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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Proceedings of Canadian Good Roads Congress

Sixth Annual Meeting, Held Last Week in Quebec City, Attended by Official Representatives from Eight of the Nine Provinces in Canada—Sir Lomer Gouin's Discussion of Federal Aid Creates Mild Sensation

QUEBEC was well chosen as the meeting place for the "Sixth Canadian Good Roads Congress and Exhibition," which was held last week under the auspices of the Canadian Good Roads Association. In no other city could the delegates have received a more hospitable welcome, and in no other province could they have found officials more sincerely loyal to the good roads movement. Sir Lomer Gouin and his cabinet took an active interest in the work of the congress and assisted it in every way possible. The attendance rarely fell below 70, and was fully 200 at the opening session, while nearly 400 registered at some time during the three days' sessions.

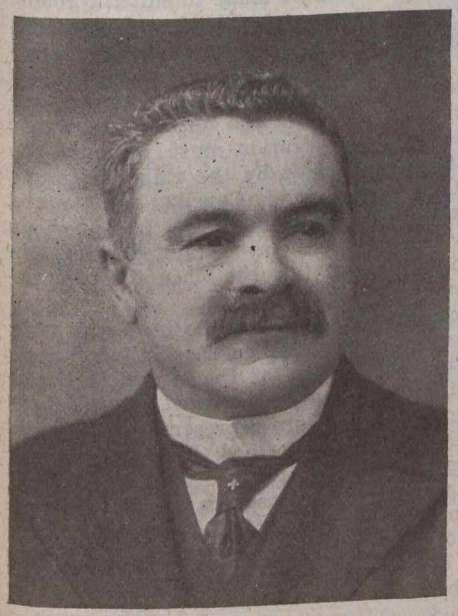
The government of the Province of Quebec donated the use of its beautiful restaurant room, which was an ideal place for the meetings. Its high ceilings, excellent lighting and impressive decorations, and the general dignity of its architecture, lent to the meeting a tone and prestige which the association keenly appreciated.

There were six sessions at which addresses were delivered and technical papers read,—one each morning and afternoon during the three days, May 20th, 21st, and 22nd. Tuesday evening, May 20th, the annual dinner was served at the Chateau Frontenac. The following evening there was held the annual general meeting of the Canadian Good Roads Association. The congress concluded Thursday afternoon with a drive, by courtesy of the Quebec Automobile Club, to the Quebec bridge and to "Spencerwood," the official home of the lieutenant-governor.

At the opening session, which was called to order about 11 o'clock Tuesday morning, Sir Chas. Fitzpatrick, lieutenant-governor of the Province of Quebec, was the guest of honor. Among the others on the platform were Sir Lomer Gouin; Hon. J. A. Tessier, Minister of Roads of the Province of Quebec; H. E. Lavigueur, mayor of the city of Quebec; Hon. J. A. Caron, Minister of Agriculture of the Province of Quebec; Hon. F. Carrel, member of the Quebec Legislative Council; Hon. A. Veniot, Minister of Public Works, New Brunswick; A. E. Arsenault, Premier of Prince Edward Island; J. T. Ross, Quebec Board of Trade; Hon. Sam Latta, Minister of Highways, Saskatchewan; L. B. Howland, president of the Canadian Automobile Association; J. A. Duchastel, manager of the city of Outremont, and past president of the Canadian Good Roads Association; Col. W. D. Sohier, chairman of the Massachusetts Highway Commission. S. L. Squire, municipal adviser to the Ontario Government, who is president of the Canadian Good Roads Association, briefly declared the meeting open and thanked the members of the Quebec Government for their interest and assistance.

Sir Chas. Fitzpatrick welcomed the delegates to the Province of Quebec and urged them to study Quebec as it really is, and to try to understand its conditions and ideals, and they would then realize the broad spirit of Canadianism which exists in as large a measure, he declared, in Quebec as in any other part of the Dominion.

Sir Charles was followed by Sir Lomer Gouin, whose address will be published in the next issue.



HON. J. A. TESSIER
Minister of Roads, Quebec

S. L. SQUIRE
President, Good Roads Association

SIR LOMER GOUIN
Prime Minister of Quebec

Hon. A. Veniot said that upon his department rests the responsibility of the improvement of roads in New Brunswick. Up to two or three years ago extensive road improvement was out of the question. The government had previously had no definite policy of road improvement, and owing to the limited revenue, it had been impossible to lay down any system. Lately the feeling had spread that good roads were essential, and to-day the people are forcing the hands of the governmeint for improved roads. New Brunswick stands in a different position from the other provinces in regard to a good roads policy. In Quebec, Ontario, Nova Scotia and other provinces, the municipality contributes to the construction and maintenance of roads, but in New Brunswick the provincial government constructs and maintains the roads without any municipal aid excepting a road tax amounting to no more than $80,000 in one year. The province had found it difficult to carry on much road work on account of this limited revenue, but by funding the automobile fees it was found that a large amount of money could be raised for expenditure upon roads. The province is not constructing the higher types of permanent roads at present owing to climatic and soil conditions, said Mr. Veniot, and even if they had the revenue to construct them he doubted whether it would be wise on account of the climate in New Brunswick. However, the province is anxious to adopt the best program which will give good results, and he declared his viewpoint open to change upon hearing the discussion by men more experienced than he in road construction, and he hoped to derive extensive benefit by putting their ideas into practice.

Speeches of Welcome

Hon. Mr. Tessier welcomed the delegates and told how the good roads movement had grown in Quebec. His speech appears in full on page 495 of this issue.

Hon. A. E. Arsenault said that his province had been patiently waiting to hear something definite from Ottawa regarding federal aid. Transportation begins at a man's door and continues to the place of delivery of the goods. Every link in the road must be complete. If there is a break, the whole road is only as efficient as the weakest part. Good roads are just as necessary to the farmers as are railways, as everything which goes over the railways must also go over the roads.

Mayor Lavigueur welcomed the delegates in the name of the city of Quebec. An abstract of his address will appear in the next issue of *The Canadian Engineer*.

Mr. Ross, of the Quebec Board of Trade, declared that any coast-to-coast highway scheme is premature. He thought that good motor roads, carriage roads and colonization roads are urgently needed for better and more efficient service to the business men and farmers, and that the necessity of better business roads could not be over-emphasized.

Hon. Sam Latta called attention to the fact that while his province has not yet even one million population, it has a road allowance of not less than 120,000 miles, about 20 per cent. of which are classified as main roads, or the chief roads which carry the products from the farms to the railways. He outlined the difficulties of a prairie province where vast districts are populated within a few months by people living in shacks, and where road allowances are suddenly fenced off so that one cannot travel along the road at all.

To provide roads under those conditions and to satisfy the clamor for highways in a vast province like Saskatchewan, with its limited population, is indeed a more difficult problem then confronts the more thickly settled portions of Ontario and Quebec, he declared.

Dominion Commissioner Urges Uniformity

Owing to the fact that the federal aid bill has not yet been passed by the House of Commons, Hon. Dr. Reid, Minister of Railways and Canals, under whose jurisdiction it was proposed to establish the federal department of highways, did not attend the congress, but his former deputy, A. W. Campbell, who is at present Dominion Roads Commissioner, was invited to address the delegates.

The principles of road building are few in number, said Mr. Campbell, and the necessary equipment is simple. But none of the principles can be overlooked and none of the equipment can be omitted. The rock crusher and road roller are as necessary to-day as they were when they were introduced, and the method of employing them is the same. He realized the great difficulties facing each province, but the problems are the same in Nova Scotia or Prince Edward Island as in Saskatchewan. There are certain basic principles which may be old, but they must be observed in all provinces, and there is no reason why there should not be concord and uniformity in highway work throughout Canada. He was delighted with the excellent work being done in Quebec. It is an object lesson; splendid work had been done. No doubt defects had entered in, but the general work done by the province is a demonstration of the possibilities of good roads development.

Suggests Traffic-Control Commission

Hon. Frank Carrel, briefly welcomed the delegates to Quebec. He was chairman of the reception committee. Mr. Carrel urged that money spent on vacation trips be kept in Canada. Quebec's scenery, he declared, is equal to any in the United States.

L. B. Howland said that all present were unanimous in putting their shoulder to the wheel for good roads. There were certain fundementals, however, which should be decided, declared Mr. Howland, of which the most important is the question of whether the roads should be built to suit the traffic or whether the traffic is to be made to suit the roads. If the latter, then the traffic permissible for the various classes of roads should be determined and a central commission should be established to control the traffic. In California there is a truck traffic commission to which application must be made by anyone who desires to operate a truck freight line. This application must be much the same as the applications now made by the railways to the Board of Railway Commissioners of Canada. The route, time-table and schedule of rates must be fyled. If a previous company is already operating in a certain district, its rights receive consideration and fairness when the commission deals with a new applicant.

J. Duchastel declared the meeting to be on a par with the meetings of the road associations in the United States. He had attended the last meeting of the American Road Builders' Association, and the number present at the opening session was no greater nor more representative than in the case of this sixth Canadian Good Roads Congress. Every province excepting Nova Scotia was represented, and all of the delegates were keen on good roads. He thanked Sir Lomer Gouin and the members of his government for the way they had worked in the interests of the association since its inception, stating that the association had been greatly encouraged by Sir Lomer and his colleagues.

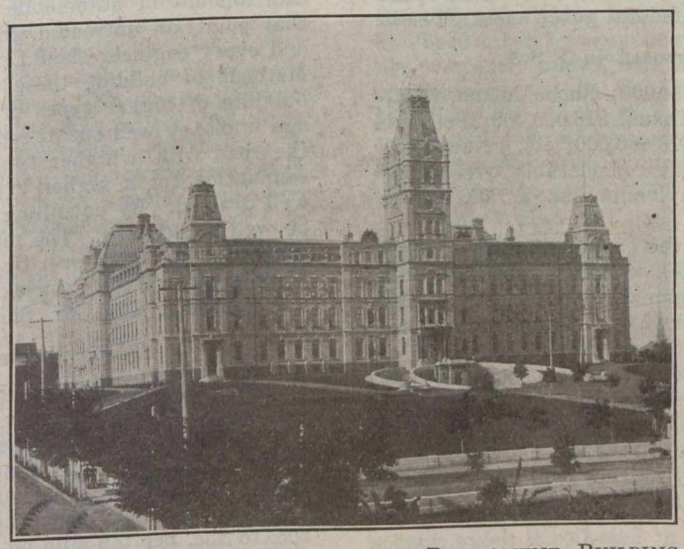
"Roads Speak Common Language"

President S. L. Squire declared that collective effort is necessary in road building if the greatest effect is to be accomplished. Public men cannot shelve their responsibility for good roads. He was extremely pleased to see an attendance drawn from so many different classes, including statemen, contractors, business men, engineers and others. Roads extend the hand of brotherhood to the farthest hamlet and connect it with the centres of populations. Roads speak a common language; they pass the door of the poorest as well as the richest, and perform a like service for both. A man's constituency is enlarged according to his roads, declared Mr. Squire.

In opening Tuesday afternoon's session, President Squire said that some system of control of roads in Canada is advisable. New Brunswick may be behind or ahead of the other provinces in its method of building improved roads. He would not say "permanent roads," declared Mr. Squire, because that term is no longer in his vocabulary. He had found that there is only one thing that is permanent in road-building, and that is maintenance. There are two chief things to be considered in road work,—location and maintenance.

President Squire then introduced Col. Sohier, of Massachusetts, who spoke on federal aid. Col. Sohier paid a tribute to the roads of France, where highway construction began in 1836, and where, up to 1916, there had been constructed no less than 371,000 miles of macadam, 24 ft. wide, on a 66 ft. road allowance, and with a maximum grade of 5%.

Napoleon had built roads for the defence of the lives and property of his people; they were built by the national government with the labor of the soldiers, and decades later they served their purpose at Verdun. Six thousand motor cars a day saved the battle for France until light railways could be built sufficient to carry the requirements of the defending army.



THE CONGRESS WAS HELD IN THE PARLIAMENT BUILDING

Col. Sohier referred to the English road system in complimentary terms, and spoke of having travelled over a hundred miles of asphalt road, beautifully laid. Under the English system, the counties contribute $1,600 a mile a year for the maintenance of the trunk highways, and the sixteen boroughs and the county of London, which make up what is known as the city of London, contribute $2,200 a mile a year. This is not all maintenance, said Col. Sohier, but is partially used for the reconstruction of old roads. The English government found that the counties were unable to stand the total expense of road-building and maintenance, and the government is now aiding them very largely. In France the cost of transportation per ton per mile is 7 cents, in Massachusetts 25 cents, on all farm produce.

The question, then, said Col Sohier, resolves merely into this: Are we going to have a certain number of good roads on main trunk lines or not? If so, the little community cannot pay the bill, and the government must help. On the Mohawk Trail, in Massachusetts, the grading alone cost $20,000 a mile. They spent $500,000 on this road for the sub-grade alone, and when surfaced the cost will be over $1,000,000. The road is 25 miles long, and is entirely within three townships. The cost of the road exceeds the total value of the property, both real and personal, within these three townships. Each township must maintain 80 miles of its own roads, besides 6 or 10 miles of the Mohawk Trail.

It is impossible for the townships to levy any tax rate which would permit this financial drain without the state coming to its aid. It is this sort of thing that drove Massachusetts, New Jersey, Connecticut and other states to admit that the state must assist in building the main roads through the smaller townships. Financially, state aid in Massachusetts means that 56 to 60 of the townships pay 82% of all the state tax, and 300 townships pay only 18% of the state tax, and that the townships of less than $1,000,000 value pay only 2% of the state tax, yet in these townships there are over five thousand miles of road to be taken care of, and many main highways go through them.

Col. Sohier told of the remarkable extent to which trains of motor trucks were used in shipping heavy freight of all kinds in the United States during the war. He also told of the disastrous effect this heavy and fast traffic had on roads which had not been built for it. This traffic was inter-state, and the damage done was a national matter, and it had led to larger aid by the government of the United States. The government found that it must treat the poorer states the same way that the state of Massachusetts found it must deal with the poorer townships. The states of Massachusetts, New York, Illinois and Pennsylvania pay into the national fund for road-building much more than they get out of it.

Eight states pay over 60% of the tax and have within their boundaries less than 10% of the roads that will be aided. Massachusetts pays 8% of the tax and gets back about 1¾% of it. That led some of the states to wonder whether federal aid would be a good thing or not, but they decided that good roads are national questions and not local, and that the richer states should help the poorer in order that there should be through roads of equal standard wherever required by the traffic.

In Massachusetts over 200,000 motor cars were licensed last year, for which over $2,000,000 fees were collected, every cent of which was spent in the maintenance of roads, but many of these roads run into Maine, New Hampshire and other states, where they cannot be built and maintained by

OFFICIALS FROM EIGHT PROVINCES AND THE DOMINION GOVERNMENT ATTENDED THE ROADS CONGRESS AT QUEBEC

the local community to the same standard as Massachusetts, and they are not solely used by the local community. Much of the traffic originates in Massachusetts, and that is why Massachusetts is willing to contribute to the building and maintenance of these roads through the federal fund.

The United States government through its recent appropriation, and including the balance from previous appropriation, has $275,000,000 which will be available in the fiscal year 1920-21 for federal aid for road building in the United States. After July 1st, 1920, any state can take up as much as this money as it wishes to use, but the state must spend a dollar for every dollar that the federal government gives it.

Big Expenditures Proposed in U.S.A.

Delaware has applied for $474,000; Rhode Island, $641,000; Massachusetts, $4,000,000; Texas, $16,000,000; Pennsylvania, $12,000,000; New York, $13,600,000, etc. New York and Pennsylvania have each spent considerably over $100,000,000 in recent years. Pennsylvania has $27,000,000 to spend this year.

One result of federal aid is the organization of a highway department in every state, whereas formerly only twenty of the states had such organized departments. Texas, which, until recently had no highways department and had done no road work whatever, will now spend $16,000,000 of the government's money. The total appropriation for road work in the United States at present amounts to not less than $982,000,000, including $60,000,000 in Illinois, $50,000,000 in Pennsylvania, etc. Some states have appropriated nearly four times as much money as they will get from the government, which shows how state governments are regarding highway improvements.

Col. Sohier said that from a blue book which he had recently picked up, he noted that the total income of the provincial governments of Canada in 1918 was $17,000,000, and of the Dominion government, $232,000,000. This shows, he said, who has the money and who is able to raise the money, and the people who have the money must be the ones to spend the money on road work. The federal government should give at least 10% of its revenue each year to help the provinces to build roads.

J. Duchastel then read a paper on highway maintenance, which is published in full on page 497 of this issue.

The president appointed Messrs. Duchastel, Wheelock, Michaud and Regan as members of the nominating committee, and Hon. Frank Carrel, Mr. Kelly and Dr. Desaulniers as members of the committee on resolutions. The members of the executive were named as the legislative committee.

Improvement of Gravel Roads

Mr. Talbot then read his paper on gravel roads, which is published on page 499 of this issue.

B. M. Hill, of New Brunswick, said that 80% of the roads in that province are built and maintained as gravel roads. Two years ago they had no permanent road department. However, they have some large, fine, permanent bridges, including an arch of 650 ft. span across the St. John River. In two years the department had done at least some work on 900 miles of road, 600 miles of which were gravel roads.

He thought that a 30-ft. road, from shoulder to shoulder, is too wide and that a road built with 18-ft. gravel and 3 ft. shoulders, properly built, would be ample to carry any traffic.

In 1917 some of the roads in New Brunswick were carrying from 150 to 200 motor cars a day, and 6 ins. of gravel, well rolled in, was ample to take good care of this traffic; but to-day these roads are carrying 600 to 700 motor cars a day and in wet weather they are being rutted, although they stand up in dry weather. He believes that if oiled, gravel roads can be maintained cheaper than in any other way. He told of the trouble the province had with the corduroy roads. He stated that they are now removing all the logs from the corduroy roads, and in swamps, where they cannot drain the water away, they are laying a thick brush mattress and piling the gravel on top of that. Where necessary they lay a mattress 18 ins. deep, of heavy spruce boughs, covered with brush. In one road they had taken up, in which brush had been laid forty years ago, it was found that the brush had turned a dark brown but had not rotted; it had been protected from the air by from 6 to 8 ins. of material.

P. P. Sharples, of the Barrett Co., New York, said that the road problem in Canada was the same as in the northern states. Gravel roads would stand up under a certain amount of automobile traffic—say 200 a day. Up to that point, an untreated gravel road is a good proposition, and every engineer should study his local supply of gravels. Methods of building these roads should be parallel to the building of higher types of roads. Money spent on drainage is money well spent, especially when it comes to replace the road with a higher type of road, as there is no better foundation for a higher type than a good old gravel road well drained. By patrolling and dragging, gravel roads can be well maintained. The main trouble is the dust nuisance, which can be gotten over by oiling. A gravel road can stand from 2,000 to 3,000 vehicles a day in the summer after cold tar treatment, said Mr. Sharples.

Traffic Increased Thirty Times

Mr. Veniot, of New Brunswick, said that the main question of the day is how to make gravel roads meet the heavier traffic. He had seen the traffic on some roads increase thirty and forty times what it was some years ago, and these roads have held up merely under constant patrol. He had also seen the cost of transportation lowered from 50c. to 25c. per ton-mile by the improvement of these roads. If the gravel roads can be treated to meet existing conditions, it will save the province a great deal of money, as permanent roads cannot be built where the traffic does not warrant them. Mr. Veniot said that he does not always believe everything that the engineers tell him, as many engineers, he declared, are experimentally inclined and have their own theories.

President Squire said that of the 58,000 miles of road in the older part of Ontario, 20% will be permanent roads and 80% will be earth or gravel roads, and of the 2,500 miles of trunk roads, probably not more than 500 miles will be first-class or standard roads. In road discussions, perhaps, everyone had been emphasizing the 5% of the roads too much and neglecting the 95%.

Mr. Veniot said that he was in Ottawa recently and from arguments which he had heard between members of parliament as to how the federal aid should be spent, he was afraid that it was the intention of the government that it should be spent mainly on trunk roads and permanent types of construction, whereas he thought the provinces should be allowed to use the money for the improvement of their gravel roads.

Mr. Talbot called attention to the fact that he had not dealt with the treatment of gravel roads in his paper, because, when treated, a gravel road ceases to be a gravel road, and he had considered his subject to be roads built merely of gravel.

Bituminous Treatment in Massachusetts

Col. Sohier said that the roads in Massachusetts which average 300 motors a day must carry 700 or 800 on a nice Saturday or Sunday, and that then they become rutted on the hills and must be dragged on Monday. He had found that treatment with bituminous material, either asphaltic oil or tar is very good if applied in small quantities. He had tried heavy blankets of bituminous materials, but they had rolled and bunched. Many of their roads are being given four treatments of one-fifth gallon per square yard.

Constant care in maintenance is the secret of successful roads, said Col. Sohier. In Massachusetts some roads are maintained at an expenditure of $1,000 per mile a year, and are little better than roads in Vermont maintained at $125 a mile per year. On these Vermont roads they have not used much bitumen, and only in short sections where the

traffic is heavy, but they did constantly drag the roads and clean the ditches, and in this manner they kept their roads in very good condition even under a traffic of 300 motor cars or more a day.

At the Chateau Frontenac, Tuesday evening, was held the annual banquet of the Canadian Good Roads Association. President Squire introduced R. T. Kelly, of Hamilton, as toastmaster. Mr. Squire incidentally stated that the road problems throughout Canada are much the same, and he thought that there should be some central organization under the control of the federal government, where experiments in road work could be carried out and where materials could be tested, and where advice could be given to the various provinces. He thought that such a bureau would save the municipalitites much money. Mr. Squire declared when one asks engineers questions, they admit that there are some things that they do not yet know about road building. In colleges, chairs of highway engineering are being established to give the engineer a more complete education in road building, and who could encourage that work better than the federal government? Provincial and federal governments should have a common purpose, and that is the improvement of roads in the Dominion of Canada.

Sir Lomer Gouin's Attitude

Mr. Kelly called upon Sir Lomer Gouin, who created a mild sensation by announcing his opposition to any federal policy which would give the Dominion government any control whatever over roads in the Province of Quebec.

"If we are to be told that the federal government is not satisfied with the work done by the provinces, and if we are to be reproached as to the way the work has been done, I must say that I think we have done very good work in building good roads," said Sir Lomer. "I am not jealous of federal jurisdiction, but Ottawa at the present time has plenty to do without taking new works in hand. As to our engineering experts being under the control of Ottawa, we have good engineers in this and other provinces."

Money should be voted at this session by the House of Commons to aid all road work, declared Sir Lomer. He said he had no objection to such a vote of money, provided that it is upon the same terms as the special aid for agriculture.

"But if we are to be told we have to renounce any of our rights or duties as to building and maintaining roads, let me tell you that we won't agree to it," said Sir Lomer impressively. "We have done in the past as well as Ottawa, and will do in the future as well as Ottawa or any other government can do. This is a very important subject on which there should be no misunderstanding."

Sir Lomer paid a high tribute to the Canadian Good Roads Association and said that if the government has succeeded in making any progress in the Province of Quebec, it is largely due to the association, which helped to persuade the people into paying their fair share of the wor. Members of the association were teachers in the good roads movements and had gone through the province telling the people of the advantages of good roads, until now the people clamor for more good roads than the province can build.

Sir Lomer said he had come to the banquet to thank the association for its good work and he urged it to carry on in the future as it had in the past.

"Pray, pray don't introduce innovations which are not for the good of the association or for the advancement of the roads of the various provinces," he urged. "There should be no race, creed, politics or differences regarding jurisdiction, in road building."

President Squire's Reply

President Squire replied to Sir Lomer that it was not the policy of the association to advocate that the federal government should do any construction of highways. Sir Oliver Mowat, one of the greatest of the past premiers of Ontario, had made this the fight of his life. The present premier is an equally strong advocate of provincial rights, said Mr. Squire. At the same time he still believed that there is certain work that the federal government could do for all the provinces, and one expenditure would take the place of nine separate expenditures. He would not advocate for a moment that the Dominion government enter a province and build a single mile of road, but in questions of geology, in testing stones and materials, he thought the federal government could save money for all of the provinces without taking a single bit of responsibility or expenditure away from the provinces.

Government Merely the Trustee

He referred to the magnificent work done in the Province of Quebec, and told how thoroughly he had enjoyed the 180-mile trip by motor from Montreal to Quebec which had been taken by some delegates the previous day. He had not previously known that there was such a continuous piece of finished road in Canada. The only poor stretch he found on the whole road was just outside Montreal, and not actually on the provincial highway at all. He congratulated the premier on that road, and only wished that other delegates could have taken that trip.

Hon. Walter Mitchell, treasurer of the Province of Quebec, said he hoped we were only on the threshold of road-building in Quebec and in Canada. He had always been a believer in road building and never had been able to see any other side of the question. It matters little where the money comes from, whether from the provincial or federal government, because it all comes out of the pocket of the tax-payer anyway, and the governments are only in power as administrators of those funds. The public should always remember, when asking for roads, that they are paying for them and that money cannot ever be spent on roads without the public having to pay for them sooner or later. The government is simply handing back the money which it collected in taxes and which it held in trust for the people.

Hon Mr. Tessier reviewed the progress of road building in Quebec and gave a list of the roads which he proposes to construct in the near future. An abstract of Mr. Tessier's speech will be published in next week's issue.

Hon. Findlay MacDiarmid, Minister of Public Works and Highways of the Province of Ontario, declared that all public men should recognize their responsibility in good roads matters. He said that the Dominion government should set aside a certain sum of money to be divided in the same manner as the aid to agriculture. The local municipality should not be asked to spend more than its fair share on road improvement. Much of the traffic is provincial and interprovincial, and it is necessary that the Dominion government should step in and help the provinces. He did not know any way in which the problem of keeping the boys and girls on the farms could be solved more readily than by the standard improvement of highways, which will make the people more contended to live on farms and which will reap untold advantages for Canada in years to come.

Speeches were also made by Hon. Sam Latta, A. P. Sandles, T. P. Regan, J. A. Duchastel and others, followed by a light vaudeville entertainment.

Good Roads and Agriculture

"Good Roads and Agriculture" was the title of a paper with which Hon George S. Henry, Minister of Agriculture, Province of Ontario, opened the Wednesday morning session. An abstract of Mr. Henry's paper will appear in the next issue of *The Canadian Engineer*.

Mr. Henry was followed by Hon. J. A. Caron, Minister of Agriculture of the Province of Quebec, who said the policy of the Quebec government was not definitely directed toward road improvement until 1911, when a new department was organized and authorized to spend $250,000. It had no machinery, no experience, no personnel. Work previously had been under the direction of the Department of Agriculture, which had only one engineer, Mr. Henry, who had given the subject any special study.

The new department was obliged to buy machinery and to train farmers' sons in the use of it. They had prejudices to overcome, and had to educate the people that good roads were not only for city folks, but also for the farmers. After two years' work, the question was not how to get the people

to improve the roads, but how to give the municipalities all the money which they wanted for road improvement. Quebec had spent $20,000,000 on road improvement, but the people were behind the government and the work would be gone ahead with. The farms had increased in value,—in some instances at least 25%—as a result of good roads. At Laprairie, farmers who had put their farms up for sale had withdrawn them from the market and had kept them in operation. Other farms had sold for 25% to 30% more than had been previously asked.

Farmers found that they could transport their products for half the cost they had to pay previously, and they saved much time. Owing to the scarcity of help on the farms, time was a very important factor.

Value of Products Increasing

The value of agricultural products in Quebec was $45,000,000 in 1915, and over $300,000,000 last year. No doubt some of this was due to increased prices, but much of it was due to good roads. The crops in Ontario are worth at least $400,000,000 each year, so that there would probably be $700,000,000 worth of agricultural products in these two provinces transported by trucks. Good roads are needed to transport them economically. Also the farmer has a right to some pleasure, and it is now possible for him to travel far and get back to his farm in time to continue his work. The financial value of this, in educating the farmer, cannot be measured. The roads in Quebec are also business roads and will attract travellers from the United States.

Francis P. Smith, consulting engineer, of New York City, then read his paper on "Hot Mix Asphalt Pavements," which was published in last week's issue of *The Canadian Engineer*. It was warmly receivced by the delegates, and Mr. Smith was the recipient of many compliments upon its value.

Alex. Fraser, assistant chief engineer of the Highways Department, Province of Quebec, opened the Wednesday afternoon session with paper on "Practical Advice to Road Superintendents and Municipal Councils." An abstract of this paper will be published in next week's issue of *The Canadian Engineer*.

Col. Sohier then started a discussion on gravel and water-bound macadam roads, emphasizing the importance of proper drainage of subgrade.

Mr. Sharples thought that plain water-bound macadam should stand very heavy traffic, provided that hard stone is used. If the stone is soft, there will be internal crushing. Anyone with experience, said Mr. Sharples, knows that while a road may be built with 2½ to 3-in. stone, there is no such stone in the pavement when it is pulled up. The stone is crushed under the weight a road is now called upon to carry. The problem is to find some way of preventing that crushing action. The penetration method, said Mr. Sharples, will prevent it. Penetration roads have carried 3,000 to 4,000 vehicles a day since 1908, without failure. With the penetration method, soft stones can be used that would not be of any value for water-bound macadam. The bitumen reinforces the stone and prevents internal wear.

"Penetration Method" is Discussed

Prof. Scott, of Queen's University, Kingston, Ont., asked where it would pay to lay a penetration pavement. He declared that it uses as much stone and asphalt or tar, and almost as much plant, as a mixed pavement, and that when finished, one had only "near-pavement." He thought the field for penetration pavement is very limited owing to the fact it shows no economy in materials.

Col. Sohier, defending the penetration pavement as a result of his experience in Massachusetts, stated that through the penetration method they had gotten very good results with stone that would not have stood up at all in water-bound macadam. They had used soft granite which, if thoroughly rolled into a waterbound macadam pavement. would have been crushed into sand. In eight years, two gallons of tar per yard had been sprayed into this stone. He felt sure it would have been more expensive to buy a higher priced stone than to use this stone and treat it with bitumen. He estimated that the better stone would have cost 20 cents more per yard than the poorer stone plus treatment.

He was a believer in the mixed method, provided that the mineral aggregate is graded as for sheet asphalt and various patented pavements, but Massachusetts has obtained very excellent results with penetration roads. He believed that either mixed or penetration roads, if well laid and well rolled, will give satisfactory service. In fact, said Col. Sohier, one of his engineers believes that penetration roads give better service than mixed roads, thinking that the latter tend to wave more. Of this, however, Col. Sohier, personally had not been convinced. The state of Massachusetts has both mixed and penetration roads, and both have been in service for eight years and neither has failed, so he was not in a position to say which is the better.

Mr. Sharples called attention to the advantage of resurfacing old macadam roads by this method, which can be done for 40 cents to 50 cents per square yard, whereas hand-graded and mixed bituminous pavements would cost $1.50 to $2.25 per square yard, he said, and sheet asphalt, $1.25 to $1.50, "even if it is desirable to put sheet asphalt over old macadam." The penetration type of pavement fills a gap that no other type of pavement fills, said Mr. Sharples. The apparatus is simple compared with a mixed job, on which the cost of plant alone is likely to run from 15 cents to 20 cents per square yard, and labor from 25 cents to 30 cents.

Address by Federal Commissioner

Hon. Dr. Reid was on the program for a paper on "Federal Aid," but in his absence Mr. Campbell was requested to speak on the subject. Mr. Campbell stated that he had been greatly interested in the discussion by Col. Sohier, but that no representative of the Canadian government could make any statement at this time as to what aid might be granted in Canada, that he could say but little on this subject. However, he wished to state that he had attended a number of good roads meetings both in Canada and the United States, and while he had never said anything flattering of any one meeting as compared with the other, he must say that this meeting was one of the best he had ever had the pleasure of attending.

The first meetings of the Canadian Good Roads Association had been attended by representatives only from the province in which the meetings were held, or at the most from two provinces, but at this meeting he understood there were regularly appointed delegates from eight of the nine provinces in the Dominion. The men at this meeting were not men who were carried away by enthusiasm or wanted to listen to pleasant speeches; they were nearly all men who were seeking experience in technical work and had come to get in touch with the authorities who had had that experience and who were willing to retail it to them free of cost.

In addition to these experts, there were representatives of those in authority who had the say very largely as to how expenditures were to be carried on in the various provinces. Such a combination as this must result in good.

Ontario views the subject of road-building from its own standpoint; the Quebec situation seems to single itself out and find difficuilties of it own; New Brunswick states that it has peculiar features, and in turn there are Nova Scotia, Prince Edward Island, Saskatchewan, etc. From his own standpoint, said Mr. Campbell, he must consider this question with a great freedom from localism or provincialism. There are certain principles in common in all the provinces and which must be followed by one as much as by another province if success is to be obtained.

Differences in Classification

Provinces may have difference as to classifications of the roads to be built. The prairie provinces may have difficulties that require special treatment, but the basic problems remain the same. In British Columbia, in crossing the mountains and valleys, roads must be chiselled through the rocks, and there they believe that the location of the road is the all-important question. The mere grading of a road

there may be as expensive as the construction of a concrete road in another province.

Each difficulty between the provinces cannot be singled out as an entity. The whole question must be treated from ocean to ocean. It is simply a matter of how we are going to build these roads to carry the load.

Certain conclusions can be reached and put away as settled. We all agree that good roads are necessary to agriculture and to the industrial and commercial development of this country. Transportation is the most important public work we have to deal with. It falls under three headings: Railways, waterways and highways. These three make up the transportation system of this country. All are important, all are necessary, none can be neglected. Our waterways have cost millions of dollars and our railways an enormous sum, but after all, the most important, so far as the transportation system is concerned, is the ordinary road.

Roads must carry all freight to be brought up to the waterways or railways. Close the common roads of the country and the railways will starve and the ocean freighters rust at their wharves. The big question is how to improve the common roads of the country.

Finance vs. Lack of Finances

In this connection, said Mr. Campbell, he had reference to the 250,000 miles of wagon roads in Canada as a unit. There are 40,000 miles of railways but there are 250,000 miles of wagon roads to keep up.

Mr. Campbell declared he found it interesting that the congress was discussing the higher classes of pavements. He felt that if an organization were formed to discuss the higher classes of pavements alone, that it would take all of its time, as it is so big a subject. The people must look after the whole mileage and how to better the common roads and to extend them to reach those not properly constructed now.

How to care for the leading roads is possibly a simpler problem than how to care for the earth roads. One is a matter of finance and the other is matter of the lack of finances. These roads are passing away from the jurisdiction of those originally in charge of them, because we have now come to a cash system of building these roads, even the most elementary roads in the country.

The roads should be mapped out and then classified according to the requirements of the traffic, declared Mr. Campbell. Traffic is largely measured by the population and the importance of the community. The first class contains all the leading roads through a province, connecting the town and market centres, passing through the densely settled communities. These carry the majority of the traffic in each community. It may be that in one community the road to meet this class of traffic will cost from $25,000 to $30,000 a mile. For building these roads bitulithic, concrete, asphalt or some other hard-crusted road will be required. The second class of roads are the principle feeders throughout the central parts of the province. The first class of roads forms probably 10% of the total road mileage. If this percentage is correct throughout the Dominion, there are 25,000 miles of road in the first class, leaving 225,000 miles of other roads to be considered.

Department in Each Province

In each province there is now a special department of roads making surveys, locating the roads and designing them. Such departments did not exist five years ago. They are doing splendid work, for the roads must be properly located and graded according to well-established grades. The width must be left to the engineer in charge of the road, as the traffic determines the width. Traffic requirements of a community must be studied very fully and carefully before the width can be decided upon. The width of a road may vary in different places also. A road may start out of a large city with a width of 30 ft., and after 15 miles or so, it might possible taper off to 20 ft. The money spent in study of problems of this kind is money more wisely spent than most people realize.

Drainage, said Mr. Campbell, is of first importance. He declared it a crime to put one of these hard shells on top of a weak, wet or yielding foundation. It is an unpardonable offence; yet one often finds that in our haste to make a showing in surface work, chances are taken on the foundation without proper drainage. As much care should be given to the building of the foundation as to the planning of the surface. It is a problem which must be considered scientifically.

Ditching Must Receive Attention

Ditching should also receive more attention. There is no use building a drain on the side of the road and then allowing water to stand in the ditch, as frost will act on it in such a matter as to dig up the road.

In building earth roads, there should be a crown of at least one inch to the foot, said Mr. Campbell. For harder surfaces a quarter inch might be sufficient, but at all times materials should be used that will shed water and not absorb it. The earth road is inclined to absorb water, and after a rain must be dragged and repaired.

Hard-finished roads should be graded and paved to offer the least resistance to traffic. These roads must now be built to carry the very heaviest traffic,—vehicles carrying 15 tons and travelling 40 miles an hour. For traffic of this sort, to build anything but the best class of road would be negligence and waste. At the same time, to build a more expensive road where the traffic does not require it, would be equally reprehensible.

The earth road is as good to some communities as the road costing $15,000 a mile. It would be as wasteful to put the $30,000-a-mile road down where it is used by an occasional settler, as it would be to put the earth road which he needs, between two great cities. Maintenance should be built into construction as far as possible, said Mr. Campbell. It is better to pay $10,000 a mile if maintenance is obliterated than to pay $7,000 a mile and be troubled with maintenance at all times. The cheapest road is sometimes the most expensive.

"Show me that you were planning the most efficient and economical road for the purpose, and I will say that there is a road worthy of expenditure of money," said Mr. Campbell, "but if you call for extravagant outlay for a road, we will say, 'No.' We do not want to lead you into building expensive roads that are not justified."

Gravel Road Requires Engineering

There is as much engineering in building a gravel road as in building a high-class road, he declared. The careful engineer is not the one who wishes to make the greatest show of expensive pavements. The foundation of a road is the only part of a road which can be made permanent. The foundation should be built so it can be surfaced and resurfaced. If you build a good foundation, well-located, well-drained and well-graded, after twenty years' use you will be able to raise any amount of money desired to put any surface required upon it, however expensive it may be, as the people will then know the benefits of the road.

Judgment, care and caution should be exercised. If you want to get ideal specifications, they can easily be had. "I would like to warn all those in charge of road improvements with a view to getting assistance other than the assistance that you have at present, that you should design cautiously, construct efficiently and maintain by careful attention, to protect the investment which you have put into it, whether for common earth road or for building the ideal high-class and high-finished road," said Mr Campbell.

"Build your bridges and culverts substantially and get them off your hands for all times. Get rid of patching and repairing on temporary bridges. Use concrete for foundation and steel or concrete for superstructure. Then there is time to think of the surface coat after all this work has been finished and the foundation in the road thoroughly settled."

Mr. Campbell expressed his pleasure in listening to the different papers read at the congress, and thought that the

information given by the various speakers was worth thousands of dollars. His last word of advice to the delegates was to use local materials wherever possible.

F. W. Fenn, secretary of the U. S. National Motor Truck Committee, then presented a paper on motor truck freight service, which will be published in next week's issue of *The Canadian Engineer.*

Annual Meeting of Association

At the annual meeting of the Canadian Good Roads Association Wednesday evening, the secretary read the minutes of the previous meeting and submitted a financial report showing that all debts, including the cost of incorporation, had been met, and there was a balance of $592 in the treasury March 31st, 1919. Financial assistance had been received from a number of provinces. The membership now stands at about 260, including 30 municipalities and 7 contributing members.

The president stated that the past year had been very successful. One of the biggest things for which the association had worked was federal aid. Some weeks ago representatives of the executive had an interview with Sir Thos. White at Ottawa, and had gone away quite happy. They were now concerned as to whether the promises made to them at that time, or at least the impressions they had then received, were going to be fulfilled. However, should the federal government not pass any appropriation for assistance in highway construction at this session, whether for political or other reasons, the executive would most certainly bring the subject most forcibly to the attention of the government again, and hoped to bring sufficient pressure to bear to have the desired bill passed before very long.

Resolutions were passed asking for a reduction of 10 cents per ton in freight rates on road building materials; approving of federal aid for highways; approving of the naming of important roads, and suggesting the name of "Route Gouin" for the Montreal-Quebec highway; and urging the Dominion government to take into immediate consideration the construction of all bridges necessary for the improvement of highways or other transportation facilities.

Officers and Directors Elected

The report of the nominating committee was accepted without change, and the following officers were declared elected for the ensuing year:—

A. W. Campbell, honorary president; S. L. Squire, president; A. F. Macallum, works commissioner of Ottawa, first vice-president; Dr. E. L. Desaulniers, deputy-speaker of the Quebec Legislature, second vice-president; Geo. A. McNamee, secretary-treasurer.

The directors will be the officials and the following:—

A. L. Caron, president Automobile Club of Canada; J. E. Griffith, deputy minister of public works, Victoria, B.C.; S. R. Henderson, president, Manitoba Good Roads Association, Winipeg; L. B. Howland, president, Canadian Automobile Association, Toronto; Russell T. Kelly, president, Hamilton Board of Trade; Hon. Sam Latta, Minister of Highways, Saskatchewan; T. P. Regan, president, New Brunswick Auto Association, St. John, N.B.; C. R. Wheelock, honorary president, Ontario Good Roads Association, Orangeville, Ont.; W. G. Yorston, Assistant Road Commissioner, Province of Nova Scotia, Halifax; W. Findlay, "The Globe," Toronto; H. H. Shaw, chief engineer, Prince Edward Island; Napoleon Lavoie, general manager, Banque Nationale, Quebec; L. C. Charlesworth, deputy minister of public works, Alberta; Hon. Frank Carell, proprietor of the Quebec "Telegraph," Quebec; and J. A. Duchastel, city manager of Outremont, P.Q.

Invitations were received from Winnipeg, St. John, N.B., and Victoria for next year's congress, but St. John withdrew in favor of Winnipeg upon condition that the Winnipeg members would support St. John for the convention in 1921. Upon a show of hands, the delegates were largely in favor of going to Winnipeg, but it was finally decided to leave the matter to the executive.

Thursday morning, H. E. Breed, formerly chief engineer of the New York State Highway Commission, read a paper on concrete roads, which is printed in full on page 493 of this issue. He was followed by A. P. Sandles, who spoke on macadam roads. This paper will be published in full in next week's issue of *The Canadian Engineer.*

H. S. Carpenter, deputy minister of highways, Saskatchewan, briefly addressed the gathering, and Lieut. Smith, who had just returned from the front after fourteen months' service with a motor-driven battery, told of the benefits of good roads in France.

At the afternoon session Thursday, Hon. Frank Carrel delivered a paper on keeping the highways open in winter, which is published on page 496 of this issue. A Lalonde, assistant engineer, Outremont, P.Q., contributed another paper upon the same subject, which will be published in next week's issue of *The Canadian Engineer.*

The last paper of the congress was by Prof. A. H. Blanchard, of Columbia University, on "Road Machinery." This paper will be found on page 502 of this issue.

On behalf of the delegates, Capt. Duchastel presented a handsomely fitted travelling bag to President Squire and Secretary McNamee as a token of appreciation of their energetic work on behalf of the congress.

TO BUILD ROADS BY DAY LABOR

TENDERS received by the Department of Highways of the Province of Ontario for the construction of the section of the provincial highway between the Rouge River and the town of Whitby, have all been rejected and the certified cheqeus are now being returned. The closing date for the tenders was May 8th.

In an interview with *The Canadian Engineer*, W. A. McLean, Deputy Minister of Highways, stated that the average tender per mile for either cement-concrete or asphaltic-concrete was about $50,000, exclusive of the bridges over the Rouge River and at Pickering, which will likely cost upwards of $100,000. Considering the present conditions of the labor and material markets, both the provincial authorities and the various municipal authorities concerned had decided that all of the tenders were too high. When he was asked what he would have considered a fair tender, Mr. McLean referred to a report made last January by the highway commissioner of New York State, in which the latter said that the state would have to be prepared to enter into contracts whereby it would pay approximately $18,000 per mile for waterbound macadam roads, $23,000 for bituminous-macadam, $28,000 for cement-concrete, and $35,000 for brick.

The rejection of the tenders will not interfere with the work, said Mr. McLean, as the department will go ahead by day labor, and he hoped that by the end of the season the mileage constructed would exceed that of any previous season. He will arrange other small contracts wherever possible, and will apply the principle of maintenance, combined with partial construction, in such manner as to endeavor to give an adequate road service from border to border or the province by the end of this season. These methods, declared Mr. McLean, would largely be preparatory to letting larger contracts upon a more favorable basis at a later date, when contractors would be asked to bid on straight paving work, with all grading and drainage completed and bridges and culverts built.

"CONTINUED IN OUR NEXT"

IN last week's issue of *The Canadian Engineer* appeared the first part of an article on the "Organization of a Standard Municipal Testing Laboratory," by J. O. Preston, assistant engineer of the Rochester Bureau of Municipal Research, Inc. It was stated that this article would be concluded "in next week's issue." Owing to lack of room in this issue, due to the demands upon our space by the report of the Canadian Good Roads Congress held last week at Quebec, the conclusion of Mr. Preston's article will be deferred for a week or two.

CONCRETE IN ROADS, BRIDGES AND CULVERTS*

By H. Eltinge Breed
Consulting Engineer, New York City

THE trenchant title of the paper assigned me assures concrete its rightful place in the family of good roads, so as to make superfluous any further introduction from me concerning its value. Questions as to its genealogy and relationship, I shall be glad to answer in the discussion. What I thought might most interest you now are the working details of its creation.

Concrete pavement is composed of cement and fine and coarse aggregate, with the admixture of water.

Fine aggregate is sand, crushed slag or rock, consisting of hard durable particles smaller than ¼ in. in size, free from organic impurities, carrying not over 5% of silt or loam, and of such gradation as will give equal or greater compressive strength than the standard Ottawa sand, when tested in like manner, using the same cement.

Coarse aggregate is crushed rock or pebbles, consisting of tough, hard particles free from dust and of such size as will pass a 3-in. circular ring and be retained in a ⅜-in. circular ring.

The success or failure of the pavement depends on quality, sizing and proportioning of the materials and the placing and curing of the concrete.

First in importance are the materials used. They determine the quality of the pavement. The fine aggregate should be tested for:—

(1.)—Organic impurities.
(2.)—Gradation (sieve analysis.)
(3.)—Mortar strength.
(4.)—Volume of silt or loam.

I shall give only the field tests, as these are the most useful and can be readily made by the inspector to determine that the material being used measures up to that approved by the laboratory tests.

Field Tests of Fine Aggregate

(1.)—Organic impurities are detected as follows:—

"Fill a 12 oz. graduated prescription bottle to the 4½ oz. mark with the sand to be tested. Add a three per cent. solution of sodium hydroxide (NaOH) until the volume of the sand and solution, after shaking, amounts to 7 oz. Shake thoroughly and let stand over night. Observe the color of the clear supernatant liquid." If it is colorless, or has a bright yellow color, any organic impurities contained are harmless. If it shows a darker colored solution, the sand should be rejected and accepted only after full laboratory test, a description of which can be found in Part I of the 1917 "Proceedings of the American Society for Testing Materials," pages 327-333.

(2.)—Gradation tests for sand (sieve analysis):—

Field testers are made which have the ¼ in., the 20 and 50 sieves. By the use of these it can be determined whether the material comes within the limits of the specification.

(3.)—Mortar strength tests must be made in the laboratory, on account of the necessity of a testing machine to determine the compressive strength. However, a test for set can be made in the field by mixing the sand with cement and forming a pat with thin edges. By breaking the edges after 24 to 48 hours, the engineer can determine how the material sets.

(4.)—Volume of silt or loam is determined by adding an excess of water to a given quantity of sand in a glass graduate. The whole is well agitated and allowed to stand until the loam and silt has settled on top, when their percentage may be measured.

The coarse aggregate cannot be tested in the field. Field determination of these materials can be made only for voids. Visual inspection should, of course, detect soft material and dirty aggregates. Such inspection should be made constantly, to know that the material is running uniform and of quality equal to the original sample. When we realize that nature never has two deposits alike, the importance of these tests in securing good work will be readily appreciated.

For laboratory test of coarse aggregates, the most valuable is the Deval abrasion test. It is in general use and has been standardized. How accurate it is in determining the suitability of coarse aggregate for concrete remains to be seen. Certain it is, however, that this test indicates the difference between poor and good stone; and taken in conjunction with the impact test, which I will describe later, it is the best means we yet have of determining the suitability of stone for concrete roads.

Deval Abrasion Test

The tests for pebbles, by some called gravel, with the Deval machine have been unsatisfactory, because certain pebbles much inferior in service to trap and syenite rock show less loss when tested than do these standard materials. In 1915, in our New York State Highway Department Laboratory, we modified the Deval stone abrasion machine by substituting a slotted cylinder for the closed cylinder. The slots allow the fines to escape, so that there is no protective cushion of dust to keep the pebbles from wear. For four years we have found that this machine has given slag and pebbles a truer rating in accordance with the service test, though often at variance with the showing of the standard cylinder.

After testing the aggregates, we make tests of the concrete they compose, for two purposes; first, to determine its wear; second, to determine its strength.

By far the most valuable test to determine the wear resisting values of various aggregates used in concrete roads, is a machine which generates impact stresses, closely paralleling those set up by traffic. In general the machine consists of an arm which is raised by a cam and falls freely, striking the concrete cube. At the head of the arm are placed nine hitting points, armored with non-slip horse calks, each point and its shaft being held in place by a spring giving ½-inch play to compensate for any irregularity or unequal wear during test in the surface of the sample. The effective weight of the head is 29 lbs., and the blows are delivered at the rate of 100 per minute. The sample used is a 6-in. cube or cylinder placed upon a table which is revolved by a dog attachment, so that the blows of the calks strike in nine concentric circles, ¼ inch apart.. To date several hundred tests have been run with this machine, of which the following results are representive:—

Coarse aggregate.	Fine aggregate.	Mix.	No. tests.	Grams loss per test.	Average loss.	Remarks.
Trap	Sand Niagara	1:1½:3	3	150-110	103	Small stone
				105-95		area omitted.
"	" Cowbay	"	4	110-120		
				110-100	110	
"	" Albany	"	4	140-100		
				125-125	122	
"	" Long Island	"	2	120-135	127	
"	" Marlboro	"	2	130-135	132	
"	Tailings-Graphite	"	2	155-135	145	
"	Sand-Booneville	"	4	165-130		Group (1)
				165-135	149	103-165
"	Tailings Iron Ore	"	5	200-155		
				165-155	164	Excess grout
				165-180		omitted.
"	Sand Cowbay	1:2:4	2	150-150	150	Group (2)
"	" Albany	"	3	180-160		Small stone
				185-225	175	area omitted.
"	" Marlboro	"	2	180-170	175	
Syenite	Sand-Booneville	1:1½:3	8	150-145		
				150-140	141	Group (3).
				145-125		Small stone
				185-130		area omitted
						141-186
"	" "	1:2:4	4	180-205		
				180-180	186	
Buffalo Limestone	" Niagara	1:1½:3	5	150-120		
				155-125		Group (4)
				135	137	137-170
"	" Cattaraugus	"	5	155-160		
				140-125		
				160-200	148	Excess grout
						omitted.
"	" Booneville	"	4	180-160		
				185-160	171	

The above results indicate that generally the average loss increases as the mortar strength of the sand decreases. An average loss for each test shows that there is greater

*Paper read May 22nd, 1919, at the Canadian Good Roads Congress, Quebec.

strength in the 1:1 ½:3 mix than in the 1:2:4 mix. It is interesting to note that syenite with the French coefficient of 12.5 shows approximately an equal loss under this test to Buffalo limestone with a French coefficient of 7.9. On the basis of the Deval test, the limestone is inferior for road purposes to the syenite, but service conditions indicate that the Buffalo limestone and many other limestones with a French coefficient of 7 and better, are very satisfactory in service. In general six conclusions from the full results of the impact tests seem justifiable:—

(1)—Crushed stone concrete resists impact better than gravel concrete.

(2)—Large sized material is more durable than the small sizes.

(3)—Toughness is a very important factor in aggregate that is subjected to impact.

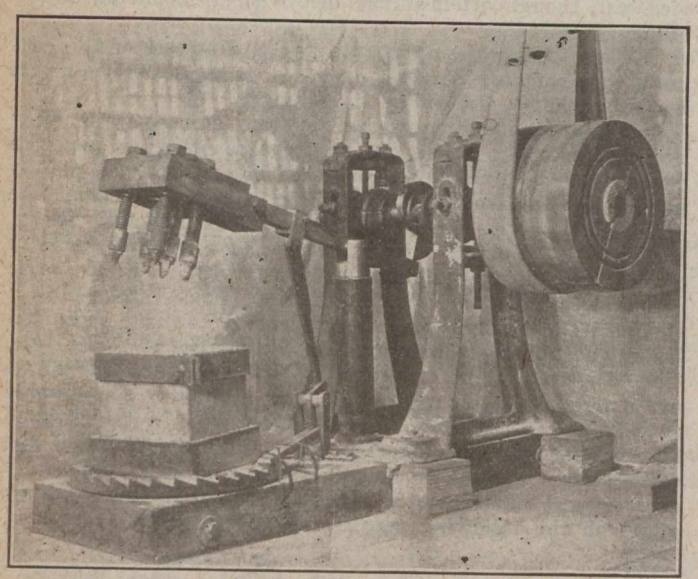
(4)—The fine and coarse aggregate must both be good, if we are to get the most from the pavement.

(5)—Coarse-grained sand mortar resists impact better than a mortar made with finer grained sand.

(6)—No relation has as yet been observed between compressive strength and resistance to impact.

Tests for Strength

In the test to indicate strength, concrete from a batch is made up on the road into 6-in. cubes, or 6 by 12 in. cylinders, from every 500 cu. yds. or less of material. They



MACHINE FOR GENERATING IMPACT STRESSES CLOSELY RESEMBLING THOSE CAUSED BY TRAFFIC, THUS DETERMINING WEAR-RESISTING VALUES OF VARIOUS AGGREGATES

are cured for 21 days in moist sand and then shipped into the laboratory and tested at 28 days. The following is a record of four years work done under my direction:—

Years	Mix	Coarse aggregate	No. of cubes	Average compression per sq. in.
1915-16	1:1½:3	Stone	1684	3590
1917-18	1:1½:3	Gravel	221	2950

It will be noted that a total of 1,905 tests were made and that with the exception of the gravel, they are well over 3,000 lbs. per square inch. When any individual test shows below 3,000 lbs., we immediately make a thorough investigation to determine the cause. While this would occur too late to correct the given piece of work, it had a good moral effect on the contractor; and wholesome rivalry was inspired among the engineers to have a high test value for their work. The figures given above represent actual tests from the laying of something over 400 miles of 16 ft. concrete pavements of 6 ins. average thickness.

Next in time, but of equal importance to the choice of materials, is the method of application. Upon this depends the strength of the pavement.

First:—Proportioning. The mix should be proportioned in such a manner as to give the greatest density. For the general run of materials and the strength necessary, the 1:1½:3 mix most nearly meets all requirements, varying slightly the fine and coarse aggregates, are indicated by the field tests for voids, so that greatest density is obtained. The coarse aggregate should consist of well graded particles from ⅜ to 3 in. size.

Second:—Mixing should be thorough and of at least one minute duration; however, many specifications require a minute and a half. Whatever the requirement, there is just one sure way to get the full time called for, that is by use of the batch meter. It eliminates all argument with the inspector. It is fairer to the contractor, for it puts them all on the same basis. The water used must be clean and free from oil, acid alkali or organic matter. An excess of water impairs the strength of the concrete. Only enough should be used to make the concrete workable. Prof. Abrams says that his experiments show that one pint more water than necessary to produce a plastic concrete, reduces the strength to the same extent in a one bag batch as though it had been robbed of two or three pounds of cement. (See Bulletin No. 1, entitled "Design of Concrete Mixtures," by Duff A. Abrams, Lewis Institute, Chicago.)

Third:—Placing and finishing. There are two methods of finishing concrete after it has been placed upon the subgrade. One is by the use of a machine finisher; the other, which is still more generally used, by hand. Machine type of finishing is proving more and more satisfactory. It gives a uniform, smooth finished result, lessens the amount of labor behind the mixer—a decided advantage in the present labor shortage—and by permitting a stiffer mix, insures a stronger concrete. By hand, the finishing is done in various ways. The one that gives the best results is by use of a steel shod strike board to level and tamp the concrete. This should be followed by a light roller to take off the excess water and compact the concrete. In some cases this is all the finishing that is done. Greater smoothness may be secured, however, through the use of two belts, which are drawn backward and forward across the pavement with a slightly diagonal motion in moving ahead.

Fourth:—Curing. On this depends the final set and durability of the pavement. Soon after the use of the final belt, the surface should be protected by an awning of canvas to prevent rapid evaporation. There are two methods of curing, that of the earth covering with subsequent sprinklings to keep the earth moist; and that of ponding. Both of these methods can be put in operation as soon as the concrete has hardened sufficiently to stand the earth cover or the dams for the pond. With the earth cover at least two inches of earth should be put upon the pavement; for the ponding, a depth of two inches of water should be carried. If the temperature is running below 50 degrees Fahrenheit, the covering can be omitted and the concrete sprinkled two or three times a day. Traffic should be kept off the pavement for at least fourteen days, though the cover can be removed after ten days of ordinary weather. During cold weather, opening to traffic should be still further deferred unless calcium chloride is used to accelerate the set of the concrete.

All that I have said so far of concrete for roads applies equally to concrete for bridges and culverts with the exception of such obvious details of curing and finishing as must be familiar to everyone. Worthy of special emphasis here, however, is the concrete pipe culvert, because many road builders do not yet seem fully aware of its value. The laying of culverts is almost the first piece of work to be done on a job. To have to wait for the arrival of sand and stone to mix concrete often means loss of time and labor that would be conserved if the contractor had his concrete pipe culvert delivered direct from the manufacturer all ready to put in. Then the rest of the work could proceed independently and to greater advantage. The head walls of the culvert can, of course, be built on at any time.

Economy of Construction

All that might stand as part of a primer on concrete road building. It is trite. I have ventured to bore you with the repetition of it only because every failure I have ever seen in concrete pavement has been directly traceable to some neglect of these first principles.

Now, taking for granted the skill and care essential to the success of our pavement, let us jump from the primer to the last chapter of a treatise on engineering. Consider very briefly, economy of construction.

There are three general methods of building concrete roads:—

(1.)—The delivery of the materials on the sub-grade.

(2.)—The delivery of batches direct to the mixer.

(3.)—The manufacture of materials at a central mixing plant.

The first method (materials on the sub-grade) has the advantage as a rule of lower plant charges, but it requires more labor and involves a loss of from 5 to 10% of the materials used, plus the necessity of re-shaping the sub-grade. The second method (delivery of batches direct to the mixer) has the advantage of saving the loss of materials on the sub-grade and eliminating the extra grading cost; it lessens the number of laborers needed and ensures the delivery of materials, when industrial track is used, at times of soft sub-grade and inclement weather. The third method (the central mixing plant) is most economical of all. It saves time and labor through the stationary mixer and the once-made sub-grade. Its chief disadvantage, the segregation of materials in transit, may be obviated by the use of a dry mix and a finishing machine.

If the materials are placed upon the sub-grade, great care should be taken that the piles or winrows of material are of such size and so placed as to require little handling to get them to the mixer. I have known poor placing to increase the manipulation cost one third.

Where local stone is being manufactured, screenings can be used in some cases for the fine aggregate. Thus we save what generally is a waste product. However, before permitting their use, thorough tests should be made of their fitness. I have had tests made of commercial stone screenings showing all the way from 95 to 240% of the compression strength of Ottawa sand.

Finding Local Materials

A thorough examination of the site of the work and its surrounding territory will often disclose good available local materials. One may fall here between two evils—a too cursory or inexperienced examiner who finds nothing where there is much; or a too zealous discoverer who ardently insists that what he finds is good, whether or no. The people for this work are those with sound training in geology and mineralogy. They will save the state many thousands of dollars that might be lost either through the consideration of poor materials or through needless transportation charges.

In another way, hitherto neglected, can the state save large sums in building its concrete roads. We all know that by the use of well-graded aggregates in making concrete, the necessary amount of cement, its most costly factor, is diminished. In other words, the finer stones fill up the interstices that would otherwise absorb cement and sand. Or, using the same amount of cement and sand, and the well-graded stone, you can get an increase over the ungraded stone of from 5 to 10% in bulk. Shrewd contractors have been quick to take advantage of this, in spite of the fact that some states, like New York, have written their specifications for a graded aggregate. I believe the states would save large sums of money and secure *much* better work by buying *all* the materials for the concrete used in road work.

But that is matter for another story, which would detain us now beyond limits. I will only say, with a careful attention to adjectives, that built with due care for first principles and close observance of practical economies, the concrete road will yield generally satisfactory results at comparatively low cost.

A water filtration plant may be installed at Detroit, Mich., and worked at a very high rate of flow. The speed through the sand filters will be such as to give 175,000,000 gallons per day per acre. In the alum coagulating basins, the flow will be 3 feet per minute. The estimated capacity of the plant is 300 million gallons per day.

GOOD ROADS WILL BIND CANADA*

Improved Highways Will Enable People to Know One Another Better and Will Aid in the Development of Our Natural Resources

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

IT is also with an extreme pleasure that I see joined here so considerable a number of eminent personages, of influential public men, distinguished civil engineers and experienced constructors of roads, all convinced partisans of the improvement and development of good roads in this country.

I see also with much pleasure that the other provinces of this country and several states of the adjacent republic have sent men well-informed on the roads question.

Movement Started in Quebec

I thank the promotors of this convention for having chosen the capital of the province of Quebec for their congress this year. It is certainly appropriate that the Good Road Congress should assemble here, as it is in this Parliament Building that the first road laws were elaborated and it is from here that started the movement that has spread to all Canada.

It is true for several years we paid attention only to the improvement of the rural roads in the province of Quebec. In 1907 and 1908, the legislature of this province adopted the road laws which marked the first steps in the road of progress. In 1911 these laws were considerably revised and amended and served as a basis for the Good Road law of 1911, 50% system, which is still in force.

But it was in 1912 that the legislature of this province adopted a law which should transform all our system of rural roads and give the best results. I want to speak of the law of 1912, or the ten millions' law. In virtue of this law, the provincial government of Quebec was authorized to borrow a sum of $10,000,000, which would be advanced to the municipalities willing to improve their roads, at a very low interest and without sinking fund. This good road policy, inaugurated by the government of Quebec in 1912, was enthusiastically received by all the province and gave the most magnificent results. That, everybody could appreciate.

I am then very happy to see that the promoters of this congress have understood and appreciated the efforts made by the provincial government of Quebec to widen the improvement of rural roads, and I thank them for the delicate compliment in choosing old Quebec for the congress. It is a pilgrimage they wished to make to the cradle of the work of good roads in Canada. I hope that the delegates will not return home before visiting some of our roads, to see the work done and the progress realized.

No Intention of Stopping

We have not just talked of roads, but have also constructed a good number of good roads, and several important arteries are actually in construction. Moreover, I think I must add that the provincial government of Quebec has no intention of stopping in such a good method of making progress, or of leaving to private initiative the care of completing the work begun. On the contrary, more than ever, perhaps, the government is ready to encourage the improvement of roads and to make sacrifices to equip the province of Quebec with modern roads.

Of all the great problems of reconstruction which must occupy our attention during this after-the-war period, the one of improving rural roads is perhaps the most important one. We live in an immense country where the natural resources need roads for development.

We must look at the good roads problem in our country under two different and principal aspects; viz., the

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*Address delivered May 20th, 1919, at the Canadian Good Roads Congress.

economical and philanthropical aspects. From the economical point of view, the improvement of roads is of primordial importance for the development of the industry and agriculture of this country. The advantages which are derived from the construction of a modern road in an agricultural region or an indutrial centre, cannot be calculated. We have already numerous proofs on the great arteries which we have built through the Province of Quebec during the past five or six years. Agriculture has developed wonderfully in the neighborhood of the roads, the farms have taken more value and the farmers have realized big profits by the facilities they have in selling their products.

In industrial centres good roads are also considered indispensable. In a few months we will complete the construction of a regional route in one of the most important industrial centres of the Province of Quebec, the St. Maurice Valley. The Three Rivers—Grandmere road which is now being considered, has been asked for by the great industrial companies established at Shawinigan Falls and at Grandmere, and I must say that they have consented to pay a notable part of the cost of construction, so desirous are they to have this project realized for the development and the progress of their undertakings.

Good Roads Saved France

During the war, at two different times, good roads have saved France from disaster. We must say that the political road of the great countries of Europe has been developed, mostly at certain periods, to allow the rapid and sure mobilization of troops on the borders. It is also to a military end that the Romans, the first constructors of roads in the world, traced through Europe these great arteries which resisted the destructive actions of years and which still exist for the greatest part. Napoleon 1st, at the moment of his glory, was one of the most ardent partisans of the construction of an artery of great modern roads through Europe.

But after the torture which has passed on the world, coming out of a nightmare of more than four years, it is not toward the things of the war that we bend our thoughts, but it is to the problem of peace that we must devote our work and our energies. To-day the road must serve more pacific ends. A good road is an economic advantage that we did not suspect before and for which we did not care enough when everyone was at war.

But during the terrible drama which ended recently, ideas have evolved and opinions have modified. We seem to-day to enter into an era of universal peace.

Will Contribute to Unanimity

Thanks to the great arteries, the different provinces which form the Canadian Confederation will be bound together; we can entertain better relations and learn to know each other better. The good relations thus created will quickly remove the prejudices existing in certain parts.

Good roads, then, will contribute to unammity in this country and to the attainment by our populations of the peace, co-operation and concord which are needed to ensure the development and future progress of our fine and great Canadian nation.

An irrigation district has been created by farmers owning about 17,000 acres of land in the Tabor district, near Lethbridge, Alta. The Canadian Pacific Railway Irrigation System will be extended by a 25 mile ditch, to supply the necessary water. Construction work will be completed this fall; the estimated cost is $272,000.

It is rumored that R. C. Harris, works commissioner, city of Toronto, will be offered the position as business manager of Toronto schools at a salary between $10,000 and $12,000. Should Mr. Harris accept, it is also rumored that the position of works commissioner will be offered to G. G. Powell, principal deputy city engineer, or to E. L. Cousins, manager and engineer of the Harbor Commission, Toronto.

KEEPING THE HIGHWAYS OPEN IN WINTER*

By Hon. Frank Carrel
Vice-President, Canadian Automobile Association

No more would I say that it is impossible to keep our winter roads open to motor traffic than I would contend that the aeroplane is not here to stay, both commercially and otherwise. Yet, how little did the world believe in this new service of travel when it was first experimented upon? Therefore, the realization of speed and progress in road traffic is no more to be doubted to-day than was wireless telegraphy, and even still more wonderful, wireless telephony.

It is safe to look into the future and prognosticate the use of the motor car upon our winter roads, because there is no great obstacle to such a materialization, except that the time is not quite ripe for its profitable operation, under all conditions of our climate, in some sections of the Dominion, where the fall of snow is not quite so plentiful, welcome and beautiful as it is in and around Quebec. I do, however, want to emphasize the fact that if we are to look forward to the day when we may expect to treat our winter roads for motor traffic, it will be necessary, first of all, to have a solid road surface to work upon, and on this point let me say that the better the construction of the road, the easier will it be to make the winter highway trafficable for the motor car.

Traffic Depends Upon Production

There is another important subject to be studied in the consideration of this subject. There must be greater production, more modern scientific agricultural knowledge imparted to our farmers and more economic and business-like management of farms. When this is accomplished, there will be increased farming, village and town populations, and, in consequence, a larger number of automobiles upon our highways, transporting this immense farm production to the markets. You will see by this that the future use of winter roads for motor traffic depends indirectly upon the increased production and population of any district where there is a heavy fall of snow, and where sleighs are used at the present time.

But for those who may have any doubts on the subject, let me give some present-day facts to substantiate these opinions. It is not so very long ago that the people of the city of Quebec, which is graced with a winter of several months, ridiculed the idea of a street railway being in full operation in winter time. To-day it is a rare thing to see even a blockade on our tracks for a few hours, so competent has the science of man, with the aid of electrical power, been able to overcome nature's traditional temper, with her tempestuous tantrums. But what is even more astounding, and to the subject of this address, is the large number of motor cars which were in commission in the streets of Quebec and Montreal during the recent winter, proving conclusively the feasibility of motor traffic upon winter roads.

Motor Trucks Used Every Day

To offer still further evidence, it might be mentioned that the Quebec "Telegraph" delivered its papers to its 106 agents in all parts of the city, even in the suburban streets, every day but seven during last winter, and were it not for the fact that its trucks have to go into the back streets so frequently, it could have accomplished this work every day. These cars travel over 25 miles of streets in Quebec every day of the winter. To even prophesy the use of the motor truck upon our winter streets, a few years ago, would have been considered a sign of unsound mental balance.

Nevertheless, we can as readily believe to-day that, once a thought becomes a convinced idea, there is no limit to its realization, and just as soon as the population and the number of cars increase in our rural districts—we will say on the

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*Address delivered May 22nd, 1919, at the Canadian Good Roads Congress, Quebec.

main highway between Quebec and Montreal—so surely will you see the effiicent manner in which such encumbrances as snowbanks disappear and the road kept open. Almost every day in the winter a motor car is capable of using the road to Montmorency Falls, which is so well travelled that the snow packs hard enough to carry the weight of an automobile. This is exactly what will happen with other roads when they become so thickly bordered by inhabitants and as largely used as is this thoroughfare.

Tanks to be Utilized?

It may be mentioned that the average fall of snow in Quebec is 10.9 ft. Where the fall is below 2 or 3 ft., its removal is a simple task.

The late world struggle has opened our eyes to the possibilities of utilizing a mechanically-driven machine, the tank, that may revolutionize road-making, and certainly assure the feasibility, even in its present shape and motion, with few changes, of its being used for tramping down the soft snow into a hardened, packed mass, solid enough to sustain automobile traffic.

Perhaps, too, we may even prognosticate that the width of the motor-car wheels and the sleigh runners will some day run in the same tracks. Even the horses are destined to give up their middle tracks on our Quebec roads and follow the runner tracks, which will relieve them of much of their present-day travelling energy. All these manifest reforms are signs of the times, portending to teach us that there is nothing new under the sun, and that all things are possible to man's aggressive combat with nature. But perhaps the most convincing evidence in favor of winter roads for the automobile and motor truck is to be seen in the steam-hauled train of logs.

If this process of transportation can be carried on over the deep snow in our backwoods, where there is no regular road traffic, and where the snow piles many feet high, how less difficult will it be to carry on the same kind of traffic on well-beaten and snow-packed highways.

To-day the system of keeping our winter roads open is as old as the history of the country. The line of passage is along that of the least resistance from wind and snow piles. It may be across fields and pastures, between a farmer's back door and his barn, instead of several hundred yards or feet from his front door, or it may be along the ice over a river or lake. Wherever it is, and if for any reason it is likely to be lost to view, it is marked out with what are known as light sapins, a small, thin tree, which is of little commercial value.

Over it, after each snowstorm, passes an improvised rural plough, and sometimes, but not often, a wooden roller. Ploughs are of all descriptions of make and shape, with a preference for the V-shaped ones. From time to time, ruts are filled in and drifts cut through with the aid of shovels. One thing certain, when left to themselves, the farmer is not over-zealous or anxious to keep his winter roads in the pink of condition, even though it is the season when he has more time in which to do it. To the farmer, road-making is one of his distractions, and, not being a man who takes much pleasure in life, he too frequently absents himself from such imaginative waste of energy.

Farmers Realizing the Benefits

Through the excellent missionary efforts of the Good Roads Association, whose objective is real road propaganda of the very highest and most practical form, he is beginning to see eye to eye with the city man, and believes that there is a good deal more benefit coming to him, by having good roads, than he ever dreamed of before. The farmer is not any different in thought to those who hold the opinion to-day that it will be impossible to keep our winter roads open for motor traffic, but our past dreams of improved roads and speedy road traffic are being materialized in such quick order that it should prompt us to look into the future, and believe that there are many more visions on this subject which we would not even dare to mention to-day, and which will be realized as time goes on.

There is, however, considerable satisfaction for the present generation in observing the progress and development of man,—in the rapid growth of our road transportation; and all those provinces and municipalities of Canada who have been the most progressive in this direction must feel very proud of their present-day achievement, for the reason that their judgment was sound, and the people of their respective districts, including the farmers, have reaped an enormous benefit, both financially and otherwise, from the far-seeing foresight of those administrations who have favored and supported a universal movement for good roads.

If we only keep to those dreams which we are seeing realized in this and other provinces in Canada in our good road policy, we have much to be thankful for, and there is a sense of satisfaction in being able to recognize that this movement in favor of good roads is spreading so rapidly throughout the country that our governments are now embarrassed to find sufficient financial resources which they were so willingly prepared to offer some years ago. The farmer to-day is as intelligent in his belief of the great benefit to be derived from good roads as is any other body of good road advocates, and just as soon as he thinks he wants to use his car in winter as much as he does in summer, you will see the roads kept in condition to be used by him for that purpose.

HIGHWAY MAINTENANCE*

By J. A. Duchastel
City Manager, Outremont, P.Q.

A T a recent road congress I heard an eminent road builder state that the three essentials of a good road were as follows: First, drainage; second, drainage; third, drainage.

I agree entirely with him. Thorough drainage is particularly important in a cold climate as ours, where we have so many alternating thaws and frosty weather. If drainage is the most important problem in the construction of the road, maintenance is equally the most important duty which has to be performed once the road has been built.

There are many people who believe that once a road has been built it is down forever, especially if it has been constructed of the so-called "permanent" type. But this is quite incorrect. Road maintenance should begin the day and moment the road has been completed. I do not mean by this that large sums should be spent for maintenance on new roads, but some thorough inspection and superintendence should then be started and kept up.

Strict Meaning of "Permanent"

Too many people misunderstand the meaning of the word "permanent" applied to road construction. The dictionary definition of this word is too often taken literally. The word "permanent" is derived from the Latin "permanens," from "per" (through) and "manere" (remain); that is to say, "remain for ever." It has been the custom to use this word "permanent" when a more durable type of road construction has been advocated, and many road enthusiasts have misused this term.

Another erroneous conception people have about the permanency of a road is due to the fact that they have hazy ideas about the roads built by the Romans and, according to what they have been told, are still in existence and used even to-day, but the wearing surface has been replaced time and time again.

I know only two permanent features of a road and they are: (1) Its location; and (2) the heavy grading work which was done at the early ages of its construction. All other details of road construction, including bridges and culverts, are more or less of a temporary nature.

The road surface, or better, the wearing surface of a road has only a limited life, and the sooner the public is accustomed to realize this fact, the better it will be. The life

*Paper read May 20th, 1919, at the Canadian Good Roads Congress, Quebec.

of a road surface depends upon the nature of the materials used in its construction and also upon the nature and volume of the traffic travelling over it.

The surface of a roadway should be selected with respect to the traffic the road is likely to have after the improvements have been completed. It is sometimes very hard to determine in advance the density of the future traffic. Improved roads will attract an ever-increasing traffic, but a fairly close estimation can be arrived at after a little study.

The majority of the roads in this province are of the non-permanent type, and my intention is only to talk upon the maintenance of the earth, gravel and macadam roads.

General Principles

There are a few general principles common to all roads that I would like to bring out here. A bad road wears out much faster than a good road, and, consequently, the cost of maintenance is greatly increased if the road has been neglected for any length of time. Two types of wear to roads are known:—

(1) Surface wear. This wear is caused by the direct contact of the wheels passing over the road, and by the hoofs of horses, and also by the deteriorating action of the elements, such as wind, rain, etc.

(2) Internal wear. This wear is caused by too heavy loads and frost action. The materials with which the road is constructed are disturbed from their position and a general disintegration sets in.

I wish to submit a few suggestions in connection with the maintenance of earth roads. It must be remembered that the great majority of roads in this province are of this type.

When the surface of an earth road is very rough, it is advisable to harrow it with a spike-tooth-harrow, so as to facilitate the dragging. It is preferable that this harrowing be made in the spring when the road surface is still impregnated with water.

All the ruts and depressions of the road surface must be filled with material of same nature as the road surface itself.

It is important that no sod or vegetable matter of any kind be used to fill the ruts or depressions of the road.

In reshaping the road surface use a road drag, and make sure that all the ruts and depressions have been thoroughly filled.

In dragging a road it is important that the dragging be started from the sides of the road working towards the centre.

No ridges should be left on any portion of the road after the dragging has been completed.

The best time of the year to do this work is early in the spring and, if necessary, after a heavy rain.

It is necessary to remove all foreign substances that might have been brought up to the surface of the road by dragging.

It is also very important that the culverts be thoroughly cleaned, and that their outlets be left in good order. The ditches must be cleaned and enlarged if necessary, so as to improve the drainage.

The cost of maintaining this type of road varies from $50 to $100 per mile per year, according to the width of the road.

Gravel Roads

The suggestions made in connection with the earth roads can be applied to the gravel roads if they have not been superficially treated with bituminous material.

The cost of maintenance of a gravel road varies from $15 to $50 per mile per year. This price is exclusive of the cost of the cutting of weeds, etc.

Macadam Roads

Mr. Blanchard, in his American Highway Engineers' Hand Book, treats of the causes of wear in macadam roads as follows:—

"The length of time a broken stone road will last under traffic depends principally upon the amount and nature of the traffic. If traffic is light, a broken stone surface may last 15 years if originally built of good stone on a good foundation.

"Water, if allowed to stand on a broken stone surface, will soften the latter and cause it to rapidly wear out. When the frost is coming out of the ground in the spring, the surface will also be in a soft condition and require attention. The effect of horse-drawn vehicle traffic is frequently observed in the formation of the horse path, so-called, in the centre of the road. If the surface is given a flat crown, this will be prevented to some extent, since the traffic will be encouraged to use the entire width of surface. If the teams track each other, the wheels will form ruts, particularly when the road is in a soft condition. The grinding action of the wheels wears the stone and forms dust which, in a dry state, is swept away by the wind, thus leaving the stones in the top course exposed, in which condition they are liable to be displaced by the action of traffic. A heavy traffic of motor-cars travelling at high speed will also cause the broken stone surface to ravel very quickly, when the mosaic of the upper course is exposed. Sometimes, when the road is in this condition and the weather has been dry, a concentrated motor traffic of only one or two days' duration will cause ravelling.

Preventing Surface Wear

Modern traffic, composed of steel tire vehicular traffic and automobile and heavy truck traffic, has been the cause of many failures of highways that were considered of first-class construction up to recent years. The steel tire grinds and pulverizes the road metal, and the automobile traffic sweeps away the dust thus produced. To prevent this surface wear it has been necessary to find some material that will set as a sort of preservative to the road surface. After numerous experiments, road builders have found that the method of oiling the roads produced a carpet coat giving good results.

The bituminous carpet is laid on the road with the idea of protecting it from wear from traffic and climatic conditions. It renders the road impervious and lengthens the life of the road considerably.

To be effective, the carpet coat must be laid according to the following rules:—

Rules for Carpet Coat

All dust must be thoroughly removed from the road surface with brooms so as to permit an intimate adhesion between the road carpet and the road surface. For economy's sake it is advisable that a rotary horse sweeper be used. All the small depressions of the roadway in which dust might lodge should again be swept by hand brooms. The road surface should resemble a mosaic after the sweeping is done, and all stones should be exposed over the entire area.

The liquid bitumen should be applied after heating, and in moderate quantities. The quanitity applied per square yard will vary from one-fifth to one-third of an Imperial gallon, all depending upon the conditions of the road surface. All surplus bitumen will be swept with hand-brooms over the road, so as to avoid the formation of puddles, otherwise the carpet would be of unequal thickness and creeping of the road surface would soon take place.

A couple of hours after the application of the bitumen, the surface should be covered with sufficient coarse sand or screenings to absorb all the bitumen.

No road oiling should be undertaken unless the roadway is absolutely dry, otherwise any dampness at the surface of the roadway might prevent the adhesion of the carpet. Unless perfect adhesion is obtained, the carpet is apt to break away in slabs during the cold weather.

It is important that the heating of the bitumen shall be constantly observed, and the use of thermometers is recommended. Care should be taken that the flash point of the road oil be not exceeded.

In the case of bleeding of finished surface, an application of coarse sand or screenings should be made without delay.

I have had some experience myself in road oiling, and am pleased to state that the results obtained are far beyond

my expectations. I find that the roadways that I have treated with road oils have been cheaper to maintain from year to year. They are easier to clean; they are dustless and mudless.

I am submitting herewith a few figures, showing the annual cost of repairs to roadways in Outremont for the past nine years, and also the cost of oiling these roadways. It will be noticed that the cost per square yard for repairs has decreased from 1910 to 1918 at the rate of 50%, and this in the face of the fact that the wages and material have increased 83%.

COST OF STREET REPAIRS, CITY OF OUTREMONT
(Permanent pavements not included)

Year.	Total cost.	Sq. yds.	Cost per sq. yd. Cents.	Average price of labor.
1910	$ 8,866.81	124,945	7.1	$1.50
1911	10,557.79	157,595	6.7	1.75
1912	14,412.84	208,419	6.9	1.75
1913	11,773.45	244,474	4.8	1.75
1914	15,165.20	273,014	5.6	1.75
1915	18,928.88	300,734	6.2	1.75
1916	11,314.83	302,784	3.7	2.00
1917	12,817.86	322,604	4.0	2.50
1918	11,824.74	335,624	3.3	2.75

COST OF STREET OILING

Year.	Total cost.	Sq. yds.	Cost per sq. yd. Cents.	Average price of labor.
1914	$ 787.42	3,000	2.6	$1.75
1915	2,624.80	101,930	2.6	1.75
1916	5,037.44	187,675	2.7	1.75
1917	6,331.21	184,540	3.4	2.50
1918	6,202.33	138,690	4.5	2.75

In conclusion permit me to say that we have good maintenance laws in this province. I believe it to be the general wish of road enthusiasts to see the Minister of Roads apply this law with all the rigidity he can. I was pleased to see recently the appointment of provincial District Road Engineers. It is a move in the right direction. Quebec has been in the lead in road building, and we are anxious that no other province should walk away with the blue ribbon.

The franchise to operate cars in the city of Merritt, Wis., now held by the Wisconsin Valley Electric Co., of Wausau, Wis., expires on December 30th, 1919. The city lines in Merritt have been operated at a constant loss since their installation in 1889, the loss for the current year being estimated at $5,000. In view of the possible desire of the city to continue operation of the cars, the Wisconsin Valley Electric Co. has offered the property to the city for the consideration of $1, such offer to be conditioned upon the city operating the line for a reasonable period. The offer includes all property with the exception of real estate and power house equipment.

At a mass meeting, held May 20th, in Whitby, Ont., to consider the Hydro-Radial proposal, the following resolution was unanimously adopted: "That the Hydro-Electric Power Commission of Ontario be requested, on behalf of the municipalities between Toronto and Bowmanville that will be served by this railway, to enquire into, examine, investigate and report upon cost of acquiring, completion of construction and operation of the Toronto Eastern Railway between Toronto and Bowmanville, the municipalities, the inhabitants of which will be served by the railway, the population of each municipality as shown by the last enumeration of the assessors, and estimate the probable revenue from the railway, the practicability of the undertaking, and the economic value to the municipalities, as provided for in Sec. 3 of the Hydro-Electric Radial Act, 1913, and as amended; and recommends that by-laws be submitted."

GRAVEL ROADS*

By Chas. Talbot
County Road Superintendent, London, Ont.

ONTARIO Government reports of 1913 show that the organized portion of Ontario has 56,000 mile of public highways. Of this mileage 19,000 miles were gravel roads, 2,700 miles stone roads, 16,000 miles graded earth roads and the remainder unimproved. From these figures you see at a glance that gravel was practically the only material used to any considerable extent on highway work, and its general use was altogether commendable under the conditions that existed previous to 1913.

Since 1913, traffic conditions have entirely changed, caused by the general adoption of the motor driven vehicles as a means of transportation and now it is beyond doubt that pit-run gravel is unsuitable material to use for either the construction or maintenance of the main roads. It is worthy of note that since 1913, the back roads throughout the summer season and the early autumn have been in better condition and more pleasant to drive on than the main highways, with the result that hundreds of miles of serviceable back roads are being destroyed annually by traffic diverted from the main roads because their class of construction is not strong enough to withstand the demands placed upon them. It follows that the whole of our back road mileage, well constructed and serviceable, will be destroyed because of the lack of a comparatively short mileage of first class roads on our main thoroughfares. This remark only apply to portions of the country where the back roads as well as the main roads are, or previous to the advent of the motor, were, considered improved.

It is these main roads that must be taken over by the provincial governments and they, together with the roads required to make necessary connections, will form the great provincial highways of Canada.

The management and control of the public highways is one of the greatest problems confronting our governments to-day and must be solved by them. The undertaking is too complex and altogether too expensive to be successfully directed by the councils of the local municipalities. The trunk lines of the roads must be assumed and built by the provinces.

The necessity of their provincial control is the outcome of the natural growth and development of the country and its means of transportation. As the distance covered by the users of the highways increases, so the area responsible for the financing of the roads must be extended. But a few years ago the traffic, to a great extent, originated and ended within the limits of the township, and the township could reasonably be charged for it; now the traffic, through the introduction of the motor, has become provincial wide and the provinces are obliged to assume responsibility for its control. In keeping with these developments, the road laws are being altered and the provinces are assuming control of the main roads.

Almost the whole of the road mileage that will be assumed and will form the provincial highways of the Province of Ontario, are gravel roads built by the township, the county, or by toll road companies. In a few instances they were constructed by the provincial government and years ago placed under the management of the municipalities. The highways were well graded, well drained, and the greater mileage well metalled, and were in all respects roads that their builders had reason to be proud of. They have not failed because of inferior construction but rather because conditions have changed and a class of highway that was perfectly adaptable to conditions existing but a few years ago is altogether inadequate to meet conditions existing to-day.

The failure of gravel roads on main lines of travel does not mean the material of which they were constructed is not suitable for road building. On the contrary, a very large percentage, perhaps ninety per cent., of our total

*Paper read May 20th, 1919, at the Canadian Good Roads Congress, Quebec.

mileage must for generations be constructed and surfaced with gravel or crushed rock or be maintained as earth roads; more than 50% of the total mileage will be constructed and maintained with gravel surfaces.

In order to place on record the methods followed by the pioneer engineers and settlers of our province, I submit to you a copy of the specifications of the gravel road construction prepared by the county engineer of the county of Middlesex in 1854, and, used for the construction of the gravel roads of the county of Middlesex at that time.

I give the specification not because it is old, but, rather because the roads built under it gave good service, over half a century; in fact, they are still in use, but the present traffic demands a better road for our main highways, and furnishing the funds for the modern construction necessary, is the problem we find so difficult.

Specification for County of Middlesex, 1854

"The road bed is to be graded 30 feet wide from shoulder to shoulder, with side ditches not less than 2 feet 6 inches on the bottom and of such depth as to prevent water lodging within three feet of the surface of the crown of the road bed. They are to be cut to such levels as the engineer in charge may deem necessary for the thorough drainage of the road. In places where the side ditches are required to be sunk to such depth as to give a surplus of earth for the foundation of the road bed, the earth must be hauled into the low places in the road bed if required, and if not required in such low places, it must be thrown upon the outside of the ditches and spread; and in places where the ditches are required to be cut to such a depth as not to give sufficient earth for the foundation of the road bed, the earth must be taken from the sides of the road, or it must be hauled onto such low places. In swamps, and soft places where the earth in the side ditches, or at the sides of the road, contains too much mud or soft matter for a road, other suitable earth must be obtained, by hauling it from other portions of the road where it can be obtained of a good quality, which is to be placed on the road in all the swamps and low places to such depth as the engineer is charge may deem sufficient. The road bed is to be neatly formed, crowning in the centre 15 inches for gravel and 18 inches for earth road as shown in the cross section, hereon drawn. All the trees, stumps, logs, log causeways, and other obstructions to be removed from the road bed to the width of at least 46 feet, or to such width as to give sufficient breadth for the road bed and side ditches. The remaining portion of road allowance to be well cleared of all the logs, brush, trees and other obstructions, all the stumps in the road bed and side ditches to be grubbed out so as not to leave any roots in the ground within 18 inches of the natural surface of the ground.

"All the minor inequalities in the road bed must be reduced, by removing the heights into the adjacent hollows so as to make the grades very gradual, flowing and uniform as shown on a profile prepared by the county engineer and signed by the contractor, and in no case will excavation or filling be measured and paid for by the yard until it exceeds 2 feet in depth (the 2 foot filling to be over and above the earth that is thrown up out of the side ditches, and in no case, to whatever depth the side ditches may be required to be sunk for the formation of the road or drainage, will the earth be paid for by the cubic yard) but in large swamps of more than 10 chains in length each, where the earth is required to be hauled on, it will be paid for my the cubic yard as excavation or filling.

Excavation in Hills

"The hills will be laid out where required to be excavated and properly marked, denoting the depth of cuttings and fillings, and in no case will the grades be steeper than 1 in 20 with slopes both in the cuttings and embankments of 1½ to 1. The road bed must be neatly formed as in the grading, with side ditches sufficient to carry off the surface water, and water from springs that may be in the cuttings. The earth to be measured either in excavation or embankment, as the engineer in charge may determine, making such allowance in forming the embankments for shrinkage as he shall deem proper, and the embankments if deemed necessary by the engineer in charge, shall be made in layers, not exceeding 4 feet in thickness and in all cases the slopes of the embankments shall be made full in the first instance, and carried up faster than the centre, and all vegetable matter or loose earth, which shall be unsuitable for embankments shall be removed, and no stumps, logs or other perishable matter shall be placed in the embankments. The embankments must be neatly trimmed or finished at the expense of the contractors.

Tap Drains

"To be cut where deemed necessary by the engineer or person in charge of the road, and of such size as he may think necessary for effectually draining the road, such drains to be paid for by the cubic yard, and in place where the tap drains pass through cultivated lands, the earth thrown up out of them must be spread by the contractor, or at his expense, should the proprietors of such land require it done.

Culverts

"Wooden culverts will be placed where directed by the engineer, or person in charge of the road, and of such dimensions as he may think suitable, to be made of white oak, rock elm, or cedar, free from sap, shakes, rot, bad knots or other defects, the timber to be well hewn, and to be clear of waine according to the plan and specification for the culvert signed by the contractor.

Masonry

"The different varieties of stone and brick work, where these materials can be obtained at a reasonable price, comprising bridge abutments and piers, arch and cylindrical culverts must be composed of durable well shaped stone, or hard burnt brick adapted to the formation of the different structures.

"Arch culverts will be in spans of three to eight feet, as circumstances may require, laid throughout in cement. The side walls will be built of field stone or bolders where they can be obtained, and the arches of brick, of the thickness shown in the plan. Where stone cannot be obtained, the side walls will also be constructed of brick, with good bond in cement. All of the brick to be selected and hard burnt.

"Bridge abutments of first class will be of hammer dressed masonry laid in cement. The stones must be of large size, laid so as to be well bonded throughout by alternate headers and stretchers. The headers must be at least five feet long, the stretchers on the face must be not less than thirty inches in line of wall, to have a least 18 in bed, and at least 18 in more bed than face, the backing stone must have at least as much bed as face, the end joints to be dressed back close for a distance of at least 12 inches from the face of the wall. The beds must be pointed down so as to give a firm and even bearing over the whole surface of the stone, and must be brought to three-eights of an inch joints, both vertically and horizontally. The facework to be rock dressed, with cut quoins, and joints pointed with cement. A second class quality of bridge masonry may be adopted at the option of the engineer. The stone must be of good shape and size and laid with the utmost regard to strength; they must have a good bearing upon each other, and be laid without pinners in the face of the wall. The beds and builds of the stones when not parallel in the state in which they come from the quarry are to be roughly dressed to such extent as may be necessary to afford an even bearing upon each other at least 18 inches from face of wall. The joints are to be well broken and the whole work well bonded, especially at and near the corners.

"The whole of the masonry to be done in the most workman like manner, under the inspection of the engineer, or a person appointed by him to take charge of the same.

"The mortar for all masonry required to be laid in cement shall be composed of the best hydraulic lime and clean sharp sand, thoroughly mixed upon a platform of boards, in such proportions as shall be directed by the engineer, or by the person appointed for that purpose, and shall be applied to the work within the proper time re-

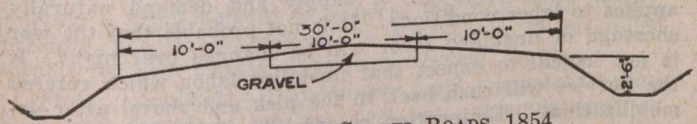
quired for rendering the adhesion and solidification most perfect. Grout must be made of cement and sand formed into well tempered mortar, and then reduced in a box to the proper consistency for running freely by admixture of mortar.

Bridges

"The timber composing the bridges must be of white oak or rock elm, for piers and abutments; superstructure, white pine perfectly sound and free from sap, shakes, loose or black knots, or any other defects, and sawn or hewn in a workmanlike manner, so as to form sticks when neatly counterhewn and seasoned, precisely of the size given in the bills of material. The kind, length, size, etc., of the timber of the different structures must conform to the bills furnished by the engineer in charge, and the whole must be framed and put together in the most accurate and skillful manner, so as to secure the whole strength of the timber. All the joints in the superstructure of the bridge to be well coated with white lead and oil in all the mortices, tenons and bearings.

Gravel

"The contractors for the gravel will be required at their own expense to prepare the metal bed, and place the gravel upon it in the centre of the road bed, by filling up where required, and reducing where too high. The metal bed to be formed from 1 to 2 inches crowning in the centre, and the earth for the metal bed must be excavated to the depth of six inches before laying the gravel upon it, in all cases where deemed necessary by the engineer in charge. The contractors for the gravel will be required to furnish 412½ cords per mile, of good screened gravel, and place it upon the metal bed, of the best description, broken in all cases before laying it upon the metal bed, so as to pass through a 2-inch ring. The depth of the gravel to average one foot, to be fourteen inches in the centre and ten inches at the sides, and ten feet wide, and the earth at the sides of the metal or gravel must be neatly made up and formed so as to



CROSS-SECTION OF GRAVEL ROADS, 1854

give the road bed 15 inches crown from shoulder to shoulder as shown in the cross section prepared by the county engineer, and hereto annexed, and the road must be neatly trimmed and finished at the expense of the contractor for gravel. If it should so happen that any contractor or contractors should place any gravel or metal upon the road bed or metal not prepared as contracted for, or of an inferior quality, he or they will be required upon being duly notified by the county engineer to remove such metal or gravel at his or their own expense, and in case he or they shall neglect or refuse to do so, the engineer or person in charge shall have power to remove such metal or gravel as in his opinion is of an inferior quality to that contracted for, or that it is not prepared in accordance with the specification, and in either case to reject it altogether, or have it properly prepared, and charge the expense of so doing to the contractor or contractors in default.

"All the ruts formed by the travel while the roads are being made must be attended to by the contractor (without any claim for extra pay) and the ruts must constantly be filled by raking in the gravel into them, or otherwise, so as to keep the road bed smooth and uniform, until the work is completed and accepted.

"All the material found in or upon the road, which is of any value, must be saved by the contractors for the use and benefit of the county, and such material to be deposited where directed by the engineer in charge.

General Clauses

"The contractors shall be accountable for all fences thrown down by their operation, and for leaving open gates or fences of landowners or occupiers, and for all damages occasioned thereby or to any property by their workmen, for all damage occasioned by passing to and fro from the roads by teams, workmen or otherwise.

"The engineer in charge of the work may alter the location or grade at any time before the commencement or during the progress of the work, either in the earth work or in any other work on or connected with any of the roads. Any additional work involved in any such alteration shall be estimated and paid for in the same manner and at the same rates as the other work of the same character. And where the quantity of the work shall or may be reduced by any alteration or location or grade or otherwise decided upon and made by the engineer in charge, no claim for damages, or loss of time will be allowed the contractors for such reduction of work.

"The contractors will be required to do any and all the extra work that may be required, and to be paid for it at a price to be fixed and settled by the county engineer.

"The roads will not be considered as finished until the excavation, grading and embankments, gravelling and trimming of the road is completed, and dressed off at the required grades, nor will any part of the work be received as finished according to the plans and specifications furnished the contractors, until the same shall have been accepted by the county engineer.

Conclusion

"All the materials intended to be used in the construction of the work named in the above specifications, must be examined and approved by the county engineer before being used. The whole of the work to be done in a good, substantial, workmanlike manner, subject to the constant supervision, inspection, approval and acceptance of the county engineer, or some person appointed by him for that purpose. The county engineer shall be the sole judge of the quantity and quality of the work, and his decisions and admeasurements of the same shall be final and conclusive between the contractors and the warden and municipal council of Middlesex.

"No charge for detention shall be made and allowed except for sufficient cause, and in no case unless the county engineer shall have been notified in writing at the beginning of such detention, that such charge would be made, and no claims for detention on account of work not being laid out in season shall be allowed unless the county engineer shall have been notified in writing of the want of such work, at least 10 days previous to the commencement of such alleged detention. No claim shall be allowed for extra work unless the same shall have been done in pursuance of written orders signed by the county engineer."

Roads Built Under Above Specifications

Under the foregoing specifications, some 200 miles of gravel road, including the bridges and culverts, were constructed within a period of five or six years. Their cost was $800,000. At the time they were built, the total assessed value of the county was less than $6,000,000.

Since that time, the gravel road mileage of the county has been extended to some 1,700 miles, but these 200 miles of wide, well graded, well drained and heavily metalled roads, remain a class by themselves. Their gravel surfaces, have been maintained, and some of them will, in the near future, be replaced by a more permanent wearing surface, but the general outline and foundations will remain and continue to be a monument to the optimism and foresight of their builders.

You will find the regulations prepared for the guidance of the county council under the Highway Improvement Act of the Province of Ontario, to a great extent, in acordance with the provisions in the specifications above quoted. The grades are built the same width, the hills are reduced to nearly the same grade, the gravel, where gravel is recommended, is placed on the grade practically in the same manner, except that the shoulders of the grades are recommended drawn to the sides of the gravel to retain it in position instead of placing it in a trench in the centre of the grade.

In the Middlesex specifications, nearly one-third more gravel was required than is recommended in the Ontario Government regulations, and it had to be screened and the stones broken instead of placing it on the road in its na-

tural condition, and raking out the stones and placing them in the base of the metal bed. The screened gravel produces a road which in the spring and fall and during excessively wet weather, sustains the traffic better than the unscreened material but the screened gravel road, is a rough and objectionable road to drive upon during the greater part of the year. The unscreened gravel road is a little muddy during wet weather and ruts more readily than the screened gravel, but the mud soon dries and the ruts are readily filled with the road drag, and the road is much more pleasant and useful, in that the surface is easily maintained in a smooth and satisfactory condition, provided always that the traffic is not excessive.

On ordinary market roads, and all other roads of less importance, gravel can be used, and will form a good road surface upon a sub-grade that has been properly prepared and adequately drained. Open side drains, as used in the old specifications, are unsightly and ineffective. Their construction was justified in 1854, but under present traffic conditions there is no place for them on the highway, and no reasonable excuse can be offered to justify their construction or their maintenance. They are jealously protected by the farmers of the adjoining lands, who use them as outlets to their tile drains, but they are of little value to the road for drainage purposes, and should be replaced by adequate under-drains, which, when completed, will render an improved service to both the farmer and the highway.

It is essential that the surface water be cared for at the sides of the grade, but seldom is it necessary to make the open drains so deep that they cannot be crossed without danger of an upset. When it is impossible to avoid the use of a deep open drain, they should be properly guarded.

The drainage of the sub-soil can be taken care of much more effectively and with less money with under-drains than similar results can be obtained with open drains, and always you have a safe road grade that is easily maintained and pleasant to work upon.

With the water line at the road sides lowered 2½ feet to 3 feet below the shoulder of your road grades, you still have a road imperfectly drained, for on the inclines of the grades and on higher elevations of the road the metal crust of the roads frequently breaks up in the springtime, and so accustomed have we become to this condition, we have succeeded to a great extent in making ourselves believe it is impossible to prevent their breaking, and without hesitation we proceed, as soon as the road surface is sufficiently dry, to level up the broken parts, add sufficient new metal to restore the crown, and annully repeat the operation instead of removing the cause of the trouble by placing a few feet of stone and the drain from the pocket containing the water to the side drain.

In the construction of a new road, no surface material should be placed until the new grade is perfectly consolidated and adequately drained, and the drainage of the old gravel highways should be perfected if they are to be maintained in good repair at the least possible outlay.

I am of the opinion that it is not advisable to screen or in any way attempt to treat the ordinary pit gravel, neither do I believe it is necessary to use a road roller in the construction or the maintenance of an ordinary gravel road. A harrow, a drag and a hand roller can be used to good advantage. There is no objection to a road roller if available.

The screened gravel road, built with the stone placed in the base and finished with the fine material, produces a road, the base of which is very deficient in binding the round stones pushed from under the wheels, and ruts are readily formed, and are quite as difficult to fill as the ruts in the crushed stone road. On this account I have discontinued the screening of the gravel. Where a pit contains a large percentage of stone over two inches in diameter, a stone crusher, screen and road rollers can be used to good advantage, and with this material a water-bound macadam road can be built that will compare favorably with the quarried stone road, and will, if the sub-grade has been properly drained, render good service, but is not better than a road built of a good quality of pit-run gravel; and the gravel road always can be maintained at a lower cost than the stone or crushed gravel road.

Throughout this paper I have emphasized the fact that gravel is an unsuitable material to use for the construction of main roads. Living, as I do, in a section of the country where the gravel deposits are plentiful and of a superior quality, and, having made a study of the effect of present-day traffic upon the gravel road, I have decided it is not advisable to use it on trunk road construction.

Good roads cannot be built on heavily-travelled highways without the expenditure of large sums of money. It is a mistake to claim it can be done, and any attempt to do so must result in loss and disappointment to these responsible for the work. A large percentage of the less important roads of Canada will be maintained and constructed with gravel surface, and they will in the future, as they have in the past, render good service.

ROAD MACHINERY*

By Arthur H. Blanchard
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HIGH wages of unskilled labor in 1917, 1918 and 1919, and the uncertain status of the labor supply of the future, has resulted in a thorough analysis of highway construction data to determine economical methods of using road machinery. The trend of wages of unskilled labor was ably covered in the 1919 report of the the "Committee on Unskilled Labor Supply" of the American Road Builders' Association, wherein it was stated that the average rate per hour in the United States in 1912 was 19 cents; in 1913, 20 cents; in 1914, 20.9 cents; in 1915, 22.5 cents; in 1916, 26 cents; in 1917, 30 cents; and in 1918, 39 cents.

In the opinion of the writer, American highway officials must face high wages for unskilled labor for several years. The basic economic law of supply and demand naturally applies to labor conditions. It is not probable that the war shortage of unskilled labor will be changed over night. It is not logical to expect that unskilled labor which entered the Service will rush back to the pick and shovel after demobilization. Emigration records show that thousands of laborers are leaving America every month. Immigration, the usual source of supply of unskilled labor, is an unknown quantity and agitation in the United States for restricted immigration further complicates the situation. It is not surprising, therefore, that the reconstruction period finds highway officials, engineers and contractors investigating all types of labor-saving machinery.

The selection of equipment for the construction and maintenance of highways should be based upon a consideration of the following factors: (1) Character of work; (2) specification requirements covering plant equipment; (3) amount of work; (4) portability of plant; (5) large and small units; (6) ease of manipulation; (7) adaptability to different classes of work; (8) funds available; (9) depreciation of plant; (10) transportation facilities. The practical necessity for the consideration of many of the above factors is self-evident.

Character of Work.—In the case of contractors whose work is confined to the construction of sheet asphalt pavements, and in the case of a department such as, for instance, that of Wayne County, Michigan, where the highway work consists primarily of grading operations and the construction of cement concrete pavements, the problem is materially simplified. On the other hand, where a contractor's work covers the construction of all the various types of roads and pavements used in a municipality, county or state, the selection of the several units of plant equipment should be based upon their adaptability to different classes of work. For example, where cement concrete pavements as well as concrete foundations are to be constructed, in many cases a type of mixer should be purchased which is satisfactory

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for the construction of pavements, the requirements for which are more specific than in the case of mixers used only on foundation work.

Specification Requirements Covering Plant Equipment.—In the modern practice of highway engineering, many specifications include stipulations which must be met by machines and accessories employed. As illustrations there might be cited the weight of rollers, pressure limitations in distributors, grouting apparatus, and details of mixers for the manufacture of bituminous concrete.

Amount of Work, Portability of Plant, Large and Small Units.—It is evident that a contractor or a department will be justified in the purchase of an ideal equipment if the work is to be extensive in character. If the work is centralized and large in amount, as in the case of sheet asphalt work, in many municipalities a large, well-equipped permanent plant will prove economical. If, on the other hand, the work is large in amount but distributed over considerable area, small portable units will prove more satisfactory, as in the case of mixing plants for the manufacture of bituminous concrete to be laid on provincial highways.

Ease of Manipulation.—In cases where contractors are engaged in general highway work and their organization does not include foremen who are specialists in the manipulation of various types of complicated machinery, it is of utmost importance that simplicity of machines and ease of manipulation should be given great weight in the selection of equipment. This is particularly true in connection with various types of machines used in the construction of bituminous surfaces, bituminous macadam and bituminous concrete pavements.

Adaptability to Different Classes of Work.—It is well known that specifications for different classes of work, requiring the same type of machine, call for differences in detail. For grading work, specifications might require rollers weighing from 12 to 15 tons, while in the construction of wearing courses of some types of pavements a 10 to 12-ton roller is stipulated. A contractor who is handling a small amount of general highway work would, therefore, find it advantageous to purchase a 12-ton roller suitable for both classes of work mentioned above.

Funds Available.—Departments and contractors are necessarily forced to consider first cost of equipment, as the funds available may not permit the installation of the most economical and efficient machines. In many cases where such conditions are encountered, it is obvious that it will not be practicable to anticipate that the work can be accomplished with the same degree of rapidity and at the same cost as if more efficient machinery constituted the plant equipment.

Depreciation of Plant Equipment.—Depreciation charges on plant equipment should be given careful consideration prior to the purchase of machines and accessories, as well as in the consideration of the cost of highway work.

Transportation Facilities.—Facilities for the transportation of machinery and materials materially affect the efficiency of the several units of plant equipment. Brief consideration will be given to the plant equipment suitable for grading, quarrying, construction of the several types of roads and pavements, and snow removal. It is also evident that normal conditions usually will be assumed as the basis for suggestion of plant equipment for the various items of highway work enumerated.

Transportation Equipment.—Motor trucks and wagons usually will be found a necessary part of the equipment for all classes of highway work. Tractors and trailers are proving of particular value on long haul work where loading apparatus require motor trucks to remain idle during several hours a day. Industrial railroads have proven efficient equipment on highway work where a large tonnage is to be handled quickly on long hauls.

Grading.—Grading operations vary from the scarifying of an old road surface, preparatory to the construction of a new wearing course, to heavy cut and fill work requiring the moving of thousands of cubic yards of material. It is apparent that only extreme conditions can be mentioned in this discussion as the economics of the utilization of various classes of machines on average grading work would necessitate a comprehensive discussion. For the lightest class of grading mentioned, scarifiers drawn by rollers have proved more economical and efficient than the use of picks in roller wheels or any one of the several types of plows drawn by rollers or tractors. For the heaviest class of grading work, in many instances steam shovels loading into wagons will be found economical. In connection with all grading work except light scarifying, one or more of the following types of machines should form a part of the plant equipment for grading: Road drags; grading and rooter plows; drag, buck and wheel scrapers; elevating graders; and rollers. It should be noted that the utilization of the elevating grader has not been fully developed by many contractors.

There are on the market many types of steam and gasoline traction engines suitable for hauling grading machinery. For many classes of grading work, their use is more economical than the employment of horses and mules. Essential features which should be based by a contractor for grading work are as follows: (1) Sufficient power for hauling the several types of grading machines under the variety of conditions on which it is expected to be used; (2) adequate mechanical strength; (3) simple mechanism enabling it to be easily steered, controlled and otherwise operated; (4) driving wheels of large diameter and of such width as to enable the tractor to operate efficiently on soft ground.

Quarrying.—Plant equipment for quarrying depends primarily upon the kind of rock, the required output per day, and the length of time during which the quarry will be worked. Drills and blasting devices are a necessary part of all equipment for rock work. Contractors or departments working the quarry to supply material for a specific highway would use the ordinary portable crushing and screening plant, consisting of boiler, engine, jaw crusher, elevator, screen and bins. Small quarries, more or less continuously operated, are generally equipped with the above plant except that in many cases the gyratory crusher proves more economical. Passing to the largest quarries, modern equipment for the economical manufacture of broken stone should consist of steam shovels for removing the rock masses from the quarry face to steel cars. In such quarries the pieces of rock transported to the crusher may vary in size up to masses weighing 7 or 8 tons. The rock should be first crushed in a mammoth jaw crusher, from which the rock should be passed through a series of gyratory crushers, jaw crushers and rolling mills and thence to elevators, screens and bins. In some plants of this type, washing devices are a necessary part of the equipment in order to produce stone chips free from dust.

Earth Roads.—In the construction of earth roads on a large scale, the following equipment has been found to be economically efficient: Elevating grader drawn by horses or by a tractor, scrapers, disc and straight-tooth harrows, road drags, rollers and watering carts. The combinations of the machines mentioned which will be used will depend upon the amount of work, character of the soil and the cross-section to which the road is to be built.

Gravel Roads.—Spike-tooth harrows, scrapers, road drags, rollers and watering carts constitute the equipment for the construction of gravel roads. Many engineers and contractors have found grooved rollers more satisfactory for this class of work than smooth-faced rollers.

Broken Stone Roads.—The average equipment consists of rollers and watering carts. For many types of construction and kinds of rock, rolling for long periods with 10 or 12-ton rollers has secured a better compaction and economical bond than in cases where 15 and 18-ton rollers have been used for short periods. Some contractors have found automatic screening spreaders a valuable addition to the plant squipment.

Bituminous Surfaces.—The equipment required for the construction of bituminous surfaces depends upon the amount and character of the work and the rapidity with which it must be accomplished. For example, the construction of a bituminous surface on a broken stone road will require an equipment of rotary brushes or coarse fibre

brooms, bass fibre brooms, in some cases batteries of heating kettles, a distributor to meet specifications and adaptable for the distribution of the kind of bituminous material under conditions stipulated in the specifications, pouring cans, squeegees, and in some cases 5 to 10-ton rollers and hand-drawn or horse-drawn automatic stone chip distributors.

Bituminous Macadam Pavements.—The equipment will depend primarily upon the specifications and the kind of bituminous material employed. The usual equipment consists of batteries of heating kettles, a distributor, pouring cans and a roller. The specifications covering certain features of the distributor may be specific, as in the case of the 1918 specifications adopted by the American Society of Municipal Improvements herewith quoted:—

"The pressure distributor employed shall be so designed and operated as 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 6 ft. and so that it will be possible on either side of the machine to apply widths of not more than 2 ft. The distributor shall be provided with wheels having tires each of which shall not be less than 18 ins. 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 2 ft. diameter wheel, 250 lbs. shall be the maximum pressure per linear inch of width of tire per wheel, an additional pressure of 20 lbs. per in. being allowed for each additional 3 ins. in diameter."

Bituminous Concrete Pavements.—The type of pavement, amount of work, the specifications and the kind of bituminous material employed materially affect the selection of the plant equipment for this class of work. Batteries of heating kettles and a roller are required for the construction of all types of bituminous concretes. Although the practice of contractors has varied to a considerable extent with reference to the weight and type of roller, many now favor the 10 to 12-ton tandem roller for all classes with the exception of Topeka bituminous concrete. Plants of many types have been successfully employed in the manufacture of bituminous concretes. Naturally the most economical and efficient work has been accomplished by a plant especially adapted for mixing the type of aggregate used. Generally, on highway work outside of urban districts, the portable plant proves most satisfactory. Dependent upon the plant accessories, the aggregate is measured by volume or weight before being dried or by weight after drying, the latter being preferable. The aggregate is usually dumped into bucket elevators, which discharge into rotary driers. In the best types of plants, the heated aggregate is then raised by bucket elevators and discharged into a small storage bin. As desired, the heated aggregate is drawn from the storage bin and allowed to fall directly into the pug mill mixer or, preferably, first into a weighing box. The bituminous cement is weighed in scales on the mixing platform and then dumped into the mixer. After thorough mixing, the bituminous concrete is usually discharged into a wagon or truck, which the plant arrangement permits to be placed directly beneath the mixer. For pavements of the type of bitulithic, a rotary screen, several bins and a special weighing device are necessary adjuncts to the plant. For those types of bituminous concrete in connection with which seal coats are employed, the equipment will necessarily be increased by the addition of hand-drawn distributors, pouring cans, squeegees and in many cases hand-drawn automatic stone chip distributors.

Sheet Asphalt Pavements.—The plant equipment necessarily depends upon the amount and location of the work and the specifications. A tandem roller constitutes a part of the equipment for all sheet asphalt work. The mixing plants are of three types, portable, semi-portable and permanent. A complete plant includes a cold-sand elevator, a drier, a hot-sand elevator, a hot-sand storage bin with screen, an asphalt elevator, a flux tank, melting tank, draw-off tank, a sand-measuring box, a dust elevator, bin and measuring box, an asphalt-cement bucket and a pugg-mill mixer.

Cement Concrete Pavements.—Variations in economical equipment depend primarily upon the specifications. A beam and bucket cement concrete mixer, forms, screeds, bridges, belts, long handled light rollers, watering carts, pumps and hose usually constitute the equipment for the construction of cement pavements constructed by the mixing method.

The essential features of a plant are covered by the following excerpts from a report of a committee of the National Conference on Concrete Road Building: "The concrete mixer should be of the batch type provided with an automatic water tank, traction drive and power loader. Mixers having a boom and bottom-dump bucket of sufficient size to convey one complete batch for placing the mixed concrete are preferred. Where necessary to keep from cutting into the subgrade and to facilitate moving, the wheels of the mixer should be run on suitable planking. The mixer should be provided with a suitable automatic water tank which can be quickly filled and emptied, so that when once determined, the required amount of water can be added to each batch of concrete. The power loader or skip should be of sufficient size to hold all the materials required for the batch."

Wood Block Pavements.—For the building of wood block pavements, the equipment should include the necessary apparatus for the construction of the mortar cushion, or a template and hand roller when a sand cushion is employed, a tandem roller weighing from 3 to 5 tons and the necessary distributing apparatus for the application of fillers and the construction of expansion joints.

Brick Pavements.—The equipment should include a wood template and hand roller for the construction of the sand cushion, double metal template for constructing a mortar bed on a green concrete foundation, a tandem roller weighing from 3 to 5 tons, brushes, cement-grout boxes or a small mixer if a cement grout filler is employed, or conical pouring cans if bituminous fillers are used for the construction of transverse or longitudinal joints.

Stone Block Pavements.—The equipment includes, in some cases, templates and hand rollers for the construction of the sand cushion, tampers and the necessary apparatus for filling the joints.

Snow Removal.—Equipment for snow removal is affected by the amount of snow in a storm, the yardage and location of the roads to be cleared. For highways outside of urban districts, road scrapers and horse-drawn and motor plows have been found economical and efficient. In the case of many roads, compaction of the snow being principally required, snow rollers constitute the equipment.

It has been officially stated that since 1912 the Ontario government has built about 2,800 miles of roads, and one-third of these have been in Northern Ontario. "Although the start made has been important, yet the lack of transportation and the largeness of the area seem to make it imperative that the road building program should be enlarged as much as possible in order to keep pace with development of the mining, the farming, the lumber and the paper industries."

The Idaho bill for licensing civil engineers has recently been passed. In this bill, the term "civil engineering" is defined as "the practice of any branch of the profession of engineering other than mining, metallurgical and military. Said profession embraces the design and supervision of the construction of all public or private utilities except those in connection with mining operations exclusively and other works which require experience and the same technical knowledge as engineering schools of recognized reputation prescribe for graduation."

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PRINCIPAL CONTENTS

THE GOOD ROADS CONGRESS

WHEN any organization can attract to its annual meeting, or congress, officials from eight of the nine provinces in Canada, its success can be taken as an established fact. This wide-spread official recognition that was granted last week at Quebec to the Canadian Good Roads Association, augurs well for the good roads movement in Canada.

The founders of this association have worked hard and acquired considerable prestige at Quebec and Ottawa at least, and their influence has been entirely beneficial to the road movement.

The meeting at Quebec will long be remembered by all who attended, not so much for the value of the papers or discussions as for the splendid opportunity it gave of coming into contact with the biggest men in highway work in Canada, and for the ardent hospitality of the people of that proud city.

Quebec deserved this road congress, as it has been a pioneer in Canada in road work. The beautiful Montreal-Quebec Highway, over which forty of the delegates motored the day before the opening of the congress, can be equalled by few roads in Canada, either for quality of work or for scenery. The waterbound macadam which forms the greater part of the road is in good condition, and is now being preserved by a surface treatment of bituminous material. There are also a number of miles of excellent concrete highway at various points, and at the Quebec end are a few miles of splendid asphaltic-concrete road of the "Warrenite" type. All four types of road encountered on this highway were smooth and pleasant, and all of the motors, whether Fords or Packards, had no difficulty in maintaining a speed of about 35 miles an hour throughout the entire journey.

FEDERAL AID FOR HIGHWAYS

WARNING Ottawa to go slow in voting money for highway improvement, is about as logical as equipping a snail with speedometer and brakes. But, slow-moving as the Dominion government has been in granting federal aid for highways, it now seems that "Ottawa" cannot yet take a forward step without being in danger of slipping on the ice of provincial rights.

Sir Lomer Gouin took the public into his confidence last week at the banquet of the Canadian Good Roads Congress in Quebec City. He pulled aside the curtain of diplomatic relations between province and Dominion sufficiently for those present to get a glimpse of the ropes that are holding the federal aid bill at its moorings, preventing it from embarking upon what may prove a rough and stormy parliamentary voyage.

Federal aid for highways will be welcomed by all of the provinces provided that it takes the form of a straight gift of money, with no strings attached. But Quebec at least—and Ontario, Saskatchewan and other provinces are said to think likewise—does not want Federal aid if it entails the surrender of any of the provincial rights and prerogatives in road building.

The Dominion government appears reluctant to introduce any bill for federal aid that does not provide for jurisdiction over and inspection of the roads that are aided. It fears that the money might be used for political purposes, it is said; that is, for the construction of roads as a bribe for support from uncertain districts. Moreover it wants to make sure that the money is spent honestly and to the best advantage of the whole Dominion.

Such an attitude, thinks Sir Lomer Gouin, puts into the public mind ideas that are most harmful to the good roads movement. Money is not the only requisite for the success of public projects. Trust and confidence are equally essential. Without public confidence, no government, provincial or federal, can build roads. If the federal government leads the people of any province to believe that its provincial government cannot be trusted with road-building funds without federal policemen being on the job to watch their expenditure, then it will kill all expenditures for road work in that province. If the federal aid bill were really to result in such a psychological effect upon the public—and but few statesmen in Canada know the trend of the public mind as does Sir Lomer Gouin—then it would be better if the bill be still-born and the provinces allowed to carry on as at present, with their own funds.

Federal aid would not be essential, anyway, if every province in Canada were to build roads as energetically as does Quebec. But federal aid is highly desirable as a stimulus to road-building. All provinces contribute indirectly to the funds from which the aid is given, so no province is likely to fail to participate in the benefits of the aid, particularly when the financially weaker provinces will get more out of the fund than they have indirectly contributed. Moreover, the money that could be contributed by the Dominion government would have been raised by methods of indirect taxation not available to the provinces, and less likely to arouse opposition than a direct road tax.

It is to be hoped that some way will be found of making the bill satisfactory to every provincial government in Canada, so that the aid can be obtained. After all, the members of the House of Commons are but the representatives of the various provinces, and if the bill is not satisfactory to a large majority of the provinces, it stands no chance of becoming law. It is somewhat surprising that this legislation should have been inaugurated at all without having first met the views of all of the provincial governments. There is no more danger of road appropriations being used as political footballs at Quebec or Regina or Toronto than at Ottawa. For the sake of good roads in Canada, the strings to which the provinces object should be cut, and the $20,000,000 aid for highways should be passed unconditionally. The Dominion government should aid the provinces to that extent every year. But in encouraging the backward provinces to build roads, nothing should be done to discourage the progressive provinces.

PERSONALS

COL. G. H. JOHNSON, consulting engineer of Ottawa, has recently returned from overseas. He has been O.C. of the Canadian Engineers for the last three years, constructing mountain railroads, etc., on the Alsace-Lorraine front.

CALVERT TOWNLEY, assistant to the president of the Westinghouse Electric & Manufacturing Co., was elected president of the American Institute of Electrical Engineers May 16th at the annual meeting of the institute, held in New York City. He is a graduate mechanical engineer, Yale University, 1888. Starting with the above company, then "The Westinghouse Electric," in 1888, he has served in many capacities, finally receiving his present appointment as assistant to the president.

OBITUARIES

W. T. PRESTON, senior assistant United States engineer for the Puget Sound district, died May 14th, at his home in Seattle, Wash., of pneumonia. Mr. Preston had a great share in the engineering problems throughout Western Canada, one of which was the construction of the Canadian Pacific Railway through the Rocky Mountains and down the Fraser Canyon.

A. T. FRASER, chief engineer, western lines of the Canadian National Railways, Winnipeg, was instantly killed in a snow slide in the Rocky Mountains. He was born in 1872, at Pembroke, Ont., and had been engaged on railway work for 22 years. During this time, Mr. Fraser had held many important positions for the different Canadian railways, receiving the appointment of chief engineer of western lines of the Canadian National Railways at the beginning of this year.

ERNEST MARCEAU, superintending engineer for the Province of Quebec of the Department of Railways and Canals, passed away last Friday evening at his summer residence at Sault au Recollect, P.Q., at the age of 66 years. Mr. Marceau had been ill for more than a year with heart trouble. In addition to his active engineering duties, Mr. Marceau was a professor on the technical staff of Laval University, and was treasurer of the Engineering Institute of Canada, having held the latter honorary position for the past ten years. He was one of the charter members of the Canadian Society of Civil Engineers, and was president of the society in 1905. He graduated in 1879 in civil engineering at Laval University and joined the engineering department of the provincial government. In 1894 he accepted the post with the Department of Railways and Canals. The funeral, which was held Tuesday morning, was attended by a very large number of engineers from Montreal and many other cities. Interment was in Cote des Neiges cemetery.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer*, to which reference is made.

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Welland, Ont., fire hall	June 3.	May 22.	52
Winnipeg, Man., sewer	June 3.	May 15.	45

BRIDGES, ROADS AND STREETS

Alexandria, Ont.—The Town Council has decided to submit a by-law to ratepayers on June 2nd for raising $20,000 to be expended on improvements to streets within the town limits.

Arnprior, Ont.—The Town Council contemplates the construction of concrete walks at a cost of about $4,500.

Arthur, Ont. (Wellington).—Contracts for construction of bridges have been awarded as follows: 38th St., Cormack Bridge, to C. J. Callahan, Arthur, without steel, $2,224; Parker's Bridge, to P. McGivney, Arthur, without steel, $792; Hagarty Bridge, to P. McGivney, Arthur, without steel, $620; O'Donnell and McNabb Bridges, to John Langdon, without steel, $1,000; Bethany and Roy Bridges, to E. G. Marlin, Elmira, without steel, $1,590; Shantz Bridge, to J. Wilkinson, Morriston, without steel, $825; Caldwell Bridge, to Chas. Mattaine, Caldwell, $1,180; McConnell Bridge, to E. Simmons, $625. Bowman and Connor, engineers, 31 Queen St. W., Toronto.

Arthur, Ont. (Peel).—Contract for construction of abutments for Peel Township Bridge has been awarded to the Standard Steel Construction Co., Port Robinson, $1,164. Steel work, with 115 ft. span, with concrete floor, $5,273.

Arthur, Ont.—Tenders are called until June 3rd for construction of six bridges for the County Council. Bowman and Connor, engineers, 31 Queen St. W., Toronto.

Brampton, Ont.—The Town Council has awarded contract for construction of pavements, storm sewers, etc., to the Grant Contracting Co., Ltd., 50 Front St. E., Toronto.

Brantford, Ont.—Tenders will be received until noon, June 7th, for construction of pavements. Alderman Henry Simpson, chairman, Board of Works. For official advertisement see elsewhere in this issue.

Brockville, Ont.—Tenders will be received up till 4 p.m., May 30th, for the construction of bituminous macadam roadways and concrete curb and gutters on Buell and Bethune Streets, Brockville. J. M. Dobbie, chairman Works Committee, Brockville. G. H. Bryson, town engineer.

Bury, Que.—Tenders will be received by the undersigned until noon, June 14, for the construction of a reinforced concrete bridge on the Beauville-Sherbrooke road in this municipality at station 119-45. The span is 15 ft., height