of 12 to 36" diameter. On our provincial roads all the circular culverts are of concrete, and of all the other circular culverts made in the province, a little more than two-thirds are of concrete, the rest being of corrugated steel, iron or vitrified clay pipe.

I believe that the concrete culverts will give the most satisfactory results if the materials used and the methods of construction are those commonly known as the best.

Concrete today, though it may still improve in the future, has passed the experimental stages as to the certain results expected. But our manufacturers of concrete pipes, at least as far as the province of Quebec is concerned, do not all use the best methods of manufacture. Fortunately, a movement is now under way with a view to the formation of an Association of all the concrete pipes manufacturers like that existing in the United States whose main purpose will unquestionably be to put on the market a more uniform product and one of the very best quality.

The quality of the pipes is not, however, the only consideration that can assure to the culvert its permanency and its efficiency. It is also absolutely necessary in place with care if we want them to give good results. Many foremen or inspectors since they do not always understand the importance of every detail are frequently inclined to overlook some of them in order to save time. Consequently the need of intelligent and experienced foremen is greater than one is commonly led to believe, because it is often very expensive to repair a culvert when, after the roller has passed or the pavement is sometimes nearly finished, breaks or dislocation is noticed.

A culvert has two main purposes to perform: to provide a safe passage to the traffic and to secure a perfect drainage while protecting the road.

To provide a safe passage to the traffic, we will have to give to the culvert a length equal to the width of the travelled way. This is specially important at the inter-sections of roads. A reduction of the width of the travelled way in a road at each culvert would mean a serious danger, especially where the culverts are numerous, as they generally are along a river or a lake. Moreover, the addition of one or two pipes to a culvert in order to provide an adequate length can be done in most cases without increasing the cost of the culvert. The addition of one or two pipes will often allow us to build a smaller headwall and so economize a certain quantity of concrete which will compensate for the additional sheets.

The alignment of the culvert must be so as to provide a

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rapid flow of the waters. To that end the introduction of two or four right angles in the line of a ditch for the laying out of a culvert, as it frequently happened in the old structures, must be avoided. If the line ditch at the upstream and downstream side of the culvert happen to be on two different lines of not more than 25 feet apart, we generally prefer to place the culvert at a certain angle with the centre line of the road so that its two ends will meet the two lines of the line ditch at each side of the road.

We must specially take care not to place the culvert at right angle or nearly so with the centre line of the road and between the two line ditches. If those two ditches are too far apart, it will be better then to place the culvert on the produced line of the upstream end ditch. By doing so we will get rid of two angles and we will reduce to the minimum the underminings which may be caused during the flooding seasons.

To determine the opening of any culvert we can take the impirical formulas of Talbot or Kutter which are most commonly used, but it will also be kept account of the present dimensions of the old culverts and of the information often very important that can be procured from those living in the locality and knowing perfectly well all the local conditions.

The trench to be excavated for the culvert ought to be at least two feet wider than the external diameter of the sheets to be laid. This is a detail of which I frequently experienced the importance. If the trench has but a width equal or nearly equal to the external diameter of the culvert it will be difficult to sufficiently ram the earth in the lower part and the latter will seldom be rammed at all. Consequently the culvert will not be held firmly enough in place, and when the rolling starts it will tend to move, the joints will be dislocated and the sheets will frequently break.

We must be careful to give to the bottom of the trench a concave form suitable to the sheets to be placed so as to ensure to the latter a greater bearing surface and of a more uniform resistance. The minimum grade of the bottom of the trench will have to be at least of 5 inches per 100 feet, and be made so as when the culvert is in place to allow the water to flow freely on a regular grade inside as at the upstream and downstream ends. It is very important to have all the joints cemented on both sides so as to avoid all washouts and caving in of the soil around the culvert.

A very important detail which is too frequently overlooked in practice is to make the backfill by parallel and successive layers of not more than 6 inches thick, and to perfectly ram each of them. This is a most necessary condition to keep the culvert from moving and breaking under the roller. The backfilling materials must be carefully selected. The materials taken out of the trench are not always satisfactory. They will frequently have to be replaced by a more stable and more dense material, clay, gravel, or course sand. Light soils, fine sand or any material containing vegetable matters should never be used.

It is necessary to pave the bottom of the ditch at the upstream and downstream end of each culvert specially if on account of a steep grade or of a break in the profile there is danger of erosion occuring.

We must be careful to leave at least 12 inches of earth over the culvert, specially if we have to deal with vitrified clay, corrugated steel or concrete pipe. If it is not possible to give the 12 inches, it will be better to lay a cast iron pipe culvert.

Other Different Types of Culverts.

Most of the remarks made with regard to circular culverts apply to the other types of culverts of plain or reinforced concrete, quadrangular culverts, slab culverts with or without beams and arch culverts.

A control which cannot be exercised in the case of circular culverts, control of the mixture, of the quality of materials and of all the other details in the making of concrete, can here be exercised freely. To this end, it is important to permanently keep a competent foreman or inspector on the work being carried out. His duty should not be limited to the supervision of the proportion of the mixture and the time of mixing of each batch. A mechanical inspection is not sufficient, the theoretical reason of the importance of all the details must be well understood. When the materials are accepted by the engineer, the inspector or foreman must see that the stone and the sand are always kept clean, that the mixture is done methodically, that it is not too wet, etc. He will frequently have a look to the forms, see that they are always kept in line and the dimensions permanent. He must pay attention that the concrete is steadily rammed to provide a compact mass, and that the stone is always kept away from the forms to insure even surfaces.

The width of the roadway on these culverts should be of 18 feet on local roads and of 24 feet on trunk roads.

The bed of the creek where the culvert is located must be paved with dry stone if on account of the grade it is exposed to erosions.

The alignment of the road in view of the location of these culverts must be made in a judicious way. Except where unavoidable they should not be located on curves specially on short radius curves. Too frequently the culverts have been located to suit the creek and not enough consideration has been given to provide a judicious alignment satisfactory to traffic.

In the course of the few foregoing remarks I do not pretend that the subject has been fully dealt with, I have only touched a few main points of which experience has shown me the most practical usefulness and without which a culvert will but accidentally possess the necessary qualities of permanence and efficiency.

The Chairman: We have now with us Mr. E. A. Cunningham, the representative of the Board of Trade and the city of Lethbridge, Alberta. I am afraid there is a conspiracy on, because there are so many members from the west, who seem very anxious to have the next convention in Winnipeg. It shows you they think a good deal of these Conventions when they want them all over. We have had many applications from the city of Baltimore—they think we can run Conventions and they want us to go there. It is very flattering to us, I don't know what the annual meeting which takes place on Friday morning will decide, but I am sure our friends from the west are putting in a strong bid to get the next Convention there. Although Mr. Cunningham is not on the programme I am sure you will be glad to have a few words from him.

Mr. Cunningham: I extend to you the greeting of the city of Lethbridge, Alberta. The fact that the city of Lethbridge should have requested me to act as delegate indicates that the noise of this Convention has reached to the foothills of the Rocky Mountains. The question of good r9ads needs no enlargement to indicate how important it is to the whole of Canada. There is a great deal of credit due to Mr. Dandurand for having inaugurated such a movement as this. I agree with him that it should be national as well as international. It has been estimated that we have a crop of 330,000,000 bushels of wheat in Western Canada this year, and we will probably realise how important good roads are to Canada when we say almost every bushel of that will have to be put on some highway. The city of Lethbridge may not be very well known to some of you, but I may say it is at the entrance to the Crow's Nest railroad, the centre of the domestic coal mining of Western Canada, the centre of a very large, and the first, irrigation system, where something over 300,000 acres are irrigated at the present time, and have been for fifteen years past, also the centre of the famous Alberta red wheat. It is estimated that two and a half million dollars worth of grain will go through that city this year of the 1915 crop, and the value of the coal mining is $150,000 to $200,000. A great deal of interest has been taken in the road movement in Alberta, and perhaps one point which will be interesting to this Convention, is that, just as soon as the national highway is carried across Canada the Province of Alberta has its roads from the east and west ready to couple up with it. So that you can strike a forty-mile automobile clip across that province, and as I know the chairman of this session is an enthusiast in automobiling, that may be an interesting point for him. It goes without saying that the automobile clubs are assisting in this good roads movement. Needless to say we are going to bring the Congress to Winnipeg next year, you will probably receive an official invitation before it closes, and I think it would be well for the people of Eastern Canada to come out and see what sort of a country we have, There is a disposition to be rather local. I think perhaps, we may say that there are five grand divisions in Canada—Nova Scotia, New Brunswick, Prince Edward Island and Cape Breton, forming one, Quebec another, Ontario another, the three central provinces another, and B. C. the fifth. It would be well to bring all these together, and there would be no better medium than the good roads. The press of Canada is doing a great deal to boost different sections of Canada in the efforts which are being put forward for development. We get the Montreal papers in Alberta, we read them, and the fact that they are read is in part an explanation of my presence with you in this important Convention.

Mr. Cunningham then took the chair for the balance of the session, which was devoted to an illustrated lecture by Prof. Crandell, of Pennsylvania State College on Road Making.

[End of Fifth Session].

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SIXTH SESSION.

Mr. Michaud in the Chair.

The President: We were to have had Colonel Sohier and Major Crosby with us this morning; unfortunately, these gentlemen are unable to be present, and we have made arrangements to replace them. Major Crosby's paper on "Foundations" will be read by Mr. Duchastel, and he will give us afterwards some information and explanations in French on this same subject.

Gentlemen, you are quite able to judge of the different types of roads. The question of what type of road to choose is very important from a double standpoint. First, how far will a certain type of road be suited to the traffic it will have to carry, and secondly, the cost of the road and its maintenance.

Every one knows the various types of roads. First of all, we have the rudimentary or dirt road. Of course, underneath this, we have a path which has not been shaped at all. Let us take this rudimentary road first. This road has been built to a certain extent; it has probably been drained, ditches and culverts have been put in, and it really is a good road for a moderate traffic, especially if the soil is of a nature to stand the weather and the wear and tear of traffic.

The clay road, which I am sure you all know, is not as desirable as the dirst road. In July and August, when it is hot, a good clay road is ideal. Some clay roads are as hard as concrete; there is nothing better. Unfortunately, this only lasts through July, August and sometimes September. When the rain sets in with October, a clay road becomes almost impassable; it is the same in the spring.

After the clay road, we get the "sand-clay" road. The Roads Department made an experiment on a short section of "sand-clay" road, about two years ago, at the request of certain people who had very little money, but a lot of sand and clay. We sent down an engineer to build this sand-clay road, and the following year, we had a block of it cut, and we found it to be a remarkably hard paving block. The clay, evidently, gave it adhesion, and the sand prevented the surface from being slippery.

However, we cannot always make a road out of sand and clay; sometimes we have a lot of clay and nothing else; or else a great deal of sand and no clay. All the same, it is worth while mentioning this kind of road, because people need to be told of exceptional cases like this, because there is a possible chance that money could be saved by this combination. We are quite ready to spend money, we won't ask any better than to do so. I am speaking here for the Government and also for the population of this province; we have seen now ready the latter is to spend money in order to improve conditions, but we are obliged to put the drag on sometimes, as our farmers want to spend too much at times. Of course, that is a good sign; the farmer is getting progressive; he is getting out of a rut, and the worst rut you can possibly get into, is that of saving every cent. We have made some sort of propaganda, and I must admit that our best propaganda has been the good roads we have built; they were something tangible, and so we gradually got the good people of Quebec to see that some money must be spent. Naturally, it must be spent as carefully and as economically as possible. Now I am going back to a very essential point; if there is good material at hand, you must not think of bringing other materials from a distance, which probably cost ten times as much. And there we get back to the "sand-clay" road.

After these, we get the gravel road. A gravel pit is as good as a gold mine. In the States and in Ontario there are many sections entirely of gravel formation. In many places, you only have to use the drag on the road, taking off the larger boulders, and you have at once a very good road, and one which will stand traffic well; it even gets better with traffic on it, so long as the drag is used now and then. All that at a very moderate cost. There is a gold mine to be exploited. In all districts with a gravel formation, that is decidedly the road to be built, unless there is an enormous traffic of motor trucks; with those you would not use macadam either. Begin by careful calculations; look around you and see what you have at hand; we must do like the savages do, use the smallest blade of grass, the smallest pebble, if it doesn't cost anything.

Gentlemen, let me assure you the government does not only give advice in political economy and in road building, but it tries to carry out those same principles. Three or four years ago, when we began the present system of improved highways, we had a few general principles on the subject. We knew perfectly well that a macadamized road was a permanent one; those were the old French and English ideas, which have had to be modified with the change in traffic. We knew that and we said: We are going to build permanent roads, macadam roads, gravel roads, and if necessary, we shall do even better than that.

In improving some fifteen or twenty miles of road, the first idea is the popular one: Let us have a permanent road, a good macadamized road, the government is going to pay for it, so it's all right.

Perhaps we encouraged this movement; there is one thing that must not be forgotten; you must look for your materials. We ourselves have built some macadamized highways, and while we were building them at the urgent request of the public and because they were absolutely needed, at the same time we were prospecting to see if we could find some gravel banks. People who go around with their noses in the air, never pick up any money; keep your eyes on the ground, and you may not find any gold or silver, but you may find gravel. A macadamized road can be built for $5,000, $6,000, $8,000 or $12,000 per mile; you cannot do it for less than four or five thousand dollars; but you can build gravel roads for $2,500, $2,000 and $1,800. Exception would have to be made for provincial highways, where bridges, culverts and getting the road into good shape entails additional expense. As a rule, a municipality can build a gravel road for $2,000 or $3,000.

I especially want to draw your attention to the question of economy. Study your soil well, and see if you cannot make a good road with it; look around you and see if there are not any gravel banks within easy distance. If the gravel is some four or five miles off, then you had better make some macadam.

We must make some distinctions here; you must reckon up what sort of road is most suited for your purpose, what kind of gravel it is, how far off it is, and what is the quality of the stone. All such questions must be discussed before you make a final decision as to the kind of road you want to build. The engineers of the Department of Highways are always at your beck and call; it may make a delay, but I want you to understand that you are all asking for so many improved roads, that no service can possibly keep up with your demand, but we are always ready to help.

Now we come to the macadamized road. I am certainly not gone to give you a lecture on macadam. The real difficulty lies in the foundation; whatever the road be, you must have a good foundation. For a gravel road, a foundation of broken stone is often better, if the stone can be had at a reasonable cost, and if the gravel is not food enough; with a macadamized road, you must have a foundation, unless the subsoil is pure rock. In all plans sent out by the department, allowance is always made for the foundation in macadamized roads.

For certain kinds of traffic, macadam is permanent; it has to be kept up, if there is a great deal of traffic; if I were speaking on macadam, I should not talk about its construction, but about its up-keep; I want to draw your attention to that fact; don't lose the money invested in macadamized roads by neglecting the maintenance of them.

As Mr. Huber said the other day, speaking on macadam, you have to begin the maintenance of a macadam road immediately after it is finished. There are several ways of maintenance. In France, there are two systems: One, a renewal of the surface, and the other, "the stitch in time." The latter means mending at once any little defect that may appear; if one stone goes, it has to be replaced by another at once. If this system is not followed, the macadam may last two or even five years, but the time will come when you will have to resurface it entirely. The macadam will have to be broken up, a new upper course of broken stone must be laid and rolled, in fact, the macadamizing must be done over again. I hope none of our country districts will let their macadam roads get into that condition.

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Speaking in English, in response to a request, he said:

"I have just pointed out to the audience the different types of roads available which may be built, from the earth or dirt road, passing to the gravel road, the macadam, the bituminous, and concrete roads. I have stated that as far as we are advanced in this country and in the United States or elsewhere nobody has come yet to a conclusion as to a definite road. We are all seeking the definite road that will not wear out. I don't think it is possible. If you can make a suggestion in that sense it would be welcome.

F. A. Snyder: I am afraid I cannot tell you very much, but I think that one of the main lessons that we want to impress on everyone is if we cannot get a well-constructed road, that is, I mean, a semi-permanent road, let us fix up the dirt road. And the main thing is to get your drainage ditches open and to get your water so that it runs off. The only time to start is in the fall, get all your weeds cut and ditches open, so that when the snow melts off and the weather starts breaking, send a gang up and down your roads and drainage ditches, and see that the water runs off quickly. There are lots of places where your ditches are in such shape that they are practically graded the wrong way. A little engineering, two men running over these ditches with levels, is all that is wanted, and instead of having a section that has to be cleaned out with pick and shovel, you can alter the section so as to get, not so much a drag scraper in them, but some other type of cheap light road grader, to keep your ditches in shape so that the water runs off. The next thing is, when the roads are in bad shape to pick out all the bad spongy spots, dig them round and replace them with good hard material putting in lots of good drains. And instead of using a very heavy road machinery, use a light machine, and you will find that your work will go much further. You will not need so many men per mile and your money will go further. Another thing is the use of the road drag. The steel and the split log drag both work very well in certain cases. But I have found, in my experience, that where your roads begin to get rutty, the best plan is to run over the road with a very light grader, you only need two men and two horses, and just merely cut out the ruts and put your drag on right after. That gives you better results than to go along with a big grader, with six or eight horses, each trying to buck against the other, and really destroying the road instead of smoothing it off. That is my idea of keeping up a dirt road. As to the other roads it is a question of watching them. Never let them get out of hand, and I believe that with most roads, the patrol system is better than the gang system. The main thing is never let your road deteriorate, keep at it all the time.

C. D. French: The only thing I am familiar with is the construction of concrete and macadam, and that is the only two questions that I will take up, having personally supervised the construction of the concrete and macadam roads last season on the Quebec and Montreal route, building about nine miles of concrete and about the same quantity of macadam. The macadam has a foundation which varies from six to eight inches, with a six-inch macadam top. Using the concrete it was laid fourteen feet wide, six and a half inches thick at the side and seven and a half inches at the centre, with the joints about 25 feet apart. We found in the construction of the macadam roads that the sub soil in most cases required a heavy foundation, and in these two cases that brought the cost of the road up, so that the concrete was practically the same cost as the macadam. In places it was cheaper, and some of the macadam built in the spring showed signs of wearing in the fall. Repairs should start immediately after construction is finished, but in the concrete that we built in the spring, there was no more evidence of wear when the snow came on than there was the day the work was finished. No wheel marks of any kind whatever, no cracks—none would appear in the spring, but as most of the concrete was laid on a sub soil of sand, we don't expect any cracks to any great extent. There might be a few contraction cracks, but we don't expect any longtitudinal cracks owing to the sand. In the macadam when construction was finished, the road was in perfect shape, but we found after four or five months use, it would be sagged in places. It would not be detected when the road was finished, but would appear later, especially over pipes or culverts. We took all the necessary precautions we possibly could with the pipes and culverts, stamping the clay or soil carefully around the pipe and using water, but in spite of that we found holes or depressions in the road. But in the concrete there is no depression whatever.

Paper of Major W. W. Crosby read by Mr. J. Duchastel on Road Drainage and Foundations.

Road Drainage and Foundations

By MAJOR W. W. CROSBY, Consulting Engineer, Baltimore.

It will be assumed that the "Drainage" referred to in the title is that provision made for taking care of the water so as to improve the foundation or protect it from injury, and is not intended to cover provisions to be made for the disposal of surface or storm water to be cared for in any event. Drainage therefore becomes a consideration in this paper incidental to foundations and reference to it will be made along these lines instead of by attempting the really impracticable separate consideration of it.

Let us, in approaching the subject of foundations, first divide the foundation into two classes—the natural and the artificial. The natural foundation must ultimately be that portion of the earth's crust on which the beginning of the artificial structure rests. It may be some distance below the surface of the roadway and be separated from the surfacing of the latter by various layers of construction, including an artificial foundation.

The requirements for a foundation are (a) that it shall be capable of supporting, under the most adverse conditions likely to surround it, the loads coming on it; (b) that it shall be homogeneous and uniform to an extent sufficient for the probabilities of the case; and (c) that the above qualities "a" and "b" shall be obtainable at the minimum cost in the long run.

Considering now natural foundations, i.e., road beds on the soil in situ—when the proper grades shall have been reached by excavation or embankment it is evident that requirement "c" is complied with. Questions as to "a" and "b" above immediately arise. When the material is ledge, sand or sandy gravel, and perhaps some other materials, there will be slight if any need of further considering "a." There may be, however, need for considering a subordinate matter involved in "a," and that is the question of the probable permanence of the supporting power of the material under such conditions as may later arise. For instance, the incompressibility and supporting power of sand may be extremely high as long as there shall be no chance for the sand to flow. On the other hand, the tendency of the sand to flow may be tremendously increased by the assistance of water. Consequently the probabilities of the presence of other conditions which would seriously injure the supporting power of even such materials as sand and gravel must be considered, and such precautions taken by provisions for drainage perhaps as will prevent the existence to a dangerous degree of such conditions.

Drainage thus enters into the consideration of the foundation. If for no other reason, drainage must be provided in order that water shall not by its advent into the foundation injure the supporting power of the latter seriously. Again, if the amount of water normally present in the foundation is weakening its supporting powers, drainage may be provided to take away this water and thus at a moderate expense frequently to render satisfactory the natural foundation material, as well as to protect it from further weakening against the advent of more water under abnormal or exceptional conditions. With earths less desirable than sand or sandy gravel as foundations, in view of their weaker supporting powers or greater liability to weakness under adverse conditions, the necessities for proper consideration of their capabilities and of the probabilities and effects of adverse conditions are emphasized. Here again careful consideration of the possibilties of proper drainage, toward an economic and effective solution of the problems, enters.

So much has been said and written regarding the details of drainage that the writer will not attempt to go into these matters again here. He believes that, if he has made intelligible the reasons for drainage in connection with foundations, his readers will be perfectly well able to work out the details of construction for themselves. He would simply add one word of caution, and that is, the drainage provisions in every case should be not merely sufficient for the conditions existing at the time but should be ample to take care of any conditions that may seem possible of occurence.

As provisions for the protection of natural foundation in its most stable form begin to be demanded, and as pro-

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visions for protection against adverse conditions are demanded and begin to accumulate, it will be seen that consideration of the substitution or interposition of an artificial foundation for the pavement enters, in order that requirement "c," as well as requirements "a" and "b," shall be met, and a permanently stable, uniform support for the pavement surface shall be provided at the minimum cost.

Perhaps a few words regarding requirement "b" should be said here before proceeding further. The desirability for uniformity in the foundation for a pavement is going to be more generally recognized. It is important because otherwise uniform wear of the surface is not likely to take place, and uniform wear of the surface, even if somewhat more rapid, is more desirable and less expensive to counteract than light or slow wear in some spots and heavy or rapid wear in adjacent areas. This latter condition means constant expense and trouble to keep the pavement surface in satisfactory shape. A uniform wear, however, requires little if any expense for keeping the surface in satisfactory condition, and if not too rapid, will not result in as much expense in the long run.

Most natural materials can be made into sufficient foundations for pavements if they are of the so-called "mineral kingdom." Vegetable matter ordinarily cannot be, and must be excluded from the foundation because of its tendency to instability. The question, however, as to whether to use the natural mineral material in place, or whether to substitute something else for it, is often mainly an economic one, and comprises, as will be seen, the question of whether or not the material is, and will be sufficient for the purpose in its natural state and the question of what it will cost to preserve it indefinitely in a satisfactory condition, or what it will cost to remove the material and substitute therefor something else more satisfactory. The decision should be on the safe side, if for no other reason, because of the probabilities of unexpectedly severe strains eventually coming on the foundation. The modern tendencies are toward the more severe use of roads and street, with greater demands on their foundations than heretofore, and these tendencies should be recognized. On the other hand, the need for economy is equally rapidly growing greater, and if, as the old definition has it, "the engineer is a man who can do with one dollar what any fool can do with two," the demands of economy,—i.e., true economy in the long run, must be recognized and sought by him.

The decision in this matter at present must be made largely on the basis of judgment founded on general knowledge and experience. There is little scientific data recorded to guide one in the matter though there is some. It is admitted that the stresses from the load on the surface of the pavement passing down through the body of the pavement itself are distributed over a larger area of the foundation. The supporting powers of various kinds of earth have been approximately determined. If now, some conclusions can be reached as to the distributing effect of the stresses through the surface of the pavement, a fairly accurate determination of the questions concerning the use of the natural material or the substitution of other material for the foundation of the pavement surfacing may often be had.

Summing up in regard to natural foundations for roadways, it may be said that the highway authorities should be sure that the supporting power of the material is and will be continuously sufficient for the purpose, and that sufficient protection against injury to its supporting power is provided, that the foundation shall be stable in place and sufficient protection against displacement of it shall be provided; that the natural foundation shall be homogeneous and uniform in character; and that these results shall be obtained at the minimum cost. Possibilities of failure in any of these respects should generally warrant the authority in prescribing reinforcement by foreign material or the substitution of other material for the natural foundation, or in prescribing the use of an artificial foundation.

Artificial Foundations.

Under the head of artificial foundations will be included for convenience all layers of foreign material not naturally found in place and specifically provided for the purpose of interposing a layer of some sort between the natural material and the pavement surfacing. Consequently under this head will come layers of sand, gravel or similar material, macadam (old or new), paving (old or new), as well as the more common exposition of the term—i.e., the concrete slab.

A layer of sand or gravel as an artificial foundation for the pavement is sometimes used to good advantage on subgrades whose supporting power is relatively weak, under such conditions as may be expected to prevail around it, and largely for the purpose of distributing, through the medium of a cheaply installed layer, the stresses coming down through this layer from the pavement, so that the strains on the foundation will be within what might be called the "elastic limits" of the latter. Sometimes, the further advantages of such a layer are that they assist in providing drainage and in increasing the stability of the sub-grade in places. For instance, such a layer may be valuable in preventing the serious effects of frost action otherwise taking place in the Spring. Again with sub-grades of clayey material, such a layer of sand or similar fine material, will prevent the working of the sub-grade material up into the somewhat porous bottom layer of the macadam to the detriment of the latter. Again, economy may dictate the use of a layer of considerable thickness, say two feet, of sand for the foundation of a pavement where traffic conditions will be relatively light and yet an insufficient natural sub-grade exists locally.

Properly graded gravel with sufficient sand in it to reduce the voids to a minimum will prove an even stronger artificial foundation than the sand layer above referred to, as there will be less tendency toward displacement under traffic. In the same way, macadam may be superior to the gravel layer and a thinner foundation of macadam may equal or be superior to a much thicker layer of the best available gravel. Well compacted macadam is high in its supporting powers and in its stability in place. The difficulties of using it as an artificial foundation are those always found with materials containing a large percentage of coarse particles—i.e., it is difficult to get its surface sufficiently even so that the surfacing shall be sufficiently smooth, and at the same time have the requisite degree of uniformity in thickness. Without going too much into the question of surfacing, the speaker wishes to point out the necessity, for the sake of evenness in wear, of uniformity in thickness for the surfacing layer of a pavement, whether the latter be sheet asphalt, wood block, brick or stone block. It is true that the blocks are now generally made with a reasonable degree of uniformity in this respect, but if the bedding material on which they are placed be, as if frequently the case, sand, it must be considered as a part of the surfacing layer. The necessity for this bedding layer to be of reasonable uniformity in thickness is now generally recognzied and a general demand exists rationally for a high degree of smoothness and evenness in the surface of the foundation. This demand will exist and even become more severe so long as a layer of material quite different from either the foundation or the surfacing material itself shall continue to be placed between the two.

Many brick pavements have been laid using the old macadam surfacing as a foundation. The failures of most of them have been directly connected with the unevennesses of the sand layer required for the purpose of evening up the surface of the macadam and furnishing a bed in which to set the brick. Where newly laid macadam was attempted, to provide for a foundation for such pavements, some of the failures have been attributed to insufficient consolidation of the macadam prior to the brick laying and to subsequent shifting of the sand layer between the macadam and the brick, which shifting was caused or intensified by the passage of the sand into the interstices of the insufficiently compacted macadam foundation, as well as to the lack of evenness for the surface of the macadam and lack of uniformity in the thickness of the sand layer.

Old pavements have frequently been used as foundations for new pavements and in some cases, an artificial foundation in the shape of a stone pavement, has been provided for the new pavement. Such foundations are of considerable antiquity. The Telford pavement as a base for a macadam surfacing is a well known instance. There are many cases in cities of this country where the streets were originally paved more or less roughly with stone blocks, or so-called cobble stones, and these old pavements used, with or without relaying, as foundations for different kinds of pavement surfacings. Various degrees of satisfaction have resulted. Properly laid, the supporting power and stability of such foundations is relatively high and in many cases under the local conditions, their use has been economical. On the other hand, in some cases, the development of traffic conditions has resulted in such severe strains on these foundations that they have failed, and have had to be replaced by the more substantial concrete slab. Probably most of the failures of these pavements as foundations have come through the lack of evenness of surface obtainable on them, and a consequent lack of uniformity in the thickness of the pavement surfacing.

Apparently the highest type of artificial foundation is the concrete slab. The power of such a foundation to distribute widely stresses coming through it is very high, so high in fact that it will often carry stresses like a beam.

Little has actually been determined as to its distributing power and as to its abilities in pavement foundation to carry indefinitely these beam-like strains. There is great need for investigation on these points. The cement concrete slab, however, has proven its ability to aid weak sub-grades to carry satisfactorily continuous heavy traffic; to aid good sub-grades to support the heaviest traffic; and, within limits, to insure permanency for these effects or results. "Within limits" is used in this statement because of the rather recently developed agreement among at least engineers advanced in the study of the matter, to the effect that cement concrete slabs used as pavement foundations are not the rigid masses they were commonly supposed to be, nor is their elastic limit in any case coincident by any means with their ultimate strength. On the contrary, they have a limited amount of resiliency or elasticity, and they have what is perhaps fully as important, the ability to become permanently deformed. That is, the cement concrete under continuously repeated stresses flows and the slab takes a different position from that which it formerly occupied. This theory explains the deformation of the surface of some pavements which has occurred in numerous cases, and which cannot be explained by any shifting of the pavement surfacing or of any intermediate sand layer.In such cases, the surface of the concrete foundation is found to be deformed and yet no deterioration of the concrete itself is evident. Admitting this to be true shows again the necessity of proper consideration of the sub-grade even when it is to be reinforced or supplemented by a concrete layer above it. Too often the practice has been to consider no care necessary in the selection or preparation of the sub-grade where a concrete slab was to be interposed between it and the pavement surface. The contrary should be the real practice, and not only should the decision as to the use of the concrete slab be based on careful consideration of the possibilities with the natural material of the sub-grade, or of other materials brought in for its improvement, but also when the concrete slab shall be decided upon for use, careful consideration of the possibilities of the natural material for the sub-grade, and even of other materials brought in for its reinforcement, should be had, so that the utmost use of the concrete slab may be developed, as well as economy had in its introduction.

The standard concrete pavement foundation in America is 6" in thickness. A greater thickness has been advocated as desirable and even necessary under certain extreme traffic conditions. It is a fact that the pavement on a 6" slab seems to have given way under such traffic conditions in certain cases, but it is equally the fact that even in these cases, the fracture of the slab or the actual failure of the slab itself as such has seldom been found to take place. What did occur was the subsidence or deformation of the slab without fracture and without destruction and this deformation appears to have been permitted by a failure of the supporting foundation. It would seem to the writer that a remedy such as preparing and providing better sub-grades should be considered in these cases along with the provision of a thicker slab, and that the decision might be for one or the other according to the demands of economy in the case.

On the other hand, the necessity for a minimum of 6" to the concrete slab in all cases may be questioned, and why even 3" of good concrete would not answer the purpose under many local conditions and where proper regard is to be shown the preparation of the sub-grade and the provision of a permanent and fairly substantial natural foundation, is not apparent.

It is impossible in the limited time assigned the writer to discuss exhaustively, or even perhaps to mention all the points of interest in connection with foundations, but if he has indicated to you a majority of the important ones and done so intelligibly and in a manner which will permanently impress them on your minds as well as inspire discussion at this meeting, he is repaid for his effort.

End of Session Six.

SEVENTH SESSION.

(Mr. Michaud in the Chair).

The President: We are honored to-day by the Presence of the Mayor of Quebec who takes a great interest in this question. One of the chief problems he has to solve at present is the improvement of our toll-gate roads round Quebec. However it seems that the legislature is going to take up that question this year. I am sure you will be pleased to listen to Mr. Lavigueur.

Mr. Lavigueur, Mayor of Quebec:

Mr. Chairman, Gentlement: I wish to thank the president for having asked me to say a few words to you, as I consider it a great honor to address this Assembly. I must say frankly, however, that I came here to learn something, and not to talk. I am delighted to see the interest taken in this Association; we expect the best results from it for the country and for our towns and villages.

The provincial government passed a law some time ago relative to good roads, and we certainly have derived a lot of benefit from it. We hope soon to have a law passed by the legislature abolishing the tolls; they have alweys been an obstacle to the traffic in and about Quebec. As Mayor of Quebec, I can assure you I shall do my utmost to further this project, as our city will certainly have to pay its share in the construction and maintenance of the roads that the government will take over; and I am sure the City of Quebec will also help to do away with the tolls.

Mr. Duchastel: Mr. Michaud has asked me to say a few words about foundations. I am afraid I can hardly add anything of importance to what has already been said here. Mr. Snyder has called our attention, and rightly too, to the use of the split log drag and other machines to get our roads in good order in the spring. In a climate like ours, the foundation is very important, on account of our severe frosts.

The main thing in road-making is to build your foundation in such a way that the drainage is as deep as possible. The foundation should be solid, built of proper materials, and drainage provided to take away all water from the surface of foundation.

I am only speaking of country roads; we have more of them ,and therefore they are really the most important. Our ancestors made the first roads, these were gradually improved, and became later on, the highways of commerce. If the work was badly done at first, the upkeep of these roads was a very expensive problem, so that really, the financial part of the question is the one to tackle first.

We often speak of a permanent road—such a thing does not exist: any kind of road surface will wear down in time. The better they are, the quicker they will wear because they will get more traffic.

How long will these coverings last? That is rather difficult to decide; of course ,maintenance has a great deal to do with it. Some parts of the road are really permanent; the banks and earth-works, if they are well done, are practically permanent, and will not have to be renewed. The grading must be properly done, the curves right, and the road built in the right locality.

Then comes the foundation; if the latter is wide enough to bear an improved highway which might be constructed later, then we can consider the foundation as an expense that is done once for all.

Looking over the cost of this work, two-thirds of the expense represent permanent structure, and the other third represents the wearing surface, and that is almost like a coat you are buying. If it is a Sunday coat, it may last you two or three years, but some day, you will have to put it aside; but if it is a coat for every day wear, it wont last nearly as long. There is a limit to the wearing surface, and that depends a great deal on the amount of traffic on the road; however, the average cost of the surface should not be more than one-third of the whole cost of construction.

The President: I see Mr. Boyer, from Vaudreuil here; he knows a lot about roads; I am sure he can tell us many interesting things.

Mr. G. Boyer, M.P. I did not come here to speak, but to listen. I am perfectly astonished at the work accomplished by this Congress and I am sure we shall all get some good results from it.

We are very much interested in good roads in Vaudreuil. Eight municipalities alone borrewed a million dollars for this purpose; we have about 129 miles of roads in our county, that makes about $6,000 per mile. From what I have heard to-day, I am afraid that sum will not be sufficient.

Road-making is one thing, but keeping them up is another, and the more important of the two. The president insisted on this point. But we don't need only technical means, if I may say so, but mechanical means. We cannot expect our roads to last, if we do not inspect them and do all that is necessary to maintain them in good condition; but I think we could do something more than that; for instance, the width of the tires of heavy wagons should be increased for all heavy loads; we have to keep up our roads, but we might also reduce the wear and tear a little. We passed a bye-law, last summer, making the width of the tire equivalent to the load; to carry

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an eight-ton load, the wheel had to be 5 1-2 inches wide. Such a policy would have to be adopted generally, otherwise, we should not get many results. This association might take the matter up, and have the legislature pass a law for the whole province.

I also want to call your attention to the question of quick traffic. Some automobiles travel through the country at a reasonable rate; others rush along at a break neck speed, and the farmers find their roads positively dangerous; surely tourists might remember that the roads were not made for them in the first place, and that the farmers have the first right to them.

I haven't any grudge against automobiles, because they do represent progress, just the same as the railroads do, but I should like this Association to call them to task a bit for their shortcomings. I notice that some one said that gravel banks are a gold mine—well, I did not know that we had any gold mines in my county, I'm very glad to hear it. Rigaud Mountain is composed of hard gravel, containing little or no sand. We are going to profit by this idea, and I can tell you, we shall make some fine roads with that gravel.

It's really technical knowledge that we lack; all these things should be better known, we want more technical education everywhere.

Selection of Surfaces and Materials as Governed by the Traffic that they Must Carry

[By Wm. D. Sohier]

(Chairman of the Massachusetts Highway Commission).

The President: We shall now have the pleasure of hearing Col. W. D. Sohier, Chairman of the Massachusetts Highway Commission, who is a very distinguished expert, and who will speak before you of the beautiful roads of his State. He will also put before you some of the beautiful expenses in regard to construction and maintenance.

Col. Sohier

The selection of the best materials and the proper use of those materials in the construction of a road surface that will remain in good condition for a reasonable length of time, and will economically carry the traffic that uses that particular road, is the most important as well as the most difficult problem which the highway engineer and road builder has to solve.

Selection Determined by the Available Funds.

Many times and in many places he cannot build the class of road he wants to, because there is not money enough available, or the materials which he knows would give the best results are not available and cannot be secured at any reasonable expense.

The engineer, therefore, has to take every time into consideration, the money available, the best materials that can be secured within a reasonable distance of the road, and the best method of using those materials in constructing the road.

Use of Local Materials.

Speaking broadly df both Canada and the United States and of my own State, Massachusetts, as well, on the main through roads in the country districts the best local materials must be used, because you could not possibly secure enough money to build the long through routes with any other materials within any reasonable number of years.

A road, like a chain, is no better than its weakest link. If portions of the road are impassable, the whole road cannot be used, and through traffic will cease.

Good Location, Alignment and Grades Essential.

For the purposes of this paper I must assume that a right of way has been secured of adequate width, properly located, with good alignment, reasonable grades, etc.

Adequate Drainage Essential.

I must also assume that the road has been constructed with adequate drainage, as without the necessary drainage any road will soon be destroyed and will become a series of bog holes and ruts with a horse path in the middle, full of mud, and that does not constitute a road, even if we do have to travel over many miles of such abominations in both countries.

Foundation Must Carry the Road Surface.

I must also assume that the road has been properly graded with suitable materials, so that the sub-grade and foundation are strong enough to uphold the road surface with all traffic that goes over it without failing, because if the bottom drops out no road surface will stay up.

Selection of Surface.

This brings me to the question of the selection of the materials of which the road surface is to be constructed, and what methods should be used in its construction and maintenance.

Here again the road builder has necessarily to consider how much money can be secured for the construction, and how much money he can secure for maintenance thereafter.

If he cannot get the money to construct a permanent road, even though such a road would be the most economical in the long run, including the yearly interest and sinking fund charges, but can obtain the money for maintenance, from the motor vehicle fees or elsewhere, he may be forced to select cheaper materials and then rely on constant maintenance, oiling, tarring, and patching to maintain his road surface in good condition.

Traffic and Roads.

In the near future, no doubt, the heavy traffic on our roads will increase greatly, but will be carried by motor truck instead of by wagon, and then, possibly, as is now the case in England, the traction engine, weighing from ten to fifteen tons, may come into general use, hauling several trailers, each carrying from six to ten tons. The roads may have to supplement the railroads in transporting the freight to our larger cities. I believe, however, that in this country, with its tremendous development of trolley roads, the rails and not the roads will take the bulk of this traffic. Certainly I hope so, as the poor road builder has enough hard problems to solve today without having to care for such additional and extremely heavy traffic.

Roads Must Carry the Traffic, and Economically.

Naturally, the first and most important perquisite of a good road is that it shall carry the traffic of all kinds that goes over it, comfortably, economically both for that traffic and for that road. The road must be so designed, built and maintained that it shall be at all times in proper condition to bear the traffic to which it may be subjected, and not only at the least cost to the user, but also at the least ultimate cost to the taxpayers, taking everything into account, viz.: interest, sinking fund, yearly maintenance and occasional resurfacing.

Traffic Indicates the Kind of Road Required.

Road builders must consider not only the traffic that is now using any given road to be built or resurfaced or even

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maintained, but also what the traffic will be in the near future and how much it will increase and what changes will come in its character and volume. After these premises have been ascertained the road builder can, if he knows enough, build or resurface or maintain the road so that it will economically and satisfactorily carry its traffic in a series of years.

Knowledge of Traffic Necessary.

Without that knowledge he is really entirely at sea; he is likely to make serious and costly errors by determining upon the wrong kind of construction and by selecting improper or unsuitable materials or methods. Naturally, also, he must select the type of road to be built, not only with regard to the traffic to be borne, but also with regard to the cost of the particular materials in any given locality, and the amount of money he can afford to spend.

Even were I competent, I could not discuss all these topics in one short paper, so I will stick to my theme "Traffic," with possibly a few remarks upon our experience, failures or successes, with certain materials and certain kinds of construction and maintenance compared with the traffic on the road.

Traffic Census on Roads in Massachusetts in 1909, 1912, and 1915.

The Massachusetts Highway Commission in 1909 had a census taken upon the state highways at 238 stations, scattered throughout the state; and in 1912 a similar traffic count made at 156 stations, and in 1915 at 192 stations. A traffic census was also taken at the same time at quite a number of points around the city of Boston on roadways in Metropolitan and Boston park systems. The time and method of counting was identical at all points, and the full returns and methods will be found in our annual report for 1909, and again in the report for 1912, and in the report for 1915, which will be printed and ready for distribution next June.

How the Census was Made.

The vehicles actually passing on the road were counted by observers who were engaged for the purpose. All vehicles were counted for 14 hours a day (7 a.m. to 9 p.m.) for seven consecutive days in August, 1909, and again for seven days in October, 1909, at 238 stations, the daily census at each station being tabulated on a card. This same census was made again for like periods of time in August and October, 1912, and again in 1915. At a few important points a count was also made at night, the census at these places covering the whole twenty-four hours.

Method of Tabulating.

The cards kept by the census takers were printed and had a separate line for tabulating the following class of vehicles:

KIND OF VEHICLE:	7 a.m. to 9 a.m.	9 a.m. to 11 a.m.	11 a.m. to 1 p.m.
Single horse (light vehicle)			
Single horse (heavy vehicle)			
Two or more horses (light vehicle)			
Two or more horses (heavy vehicle)			
Automobile (runabout)			
Automobile (touring car or wagon)			
Motor (truck or omnibus)			
Totals			
Weather conditions			

The cards were filled in by the observers and sent daily to the engineer, who in turn forwarded them to the main office of the commission for tabulation.

Tabulation and Computation.

After the cards were received the number of vehicles observed at each point was tabulated and computed to show the average number of each class of vehicle passing the given point per day, the total number of vehicles, and the total of each class, both motor and horse-drawn.

When these figures were obtained the percentage of each class of vehicle using the particular road was computed, and the percentage of the total of each class at all stations was computed as well.

After these averages were computed for each of the 238 stations in 1909 and for the 156 stations in 1912, and for 192 stations in 1915, the total average number of vehicles at all the various stations was added, the numbers ascertained, and from this was obtained the average number of vehicles passing each day at all the points where the count was made, as well as the average number of each class and kind, and the percentage that the vehicles of each class bore to the average total number.

Increases and Changes in Traffic in 1902, 1912 & 1915.

In Massachusetts the traffic using our roads is constantly increasing, but it is changing much more rapidly than it is increasing. This is conclusively shown by the following tables:

COMPARISON OF TRAFFIC IN 1912 AND IN 1915.

	—1912 Census, 156 Stations—			—1915 Census, 192½ Stations—			
	Average total number per day	Average per day per station	Per cent of each class	Average total number per day	Average per day per station	Per cent of each class	Per cent Increase or Decrease over 1912
Motors:							
Runabouts	5819	37.2	11	15746	82	13.5	x 122
Touring Cars	27178.5	173.5	49	73207	380	63.0	x 114
Trucks	1800	11.5	3	7260	38	6.0	x 230
TOTAL	34797.5	222.2	63	96213	500	82.5	x 129
Horse-Drawn Vehicles:							
1-horse, light	8380	53.5	15	6886	36	6.0	–33
1-horse, heavy	7458	47.6	14	8412	44	7.0	–7
2 or more horses, light	556	3.6	1	613	3	0.5	–17
2 or more horses, heavy	3870.5	24.7	7	4417	23	4.0	–7
TOTAL HORSE-DRAWN	20264.5	129.4	37	20328	106	17.5	–18
TOTAL ALL KINDS	....	351.6	....	....	606	....	x72

	1909 Average per station per day	1912 Average per station per day	1915 Average per station per day	% Increase in 6 years
MOTORS—				
Runabouts	20.8	37.2	82	*300
Touring cars	75.3	173.5	380	*405
Trucks	....	11.5	38	....
Total	96.1	222.2	500	*420
HORSE-DRAWN—				
1-horse, light	71.5	53.5	36	–35
1-horse, heavy	49.3	47.6	44	–11
2 or more horses, light	4.2	3.6	3	–28
2 or more horses, heavy	26.0	24.7	23	–12
Total horse-drawn	151.0	129.4	106	–30
Total all kinds	247.1	351.6	606	*145

The above-mentioned figures represent a traffic count taken in 1909, 1912, and 1915, for fourteen days in each year, and from 7 a.m. to 9 p.m. on each day.

The average number of vehicles passing over the State highways a day was 247 vehicles a day in 1909, 351 vehicles a day in 1912, and 606 vehicles a day in 1915.

This represents the average number at each station. Naturally the number passing a given station each day varied from 125 a day, or 20 on a road out in the country, to over 2,000 a day on a main highway near Boston.

The most important feature, however, is not the total increase but the change in the class of vehicles that are using the highways.

Motor Vehicles, which had increased in numbers 131% from 1909 to 1912, from 96 to 222 a day, again increased 129% from 1912 to 1915, increasing from 222 a day to 500 a day.

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On the other hand, the number of teams using the roads decreased on the average 14%, from 151 a day in 1909 to 129 a day in 1912, and again the number decreased 18% from 129 a day in 1912 to 106 a day in 1915.

The net increase in the traffic was 72% from 1912 to 1915.

Comparison of Changes in Six Years.

The total number of vehicles using the State highways has increased 145% in the last six years, from an average of 247 vehicles a day in 1909, to an average of 606 vehicles a day in 1915.

What is even more astonishing is the change in the traffic.

In 1909 the average number of horse-drawn vehicles was 151 a day, and there were only 96 motor vehicles a day.

In 1915, six years later, there were only 106 horse-drawn vehicles a day, as compared with 500 motor vehicles. The horse-drawn vehicles have decreased 30% while the motor vehicles have increased 420% in the last six years.

The decrease in the horse-drawn vehicles during these six years has been 35% in the light single-horse vehicle; 28% decrease in the two-horse light vehicle; 11% decrease in the single-horse heavy vehicle, and 12% decrease in the heavy two or more horse vehicle.

In these six years the average number of light horse-drawn vehicles using the roads has decreased from 76 a day in 1909 to 39 in 1915, while the automobiles have increased from 96 a day in 1909 to 500 a day in 1915.

Motor Trucks.

As we stated in our report in 1912, motor trucks were rapidly increasing in numbers and were going over roads a long distance away from the cities.

With their heavy loads and comparatively great speed, they will soon destroy any road that is not strongly built, with a strong surface on an adequate foundation.

Their increasing use of the roads is making it more and more expensive each year to either maintain, construct, or resurface the roads. They make necessary stronger and deeper foundations, as well as stronger and more expensive surfaces on all main roads.

There were practically no motor trucks on the State highways in 1909. In 1912, however, there were 11½ a day on the average, and they constituted 3% of the traffic.

In 1915 the average number of motor trucks was 38 a day, or 6% of the traffic.

They just about equalled the light horse-drawn vehicles, of which there were 39 a day in 1915.

One must realize that this 38 a day is the average number at all the 192 stations.

The number of motor trucks on main roads near the cities was, of course, several times greater. There were over 50 a day on the average on the State highway in Pittsfield, Lenox, West Springfield, Deerfield, Hadley, Northampton, Leicester, while Longmeadow had 76 and Chicopee 95 a day.

On roads running out of Boston, 15 to 18 miles out, there were usually between 30 and 70 a day.

Blackstone had 29, Uxbridge 30, Wayland 88, Grafton 44, Shrewsbury 4, Lexington 60, Tewksbury 41, Andover 70, Salisbury 63, Lynn 96, Stoneham 5, Salem 139,

These roads fairly represent through, inter-urban motor trunk traffic, between Boston and cities like Salem, Lowell, Lawrence, Worcester, etc.

Then you will find certain roads where much of the local traffic is carried by motor trucks, carrying ice, coal, hay, express, etc.

You find in Gloucester 143 motor trucks a day; in Beverly 208; Salem 209; Saugus 151; Somerville 131, on the road to Medford and 102 on the road to Malden; Boston 120, and Watertown 339.

The same numbers of motor trucks are found south of Boston on the main roads.

Quincy had 62, Dartmouth 130, Bridgewater 40, Middleboro 29, Marion 62, Falmouth 32, Seekonk 70, Harwick 48; Orleans 35; Attleboro 100, Brockton 70, Barnstable 84, Milton 120, and Hingham 132.

These figures show conclusively that our highways must be strong enough to withstand motor truck traffic.

Pleasure Traffic Around Boston.

The census around the city of Boston in the Metropolitan parkways and in the Boston city parks is interesting.

The following figures relate to the census taken in August, 1912, for a week, and in August, 1915, at the same points. The figures are the average number of vehicles a day.

METROPOLITAN PARKS (Mostly Pleasure Vehicles):

	1912		1915		
	Total, all Vehicles	Motor Vehicles	Total, all Vehicles	Motor Vehicles	Percentage Motor Vehicles
Lynn, Prescott Place	1530	1411	2344	2297	98
Revere, Saugus River	1872	1808	3285	3211	98
Somerville, Alewife Brook	491	474	1528	1508	99
Medford, at Main Street	515	492	1051	1039	99
Somerville, Wellington Bridge	2528	2174	4155	3853	93
Milton, Mattapan Bridge	2383	1717	3907	3535	90
Medford, Malden River	1884	1848	4614	4597	100
Boston, Soldiers Field	NO COUNT		429	354	83
BOSTON PARKS (All Classes of Vehicles).					
Prince St., Jamaica Plain	1934	1715	3107	2951	95
Commonwealth Avenue, Charlesgate E.	3009	2634	3023	2848	94
Columbia Road, cor. Washington St.	1109	671	2428	1536	63

It should be noted that heavy traffic is excluded from most of the parkways except for local traffic.

Here again, on the traffic roads there were many motor trucks. In Revere there were 96 a day, in Somerville 127, in Milton 365, on Columbia Road 352 a day.

The increase in traffic is very remarkable on certain roads; for instance, in Medford, from 1884 vehicles a day in 1912 to 4,597 a day in 1915.

Only on one road, Columbia Road, which is a traffic road, is there a large percentage of horse-drawn vehicles. and even on that road the motors are 63% of all the vehicles,

On the parkways proper and strictly park roads, the percentage of motor vehicles varies from 95% to nearly 100% of the total traffic.

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Traffic at Night.

The commission had a count made at a few points for twenty-four hours, and the results shown in the following tables may be of interest.

DAY AND NIGHT, TWELVE HOURS EACH—(1912 and 1915).

	1912				1915			
	Automobiles		Total Vehicles		Automobiles		Total Vehicles	
	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
Lexington	302	59	438	104	987	67	1148	83
Watertown	373	72	671	141	1028	153	1217	202
Chelsea	103	10	358	53	248	43	618	111
Somerville	266	70	689	231	311	68	593	101
Boston	358	69	513	94	1249	102	1763	122
TOTAL	1402	280	2669	623	3823	433	5339	619

Twelve per cent of the traffic over these roads was in the nighttime in 1915, and over eighteen per cent in 1912. It should be noted, however, that both the day and the night traffic increased, but the traffic in the daytime increased more in proportion. The traffic in the daytime increased about 184%, while the traffic at night increased only 68%.

In connection with this traffic census which was being made at the different points, the city of Newton had a count of the traffic made at three different points on its main roads, the county covering twenty-four hours. The traffic in Newton is shown in the following table:

CITY OF NEWTON TRAFFIC.

	Automobiles		Total Vehicles	
	DAY	NIGHT	DAY	NIGHT
Washington Street, cor. Centre Street	1816	218	2274	258
Commonwealth Avenue, and Washington Street	2798	500	3027	524
Walnut Street, cor. Washington Street	1747	219	2343	265
TOTAL	6361	937	7644	1047

Here again 12% of the traffic was at night.

Computing several of the day and night counts shows that the average traffic at night is 12% of the total traffic which passes over a road; consequently about 14% should be added to the count made in the daytime and printed in the Appendix of our Report, to ascertain the total number of vehicles passing over any particular road during the twenty-four hours.

Increase in Travel Caused by Building a Good Road.

In some instances this is caused more by a diversion of travel from other roads in the neighborhood than it is by creating a new and pleasant route; in other places it is because a new and pleasant route is furnished, and, of course, always both causes enter in more or less.

Naturally, automobiles have brought in traveling, and put many places upon the map which were not there before, especially in New York and New England, where the woods, lakes, mountains and seashore furnish the great recreation and vacation resorts for the whole country.

A Few Specific Instances to Illustrate.

I have here used the August census in each case because it shows the summer travel.

There are two routes to Newburyport, on the main line for Maine and New Hampshire seashore resorts and also to the White Mountains via Crawford Notch.

In Rowley on the shore route, in 1909 there were 296 vehicles a day, of which 97 were motor vehicles. In 1912 there were 591 vehicles a day, of which 465 were motor vehicles, and in 1915 there were 759 vehicles a day, of which 650 were motor vehicles. Motor vehicles had increased from 97 a day to 650 a day in six years.

Newburyport Turnpike.

The Commission has been improving the Newpburyport Turnpike, using motor vehicle fees for the last five years. In 1909 it was a narrow, rough, and hilly country road. It is now a very fair oiled gravel road 16 to 18 feet in width for 26 miles.

It makes a second and shorter route to Newburyport.

The figures quoted represent the vehicles using the Turnpike 20 miles out of Boston, practically all through travel.

In 1909 there were 11 vehicles a day, of which 4 were automobiles. In 1912 there were 121 vehicles a day, of which 94 were automobiles; at that time the road was reasonably passable but not yet oiled.

In 1915 when the whole road was improved and oiled, there were 347 vehicles a day, of which 341 were automobiles.

There were 7 teams a day in 1909, and 6 in 1912; 4 automobiles a day in 1909 and 341 a day in 1915, six years later.

The Mohawk Trail.

What will happen when a new through route is opened, especially when the road runs through beautiful scenery, is well shown by the opening of the Mohawk Trail in the fall of 1914.

This highway is on the main highway east and west in the northern part of the State, and it connects Greenfield with North Adams.

Before the trail was built, the road over Florida Mountain was very steep, rough, and nearly impassable.

There are now on this route many miles of only reasonably good country dirt road, but it has all been widened and made safe and no grades on the trail are over seven per cent.

It is a most beautiful trip.

In 1912 on Florida Mountain, on this through route, there were 30 vehicles a day, of which 7 were automobiles. In 1915 there was an average of 287 vehicles a day, of which 266 were automobiles. This was in August before the route became well known. In October there were 496 vehicles a day, of which 472 were motor vehicles, and on the Sunday before Labor Day there were 3,268 automobiles that passed over the mountain.

It is not at all unusual to see automobiles from eight or ten different states drawn up on the roadside to enjoy the beautiful scenery.

The increase in through travel on the through routes is well illustrated by the traffic count taken on the Jacobs Ladder route, the main route between Springfield and Pittsfield.

In 1909 there were many miles of poor road on this route; in 1912 the whole road was passable and there was no extremely bad road; in 1915 the whole road is in very good condition.

In August, 1909, there were 115 vehicles a day, of which 77 were automobiles; in 1912 there were 325 vehicles a day, of which 209 were automobiles, and in 1915 there were 553 vehicles a day, of which 462 were automobiles.

The same thing is true on Cape Cod, where the main road to Provincetown in 1909 was extremely bad, but by 1915 the whole road has been put in very fair condition so that motor vehicles could go the whole distance in high speed.

In Wellfleet in August, 1909, there were 77 vehicles a day, of which 31 were automobiles. In 1912 there were 133 vehicles a day, of which 105 were automobiles, and in 1915 there were 196 vehicles a day, of which 136 were automobiles.

The same thing is true all over the State, and the road builder must not only build his road for the traffic that is using it now, but he must anticipate and provide for the greatly-increased traffic that is sure to come as soon as it becomes known that there is a good road on any particular route.

Motorists especially are always trying to find new routes and to see new country, whenever the roads are even fairly

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decent. When a really good road is built they come in hundreds and thousands, especially if the scenery is attractive.

The above statistics of the traffic and the increase in the traffic caused by the building of the roads and by the tremendous increase in motor vehicles, clearly show that the road builder must consider most carefully the traffic that will use the road after it is built, and not the present traffic alone.

What Traffic Must be Anticipated.

You must expect in Canada that when you get even a reasonably passable road leading from New York and the New England States into your beautiful country, that the motorist will soon find it out and you will have probably on a few main roads as much traffic as we have on the average on our State Highways in Massachusetts; to wit, 500 or more motor cars a day during the season.

You must anticipate this traffic and build your roads accordingly.

Width of Road Surface.

One thing which we have observed in Massachusetts is that when the traffic increases you must increase the width of the hardened surface of your roadway.

Our standard width for a macadam or gravel road surface for over fifteen years was 15 feet, with a 3 foot shoulder on each side.

We now find that on any main route, even far out in the country districts, there are so many motors a day that they have to constantly turn out onto the shoulder to pass other vehicles. This results in the macadam or gravel surface's being cut into and rapidly narrowed up, until only 10 or 12 feet in width is left. Consequently we are now constructing our main routes at least 18 feet in width of hardened surface,and having 21 feet in width on all corners and curves

As soon as the use of any tar or oil is made necessary to preserve the road surface, the narrowing up of the road surface proceeds very rapidly, unless the tar or oil is carried out over at least 18 feet in width, or the road is widened. Otherwise the whole hardened surface of the road would soon be sheered off and destroyed.

Road Surfaces.

What materials should be used and how?

This brings me back to the question of the money available and to what should be accomplished to accommodate the travel for some reasonable period of time.

As I said before, generally the best local material available has to be used.

If the road is on a route, like many of ours, that has practically no local traffic in teams, but is merely used for six to eight months in the year by touring motors, the road builder will naturally feel that all he needs to do is to build and maintain a summer road kept constantly shaped and in repair.

He will build this road of the best material he can obtain within a reasonable distance.

Take the 16 miles of new road which we have built over the Mohawk Trail; the funds available did not allow us to build anything better than a graded road, using the best available material. This road has two repair gangs kept constantly at work in keeping the road in repair. It is shaped with a log drag or road machine after every rain.

It now has to carry in the summer months an average of about 500 motor vehicles a day, and consequently we have had to coat it for the last two years with about one-fifth of a gallon of light asphaltic oil per square yard, each year, and this oil has had to be covered with sand to prevent its being slippery or picking up on the vehicles.

In many places a good dirt or gravel road can be made extremely satisfactory for summer travel if it is properly maintained.

I am going to insert a table that I made up a year ago, to illustrate what our experience has been with gravel and macadam roads with various surface treatments.

Surface Coatings of Asphaltic Oils, Tars, etc.

Today nine-tenths of all our State highways that have not been resurfaced have been coated and kept coated with some bituminous material and have been kept constantly patched. Where the heavy hot oil was used, it has lasted in some instances for five years, carrying a large amount of automobile travel but a small amount of heavy teaming. Under many heavy teams it has failed in a month or two. We have then used a light oil to lay the dust and prevent the automobiles from tearing the road up, and have left the stone to carry the travel until we could resurface the road.

Because of the automobile traffic on many main routes, we are now using in our resurfacing a bituminous top two to three inches deep. We have used refined tars by both the mixing and grouting method. We have used asphalts with the same methods, and we believe that use is economical and necessary on any roads that have more than 50 automobiles a day and where there are more than 50 loaded teams

I am giving a table showing the class and character of surfaced roads that we believe will stand traffic of a certain class, kind, and character—we believe it will prove economical and satisfactory with the traffic.

1914—AVERAGE DAILY TRAFFIC.

Table showing results of observations of traffic on different types of road surfaces in Massachusetts—Standard Road, 15 feet in width, gravel or waterbound macadam 5 to 6 inches in thickness, with adequate drainage and proper foundation, with 3-foot gravel shoulder on each side.

	light teams, carriages, wagons	heavy teams, 1-horse	heavy teams 2 or more horses	Automobiles
A good gravel road will wear reasonably well and be economical with	50–76	25–30	10–15	50 to 75
Needs to be oiled with	50–75	25–30	10–15	over 75
Oiled gravel, fairly good heavy cold oil, ½ gal. to the sq. yd., applied annually with	75–100	30–50	20	500 to 700 or more
Water-bound macadam will stand with	175–200	175–200	60–80	not over 50 at high speed
Cold oil or tar will prove serviceable on such macadam with	175–200	175–200	60–80	50–500
Macadam will then stand but the stone wears, of course, with	175–200	175–200	60–80	500 or more
Water-bound macadam with hot asphaltic oil blanket will be economical with	100–150	50–75	25–30	1500 and more with fewer teams 5 0trucks
And stand at least				
But will crumble and perhaps fail with over	150	75	30	
(on narrow tires, ice, farm and wood teams, etc.)				
Water-bound macadam with a good surface coating of tar (½ gal. to the sq. yd.) will stand with	100–150	50–75	25–30	1500 or more
bit requires to be recoated annually with ½ gal. of tar per sq. yd.				

It is assumed that all road surfaces are kept constantly patched, that before applying bitumen the road surface is cleaned and patched, and the bitumen covered with pea stone and sand or gravel and kept covered so that it never picks up.

Of course, in connection with this table it is absolutely essential that the drainage and foundation are sufficient and the material used is strong enough to crry the heaviest load which goes over the road without the road's being rapidly destroyed.

Materials That Have Not Failed.

The foregoing table has been somewhat changed as the result of our experience since 1912 when I first published a like table.

It expresses the consensus of opinion of our chief engineer and four division engineers and my own best judgment.

The results have all been obtained on many miles of road where we have used a good grade of asphaltic oil, either or cold, heavy or light, or a good grade of refined tar.

We have had many failures on short sections of road where a non-asphaltic oil was used or a poor grade of oil or tar, and many proprietary so-called dust-layers have failed. Roads that failed have been resurfaced or retreated, but the results are not tabulated in the above table.

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The table relates merely to the maintenance of gravel or water-bound macadam roads, not to bituminous macadam.

It represents our average experience on many miles of road at over 150 observation points.

Certain exceptions should be noted.

Army manœuvers, especially large bodies of cavalry and artillery, will rapidly destroy any bituminous blanket surface.

A blanket coat of hot oil on macadam will carry a much larger number of teams if there is a ratio of two to three automobiles on pneumatic tires to each team to keep the bituminous surface constantly rolled down when the horses and teams pick it up.

But note that a very few teams on narrow tires, or a few very heavy teams every day, will destroy the surface if the load is heavy enough to shear down entirely through the surface to the stone.

If this process is repeated once or twice a day, a rut soon develops and the road becomes muddy and the bituminous surface rapidly disintegrated.

Light oil or cold tar will then be more serviceable, laying dust while the stone takes the wear.

We have maintained a few miles of road in reasonably satisfactory condition with annual applications of a cold tar or water gas tar. They have required one-half gallon per square yard annually, and the results have been about the same and certainly no better than where we have applied two quarter gallon coats per square yard off light asphaltic oil the first year and one quarter gallon per square yard each succeeding year.

The cost for the cold tar has been more.

Invariably we clean and patch the road first and cover the bituminous material sufficiently to prevent its picking up.

We have sometimes tried dispensing with the cleaning and covering but shall not repeat that expensive experiment.

We can usually have the light asphaltic oil sprayed onto the roads by motor trucks for 1.2 cents to 1.5 cents per square yard, using one-fifth to one-quarter gallon per square yard.

The cleaning, patching, and covering costs about the same.

Since the above table was made up we have had no occasion to believe it was incorrect, as an approximation at any rate.

You must use some bitumen on the surface of either a gravel or a waterbound macadam road, if there are any motor vehicles using the road every day, say over 100.

More Permanent Types of Road.

We have had, as I have shown, not only a tremendous increase in automobile traffic, but the motor truck is constantly increasing.

I am printing a table of the motor vehicles registered in Massachusetts from 1906 to 1915.

STATEMENT SHOWING THE NUMBER OF MOTOR CARS REGISTERED AND LICENSES ISSUED, 1906-1915.

	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915
Autos (pleasure)..	6,572	7,733	18,066	23,011	29,792	36,284	46,096	56,712	68,100	90,693
Dealers' autos....	755	455	1,905	2,455	3,305	4,920	6,301	7,462	7,898	8,700
Trucks.....	.....	.....	.....	960	1,568	2,623	4,036	5,948	8,053	11,960
	7,327	8,188	19,971	26,426	34,665	43,827	56,433	70,122	84,051	111,333
Operators and chauffeurs.....	10,083	10,696	13,170	18,251	41,259	51,950	66,645	81,034	95,577	133,935
TOTAL RECEIPTS..	$33,085	$92,096	$121,488	$169,973	$374,789	$477,417	$616,245	$764,153	$914,119	$1,205,420

The traffic on most of the roads has increased even more in proportion than have the motor vehicles. On many new routes the motor vehicle traffic has increased from ten to fifteen times during the last three years.

The motor truck has come to us and will undoubtedly increase in numbers in the near future, especially on any route near the cities.

What this traffic costs has been clearly shown in a paper published by Mr. H. T. Wakeland, Engineer for the County of Middlesex in England. I quoted his figures last year, but I quote them again as you have not all read my remarks.

Motor Trucks and the Cost of Road Maintenance.

Mr. H. T. Wakeland, engineer of the County of Middlesex, which is just out of London and has a very large amount of traffic over its roads, has given some very careful figures showing damage caused to roads by motor omnibuses weighing about six tons each when laden. He took certain roads which had heavy traffic and gave the cost of maintenance (not including watering or cleaning) for macadam roads for three years previous to the motor bus traffic, and the cost per square yard for the year 1912-13. I insert a table:

ROAD	Average cost per yard super per annum for three years previous to motor omnibus traffic.	Cost per yard super for 1912-13, since advent of motor omnibuses.
	(cents)	(cents)
A.....	13.5	25.8
B.....	11.2	33.1
C.....	14.1	41.9
D.....	15.6	16.9
E.....	9.1	15.4
F.....	8.7	15.1
G.....	5.9	16.8
H.....	5.1	11.1
I.....	21.5	36.4
J.....	16.9	42.9
AVERAGE..	12.3	25.6

This shows that the average cost of maintenance for three years before the motor bus came in was about 12 cents a square yard a year. Since the motor bus was put on, the cost has increased to over 25 cents a square yard a year. The maintenance cost to carry one ton one mile in 1911-12 was 1.2 cents. When the motor bus was put on, the maintenance cost was raised to 1.8 cents per ton per mile. Mr. Wakeland's opinion is that this increase was practically all due to the motor bus. The increased cost of the road up-keep has been found to be about four cents per car per mile, or two-thirds of a cent per ton per mile in the case of a motor bus on rubber tires. In many cases the macadam surface has been practically destroyed by motor bus traffic on hard rubber tires. These were macadam roads in good standard condition prior to the inauguration of the motor bus traffic and more than sufficient to carry the ordinary traffic. The road authorities should be authorized to direct which roads shall and which roads shall not be used by motor vehicles and motor busses, and Mr. Wakeland states, as do the other county engineers in England, teat a license fee of $50 a year for motor trucks is entirely nsufficient to pay for the increased cost of maintenance caused by the use of the trucks on the roads.

We believe that this traffic will increase in the future and that we must provide for it and prevent its destroying our roads by building stronger roads, not only on the surface but thicker and on more adequate foundations.

Present Road Construction.

In our construction work in Massachusetts on all main routes we are now building 18 feet wide with a three-foot shoulder on each side. We are making the curves 21 feet in width, and banking them where possible, and we are diminishing the camber to ¼ inch to the foot in width. This spreads the traffic and makes the road much less slippery for horses, and also prolongs its life.

We are building bituminous macadam surfaces, usually by the penetration method, using from 1½ to 2½ gallons of tar or asphalt to the square yard of surface. This is sprayed in under pressure in two or three applications.

We are building cement concrete roads where the traffic is heavy in loaded teams and trucks as well as in automobiles.

GOOD ROADS CONGRESS.

Gravel Asphalt Road Surfaces.

We have built some roads that, up to the present time, give every indication of being economical and extremely satisfactory for any reasonable volume of traffic, that are made of gravel (it must be clean gravel almost free from loam or clay) heated and mixed with a hot asphaltic residum or asphalt. When properly built these roads promise to be very permanent, and they cost about the same as a waterbound macadam road, when this gravel can be obtained near the road.

Extreme care must be taken to get a good foundation, well compacted, made of Telford or of a good gravel, to provide drainage where the sub-soil is loam or clay.

We often put up a crusher in the pit and use the coarser stone in foundation, rolling them thoroughly before spreading the asphalt mixture 3 inches deep on top.

The gravel should be a sandy gravel, and should contain a sufficient quantity of the finer material to diminish voids as far as possible. It must be thoroughly heated and mixed, using stones up to about 1¼ inches in size mixed with all sizes of finer material down to sand or stone dust.

The asphaltic product is heated and it is then thoroughly mixed with the gravel and sand in a mechanical mixer. It is then spread as evenly as possible upon the carefully prepared sub-base, and rolled with a tandem roller. The quantity of asphalt that should be used varies with the voids in the gravel and sand, aggregating from 18 to 22 of even 23 gallons of asphalt to the cubic yard of gravel. The variation is a matter of experience and judgment on the part of the engineer, but speaking in a general way, when the proper quantity is used the hot mixture has all particles coated, and it must spread and rake evenly and without compacting into lumps. It should, however, have sufficient bitumen to compact under the roller or become pretty well consolidated if you compress a lump under your foot. A little experience and experiment will give you the correct mixture. These roads can be built in many places where the proper quality of gravel is obtainable, for from $0.75 to $1.17 a square yard. With last year's prices for the asphaltic material of 6 to 8 cents a gallon, the gravel asphalt alone cost from 50 to 60 cents a square yard.

Selection of Road Surface.

The engineer who has to select a road surface has one of the most difficult problems possible to determine. I believe it may help you to reach the correct decision if I insert here again some tables published in England.

English Roads.

There is a very interesting and useful paper on construction and maintenance published in connection with the International Road Congress in 1913, this paper giving the experience of five of the most competent road engineers in England.

I am printing a table showing the weight in traffic in tons carried one mile for one cent of maintenance cost.

ALL WATERBOUND MACADAM WITH OR WITHOUT SURFACE TAR.

County.	—Weight of traffic in tons— Per day	Per annum	—Average cost— Per mile per annum $ c.	Weight in tons carried 1 mile for one cent.	Cost of maintenance in cents per traffic ton-mile.
Norfolk	39	14,200	206.25	.70	1.45
	96	35,000	80.00	4.50	.23
Warwick	185	67,500	430.00	1.60	.64
	239	87,200	635.00	1.45	.73
	242	88,300	430.00	2.15	.49
*Kent	348	126,700	1,495.00	.85	1.18
Norfolk	359	131,000	366.25	3.70	.28
	385	140,500	281.25	5.20	.20
	390	142,300	275.00	5.35	.19
Warwick	451	164,600	635.00	2.70	.39
Norfolk	504	184,000	251.25	7.55	.14
Kent	528	192,100	1,740.00	1.10	.90
Warwick	609	222,000	1,345.00	1.70	.60
	734	268,000	2,095.00	1.35	.78
	736	268,600	670.00	3.95	.25
*Kent	796	289,800	960.00	3.15	.33
E. Sussex	984	359,000	1,665.00	2.20	.46
Norfolk	1,057	386,000	1,090.00	3.65	.28
*Kent	3,030	1,102,810	10,500.00	1.05	.95
	3,030	1,102,810	8,960.00	1.25	.80
*Surrey	5,694	2,078,300	5,160.00	4.20	.25
	5,694	2,078,300	3,020.00	7.15	.14
COMPARISON WITH TWO MASSACHUSETTS ROADS.					
Beverly	2,898	1,058,430	3,257.00	3.25	.31
Weston	1,920	699,924	1,993.00	3.52	.28

*Surface tarred. Period of 14 years.

I have used the English long-ton but have changed the pennies to cents. This table shows that the cost on waterbound macadam roads to carry one ton one mile over the road varies from about a quarter of a cent to one and one-half cents for the maintenance. This illustrates very well, I think, the necessity of the traffic census showing the class and character of vehicles which use the road, rather than any formula which merely uses an assumed weight for each class of vehicle.

Massachusettes Experience.

We have found on our roads in Massachusetts that the largest cost of upkeep on macadam road could come from two causes; first, automobile travel, which would disintegrate a plain gravel or macadam road in a month if there were many automobiles. This could be prevented by the use of some bituminous material on the surface, provided the team traffic was not so heavy that it would quickly wear the binder out. A large number of heavily-laden teams, of say three tons or more, would wear the binder out in a very short time. Also, a very large number of heavy loads carried on narrow tires would wear a macadam road out relatively quickly. Some of the roads that I am showing would be worn from a half inch to an inch a year, if of macadam; whereas, when a bituminous macadam road with a three-inch top was constructed the amount of wear was very much reduced.

The necessity for knowing the kind of travel is well shown by the English tables. On one road in one of the counties it cost one and four-tenths cents to carry a ton a mile, and on another macadam road in the same county it cost twelve-hundredths of a cent. It appears from the English figures that when the cost of maintenance exceeded two-thirds of a cent a ton a mile, it was more economical to use granite block on a concrete base. The cost for annual maintenance of a six-inch block on a concrete base near the docks in Liverpool has been fifty-eight one-thousandths of a cent a ton a mile.

GOOD ROADS CONGRESS.

I am enclosing a table of some of the costs of different kinds of street surfaces and pavements in Liverpool.

Table giving particulars of experience obtained in Liverpool with different classes of surface pavement—including life-tonnage and ton miles per yard width per cent of cost.

Pavement.	Tons per yard width per annum.	Life, Years.	Life, Tonnage per yard width.	Cost per square yard of surface.	Annual cost including proportion of capital and maintenance per sq. yard.	Ton miles yard width per cent.	Cost in cents per traffic. per mile.
6-inch Belgium Block	524,000	18	9,432,000	$2.50	$0.17	17	.058
4-inch Belgium Block	150,000	50	7,500,000	1.87	07	12	.08
Hardwood	162,000	17	2,754,000	3.37	25	3.7	.272
Softwood	204,000	18	3,672,000	2.12	15	7.7	.128
4-inch Pitch Macadam	120,000	11	1,320,000	75	066	10.3	.096
7-inch Waterbound Macadam	120,000	1	120,000	.....	18	3.8	.264
7-inch Waterbound Macadam. Tar sprayed	120,000	2	240,000	25	12	5.7	.18

Tonnages on Roads Board basis, except on exceptionally heavy traffic when it is based on estimated total actual weights. English Ton equals 2,240 pounds.

From these tables it seems to me to be evident that there are two ways of ascertaining which road surface will be the most economical and best in the long run, and which will most economically carry the traffic. First, you must actually determine what the traffic will be. Then you can figure your cost including maintenance, interest, and retirement of debt.

From the English tables it seems evident that whenever on a macadam road the cost of maintenance exceeds somewhere about one-half a cent a ton a mile, such a road is not economical. One can better afford to build a more durable form of pavement and pay the interest and retirement charges and save maintenance.

Another way of stating the same thing is that when your yearly maintenance, oil, tarring, patching, etc., exceeds from twelve to fifteen cents a year per square yeard, you should adopt a more permanent type of pavement and cannot afford not to do so.

You will see from Mr. Brodie's table of the Liverpool pavements that for heavy traffic the granite block on a concrete base is the cheapest form of road surface, provided the traffic is so heavy that such a pavement is necessary.

I have merely made some figures to illustrate my ideas somewhat crudely, taking merely average costs and an assumed life. These figures are based upon the issuance of 20-year serial bonds, one-twentieth of the bonds being retired each year, interest being figured at 4 per cent. I have also assumed the maintenance cost of the road surface, assuming that the gutters, shoulders, and drainage work would cost the same on each class of road. These figures are not intended to show the average cost of the various classes of pavement where such surface should be used, but to show where, because of too much traffic, they wear out too quickly and are not economical.

Twenty-year Serial Four's:
Cost for retirement and interest, per $1 per year ... .071

Granite Block at $3 per yard:
Cost of bond per yard per year ..... .213
Average maintenance (assumed) ..... .01
.223

Sheet asphalt on concrete base at $2.25:
Cost of bond per yard per year ..... .160
Resurface in ten years for $1.25 per yard, plus ten years' interest at 4% (cost of resurfacing per yard per year is 1-20 of 1.75 ..... .0875
Average maintenance (assumed) ..... .045
.2925

Concrete at $1.50 per yard, 7½ inches thick:
Cost of bond per yard per year ..... .1065
Average maintenance (assumed) ..... .0275
.1340

Assume this road in ten years needs two-inch bituminous top at $1.25 per yard, plus ten years' interest at 4% (cost of resurfacing per yard per year is 1-20 of $1.75) ..... .0875
.2215

Bituminous macadam at $1.25 per yard:
Cost of bond per yard per year ..... .08875
Resurfacing in 10 years for 70 cents plus interest at 4% per yard per year ..... .0490
Average maintenance (assumed) ..... .0450
.18275

Macadam with tar or oil at 80 cents per yard:
Cost of bond per yard per year ..... .0568
Resurface in 10 years at 50 cents per yard, plus 10 years' interest at 4% (cost of resurfacing per yard per year is 1-20 of $1.75 ..... .035
Maintenance, oils and patching) ..... .055
.1408

Gravel Road at 25 cents per yard:
Cost of bond per yard per year ..... .0177
Cost of resurfacing at the end of each 5 years, at 25 cents ..... .0375
Cost of interest on first for 15 years, on second for 10 years, and on third for 5 years spread over 20 years is ..... .0150
Oiling, patching and maintenance ..... .0550
.1252

I think I have used maintenance cost and resurfacing, etc., figured at a point where each class or type of surface ceases to be economical or to make a satisfactory road.

The figures are based in most instances on some average costs on some of our roads, but in general a more permanent type of pavement would be better if the resurfacing and maintenance costs were as high as I have shown.

On many roads with very light traffic, gravel will wear much more than five years, perhaps with a maintenance cost of only one cent a square yard. With less than fifty or seventy-five motors a day it will not have to be oiled. On such roads it will be economical.

So it is with macadam and all other illustrations.

We have old waterbound macadam roads on main routes carrying an average of nearly one thousand motor vehicles a day, that are 20 years old. The maintenance cost including surface oiling or tarring, patching, etc., is from five to six cents a square yard a year. These roads are thin, and it would take but a few heavily-loaded teams or heavy motor trucks to break through and destroy them, and they must soon be replaced with a stronger surface, and often they will need a foundation as well when the motor truck or heavy team traffic increases.

Again in some places with a certain character of traffic, cement concrete roads may wear many years without needing any new surface of asphalt or tar concrete, but I thought I had better figure my fears rather than my hopes and be on the safe side.

I have selected a few places, out of a great many, to illustrate what the traffic is where the road surface will wear long enough to be economical, and other places where the traffic is too heavy and the road surface does not wear and therefore is not economical. I am giving the average traffic per day, adding the 1909, 1912, and 1915 traffic together and dividing by three.

All of these were waterbound macadam roads, and all have been coated with oil or tar on the surface, recoated when necessary, and kept constantly patched.

GOOD ROADS CONGRESS.

In the following places a macadam road has worn from 11 to 15 years, without resurfacing and with only enough additional stone to fill the pot holes. Two of them need resurfacing now, and four will probably last several years more with surface treatments and patching.

TRAFFIC AND ROADS THAT HAVE WORN.—Average Traffic 1909, 1912, 1915.

		—Horse-drawn Traffic—		———Motor Traffic———		
	Built	Light	Heavy	Autos	Trucks	Total
Hamilton	1900	83	54	323	35	495
Bourne	1898	33	49	436	39	557
Sandwich	1898	31	15	115	5	166
Falmouth	1904	54	46	264	17	381
Tewkesbury	1903	43	33	295	29	400
Brookfield	1900	25	21	429	13	488

In the following places the macadam surface, although coated with tar or oil has worn out rapidly and has had to be resurfaced, or needed it, within five or six years:

AVERAGE TRAFFIC, 1909, 1912, 1915.

		—Horse-drawn Traffic—		———Motor Traffic———		
	Built	Light	Heavy	Autos	Trucks	Total
Beverly No.	1896	126	203	402	63	794
Resurfaced in 1908. Resurfaced—Bituminous Macadam—1913-15.						
Somerville	1908	76	325	251	92	744
Cost 10c. sq. yd. a year for stone to patch holes. Resurfaced in 1915—Topeka Mix.						
Salem	1909	49	106	696	130	981
Constant pot holes. Resurfaced in 1915—Bituminous Macadam.						
Saugus	1898	25	233	110	118	486
Resurfaced in 1909 and again in 1915—Trap Rock—wore out ¾-inch to 1-inch a year under this traffic.						

In selecting the places mentioned above I have not attempted at all to show the total number of vehicles per day that could be carried by waterbound macadam with the surface treatment of tar or oil. I could give a great many illustrations of roads that had carried from 800 to 1,200 motor vehicles on pneumatic tires each day, and were still in good order.

What I have attempted to show and what our experience certainly demonstrates is that when you have once had to treat a road with some bituminous binder on the top, it is not the automobile traffic on pneumatic tires that wears it out; you have then got to consider mainly the actual crushing weight of heavily-loaded teams and trucks that go over the road. If they are sufficient in number to wear out the stone in a macadam road in five or six years, there is no question that such a road is not only not economical but is never in good condition for the traffic, and for all reasons a more expensive and durable type of pavement should be used.

If, on the other hand, the macadam road will wear without resurfacing and with only slight patching, tarring, and oiling, for twelve or fifteen or more years, then such a road and surface treatment are economical.

You will note in the tables given of traffic in the Metropolitan Parks that there are even 2,000 automobiles a day, but heavy traffic—meaning heavy teams and trucks—is not permitted. These roads are wearing extremely well with either light tar macadam or surface treatments only. The yearly maintenance cost is not at all excessive, probably from three to five cents a square yard a year.

I am printing in an Appendix a table which was made by one of our engineers, Mr. F. C. Pillsbury, giving the original cost of pavements with the life of the road figured at the end of every five years, and the maintenance cost figured from one to nine cents a square yard a year, with the interest on the original cost, so that you can figure from the table what the total cost per square yard per year of any kind of pavement is, including the repayment of principal and interest thereon for whatever length of time you assume that the road will wear.

In general, may I say to my Canadian friends and fellow-laborers, be of good cheer. It always seems slow at first, but you are much more awake, much more interested, have much more money than we had in Massachusetts only a few years ago.

In 1908, only eight years ago, it didn't seem possible to me that we could ever get our main routes passable, let alone constructing them. We were then spending $600,000 a year for construction and maintenance and State Aid roads.

Already most of the main routes we were trying to construct are completed, and at least are in passable condition from east to west and from north to south, and many other routes are completed or are well under way.

Our Commission is now spending about $3,000,000 a year instead of $600,000 for construction, maintenance, and State Aid roads, but this is not the most hopeful sign.

In 1908, just eight years ago, 37 towns appropriated about $37,000 to go dollar for dollar with the State's money in improving their roads. The Commission had then only $50,000 available for this co-operative work.

Last year and the year before the Commission had twice as much available from the State, or $100,000, and it also had $180,000 to $200,000 available from the motor vehicle fees to do work on the through routes in the towns in co-operation with the towns.

Instead of 37 towns appropriating $37,000 work was done in over 220 towns, out of a little over 300 in the State, and the towns and cities appropriated and spent over $300,000 of their own money in connection with that spent by the Commission. Besides this many towns and cities have co-operated by building the connecting roads through the villages entirely at their own expense, so that one year over $600,000 was appropriated by the municipalities themselves to help in this work, several municipalities appropriating from $50,000 to $75,000 in one year to connect up the main roads.

This is not the only hopeful sign; the counties are waking up and are co-operating with the towns and the State. In several of our counties the county commissioners are appropriating one-third of the cost of improving any main road in a poor town where the Commission will give one-third. The State pays one-third, the county one-third, and the town one-third. I look forward to the near future when we shall all get together, and when for every dollar the State spends, the country will give one dollar and the municipality a dollar, and three miles of road will be built instead of one.

Take last year alone: 180 miles of road were improved by the Commission; only 60 miles were State Highway, and nearly 120 miles were roads that were constructed by the co-operation of the state, county, and municipality.

I can say to you here that you have a much better chance than we had when we started. You are co-operating. The road may look long, the gaps large, and the task immense, but constant effort and co-operation will overcome all these. Before you realize it you will have completed your main through lines and you will be even talking of side lines.

Conclusion.

The best argument for a good road is the road itself. Get busy, build the best road you can afford to build; locate well, secure sufficient width of location, drain it well and grade it well with proper materials.

If that is all you can afford to do, do that and then keep the road constantly shaped and always in passable condition except for a short time, perhaps, in extremely wet or frosty weather. Show what a little care, attention, and money will do.

GOOD ROADS CONGRESS.

If you can afford it, put on a surface suitable for the traffic that uses the road and keep that constantly maintained.

One mile of road in good order is a better argument for good roads, and will produce more votes and more money and more good-road advocates in one year, than all the conventions and learned speeches that have ever been held and delivered in the last thirty years.

In closing let me say to you that I have never met anywhere in this country or abroad men who were more interested, more intelligent, or more competent than the engineers and committees that I have met that are doing your road work in Canada.

It has been a great pleasure to me to meet them, and I have learned a great deal from them, much more than I could impart. Mr. McLean and Mr. Michaud are well known to us in the States, and we value their advice greatly on all questions affecting roads and road building.

Table showing annual cost per square yard of various priced road surfaces, including first cost, plus interest at 4% on serial bonds, life of road equaling life of bond, with maintenance varying from 1c. to 9c. per square yard per year.

Maintenance	Life or Road & Bond	$ .25	$ .50	$ .60	$ .70	$ .80	$ .90	$1.00	$2.00	$3.00
$ .01	5	$.066	$.122	$.144	$.167	$.189	$.212	$.234	$.458	$.682
	10	.041	.071	.083	.095	.108	.120	.132	.254	.376
	15	.032	.054	.063	.072	.080	.089	.098	.186	.274
	20	.028	.046	.053	.060	.067	.074	.081	.152	.223
	25	.025	.040	.047	.053	.059	.065	.071	.132	.193
	30	.023	.037	.042	.048	.054	.059	.064	.118	.172
.02	5	.076	.132	.154	.177	.199	.222	.244	.468	.692
	10	.051	.081	.093	.105	.118	.130	.142	.264	.386
	15	.042	.064	.073	.082	.090	.099	.108	.196	.284
	20	.038	.056	.063	.070	.077	.084	.091	.162	.233
	25	.035	.050	.057	.063	.069	.075	.081	.142	.203
	30	.033	.047	.052	.058	.064	.069	.074	.128	.182
.03	5	.086	.142	.164	.187	.209	.232	.254	.478	.702
	10	.061	.091	.103	.115	.128	.140	.152	.274	.396
	15	.052	.074	.083	.092	.100	.109	.118	.206	.294
	20	.048	.066	.073	.080	.087	.094	.101	.172	.243
	25	.045	.060	.067	.073	.079	.085	.091	.152	.213
	30	.043	.057	.062	.068	.074	.079	.084	.138	.192
.04	5	.096	.152	.174	.197	.219	.242	.264	.488	.712
	10	.071	.101	.113	.125	.138	.150	.162	.284	.406
	15	.062	.084	.093	.102	.110	.119	.128	.216	.304
	20	.058	.076	.083	.090	.097	.104	.111	.182	.253
	25	.055	.070	.077	.083	.089	.095	.101	.162	.223
	30	.053	.067	.072	.078	.084	.089	.094	.148	.202
.05	5	.106	.162	.184	.207	.229	.252	.274	.498	.722
	10	.081	.111	.123	.135	.148	.160	.172	.294	.416
	15	.072	.094	.103	.112	.120	.129	.138	.226	.314
	20	.068	.086	.093	.100	.107	.114	.121	.192	.263
	25	.065	.080	.087	.093	.099	.105	.111	.172	.233
	30	.063	.077	.082	.088	.094	.099	.104	.158	.212
.06	5	.116	.172	.194	.217	.239	.262	.284	.508	.732
	10	.091	.121	.133	.145	.158	.170	.182	.304	.426
	15	.082	.104	.113	.122	.130	.139	.148	.236	.324
	20	.078	.096	.103	.110	.117	.124	.131	.202	.273
	25	.075	.090	.097	.103	.109	.115	.121	.182	.243
	30	.073	.087	.092	.098	.104	.109	.114	.168	.222
.07	5	.126	.182	.204	.227	.249	.272	.294	.518	.742
	10	.101	.131	.143	.155	.168	.180	.192	.314	.436
	15	.092	.114	.123	.132	.140	.149	.158	.246	.334
	20	.088	.106	.113	.120	.127	.134	.141	.212	.283
	25	.085	.100	.107	.113	.119	.125	.131	.192	.253
	30	.083	.097	.102	.108	.114	.119	.124	.178	.232
.08	5	.136	.192	.214	.237	.259	.282	.304	.528	.752
	10	.111	.141	.153	.165	.178	.190	.202	.324	.446
	15	.102	.124	.133	.142	.150	.159	.168	.256	.344
	20	.098	.116	.123	.130	.137	.144	.151	.222	.293
	25	.095	.110	.117	.123	.129	.135	.141	.202	.263
	30	.093	.107	.112	.118	.124	.129	.134	.188	.242
.09	5	.146	.202	.224	.247	.269	.292	.314	.538	.762
	10	.121	.151	.163	.175	.188	.200	.212	.334	.456
	15	.112	.134	.143	.152	.160	.169	.178	.266	.354
	20	.108	.126	.133	.140	.147	.154	.161	.232	.303
	25	.105	.120	.127	.133	.139	.145	.151	.212	.273
	30	.103	.117	.122	.128	.134	.139	.144	.198	.252

1st Cost	Life of Road & Bond	Interest at 4% Interest
$ .25	5	$.006
	10	.006
	15	.005
	20	.005
	25	.005
	30	.005
.50	5	.012
	10	.011
	15	.011
	20	.011
	25	.010
	30	.010
.60	5	.014
	10	.013
	15	.013
	20	.013
	25	.013
	30	.012
.70	5	.017
	10	.015
	15	.015
	20	.015
	25	.015
	30	.015
.80	5	.019
	10	.018
	15	.017
	20	.017
	25	.017
	30	.017
.90	5	.022
	10	.020
	15	.019
	20	.019
	25	.019
	30	.019
1.00	5	.024
	10	.022
	15	.021
	20	.021
	25	.021
	30	.021
2.00	5	.048
	10	.044
	15	.043
	20	.042
	25	.042
	30	.041
3.00	5	.072
	10	.066
	15	.064
	20	.063
	25	.062
	30	.062

GOOD ROADS CONGRESS.

Some examples showing comparisons of various types of surfaces.

1—Gravel vs. Waterbound Mac., 10 yr. life, 5c. maint.
Both directly from table.
Gravel, 1st cost, $ .25, equals $ .081 per year.
W. B. Mac., 1st cost, $ .60, equals $ .123 per year.

2—Gravel, 10 yr. life, $ .05 maint., vs.
Tar macadam, 15 yr. life, $ .03 maint.
Gravel, 1st cost, $ .25, equals $ .081 per year.
Tar Mac., 1st cost, $ .118 per year.

3—Tar Mac., 15 yr. life, $ .03 maint.
vs. Granite Block, 30 yr. life, $ .01 maint.
Tar Mac., 1st cost, $1.00, equals $1 .118 per year.
Granite Block, 1st cost, $3.00, equals $ .172 per year.

4—Gravel road, 5 yr. life, resurfaced at $ .25, at 5 yr. intervals for 20 yrs., $ .05 maint.
vs. Concrete, 20 yr. life, $ .01 maint.
Gravel, 1st cost, $ .25.

From table, annual cost: 1st 5 yrs, $.106 x 5yrs.	$ .53
Resurfacing 3 times at $ .25	.75
Maintenance for 15 yrs. at $ .05	.75
20	12.03
per year	.101

Concrete, 1st cost, $1.20

From table under .70 column	.060
From table under .50 column, $.046 – $.01 maint.	.036
per year	$ .096

5—Asphalt macadam, 10 yr. life, resurfaced, at $ .80 at 10 yr. intervals for 30 yrs., $ .02 maint.
Brick Pavement, 15 yr. life, resurfaced, at $1.60, at 15 yr. intervals for 30 yrs., $.01 maint.
Asphalt mac., 1st cost, $1.00

From table, annual cost, 1st 10 yrs — $ .142 x 10 yrs.	$1.42
Resurfacing 2 times at $ .80	1.60
Maint. for 20 yrs., at $ .02	.40
30	3.42
Brick pavement 1st cost, $2.50 ..... per year	.114
From table under $2.00	.186
From table under .50—.054 — .01 maint	.044
230 x 15 yrs.	3.45
Resurfacing 1 at $1.60	1.60
Maint. for 15 yrs. at $.01	.15
30	5.20
per year	.173

Discussion on Col. SOHIER'S Paper by Col. E. A. STEVENS (Highway Commission), New Jersey

The subject treated by Colonel Sohier in his very interesting paper is one of the utmost importance in the general questio nof road administration. In the selection of the type of road, the cost of maintaining a cheaper structure as against the interest on the cost of a more expensive one, should be given careful weight. It is also necessary to consider the kind of treatment that the road is likely to receive. Early, intelligent and thorough repair, especially of the minor defects will greatly reduce the cost of maintenance. it is to be recalled that if repair is not going to be properly attended to, a more expensive original construction will have to be provided, if satisfactory service is to be expected.

In considering the cost of maintenance, it is not enough to refer merely to the number of vehicles nor to the tonnage passing over the road. The speed at which traffic is carried is a very important factor, not only in that it entails a higher repair cost but because there is a commercial value in speed that can be measured, to a partial extent, in dollars and cents. A truck making a haul of four miles, with 7½ minutes at each end for loading and unloading, will at 8 miles an hour make eight round trips a day of 10 hours. With the same time allowed for loading and unloading, it will make twelve trips at about 13.7 miles, or 15 at about 19.2 miles per hour. Delivery service runs of 90 miles are quite common. The average speed being about 15 miles. while under way, and the time taken is about 10 hours. The actual running time is about 6 hours. It is easy to see that at 12 miles the length of run must be reduced about 18 miles or the time increased one and one-half hours.

For inspection of overhead wire lines, or transport of men, there are similar increases in the value returned. This value is the true measure of the service rendered and must be distinguished fro mthe increased cost of rendering the service. The latter is due to the increase in wear caused by increase in speed. The difference in wear on road structures due to this increase for a given weight transported will vary to a great extent with the character of the surface. If the figures for air resistance correspond with the generally accepted Beaufort scale, the air pressure against a moving vehicle would increase approximately as the square of the speed. The power, therefore, necessary to yield the thrust to overcome this pressure will vary as the cube of the speed.

At the higher speed it is probable that the air resistance forms by far the largest absorbent of the power exerted at the rear wheel. It is only reasonable to believe that the effect of the thrust upon the road structure will vary as the work absorbed, and, consequently, that it will be much greater at the higher speeds than at the lower. If the road structure is over-strained, the damage due to high speed will be very considerable. If, however, the stresses imposed are well within the capacity of the material, the damage due to the high speed may not be excessive. It is also well to consider in this connection the extent an ddirection of the resultant of all forces acting at the rear wheel of a motor driven vehicle. If the horizontal component is very large, there will be generated very considerable tensile and compressive stresses parallel to the road surface. If, as in the case of the front wheel, the forces exerted are almost vertical, the material will give satisfactory service as long as its crushing strength is not exceeded and the bonding material that holds it is not displaced.

The consideration of these facts will seem to explain the figures given by Mr. Wakeland and quoted by Colonel Sohier, as to the increased cost of maintaining English roads before and after the advent of the motor bus traffic. It would be interesting to know what had been the increase in the total of motor driven traffic during the period covered by Mr. Wakeland's observation, and the increase in the average speed of traffic. Without these, Mr. Wakeland's figures lose much of their value.

Our experience in New Jersey, while it has not been reduced to sufficiently accurate figures to allow of any close estimate of the cost, appears to agree very well with that of Massachusetts. Our gravel roads, however, are made of a very different material. Attemps to oil or tear them have been unsuccessful. The best results on such roads has been obtained with the use of lignin binders.

Cost figures alone, however, do not yield a satisfactory base of comparison, but must be studied in conjunction with a fairly accurate knowledge of the weight and speed of traffic carried. It would appear from our experience that a very considerable sum could be devoted to gaining this information and that economy, not only in design but in the system adopted for maintenance, would thereby be made possible. I do not, however, believe that counts taken three years apart will give enough information for this purpose. In taking any traffic census, it will be necessary to divide the traffic into classes and to assign certain average weights to each class. If speed is to be considered the same must be done for that factor. It would seem that the proper recording of each class could be insured, in the motor vehicle classes at least, by fixing conventional tags to the number plates. As to horse-drawn traffic, the observer's discretion could probably be trusted. Speeds and weights would have to be combined in each class so as to yield a moment to be applied to the total number of the class counted to give it its proper weight.

If value of service is to be considered, a function of the product of speed and weight would yield the correct unit; if, however, wear and consequent increased cost is to be considered, speed should be given greater weight by using some power of the speed as a factor.

The above ideas are not original with the writer. They were, I believe, first suggested by Mr. W. W. Crosby, Member A. S. C. E.

GOOD ROADS CONGRESS.

The President: We must congratulate Col. Sohier for his very interesting paper. He has told us that to a certain extent, the Province of Quebec is taking the same steps as they have taken in Massachusetts years ago. If they have won success I do not see why we should not win success in the matter of roads. He has paid a very great compliment to us, saying that, even in Canada, the progressive American could learn something. That is a very big compliment, and we are very glad to put it on record. He says he is always pleased to come to Canada. I think he is sincere and I am glad to say that as far as roads are concerned, our friends the Americans, are not neutral but they are our allies. We have always worked together for some years. We have gained by their knowledge and especially that of Col. Sohier, who has a big reputation, and a well deserved one, in the States, and who has always been so kind as to answer our invitation and give us the benefit of his knowledge. This morning we had a paper written by Major Crosby dealing with foundations, and we had no time to take up a discussion on the matter: we will do so now.

Mr. Snyder: I think the Congress is to be congratulated on Major Crosby's paper. I think that the drainage of a road and the foundation are the two most important things that we have. Now the drainage of a road may roughly be divided into two classes, that is for city roads and for country roads. In the country road the drainage is usually what you might call natural drainage where the water is carried to the nearest water courses either along the gutters or in ditches, but in your city roads and streets you usually have sewers and inlets to take care of your drainage. One of the main troubles in the city streets are not so much with your new roads and streets as with your old roads and streets. There are too many of us engineers who, when we repair an old road, accept the present grades, and go ahead and put on our surfaces the same as the old. Now I have found in my experience that it pays to re-run levels over your road get your gutters the grade of the streets and the inlets, and try and improve them by raising the gutters, making them shallower at the summit and water is going to lie in pools and it is going to deteriorate your roads. In the roads in your country districts your main trouble there is not so much the water that falls on the road from the rain but the water that runs on from the side hills, so it, in most cases, pays to put in side ditches to keep the water away from your roadway, and where you have a steep grade it always pays to put in inlets to keep your water from running along your roadway and deteriorating your road. Another thing I very much believe in is under drainage. Drain tiles don't cost much and in most city streets we may have sewers, they are very easily put in and you can connect them to the manholes or the inlets. Do the same in the country roads, put in French drains and drain tiles, and do your best to keep the water not only away from the roadway itself but from the ground under the road and you will find you will have less trouble with your roads. There is another thing, and while it is not exactly part of this paper it is important, that is the cuts and the pipe trenches in your city streets. One of the worst things you have to contend with is the putting of trenches for water and other pipes in your city streets. A by-law is to be passed that a certain street is going to be paved. That might pass today, in the summer time the contract will be let, and the new pavement put down. Within a month or two the water department, gas company, or other public utilities will go in and tear the street all to pieces from one end to the other to renew the pipes. The trenches will not be half filled and the consequence is that your pavement settles all along and the poor contractor that put in the pavement is condemned for putting in a bad job ,when it is the fault of the administradtion in not compelling all the public utilities and the others to have all this work done at least six months in advance of the pavements. Another thing there is a lot of trouble with cuts in pavement. Most of the work I have noticed around here and other cities is done like this. A public corporation will take out a permit for a cut, will dig a little hole for a man to crawl in, and will dig around under the pavement and subsequently fill it in any old way, and then they wonder why the pavement sinks. That should be regulated by by-laws, and they should be very strong. In planning a new road it is wise to go over the roadway in the spring, when the frost is coming out, and notice the bad spots, the spots that heave, and then when you build your road you can take these spots and provide some method for taking care of the ground water. If you do not do this, when you come along in the middle of the summer you will find that this ground, apparently is as hard as any other part of the ground and make no provision to take care of the heaving action that is going to happen the next spring when the frost goes out of the ground. Another thing very important in the upkeep of the road is to keep your drainage ditches open, to cut the grass and weeds and have your shoulder in good condition. If you don't do this you are going to have trouble—water will not flow naturally through ditches that are plugged. By taking all these precautions it is the only way we can get good drainage and good foundations and if the drainage is good and the foundation is good, even a poor material on your foundations will carry a good load.

Snow Removal in Montreal

By PAUL E. MERCER, Chief Engineer, Montreal.

The City.

The City of Montreal has a total area of 26,226 acres. The length of the streets aggregate 485 miles, 104 miles of which have tramways tracks. The sidewalks form a total length of 622 miles.

The Snow Fall.

The snow fall varies each year, but has averaged, for the last 41 years: 119.3 inches.

The number of days on which snow fell in 1915, was 79. Out of these 79 days, it rained and snowed on 28 days.

The snow-fall period covers five months: November to March. The heaviest snow fall we have had this winter was on the 14th of December, and was of 7.4 inches. The previous day we had a snow fall of 2.1 inches. On the 14th the temperature was 9.7 degrees, and the wind had a velocity of 23.7 miles per hour. The following day the temperature went down to 5.4 ,and the wind went up to 32.6 miles per hour.

Administration.

The affairs of the City are administered by a Board of Commissioners. The different departments report to and receive their instructions from the Board through the Heads of the Departments.

The Chief Engineer, known in the Charter as the City Surveyor, is the head of the Public Works.

The Public Works are divided into roads, waterworks and sewers, each under a Superintending Engineer.

The Roads have charge of the construction and maintenance of the roadways and sidewalks; the cleaning, watering and oiling of streets; the snow removal.

The snow removal is done entirely by the City, by day work. The cost of removal of snow from the sidewalks, is paid by the proprietors at the rate of five (5) cents per running foot. The cost of the snow removal from streets with tramway tracks is paid half by the Montreal Tramways Co., half by the City.

The cost of the snow removal in any other streets is paid by the City.

As the country surrounding Montreal has winter roads, the City does not entirely remove the snow from its streets, but keeps, during the winter months, a thickness of 6 to 12 inches of snow.

Organization of Labor.

The Road Department is divided in three divisions under the charge of a Superintendent, and in sections under a Section Foreman.

We have, therefore, the following organization:

BOARD OF CONTROL.

Chief Engineer.

Supt. Eng. Waterworks Dept.	Supt. Eng. Road Department.	Supt. Eng. Sewer Department.

General Superintendent.

	East Division. Superintendent.		North Division. Superintendent.		West Division. Superintendent.	
	Streets.	S'dw'ks.	Streets	S'dw'ks.	Streets.	S'dw'ks.
Time-keepers	2	4	2	4	2	2
Foremen.	21	18	23	19	20	23

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The snow plow, walkaways, etc., are kept in City yards as near as possible to the centre of each section.

Each section foreman keeps a list of laborers and owners of horses within his section.

The Division Superintendent keeps a list of owners of sleighs, single and double, in his division. Each sleigh is numbered and measured. A single sleigh must contain 65 cubic feet, and a double 210 cubic feet.

The Superintendents keep at their Offices reliable barometers.

At the beginning of a storm, word is sent to all section foremen to gather their forces.

Long before the snow season starts, routes are defined each plow is detailed to a certain route, so that each man knows where to go and what he has to do.

The Montreal Tramways Company, to keep its tracks clear during a snow storm, has a wonderful organization. Regular routes are mapped out for the sweepers, before the beginning of the winter. Routes that can be handled to best advantage from it are given to each depot. These routes are arranged so that each can be covered by its sweeper in from forty-five minutes to one hour and also arranged so as to have one central conveying point for three or four sweepers. In case of need, it is, therefore easy to direct a sweeper from another route, when it reaches this spot.

In each car, a blue print is posted, giving the detailed route of that particular car.

The necessary men are appointed to each car at the beginning of the winter, and they are kept during the entire winter. The Superintendent meets all of these men before the winter season and discusses with them proposed improvements on actual conditions.

Their organization is so well thought of, that, as Mr. Gaboury, the Montreal Tramways' Superintendent, said: "Each man knows where to go and what he has to do, and it seems that he simply goes and does it."

Machinery Used.

The Montreal Tramways Co., has 39 sweepers and 12 levellers or wing cars. Most of the sweepers are of the two-broom type, having on the right side a large iron wing to clear the snow from the outside of the track, and on the left side a smaller wing to clear the devil strip.

Single truck sweeper: 2-50 h.p. motors (G.E. 80), and 1-K10 controller at each end, 1-K10 controller for broom, length 28 ft., width 8 ft., height 11 ft., weight 31,000 lbs., wing 8 ft. by 2 ft. Used to brush off the snow from the track and push it towards the sidewalk.

Double truck: 2-50 h.p. motors (G. E. 80), and 2-K35 controllers for motors, 2-101 motors and 1-K10 controller for broom, length 39 ft. 6 in., width 7 ft. 6 in., height 11 ft., weight, 44,500 lbs., wing, 11 ft. Does the same work as the first one.

Leveller or wing car: Flat freight car fitted up with iron shaped wing 12 ft. long and 2 ft. high. The wing is pushed out by reinforced wooden bar operated by chains and drum—4-50 h.p. motors (G. E. 80), weight of car 43,400 lbs. Used to push the snow towards the sidewalks.

Single truck leveller or wing car: Made from old box car, length 26 ft. 7 in., height 11 ft. 1 in., width 8 ft. 6 in., 2 G. E. 80 motors, wing 16 ft. long, weighted down by double floor filled in with rails and cement, total weight 30,640 lbs.

Walkaways to move snow from the road towards the sidewalk. Ordinary automobile truck, fitted up with a side plow. The plow can be raised and put to any angle.

Snow scarifier used to lower or level the roadway. Hauled with four horses or by a truck. Cost $165 to $200. Built by the City.

Two-horse plow. The plow can be placed at any elevation or any angle. Bought at $150 and built by the City for $85.

One horse plow, same as the former one, but lighter. Cost $35, built by the city.

One horse iron scraper "Jumper," built by the City for $35.

One horse wooden scraper, used also as a plow: for sidewalks. Built by the City for $18. The bottom of this plow is protected by a flat iron bar, one edge of which is toothed. When necessary the toothed edge is used on the sidewalk to make a rugous surface.

The machineries are divided as follows:

	East.	North.	West.	Total.
Truck Levellers	4	2	4	10
Walkaways	11	12	15	38
Snow scarifiers, streets	4	2	5	11
Do., sidewalks	20	29	35	84
Plow, double	6	18	10	34
Do., single	96	84	109	289
Jumpers	35	..	..	35
Wooden scrapers	124	208	99	431

At the beginning of the storm, all hands are called. The Tramways sweepers are sent out on the route; the City plows are sent out to remove the snow from the roadways and from the sidewalks. The heavier the snow storm, the shorter the routes are made, so that each plow can be back at the starting point before the snow accumulates. Snow shovellers are sent out to keep the street corners clear of snow. Whenever a section foreman feels that his section will be snowbound, he calls the Division by telephone for more help.

In case of emergency, section or division lines are wiped out, and everybody works with one ambition: beat all the others in results.

Working hours are the usual hours in a ten hour day; but, if necessary, the work lasts as long as the snow.

We are now at another phase of the work. The snow has been brushed away from the tramway tracks, from the sidewalks and from part of the roadways. However strong the snow storm and however cold the wind may have been, the tramways have never ceased carrying the laboring class to their work, the office people to their offices, the ladies to the stores; the sidewalks were always kept in such a good state that even "my lady" could not find fault with the City employes, the roadway was clear enough to let the tradespeople deliver their goods.

The work of the sweepers and of the levellers is done, the Tramways crew may now rest and the cars are sent back to the yards.

A new phase now appears. This force is composed of 3,000 men and horses. They attack the snow banks from all sides and cart it away.

The City is, as you are probably aware, built on an island seven miles wide.

The snow used to be dumped in the river from the wharves, or on vacant lots. The larger the City got, the further the northwest boundary was, and the greater the hauling distance became.

The residents facing the dumping grounds objected, with reason, to the snow being left there. There was, therefore, only one place left: the river. But, in places, the distance was so great, that the cost was prohibitive.

In 1913, the Chief Engineer of the City, the late Mr. Janin, thought that the cheapest way to send the snow to the river was by the sewers. Special manholes were built and the snow was dumped in the sewers.

The sewers were not designed for this purpose, and nobody knew what would be the result of throwing such a large quantity of snow and ice in the sewers. The Department of Sewers, responsible for the maintenance and the cleaning of sewers, took the matter in hand, and studied the results.

The sewers used were collectors of a diameter varying from 3 ft. to 7 ft. 6 in. Some were 10 ft. below the roadway, some 42 ft. The length of the collectors varies from 1 to 4 miles, they are mostly built of brick and cement. The "snow manholes," as they are called in Montreal, were made of steel, with a 3 ft. 5 in. by 7 ft. cover.

To prevent large pieces of ice from falling through, a grating having openings of 4 in. is employed.

After three years of operation, the results were satisfactory. The sewers were, of course, found dirtier, and in some places the invert was crushed by solid ice falling 40 ft.

We have, therefore, designed a new snow manhole covered with galvanized iron ⅛ in. thick, and the sewer was also lined with galvanized iron ⅛ in. thick for a length of 12 ft. We think that this new manhole will answer this purpose, and withstand the shock of the falling ice.

The distance between the manholes varies very much, but the longest haul is approximately 2,000 ft.

Cost of Work.

The cleaning of sidewalks, including the spreading of sand, scraping, etc., costs 7½c. per running foot.

The cost of removing snow from streets is $2,500 per mile.

Concrete Roads and Pavements

By PELCY H. WILSON.

That good roads are a necessity for any growing community is a fact that has long been recognized by all students of economy, and not only are they advantageous to those who use them daily for the hauling of produce, or for general business transactions requiring the use of horse-drawn or motor-driven vehicles, but their advantage for military purposes is fast becoming recognized.

To those countries which have shown the greatest and most up-to-date expansion in the building of good roads, the words "good roads" are synonymous with the words "hard surface road." This has been forced upon the recognition of those having to do with road construction by the havoc caused by the increase of motor-driven over horse-drawn traffic.

While roads built ten or fifteen years ago, principally of Macadam or Telford types, admirably fitted the requirements of horse-drawn traffic, such roads were considered the last word in road construction, and a great majority of road engineers felt that when they had learned how to properly construct roads of these types, there was no further information that would be of advantage to them.

A glance at statistics, easily available, showing the increase in the number of automobiles, gives the reason for a radical change in road construction.

In the Province of Ontario in the year 1905 there was one automobile for every four thousand inhabitants; in the year 1915 there was one automobile to every seventy five inhabitants—an increase in ten short years of over 5,000%.

In motor driven traffic is the reason the maintenance charges on macadam roads has increased by leaps and bounds, and why road engineers are becoming more and more insistent on a class of construction to withstand this automobile traffic with a minimum maintenance charge. The answer is a hard surface road.

Our original roads were trails, and those pioneers breaking the trails naturally picked out the easiest course, that is, the direction which presented the least natural obstacle. Such trails were crooked, and were far from economical in so far as the cost of hauling was concerned.

As the country became more thickly populated these roads were straightened, bridges were built and swampy sections covered with corduroy, but little effort was made to place a harder material on the surface of the road. In consequence, hauling was confined to periods during the year when weather conditions did not make the road impassable. This was, of course, a great detriment to the farmer, since he could only haul his goods to the market at such times as the weather permitted, entirely irrespective of the prices which could be obtained for his goods when delivered.

We all recognize the fact that the value of a man's land depends upon the value of the material which he can raise on it; if the prices which he can obtain for his produce are seriously affected by road conditions, this, of necessity, affects the price of this land.

The reason cities and towns have grown is because their inhabitants recognize the necessity of having hard pavements over which to do business, and while this was forced upon them as a matter of convenience—getting out of the mud as it were—yet some certainly recognized the advantages to the town, both from standpoints of business and sanitation, and took advantage of the ultimate rise in land values by purchasing property when they found hard pavements were to be laid, and profiting by the rise in value.

Prior to a road improvement, the two most important items to be considered are the selection of the type of road, and the method of raising the money to build such a road.

In selecting the type, the first cost of the road is a matter for consideration, and in many localities those having to do with road construction have permitted their anxiety to stretch the amount of money available over as great a mileage as possible to cause them to lose sight of the fact that most roads are built on borrowed money, and that the time would come when the municipality would be forced to pay that money back.

Many roads, built from the proceeds of bond sales, maturing at periods of from twenty to forty years or over, are worn out at the end of five years. If the community is to obtain any value from their investment, a yearly maintenance cost is required to make the roads passable, taking each year a large percentage of the taxes. In the meantime, the community is paying interest on an investment for thirty-six years, which is of little or no use to the community.

The road, therefore, is no longer an investment but a cost to the community, and a type of road acting in this particular way will certainly never be accepted by tax-payers, provided they are conversant with the facts.

The combined maintenance and repair costs of roads in Massachusetts, Connecticut, Rhode Island, New Jersey, and New York for eight years, from 1905 to 1912, amounted to $698.00 per mile per year on all improved roads.

These roads averaged originally a cost of practically $10,000.00 per mile, and based on this cost the amount that the community was paying for maintenance alone was something over 6%—an amount greater than the interest on the bonds, together with the sinking fund if the bonds were to run for a period of over twenty years.

The type of road should, therefore, be moderate in first cost—not necessarily cheap—and further of a type of construction where the need of additional money accruing from taxes would not have to be expended in maintenance, but could be expended from year to year in extending the road system.

A road is built for use, not during three, four or five months in the year, but during the entire year, therefore the road must be of such a type as to permit this use by those paying for it at all times during the year, and only such a road as will permit of this use, and as will require the minimum maintenance charge with a moderate first cost, is the road which any community can afford to build on borrowed money.

For such communities as have nothing but dirt roads it seems a big jump to pass from them to hard surface roads; from a cost of practically nothing for the dirt road to a cost of about $12,000 per mile for the hard surface road. If, however, the taxpayers appreciated the fact that in building a road, other than a hard surface road, at practically a cost of from $6,000 to $12,000 a mile, loading the municipality with a debt they would be paying for over a period of forty years, and that out of the road they would get a maximum of five years' service, few would hesitate to build less mileage, and build roads of greater permanence which would not require continuous repairs.

Other items which should be taken into consideration are cleanliness, non-slipperiness in wet weather, and dustlessness. The concrete road or street fulfills all of these requirements in a very perfect way.

All those who have engaged in building roads realize that so long as the binder of the road is intact the road remains a unit under all conditions of traffic. The cement in a concrete road is the most permanent known binder. It is not affected by weather conditions, and on account of its positive nature presents a surface available for traffic at all times of the year.

The permanent character of a concrete road is best illustrated by the conditions of the roads which have been built for a number of years. One concrete road in the United States has been in continuous use for almost twenty-four years, and is in as usable shape today as when laid, in spite of the fact that this road was not built along the lines of later day practice.

We have many roads of concrete which have been in continuous service for five, six and seven years, and these roads have given most excellent satisfaction.

Concrete also requires an extremely low maintenance cost. The cost of maintaining a concrete road which has been in use for over twenty three years has been less than $30.00 per mile per year. Other concrete roads vary in the cost of maintenance required, but out of about 34,000,000 square yards, of which there are records, the maintenance charges on none of these roads have exceeded $50.00 per mile per year in any one year, and this is considerably higher than the average cost of maintenance over a period of several years. These costs do not include repairs to inadequate drainage system.

Some are deterred from building concrete roads, since they consider concrete a mysterious material, hard to understand. As a matter of fact, to build a successful

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road of any type requires care and attention to detail, a proper selection of material, a proper mixing of it,

The building of a concrete road requires attention to the same details, but all these details have been thoroughly tried out and the specifications recommended give those details settled upon as being the best methods to employ which will give the most satisfactory results.

Cement is a wonderful material. It is astonishing the amount of abuse it will stand and yet give fair results The concrete which goes into a road is not only exposed to the ordinary stresses which require strength, but in addition must withstand the impact and abrasion of traffic. Therefore, the concrete and aggregate composing it, must be as good as any.

In building a concrete road the same care should be taken to select an aggregate which is clean and proper for combination with the cement as is taken to select the proper sand to mix with asphalt or the proper brick to withstand traffic. It is no more difficult to lay concrete properly if ordinary caution is oberved than it is to construct any other class of road.

The following items of construction should be given very careful attention:

First—Drainage. Any road which is so badly drained as to permit the water to pass from one side of the road to the other, or to lie underneath the road surface, will leave in times of frost and the road disintegrate. Concrete is a little less likely to do this than any other class of road, due to the greater strength given to the road surface by the cement binder than any other known binder.

The majority of cracks, however, in a concrete road are produced by the lack of proper drainage caused in turn by the lack of proper preparation of foundations.

All road builders agree that a proper foundation is an essential, so far as road construction is concerned. It is no more essential for concrete than any other type of road—perhaps a little less so, due to the fact that the concrete has a strength which permits it to bridge over to some extent hollows or soft spots in the foundations.

The selection of materials, as has been previously noted, is extremely important. The cement is furnished under specifications adopted by the Canadian Society of Civil Engineers, and is subjected to rigid tests, both by the municipality purchasing same and by the cement company furnishing it.

The sand, however, is very generally left up to the engineer and the tendency is to use the cheapest local sand which can be obtained, regardless of its fitness.

It must be remembered that the combination of cement and sand forms the mortar which holds in place the particles of larger aggregate, and the strength of this mortar depends to a very great extent on the class of sand used. Soft sand, fine sand or dirty sand, will produce a weak mortar. The sand should, therefore, be well graded in size from fine to coarse, and should be clean, that is, free from loam or clay. Dirt in the sand does not permit the particles of cement coming in contact with the sand, and seriously affects the strength of the mortar.

The coarse aggregate is depended upon to take the wear in a concrete road, as it is depended upon to take the wear in every other class of road construction, and therefore, it should be hard, durable and clean, since again the cement must come in intimate contact with every part of the coarse aggregate in order that the coarse aggregate may be rigidly held in place.

In proportioning each batch the various quantities of materials should be very carefully measured, including the amount of water. The mass should be mixed to a consistency which will spread with comparative ease as dumped—not so dry as to permit loose stones to roll out of the mass, nor so wet as to cause the concrete to settle in the middle of the slab and bulge at the side of the road nxt to the forms after being struck off.

Bank-run material should never be used without first separating by screening into coarse and fine aggregates, so that the exact amount of each may be known. This is absolutely requisite for first class workmanship, and while it adds a certain amount of cost to the work, yet it prevents unsatisfactory work and saves money in the long run by using only the exact quantities of materials required.

In finishing a road wooden floats are used in order to give the road a rough finish. As thin a skin coat of cement and sand as possible should be drawn to the surface, since the skin coat under traffic rapidly disappears allowing the coarse aggregate to take the wear.

The most common mistake in finishing a concrete road is in over-floating. Such practice not only costs the contractor more money, but does not make as satisfactory a road.

Green concrete must not be exposed to the hot rays of the sun, and naturally must not be exposed to freezing, since concrete requires a certain amount of moisture to have it set with the greatest speed, and tne greatest early strength.

Curing is an important item. On bright sunshiny days, or on days when a hot dry wind is blowing the surface should be covered with canvas, supported so as not to touch it. After about twelve hours the concrete is hard enough to be sprinkled, and after twenty-four hours it is hard enough to be covered with dirt. This dirt covering should be kept wet for at least seven days. The wetting prevents the surface from drying out with greater speed than the interior of the mass and avoids hair cracks and also a chalky surface, both of which are most undesirable.

Another method of curing has been used in high altitudes where the evaporation is considerable, and also in street pavements where it is undesirable to haul the dirt on to the concrete and later on have to clean it up and haul it away again.

Dikes of earth are built around the slabs and the area enclosed flooded with water. This has been found a most effective method of curing.

The time of opening a concrete road to traffic varies to a great extent with the time of the year the road is built. Cement sets slower with the temperature verying from 40 to 50 degrees than it does with the temperature running up to from 80 to 90 degrees. A road, if built during cool weather should, therefore, be kept closed to traffic a greater length of time. All who have built roads appreciate the pressure brought to bear on the engineer by the community to force him to open the road in the least possible time. It seems ridiculous, however, for a community to pay from $12,000 to $15,000 a mile for a concrete road, and then become so impatient for its use to force its opening a week earlier than it should and ruin the road. The proposition is so absurd that it hardly seems necessary to even mention it.

There are a number of supposed objections to concrete as a paving material. These are very readily overcome when once a piece of concrete road has been properly placed.

There seems to be doubt in the minds of some engineers as to the effect of extreme ranges of temperature on concrete. A change of temperature, without a doubt, causes expansion and contraction in the road itself, but we know of no instance where it has had a bad effect on the road, provided the condition of the drainage, preparation of the sub-base and the making of joints have been properly cared for.

A slab 30-ft. long moves in a range of temperature of 150 degrees, $\frac{1}{4}$ inch, but since in such a movement the concrete is brought into compression no bad effects are experienced.

The cracks which appear in concrete roads are due in almost every case to the lack of drainage or the proper preparation of the sub-base, and not to the movement of the pavement due to expansion and contraction. These cracks are without a doubt unsightly, but they are not a serious detriment to the road provided they are properly cared for.

If the crack is a hair crack it will stand for a very considerable length of time without any repairs. As it wears down, under traffic, the edges breaking down, it should be thoroughly cleaned out and filled with hot asphalt, and sand spread over the top of the asphalt. Traffic will smooth this down, and as far as the usefulness of the road itself is concerned, it is in no way impaired.

The use of reinforcement is suggested as an insurance against poor drainage and the lack of proper compacting of the foundations, but the fact that the road is to be

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reinforced should never in any way influence either the engineer or the contractor in the care which should be taken in the foundation and drainage work.

As a rule, the greatest objection raised to concrete roads, particularly in farming communities, is their effect on horses' feet. We have many testimonials from people continuously using concrete roads, showing that a horse does much better on a concrete road than on a gravel, macadam or bituminous macadam road. This is due to the fact that the concrete road presents at all times an even surface, which is not slippery, upon which the horse places his feet.

The crown of the road is so slight as to make side-slipping, so hard on horses' knees and shoulders, impossible.

My discussion of concrete roads has, of necessity, been brief, since your time is limited, and I have only made an effort to call to your attention the most essential requirements for successful roads, the value of concrete as a road material and its extreme economy when consideration is given to the cost of maintenance in connection with its first cost.

Without doubt a number of items have been entirely omitted, and I shall be glad to answer any questions which you may wish to ask.

In closing I wish to call your attention to the tremendous growth in concrete road construction, which has increased from 561,000 square yards laid in 1909 to 14,500,000 square yards laid in 1914.

One of the most satisfactory tributes which can be paid to the concrete road is that where municipalities have one laid they have continued to lay them, and in many cases where a municipality has laid its first concrete road unsuccessfully, due to poor specifications and improper workmanship, they have been so impressed with the utility of concrete as a road material as to continue laying this type of road properly in following years.

DISCUSSION.

Mr. J. Duchastel, who had taken the chair at the request of the president said: It is very important indeed if some discussion would come out over this paper, which is a very important one in this section of the country, in which concrete roads are practically a new thing. I know we have some very good rural roads, but I have been very interested indeed to have some particulars about concrete pavements for streets. I have had many discussions on that point with friends around here, but the data we have is rather limited and I would ask if Mr. Wilson can give us specific data on the construction of cement roads for cities and the nature of traffic which would warrant this type of road.

Mr. Wilson: I may say that in 1914 there were over five million square yards of concrete laid on city streets and practically 300,000 square yards laid in what might be called alleyways. The traffic census which has been made, as Col. Sohier told you, only gives an indication of the use which either the road or the city street gets after it is improved. Traffic is drawn to the good roads and to the city streets and is drawn there very quickly, after the people once find out that the road has been improved, therefore never base the type of road on a traffic census taken prior to the roads having been improved. Relative to the city street proposition there are two classes of city streets, one of which have car tracks and the other of which have no car tracks. A concrete road for a city street is built exactly the same as for a country highway with the exception that due to the greater width, in order to save material the sub base is crowned and reinforcing is put into the concrete, not to prevent preliminary cracking, but to prevent these cracks from opening up, so that they can be readily dealt with at a minimum maintenance cost. The method of putting concrete on city streets that have car tracks on them, as far as the engineer is concerned, depends to a certain extent on the foundation under the ties of the tracks themselves. In case there is a concrete foundation under the ties, and in case they are going to put concrete between the tracks it is perfectly feasible to bring your concrete up to the edge of the rail. If, on the other hand, the car track is placed on nothing but stone ballast, or the ordinary sub soil on which the road is to be placed, the concrete must be kept back of the tie with a joint off the end of the tie between the road itself and the part which comes next to the rail. The matter of grades, as far as city street is concerned, is a matter which is absolutely controlled by the grade of the pavement and the grade of the curb. As a rule it is perfectly feasible to make a flat grade from the centre of the street to the curb line and leave out the curb crown which we make on country roads. As far as the traffic itself is concerned a great deal depends upon the length of time the traffic can be kept off the city street. If concrete is to stand in a city street with heavy traffic, the street should be closed at least four weeks. It is better to put it down in one section and reinforce it over the entire width than to have a longtitudinal joint down the centre of the street, although, if only half the street can be closed at one time, the street can be built that way.

Mr. Duchastel: I want to know what is the success of concrete in city streets where the traffic is rather heavy, and what possible means are adopted in those cities to resurface concrete roads when the wearing is appreciable? In other words how will you treat the surface that is worn down two or three inches. Will it necessitate the whole reconstruction of the road, or would you advise a new application of a few inches of material?

Mr. Wilson: If the concrete road is worn down three inches although I frankly don't know of any road that has worn down in rhis way, it will not do to put 2 or 3 ins. of concrete over the old concrete, the material will not stay on the street. The better way, if concrete is proving by its wear that it will not stand the sort of traffic, is to put blocks on top of the concrete and to use the old concrete as a foundation.

Mr. Drinkwater, St. Lambert: It is a well-known fact that the lateral cracks in concrete roads are usually the most dangerous and cause the most deterioration to the road. I am asking for information in regard to not exceedingly heavy traffic streets but residential streets which have side walks alongside the pavement. Most of the data we get on concrete roads comes from the United States, where they do not have in many places the extreme range of temperature we have in Quebec, where they do not have the same frost penetration. I would like to know if Mr. Wilson thinks it possible to build a concrete road economically that will withstand the longtitudinal strains that are put on a concrete or any other pavement due to the heaving of the ground under low temperature caused by the further penetration of frost. Here, where lines of traffic run in the winter, the centre gets a very hard packing of snow, and you get a very deep penetration, but in the States you do not get the same penetration. To my knowledge a pavement not carrying very heavy traffic rises one inch and three-quarters higher during the winter in the crown of the street than what it does in the gutter. Also these streets I have found in that condition are perfectly drained with laterals and cross drainage, concrete gutters and under the curbs French drains and tile drain in the bottom connected with street gullies. I would like to know whether Mr. Wilson can give us any means of preventing the lateral cracks which are so dangerous in concrete roads under these conditions.

Col. Sohier: I agree with a lot the gentleman has said. I have a diagram here of about one and a half miles of concrete roads. It developed some longtitudinal cracks, but did not crack anywhere where it was thrown evenly by the frost. It could take three tenths of an inch throw on both sides of the middle and come back without any cracks. But where we had a road thrown four-tenths of an inch more on one side than on the other, we got longtitudinal tracks. What have we done to prevent that? We had a spring on the road on one side that we could not find in summer, and the road was thrown ten inches on one side and only two on the other. That broke it. But what threw our road was the water. Now we have drained the water out that road has not thrown in years. We can stand a two-inch throw over all our road where it is well built and we do not get any longtitudinal cracks. It was lack of soil that the water would run through and lack of the drain and we think we cured it—it has gone two years since we got the gravel away.

Mr. Drinkwater: In reference to the data I have as to the amount of traffic both vehicular and pedestrian, it was obtained outside the public schools and Post Office, not in one place, but at fourteen points, and the readings were taken from November 21, 1914, to April 20, 1915, and where the traffic was heavy the rise was greater than the places where it was not used at all—

at the latter I had no appreciable rise at all. Where I had heavy traffic it went up to 1¾ inches. On the sidewalk on one side of the street which had been closed to traffic by the snow it never moved, but on the other side of the street over which people went to the post office, it rose 1¾ inches.

Col. Sohier: I would ask him whether one was not well protected by the snow and the frost went deeper on the other.

Mr. Drinkwater: That was so, the frost penetration and not bad drainage caused it to heave.

Mr. Wilson: There must have been some water underneath the road in order for the frost penetration to take effect. The ground will not heave with frost unless it has water in it.

Mr. Drinkwater: The ground in question is very heavy clay which carries a very large percentage of moisture.

Mr. Wilson: There is one point relative to the range in temperature. You perhaps have a greater range in temperature here in the province of Quebec than we have in the United States, although we have built successful roads in the Dakotas and Montana, and I think their temperatures would be as great, as far as range is concerned, as yours here. But you have one advantage we have not, and that is that when your frost starts to penetrate it keeps on gradually penetrating and the ground stays frozen practically all the winter. We get six or ten inches of frost and the next day it thaws and there is more alternate change and quick changes with us than you have in Canada. Your frost comes and increases rather slowly and gives the material itself, without a doubt, an opportunity to adjust itself to new conditions, as far as the frost is concerned. We do not have that. One day our material is frozen and the next thawed out again. But it seems to me the whole matter of heaving by frost is a matter of drainage.

Mr. Drinkwater: The temperatures in the province of Quebec is very alternate. We sometimes have three or four very soft spells, that is where the danger is caused by the moisture getting under our pavements. We have something like five drops and rises in our temperature during the winter. I would be very plaesed to show you the data.

Mr. Wilson: What is the range of that in temperature —it is nothing like 103 degrees?

Mr. Drinkwater: Yes, over that. It sometimes goes as high as eighty or ninety degrees.

Mr. Hurtubise: In the answer you gave to the Chairman about city concrete roads, you said that the roads were built the same for the rural roads and for the city roads with the exception that the city roads were reinforced. Do we understand that you would advocate the non-reinforcement of rural roads?

Mr. Wilson: The only reason that you make a difference in the reinforcing between city and rural roads is on account of the greater width of the city streets. There are very few city streets under twenty feet in width, and very few rural roads that are over twenty feet in width, and it is more a matter of the width of the road than it is as to whether they are used in the city or the country that has to do with the reinforcement.

Mr. French: I have been interested in building concrete roads. Last season we built ten miles of concrete road on sand soil. Next season I intend to build a couple of miles on heavy clay soil Would it be necessary to put a sand cushion between the concrete and the clay?

Mr. Wilson: It depends altogether on your subdrainage, and as to how much water your clay holds. If your clay will hold water it is better to put a very small cushion of sand underneath, and roll it well. But if, on the other hand, your clay can be drained there is no necessity for putting in any cushion.

Mr. French: It cannot be drained very well, it is very heavy clay and flat country.

Mr. Wilson: Then I think a little sand on top, an inch of sand, and rolled into the clay sufficiently so that it will not act as a sponge to take the water and the cement out of the concrete when you deposit it, will be an advantage to your road.

Mr. J. F. Rhodes, Montreal: With regard to the street wearing film how is it to be maintained or renewed? I would like to know of any cases where that has happened. There was one concrete road badly constructed over in the province of Ontario and this road had been repaired by putting four inches of concrete over the old concrete road. The concrete road is economical from the point of view of low maintenance cost. But if your concrete is worn so thin what is the best thing to do?

Mr. Wilson: Considering that the road has worn for years it would probably be economy to build another road on top of that, instead of changing to some other type of construction. I think if you look up the records the cost is a quarter to half a cent a year for maintenance.

The Chairman: I am sorry we cannot prolong the discussion on this topic, but though I am ready to hear any convincing talk on the matter I don't wish my statement of a few minutes ago to go as criticism. It was more to try and draw out information that I brought up the subject.

The Chairman: I find that Mr. Callum will not deliver his lecture till tomorrow morning, so we might reopen the discussion on concrete roads and pavements. Col. Sohier says we haven't had a real good scrap, so I will be pleased to referee anything like that.

Col. Sohier: Just to start something I asked all my engineers how many concrete roads we ought to build. We built 180 miles last year and eight were concrete. I said if concrete roads last twenty years in other parts of the United States and don't cost anything to maintain, and ours last ten years and we have to rebuild twice, we look like thirty cents. And the answer they gave was they were not sure that they were going to last. There is one thing to remember in building concrete roads. I reported at one time to the Cement Manufacturers' Association a case, and it got back to me after a year through a Municipal Improvement Association. We were going to use concrete in building a bridge and we got cement of standard specification, and we got a very good sand, if it was washed, that came out to not quite the Ottawa test, but very near it. When we combined that cement—I don't remember the name—with that sand it did not set in ten days. And we tried three other brands with the result that we eventually got a brand that set up in 24 hours and would set pretty hard in seven days and we used that brand. It was not any better in any way, with the Ottawa sand test, and the concrete was very good. But we put a ninety foot road bridge in and the flood carried out the false work in seven days. And if we had used the other cement we would have lost that bridge. The engineer on some dams told me that on no one of those dams could he use the same cement with the same result as to strain, initial setting and so forth with the local sand, and they used five different brands of cement and everyone of them came up to specification, but with the particular sand they were using they did not get the set or strength, and I have never known why. I want to tell you that you had better adopt what we have adopted many years on our bridges, always try your sand and cement and test it in the laboratory itself and break it and find out when they do set. Don't say that because you have sand and cement coming up to specification that it is going to set up in time, or you will find as we did, there is quite a difference in the chemical quality of the sand. It was not the fineness of the grain or the size of it, the sand was perfectly good. We have tried concrete roads, and are going to build more of them, and I am getting to believe more in them. We built a road we are not at all ashamed of and it has got quite a number of three-quarter inch cracks, every time that we did not drain the side of the road enough, so that one side was not thrown four inches more than the middle. Where it was we got a good crack, but I don't blame the concrete for that. Where we reinforced we got a crack but it did not open up so much, but we got just as many cracks proportionately. What made me a believer in concrete roads was Wayne County. It was a road that failed, it was a road that the state engineer says is 85 per cent a failure. Six years laid it has a great many—too many—cracks about twice as many as any decently built concrete road today, but it has a thousand horse-drawn vehicles and more than a thousand motors using it everyday. I did not know what we were going to do to a concrete road when it had cracked, and that the side would crumble off and in a very little while it would be like some of our concrete roads around Boston eight years old, and they are not there. Our bituminous roads just beyond are still there. They let the pothole develop and in a little while you could not go over the road and it was a patented pavement too, with a grouted No. 1 stone concrete road. It developed the holes in the cement first, it was not strong enough to carry it against the big stone but, had it been taken care of, it would have been on the job today. In one county I found the same crack and the same hole that I marked five years ago, and it had been filled with tar and sand.

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It looked like a rag on a sore thumb, but the thumb was there' and the road is there still, carrying the traffic. They have a few machines and it costs twenty dollars a yard to put the patches on, and it does seem to prevent the further breaking up of that road. I will say that we are just as sceptical in Massachusetts. We built a concrete road that was thirty feet wide, and we reinforced a part of it, on what is nearly a city street, carrying heavy team traffic, and we were so uncertain as to whether it would wear uneven that we laid it seven inches below the curb line, and when it does break out we are going to put two inches of topeka bricks on the top of it and take care of it whenever necessary. We have a road built in 1906 which has absolutely gone to pieces and that began to go into potholes. That is a farming country through road, and twenty seven teams and fifteen hundred cars a day. We gave it a half gallon tar coat covered with pea stone and have had to repeat that once. The cost of maintenance is two cents a square yard a year and it is just as good today as in 1906. If we had not put that coat on we should have developed large pot holes and probably thrown the road away, but the tar carried the traffic, In Springfield, the tar lasted two months with 250 heavy teams a day. The road was not well built, it was rough and not even on the joints and the first job we tried. And now we have covered part of it with two inches of bituminous mixture. The half gallon tar surface will not wear with 250 large teams a day, they cut through it and carry it off. But that does not say the concrete will not carry it, because it is going to if it is built well.

Mr. Wilson: I would like to speak for just a moment on the road which Col. Sohier referred to as the Wayne county failure. The first part of this road was built in 1908. As Col. Sohier described it, it is very much like a sore thumb with patches on, but the thumb is there and the patches are also there, and have continued to be there. It gets extremely heavy traffic, something over four thousand vehicles a day. The road is in first class condition and the man to whom the Colonel refers, who says it was a failure, also made some very careful tests on the wear which has come on the road, and he has determined that the road since 1908, up to and including 1914, has worn down in all about three-eights of an inch. It is one of the best failures that I have ever seen in my life. Relative to the aggregates for concrete roads I quite agree with Col. Sohier, they should be tested out, and there is a clause in our specifications which, if followed, would cause much less difficulty in the selection of materials. It provides that the cement which it is proposed to use shall be mixed with the sand which it is proposed to use, and regulation tests made to determine whether the strength is equal to the strength obtained with Ottawa sand or not. I have only one more word to say about these doubters. Two years ago the state of Massachusetts built two miles of concrete roads, last year they built about twenty miles of concrete road, and next year I am not quite sure how many they will build, but it will certainly be more than twenty, and if all others engaged in road construction were the same class of doubters we would have nothing but concrete roads.

The Chairman: I was not a doubter for concrete roads in country districts. I have been over the Wayne failure myself and I was very much enthused with it. But the point I am trying to get at is this, to what extent have concrete roads been built in large cities. What traffic are they supposed to accommodate. We have an example of one neighbouring municipality in the island of Montreal that has built a very heavy concrete pavement and possibly somebody may give us information as to cost, wear and so forth.

Mr. Rhodes: With regard to how concrete takes heavy traffic in the Montreal district I might point out that St. Catherine street, Ontario street, and Notre Dame street in Maisonneuve are concrete. As to the wearing of these streets they were built under a system similar to the Blome system, in that they were built and marked in blocks. They were built in 1912-13 and have carried traffic similar to that using the streets of Montreal, and you will find very few places where the traffic marks have been worn or are visible today. Along the line three to four feet from the trolley tracks, where the traffic is concentrated, the marks are just visible These streets are cracked some, but they are built very thick and very strong. The cost of the street has nothing whatever to do with the wearing surface—the way it stands up under traffic. The wearing has nothing to do with the thickness of the concrete—a cheaper street that was laid with a thinner concrete would wear equally well. There is another sample in Brantford, Ontario. That was built in 1912-13 and has carried the traffic from the station, has a line of tracks, one line like on Notre Dame street, and they had to recorrigate that in spots last year. I think that will tell you about how well concrete is standing up under traffic—on Notre Dame street they have a very large percentage of steel tyre traffic in one-horse carts through the streets.

[END OF THURSDAY AFTERNOON SESSION].

Legislation on Roads Before Confederation

(Dr. Desaulniers)

FINAL SESSION - - FRIDAY MORNING.
The President, B. Michaud, in the Chair.

The President: First we have a French paper by Mr. Desaulniers, member for Chambly, and afterwards papers by Mr. Blanchard, Mr. McCallum, and Mr. Dean. We have during this week taken up the matter of our roads; now we are going to hear about the roads before Confederation, which is the very interesting subject Mr. Desaulniers has chosen for this morning.

Mr. Desaulnier's Paper.

Mr. President, Gentlemen,

I wish to express my thanks to the officers of this third Good Roads Congress for their kindness in inviting me to take part in their discussions. I wish also to congratulate the President and the honorary secretary and the other organizers of this Association for the splendid work they have done, and for their untiring efforts to make this Congress a success, and to get together such a large number of delegates interested in the improvement of our roads.

A Congress such as this one, of vital importance not only to our own province, but to the whole of Canada and the United States, certainly shows a great advance in the history of road making, both from a legislative standpoint as well as from that of their improvement.

Ever since 1908, a very energetic and effective campaign, has been waged on behalf of our highways. This has been so successfully done, that our rural population have now a very good idea of the necessity of building and maintaining our highways according to the latest methods. More than 500 of our rural municipalities have fallen in line in this respect.

I may say further that at the present moment, all classes of society are agreed on the subject of good roads, and they are all willing to help in making this tremendous undertaking a success and in giving our province a network of roads equal to those of Europe and of the United States.

Every one admits that good roads tend to further the development of all our natural resources and that they are o fthe greatest benefit to our agricultural communities. If we consider for a minute the work that has been done in the last few years, we shall be enthusiastic for this Good Roads movement, and for the results it has already accomplished. We thoroughly appreciate the initiative of our provincial government, their energy, and their generous financial support in this great work. And I do not want to forget those who have been preaching good roads to us, giving us such an admirable example of energy and public spirit. But while I mention all these men who have worked so hard for this cause, we must not forget that they are but the successors of those who first started this enterprise, the first legislators of our country.

In looking through some old books and documents about this Good Roads question, which has always been very interesting to me, I found a little volume written in 1840 by Jacques Viger, entitled: "Observations on the Improvement of the Laws relative to Roads in Lower Canada, 1825."

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Ths book is written in old French, and contains some very interesting information on the subject of our highways.

Jacques Viger tells us that the first parliament in Canada, 1791, took up the question in 1796 and passed a bill called the "Roads Act". This measure consists of about one hundred articles, decrees and regulations, Jacques Viger tells us further that, in 1709, another bill was passed in parliament, whereby he himself became inspector of the roads, streets, alleys and bridges of the City and Parish of Montreal. He also speaks of his predecessor, Louis Charland, who occupies the same position for 14 years previously.

Some of the observations of Mr. Viger are so interesting that I will quote a few passages from them:

OBSERVATIONS, ETC.

I have been Surveyor of Highways, Streets, Lanes, and Bridges, for the City and Parish of Montreal during the last eleven years. An assiduous practice of the duties and obligations of that office, during all that period, under the direction of zealous and active Magistrates, in an industrious city, among inhabitants distinguished by their good taste, liberality and anxious solicitude to promote and give every encouragement to its progress and improvement of every kind, have in fact led me to discover deficiencies in those Acts, without doubt originally excellent, and to wish that they were in part new modelled, in order to render them, if possible, more analogous to, or better adapted to the present time. My small experience in this behalf is chiefly limited to the wants of the city.

My jurisdiction in the county not extending beyond the limits of the single parish of Montreal, and my predecessor in office, Mr. Louis Charland, having been actively employed during fourteen years in giving there the assistance required, little remained there for me to accomplish, and therefore fewer opportunities of forming a judgment wherein those Acts are defective, respecting the country parts in general. I have nevertheless ascertained in the course of my practice that it would be beneficial to the parishes circumjacent to the cities, were some of the Sections of those Acts reduced, and others corrected. I shall point out the defects, yet with diffidence, and shall propose the amendments wih all possible submission to the better judgment and enlightened prudence of the Members of the Committee. I shall also offer some suggestions which, to me at least, appear worthy the attention of the Committee.

The committee mentioned here by Viger met on the 10th of March, and made the following report to the House:

NOTE.

These observations were printed in the Journals of the House of Assembly of Lower Canada, in 1825, (Appendix X.), with the Report of a Committee of the same House, dated 10th March, viz:—

"HOUSE OF ASSEMBLY.
COMMITTEE ROOM, March 10, 1825.
"PRESENT:
"MESSRS. CULLIVIER,
TASCHEREAU,
QUESNEL,
BUREAU.

"MR. TASCHEREAU in the Chair.

"Read the Order of Reference.

"Ordered, that Mr. Jacques Viger be examined as a Witness.

"And the said Mr. Jacques Viger forthwith appeared, and the following question was put to him:

"Q. Is the existing Road system susceptible of improvement? are the laws respecting the same defective? What are the inconveniences thence arising; and have you any plan of improvement to propose to the Committee, especially respecting the Highways of the Cities and of the Parishes in which the cities are?

"Mr. Viger accordingly made answer as follows:"

(Here are inserted my Observations, as Evidence. Then the Committee proceeds thus:)

"Your Committee, after having attentively considered the object of the present reference, and the evidence produced thereon, is unanimously of opinion, that the Road Acts in force in this Province, admit of being altered for the better, and that it is necessary to consolidate them into one Act; but that the labour which this would require would take up more time than it is possible for your Committee to extend to it in the present Session; but that these Acts should be the subject of the consideration of this House at the commencement of the next Session of the Legislature.

"That nevertheless there are inconveninces resulting from the obscuriy of certain classes of the Road Acts now in force, which render the execution of them more difficult, and which it is easy to remedy in the present Session, and which require that such remedy be immediately applied.

"Ordered, that the Chairman do now leave the Chair and report progress.

"The whole nevertheless respectfully submitted."

In consequence of the Report of the Committee, the Parliament passed in the same Session (1825), an Act, intituled "An Act to make certain Alterations to he Road Laws," (chap. 3.)

Many of my suggestions have since been adopted, either by Acts of the Legislature, or by Rules of the Magistrates of Montreal.

J. V.

Montreal, December, 1840.

The President: We thank Mr. Desaulniers, not only for his work but for his active co-operation in the good road movement in the Province of Quebec. He is a promoter of good roads in his county of Chambly, and has assisted in the work of road construction in a district which is very interesting and very important.

M. J. Stack, of Stack and Leger, road contractors, Montreal, on behalf of the contractors and supply men, presented the President with a gold mounted cane as an indication of their appreciation of the keen interest he had taken in the Congress and in the Good Roads movement.

Recent Developments in Bituminious Macadan Concrete Pavements

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Before proceeding with the discussion of the many improvements in the construction of bituminous macadam and bituminous concrete pavements which have been developed during the period from 1914 to 1916, it is advisable, in order to avoid misunderstandings, to quote the definitions of the two types of pavements as recommended by the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers.

"Bituminous Macadam Pavement. One having a wearing course of macadam with the interstices filled by penetration methods with a bituminous binder."

"Bituminous Concrete Pavement. One composed of stone, gravel, sand, shell or slag, or combinations thereof, and bituminous materials incorporated together by mixing methods."

General.

Certain developments which are common to both classes of bituminous pavements will be discussed prior to considering improvements which specifically refer to each of the several types:

Foundations.

There has been a general acknowledgment of the ultimate, economy of constructing adequate foundations to support the amount and character of traffic which the several types of bituminous pavements are able to carry. In the case of bituminous macadam pavements, this development usually has been characterized by the construction of well compacted and, in many cases, thoroughly filled broken stone foundations. In the case of bituminous concrete pavements, due to numerous failures which have occurred where this type of pavement has been built on old macadam or poorly constructed broken stone foundations, there has been a general tendency to advocate the use of cement-concrete foundations from four to six inches in thickness. It has generally been found that the cost of cement-concrete foundations does not exceed the cost of well compacted and filled broken stone foundations of equivalent strength. Furthermore the use of cement-concrete foundations renders repairs and renewals more satisfactory and much easier of accomplishment.

Non-Bituminous Highway Materials.

There has been a general recognition since 1914 of the desirability of covering in specifications in more detail and with greater rigidity the physical properties of the aggregates to be employed and the sizes of the particles which compose such aggregates. For example, the 1914 Specifications of the American Society of Municipal Improvements covering bituminous macadam pavements state, with reference to the physical properties of the stone, that the rock employed must meet the following requirements:

"The broken stone shall be subjected to abrasion tests and toughness tests conducted by the Engineer in accordance with methods adopted by the American Society for Testing Materials, August 15, 1908. The broken stone used for the construction of the first and second courses shall show a French co-efficient of wear of not less than 7.0 and its toughness shall be not less than 6.0. The broken stone used for the construction of the third course and for the first and second applications of No. 1 broken stone shall show a French co-efficient of wear of not less that 11.0 and its toughness shall not be less than 13.0."

The necessity for more carefully drawn specifications covering the sizes of the particles of which a given product of a stone crushing and screening plant is composed is illustrated by the following mechanical analyses of two products obtained from the same plant, both of which products passed over a section of a rotary screen having circular holes of 1¼ inches and through a section of a rotary screen having circular holes 2¼ inches in diameter.

				Sample "A"	Sample "B"
Passing	⅛	inch	screen	0.2%	0.1%
"	¼	"	"	0.1	0.1
"	½	"	"	0.4	1.1
"	¾	"	"	2.2	12.6
"	1	"	"	8.0	37.5
"	1¼	"	"	29.1	40.9
"	1½	"	"	27.1	7.7
"	2	"	"	32.9	0.0
				100.0%	100.0%

It is hence obvious that for many forms of bituminous construction, in order to secure successful results, greater care must be used in the writing of specifications for products of broken stone. As an illustration of an improvement in specifications covering this det 'l, there is cited those adopted at the at the 1915 Convention of the American Society of Municipal Improvements covering broken stone to be used for the aggregate of one type of bituminous concrete pavement.

"Broken stone for the mineral aggregate of the wearing course shall consist of one product of a stone crushing and screening plant. It shall conform to the following mechanical analysis, using laboratory screens having circular openings: All of the broken stone shall pass a one and one quarter (1¼) inch screen; not more than ten (10) per cent nor less than one (1) per cent shall be retained upon a one (1) inch screen; not more than ten (10) per cent nor less than three (3) per cent shall pass a one quarter (¼) inch screen."

It is noted that in this form of specification an attempt is made to cover in the mechanical analysis only the limits of the smallest and largest particles. No attempt is made to secure a carefully graded aggregate but simply a product suitable for the type of pavement in question and uniform in character. For example, the following mechanical analyses show three products used in the successful construction of three different bituminous concrete pavements of the type mentioned.

				Sample. "A"	Sample. "B"	Sample. "C"
Passing	⅛	inch	screen	1.2%	2.7%	1.0%
"	¼	"	"	4.2	5.6	2.5
"	½	"	"	34.7	45.0	30.8
"	¾	"	"	40.6	35.1	34.2
"	1	"	"	17.3	10.1	23.4
"	1¼	"	"	2.0	1.5	8.1
				100.0%	100.0%	100.0%

Bituminous Materials.

There has recently been considerable discussion pertaining to the advisability of the adoption of so-called "alternate type" specifications in preference to the so-called "blanket" specifications for bituminous materials. By alternate type specifications is meant a series of specifications, each of which covers the physical and chemical properties of the most desirable grade of a given type of bituminous cement for the purposes for which it is to be used. On the other hand a blanket specification covers in one set of requirements, pertaining to physical and chemical properties, all the types of bituminous cement which are to be used in connection with the construction of a given kind of pavement. For example, in the case of specifications for asphalt cement for bituminous concrete pavements, it would be desirable under alternate type specifications to have not less than five sets of physical and chemical requirements, the limits for each requirement being as narrow as the several processes of manufacture would permit, while on the other hand a blanket specification would cover with a wider range of limits the same chemical and physical properties for the five types mentioned. As an illustration will be cited the limits in the cases of Specification "A" to "E" inclusive under the alternate type specification method for specific gravity, and the penetration at 25 deg. C. (77 deg. F.).

	"A"	"B"	"C"	"D"	"E"
Sp Gr...	0.97-1.00	1.00-1.03	1.03-1.04	1.02-1.05	1.04-1.06
Pent. . .	75-90	90-100	70-90	85-95	140-150

In the case of a blanket specification to cover the same grades of the several types, the limits for specific gravity would have to be 0.97 to 1.06 and the limits for penetration would be 70 to 160. The penetration test, for example, can only be of maximum value when applied to the grade of a specific type of bituminous cement which is most suitable for the type of pavement in question. In the case of the bituminous concrete pavement of the type mentioned, the proper penetration limits for a California asphalt lie between 70 and 90 while for a fluxed Bermudez asphalt to be used in exactly the same type of pavement and under the same conditions, the penetration limits should be between 140 and 160. It is evident that to attempt to cover the penetration limits for both materials in one specification is impracticable. In the first place such limits as 70 to 160 are so wide as to insure but little uniformity in different lots of the same material and in the second place an entirely unsuitable material of one class could be supplied under the maximum or minimum test limits of the other class.

The proper use of alternate type specifications allows the contractor to bid to supply so many tons of bitumen which will comply with any one of the sets of requirements. It will be noted, therefore, that the contractor is in exactly the same position as in the case when he bids to supply any asphalt cement which will comply with the requirements of a blanket specification.

Guarantees.

There has been a general tendency to abandon the use of guarantees on bituminous pavements as it is believed that, with proper specifications and efficient supervision and inspection, guarantees are not necessary and that the requirement of a guarantee materially increases the price bid on a given pavement. The subject of guarantees is too broad to discuss in this paper, but it should be noted that under the title "The Economics of Guarantees of Pavements on State and Municipal Highways," it has been admirably treated by Mr. George C. Warren in a lecture in the Graduate Course in Highway Engineering at Columbia University, which lecture has been published under the auspices of the National Highways Association, Mr. Charles Henry Davis, President.

Bituminous Macadam Pavements.

In addition to the improvements noted above, the most notable recent developement in the construction of bituminous macadam pavements has been in connection with the compaction of the road metal and the distribution of the bituminous materials.

As a result of the numerous failures of bituminous macadam pavements which have occurred due to the improper rolling of wearing courses of road metal prior to the application of bituminous material, there has been a general recognition of the necessity for more thorough compaction of the road metal. This principle has been recognized by the Special Committee on "Materials for Road Construction" of the American Society of Civil Engineers in its 1915 Report, the conclusion referred to reading as follows:

"An important factor for successful results is the proper compaction by rolling of the road metal before the spreading of the bituminous material."

The above Committee emphasizes another improvement which is aimed at the use, in some cases, of an excess amount of bituminous cement in this type of pavement. This conclusion is as follows:

"Present indications are to the effect that the use of bituminous materials in quantities of more than 2½ gallons per square yard where the upper course of the macadam is to be 3 inches in thickness after compaction is inadvisable under the penetration method."

There has been a general recognition of the advisability of using properly designed distributors in connection with the application of bituminous materials in order to secure uniform distribution economically. Some specifications cover the requirements which a distributor must meet. For example, the 1914 Specifications of the American Society of Municipal Improvements contain the following paragraph pertaining to the pressure distributor.

"The pressure distributor shall be designed and operated to distribute the bituminous material specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy-five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the bituminous material and with an accurate pressure gauge so located as to be easily observed by the Engineer while walking beside the distributor. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributor shall be provided with wheels having tires each of which shall not be less than eighteen (18) inches in width, the allowed maximum pressure per square inch of tire being dependent upon the following relationship between the aforesaid pressure and the diameter of the wheel: For a two (2) foot diameter wheel, two hundred and fifty (250) pounds shall be the maximum pressure per linear inch of width of tire per wheel, an additional pressure of twenty (20) pounds per inch being allowed for each additional three (3) inches in diameter."

This specification provides for a distributor by which it is practicable, under competent supervision, to secure uniform application of the bituminous material and allows the use of a pressure distributor without danger of rutting of the wearing course of broken stone by narrow tires carrying excessive weights.

Bituminous Concrete Pavements.

The improvements in the construction of bituminous concrete pavements to which attention should be called will be considered under the following classification of the three types into which bituminous concrete pavements generally may be divided. These types are designated as follows:

(A). A bituminous concrete pavement having a mineral aggregate composed of one product of a crushing and screening plant.

(B). A bituminous concrete pavement having a mineral aggregate composed of a certain number of parts by weight or volume of one product of a crushing and screening plant and a certain number of parts by weight or volume of fine mineral matter such as sand or stone screenings.

(C). A bituminous concrete pavement having a predetermined mechanically graded aggregate of broken stone or gravel, either alone or combined with fine mineral matter, such as sand or broken stone screenings.

Patents.

Unfortunately the present status of patent litigation has to be considered in connection with the discussion of the several types of bituminous concrete pavements. The majority of engineers and highway officials are interested in the types of bituminous concrete pavements which may be constructed without danger of litigation rather than in a prolonged discussion of the probabilities of successfully defending suits for infringements. There is ample evidence at hand that bituminous concrete pavements of type (A) may be constructed without danger of litigation proceedings provided that the mineral aggregate is of the general character heretofore mentioned in this paper under the section "General. Non-Bituminous Highway Materials."

The history of litigation cases indicates that the construction of bituminous concrete pavements of type (B) on a large scale will in all probability lead to litigation. The same remarks apply to the construction of bituminous concrete pavements of type (C) except in the case of the so-called Topeka bituminous concrete pavement with an aggregate of the type specified either in the 1910 Topeka decree, or of the grading which was adopted at the 1915 Convention of the American Society of Municipal Improvements.

Type (A) Materials.

Practice has demonstrated that broken stone, because of the satisfactory mechanical bond secured, makes the most suitable aggregate for this class of bituminous concrete although pavements constructed with gravel have proved satisfactory for light traffic where great care has been taken in the selection of the gravel and in the construction of the pavement. The development of the character of materials used in current practice has been covered in this paper under the title "General." Much more care has been taken in recent years with reference to the quantity of bituminous cement to be used in the mix. There has been a general recognition that the amount used depends upon the kind of road metal and the bituminous material, the character of the aggregate and the climatic conditions. For the product of broken stone heretofore mentioned, it has been found that bituminous concrete mixtures should contain between 5 and 8 per cent by weight of bitumen.

Mixing.

Many improvements are noted in the methods employed in the mixing of bituminous concretes. There has been a general evolution from hand mixing methods to the utilization of mechanical mixers especially designed for the manufacture of this type of bituminous concrete. The large

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contract for thirty-five miles of bituminous concrete pavement of this type around the Ashokan Reservoir, constructed under the direction of the Board of Water Supply of the City of New York, demonstrated the desirability of the manufacture of a plant especially designed for this class of work. The type finally evolved showed that it is practicable and economical to use a self-propelled plant, consisting of elevators, a rotary dryer, weighing devices and a mixer, having a capacity of from 800 to 1,000 square yards of 2-inch wearing course per day. Experience has demonstrated that, except on small contracts and for repair work, mixers which provide for the heating of broken stone by the use of a flame in the chamber should not be used on account of the danger of burning the broken stone or the bituminous concrete.

Laying.

There has been considerable discussion pertaining to the proper type and weight of roller to be used for the compaction of the wearing course. Experience demonstrates that in order to secure an even surface and edequate compaction by thorough interlocking of the particles of broken stone, a tandem roller weighing between 10 and 12 tons should be used.

Seal Coat.

Many methods have been developed for the application of the seal coat of bituminous material. It has been found that seal coats of from 1-2 to 1 gallon per square yard of bituminous cement are distributed most uniformly by the use of hand-drawn gravity distributors followed by a squeegee.

Seasonal Limitations.

Experience in many localities has demonstrated that bituminous concrete of this type should not be mixed or laid when the air temperature in the shade is below 50deg. F. as otherwise it it difficult, under average conditions, to secure an even and well compacted wearing course.

Type (B)

Specifications for this type of pavement have, during recent years, generally stipulated that so many parts of broken stone and so many parts of sand or other fine material are to be mixed with a certain amount of bituminous cement. By the use of this specification, unless employed under unusual supervision, it has been found to be impracticable to secure a well graded aggregate. In many cases the mixture has contained an excess of broken stone with insufficient fine material to fill the voids therein, while in other cases it has contained an excess of sand in which the broken stone exists as isolated particles. It is the conclusion of many engineers, because of the conditions described, that when bituminous concrete pavements are to be employed either type (A) or type (C) should be selected.

Type (C)

During recent years, the bituminous concrete pavements of this type which have been most extensively employed are known as Bitulithic, Warrenite and Topeka.

Bitulithic and Warrenite. Differentiation.

The general use of Bitulithic and Warrenite bituminous concrete pavements throughout America has brought up for discussion the matter of the fundamental differences between these two types of patented pavements. It is believed that it will be of interest and value to the engineering profession to submit the mollowing statement, prepared by Mr. George C. Warren, President of the Warren Brothers Company for the information of the engineers enrolled in the Graduate Course in Highway Engineering at Columbia University.

"Bitulithic and Warrenite mixtures are both made under the provisions of the Warren patents, which the courts have held 'cover the product no matter how produced'. Bitulithic is designed to meet the conditions generally prevailing on city streets, and Warrenite is to meet such conditions as may arise on country roads so as to meet the physical and economic conditions and public demands as to cost.

"Generally speaking, Bitulithic is mixed by a plant which is too cumbersome to meet country road conditions, which provides for combining the materials proportioned by separation of sizes of the aggregate, after heating, and then recombining by weight.

"Warrenite is, generally speaking, mixed by a plant so portable that it may be set up either alongside the railroad; along the side of the road being constructed, or in the quarry or gravel bank from which the bulk of the aggregate is being procured as may be most economical in any particular case. This plant is constructed on the principle of proportioning the several separated sizes by careful measurement by bulk before heating and retaining the batch so measured as a separate entity through the process of heating and delivery into the mixer in which the bituminous cement is added.

"Generally speaking, crushed stone predominates in the fine aggregate of Bitulithic, while sand predominates in the fine aggregate of Warrenite; also, fine crushed stone and sand respectively are correspondingly used for the seal coat aggregate.

"In the selection of quality of material (whether gravel or crushed stone) for the coarse aggregate a greater latitude is permitted in the case of Warrenite to practially meet the conditions of less opportunity for selections which are liable to prevail in localities considerable distances from railroad centres. This latitude is allowed, because, while the traffic conditions on country road thoroughfares are in point of weight and concentration of traffic rapidly becoming fully as severe as on most city streets, there is the important difference that on country roads generally the traffic is more exclusively of the motor vehicle rubber tire type and consequently less exaction in physical properties of the quality of the stone forming the basis of the agregate is necessary. Also, unfortunately, many city streets are abused by constant excessive sprinkling or daily scoured by pressure flushing machines, a practice which is more or less injurious to any road surface, while country roads are seldom, if ever, wet except by rainfall; therefore, in cases where the very best quality of stone is unavailable it would be safe to use stone of slightly lower quality in Warrenite on a country road although the same quality stone might not be safe for use in Bitulithic on a city street."

Topeka.

In many specifications the mineral aggregate for the Topeka pavement specified has been that contained in the decree of 1910, namely:

"Bitumen, from 7 per cent to 11 per cent."

Mineral aggregate, passing 200-mesh screen, from	5% to 11%
Mineral aggregate, passing 40-mesh screen, from	18% to 30%
Mineral aggregate, passing 10-mesh screen, from	25% to 55%
Mineral aggregate, passing 4-mesh screen, from	8% to 22%
Mineral aggregate, passing 2-mesh screen, less than	10%

Many unsatisfactory pavements have resulted by the unintelligent use of this grading. It has been found necessary, in order to secure successful results, to specifically define the character of the sand or other final material which shall be employed in order to secure a satisfactory grading. Many specifications now cover the sand grading with almost the same care as in the case of sand grading requirements for sheet asphalt pavements. In order to encourage the use of a more satisfactory grading for this type of pavement, the American Society of Municipal Improvements in 1915 recommended the adoption of the following grading:

Passing 200 mesh screen,	7-10%
" 80 " " but retained on a 200,	10-20%
" 40 " " " " " 80,	10-25%
" 20 " " " " " 40,	10-25%
" 8 " " " " " 20,	10-20%
" 4 " " " " " 8,	15-20%
" 2 " " " " " 4,	5-10%

Highway Bridges

By Geo. Hogarth.

The subject of highway bridges is broad and to cover it completely and in detail would take considerably more time than there is now at my disposal. I shall, therefore, endeavor to present to you some of the more important points with reference to the type and design of the highway bridges now being built in the Province of Ontario.

We have to-day, sections in the south of the Province that have been settled for over a hundred years; and in the north, there are vast areas where the axe of the first settler is only now being heard. Our bridge construction, therefore, varies from the most primitive types of timber construction suitable for the lightest of traffic to the more enduring structures of concrete and steel, which are capable of safely sustaining the weight of a twenty ton road roller.

Our rivers of the north are usually broad and deep with nothing more secure than a shifting, slippery, clay bank upon which to build abutments or piers. The crossing of such rivers is an expensive undertaking since the river bottom is frequently soft and very liable to be deeply scoured if the current is in any way deflected by a pier. In Ontario hundreds of bridges are required each year, and those large structures which are more expensive and serve only a small population must frequently give way to less costly smaller structures or ferries, which furnish communication till bridges are warranted. In deciding on the type of bridge to build, consideration must be given to the lumberman who is bringing sawlogs down the river, and piers must be located or omitted with a view to avoiding log jams. The safe location of the piers usually governs the length of bridge span to use, since the crowding of logs cannot always be prevented, and a heavy jam will often pull timber piers clean out of the river, piles and all. There is also the ice to contend with and it works almost unceasingly to destroy any timber structure with which it comes in contact. Late in the fall when the water is low in the river, the ice forms and sticks solidly to the piles or cribs for a depth of probably three to four feet. Should a sudden thaw come in February, the water lifts the ice and gives the piles a heave that throws the entire structure out of grade. For these reasons, it has been found advisable to bridge the rivers with one span wherever possible, and to place the abutments or piers out on the banks of the stream. The placing of piers in the river channel is usually an expensive piece of work, and the maintenance money that must be spent to protect them from logs and ice in the spring of the year is frequently considerable. The use or long span bridges is therefore an economy.

There is very little gravel or rock to be found in some sections of Northern Ontario and concrete abutments of floors cannot be considered. Practically everywhere, though, there is standing timber of fair size and quality which can be quickly cut into piles and roughly hewn to form portions of the piers and flooring. The design of structures has thus developed along the most economical lines, and to-day, you will see on the highways of the north steel bridges resting on timber piers and having a sawn or hewn plank floor.

On the smaller creeks and rivers, the timber queen post bridge is still built and is supported by pile piers or timber rock filled cribs; but where the bridge must be 60 feet or over in length, a steel span is the best and cheapest type of structure that can be built. The cost of labor in remote sections of the north is sometimes out of all proportion to the work done, and these types of construction have been developed from actual experience as being the most economical under present conditions. With such a type of bridge, the building of the pile piers requires comparatively little work, and four or five men and a team will finish the timberwork, erect the steel span and lay the floor of an ordinary structure in about three weeks time. Many such bridges are built in locations which are 25 and 30 miles from a railroad, and local men accustomed to the country must be employed, since the ordinary discouragements of life on that class of work drive the new comer out of the business.

The traffic on some of the newer roads of the North does not warrant an expensive bridge across a broad river, and in such a case a wire rope is stretched from bank to bank and a scow provided, by means of which travellers may ferry themselves across the stream. Such a contrivance is cheap and is of great use during the summer months of the year, but the crossing will be impassable to all ordinary travel for a week or so during the spring and fall.

The highway bridges built in the settled districts and counties of older Ontario are of a more advanced type of construction. They must be capable of carrying heavier loads and be built so as to withstand the wea, and tear of greater traffic. Since good sand, gravelr and crushed stone are easily obtained and cement is cheap, it is economical to build the structures of concrete. For the longer spans where concrete is not as serviceable, the steel bridge is used, and it is customarily supported on concrete abutments and provided with a concrete floor.

For short spans, the concrete beam bridge is a very desirable structure, and for spans of medium length, where local conditions admit of its use, the concrete arch is of pleasing appearance. Such work when well designed and properly built is very durable, but great attention must be given to the foundations and to the surrounding conditions in order that damage to the structure may be prevented. Concrete is easily adapted to almost any foundation, but it is not in the best interests of such construction to use it in important locations where settlement of the piers is to be anticipated, or where the river channel will be cramped, due to a low bridge being required. The safety and enduring qualities of a concrete structure depend to a great extent on the stability of the foundations. The slightest movement of the footings will result in cracks opening in different parts of the structure, and while such cracks may not seriously affect the strength or safety of the bridge, they are unsightly and indicate an undesirable condition of affairs. Concrete is a splendid building material and will give good results even with very indifferent workmanship. It is particularly well adapted to certain locations and designs, but if used indiscriminately failures are bound to occur. In the case of small concrete bridges, the placing of the footings at a sufficient depth below the ground or water surface is frequently disregarded. As a result, the rush of water during a freshet undermines the foundations and the entire structure may be lost. It is good practice to carry all footings down to a depth of at least four feet below low water level since at that depth the foundation will be safe from frost as well as from the scouring action of the water. There are so many vital considerations entering into the design of a highway bridge that the selection of the type and nature of the bridge should be lift entirely to the engineer and his decision should be final.

Within the last 15 years there has been a gradual development and improvement in the general design and construction of steel bridges. The tendency has been toward strong and rigid riveted construction, and the light types formerly built have been abandoned. This progress is best illustrated in the cities by the use of heavy plate girders, and in the country by the building of fully riveted bridges in place of the pin-connected structures formerly erected. With riveted details, a longer life is to be expected of such bridges. There is still, however, room for further improvement in the design of typical connections, but the overcoming of prejudice against new methods along such lines is a slow process. Details that were considered good design 20 years ago, but which are now obsolete, may be used in structures build today, if care is not exercised in checking the plans.

Our highway bridges are now designed to carry a concrete floor and a 15 or 20 ton road roller, or a live load of 100 pounds to the square foot of floor surface. The structure which is built to carry such loading is of good proportions with fairly stout members. In the past, insufficient quantities of metal were used in many bridges and they were built so light as to be unable to sustain for many years the wear and tear to which they were subjected by the traffic and the elements.

The tendency of the times indicates that a 20-ton road roller will be the maximum load for bridges for some time to come. In some locations it is proposed to limit the weight of road rollers and auto trucks allowed to pass over highways and to make the maximum permissible weight of such machines ten or twelve tons. Legislation along such lines appears to be advisable since with an unrestricted weight of auto trucks we would soon see excessively heavy vehicles doing con-

siderable damage to highway bridges. Some timber and concrete floors have already received severe treatment and have been partly destroyed by the heavy rear axle weight of loaded trucks, and unless steps are taken to curtail such weight the damage will greatly increase. It is advisable, therefore, to enact laws which will set a limit on these heavy loads so that the highway bridges can be built in the security of knowing the heaviest load they will be called upon to carry. Otherwise great confusion may result, and a condition might arise where all our bridges would be too weak the moment an auto truck manufacturer increased the capacity and weight of his product. The establishing of a definite maximum load gives the auto builder and the bridge engineer a basis upon which to develop and improve all designs.

While we now build what is believed to be a fairly stout bridge, the required minimum thickness of metal of 5-16 inch causes nearly all highway bridge work to be known as tinwork in the shop where it is fabricated. If durable structures are to be constructed, no skimping or trimming out of metal should be allowed. It would appear to be a step in the right direction if no metal less than 3-8 inch thick was permitted to go into a highway bridge. Steel highway bridges are still built too light and flimsy to give a long length of life. Many steel bridges in use 25 years urgently require renewal today because of the serious rusting of the thin material, and if our work is to be enduring and have a fair length of life, it is absolutely essential that a sufficient quantity of metal be used in the new bridge.

There are several types of flooring used on highway bridges built today, and probably the one most frequently placed and which gives good satisfaction is the reinforced concrete floor. The plank floor and the creosoted wood block floor are also used in cases where concrete materials cannot be had, or where it is desired to lighten the dead load on a long bridge. In laying a concrete floor, too much care cannot be exercised to see that all stone, sand, or gravel is clean and the best to be obtained, since otherwise the result will be a poor concrete which will soon show signs of wear and disintegration.

The office methods and specification data used in the design of bridges call for little or no comment, but many of the methods of obtaining first hand information in the field during the original survey or inspection of the site of the bridge, might be profitably reviewed. Inexperienced men should not be sent to measure up the location of a proposed bridge. Each crossing of a river is surrounded by widely different conditions and an engineer well versed in building and maintaining bridges should make the original surveys and examinations.

When a bridge is to be built, accurate information is required respecting the width of the river, the depth of the water, the height of high and low water, the navigation or log driving to be provided for, the manner in which the ice goes out in the spring, the quantity of driftwood brought down by the freshet, the nature of the banks of the river, the character of the foundations that will be required, the local materials available for concrete or timberwork and the distance to the nearest railway station. This information is necessary, be the bridge small or large, and in addition the judgment of the engineer comes into play when the question is put as to what structure is best adapted to the site. Many instances could be cited, owing to incomplete information, where a bridge pier was placed in the middle of a river. The amount of money required to protect and maintain that pier, together with its first cost, would have paid for a steel bridge long enough to completely span the river. In some cases, bridges of insufficient length have been placed at crossings of wide rivers and as a result they have been swept away on the crest of the first serious flood. The position of the banks of a river is very significant. They are standing evidence that, at one time or another, the river possessed sufficient force and power to sweep away everything between those banks, and a structure which cramps that wide waterway is putting up a losing fight with nature. The pages of our engineering journals continually record the washing away of bridges, and the lesson frequently placed before us is that the waterways provided at bridges should be of a sufficient size to pass the floods. The creek of today may be the roaring torrent of tomorrow, and provision should be made for that excessive rush of water. It is only natural to build bridges as small as possible and to construct them with the least expenditure of money, but in building a bridge the first consideration should be the safety of the completed structure and the size of the waterway to be provided must govern the design.

The nature of the foundation on which the abutment of a bridge is to be placed, deserves mention. An engineer is called upon to construct bridge footings in every kind of location from one that is a bottomless bog to one that is splendid solid rock. There are between those extremes a number of different classes of material all of which require close attention in order that a secure footing may be obtained. A solid rock foundation is ready for the concrete as soon as all the loose and decayed rock has been blasted and cleaned away. It is well to have the rock footing fairly level and yet rough enough to give the concrete a good bond to prevent any possibility of sliding.

With a foundation of gravel, boulders, or hardpan, the concrete of the footing may be deposited when the excavation reaches a depth of four or five feet, since at that depth scouring of the material cannot occur and frost will have no affect.

Where the foundation is sand, silt, muck, or soft clay, the bottom will require that piles be driven, and soundings should be made to ascertain the depth or length of pile required to bring up against hard material. In driving piles, good judgment and experience is required to know just when a pile is sufficiently driven. Many specifications require that driving shall be continued to refusal, and this is much to be preferred to under driving. The preparation of a pile foundation requires just as much care as any other part of the design of a bridge, since with improper or insufficient driving settlement will occur and the abutment or pier will be destroyed.

In some locations where an exceptionally soft foundation occurs, it is advisable to divert the road to a better crossing, where a more secure bottom can be obtained. With a highway bridge, however, there is a lack of vibration and impact and the loading is comparatively light, so that in almost all soft locations a good pile footing will be found to be all that is required to safely carry the abutment.

For short bridges up to say 40 or 45 feet in length, and where the bottom is soft, a steel beam bridge gives a very satisfactory structure. The small cost of the entire work does not justify expensive pile foundations, and a mat composed of long timbers may be laid in the bed of the river so that each timber extends under both abutments.

A slight settlement is to be expected with such a structure, but no harm or damage to the bridge will occur.

The maintaining of the many steel bridges now on the highways is a work requiring considerable experience and attention. A bridge is like any other structure built by man, it is not everlasting. In the case of steel structures, it has practically been a custom to neglect them and they are seldom painted. This neglect hastens the rusting and decay of the metal, and the day soon comes when another bridge is necessary. It is frequently a difficult matter to have councils appropriate money for painting bridges when they have seen indifferent and expensive work done on bridges in their own or in an adjoining municipality. There is no doubt whatever that money spent for painting is real economy, and there is no defense that can be offered for allowing a bridge to go to ruin. If a structure is painted every four years, it will take five complete paintings to protect it for 20 or 25 years, and at the end of that time it should be in a good state of preservation. It could then be removed to a highway having lighter traffic and would probably be of good service in that new location for a number of years. Experience with bridges that have been uncared for for 25 years, indicates that they are just about ready for the scrap heap, whereas proper painting carried out at comparatively small cost would have rendered them still useful for an indefinite period.

A competent inspector should examine all bridges at least twice a year. The inspections should be in the spring and fall, and every portion of the structure should be examined to discover any defects. The older bridges have many welded members and experience has shown that such details are liable to fail while in service. Where there are two bars in a member and one breaks there is still sufficient strength available to carry the structure, pending immediate repairs, but no chances should be taken, and if there is any doubt as to the ability of the structure to stand up it should be closed till repairs can be completed.

Notice boards calling attention to a speed limit on the bridge may be in place, but are in all probability illegible due to disappearance of the paint. Such boards are still necessary. They should be painted with easily read type and placed conspicuously in order to obtain

compliance with the stated request. The fact that a notice board cannot be read usually results in a lack of observance of a very necessary restriction on the speed of horses crossing a bridge.

The practical test of observing the bridge during the passage of a heavy load may result in the discovery that the various parts appear to be loose and that the entire structure appears to be working or moving. If there are a number of adjustable members in the trusses and lower laterals, it is probable that the tightening of such while no load is on the structure will cure any apparent looseness, while if the bridge is fully riveted it is desirable that close attention be given the various joints to see that rivets are still tight. If a number of loose rivets are found, it is best to cut them out and redrive so as to produce a tight joint.

Should any member of the structure be accidently crippled while in service, the best method of repairs requires careful consideration, but as a general principle it is advisable to remove the damaged part and renew it. Sections which have been subjected to heavy bending are not reliable, and a new member completes the repair in the most satisfactory manner. The danger to structures from fire due to nearby material or buildings requires attention, and driftwood should not be permitted to accumulate near the bridge.

In Ontario, we have many concrete bridges, and where such structures were originally well built there are no maintenance charges and little or no inspection required. The first concrete arch bridge built by the Department of Public Works was constructed in 1907. It is founded on solid rock, and to date not one cent has been expended for maintenance.

In conclusion it may be said that the highway bridge is today in an important stage of development. The knowledge gained in using the various materials of construction is tending to modify and improve the design and general appearance of such structures, and a more artistic type is being aimed at. With an established system of loads for all structures, and a greater public demand for permanency in construction, a considerable improvement in the character and type of bridges is to be expected.

Creosoted Wood Block Pavements

By Andrew F. Macallum, B.A.Sc. & C.E.

For a number of years untreated wood block pavements were laid in this country and the States, and after repeated failures attention was directed to the use of preservatives.

The first experiments made simply placed thoroughly dried blocks in a bath of creosote heated to a temperature of about 210°F. until about three pounds per cubic foot of creosote had been absorbed.

While these pavements were fairly successful it was soon realized that the best results could not be secured by dipping the blocks and the blocks were then treated with creosote under pressure until they absorbed from ten to twelve pounds of oil per cubic foot. Such a pavement laid in Indianopolis in 1898 gave such good results that City Engineer began to appreciate the possibilities of treated wooden blocks and better results were obtained.

On Tremont Street, in Boston, a wood block pavement treated with creo-resinate process composed of one-half creosote oil and one-half resin was laid in 1898. The writer saw this pavement about a year ago and it was still in good condition after sixteen years of heavy traffic.

A small piece of similarly treated wood block was laid on the west side of Yonge Street, Toronto, at Front Street, opposite the head office of the Bank of Montreal, in 1896, and was still in good condition when taken up for a new pavement about two years ago. The writer also examined such pavements in New York on Church and Warren Streets, after they had been in use for nine years under the heaviest kind of traffic and they were still in good condition. In the city of Hamilton, probably more treated wood block pavements have been laid than in any other city in Canada, and the first pavements laid in 1909 are as good as when laid, and although subjected to the heaviest traffic in that manufacturing city have not to date cost a cent for maintenance.

These examples, which I have mentioned are but a few of the numerous examples showing permanence and suitability of this form of pavement for streets carrying heavy traffic.

I may also say that it has also been laid on residential streets where the residents assume its greater cost to asphalt for the added comfort through its quietness under traffic.

The wood principally used has been long leaf (yellow) Southern pine which from experience has been found to give excellent results. Most specifications, now, however, admit Norway pine and tamarac as a result of experimental pavements laid in Minneapolis, which showed the suitability of these woods. No doubt other species of wood make satisfactory pavements but on account of the incomplete knowledge of their value as paving blocks, city engineers as a rule prefer a wood that has proved satisfactory.

The blocks are from three to four inches wide, and vary in depth from three to four and one-half inches, with a length of from 5 to 10 inches. The depth of blocks should not vary more than one-sixteenth of an inch for a given size. As for all timber specifications the blocks should be sound, free from large or loose knots, shakes, worm holes and other similar defects.

The annual rings are usually specified as to average not less than six to the inch and the blocks to average 80% of heart wood or one block not to have less than 50% heart wood.

The preservative used is usually a pure coal tar product free from petroleum oil or its products having a specific gravity of 1.10. Water gas tars have not proven satisfactory and should not be used.

The writer has been corresponding with a number of city engineers with a view of obtaining opinion as to the most satisfactory amount of treatment required per cubic foot of block according to the experience of each city and in replies from twenty cities in the United States has ascertained that six of these cities use 16 pounds, two of them 18 pounds, and twelve of them 20 pounds depending to some extent on local conditions.

The percentage of treatment will vary with the block as the denser and heavier the block the smaller is the quantity of oil which it absorbs. The sapwood will absorb a large percentage of the oil but if the block has not had the moisture first removed from the sapwood, the oil will not be able to penetrate. Thus it is invariably found that a block which fails does so in the sapwood, and the cause is insufficient amount of oil or poor penetration of the sapwood.

Laying the Pavement.

The base for wood block pavements should be of concrete, from five to six inches deep, having the crown parallel to the finished crown on the blocks. An uneven or irregular base is detrimental to any pavement as it is liable to cause a depression in the surface to hold water which the repeated impacts of waggon wheels is certain to increase, giving an uneven surface. Upon this concrete base is placed either a sand or mortar cushion, usually one-inch deep with its surface struck by templates to a surface parallel to the contour of the finished pavement. Where sand is used the sand is such that it will all pass through a quarter inch screen, besides being clean. If a mortar cushion be used, some engineers use a proportion of one of cement to three of clean sand to which sufficient water is added to insure the proper setting of the cement, while other engineers obtain good results by mixing and placing the cement and sand dry. This cushion is simply a means of securing a uniform surface for the blocks to rest upon and distribute the load. Alongside or between street car tracks, however, or on grades, sand cushions are apt to become uneven or flow, caused by the vibration of the rails or by water getting in alongside the rails, so that under these circumstances a concrete cushion should be used. Away from the car tracks the question of whether a sand or mortar cushion should be used is a matter of opinion. Sand gives a better cushioning effect and the blocks do not have to be rolled so soon after laying as when a mortar cushion is used, but the present tendency seems to favor a mortar cushion.

GOOD ROADS CONGRESS

European practise does away with this cushion altogether, but the concrete base is finished off as smooth a a concrete sidewalk and to the exact coutour of the surface of the pavement. This extra care and workmanship obtain results that are excellent in as much as the finished surface of the blocks have no depressions and consequently the wheels cause no impacts.

In most cities it is not possible to lay the blocks shortly after coming out of the treating plant and the hot sun and wind during shipment and before laying is apt to check the blocks and cause oil to exude. The blocks should be piled closely when delivered on the street and sprinkled or dipped in water before laying.

Generally the blocks are laid at right angles with the curbs with an expansion joint at each curb of from three quarters to an inch and a half according to the width of the pavement. Alongside the curbs three rows are laid parallel to the curbs with the expansion joint next to the curb. Placing a longitudinal row of blocks with an expansion joint on each side is sometimes done, but is not good practice as the single row of blocks between the joints will almost certainly rise up about the level of the adjoining pavement as the joints close up. Cross expansion joints have been used also by the writer when the treated block had been piled on a street for several months, but for fresh blocks properly treated they are not necessary on streets of heavy traffic. On streets of light traffic, however, there should be cross expansion joints placed from thirty to fifty feet apart and having a width of about three quarters of an inch. It is hardly necessary to say that the blocks should be laid with the grain vertical and having the joints in adjacent rows, broken by a lap of about 2 inches. The blocks should be laid neither too loose nor too tight, so that a block can be raised without disturbing the surrounding blocks, or one-eighth of an inch apart.

After the pavement is laid it should be rolled thoroughly with a roller varying from three to five tons until a perfect surface has been secured with no depressions and the blocks firmly in place. There should be no difficulty in this as the usual specification for blocks allows of a variation of but one-sixteenth of an inch in depth so that if the foundation and cushion have been properly laid there is usually very little trouble about depth of the blocks.

Alongside street railway tracks and about manholes, special care should be taken in laying the blocks. It is usual in such cases to thicken the cushion so that the blocks shall be about one-quarter of an inch above the wearing surface of the rail or cover and in a very short time the traffic will rub these blocks down to the level of the rail Alongside rails to prevent water flowing down and under the blocks two methods are used: one is to place specially cut creosoted plank under the rail head to give a vertical surface against which the blocks are paved, and the second and usual method is to plaster the web with a rich mixture of sand and cement to the width of the rail head and the blocks are then laid against this. As with other pavements, it has been found that the girder lip rail is more satisfactory than the ordinary tee rail, unfortunately in use in most towns, for the permanence of the block on the inside or gauge side of the rail. Incidentially it may be said that no pavement will be satisfactory alongside a street railway track if the rails lack sufficient weight, stiffness and foundation to prevent movement, especially at the joints.

There is diversity of opinion among engineers as to the best joint filler to be used. The American Society of Municipal Improvements, of which the writer has the honor of being President, recommend a suitable bituminous filler when the blocks are laid upon a sand cushion and a sand filler when laid on a mortar cushion. It is claimed for the bituminous filler, which fills the joints between the blocks two-thirds their depth (the remaining depth filled with sand) that makes an absolutely waterproof pavement and that it eliminates all expansion difficulties as such block is surrounded with an individual expansion joint. Unless the filler is a suitable asphaltic cement with a high milting point and low penetration, there is apt to be a stick surplus left on the surface. This filler will cost about 15 cents per square yard more than a sand filler.

A cement grout filler has been used but unless the traffic can be kept off the pavement for at least ten days it is little better than a sand filler.

The sand filler is generally used on street of heavy traffic; the sand being coarse and sharp grained, and preferably heated before placing. The writer has used with excellent results a bituminous filler between and one foot outside of street railway tracks and a sand filler to the curb where three rows are again treated with a bituminous filler. From results obtained he does not consider the extra expense in using bituminous filler justified for such streets unless the traffic be very light. On bridge floors, it is better practise to use a bituminous filler with the blocks. After the pavement is rolled, sand to the depth of about a quarter of an inch is spread over the surface and the street is thrown open to traffic.

This method of construction is satisfactory up to a three per cent grade, beyond which the blocks are laid in a different manner. The crown should be as light as possible, being just sufficient to shed the water freely, which applies also to the pavements between street railway tracks.

When the grade of a proposed pavement exceeds three per cent, the question of a suitable pavement, and the method to be adopted in laying it, to meet the requirements of the traffic, becomes of interest. With the variability of conditions to be met with due to our climatic changes, the limits of most paving material is soon reached, so far as the inclination of grade is concerned unless specially manufactured.

The writer inquired from twenty-four cities to ascertain the maximum grades upon which creosoted wood blocks had been laid, and found that one city had laid this pavement on a seven per cent grade, one on six per cent, three on five per cent, and five on three per cent grades. The five to seven per cent pavements were laid under two methods, described below.

The first method used was probably originated in this city, and was used on upper James street with the block pavement laid there in 1909 on a five and a half per cent grade. Each block had a piece one-half inch in width, and one-half inch in depth, cut off one face so that when the blocks were laid at right angles to the centre line of the street there was a space of a half-inch between each row of blocks giving a good foothold for the horse drawing traffic. These blocks were pitch filled and the cross grade of the street was sufficient to drain out any water.

The same method was adopted on King Street west, in this city, during the same year, and I may say that both of these pavements have been very successful in meeting the conditions of heavy traffic on two of our main streets without a cent being spent for repairs or renewals since being laid.

The special cutting of the blocks in the manner described added considerably to the cost of the pavement, and to obviate this, the ordinary rectangular block was used with creosoted laths, 3-8″ x 2″, laid between each cross row of blocks. This was pitch filled as in the first method and has been just as successful, being today in first-class condition although subjected to fairly heavy traffic for four years.

On Ravenscliffe Avenue, a purely residential street, having a 6 per cent grade, blocks spaced in this manner were laid. The reason for putting such a pavement on a street like this having very little traffic was that the residents insisted on a creosoted wooden block, suitable for such a grade and it has fulfilled expectations.

One of the criticisms made of treated wood block pavements is that it is slippery, but in the writer's experience he has found that there is very little difference between these blocks and sheet asphalt pavements. When covered with a light frost or snow, or when the weather if foggy and damp, the pavement may become objectionably slippery.

In traffic observations made at Philadelphia, Newark, and other cities, the evidence shown by the engineers at these places indicated that where treated wooden block and granite blocks were on parallel streets 70% of the teaming went on the wooden block.

On Stuart Street in the city of Hamilton, the writer laid treated wooden blocks between the street car raisl and granite block between the outside rails and curbs, the pavement being on a 5 per cent grade. Although most of the traffic was of heavy truck teaming nature, it was found that fully 80 per cent of the traffic except on wet days was on the wooden block.

The first cost of wood block pavement is undoubtedly higher than that of most of the other paving materials averaging in the city of Hamilton from $2.85 to $3.00 per square yard, exclusive of grading. When its cheapness of maintenance, ease of cleaning, low tractive resistance and durability are taken into consideration this pavement with its relatively high first cost will compare favorably and prove ultimately cheaper than one lower in first cost.

Penetration Methods with Refined Tars

By A. W. DEAN, M.A., S.C.E., Chief Engineer,
Massachusetts Highway Commission.

The inventive minds of many men have for several years been engaged in conceiving practical low cost road surfaces that will withstand, without prohibitive maintenance expenditures, the modern mixed vehicular traffic.

Stone block, brick and other durable pavements are economical under very heavy traffic, but their first cost makes them prohibitive on streets and roadways where the traffic consists largely of comparatively light motor or horse drawn vehicles.

The sudden or gradual wearing away of water-bound macadam surfaces which, previous to the advent of the motor vehicle, were considered the best surfaces for suburban roadways, called for immediate action by maintenance engineers. Innumerable experimental methods have been tried during the last decade, but the most extensively used in many localities, of any semi-permanent surface, has been and is the bituminous bound surface, applying the bitumen by the so-called penetration method. In such a surface properly constructed, there is combined low cost of construction and maintenance, good tractive qualities and cleanliness.

Broken stone roadway surfaces built by the penetration method, using refined tar or asphalt as a binder, are quite generally, and for the sake of brevity will be herein, termed "bituminous macadam." Theoretically, as usually built, they are faulty, but practically they have been sufficiently economical in construction and maintenance to warrant continued use of such construction in localities where the materials can be conveniently obtained.

While comparatively easy to construct, care in both the selection and application of material is absolutely essential for proper results. First, as in all pavements, there must be a good foundation, properly drained, that will be firm under all climatic conditions. In some localities the natural sub-grade furnishes such a foundation, while in others the soil must be excavated and a foundation of stone, gravel, slag, or other proper material or combination of materials substituted and thoroughly compacted.

On this foundation, broken stone is spread and compacted and the voids thoroughly filled with stone dust or sand. This course should be brought to a true surface and any surplus stone dust or sand above the amount necessary to fill the voids should be removed, leaving the upper surface of the stone fragments bare. The depth of this course may be varied according to local conditions. If a heavy stone foundation has been constructed, this course need not be more than two inches in depth. If, however, it is laid on a natural foundation, the thickness should be greater, the customary depth varying from three to six inches, depending upon the exact nature of the subsoil and weight of traffic to be supported.

The determination of sizes of stone used in this course is not particularly important so long as there is no segregation.

Upon this surface a second layer of broken stone is spread and rolled. The customary thickness for this course is two inches after rolling, although frequently it is built two and one-half or even three inches in depth. It is in the construction of this upper course that great attention to details is necessary. If the stone is soft the large size output of the crusher should be used, as the roller will crush the stone sufficiently to furnish the necessary small particles. If the stone is very hard, small stone may be used, depending somewhat upon whether it is desired that the finished traveled way shall be absolutely smooth or somewhat rough. The use of stone in this course varying in diameter from one and one-half to two and three-quarters inches permits or produces under proper treatment a somewhat rough surface, thus providing some foothold for hosres. If stone one-half inch to one and one-half inches in diameter is used, the finished surface will tend to be very smooth and slippery. Whatever size of stone is used it must be entirely free from dust or dirt; it must be spread evenly with the different component sizes distributed and not segregated; it must be properly rolled to reduce the voids and make the surface as stable as possible without the aid of a binder, yet not sufficiently to unduly crush the stone if soft; and it must be brought to a true and even surface before any binder is applied.

Upon this surface refined tar or asphalt is spread uniformly in sufficient quantity to fill the voids without leaving a surplus on the surface. The voids in the lower course having been filled, all of the bitumen remains in the upper course, practically filling every void in this course so that when cooled it constitutes a stable surface of stone and bitumen.

Great care needs to be exercised in spreading the bitumen to insure an even distribution. If the crude method of hand pouring is used, only skill in pouring will prevent undesirable results. If single pressure nozzles are used, skill and intelligence sufficient to secure uniform distribution of essentail importance. By far the best method for spreading the bitumen is by means of a pressure machine, forcing the bitumen onto and into the surface through a series of nozzles that insure an uniform amount on each square yard of surface.

The exact amount of bitumen to be used depends upon the size of stone and the thickness of the course. Too much bitumen needs frequent subsequent covering and tends to cause bunches, and too little permits water to penetrate the surface and is otherwise detrimental. While three-quarters of a gallon per square yard per inch thickness of stone is frequently very close to the amount used, it cannot in any way be used as a rule. Skill and experience (or the lack thereof) will here show results.

After applying the bitumen there should be spread immediately a sufficient amount of pea stone (one-half inch stone) to cover the exposed bitumen, followed by thorough rolling. A second application (or seal coat) of bitumen is then spread, using about one-half gallon to the square yard, which should be covered immediately with pea stone and rolled.

Every application of any material in the upper course must be uniform, otherwise good results are not obtained.

The bitumen used, if refined tar, should have a specific gravity at 60°F between 1.22 and 1.28, and should have a viscosity of 125 to 200 at 212°F, using 100 c.c. with the Engler viscosimeter. If of asphalt it should preferably have a penetration between 100 and 130, using the Dow penetrometer.

The maintenance of a properly constructed bituminous macadam roadway is very simple. If slight depressions or small holes occur, they are usually due to imperfections in construction and may be repaired by painting with bitumen and filling with chips or pea stone, or they may be filled with coated stone, and tamped or rolled.

Traffic and climate govern the demands for more extensive maintenance. With moderate traffic, perfection of surface is maintained by spraying the surface about once in two years with a lighter grade of tar or asphalt. The process consists in sweeping thoroughly the surface, spraying at the rate of about one-fourth to three-eighths gallons per square yard, and covering with pea stone. If the surface becomes worn too much for such treatment, it may be restored by lightly scarifying, smoothing by rakes or harrow, adding more stone and rolling it into place, and then treating the same as previously outlined for new construction.

This last method of resurfacing, provided the road foundation was originally properly constructed, may be subsequently repeated as often as necessary, thereby utilizing the permanent base and first course and maintaining a semi-permanent surface good for any except extremely heavy vehicles.

The cost of grading, drainage and foundation will of course vary greatly, being governed entirely by local conditions and necessities. With local stone conveniently available the cost of the first course three inches in thickness should not exceed forty cents per square yard and might not exceed thirty cents per square yard. Under the same conditions the first cost of the wearing course, if made two inches in thickness, should not exceed fifty cents per square yard. This is based upon the assumption that the cost of the bitumen, including heating and applying, does not exceed twelve cents per gallon.

The cost of patching holes and depressions will, of course, depend upon the perfection of material and workmanship in the original construction. The cost of placing one seal coat is from eight to ten cents per square yard, consequently, if required only once in two years, this would call for an average annual expenditure of four to five cents per square yard. If such a seal coat

were only needed once in three years, the average annual expense would be reduced proportionately.

The cost of renewing the surface by scarifying and adding new stone and bitumen would not be far different from the cost of the original construction of a two-inch surface. Such surfaces have not been in use under varying traffic for a period sufficiently long at the present time to permit even an estimate of the frequency at which such renewal would be required, consequently, an estimate of the average annual expense of renewal might be misleading.

Specification for Bituminous Macadam

APPLICABLE TO CITY STREETS

Submitted by J. VINTON DART, Engineer in Charge, Highway Department, Providence, R.I.

The old street is first scarified and the gravel or stone is thrown to one side to be used later. The roadway is then brought to the sub-grade; the gutters are then repaved and the curbs reset if necessary. During this delay, all connections to sewer and water pipes are made and all other work of the sort done in order that there will be no need of digging the streets up again. A foundation layer of five inches of the old broken stone is then laid and rolled thoroughly. Either broken stone or gravel is used for this course, preferably the former. While rolling, the street is shaped to a surface parallel and 2 3-8" below the finished grade.

After the rolling is finished, the surface is covered over with sand, which is broomed into the voids as much as possible, and a half-gallon per square yard of refined tar is applied hot. Over this is spread a three-inch layer of 2-inch stone and this is rolled thoroughly, compacting it to about 2 inches. On top of this course, is spread about 1.35 gallons of hot refined tar per square yard. Enough 1½" stone is applied to cover the refined tar and then the whole is thoroughly rolled.

The stone varying from one-half to three-quarter inch dimensions is then broomed into the voids and another coating of about three-eighths gallons of refined tar per square yard is applied, the surface then being lightly covered with the same size stone. Then the whole is thoroughly rolled.

The road is then thrown open to traffic for about a week or ten days. A final coat of one-eighth gallon of refined tar per square yard is then applied and a thin layer of sand is spread over the road with a rotary sanding machine using about 11.0 cu. ft per 100 59 yds.

Every detail of this work is subject to a rigid inspection.

The cost of this kind of pavement varies, depending on the material found in the street for the foundation, and the distance from the municipal plant. The total costs per square yard were from $0.993 to $1.415. The average cost is about $1.25 per square yard.

The refined tar used in the first three applications shall conform to the following analysis:

Specific gravity not less than 1.22 at 60°F.

Melting point (by ½" cube method in water) between 100 and 110° F.

Free carbon between 12 and 25%.

Viscosity (Engler): Time required to discharge 100 cc. at 212°F. about nine minutes.

The refined tar used in the fourth application shall conform to the following analysis:

Specific gravity between 1.14 and 1.18 at 60°F

Free carbon not less than 4%.

Viscosity (Engler) not more than 100 seconds for 100 cc. at 140°F.

Annual Meeting of Dominion Good Roads Association

The Annual Meeting of the Dominion Good Roads Association was then held, Mr. W. Huber taking the chair at the request of the President, who had to leave to catch a train.

The report of the Committee on nominations was presented and stated that the following names were submitted as officers for the coming year. The Chairman stated that the names were not final, the members were at liberty to suggest any others, which they desired or add to them:

Honorary Presidents: U. H. Dandurand, Montreal; W. A. McLean, Toronto; B. Michaud, Quebec; O. Hezzelwood, Toronto.

President: J. Duchastel, City Engineer, Outremont.

Vice-President: S. L. Squire, President Ontario Good Roads Association.

Secretary-Treasurer: Geo. A. McNamee, 909 New Birks Building, Montreal.

Committee: E. A. Cunningham, Lethbridge, Alberta; A. C. Emmett, Secretary Winnipeg Automobile Club, Winnipeg; Howard W. Pillow, President Automobile Club of Canada, Montreal; J. A. Sanderson, Hon. President Ontario Good Roads Association, Oxford Station, Ont.; R. S. Henderson, President Manitoba Good Roads Association; Thomas Adams, Town Planning Advisor, Commission of Conservation, Ottawa.; E. M. Desaulniers, M.D., M.L.A., Chambly County; J. W. Levesque, M.L.A., Laval County; A. F. McCallum, City Engineer, Hamilton; Geo. Hogarth, Chief Engineer, Highways Department, Ontario Government; Paul E. Mercier, Chief Engineer, City of Montreal.

Upon motion of Mr. A. Janin, seconded by Mr. A. C. Emmett, the nominations were unanimously accepted, and the officers named declared elected.

The new President, J. Duchastel, took the chair and in acknowledgment said: I want to thank you very much for the honor you have conferred upon me in appointing me your president for the coming year. Once or twice in my life, I have prepared a speech to deliver on occasions somewhat similar to this and when I got on the platform my speech was quite different. Nevertheless, I want to assure you that the association will, as far as I am concerned, work on the same lines as it has in the past, and one of its principal aims will be to strive to educate the masses to the value of good roads. Naturally we will always welcome discussions and papers on high grade roads and street pavements, but I think that one of the great aims of an association of this kind is to educate the rural communities to get an interest started up in the cause of good roads and to get the farmer to understand that our work is not only to provide good roads for automobile traffic, but that it is in his interest, before all, because his farm will increase in value, and his products will be sent to the markets cheaply, if good roads are provided.

I think that one of the main questions we will now have to consider is that of the selection of the city in which we are to hold our next annual meeting. The discussion is now open to any gentleman having any suggestions to make.

Mr. A. C. Emmett: As representing the Government of Manitoba, we have always taken a very keen interest in this annual canvention and some of our representatives have always attended it. We are now of the opinion that, in order to promote the good roads movement to the best possible extent throughout the Dominion that we should hold the next Convention at some point more central than Montreal. And our suggestion is that the next Convention should take place at Winnipeg, or in Western Canada, and then, in after years, the Convention should be held alternately east and west. I have here a telegram from the Hon. T. H. Johnson, Minister of Public Works, who says: You are authorized by the Government of the Province of Manitoba and also by Mayor R. D. Waugh on behalf of the city of Winnipeg, to extend a hearty and official welcome to the Congress to hold their fourth Canadian and International Good Roads Congress in Winnipeg in 1917.

GOOD ROADS CONGRESS

Mr. E. A. Cunningham: If I may be permitted to say a few words in support of the last speaker—the aims of this Congress are very very good, and it concerns Western Canada to a very large extent. As I mentioned the day before yesterday, I would like to see it national as well as international. In order to bring that about, it is advisable to have meetings at widely separated centres. I have attended Conventions in the city of Winnipeg, and all I can say is that they are very good fellows. They have had any amount of practice in the handling of Congresses and will be in a position to take care of this Congress in a splendid way. They have the accommodation, the halls, the industrial organizations to take care of Conventions no matter how large they are. Speaking for Alberta, I naturally would like to see the Convention go still further west, but I quite agree that this coming year, it is too far away. Because of the geographical location, it would take four days travelling to get to Alberta and two days to Winnipeg. And I am sure with the interest which would be awakened in the west, as well as the interest which already prevails in the east, and also among those south of the international boundary line, it would not be too much to expect a Convention of five or six hundred delegates at Winnipeg. I would like therefore, to very much support the last speaker, and to promise that the reports of this Convention will be submitted by me, not only to the city of Lethbridge, but to the city of Calgary, and to the Government of Alberta.

The President: It has been proposed by Mr. Emmett, and seconded by Mr. Cunningham, that our next annual Congress be held in Winnipeg. We have the assurance of both the provincial and municipal authorities that a hearty welcome will await us. What is your wish in the matter?

The proposition was carried unanimously.

Mr. Emmett: On behalf of the Province of Manitoba, I wish to thank you for the honor you are doing us in bringing your next Congress to Winnipeg, and to assure you we will do everything in our power to make it a perfect success.

Mr. Desaulniers: It is a very agreeable task to me to submit to this meeting the following motion: That a hearty vote of thanks be offered to the president and officers for the past year. I have no doubt that everyone will admit they have done good work and deserve that motion of thanks.

The motion was carried with acclamation, and the Third Canadian and International Good Roads Congress was then declared closed.

RESOLUTION:—

It is Resolved that since the employment of returned soldiers will be a national and a patriotic duty, that the Federal Government be asked to consider the advisability of constructing national highways.

Moved by Oliver Hezzelwood, President, Canadian Automobile Federation, Toronto, Ontario.
Seconded by S. L. Squire, President, Ontario Good Roads Association, Waterford, Ontario.
Passed unanimously at the Good Roads Congress, on March 10th, 1916.

RESOLUTION

Department of Municipal Affairs

This Congress petitions the Provincial Legislatures to consider the urgent need of setting up a Department of Municipal Affairs in each Province, to co-operate with each Department of Highways, in securing an equitable and uniform system of administering the expenditure of public monies in connection with the planning, construction, maintenance and apportionment of cost of roads and streets.

Moved by S. L. Squire, President, Ontario Good Roads Association.
Seconded by Thomas Adams, Town Planning Advisor, Commission of Conservation, Ottawa, Ont.
Passed unanimously at the Good Roads Congress, on March 10th, 1916.

RESOLUTION

Town Planning

Having regard to the need for the preparation of comprehensive plans of systems of principal roads and streets in cities, towns and rural municipalities in each Province in Canada, especially in respect of land in course of development or likely to be used for building purposes in the near future, it is hereby resolved that this Congress petition the Provincial Legislatures, which have not already passed Town Planning Acts, to give early consideration to the question of giving greater powers to cities, towns and municipalities, to prepare Town Planning schemes, with the special object of seeming more adequate and efficient means of communication by road within and between all populated areas.

Proposed by S. L. Squire, President, Ontario Good Roads Association, Waterford, Ontario.
Seconded by Thomas Adams, Town Planning Advisor, Commission of Conservation, Ottawa, Ontario.
Passed unanimously at the Good Roads Congress on March 10th, 1916.

TORONTO AND GOOD ROADS.

"Toronto has been the centre of the Good Roads movement in the Dominion of Canada. In 1909 the City Council of Toronto took the first step towards Good Roads movement in Canada. Canada has not kept pace with the importance of this particular question. The railway policy of Canada did a great deal for the people and for the railways that were presented with the roads by the people of Canada. But Canada has not had one copper to spend on Good Roads since confederation. Prior to the last three or four years, when the question has been taken up by the Dominion Government. The only time the Government of Canada have expended on Roads was an old wagon road across the Rocky Mountains, and the remains of it are still to be seen. It is deplorable to think that Canada has not had one red cent to spend on the King's Highway. The advantage of Good Roads to the farming communities and urban communities is very important because Good Roads bring the customer and the product together."—Mayor Church, of Toronto.

ROAD BUILDING BIG PROBLEM.

"In road building we are dealing with one of the most important questions which we, as a people, have to solve. It is unnecessary for me, to call attention to its magnitude. The problem we will have to face is difficult; the immense area which we possess is sparsely peopled, while the revenue of the other provinces is well defined and limited. Comparing our position with some of the States of the Union or with some of the countries in Europe it will be found that our position is exactly the reverse of theirs. They have a limited area, a dense population, and almost unlimited revenue."—Hon. Finlay G. Macdiarmid, Minister of Public Works, Province of Ontario.

COLONIZATION FOR SOLDIERS.

The C.P.R. has decided upon a colonization plan for soldiers after the war, involving the preparation of a thousand farms in Western Canada for occupation this year. Returned veterans' colonies will be established by the company, so that ex-soldiers can obtain improved farms on terms which, in time, will enable them to become landowners and create homes for themselves and their families.

The Union of Canadian Municipalities

Officers and Executive for the year 1915-1916

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Mayor of Toronto, Ont.

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LESLIE H. BOYD, Esq., K.C.,
Alderman, Montreal

2ND VICE-PRESIDENT:
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HON. SECRETARY-TREASURER:
W. D. LIGHTHALL, K.C.,
Ex.Mayor of Westmount, Que.

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2nd R. T. HAYES, Esq., Mayor of St. John
3rd L. W. McANN, Esq., Mayor of Moncton
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2nd J. JARDINE, Esq., Mayor of Summerside
3rd G. A. AITKEN, Esq., Mayor of Georgetown
4th JAMES PATON, Esq., Ex-Mayor of Charlottetown

Official Organ
"THE CANADIAN MUNICIPAL JOURNAL"
Coristine Bldg., Montreal.

G. S. WILSON, Asst.-Secretary,
Bureau of Information,
Coristine Bldg., Montreal

OFFICIAL.

To all Municipal Councils:

By the cordial invitation of His Worship, Mayor Martin, the Board of Commissioners, and the City Council, the Annual Convention of the Union of Canadian Municipalities will be held in the City Hall, Montreal, August 21st, 22nd, 23rd, and 24th, Monday, Tuesday, Wednesday and Thursday.

Your Council is earnestly invited to send one or more delegates, and to take an active part in the proceedings which will be of more than usual importance this year on account of the new conditions facing our civic life.

The Programme is now being arranged, and a copy, with other information, will be sent to you at an early date.

It has been well said that the government of our cities and towns is the most important problem we are called upon to solve in the interest of efficient democracy. It can only be solved through a general appreciation of this fact by our municipal councils, and through careful, thoughtful, organized and unremitting co-operative effort.

Yours faithfully,

W. D. LIGHTHALL,

Hon. Sec. Treas., U.C.M.

CITY OF EDMONTON.

Edmonton, Alta., April 5th, 1916.

The Editor:

I am pleased to see that you are about to devote an issue to the consideration of the building of a Canadian National Highway and good roads generally.

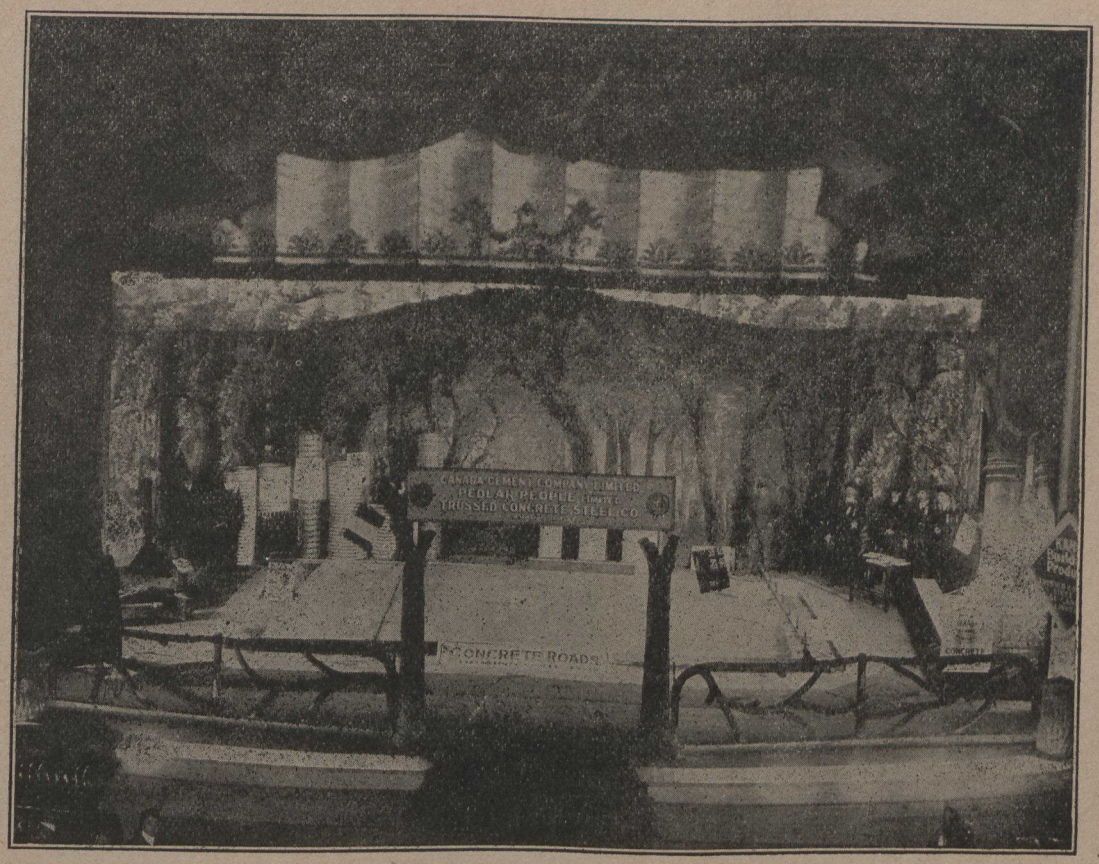
On the return of our soldiers from the war there will be many engineers available for work of this kind, and no doubt there will be many men who have developed into practical road builders.

This is a most opportune time to revive interest in the construction of a Canadian National Highway, and the connecting up of the principal cities of Canada with such a Highway. Canada, at the present time, is well supplied, at its principal centres, with magnificent hotels and such a Highway, besides giving easy access to the natural resources of the country, would also develop resources which would be of great value to the country as a whole.

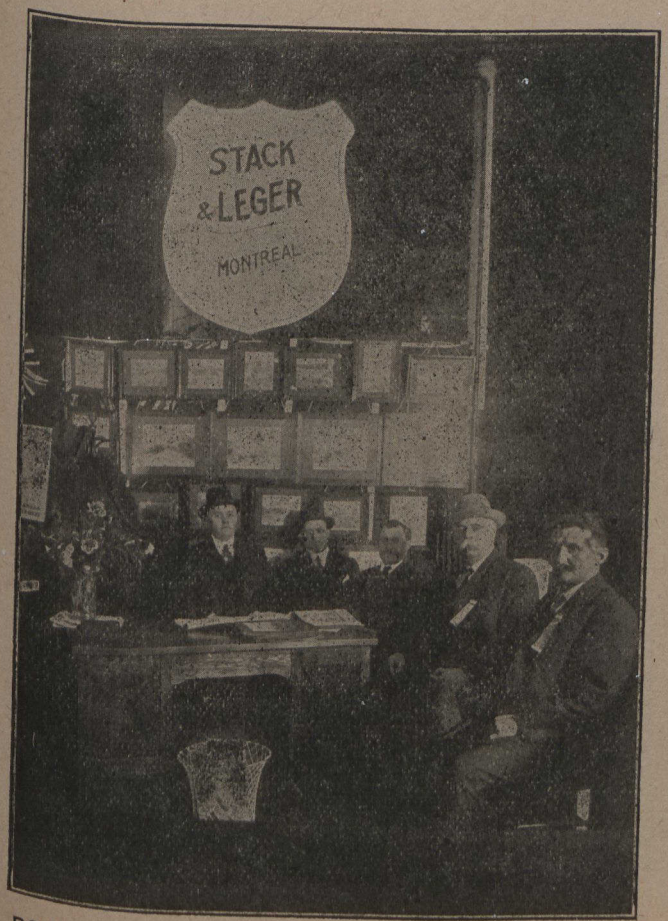
No doubt a great number of our returned soldiers will be seeking an outdoor life and not all of them will care to become farmers, but would take a keen interest in the development of the country by taking part in the building of a National Highway, as has been advocated for the last two years.

Yours truly,
A. G. HARRISON,
City Commissioner.

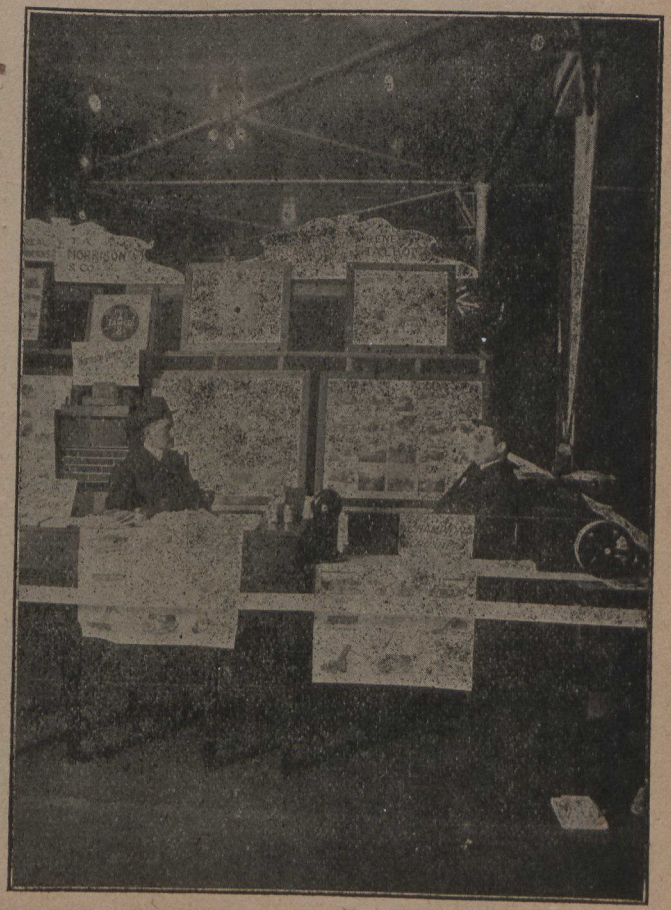
Good Roads Exhibition, Montreal, March 6, 7, 8, 9, 10



BOOTH OF CANADA CEMENT COMPANY, LIMITED



BOOTH OF STACK AND L..R, CONTRACTORS, MONTREAL



BOOTHS OF J. H. McCARTY, CONTRACTING ENGINEERS, MONTREAL AND RENE TALBOT, QUEBEC.

Good Roads Exhibition, Montreal, March 6, 7, 8, 9, 10

BOOTH OF ASPHALT AND SUPPLY COMPANY, LIMITED, MONTREAL

BOOTH OF QUINLAN AND ROBERTSON, LIMITED, ROAD CONTRACTORS, MONTREAL

Municipal Finance

JAMES MURRAY.

OTTAWA SINKING FUNDS.

Mr. Thomas Bradshaw, just before his appointment as finance commissioner of Toronto, completed a report on the condition of the Sinking Fund of Ottawa, which he prepared on the solicitation of the City Council. The report reads partially as follows:

The city's gross debenture debt total $14,417,577. There are 242 separate debentures current. The sinking fund assets, according to the bond requirement, should total $3,003,147, but they actually total $3,320,515, made up as follows:—

Ottawa debentures in fund	$1,855,229
Ontario bonds	250,000
Dominion bonds	50,000
Accrued interest	41,180
Cash in bank	1,124,106
Total	$3,320,515

Or a surplus above requirements of $317,438. The surplus has accumulated largely from miscalculations of interest earnings made with regard to the earlier debentures.

If correct accounting is to be kept it is essential that the exact amount of each levy applicable to each debenture shall pass to the credit of the sinking fund. The levies for the sinking funds should be made on the issue dates of the debentures and not on July 1st, as the city has been making a practice of doing. In justice and fairness to the fund this practice should be changed."

In a number of sinking fund accounts there is as much as $10,000 more than required, which should now be adjusted so that they will show on December 31st, 1915, the exact amount that should stand to their credit.

Proper Investment of Fund.

A number of city debentures have been sold to the city's sinking funds at par, even though the market price at the time was much lower. Such a practice, he says, is unsound and improper.

The sinking funds are entitled to purchase bonds at the most favorable terms obtainable. This practice is due to a faulty recognition of the elements of trusteeship.

Fifty-six per cent of the sinking funds are taken up with the city of Ottawa debentures. This proportion is too high, and in future the city should invest its sinking fund money in the debentures of other municipalities.

The funds are not being invested to the best advantage. They are only earning 3.74 per cent, because of the fact that $1,124,000 of the amount is in cash and only drawing 3 per cent interest from the bank. If outside investments for most of this amount were sought, it might be made to earn 5 to 5¼ per cent. The cash is left in the bank, because by leaving it there the city gets better terms from the bank on its own current account overdrafts. This practice is condemned by Mr. Bradshaw, who says that the city should not trade on its sinking funds.

Treatment of Funds.

There appears to have been considerable confusion of thought as to how individual sinking funds should be treated. In some cases the accounts showed that the sinking fund was greater than the debt for which it was being accumulated, notwithstanding that the debt would not be due for some time yet. In other cases the accounts showed that the fund was only approximately what it should be. The irregularities appear to have arisen from an attempt to associate certain investments with certain sinking funds, the investments carrying one rate of interest, while the sinking fund was calculated at another.

When debentures are issued a pro forma sinking fund statement should be immediately prepared setting forth the exact amount of the sinking fund on each anniversary date of the debt, as well as the exact amount at the end of the city's financial year.

The surplus of $317,868 is due to the fund, having earned for some years a higher rate of interest than the rate it was assumed it would earn and to the payment into the fund of premiums received on sale of the citys' bonds over par. At present the surplus constitutes a protection against any depreciation of loss which may arise. It is, of course, a proper question to ask whether the fund is now or likely to be in need of the whole of such protection.

Losses may occur by maladministration (but this is un-

likely), by investment losses, by depreciation in interest earnings, and by failure of the city to pay the annual levies to the sinking fund.

Conservative corporations, such as life insurance, and trust and loan companies, think it desirable to build up an investment reserve fund as a protection against contingencies and losses. It would be desirable to have such a fund for Ottawa. It need not, however, be unduly large. A 5 per cent reserve would probably be sufficient, which would require the city to carry $167,211 of a sinking fund reserve.

The balance of the surplus, or $150,000, might be used for some definite, useful and important work, one which will benefit the whole community.

The administration of the fund should be placed in the hands of a small permanent commission of, say, three or four absolutely independent citizens, persons of irreproachable character, and who are known to have a knowledge of financial matters, such as a judge, a bank manager, trust company manager, etc., and someone representing the city council.

INSTALMENT BONDS FOR TORONTO.

Finance Commissioner Bradshaw, of Toronto, is losing no time in putting into practice the instalment bond schemes he has so ably formulated in these columns and before the Ontario Society of Municipalities. Toronto has recently passed a number of money by-laws providing for bonds to be issued to bear interest at the rate of 4½ per cent with a sinking fund provided to retire the debt. As yet the bonds authorized have not been sold. Mr. Bradshaw has now recommended to the board of control that all of these by-laws be rescinded, and that new by-laws be passed, stipulating (a) that the bonds to be issued shall carry interest at the rate of 5 per cent, and (b) that the debt shall be paid in annual instalments during the currency of the bonds. The commissioner gives the following reasons for this change:—1. A 5 per cent interest rate is more in accordance with current market conditions than 4½ per cent, and consequently in effecting a sale a minimum discount loss would be sustained; 2. The amount of the capital debt created would be substantially less; 3. The annual levy for debt purposes would be much smaller; 4. There would be no necessity to erect and maintain a sinking fund; 5. The gross debt would be gradually reduced each year, instead of remaining stationary as it does under bonds issued under the sinking fund system.

To show how the scheme would work out Mr. Bradshaw directs attention to by-law No. 7459, which is one suggested to be rescinded. It provides for the issue of $1,166,666 of 4½ per cent, 30-year sinking fund bonds for school purposes.

If, instead, bonds were issued at a 5 per cent interest rate and the principal repayable in 30 annual instalments; (a) the amount of capital debt created would be $1,094,000, instead of $1,166,666, or $72,666 less; (b) the annual levy for interest and sinking fund would be $71,166.28, instead of $77,022.15, an annual reduction of $5,855.87; (c) the saving to the taxpayers throughout the currency of the loan—30 years—would be no less than $175,676.10.

Apart from the foregoing, says the finance commissioner, there is no doubt that the city's bonds would command a better price and market, if issued under the instalment system, than under the sinking fund.

Instalment Bonds Not Always Preferable.

The report adds: "It is not to be inferred, that I consider it would, in every instance, be preferable for the city to issue its bonds according to the annual instalment system. The question should be determined according to market conditions, etc., at the time bonds are being negotiated. At present, there is no doubt whatever but that it would be preferable in the city's interest, to adopt the instalment principle.

"The municipal act provides for bonds to be issued under both systems, and the city's request to increase the rate of interest, was approved by the private bills committee of the Ontario legislature, so there is no difficulty in putting the recommendation into effect."

"Railways and canals are, the absolute backbone of any new country, but it is just as absolutely necessary to have Good Roads. The one is a compliment to the other, and it is astonishing that we in Canada have built the railways and canals and not the roads. We must have the roads." —Sir Edmund Walker.

SASKATCHEWAN MUNICIPALITIES IN GOOD FINANCIAL POSITION.

Saskatchewan's rural municipalities, of which there are two hundred and ninety-seven, find themselves in a fortunate condition, largely as a result of the abnormally large crop of last year. Many of them can boast of a substantial cash surplus. This benefit has spread to the villages, towns and cities. A few urban municipalities find it necessary to severely retrench until they catch up with the visions of a few years ago, but the percentage s situated is small. No municipality in Saskatchewan has ever repudiated its debentures. War conditions seem to benefit agricultural areas excepting in the securing of labor.

VANCOUVER AS GRAIN ROUTE.

In a recent interview Mr. Grant Hall, vice-president of the C. P. R., stated that: "Regardless of all that is said to the contrary, it is unquestioned that grain will have to find its way out by way of Vancouver and it would seem to me that now the government had built an elevator at Vancouver of one and a half million bushels capacity they should fill it with commandeered grain to be moved just as soon as the Panama Canal is re-opened, which is expected shortly. This would be a practical way of demonstrating the advisability of shipping grain via Vancouver. It may be asked how this could be done and in reply I would say that the government must have at least six or eight million bushels of grain, which they commandeered, now at the head of Lake Superior. There is no possibility of moving all this grain via the Atlantic ports for some time and the government could arrange to sell several million bushels of it and then buy an equal amount in Western Saskatchewan and Alberta to move through to the coast."

TAXES IN ARREARS.

The provincial municipal law committee while declining to permit the city of Edmonton to hold a sale of property for arrears of taxes has given liberty to have the city charter amended to allow short-term debentures being issued and sold and made a first charge on all taxes in arrear, including schoil taxes.

RED DEER SEEKS CHARTER AMENDMENTS.

Red Deer is seeking amendments to its charter, whereby it will receive power to establish minimum tax rates. If the amendment goes through, the city will be given power to establish a minimum two-dollar tax against all property holders and a minimum tax of one dollar for educational purposes. It is stated the city will also establish a business tax.

WAYS AND MEANS.

"Is it not any longer necessary to take up time to discuss the advantages, social and economic, of Good Roads; we have passed that point to a very large extent. Some educational work may yet remain to be done, but on the whole this question meets with a favorable reception wherever it is discussed. The important matter to discuss now is the devising of ways and means to meet the different situations which arise and to finance the different proposals that may come forward."—Thomas Adams.

TORONTO AND NEW TEMPERANCE ACT.

In reference to the clause in the new Ontario Temperance Act exempting hotels, shops, distilleries and breweries from a business taxation, the effect will be to reduce the assessment and borrowing power of Toronto, says City Solicitor Johnson.

City Treasurer says that while this might be the effect, the city has ample margin on which to come and go. In striking the tax rate the assessment will be reduced by $3,554,254, making it $582,415,094.

This assessment gives the city power to borrow up to $51,343,667. The exemption of the liquor business tax reduces it to $51,093,207.

Of the city's debt $37,193,174 is not counted in computing the amount it may borrow. This leaves $48,953,350, $2,139,757 of a margin, which is further reduced by the $860,000 representing capital expenditure authorized by the Legislature and the liquor business tax exemption, leaving a margin of $1,279,608.

MUNICIPAL BONDS AWARDED.

Listowel, Ont.

$29,000 various maturities, to Messrs. C. H. Burgess and Company, Toronto.

Midland, Ont.

$25,000 5½ per cent 20-instalment bonds, to Messrs. R. C. Matthews and Company, Toronto.

Murchison and Lyell Township, Ont.

$6,500 6 per cent, to Messrs. Graham, Macdonald and Company, Toronto.

PRINCE RUPERT BOND ISSUE.

The City of Prince Rupert has entered into an agreement with Spitzer, Rodrick and Co., of Toledo, Ohio, to purchase a bond issue covering all the short-term issues outstanding and taking up practically the entire bond issue of the city. The deal involves $1,600,000 worth of bonds.

BERLIN, ONT.

The $88,909.13 5½ per cent local improvement bonds were awarded to the Imperial Bank of Canada at 100.53 and interest.

QUEBEC CITY, QUE.

The $475,000 issue of City of Quebec five-year gold bonds, bearing 5 per cent was sold to the firm of Brent, Noxon and Co., of Toronto, at the rate of 98.77.

NORTH BAY.

Two issues of North Bay, Ont., bonds $7,721 6 per cent 15 instalments, and $22,234 6 per cent 30 instalments, have been awarded to Messrs. A. H. Martens and Company, Toronto.

LITTLE OWING BY NON-RESIDENTS.

City Assessor Wallace, of Calgary, recently reported to the city council that out of a total of $2,695,662.59 tax arrears at the close of 1915, only $258,805 was owed by non-residents of the city, the balance of $2,436,857 was owned by residents.

MUNICIPAL AWARDS.

WILSON RIVER, MAN.

Wilson River, S. D. No. 688, Man., bond issue amounting to $4,000 was purchased by H. O'Hara and Co., of Toronto. These bonds are at 7 per cent, and run for 20 instalments.

SARNIA, ONT.

Brent, Noxon and Co., Toronto, were awarded Sarnia's latest bond issue, totalling $132,000. This issue was made up of $120,000 gas and electric light plant purchase, and $12,000 waterworks' extension 6 per cent 20-instalment bonds. Price, 104.43.

SALTCOATS, SASK.

The town of Saltcoats, Sask., awarded its issue of $17,000 5 per cent 30-instalment electric light bonds to W. L. McKinnon and Co., Toronto.

WESTERN ISSUES AWARDED.

W. L. McKinnon Co., Toronto, have purchased an issue of Basswood, Man., $18,000 6 per cent 15-instalment school bonds. The same firm has lately secured $60,000 of Western Telephone bonds.

NEW WESTMINSTER, B.C.

Wood, Gundy and Co., Toronto, have purchased $152,150 5 per cent bonds issued for local improvements. These bonds were issued in the following lots: $80,500 due 1945, $17,500 due 1943, and $54,150 due 1944.

SASKATOON, SASK.

Wood, Gundy and Co., Toronto, were awarded the Saskatoon, Sask., issue, totalling $160,000. These bonds were 5 per cent 30-instalments, in the following lots; $100,000 for street railway, $35,000 for incinerator, $12,000 for Childrens' Home, and $13,000 for waterworks.

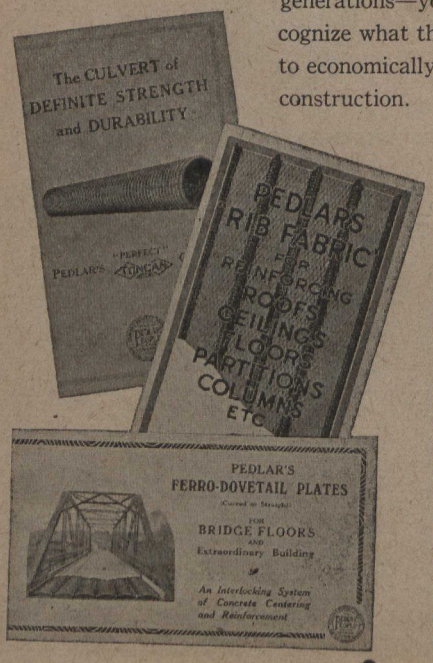
CONSULTING MUNICIPAL ENGINEERS

The Pedlar Exhibit Captured the Congress

Any who attended will tell you how much the educative value of the Good Roads Congress, Montreal, was improved by the Pedlar Exhibit on the Main Stage.

You who are expert in the technicalities of road construction would readily approve the enthusiasm displayed in the Pedlar Exhibit.

You who only want to know that the roads of your community will **Look** "Good" at first and **Stay** "Good" for generations—you too would recognize what this Exhibit means to economically-permanent road construction.



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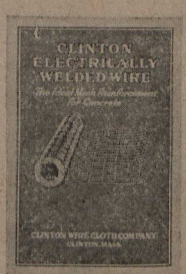


Building and Maintaining Roads with Refined Tar

Abstracted from Address by JOHN S. CRANDELL, C.E.

Of the various binders used for road purposes in the last decade only the bitumens have been successful. There are two classes of bitumens so used, and they may be divided into asphalts and tars. The former are found native or may be produced by the distillation of asphaltic oils. Tars are obtained from a number of sources, but those made during the destructive distillation of bituminous coal have given the best service and most satisfaction.

Refined tars for surface treatment of roads have been used during the past fifteen years. With the advent of the automobile came the dust nuisance and it was in great measure to alleviate this that experiments with refined tars were begun in Europe by Dr. Guglielminetti at the beginning of the 20th century. These experiments were very successful and led to the tremendous development of the road tar industries of today.

Tars are refined for roads and pavements so as to obtain materials suitable for cold application surface treatment, blanket-coat (hot application), the construction of tar bound macadam and paving pitch filler.

Bituminous Roads may be constructed either by the penetration or the mixed methods. By the penetration method is meant spreading and rolling crushed stone to the proper depth, crown and grade, after which hot refined tar is sprayed over the surface of the broken stone, then the voids are filled with chips and a second or seal coat of refined tar is applied. By the mixed method is meant mixing the heated aggregate and binder together before placing in the road. Both methods give satisfactory results when the construction is properly done, and it is a matter of judgment on the part of the engineer which he selects. Mixed work costs about 5 per cent more than penetration and requires greater skill and care.

The construction of a tar macadam built by the penetration method will first be taken up. This will be followed by a description of mixed work, and a discussion of maintenance by using a cold surface treatment which can also be used on water bound macadam, will conclude the paper.

It is assumed that the drainage problem has been solved and adequately taken care of before the construction of the pavement is begun. The purpose of a pavement of any kind is to distribute the load over the foundation as well as to provide a waterproof wearing course. The foundation is the earth on which the pavement rests, and it should be thoroughly compacted by rolling; all soft spots should be made firm and unyielding, and the surface of the foundation after rolling should be parallel to that of the finished road.

Base Course.

On such a well-compacted foundation broken stone is spread to a depth of from four to eight inches depending on the kind of stone, and the character of traffic the road is to carry. This is large sized stone, such as will pass a 3 1-2 inch ring and be retained on a 2 1-4 inch ring. The harder the stone the smaller the size that may be used. This base course should be thoroughly rolled so that no movement takes place when the roller passes. A 10—12 ton roller is best.

In order to make the base course more stable; to keep the foundation from working up; and to prevent the refined tar, that is applied later on to the next course above, from leaking through and thus being wasted, the spaces between the stones should be filled with fine, clean gravel, coarse sand, or stone screenings. Rolling should be continued, always beginning at the side and working up to the center. The rolled surface of the base course should resemble a water bound macadam free from dust.

On this base course either a penetration or a mixed top may be placed.

Wearing Course Penetration Method.

The wearing course is made up of stone 2 1-2 to 1 1-2 inches, and after rolling it should be 2 1-2 inches in depth. The stone is carefully spread, and rolled so that the surface is smooth and firm. This course is to be filled with tar, so that great care must be taken when soft stone is used to avoid crushing and thus sealing the surface with rock dust which would prevent the penetration of the bitumen.

Refined tar will not stick to dirty or wet surfaces. Therefore the wearing course stone must be clean and dry.

Refined Tar for Binder.

Not less than 1 1-4 imperial gallons nor more than 1 1-2 imperial gallons of refined tar at a temperature of from 200 deg. F. to 275 deg. F. are then spread uniformly over each square yard of the wearing course. The tar is best applied by pressure distributors, but hand pouring pots may be used if it is impossible to secure suitable apparatus.

It is very important that the tar be uniformly applied so that the resulting pavement has neither lean nor fat spots in it.

Filling and Sealing.

The spaces between the stones of the wearing course are now filled with 3-4 inch clean stone. This should merely fill the voids and not form another course.

Roll again. Sweep off any excess stone.

The road is now ready to receive the seal coat, which consists of 1-3 to 1-2 imperial gallon of tar at 200 deg. F. to 275 deg. F. temperature, and is covered with sand and peastone.

Roll for the last time, and the road is then ready for traffic.

Mixed Method.

On the base course, constructed as previously described, can be placed a wearing course made by the mixed method, or such a wearing course may be placed on a concrete base, or on a Telford base.

It is necessary to have a mechanical power mixer to properly mix stone and bitumen. There are many such mixers on the market. Some of them heat up the drum with an open flame. The flame should never be allowed in the mixer after the bitumen has been introduced. Portable plants can be had as well as stationary plants, and it is important to choose one that has a capacity suitable to the job.

The advantages that refined coal tar have over other bitumens are that it is easily used in the cold mix type in which the stone is not heated, that it requires less heat, since the tars have a lower melting point than asphalts, and that the same number of men can turn out a greater yardage per day.

The greatest care must be exercised to see that the temperature is right and that no batch is burned. A burned batch means a bad spot in the pavement that is bound to show up in time.

About 2 1-2 inches of wearing course material is placed on the base course and rolled until it is compacted to two inches, judgment being exercised as to time and amount of rolling necessary.

Maintenance.

There is no such thing as to permanent road. There is nothing permanent in the universe. The sooner that fact is realized and given due thought by our taxpayers the sooner grumbling over unmaintained roads will cease. The most enduring structures in the world, whether natural or erected by man, are not proof against the elements, and a roadway, exposed as it is at all seasons of the year to the weather, needs and should receive the best of acre.

Just why it is so difficult to make the average man realize that a road needs more maintenance than his house or his office or his barn or his farm machinery is impossible to say. Yet the popular notion still obtains even among officials who should know better that once a road is built it is there forever, although their common sense and observation should tell them otherwise.

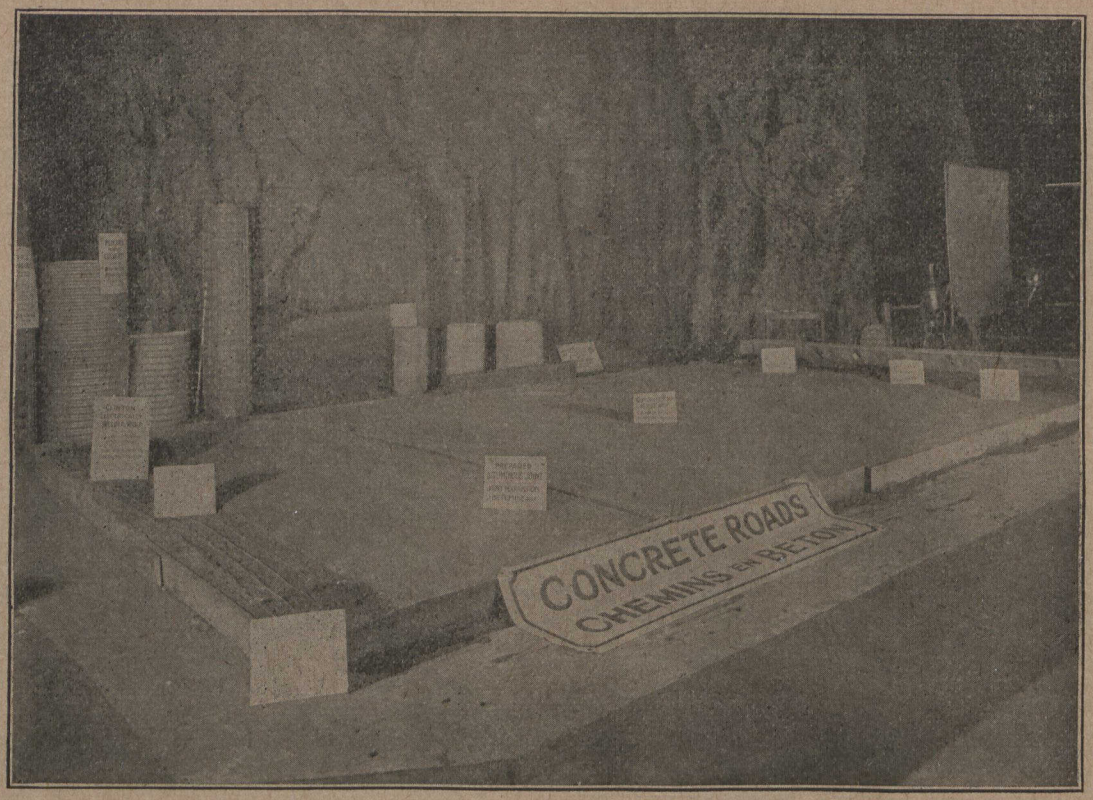
Maintenance of a tar macadam is such a simple matter that there is little or no excuse for failure to keep the road once properly constructed in excellent condition for years to come. All that is necessary is the patching of such few depressions as may need it and the cold application of a light far yearly, or by-yearly, as the traffic may dictate or the condition of the surface may indicate.

The amount of tar necessary to maintain a tar macadam varies from 1-8 gallon per yard to 1-2 gallon per yard. It is seldom that the latter amount is needed and where maintenance is the rule the former figure is nearer the average amount used. In order to get such a small amount as a pint to the yard a pressure distributor is absolutely necessary. Such a distributor may be made by attaching a system of gearing onto the rear wheels of a horse drawn sprinkler and connecting this to a pump which forces the tar out under pressure, or an auto truck may be used, or even a man driven pump attached to a barrel may be employed.

The means of application are so many and the cost is so slight that it is wasteful economy not to treat bituminous bound roads when they need it.

Water bound macadam may be treated and maintained in the same way.

Good Roads Exhibition at Montreal, March 6, 7, 8, 9, 10

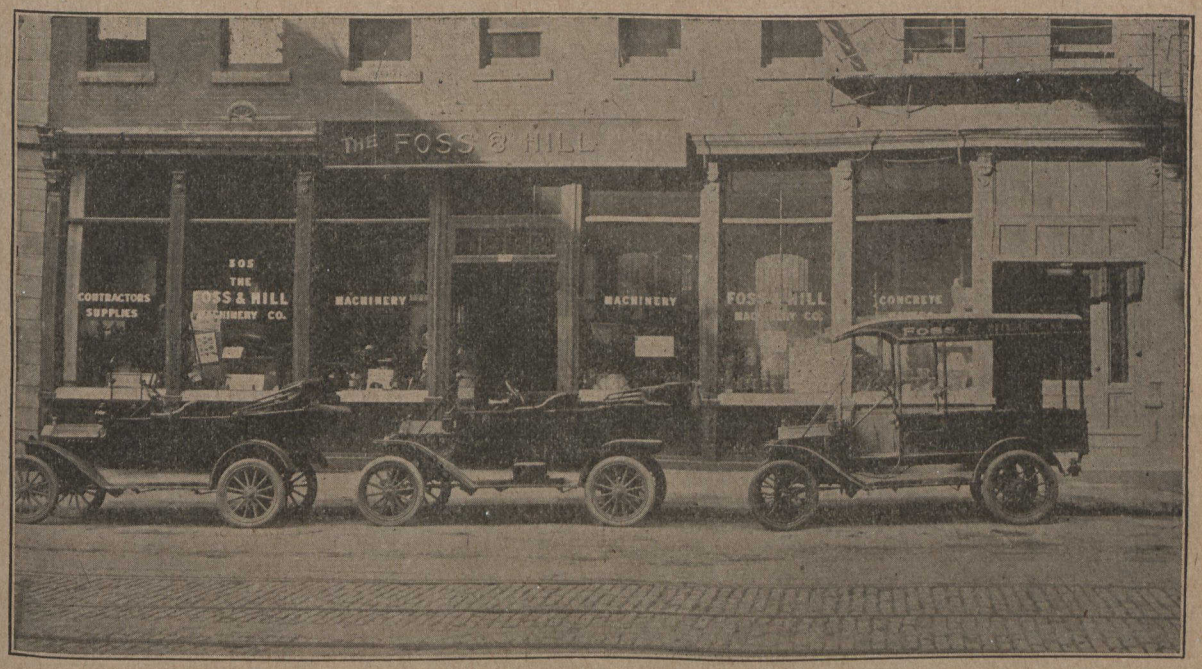


BOOTH OF CANADA CEMENT COM PANY, LIMITED, MONTREAL.

Mr. W. H. Connell's Table referred to on page 187 will be published in June issue of the Canadian Municipal Journal

FORD COMPANY O F CANADA, LIMITED

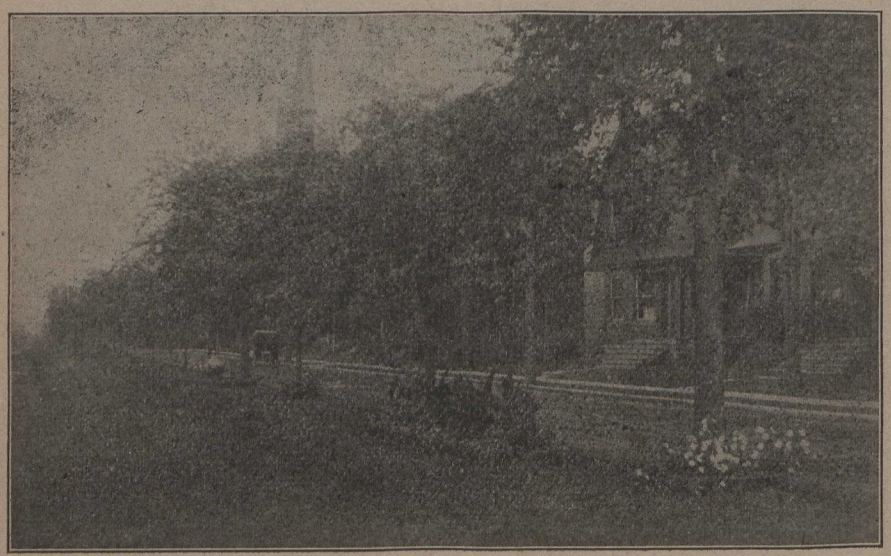
Goods Roads Exhibition



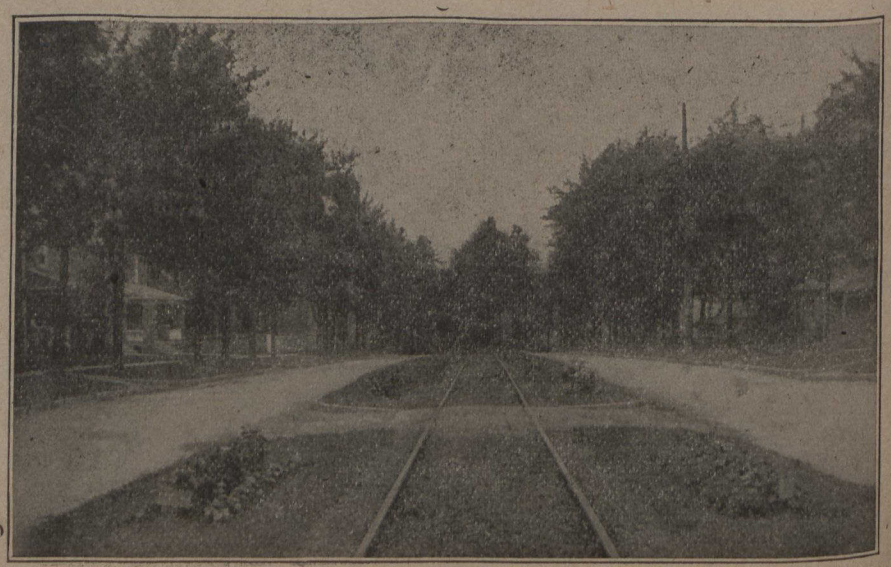
THE FOSS AND HILL MACHINERY COMPANY, MONTREAL

: : A CITY BEAUTIFUL : :

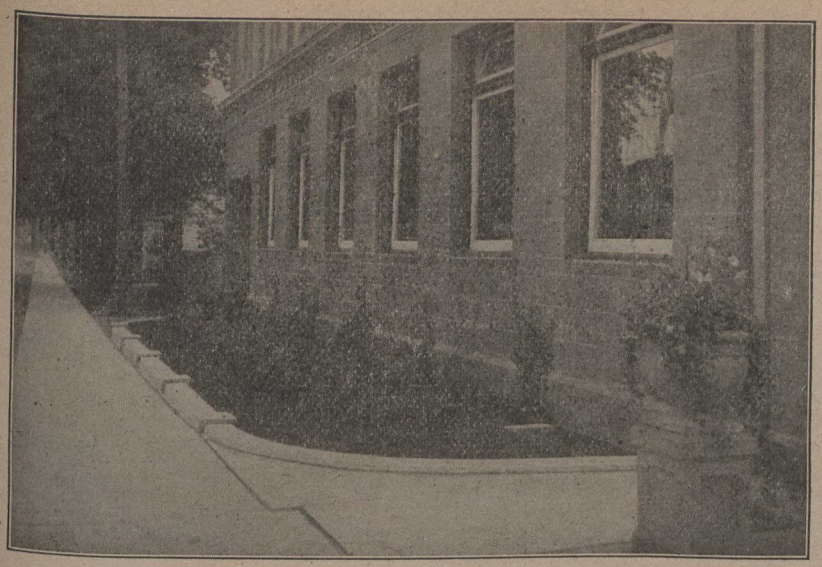
On these pages we publish four illustrations of how a municipality can become the "City Beautiful." The flowers and bulbs have been planted by the St. Thomas Horticultural Society, of which Dr. Bennett is the very much alive president. We understand that in the public beds, in the centre of the boulevards and along the streets, 20,000 tulips of every color have been planted this year and over 200,000 in the public parks and private gardens; and all this in addition to the many other kinds of flowers. This public spirit on the part of the citizens and the encouragement of the council of St. Thomas in thus beautifying their city must have a large influence on the community for good. Eastern Ontario is specially fortunate in the beauty of the streets of its cities and towns, and if only other municipalities of Canada would follow such a lead what blessings would accrue to the citizens who hardly ever see a flower-except in a florist's window.



The Boulevards of St. Thomas, Ont., are planted with tulips this season.



Flower Beds are made along the tracks.

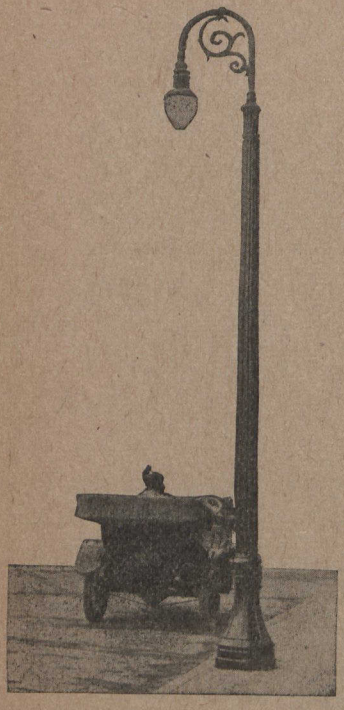


Public Spirit animates St. Thomas citizens.

200,000 Tulips are in bloom in St. Thomas.

An Example of Artistic Street Lighting

Up-to-date System Installed at Stratford, Ont.



The subject of Street Lighting is attracting attention at the present time. The great strides which have been made by incandescent lamp manufacturers in the past few years have revolutionized illumination of all kinds. The producers of street lighting equipment have been quick to turn their attention to the latest illuminants and many examples of highly efficient and ornamental installations may be seen throughout the country.

A good example of this will be found in Stratford, Ontario, where the Stratford Light, Heat and Power Commission have made an addition to their street lighting system. There are a number of features which are of considerable interest at this time.

The installation consists of 193 units located in the business district of the city. Without doubt it represents one of the most advanced types of street lighting on the continent and is moreover one of the first installations in which large units of nitrogen-filled tungsten lamps have been used. 500 watt, 6.6 amp. series nitrogen units have been used throughout. They are appropriately supported in a new type of pendant fixture mounted on brackets of serviceable and artistic design. The general style of brackets and fixtures is illustrated in Fig. 1 which shows the bracket mounted on steel railway poles. In certain localities there are no railway poles available and it was, therefore, necessary to instal a standard for lighting purposes only. This standard is shown in Feg. 2 and consists of a neat cast iron column and base with a wrought iron crook to harmonize with the other brackets, mounted directly on the top of same.

The pendant fixture consists essentially of a cast iron ventilated body having suitable ground and line insulation of porcelain, and supporting a Moonstone globe designed with very careful attention to correct illuminating properties. The globe is supported by means of a solid stamped steel ring giving a line contact and free from binding screws.

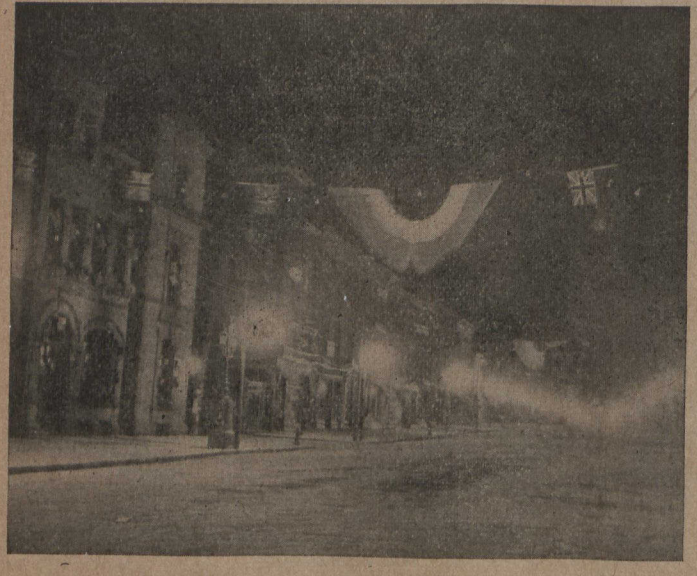
Fig. 3 is a view of the main street taken with the illumination from the new lighting at night.

The wiring of this system consists of three circuits run overhead from the main station and on the trolley poles, but where there are no trolley poles the connections to the cast iron standards are made underground with single conductor lead-covered paper cable laid in fibre conduit. The conduit is laid on a natural trench bottom and covered with 3-in. of concrete. The circuits are so laid out that two of them can be cut out at midnight and the all night service carried on one circuit.

The current is supplied from three constant current Adams Bagnall repulsion type transformers, two of which are 32 K.W. capacity and one of 22 K.W. Each transformer is controlled by a separate standard panel.

In the base of each standard is fitted a G. & W. combination absolute cutout and pothead. These devices are also fitted with a film cutout arranged to operate when the lamp is open circuited.

Most of the equipment, including the constant current transformers, panels, G. & W. combination potheads, cast iron standards and lighting fixtures were supplied by the firm of A. H. Winter Joyner, Limited, of Toronto and Montreal.



MAIN STREET OF STRATFORD, ONT., ILLUMINATED.

The well-known street lighting firm of A. H. Winter-Joyner, Limited, of Toronto, has opened a branch office at Lewis Building, Montreal, with the idea of giving a better service to Eastern municipalities.

CHANGES IN BRANCH OFFICE LOCATIONS.

The Standard Underground Cable Co. of Canada, Limited, announces that its Montreal branch office is now located in the McGill Building, instead of the New Birks Building, as heretofore.

AN UP-TO-DATE TARVIA ROAD.