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The Canadian Engineer

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Mechanical Handling of Gravel or Broken Stone

Slot, Elevator and Bin Method Very Successful Last Year in Brant County—Cost of Outfit Saved in One Season—Paper Read Last Week at Conference of County Road Superintendents and Engineers of Ontario

By ALAN MAIR JACKSON

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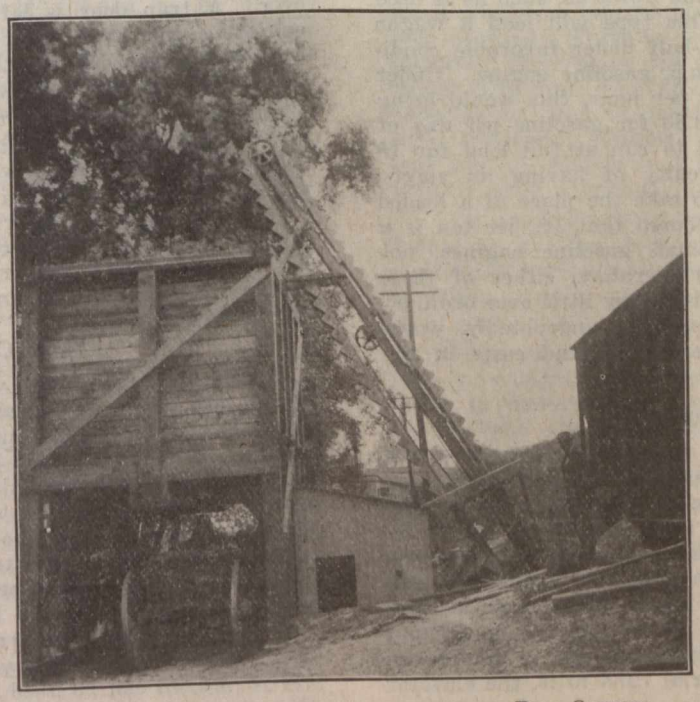
IN embarking on this subject, there comes up in my mind's eye two scenes which stand out in startling contrast, —the coaling of a liner, first in the western hemisphere and then in the eastern. In the former case, the line of railway cars loaded with coal are standing by the elevator. The end car is uncoupled, pushed on to the elevator, the gates swing to, up goes the truck to the desired elevation where it is tilted forward and outwards and the coal is deposited with a crashing roar into the hold of the vessel by the time the hard-working crew of trimmers have levelled the pile. "Stand from under" is the word, and again the coal pours from the second car, so that the train of twenty cars is empty inside an hour. In the second case, at Port Said, the coaling is done by hand, endless strings of coolies each carrying a few pounds of coal in a basket on his head, and occupying days, with tremendous labor and incessant noise and dust.

When I was presented with the fact that my name had been placed on the program of this conference against the subject of "Mechanical Handling of Stone and Gravel," I was a little uncertain whether to treat the subject as covering the transfer of stone from its point of origin to its destination or as covering only the emptying of railway cars and the loading of wagons. I decided to confine myself to the unloading of broken stone into wagons or trucks from railway cars, as I believe that the problem presented is of interest to the majority of road builders, without going into the wider problem that might be covered by the word "transportation."

The following may be said to cover most of the usual methods of transfering crushed stone from railway cars to wagons or trucks:—

1. Shovelling by hand over the sides onto the ground, and shovelling again into wagons.
2. Shovelling by hand over the sides direct into wagons.
3. Shovelling into skips (on the side of the car) which can be tripped into wagons.
4. Shovelling by hand over the sides and loading with a mechanical loader.
5. Dumping hopper-bottom cars and loading with a mechanical loader.
6. Dumping hopper-bottom cars over a slot in the track, the bottom of which is inclined so as to discharge onto an elevator which in turn discharges to a stock pile or storage bin.



BRANT COUNTY'S SLOT, ELEVATOR AND BIN OUTFIT

I found that last year, with wages at 40c. per hour, the cost of unloading by hand amounted to 20c. per ton when the material was shovelled out of flat-bottom cars with about 3-ft. sides. The cost of shovelling from hopper-bottom cars would be more; in fact, I find that the prevailing price for which coal unloading is contracted around Brantford by hand is 30 to 40c. per ton. These, I think may fairly be taken as average prices.

Shovelling by hand obviates demurrage, but entails an expenditure of almost as much as the unloading charge for reloading again into the wagon, while the reloading by hand into motor trucks higher than wagons would probably bring the cost of reloading up to 30c. per ton. This method, however, of handling stone is primitive and entails having other work available at which the gang of shovellers can be placed until another car is spotted, and it is probably practised only for small quantities of materials, as the cost is not likely to be less than 50c. per ton.

Shovelling by hand out of cars direct into wagons or trucks is obviously much cheaper than the first method, because it entails handling the material once only instead of twice, but it costs more than one handling of material. This is by reason of the time lost by the teams standing idle while they are being loaded. With men at 40c. and teams at 80c. per hour, and with 1½-yd. wagons, I found the cost of unloading cars to be 31c. per ton. These were flat-bottom cars and the teamsters shovelled, and the increase in cost over shovelling onto the ground was due to the idle time of teams and shovellers, principally the former.

Every locality has its peculiar advantages or disadvantages. Some have the advantage of a raised track and sunken wagon road so that cars may be shovelled more

cheaply by first dumping them than by lifting the material out over the side, but considering the case of wagons on a road at the same level as the track, I believe this cost of 31c. is quite usual.

I believe that no simple mechanical method has yet been found of unloading railway cars of stone from the top, and it would seem that when cars have to be unloaded from the top, the man with the shovel will long hold his own. One method, however, of making an economy on what must always remain an expensive operation, is the use of loading skips. These are fastened to the side of the car, or stand independent of it but close by, and hold about 1½ yds. Two or three may be used on one car. The skips are filled by the shovellers while the wagons are away discharging, and the wagon is very rapidly filled by tripping the skip, so that by a little arranging of the number of teams and shovellers, very little time is lost by either.

Mechanical Wagon-Loaders

A considerable improvement over the above methods is brought about by the mechanical wagon-loader, several of which are now on the market. One type in particular can be used to very good advantage from the stock pile, and another for unloading hopper-bottom cars.

These machines are portable and are of two distinct types. One, with a chain of buckets, digs into the pile, and the other, with a belt conveyor, requires that the material fall onto the belt or be placed there. Both types deliver at a height suitable for loading a wagon, truck or trailer.

Everyone knows the difficulty of shovelling into a pile of loose broken stone, and this is the difficulty which is presented to the bucket type of loader. It is a difficulty which increases with the size of the stone, and is very real when the pile consists of 4-in. and upwards, such as is used for base course road work. This type will load a wagon in upwards of a minute and a-half under favorable conditions and is operated by an 8 h.p. gasoline engine. Under the old rule of 1 pint per h.p. per hour, this would bring the cost of running to about $3.50 for gasoline per day of 10 hours. It would be unusual to run at full load for 10 hours, on account of the difficulty of having an empty wagon or truck always ready to take the place of a loaded one. It may, however, be considered that 1c. per ton is a fair cost for fuel. Having small gasoline engines, not usually requiring highly skilled operators, either of these types can be successfully handled at very little over ordinary unskilled wages. The bucket machine, undoubtedly, works better in gravel than in broken stone, and costs in the neighborhood of $1,800.

Belt Conveyor Type

The second type, with the simple belt conveyor, is a cheaper machine, costing about half the price of the former, but it requires considerably more feeding, as it does not dig into a pile but must have the material fed to it. It requires about 3 h.p., and is usually operated by a gasoline engine. Two men can, by the use of this machine, unload a 50-ton car of coal in about 4 hours. This type operates well under a hopper-bottom car, as the car can be dumped after the toe of the elevator has been set in under the pocket, and so long as the material runs to it, the elevator will automatically carry it away.

Owing, however, to the construction of hopper-bottom cars, the four pockets of the car have each a door; two of the four doors at one end of the car open simultaneously when dumped, and consequently, there is a gush of material which runs out onto the track for more than the full width of the car. It will thus be seen that with the elevator set in under the pocket on one side, considerable material will run out of the pocket on the opposite side. Moreover, when one pocket has discharged itself, the opposite side must be shovelled out by hand, and these contain on an average 5 tons. It will thus be seen that in unloading a 50-ton car, probably 10 tons have still to be shovelled by hand.

Speaking generally of these two types of wagon loaders, they are capable of a variety of applications, and have very real spheres of usefulness, not only in unloading cars but also in loading to and from stock piles and in gravel pits. The lack, however, of storage puts these machines in a different class from those which are operated in connection with a storage bin.

Slot, Elevator and Bin

The most economical method of handling stone from railway cars to wagons or trucks, so far as I know, is by the slot, elevator and bin method. A slot 4 ft. deep across the track is excavated 16 ins. wide between ties and is lined with ties one on top of the other. A plate some 9 ft. long by 16 ins. wide is set in this slot at a slope on which stone runs freely, i.e., 30 degs. from the horizontal The plate should be set so that the largest material will pass under the rail at the upper end, and the lower end so that it will discharge into the buckets of an elevator.

The elevator is set in a pit alongside of the track, with the centre of the lower tumbler about 5 ft. below base of rail. With this setting, a 30-ft. elevator, standing at 60 degs. from horizontal, will have sufficient length to fill a 55-ton bin.

The motor, consisting in this case of a 9-h.p. oil engine, is set under the elevator in a small portable house and provided with a clutch drive, by 6-in. belt, onto the jack shaft of the elevator. The elevator is of standard construction, 14 ins. wide and delivering about 120 buckets per minute.

Slide Door Controls Flow

The flow of stone onto the elevator is controlled by an ordinary slide door operated by a lever, and is set between angles fastened to two plates lining the side of the 16-in. slot at the lower end. The pit in which the elevator is set is made large enough for the operator to get down to the lower tumbler, and is timbered on the track side and decked over. A trap door is left in the deck so that the lever operating the stone feed may be accessible, and cover boards are provided for the slot across the track so that the whole may be left safe when not in operation.

The usual spacing of ties is about 20-in. centres, which leaves approximately 11 ins. space between ties. I found that railway companies would give permission on sidings for ties to be spread to an opening of 16 ins. if a piece of rail was put in under the running rails as an extra support. As they supplied the pieces of rail, this seemed easy to me, though it was necessary to sign an agreement with the railway companies relieving them from all responsibility for accident.

Three Cents per Ton

Two of these outfits were installed by the county of Brant last year and operated during the construction season. The cost of unloading cars and loading into wagons by this method was about 3c. per ton. The total kerosene, purchased at 20½c., for unloading 1,854 tons was 33 gallons, giving a cost for fuel of about four-tenths of a cent per ton. A 50-ton car can be unloaded in 2½ hours, though allowing for oiling and starting up, I figure 3 hours about a fair allowance. The operator in each case was an unskilled man paid 40c. per hour.

The bin used discharges through four 12 by 12-in. openings in the bottom, by means of any one of which a 1½-yd. wagon can be filled in 30 seconds. The height from the ground to bottom of bin is 6 ft. 8 ins., though this can be increased by lowering the roadway. The cost of unloading 50 tons may be taken as follows:—

3 hrs. time @ 40c.,	$ 1.20
50 tons @ $0.004 for fuel,	.20
Oil, waste and grease,	.10
Total,	$ 1.50

These outfits cost approximately $1,800, made up as follows:—

Engine and clutch,	$ 545
Elevator,	650
Lumber for bin and pit,	215
Ironwork for bin and slot,	225
Construction,	165
Total,	$1,800

I estimate that the unloaders can be taken down and re-erected for about $200.

A bin of this capacity is not portable in the strict sense of the word, but the bins used in Brant county last year were made so that the whole structure could be readily taken apart. No nailed parts would have to be torn out except the lining boards of the end of the bin, each of which requires two 4-in. nails, so that no loss should occur in knocking down the bin.

In most counties, I believe, stone-unloading points on the railways can be located from which it would be possible to do several seasons' work.

I assume that the commonest method of unloading cars is to shovel out into wagons, which will cost in the neighborhood of 31c. per ton, or $15.50 for a 50-ton car. Taking the cost of unloading by the slot, elevator and bin method at 3c. per ton, or $1.50 for a 50-ton car, a saving can be effected of 28c. per ton, or $14 per car. A season's work for one macadam outfit might, I think, be fairly placed at one car per day for 140 working days. This would represent a cost for unloading by the one method of $2,170, and by the other of $210, or a saving of $1,960 for one season,—a little more than the cost of the outfit. I should consider the investment worth while if the outfit paid for itself in three years.

FEDERAL AID*

By A. W. Campbell
Dominion Highway Commissioner

By an Act passed on the 7th of July last, the Dominion government appropriated $20,000,000 to be divided among the provinces in proportion to their population, this sum to be used in paying 40% of the cost of improving roads designated by the provincial governments and approved by the federal department of highways. In making this appropriation, instead of voting a certain sum of money each year, the intention was to provide for a large outlay which would enable the different provinces to lay down or map out a scheme that would cover some four or five years. This $20,000,000 is available to the provinces within a period of five years, and of that amount nearly $6,000,000 is due to the province of Ontario.

In mapping this program, it was feared that the money would be scattered throughout the different provinces in small dribs of a few hundred dollars to this road and a few thousand to another, and that nothing of a substantial or finished character would be undertaken, that no connection would be made between the expenditures on the different roads, and that in order to secure this, some more comprehensive plan would have to be laid down. The provinces may plan for five years in advance, and the first regulation under the Act provides that each province shall, in the first place, submit a general program map. That program map should show the roads which it is the intention to build within the next five years. It was somewhat encouraging to find that you have gone so far in Ontario as to have completed your general program map involving some 1,800 miles of road. That is a pretty pretentious scheme; it is a pretty broad proposition, it is a very big undertaking, and to arrange for the forces to carry out that scheme within that time, means that there must be a great deal of activity on the part of your department as well as on the part of the various municipalities having charge.

As to the location of these roads, it seems to cover pretty generally the different parts of the province. There is no doubt, with the high cost of materials and labor, that this is going to involve a very large amount of money, but I believe the benefits to result from the general improvement of the roads of the country are such that even with the high price of labor and materials, you are unquestionably justified in making the outlay; and if you are justified in providing 60% of the cost of the work, we ought to be justified in providing 40% of the cost of the work.

As to what the character of that work shall be is a debatable question and one which will give you considerable worry and trouble in determining. In the first place, we consider that the improvement should be, as near as possible, in keeping with the requirements and demands of traffic, and that in measuring that, you should measure for a reasonable number of years in advance.

Immediate Maintenance Necessary

If we are going to undertake huge expenditures on roads in Ontario, a great deal of very careful, patient thought will have to be given to the question of the design of the road, to the material that is to be used, how that is to be applied, whether the work is to be done by day labor or contract, and all the other details which would naturally appear as we go along.

Much care and study will have to be given to the question of construction, and much careful thought must necessarily be given to the question of future maintenance in order that that will be put into operation immediately the road is improved and that it will be patiently and diligently carried on for the life of the pavement.

Maintenance, to my mind, is a question that we have not given the thought to, up to the present time, that it deserves, and construction without providing for suitable maintenance is a great mistake. Provide for the maintenance before you undertake the construction, and as soon as the construction has been carried out, pass that road over to your maintenance department to care for and look after.

It may be that 1,800 miles is a large scheme for one province but every province in Canada to-day is working out a scheme, a general plan, along the lines that you have been working. Three or four of the provinces have already submitted their plans for approval, and when you consider the question from coast to coast, it means a very, very large undertaking, and it means that in every province the same intelligent interest should be given to the question that you are giving to it here, and it should be made one of your chief municipal undertakings.

The employment of capable men for the direction of this work, and the employment of capable machinery of the most modern type, are absolutely necessary, and all of these questions provide suitable subjects for your consideration each year.

When we ask for the specifications which you will prepare in connection with these different works which you are going to undertake, we are not going to insist upon an extravagant outlay, nor an outlay that cannot be justified, but among the first things which we require when the project is submitted for approval, are: (1) That you should have made a careful count of the traffic on that road; and (2) that you should have made a careful reckoning of the amount of traffic which will be developed in consequence of the improvement of the road. This should be shown in order to justify the expenditure. Possibly these, more than anything else, are the questions which should be carefully thought out. It is impossible for us to raise sufficient money to go along recklessly establishing the most expensive and up-to-date roads if the traffic on those roads will not justify the outlay. These are questions that must be answered in order that we may be in a position to pass upon the improvement which you are to undertake.

Improvement of Township Roads

We believe that the roads generally should be improved; we believe that not only should the main roads be considered, but that every road in the township should be given some attention. It is just as necessary for you, in connection with the municipal roads which your councils are managing, that you should introduce the very latest practice with regard to their construction and maintenance, as it is that you should introduce this into what might be called the provincial or more important roads. The same principles should underlie the care and keeping up of municipal roads as underlie the question of provincial roads.

*Address at the 18th annual meeting of the Ontario Good Roads Association, March 4th, 1920.

The big question is to think out carefully what class of construction should be adopted to meet the requirements of each. It is just as reckless and foolish to build a cement-concrete road on a back concession as it would be to put an ordinary gravel, such as is suitable for a back concession, on one of the main roads which is subjected to several thousand vehicles a day. The construction must be designed in keeping with the requirements. That is one thing that I would like to impress upon you. That construction should not be any more expensive than necessary, but you should not fail to make suitable expenditure wherever requirements of traffic demand it. Build the maintenance into the construction if possible; provide a road that is going to easily meet the requirements of the traffic, and wherever any section of road is so densely travelled as to require a more expensive construction, then I say it is good business economy to undertake a more expensive class of road.

Build to Meet Requirements

Let us not get away from the fact that the different classes of construction each have their own place in a proper scheme for roads. They are not interchangeable, but one at times is just as advisable as another under other circumstances. I do not believe in building cheap roads any more than in using cheap construction in connection with anything else; I mean, I do not believe in building low-cost roads merely for the purpose of making a crust which will apparently be an improvement to that road. The gravel road has its place, but it is necessary that it be as carefully constructed as is the most modern design of road.

We have been building a great mileage of water-bound macadam roads—crushed stone roads—and in various parts of Ontario this is the cheapest material one can get in some places; gravel is scarce, while stone is to be found in abundance. Where this is true, then it is up to the management to provide the most capable machinery that can be purchased for the purpose of preparing that material as it should be prepared and at the least possible outlay. In other sections of the country, good gravel is to be found where stone is scarce. It would make a road very expensive if stone had to be shipped a long distance. This is a point that must be considered: How does the cost of the local gravel compare with that of bringing in broken stone, in view of the service which the road is to be called upon to perform?

Gravel is Suitable Material

Design carefully in the first place; see that the material is of the proper quality; in a great many instances we find this has been one of the great weaknesses in connection with the work carried on in the United States. Anything in the nature of stone was, in the first instance, considered quite good enough to make a first-class road.. Stone was very much better than gravel; it did not matter what the quality of the gravel was as long as bed-rock could be found; they believed in crushing the stone and putting it down in place of the gravel; but if gravel is carefully selected and cleaned, and properly applied, and oiled or treated with some bituminous material, then it has its proper place in the road program of this or any other province.

The construction of culverts should be undertaken in the most durable and substantial way. No weak material has its place any longer in the program of the principal roads. While our bill does not provide for payment of any portion of the cost of bridges, yet it does include all culverts up to a span of 20 ft. These we expect will be made of cement-concrete and built according to modern plans, and these will include, as a general rule, most of the openings through roads except the larger bridges, which the federal government did not at the time think we should join in building.

The width of the road and the width of the material to be placed on the road must, in the first place, be prepared by your own departments. The provincial departments have the designating of the roads, they have the designing of the class of roads to be built, and they have the supervision of the work. The federal department does not undertake to join in any of these things beyond simply seeing that the plans are suitable plans and that the work has been carried out in accordance with these plans. When that is done, then 40% of the cost of the work on these roads will be paid.

The department which we are organizing is not of a very expensive character. We do not believe that the provinces are going to raise $30,000,000 of their own money and spend that recklessly in order to get $20,000,000 of our money, and we feel that the largest share of the responsibility should be placed upon the provincial departments.

It is very encouraging to know that within the last few years the provinces have all been working along the lines of establishing road departments, and these road departments now have special charge of most of the provincial or important roads. They have issued simple plans and specifications which are very useful in guiding the local authorities in carrying out their part of the work. I attach the very greatest importance to the fact that out of possibly 55,000 miles of road in Ontario, only 1,800 will be treated as provincial roads, which leaves a tremendous mileage of road still in the hands of the local municipalities.

The importance of a road is something which you have to judge from its locality, the amount of traffic that is on the road at the present time and the probable amount of increase which will be caused by the improvement of the road. The possible development of the section toward greater production may involve a more expensive road and one which would require a greater amount of care and attention. The different plans only tend to classify or single out the different kinds of road, and in this connection, it is necessary, not only to confine ourselves to the classification of the principal or provincial roads, but it is necessary that we should as carefully single out the provincial county roads, the county roads and the principal township roads. All these fall into classes of their own and should be treated accordingly.

Use Machinery Everywhere Possible

The matter of utilizing to the fullest extent modern machinery in connection with this work is very, very important. The high cost of man-power and horse-power in connection with work of this kind is making it almost prohibitive, and mechanical or motor-driven implements and machinery should be used as far as possible as a part of the economic construction of our roads.

It is not our intention, and it is outlined in our regulations, that we should in no way conflict or clash with the provinces in carrying out their work. Each province has its money singled out for it, and each one knows just how much it can earn and how fast it wishes to go. The money will be available at any time in connection with grading, or gravelling, or stoning, or putting down of bituminous or concrete pavement where such is demanded. The class of construction is not one that can be fixed by standards, and, consequently, we are not sending out standards. We are going to try and work with the different provinces and see if we can, by working together, adopt standards that will be suitable for the requirements before any fixed standards are undertaken.

No Interference from Ottawa

I believe the federal appropriation is one which was clearly justified. The provinces are all now working on their plans and seem to be very anxious to get this assistance to make improvement as speedily as they possibly can. It will be very interesting to watch the rivalry that will be created between the different provinces in this connection. I know that appears to be the spirit now, and it is surprising to find that one of the prairie provinces was the first to have its general plan filed under the Act.

This great movement is going to be one of the best investments which Ontario or any other province can make so long as they are careful in the design of their scheme and see that the work is wisely planned and that the money is cautiously expended. If this is done, you will receive the heartiest co-operation from our department and the least possible interference consistent with good management and good work.

STREET PAVING IN TOWNS AND VILLAGES*

By E. A. James
Chief Engineer, Toronto and York Roads Commission

ECONOMICAL municipal administration, inexpensive transportation, convenience and cleanliness demand paved roadways in towns and villages just as surely as present-day commerce required railroads. The building of provincial highways to the limits of towns and villages creates a new demand for pavements in the urban districts which must be met.

Unfortunately we have not been planning for pavements as we should. Streets have been graded, sidewalks laid, shop and dwelling entrances constructed without any regard to future paving schemes, and the grade line must be struck if the pavement is to be either economical of construction or easy of travel.

In every town and village in which the writer has supervised paving work, the cost of taking care of improperly constructed sidewalks and haphazard doorsteps has been many times the fee that would have been required to pay for proper plans when the street was first graded or sidewalks laid.

Preparing Plans and Profiles

A survey for pavements should usually cover not only the street to be paved, but the streets intersecting and the drainage area tributary to the street defined. Following this general plan, a detailed survey of the street should be made. In making this survey, the building line, street limits, sidewalks, poles, hydrants, trees and other obstructions should be accurately located. In the roadway itself, sewer, water, telephone and electric light manholes should be located as to position and depth.

Careful measurements should be made of existing water outlets, such as culverts and old drains, and this information carefully plotted to a suitable scale, preferably 40 ft. to the inch. On the profile will be shown the elevation of the doorsteps on both sides of the centre line, the sidewalk elevation and the elevation of intersecting streets. For the profile, levels should be taken every hundred feet, or more frequently if there be a marked change in the elevation

Broken Stone Base for Bituminous Road, Penetration Type, Mimico, Ont., Showing Depressed Curb

of the ground, at the centre, quarters, curb line and 2 ft. back of the curb. These levels will, in addition to giving a profile, serve as a basis of calculating the quantities.

Alignment

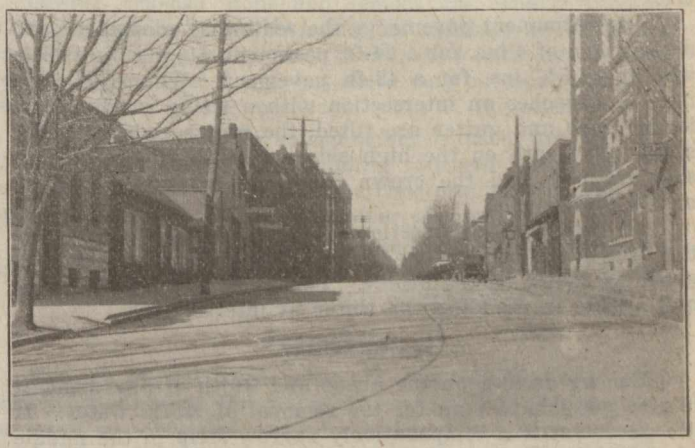
The alignment of roads in towns and villages is usually within such confined limits as to admit of little variation, the controlling points usually being the telegraph and telephone poles, electric light poles, fire hydrants and tree lines. With these controlling points fixed, the only consideration is that of safety and the expense of construction.

Of course, when possible, the centre line of the pavement should be the centre line of the street, although on streets which have a different elevation on either side, the centre line of the pavement is sometimes put off the street centre in order to assist in lowering or raising the curb line.

Grades

The grade established on the profile will, in most cases, be governed rather by the elevation of the steps of buildings than the traffic requirements of an economic grade.

Except in unusual circumstances, the maximum grade now used in towns and villages will be found to be 6%.



Orillia, Ont.—Note Elevation of Sidewalk at Right

This grade was established in the days when roads were built for horse-drawn vehicles, and in a rough way the streets were graded to a 6% maximum. The expense of lowering this grade, having regard to land damages, will usually be greater than any saving in transportation charges. It is not yet determined what grade is an economic grade for motor vehicles. The question is being carefully studied, having in mind the fact that the maximum grade for motor vehicles is the steepest grade that can be negotiated with minimum of power. Until motor vehicles are better standardized, there is not likely to be a very satisfactory solution to this problem.

At the beginning and end of all grades where the grade changes abruptly, vertical curves should be used so as to provide gradual change in direction, which is conducive to easy riding. If hauling were the only consideration, a level grade would be the most economical, but where the road surface is comparatively smooth this is not so important, as ordinarily a road surface causes greater resistance to traffic than the grade.

Width of Pavement

Having settled the alignment and the grade, the width of pavement should be the next consideration. The limit of width of vehicles operating on Ontario highways is 90 ins., so it will be seen that two trucks would theoretically pass on a 16 ft. roadway. Practically, however, due to the overhang, trucks might operate on 2 ft. less, so that theoretically an 8-ft. pavement would be sufficient for one line of traffic. When the traffic increases so that vehicles pass or meet one another at a greater rate than ten turnouts per hour, the pavement should be wide enough for two lines of traffic, or, for safety, 18 to 20 ft.; or perhaps better still, for two-line traffic, an 18-ft. roadway with 3-ft. shoulders on either side.

It is now customary to pave residential streets 28 ft. wide, as this permits two vehicles to be parked on either side of the roadway, leaving a width between sufficient for passing of other vehicles, and this also provides room for turning. Where the blocks are short and the traffic not dense, 24 ft. of pavement is sufficient.

On business streets where space may be required for three lines of traffic, streets are usually paved 36 ft. wide.

*Paper read at the conference of county road superintendents and engineers of Ontario, March 1st-3rd, 1920, Toronto, Ont.

This allows for delivery wagons to stand at the curb, leaving plenty of space for moving traffic, both slow and rapid, to pass through.

Crown

The crown given will depend upon the grade and type of pavement, and in a lesser degree on the personal preference of the engineer. Formerly, pavements were constructed with very high crown. This is not at all necessary with water-proof surfaces, whether bituminous or concrete. On the highly crowned pavements, three-quarters of the drop from the crown to gutter came between the quarter and the curb line, thus throwing extra strain on the wheel of vehicles. With bituminous materials built with a high crown, there is a tendency to creep to the curb, and because of this the first repairs usually are required along the gutter.

For permanent pavements, the writer has adopted a maximum crown of 4 ins. for a 24-ft. pavement, 4½ ins. for a 28-ft. and up to 5½ ins. for a 42-ft. pavement. When the pavement approaches an intersection with a rising grade across it, the curb and gutter are tilted, the centre remaining the same. The curb on the high side is raised and on the low side dropped, and the crown thrown over on the quarter on the higher side.

At pavement intersections it is good practice to raise the crown an inch or one and a quarter inches above the grade as shown on the profile. This adds to the appearance and assists in shedding the water at intersections.

Storm Sewers

Having decided on the grade and width of pavement, it is now possible to plan for the removal of storm water. If the pavement is a comparatively narrow strip in the middle of the highway, it may be possible to dispose of the water by open side ditches, but in towns and villages, the better practice is to construct the pavement with curb and gutter, and to provide for the removal of storm water by pipe drains provided with suitable catch basins and manholes.

The size of the sewer will depend upon the grade, distance to outlet and catchment area. It is good practice to design for the removal of 1½ ins. of rain per hour.

Where possible, it is best to locate the sewer outside of the curb of the pavement, more especially if the storm sewers and pavements are to be laid in the same year. Where this is not possible, and the sewer is laid under the pavement, great care should be taken in backfilling. As storm sewers do not need to be laid at a greater depth than 4 ft., this backfilling can be so made as not to endanger the pavement.

Selecting Type of Pavement

The selection of the most desirable type of pavement demands a knowledge of the characteristics and costs of available raw materials which go into pavement construction, together with a knowledge of the suitability of those types of pavements to the present and possible future traffic. In street paving, attention should always be given to aesthetic considerations, but among the various standard types of pavements that are now available, all, when properly constructed, have a pleasing effect.

A whole book might be written on the selection of a type of pavement, but just here reference will be made to a few of the principles that should govern selection.

Now that the Loads of Vehicles Act specifies the weight of traffic that may be carried, there is more definiteness than formerly in connection with the selection of foundation. A physical examination of the soil and sub-soil will have to be made to determine whether a concrete base 8 ins., 6 ins. or 5 ins. may be used, and experience only will guide one in forming an opinion.

It may be found more economical to use a consolidated broken stone base. It will usually be found that a rolled stone base should be 25% heavier than a concrete base. Conditions sometimes warrant reinforcing the concrete base. In fact, frequently, it has been considered more economical to add reinforcing than to add concrete when the soil and sub-soil are soft.

For a wearing surface one has a choice of concrete, bituminous-bound macadam, bituminous concrete, sheet asphalt, bitulithic, brick, block, etc., each having merit when traffic and local materials are considered.

Last season the writer laid several miles of bitulithic, using a gravel aggregate, because near the town where we were paving there was a large and inexpensive gravel deposit. In our 1920 work, we expect in at least two towns to build 50,000 sq. yds. without using a ton of stone, and in each case bituminous binders will be used.

Local materials are going to be more than ever in demand, because of the present high, and the probable future higher, freight rate.

Of course in selecting the type of pavement, one must have regard to the grade, as some of the more economical pavements are very smooth and slippery. The use of bituminous concrete or sheet asphalt up to a 4% grade is quite permissible. Bituminous macadam up to 7% will be found to give good traction, and water-bound macadam up to 12% can be negotiated without great difficulty.

Financing

The method of financing street paving in towns and villages varies all the way from the whole cost being borne by the municipality to the municipality paying but 2%.

Paving may be undertaken as a local improvement, either on petition, on the initiative or on the forced local improvement as provided in section 9 of the Local Improvement Act; or the council may submit a by-law to the people to raise funds for paying for all the pavement or part thereof.

A canvass recently made of 26 Ontario towns showed that in 66%, the abutting property pays all; in 8%, the abutting property pays 50%; in 24%, the abutting property pays more than 50% and less than 60%; in 2%, the municipality pays all. It might be pointed out that these percentages include the street intersections and flankages which the Act requires the municipality to pay.

The directors of the Dominion Steel Corporation met at Montreal last week and discussed the recommendations made by English engineers, involving an outlay of approximately $25,000,000 in the development of the corporation's plants and properties.

W. M. Irving was re-elected president of the Montreal branch of the Association of Canadian Building and Construction Industries at the annual meeting held last Monday afternoon. Other officers elected were as follows: First vice-president, K. D. Church; second vice-president, F. J. Parsons; third vice-president, Jas. K. McNutt; hon. secretary, John C. Watson; hon. treasurer, J. E. Walsh. Directors—W. C. Munn, J. P. Anglin, John Quinlan, C. M. Morssen, Douglas Bremner, T. Latourelle, J. J. Roberts, Fred B. Locker, A. W. Bermner, A. T. Alexander, Wm. McNally, J. M. G. Lockerby and John Grieve.

At a meeting of the Windsor, Ont., council held last Saturday evening, it was decided that a board of three consulting engineers should report on the proposed joint water works scheme for the Essex Border municipalities before the council would accept its share of the cost of the scheme as outlined by Morris Knowles, Ltd., consulting engineers to the Essex Border Utilities Commission. The Windsor council appointed E. M. Proctor, of E. A. James Co., Toronto, as its representative on the board of consulting engineers; the Essex Border Utilities Commission has appointed its chief engineer, Morris Knowles; and the city of Walkerville will appoint the third engineer. This board will investigate and report whether it is advisable to continue a separate water works for each of the seven municipalities interested, or whether they should all be merged in one system as advocated by the Essex Border Utilities Commission, or whether the city of Windsor should be asked to supply the entire district with water, which that city has offered to do. Meanwhile, Windsor has withdrawn its appeal to the Ontario Railway and Municipal Board.

CONCRETE ROAD CONSTRUCTION*

By H. E. Davis
Assistant Engineer, Department of Public Highways, Province of Ontario

CONCRETE pavements present many characteristics totally unlike other forms of the more permanent types of pavement. A concrete pavement has a hard, rigid, monolithic surface and is properly to be classed as sheet pavement. Practically all the other forms of rigid-surface pavement are of block type while all other types of pavement are somewhat resilient. The fact that concrete pavements are composed of large, monolithic slabs, makes it necessary to consider certain features of construction not usually important in other forms of pavement.

The strength of concrete to resist stresses of all character depends on the strength of the matrix or mortar holding the aggregate together, assuming of course, that we use an aggregate of sound, hard particles. The concrete being made of various size particles, it is necessary that none of them be loosened under the action of climatic or traffic conditions.

Preparation of Subgrade

It is practically impossible to formulate specific directions for the preparation of subgrades, that will be of general application. Every section of road involves problems that are complicated by financial, geological and physical conditions, each of which must be treated in conjunction with the completed aim. The necessity, or at least the desirability, of spending more time and money upon thorough preliminary investigation cannot be too strongly emphasized. Such expenditure is in the end a real economy.

The most common cross-sections of subgrade are as follows:—

1. Subgrade parallel to wearing surface.
2. Subgrade crown somewhat less than concrete wearing surface.
3. Flat subgrade. In this case the crown is given by varying the thickness of the concrete. This is the one most generally used.

Whatever form is used, however, the sub-base should be made of uniform texture and should be finished true and kept true to the specified outline—that is, free of tracks, holes and ruts—until the concrete is laid.

Shoulders

Experience in various localities with shoulders along concrete roadways has been variable. This is without doubt due to the variation of traffic, as regards kind and density. Where shoulders will not stand up under the turn-out of traffic along a concrete road, an additional width should be considered, or the use of a crushed stone shoulder is recommended. The width of shoulder to edge of embankment should not be less than 4 ft.

Crown

Unlike some types of pavement, concrete surfaces are undamaged by water unless it finds its way into the subgrade. Theoretically, with perfectly surfaced concrete, only a slight side fall is required. Data that is available would indicate that in case of uniformly thick pavements, the amount of centre longitudinal failure, has varied directly with the amount of crown. With few exceptions, the crowns most generally used range between 1/65 to 1/100 of the width of the pavement.

Grades

There would appear to be no reliable information on the relative slipperiness of concrete pavements. Generally speaking, concrete road is less slippery than other classes, especially after only a slight rain has fallen. It would appear that it is a matter of placing the concrete on the grades rather than a problem of grades.

Thickness

Specifications generally call for concrete roads 6 to 8 ins. thick. It should be borne in mind that owing to the monolithic structure of concrete, it is necessary to have the cross-section true to grade so that additional concrete need not be employed to fill the depressions and uneven places in the subgrade.

Handling and Hauling Materials

Materials to be handled for concrete road construction are as follows: (1) Gravel and crushed stone; (2) sand; (3) cement; and (4) water.

Gravel, crushed stone and cement are usually handled by wagon, motor truck or industrial railway, all of which prove satisfactory within their limits. The difference in cost ordinarily seems not great, but there may be conditions that justify a choice of one method in place of the others.

Water, it should be remembered, is used for at least three essential purposes in building concrete roads: (1) To wet the subgrade; (2) to mix the concrete; (3) to keep the concrete moist for several days after placing.

The average requirements based on available figures would indicate that approximately ¼ to ¾ of a ton of water is required to construct 1 cu. yd. of concrete.

Aggregates

Success in the construction of concrete highways will largely depend upon the materials used. All roads, permanent types or otherwise, must be designed and built to withstand three different destructive agencies—traffic, weather and structural stresses. The wearing resistance of concrete roads subject to given conditions of traffic and weather, will depend upon the following factors: (1) The properties of the concrete materials; (2) proportions and consistency of mix; (3) thoroughness of mixing; (4) method of placing; (5) surface finish conditions of seasoning; and (6) age of concrete.

The aggregate constitutes 75% to 85% of the material in concrete roads, hence the resistance to weather and traffic and the final integrity of the structure depend largely on the aggregate and the way in which it is incorporated.

Sand

For concrete road construction generally, the sand that is used is much coarser than that used in building construction. The purpose of using coarse sand is not only to obtain strength and density, but to prevent the formation of a thin layer of fine sand and cement near the surface.

Sand should be free from vegetable or organic matter. Frequently sand will be entirely satisfactory in appearance and yet be worthless for concrete. Defective sand may be taken from too near the surface of the deposit, or a quantity of vegetable matter may be allowed to mix with the sand due to carelessness in regard to keeping the pit clean. In most cases, deposits show a distinct line of demarcation between the section containing vegetable matter and that of the clean aggregate, and the former should be entirely removed before an attempt is made to load the material.

The voids in aggregates are largely a function of the shape and grading of the particles. Low voids should be secured, since the strength and the working ability of the concrete will thus be greatly improved. A well-graded natural sand, with coarse aggregate screened out, will show voids as low as 25%; in a poorly graded sand, the voids may be as high as 38%. The voids in crushed stone frequently run to 50%.

Gravel

The use of gravel in the most recent specifications calls for screening into sand and gravel, then recombining in proportions according to voids. Pit-run gravel generally contains sand in excessive proportion to gravel. If gravel contains 40% sand and very rich mix is used, say, 1: 3½, a fair concrete can sometimes be produced, but it is always cheaper

*Paper read at the conference of county road superintendents and engineers of Ontario, March 1st-3rd, 1920, Toronto, Ont.

in such cases to screen the gravel and re-mix the sand and stone in proper proportions. In this particular instance there will be a saving of ¼ barrel of cement per cubic yard of concrete by using proportions of 1: 2: 3; also the resulting strength may be increased.

Stone

The stone should be clean and contain hard durable particles from limestone, granite trap, conglomerate gravel or other hard rocks free of dust and organic matter.

The sizes of stone called for in concrete road construction require little screening and only those screens need to be used that will obtain a stone that will pass a 2-in. ring and be retained on a ½ or ¼-in. screen.

Mixing

The concrete mixers generally used are those of the batch type, provided with traction-driven power loader and automatically regulated water tanks. Mixers with boom and bottom-dump buckets of sufficient size to convey one complete batch, are those most commonly used and specified.

The filling of the skip is accomplished in practice in two ways: Shovelling directly from supply piles or loading from wheel-barrows. The former means, however, is generally discouraged, as accuracy is impossible; besides, the entire loading gang loses time waiting while the skip is raised and lowered. In all cases the drum should be completely emptied before the next skip of material is dumped into the mixer.

Proportioning

The question of correct proportions for concrete is being taken up in practically every laboratory in Canada and United States. The result of investigations accomplished so far indicate that unsatisfactory concrete will result from even the best aggregates if they are not properly proportioned. The recommendation of 1: 1½: 3 or 1: 2: 4 mix must be considered only general, and it is most essential that the material for use be thoroughly tested in the laboratory before use in construction.

Consistency

The question of correct consistency is, in most instances, treated with the proportioning of aggregates, as this combination results in the best concrete. Most engineers prefer dealing with the question of consistency first and allowing the question of proportion to be dealt with afterwards.

A scheme that was used on the work with which I am most familiar, proved to be of great value in keeping the consistency constant. The method was to place a shovelfull of green concrete at one end of an inclined board and note whether it would flow when the board was at the angle at which concrete of the best consistency should flow as predetermined by laboratory investigation.

After heavy rains, stock piles absorb a considerable quantity of water, but with the scheme mentioned above it is quite easy to keep the same consistency throughout the work. It requires very little time to determine the right angle and the method has the advantage of keeping the water content of the mixture fairly constant, and assists in placing and finishing.

Joints

Studies have been made of various slab lengths under various weather and subgrade conditions, and it would appear that on sandy subsoils, the slab length can be lengthened to 50 or 60 ft., and on clay subsoil to 35 or 40 ft. The more recent tendency, however, has been to increase the slab length to 70 and 80 ft. for sandy subsoil, and to 40 to 50 ft. for clay subsoil. This is a matter that should be given due consideration, as climatic conditions and temperature changes such as we have here in Ontario must be taken into account.

Reinforcement

It is generally recommended that reinforcing be placed in concrete roads over 20 ft. wide.

The amount of reinforcement to be used per square yard should be determined by an engineer familiar with local conditions. The temperature range and percentage of moisture vary with each locality. It is evident, therefore, that each roadway must be studied to meet these conditions.

Finishing

Prior to finishing, it is essential that the surface of the concrete be brought to the proper grade and cross-section. The manner of doing this will depend primarily upon the width of the road and whether side forms or curbs will be used to guide the strike board.

Curing

During hot weather it will usually be found necessary to cover the surface of the finished pavement with canvas as soon as floating or belting has been completed, as covering assists in keeping a more uniform temperature over the finished work, which results in increased strength and assists in giving a better wearing surface to the road.

The process of curing involves two distinct features: (1) Protection until the concrete has reached its final set; and (2) protection after final set.

In the first instance, a canvas is supported over the road by means of portable framework, 2 ft. above the surface. For protection after final set, the canvas is removed and the concrete covered with earth or other water-retaining material. This covering should be at least 2 ins. thick and should be kept thoroughly wet for a period of from 10 to 14 days.

Superintendent Archibald of the Water and Light Department, Woodstock, Ont., whose salary is $2,790 per annum, has refused a proffered $300 increase.

It is stated that the Hydro-Electric Power Commission of Ontario will require $17,000,000 this year from the provincial treasury for the construction of radial railways and the development of water powers in eastern and northern Ontario.

The seventh annual convention of the Canadian Good Roads Association will be held June 1st, 2nd and 3rd in the Royal Alexandra Hotel, Winnipeg. These dates were finally decided upon at a recent special meeting of the executive of the association.

Sam. G. Porter, of Lethbridge, has been chosen temporary chairman of the "Association of Professional Engineers of Alberta," which association has been formed by the Alberta members of the Engineering Institute of Canada for the purpose of introducing the institute's model bill in the Alberta legislature. R. J. Gibb, of Edmonton, will act as temporary secretary.

In the article appearing on page 267 of last week's issue, entitled "Reorganization of the B. Blair Plant," it was announced that McCracken concrete pipe is now being used in Ontario by the cities of Galt, Guelph and Woodstock, and by the Toronto Harbor Commission. Mention of the city of Galt was a typographical error, as the list should have read: "London, Guelph, Woodstock and the Toronto Harbor Commission."

The Administrative Commission of Montreal have sent copies of the aqueduct report recently presented by R. S. & W. S. Lea to the Board of Trade, Chambre de Commerce and the League of Proprietors for their consideration. Messrs. Lea outlined the possibilities of three alternative schemes for the use of the aqueduct, and the commission desire the advice of the above-mentioned civic bodies before proceeding with any one of the three schemes.

D. H. McDougall, retiring president of the Canadian Mining Institute, in his presidential address at the 22nd annual meeting of that association, held this week in the King Edward Hotel, Toronto, said that no Canadian government has ever given a worthy appropriation to the Geological Survey. "The governments have placed an inadequate number of workers in the field," said Mr. McDougall, "and have given them an inadequate appropriation. The department has not been appreciated in its true worth."

Should Professional Engineers Organize Union?

The Affirmative and Negative Sides of a Debate Held by the Toronto Branch of the Engineering Institute of Canada

Yes—

declares WILLIAM SNAITH

ACCORDING to the new dictionary of the English language, a union is a combination of co-laborers for the joint and mutual protection of their specific trade; unionism is the principle of combining for unity of purpose and action; a labor union is an association of wage workers in a trade for advancing their mutual interests; a trade union is an organized association of workmen skilled in any trade or industrial occupation, formed for the protection and promotion of their common interests, especially the increase of wages, better conditions, shorter hours of labor, mutual insurance, etc.

An engineer is defined in the Century dictionary as one versed in any branch of engineering; one who runs or manages an engine. Engineering is there defined as the science and art of making, building or using engines and machines, or of designing and constructing public works or the like, requiring special knowledge of materials, machinery and the laws of mechanics.

These definitions are more or less general and it would not be too much to say that the Engineering Institute of Canada is a union within the definition of a union as a combination of co-laborers for the joint and mutual protection of their specific trade, if we concede that trade is not very much different from profession.

Unionization, I do not doubt, conveys to your minds, as it does to mine, a more definite idea than the general one I have mentioned, and for the purposes of this discussion I think we shall agree that we mean what a labor leader would understand by unionization—i.e., a union of engineers for the joint and mutual protection of their profession and the promotion of their common interests, especially the increase of salaries and bettering of conditions; and to make the case more clear-cut, let us include the right of engineers to use unionism's final weapon in the securing of its demands,—the right to strike.

> *"Unionization is advisable, practical and necessary.*
> *"It is founded on correct principles.—If we do not hang together we will hang separately.*
> *"Salaries can be raised by unionization.—Engineering salaries are lower than those in a number of trades.*
> *"There is a stirring in the dry bones of the national engineering societies, but I cannot say that I think anything will be done."*
>
> WILLIAM SNAITH.

Introduction

Having cleared the way by the definitions, my proposition is to prove that the engineering profession should be unionized, and I should like to do this under three headings: (1) That it is advisable; (2) that it is practical; and (3) that it is necessary.

Unionization is advisable in the first place because it binds together by strong ties, such as self-interest, co-op-

(Continued on page 283)

No—

says Prof. PETER GILLESPIE

TO those whose interests are more or less identical, the value of having some form of organization for mutual advantage and for collective and individual protection, is generally conceded. The slogan, "Each for all and all for each," has exerted a powerful influence on men from the earliest times; moreover, this disposition is entirely defensible and worthy of the support and encouragement of fair-minded men.

Workmen have formed trade unions,—local, national and international. Experience has taught them that while the voice of a single worker is seldom heard in the din of modern industrialism, the united demand of a thousand is accorded a respectful hearing; hence the attempt on the part of labor to lay down the conditions under which its members may be employed, its attempts to stipulate the minimum wage which its employer must pay; its efforts to fix the number of hours that shall constitute a day's work, and finally its refusal (often successfully enforced) to work with men not of their affiliation or to handle goods or material produced by workmen not similarly unionized.

> *"It would be impossible to get more than half the engineers to support unionization.*
> *"By unionizing, engineers would prostitute an ancient, honorable and respected calling to the level of a trade.*
> *"To unionize would be to declare that we possess nothing distinctive in education . . . or capacity.*
> *"Legislation will secure everything that unionization could."*
>
> PROF. PETER GILLESPIE.

Desire to Improve Solidarity

This last attempt at control is an illustration of the desire of labor to improve its solidarity and to extend its power through the organization of national bodies where craft distinctions are not recognized. These are attempts to unite all workmen, irrespective of occupation, under one banner so strong, so thoroughly loyal and so alert to the interests of its members, that no employer or group of employers will be able to refuse its demands or successfully oppose it. To enforce its demands it has recourse to the strike, local, general and sympathetic. Men who have no grievance themselves are sometimes called out in order that the members of another craft in another locality may be assisted in securing whatever concessions they may require.

There are also associations of manufacturers, employers' associations, councils for industrial defense and what not, the objects of which are to resist what are thought to be the unreasonable demands of the labor unions and to defend themselves against their untrustworthiness and legal irresponsibility. These have advocated the placing of full legal accountability upon labor unions so that duties and responsibilities as between employers and workers might be reciprocal and equal. Generally they have been opposed to strikes and lockouts and in favor of an amicable and equitable ad-

justment of differences with employees, preserving the rights of both parties. By injunctions they have fought the boycott and through representations to legislatures they have opposed vigorously its legalizing. They have sought, generally by lawful means, to aid the regularly constituted officials and machinery of the state in the enforcement of existing laws and the punishment of law-breakers.

Strikes Undignified and Unethical

Thirdly and finally, there are the so-called professions, a profession being generally understood to be an occupation involving a liberal education or its equivalent, and mental rather than manual labor. The professions, too, have their associations for professional advancement and for individual and collective protection. One function is the dissemination of professional knowledge; another is the control of the educational qualifications of their members and the admission to their ranks. They discipline their members for breaches of professional ethics and etiquette and for unprofessional or immoral conduct. They have a code of ethics and keep a tariff of fees for professional services which can usually be collected in courts of law. They are recognized by statute in that there are certain services which by law must be performed by members of these professions, and by them alone. They seldom or never resort to the strike. To the professional man the strike is undignified, unethical and unnecessary.

Men engaged in the so-called learned professions have always been held in high esteem individually and collectively in civilized communities, for several reasons. They are usually men of attainment and culture; as a class they identify themselves with the life of the community in which they dwell. They are usually men of exemplary character and conduct and while in many cases their fees are large, there are many instances in which members of the professions have rendered valuable professional services for individuals and communities for which no remuneration was received and none was expected.

Unionism's Autocratic Disposition

Between the trade union and the profession there are, then, resemblances and differences. Each endeavors to promote the social and material interests of its members. Each controls or endeavors to control the admission to its ranks and to fix in some degree the rewards which the services of its members can command. The trade union has no code of ethics. Because of the large number of its members, it must command support by more or less autocratic measures. When disputes arise regarding hours of labor, working conditions or wages which do not seem capable of settlement by negotiation, the union has recourse to the strike to force the concession it demands. But strikes cannot be made effective if other men are permitted to take up the tools laid down by the strikers, and a strike involves picketing, persuasion, intimidation and often violence. To force the "unfair" employer to see the error of his way, the boycott is adopted, whereby his shop and its product are declared to the world to be unfair and shunned by all friends of labor. In certain cases the strikers resort to sabotage, or that species of direct action where expense and trouble are made for the employer in order to force his hand.

Engineering is an occupation requiring on the part of those who practice it, more than an ordinary amount of intelligence. It is an occupation in which the empirical gives place to the analytical to a much greater extent than in many lines of human endeavor. On the products of its work, the lives and fortunes of humanity depend. It boasts great traditions. It has tunneled the mountains, bored beneath the sea, conquered the air, made the desert to blossom as the rose. With the work of Watt, Stephenson, Smeaton, Roebling and Baker constituting the background of its history, the engineering profession has a record for achievement surpassed by no other. And with the increasing number of new applications of technology to the carrying out of the world's work, no profession has a future of greater usefulness.

It is a truism that engineers have not been accorded the recognition to which their work entitles them, nor have their emoluments in general been commensurate with the service they render. Like Kipling's immortals, their reward too often is the joy of working, and with Berton Braley, they can say:—

"Though we like our share of treasure and the pleasure that it brings,
It is something else that drives us to our goal;
It's the triumph of our labor over elemental things,
And the vision which gives splendor to the whole.
We are members of an order that is guided on by dreams,
By the voices of the prophets and the seers,
And unless you care for service more than money-getting schemes,
You had better never join the engineers."

Being human, engineers naturally aspire to a few of the better things of life. To attain them some have proposed unionization; others, that they seek incorporation so as to acquire the legal status of other professions. The results of unionizing would probably be these: There would be a minimum scale of pay; a day's work in hours and in output would be defined, and the closed shop would follow.

"Closed Shops" Among Engineers

The unionized engineer must support his union otherwise his union ceases to function, for who among engineers would support a union that could not conserve for its members the work and the pay that are available? He must therefore refuse to work with non-union men; indeed he must either coerce them into joining his union or he must eliminate them altogether. All engineering offices must therefore be closed to the non-union man.

The unionized engineer further must boycott all equipment, structures or plant tainted by non-unionism. The chief engineer of the Hydro-Electric Power Commission, for example, could not recommend to his commissioners the acceptance of tenders for turbines, motors, transformers or transmission towers upon which non-union engineers had been employed. The chief engineer of the Department of Railways and Canals would refuse to consider tenders for bridges unless the designs were by unionized engineers. If this seems fanciful, just reflect that any union that does not embrace the great body of the craft workers must fail of its purpose. The necessary means to this end are the closed shop and the boycott. And to these a very large number of engineers who object to unionizing on principle, and most of the employers, are opposed. It would be intolerable to free men everywhere. Government departments and government commissions, both large employers of engineers, would have both the power and desire to fight it, and they would. It would be bound to fail.

Coerciveness vs. Fine Sentiments

Finally, how would one reconcile the coercive methods of the union with that fine sentiment appearing monthly on the front page of the institute's journal which asserts that the function of the institute is "to develop and maintain higher standards in the engineering profession and to enhance the usefulness of the profession to the public?" Or, how could one square it with the definition of the illustrious Tredgold that engineering is the adaptation of the great forces in nature to the use and convenience of man?

Let us consider what the effect on the average citizen would be if he learned that the physicians or the clergymen or the editors of his community had become unionized and had adopted the tactics of unions. Would he feel that they had exalted their callings? Could he bring himself to believe that such a step would be consistent with the professions of men who shape to some extent the intellectual well-being of a community? I am afraid he could not. And similarly for engineers, unionization would be a fatal blunder.

But another, and a better way lies before. Engineering may become a profession, since it is unwise to become a trade. Engineers might have had legal protection ere this had they been less silent, and I believe that they can get it to-day if

they go after it in the right way. With hundreds of educated, bright and capable men in its ranks, with men of vision and capacity among its members, with a record for fine service in the past and an outlook for greater usefulness in the future, no government will refuse to grant to engineers what it has already granted to physicians, lawyers and dentists. Chartered accountants have acquired a measure of legal status where a few years previously they had none, simply by concerted, articulate transactions. Dentists, whose occupation is manual and mechanical to a very large degree, have obtained the professional status because they presented their case to a public that was open to reason and was prepared to act soon it was convinced. As engineers are we willing to become a trade union where we might be a profession? Are we willing to sacrifice our birthright for a mess of pottage? Are we going to grasp the shadow when we might have the substance?

A policy of coercion will fail where enlightened publicity and judicious propaganda will succeed. There is a story of a man who was night after night disturbed by a howling dog in front of his house. One night, no longer being able to endure the racket, he ran out in his nightshirt to silence the dog, in spite of the fact that it was bitterly cold. When he failed to return in an hour, his wife went out to look for him. She found him full length upon the snow, stiff and cold, holding on to the dog's tail. "What in the world are you trying to do," she asked. In a weak voice he answered: "I am freezing the damned thing to death." Had he been as resourceful as he was patient, he might have found a better way out of his trouble.

Summary

I am opposed to the unionizing of engineers: (1) Because I believe it would be impossible to get more than half the available membership to support unionization.

2. That being the case, in order that the advantages of unionization may accrue to the unionized membership, it will be necessary to enforce the closed shop.

3. The strike and sympathetic strike are means of coercion which we as engineers cannot entertain. It is entirely possible that because of dissatisfaction in one section of the country, all engineers, regardless of classification or locality, would be called out, although they might have no grievance of their own. And just here let it be stated that nothing has alienated public sympathy from labor unions in the past quite as much as the sympathetic strike.

4. Another sequel to this will be that unionized engineers must refuse to recommend or instal any appliance upon which non-union engineers have been employed.

5. The engineers of Canada now have in the Engineering Institute and other allied associations everything that they might hope to secure by unionization except whatever might accrue through the strike as a weapon.

6. By unionizing, engineers would prostitute an ancient, honorable and respected calling to the level of a trade. By endorsing the coercive method, we would accept the creed that between those who perform expert service and those who profit thereby, there is inevitable warfare, and that an appreciative public opinion does not exist. This, in my opinion, is not borne out by the facts.

7. We would be ignoring the principle that interests of the general public are greater than those of either employer or employee.

8. I believe that legal protection for engineers in Ontario is attainable, for I refuse to believe that from a government that grants protection to dentists and veterinary surgeons, that taxes the consumer in order to bonus a desirable industry, that refuses to tolerate the unqualified teacher in the humblest of our rural schools, the protection of professional engineers cannot be obtained. Further, that if it be not obtained, the fault will be ours, not that of the public or the public's accredited representatives.

9. I believe that the use of a crude weapon is usually an acknowledgment that the user cannot command a finer one. I believe that to unionize engineers would be to declare to the world that we as a class possess nothing that is distinctive or worthy in education, training, attainments, traditions or capacity for altrustic endeavor.

10. While neither the unionizing nor the professionalizing of engineers will ensure work where work is not to be had, nor fees where consulting services are not required, I believe that the latter will secure everything that the former will obtain, and with infinitely greater credit to engineers as a class, and with their almost unanimous approval.

"YES," DECLARES WILLIAM SNAITH

(Continued from page 281)

eration and the like, and in the second place because in union there is strength.

It is practical because it has already produced results among engineers and because it has produced results among other callings.

Unionization, in the third place, is necessary for six reasons: (1) Salaries are too low and can be raised; (2) because the world needs engineers and is not likely to get them unless salaries are raised; (3) it is necessary, very necessary, because other agencies have failed; (4) unionization has never failed in the long run; (5) unionization is necessary because, as was said in the old "tea-party" days, if we do not hang together we shall hang separately; and (6) it is necessary because it is founded on correct principles.

Unionization is Advisable

As to the advisability of unionization, the statement that it binds by strong ties, and that in union there is strength, call for little in the way of proof, and it would be necessary to place before you a concrete proposal for the formation of a union, let us say affiliated with the American Federation of Labor, before it would be worth while to amplify this phase of the subject. We shall probably reap more benefit by proceeding to our other points.

Unionization is Practical

I have said that unionization has produced results among engineers, and as proof I would submit that in the International Federation of Technical Engineers and Draughtsmen, affiliated with the American Federation of Labor, there are over 4,000 civil, electrical and mechanical engineers, besides some 3,000 naval architects and a few thousand draughtsmen, all highly trained, technical men, graduated from almost every university in America. There are 39 unions, scattered over America from coast to coast. In the National Federation of Federal Employees, which is also affiliated with the American Federation of Labor, there are more than 5,000 civil, mechanical and mining engineers, besides some 6,000 school teachers and 55,000 others, among whom are many professional men and women. The Chicago union has grown to such a point that the architectural men in the union expect this year to have the union label used on all plans and specifications, and they further expect to be backed up in this by the Building Trades Council, so that no union men will work from any but union label plans.

Some will almost instinctively oppose such an action, but the proposed legislation which the Engineering Institute is apparently anxious to secure, is based on the same fundamental principle.

Unionization is practical because it has produced results among other callings. A classic example of this is the pay of bricklayers; but the locomotive engineers and firemen, together with the other great "brotherhoods," are a still better example on account of the high tone which they have managed to give their organizations. I need not go into details in this connection. It is not pleasant for engineers to read a statement of salaries paid to the operating department of the railways and contrast it with that paid to engineers.

Unionization is Necessary

1. Unionization is necessary because salaries are not only lower among engineers than among a number of trades, but they are actually and positively too low, regardless of

what these trades may be getting. I hardly expect to be called on for proof of this point and I do not wish to "rub it in."

That salaries can be raised by unionzation need only be stated to be adopted. It is, of course, assumed that engineers will stick together and work together. If they do not, they have abandoned the principle of unionization and it cannot help them.

2. Col. Leonard, the retiring president of the Engineering Institute, has emphasized a point that has been made before,—that the world needs engineers at the present time and that it needs them very much indeed. But the world is not going to get engineers, as such, unless it pays them better to be engineers than to be something else, and the world is offering engineers much greater rewards as salesmen and managers than it is as engineers, and this not at all necessarily because their training fits them as salesmen or managers or such like, but for the simple reason that the world is accustomed to paying better salaries for these positions than it does for engineering positions.

Other Agencies Have Failed

3. Unionization is necessary because other agencies have failed. There is a stirring in the dry bones of a number of the national engineering societies of America and the members longingly expect that this time something will be done. I cannot say that I think so. It was pointed out very aptly by a writer in one of the technical weeklies that the type of man who is elected to office in these societies is not the type of man who can be expected to be very much interested in the salaries of the junior members of the profession. (And right here let me say that I have always considered that the salaries paid in the higher branches depend very much on those paid to the juniors in the profession.) The writer to whom I have referred points out that if the railway brotherhoods had elected as their presidents, the presidents of the Pennsylvania and New York Central railways, the negotiations between the brotherhoods and the railways might have been conducted with more diplomacy than they were, but the results as affecting salaries would not be comparable to what they have been under the methods adopted. Being interpreted, this means that when you elect as the president of the Engineering Institute one of the wealthiest men in Canada, you will have a splendid president, but you should not expect too much in the way of increased salaries. I mention this merely to indicate one of the reasons why existing agencies have failed in the past and will probably fail in the future.

Unionization Has Never Failed

4. Unionization has never failed in the long run. This is a strong statement, but it is abundantly justified. The Brotherhood of Locomotive Engineers has never lost a strike in its history and has not had a strike in 25 years or more. This record is probably not equalled by any other union.

Unions are fallible and make mistakes and get beaten for them. It is not surprising that union leaders should make mistakes. They are not generally expected to be men of great education, and the history of the labor union movement is such that it is not surprising if some of their leaders should go to extremes.

Less than 100 years ago it was a crime for a man to belong to a labor union, and within the lifetime of men still living, people were sent to prison for such an offence. The right of collective bargaining is not even yet universally conceded, and practically every advantage which the unions possess at the present day has been the result of battle after battle.

Because other unions have made mistakes in the past, it does not mean that a union of engineers need repeat such mistakes. If engineers unionize, it will not be too much to expect that they will act in a gentlemanly and professional way. They have handled the powers of nature in the past in a way which has been creditable to the profession, and it is not to be expected that when they secure the use of powers to which they are abundantly entitled, and which will redound to their own advantage, that they will not use these powers wisely.

5. Unionization is necessary because if we do not work together, we shall, as we have proved many times in the past, get nowhere. As it was said at the time of the American Revolution, we must hang together, for if we do not hang together it is perfectly certain that we shall hang separately. We have certainly hung separately in the past, because we have used a minimum of co-operation. This condition we must change, and the change must inevitably be in the nature of unionization.

Founded on Correct Principles

6. Unionization is founded on correct fundamental principles. A practical proof of this exists in the fourth point, which I have made before. Unionization has never failed in the long run. I might preach a sermon under this head from the text "Ask and ye shall receive," and in that case I would particularly emphasize the word "ask." There is a vast difference between asking and begging. It is a different thing to ask knowing that your request will receive serious consideration because several hundreds, if not thousands, of others are asking for the same thing at the same time, from what it is when you ask knowing that you are asking for yourself alone.

These particular arguments are valuable but they are not as fundamental, perhaps, as following the reasoning of the political economists. The economists state that there is a fund from which labor and capital draw their resources. This fund is circumscribed to this extent, according to the economists, that if labor takes too much there will be nothing left for capital. Of course, on the other hand, if capital takes too much, labor will starve, and capital would for that reason be destroyed.

Only two conditions are possible with regard to this fund. It is either ample to take care of the demands made upon it by both labor and capital, or it is not ample. If it is ample, there is no question but that engineers should receive their fair share. If wages have gone up—and surely nobody will deny that they have—the salaries of engineers should have gone up in the same proportion. I do not need to prove that they have not.

Let us suppose, however, that the fund is not ample,—that there is not enough wealth in this fund for everyone. In this case I believe that the engineer should get his share first by reason of his education and ability.

I am reminded of Æsop's fable of the bat, which I should like to quote for the benefit of the engineer who feels that he should not be classed with labor. The mice asked the bat to be their king and were turned down with a certain amount of indignation by the bat, who said that he was a bird; and to prove it he flew over to the birds, who laughed at him and assured him that he was not a bird. The bat flew back to the mice to be a king, but the mice had elected a king and would no longer have anything to do with the bat. If the engineer feels that he is an ally of capital, is it not possible that he may be giving up his position as king of labor?

Conclusion

Unionization is advisable, practical and necessary. There are many minor points that I have not touched at all; probably the first objection that anyone makes to the subject of unionization is that it is not professional, or that it would lower the dignity of the profession. Over 15,000 engineers who already belong to unions disagree with this stand and I cannot find it consistent myself with the definitions which the new dictionary of the English language gives of the words profession and dignity.

"Profession" is an occupation that properly involves a liberal education or its equivalent, and mental rather than manual labor; hence any calling or occupation involving special mental and other attainments or special discipline.

"Dignity" is defined as grave or noble bearing, impressiveness of manner or character, repose and serenity of demeanor, the state or quality of being excellent, worthy or honorable.

I believe that an engineer in a union can be as impressive of manner or character as the best engineer outside of a union, and I think the unionized engineer would be equally excellent, worthy or honorable.

I believe that the profession of engineering after unionization would still involve a liberal education or its equivalent, and mental rather than manual labor, and that it would still call for special mental and other attainments, or special discipline. In other words, I do not believe that the dignity of the profession would be harmed in any way.

I would like to go further and state that the dignity of the profession would be materially enhanced if engineers could be placed in the position that they could afford to devote some of their time and energies to matters outside of their calling, and in this I am not thinking so much of being able to go in for politics, but of such homely matters as educating their families. We are facing a condition at the present time where mechanics are better able to give their children college educations than are professional men.

I might have proposed a solution of what is undeniably a difficulty, and that is the grading of the various members of a union. In this connection I should like to say that there is more than enough material for discussion in this subject alone to take up an entire paper. If the principle is right the details can without any doubt be worked out. The first attempt may be a partial or complete failure, but the principle will eventually triumph.

I would not like anyone to get the idea that the principle of unionization can be adopted without a struggle and without individual loss and suffering. The first trades unionists faced prison sentences in fighting for their convictions. Later on, they drew down on themselves the ill-will of their employers. It was sufficient that a man belonged to a union for him to lose his job as soon as it was discovered. Some of these men must undoubtedly have had families who depended on them, and it must have been just as much a hardship for the carpenter or machinist who got on a black-list in a particular section and had to leave the town where he lived, as it would be for the engineer to pull up stakes under similar circumstances. Do I think that this would happen if engineers unionized? I have no doubt whatever that it would happen in some cases. I am satisfied that it would not happen to anything like the extent that it happened in the earlier days of the labor movement and still happens in certain sections where labor is struggling for a foothold.

Unionization does not offer engineers something which is easy, and perhaps for that reason, as well as for other reasons, it will attract them.

Toronto Engineers Demand Action on Salaries

Discussion on Unionization Debate Results in Adoption of Motion Urging Engineering Institute to Study Members' Economic Welfare

At a meeting of the Toronto branch of the Engineering Institute of Canada held last Thursday evening, there was a debate on the question, "Should Engineers Unionize." William Snaith supported the affirmative, delivering an address which appears in full on page 281 of this issue. Prof. Peter Gillespie then spoke on the negative side. Prof. Gillespie's address also appears on page 281. The question was then open for general discussion, following which Prof. Gillespie summed up and Mr. Snaith replied, concluding one of the most interesting meetings ever held by the branch. Following is a condensed report of the general discussion:—

A. W. Connor declared that legislation is needed to prevent unqualified engineers from practicing. Engineering, in his opinion, is different from other professions in that each job is a separate undertaking, and when it is finished the engineer has to look for another.

H. P. Heywood agreed with the principle of unionization, but disliked the idea of using the name "union." He suggested that a society should be formed within the Engineering Institute of Canada to further the financial interests of the members.

William Storrie said that legislation would do practically everything that unionization could be expected to do.

J. R. W. Ambrose stated that he was in sympathy with the idea of unionization. He said that engineers are too much in the habit of wishing for an increase in salaries, but taking no concerted action in this connection. His recent experience with unions had been that he merely received letters from the leaders saying that after a certain date the pay for labor of such a class would be a certain sum, and from time to time further letters advising of additional increases. He said that all that he could do was to instruct the cashier to make the necessary changes in the books. He regretted that this is not the situation with engineers. The average employer, he declared, treats an engineer as a necessary evil.

Legislation the Solution

William Harland agreed with Mr. Storrie that by legislation practically everything could be accomplished that the formation of a union would give to the profession.

Walter P. Merrick urged that engineers should stand aloof from labor. He made an interesting comparison between the results which might be expected from legislation in the province of Quebec and the lack of such legislation in Ontario.

Willis Chipman said that both of the principal speakers of the evening had presented points with which he agreed. He spoke strongly in favor of legislation and said that the bill now before various legislatures will put the engineering profession in possession of the same rights as are now possessed by lawyers and physicians.

G. W. Winckler related some experiences in the matter of low salaries on railroad work near Winnipeg, and said that until engineers are more fully represented in parliament, they can expect little in the way of legislation on their behalf. He doubted whether there is a single engineer in parliament.

John F. Cassidy said that in Ontario there is one engineer in the provincial parliament, namely, Hon. Manning W. Doherty, minister of agriculture, who is an associate of the Engineering Institute of Canada.

T. T. Black remarked that there is one engineer in the legislature in British Columbia, and that the engineering profession has one representative in the Dominion parliament.

Engineers as Leaven

Frank Barber said that he can see little objection to engineers forming a union, and that if they are allied with labor, the engineers would probably act as leaven to the advantage of labor and the engineers. To show that engineers do not have to be completely organized, he instanced the experience of the Mississippi pilots. He said that he was amazed at Prof. Gillespie's statement that labor unions have no code of ethics, and he gave an instance of lack of ethical conduct on the part of civil engineers. He claimed that the same thing could not have happened among union men.

Prof. H. E. T. Haultain said that legislation is good, but that in order to benefit the profession, it will have to be followed by unionization. He alleged that the school teachers of Ontario have legislation establishing a closed profession, but are probably the poorest paid of all the professions. He said that one of the troubles of the engineer is that he is almost invariably a poor salesman; many other professions do not undertake to market their own services; authors, even

of the highest calibre, frequently use the services of an agent in selling their product.

George Powell enquired whether, in case of unionization, employing engineers would occupy the same position as foremen in the organization of a union; that is, whether they would cease to be active in the union as soon as they became employers of other engineers.

G. A. McCarthy related an instance of the effectiveness of unionization. The locomotive engineers in New Brunswick organized a union in 1875, and were immediately dismissed, but two months later they were reinstated by the government and paid for all the time they had lost.

"For Board and Car-Fare"

E. M. Proctor drew a comparison between engineers and physicians and lawyers. He said that engineers are at a disadvantage because their profession is not closed, but he claimed that the young engineer is more prosperous than the young physician or lawyer, who has to work at the outset of his career for practically no salary at all. He also stated that he had been approached by several engineers who expect to graduate at the University of Toronto this year, who are willing to work for little more than their board and car-fare.

Prof. C. R. Young claimed that unionization would involve a levelling process that would be incompatible with the ideals of the engineering profession. He declared that an engineer's best work is frequently done outside of office hours. He feared that unionization would result in restriction of hours of labor and output. He strongly advocated legislation closing the profession, but at the same time expressed the opinion that some more effective measures would have to be adopted to improve the status of engineers. While unfavorable to the formation of a trade union, Prof. Young stated a belief that some organized effort can be made that will be entirely within the bounds of professional ethics. In order to find a solution for the problem, he introduced the following motion:—

"Whereas, by reason of inadequate compensation, salaried engineers are now working under exceptionally trying economic conditions, which in some cases amount to hardship;

"And whereas many engineers in the Toronto district are convinced that these conditions can be ameliorated only by direct, organized effort, and that immediate remedial measures are imperative;

"And whereas the Engineering Institute must either promptly face the issue and grapple with it or stand aside and permit newer and perhaps foreign associations to press the claims of the engineers in this country for economic consideration;

"Therefore, be it resolved, that this branch urge headquarters of the institute to forthwith request all branches to appoint committees of not less than five members, with power to add to their number, to thoroughly investigate and report through the various branches to headquarters upon the structure and constitution of an organization designed to bring into operation direct and concerted efforts toward the improvement of the economic status of engineers; and that, if practicable, headquarters defray all expenses of these committees in the matter of holding hearings and obtaining stenographic reports of evidence."

Thomas Taylor seconded this motion, which was subsequently adopted.

Disappointed in Institute's Achievements

H. A. Goldman opposed the statement that the Engineering Institute is doing all that engineers could desire in connection with increased salaries, and claimed that he and others who, a year or two ago, contemplated the formation of a society with the object of increasing salaries, are disappointed in the results so far achieved in this direction by the institute.

George Clark advocated legislation rather than unionization.

Prof. Gillespie then summed up for the negative, very briefly, on account of the lateness of the hour. Mr. Snaith replied, that the essence of Mr. Gillespie's remarks was that by joining a union, engineers would be giving up freedom of action. Mr. Snaith declared that the only way that a man can be perfectly free is to go to a desert island and become a hermit. It is a question of giving up a certain amount of freedom in exchange for money. He opposed Mr. Gillespie's claim that engineers would have to adopt all the tactics of labor unions, and said that he had no doubt that if engineers form a union, they will continue to act as professional men. "Although unions have made mistakes, they have no monopoly in this respect," declared Mr. Snaith. "Little can be gained by pointing out the mistakes that have been made by specific unions, because this can be readily balanced by the fact that men of greater ability and education have made even worse mistakes."

ONTARIO'S ROAD-BUILDING PROGRAM*

By Hon. F. C. Biggs
Ontario's Minister of Public Works and Highways

TO-DAY Ontario is faced with a different situation regarding roads than ever before. There are three or four outstanding features. First, there is an acute shortage of labor, which necessitates quick and short lines of transportation. Time is very important, and also it is very important that production—if it is possible to increase it in this province—should be carefully watched. I do not think there is any one thing to-day that will tend more to relieve the unrest which is so prevalent in the rural districts, than good roads to the door of every farmer, so far as possible.

We have a great deal of good roads legislation on our statute books, but the traffic has changed; it is becoming much heavier, and many of the old acts and laws are inadequate to meet our changed conditions. We must wake up and get a twentieth century policy that will meet circumstances as they stand to-day. We must also have a policy that will bear evenly on all the people of this province. When I say evenly, I mean money that is used in the development of this policy must be derived from uniform sources as near as possible, and the distributing of this money for road purposes must be carried out in such a manner that all those who contribute will receive their fair share of that expenditure.

So far as provincial roads are concerned, there are two sources of revenue: First, the source that has been made possible by the Dominion parliament's setting aside $20,000,000 to be spent over a period of five years, of which Ontario receives approximately $6,000,000. Last year there was spent on provincial highways in Ontario about $1,250,000, but I see no possible way of getting the Dominion government to take care of 40% of that expenditure.

We must keep our road system balanced in mileage, expenditure and benefit. The late provincial government designated 422 miles of provincial highways in Ontario up to the time they gave up office. This road is largely a trunk road, serving, on a large portion of the route, a one-sided population; that is to say, the road practically from Toronto to Quebec serves only the people to the north of that road. The road from Hamilton to London serves both sides, but a system of that kind would never derive the benefit for the people of this province, the taxpayers, that we are looking for, and to have this system evenly balanced I have made up my mind that it will take 1,824.7 miles to do it at the present time.

The class of construction that will be followed by the government is largely a business undertaking, the same as taking the roads over. A limited system of provincial roads will never be popular. A comprehensive system of trunk or provincial roads has been clearly demonstrated in the United States as the only system that will become popular with

*Address at the 18th annual meeting of the Ontario Good Roads Association, March 3rd, 1920.

the people and serve the people adequately. Thus the mileage I have suggested.

As to the class of construction, it is our idea and our wish to put that 1,800 miles of road in a good state of repair just as quickly as possible. We have reports on most of it, and engineers will be sent out to complete those reports. On a road of, say, 50 miles in length, which may be a fairly good road with the exception of stretches of three or four miles, or a mile or so here and there along the system, it is our intention to pick out the weak parts and try to standardize the whole system so that people can derive some immediate benefit. Then we will start from the larger centres of population with a better class of construction in the districts governed and controlled by suburban area commissions.

As soon as a road is taken over, it goes out of the hands not only of the county but of the suburban area commission, so we will start from these larger centres and build out as time, labor and money will permit. To-day we have a program for permanent work in the immediate future of about 100 miles.

The provincial roads will naturally be the most important roads through the counties. These to a large extent are now designated as provincial county roads, on which the province pays 60% and the county 40%. By taking a provincial county road and making it a provincial road, the Dominion government will pay 40%, the province will pay 40% and the municipality—which I interpret the Act to mean "county"—will pay 20%.

"Reasonable Standards of Construction"

We hope to develop the provincial system in such a way that it will be a good proposition educationally for the counties through which it passes. We hope to develop these roads to reasonable standards of construction so that the counties, even though they be proficient in the way of building roads to-day, may have an example of construction along lines of drainage and more particularly along the lines of continuous maintenance of the macadam and gravel-surfaced roads.

The counties, relieved of considerable mileage of provincial county roads, which are most important roads, will be able then to add to their systems not merely the mileage they have been relieved of, but a mileage possibly equal to 150% or 200% of that, because the mileage they will have been relieved of is the hardest part to maintain and construct on account of the traffic. Therefore, I venture to say, they will add two miles for every one they are relieved of, and still keep their county expenditure about normal. If they can do that, what does it mean for the township? But before we come to the townships, there are just one or two things about provincial county and county roads I would like to mention.

At present the government is only paying the suburban area commission 20% on maintenance. We hope to strike that out of the Act and make it read: "Work in suburban area," so that it will not matter whether it is maintenance or construction. We hope to be able to pay 40% of the work done in suburban areas, and thus not show any preference to construction over maintenance.

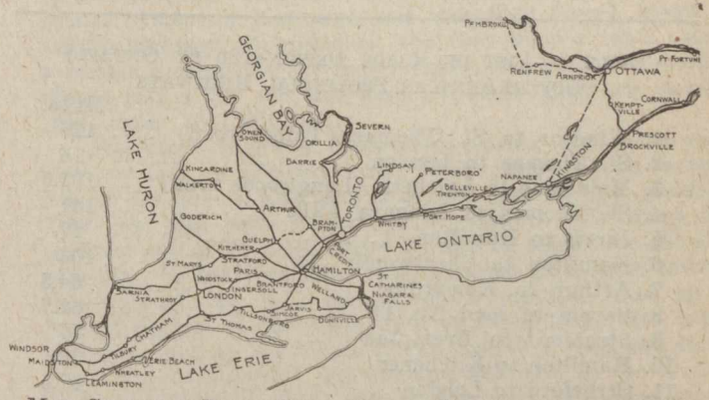
Too Many Roads Forgotten

One other matter in connection with county roads is this: About two years ago the standard was raised on maintenance from 20% to 40%. Now that construction and maintenance are on the same basis, we want you to take your part, and whether you take over a new road in your system or take the roads as they stand to-day, we do not want any road, whether it is constructed, partially constructed or only being maintained, to go down in standard one bit to what it is to-day. Too many roads are built by county superintendents and councils and then forgotten. You must get down to a system of continuous maintenance on these roads, so if you have a good road, keep it a good road. If you have a road 50% perfect, keep it that way, and do not let it fall back one bit. You would not go into business and just because one branch of your operations was paying, forget about the rest and let them so deteriorate that they would take all the profit you were making on the other end. You must keep your roads up to a state of continuous maintenance and hold them there.

We have our engineers out through the province, and we are going to keep enough men out to see what the counties are doing this season, and we are going to watch very carefully and closely the class of maintenance put on by the different county councils, and we hope at the end of the year, when the bills come in, that we won't have to discriminate against any county in the province. But, if it is necessary, it won't make any difference to me who represents the county or what it is, we are going to draw the line.

If the county takes over, in turn, a number of the principal township roads, those naturally would be the ones of most importance, the ones that cost the most to build and maintain.

Where the Ontario Good Roads Act is in force, the mileage of township roads is established. We are not opening up a lot of new roads. If the county can relieve the township of



MAP SHOWING ROADS DESIGNED BY ONTARIO GOVERNMENT AS PROVINCIAL HIGHWAYS

The lines joining Guelph and Brampton, Kingston and Ottawa, and Ottawa and Pembroke are dotted because routes for those roads have not yet been definitely determined.

a given mileage, the township with the same expenditure can just spread the expenditure that much thicker on the mileage that is left.

We propose to pay 20% on the roads and bridge account for anything that our department considers as a necessary work to make these roads of a better standard in the township. This is a new departure in any government—to help the township—but what good is a trunk system to agriculture, or a county system to agriculture, if we forget about the feeders that produce the traffic to feed the people in the urban centres? To encourage this and get the township to back it up and make a success of it, we propose to pay the township 40% of the supervisor's salary instead of 25%, up to $600. I do not think that there is any one thing in a township to-day that will standardize the work for that township and raise the general efficiency of the roads in the township as much as a sane, level-headed township superintendent.

When I say that we intend to pay 40% to the townships, we intend to pay that to all townships and villages.

We also want to give special consideration to the smaller urban centres through which the provincial highway passes; that is to say, any small urban centre up to 1,500 population. Unless the small centres are helped, we are going to have, at periods along that highway, some very rough and muddy places to drop into from a reasonably good highway. These small centres of population have probably the highest tax rate in the province, because I do not think there is any place where so much experimenting is done as in a village of 1,500. They must have sewers and electric lights and so forth, and they have got themselves into the position that they are handicapped financially, and without putting the tax rate up to a degree which would run their property off the market, they are unable to build the roads necessary in this province. Therefore, we propose to help these places of under 1,500 population.

We will build the highway through any centre of population that is not separated from the county for county pur-

poses, and spend an amount in that municipality equal to the amount we spend on either side of it. Nearly all these small urban centres and towns have western ideas. They get the idea that to be a large town they ought to have a large limit; so with a town of a couple of thousand population, if they have not three miles of limit on the main road, they generally feel that they will never be anybody or get any place. But to-day, when the provincial highway is going through, they realize the folly of an extended limit.

In these towns of 1,500, we won't regard the limit; we will regard the point to which the population comes, and we will designate the road to the population and not to the limit. Through that part of the population, we are willing to spend an amount equal to what we spend per mile on either side of it, and establish an equal width, whatever it may be; then if that municipality desires to build it out to their curbs, it will be their responsibility. This, I think, is more encouragement than those small urban centres ever received before, and we hope they will avail themselves of this opportunity of putting themselves on the map.

Table 1—List of Roads Designated by Ontario Government as Provincial Highways

	Miles.
1. Windsor to St. Thomas (Talbot road)	126
2. St. Thomas to London	16
3. Maidstone to Lambeth (Longwoods road)	102.5
4. St. Thomas to Niagara Falls	141
5. Jarvis to Hamilton	27
6. Hamilton to Chatsworth	103
7. Arthur to Kincardine	64.5
8. Sarnia to road No. 11	62.7
9. Stratford to Brampton	77
10. Hamilton to Kitchener	32
11. Stratford to London	47.5
12. Stratford to Goderich	42.5
13. Toronto to Hamilton (Dundas st.)	37
14. Cooksville to Owen Sound	102.4
15. Toronto to Bradford	31
16. Bradford to Severn river	55
17. Toronto to Rouge river	11.8
18. Whitby to Lindsay	36.5
19. Port Hope to Peterborough	26.8
20. Kingston to Ottawa	102.0
21. Ottawa to Pt. Fortune	69.5
22. Ottawa to Pembroke	89.0
Existing provincial system	422
Total,	1,824.7

I have had many deputations in the last couple of months in regard to the designation of provincial roads. I do not want to say we have not been biased by any deputation that came to the parliament buildings. We have carefully gone to work and figured out the important centres of population and districts of production. We have carefully studied all the road maps and looked very carefully into the direction and course of automobile traffic. We have watched the truck traffic. We have carefully considered the market centres, and now I am able to offer to Ontario a provincial system where every county in the province that is under the Ontario Good Roads Act will receive a portion of that trunk system.

The termini of the 1,824.7 miles of road, as we feel they should be designated in Ontario, are as given in Table 1, above.

Some people may say that there is a road from Toronto to Hamilton, but it is another one of the roads that only serves one side of the agricultural district. It is a splendid highway; it has given great profit and satisfaction to everybody that has to travel over it, but it has already got to the dangerous point as far as congested traffic is concerned. Rather than to widen that road—a policy which I could never favor—we think it is desirable to take Dundas street into the provincial highway system, whereby agriculture may be served on both sides, and that much burdened county of Halton, which has been foremost in the good roads system in the province of Ontario, will be relieved of one of their heaviest burdens.

Road 15 and 16 is the one that carries all the Toronto summer traffic; it runs through the county of Simcoe to the town of Barrie, one of the best agricultural districts in the province of Ontario, a road that will not only benefit agriculture but will benefit the people of the city of Toronto who contribute so much in automobile licenses in Ontario.

When the system was designated originally, it was designated from the Rouge through to Quebec, and there was no connecting link in York county; road 17 will connect from the Rouge to the city of Toronto.

East of Ottawa we have three counties along the Ottawa river, where they have a road that cost them a great deal to keep up,—another road with one-sided population. That is the road from Ottawa to Point Fortune, 69.5 miles. Then we have two flourishing counties along the Ottawa river to the west and north, and we wish to serve them from Ottawa to Pembroke, 89 miles.

The termini of most of the roads we are thoroughly decided upon, and the route we will take, but there are a few cases where the country is rough and the routes are not direct, on which we have not fully decided. There are some things such as railway crossings which we are trying to avoid, but we hope to relieve the counties for the year 1920 of their care and expenditure on this amount of road system.

We hope to develop this system in the next five years to a state of perfection that the whole of Ontario will be proud of. In doing this, we want the co-operation of everyone, because we have a big undertaking.

A. A. Hughson, town clerk, Orangeville, Ont., is receiving applications until 730 p.m., March 15th, for the position of water works engineer.

Charles E. Fowler, bridge engineer, of New York City, states that the proposed bridge connecting Detroit and Windsor will be started this year, financed by New York, Montreal, Toronto, Detroit and Windsor capital. "The bridge will cost approximately $28,000,000," says Mr. Fowler, "and will take three or four years to build."

The "Saskatchewan River Water Project Advisory Board" has been formed to report upon the advisability of providing Moose Jaw and Regina with water from the Saskatchewan river. Maj. A. J. McPherson, chairman of the Local Government Board of the province of Saskatchewan, is chairman of the advisory water board, other members being G. D. Mackie, city commissioner of Moose Jaw; W. F. MacBean, merchant, Moose Jaw; and Thos. Teare, farmer, Marquis. The board will include representatives from Saskatoon and Regina.

Members of the Town Planning Association of Southwestern Ontario interviewed Premier Drury and members of his cabinet last week at the Parliament buildings, Toronto. and asked that the "Planning and Development Act, 1918," be amended as suggested last November at the Hamilton conference of the association. The suggested amendments are as follows: (1) Provision should be made in the proposed act so as to ensure the permanency of town planning schemes by preventing the alteration of any scheme except with the same formality as employed in preparing and adopting it; (2) the town planning commission shall consist of the head of the municipality, three members of the council and three persons, being ratepayers, appointed by the council; the members of the said commission, except the head of the municipality and the three members of the council, shall hold office for three years or until their successors have been appointed, provided that on the first appointment of the members of such commission, the council shall designate one member who shall hold office for one year, one member who shall hold office for two years and one member who shall hold office for three years.

WISCONSIN'S EXPERIENCES IN ROAD BUILDING*

By A. R. Hirst
Chief Engineer, Wisconsin Highway Commission

WHEN we think of the great era of railroad building from 1879 to 1884, we must think of the great achievements of the engineers of those days, because in those five years there were built in the United States 40,000 miles of railway, and there was spent in that enterprise about $20,000 per mile, or $800,000,000 in the five years. This year there is available in the United States $650,000,000 for the building of highways. I say "available," because we will not spend it; our people have been willing to provide the money much faster than we can provide the brains and experience to construct the roads.

We have available in the state of Wisconsin this year, the sum of $20,000,000 for good roads, but it is not burning our pockets one iota, because we expect to spend only what we can properly spend and deliver value for, no more and no less.

Forget Politics in Road-Building

We have had in my state a very long and bitter fight. When we first started the work in 1907, and spoke before the farmers' institutes, it was lucky sometimes that we preserved an exit at the rear, because we could not always get out the front door. The farmers were suspicious of a young man who would come out and tell the old fellows with whiskers down to their knees how to build roads. As I grow older, I think that the farmers were right. If I did not know any more now than I knew then, I would hand in my resignation. The state of Wisconsin has spent eleven years and probably $60,000 in educating me. But when you start in to build roads, you must pay for the education that you receive in one way or another, and the municipality that keeps its executive in office the longest, will spend the least in education.

When we are handling large amounts of money, we must forget politics and get men who know highway construction and maintenance.

It may be of interest to describe Wisconsin. It has an area of 56,000 square miles, extends north and south about 450 miles, and is in about the same latitude as the settled portions of Ontario. A large share of the state has been glaciated, but about one-quarter of it, the southwestern portion, or Mississippi section, has never been glaciated, and is very rough and hilly. In the centre we have the bed of an ancient sea, which is now a bed of sand, and we have to go through that with no road material at hand to work with. Our population is about 2,500,000. The true valuation of the state is about $3,000,000,000. In the northern part of the state the settlement is still rather sparse, and the land is worth from $10 to $30 per acre. In the southern portion, we have some of the highest developed land in the world.

Wisconsin is the leading American dairy state. We produce more milk, butter, cheese and condensed milk than any other state in the union. Dairying is the greatest occupation in Wisconsin, as far as the farmers are concerned. We have whole counties in which the true value is $150 per acre for every acre in the county; and, on the other hand, we have whole counties where the true value is 150 cents per acre.

Movement Started in 1907

We started what might be called a modern highway movement in 1907, with 71 counties and 1,200 towns. The number of pathmasters or road superintendents varied from as low as one in very exceptional instances to as many as 80 in a township containing about 60 miles of road; in other words, they scrapped about the odd fractions of the road miles. We had 40,000 town road superintendents. They changed every year. The principal occupation of each man was to show what a fool the man before him had been. I don't blame them so much for what they did, because they were placed in charge of men with whom they had to live for 365 days in the year. It was against human nature for a system like that to give results except where they really wanted roads, and then they got roads.

Engineers can go out and build a good road when they are given $30,000 or $40,000 per mile with which to build it; but these chaps were up against $30 or $40 per mile to maintain roads which were really cow-paths; and when you think that they had to milk 30 or 40 cows each day for a living, and do other farm work, as well as look after their section of the road, it is a wonder they did so well. It was more the fault of the system than the men.

Changes in Highway Legislation

The first step we took was to enact the county aid law, which provided that the county boards should consist of the township chairman and a member from the town board, and a member from every village, city and town in the county. It also provided that this county board should lay out a county system of highways, and that they should select a county highway commissioner, and that when a town voted a certain amount for the improvement of a road, the county should vote a like sum and build the road. That law was in effect from 1907 till 1911.

The state highway department during that time was more or less an advisory body. They could call us in and ask us for advice, and take it or not, just as they pleased. This law was only moderately successful; only about 20 counties out of 71 acted under it, and of these, five did excellently. In 1911, realizing that we must go a little faster, the state-aid law was passed, which provided that on a limited portion of our roads, 15% of our mileage, if a town or county put up two-thirds of the cost of a road, the state would put up one-third, and the road was built by the county to the satisfaction of the state department. We have spent about $22,000,000 under this law in the construction of about 8,000 miles of road of all classes, and several thousand bridges.

This law had one drawback, from a general state standpoint, and that is that the location of these roads were in the hands of the town or county councils, and the result was that there were no two cities in the state that were connected by a good road. In other words, after spending up to $18,000,000 and building 6,000 miles of road, the longest stretch of continuous highway we had in the state was 18 miles. In 1917 we took a further step forward and enacted what they call the state trunk-highway law, in which it was provided that there should be laid out by the state highway commission, under the general supervision of the legislative committee, a system of 5,000 miles of road which should connect every county seat with every other county seat. This 5,000 miles was about 6½% of our 76,000 total mileage.

State Responsible for 5,000 Miles

Our federal aid money was to be spent exclusively on this 5,000 miles. In connection with this we established the greatest experiment ever tried in connection with roads; from the minute they were taken over, they were taken over by the county for maintenance by the counties under the general supervision of the state. In other words, the state took the responsibility for the maintenance of these 5,000 miles of road, no matter how good or how bad they might be when taken over. The minute when they were taken over was at 12 o'clock noon, May 1st, 1918. When a certain unit of government says it will build a road, other units of government immediately stop all work on that road, and it is allowed to get into any state of disrepair. If we had said that we were going to construct these 5,000 miles under federal aid, these 5,000 miles of road, which were supposed to be the main roads in the state, would have been the worst roads in the state, because all local effort to improve them would have immediately stopped, and, therefore, it was provided that they should be maintained by the counties through which they ran, under the supervision of the highway department of the state; and if they were maintained to our satisfaction, the county should be repaid the total cost of

*Address at the 18th annual meeting of the Ontario Good Roads Association, March 4th, 1920.

maintenance up to a certain sum per mile, which has been about $200. We are making some alterations next year, and the maintenance will run from $150 to $275 per mile per year.

That is the general plan on which will be concentrated, as fast as it becomes available, the larger share of our construction funds, so that these roads will be kept passable while we are building permanent roads. Whether the road is macadam or a gravel road, or a mud road or a sand road, it is put into certain definte sections,—what we call a patrol section. These sections vary from as short as 5 or 6 miles on some of our heaviest travelled roads to as high as 15 miles on other roads which we patrol with trucks. Of these 5,000 miles, there were 1,500 that were surfaced when we took them over. At the end of the first six months of patrol service there were not a dozen places on that system where a man would get stuck. There were sections that were not as good as other sections, but a man could travel from one end of the state to the other in comfort.

First Make Roads Passable

This year we will spend part of this fund in what we call gang maintenance. That is, we put out a heavy grader, usually with a large tractor, and we take a section of this trunk highway which is in bad shape, and we grade it, and possibly surface it with sand or gravel.

When I went into Wisconsin in 1907, I went there with the idea that any money which was not spent for construction was wasted. I am now just as firmly convinced that we can spend our first several million dollars in temporary work in making these roads passable, not in 1950, but in 1920. The old farmers who used to jump on me in 1907 did not jump hard enough. There is no state, and I will venture to say that there is no province in Canada, that can produce money fast enough, or the material or the men to build now the highway system which you must have in the next 10 or 15 years. Are you going to have everybody stuck in the mud just because you cannot construct fast enough? The proper thing to do is to make the whole system passable, and then come along and put on the fancy touches a little later. That is our theory: That we will first make our main roads passable; and in the second place, we will build them just as fast as we can furnish the money and labor and material.

I call our divisional engineers several times a year into conference, and last year, after two years of patrol service, I asked the eight engineers to place on a sheet of paper what they honestly believed was the saving in time on the state roads in 1919 as compared with 1917. They estimated that they could travel at 15 miles an hour in 1917; and at the end of 1918, 22 miles. In other words, two years' maintenance work has added 7 miles per hour to the speed of the traffic on these roads, and it has not cost us hundreds of mililons of dollars. It has cost us in the two years about $400 per mile.

Work of Patrol Men

On earth roads the patrol sections are from 6 to 10 miles. That is a horse or team patrol. This man is given a road cleaner and a two-horse blade grader or road machine that a man can both operate and drive. We have found that for earth road maintenance, this one man road grader is the most valuable tool, and the second most valuable tool is what is known as the Minnesota planer. We have, for all practical purposes, discarded the King road drag as a maintenance tool. We found that they had a tendency to make our grades too rolling, whilst the long road grader, with two parallel blades and with two or three cutting bars 16 ft. long, bridges the gaps and fills in the holes, and we get a much more easy-riding road.

We have secured remarkable results in our gravel roads (another point in my education). For years we have had a large number of miles of gravel roads in the eastern part of the state. I was brought up in the Maryland highway school, and when I went to Wisconsin I devoted myself quite largely to telling the farmers not to waste their money on gravel roads, but to build water-bound stone macadam roads instead. I am now devoting just as much time and energy to telling them not to build any more stone macadam roads, but when they cannot build a permanent road to build a fine crushed gravel road, which we have found to be the most satisfactory. We have about 1,200 miles of this type of road. The trouble with the old gravel roads was that they were not trimmed carefully; the ridges were there because no special means were taken to get rid of them, and no effort was made to take out the large stone. We are now crushing all the gravel used on our roads, so that it will not exceed one-inch in size, and if we could find a crusher that would crush it down to a ½-in., that is how we would use it for the top 3 ins. of the road.

The old standard used to be that any gravel that was fit for roads should be filled so full of clay that it stood vertically in the pit; and that any gravel road that did not consolidate readily under the roller was not fit to build. We have found that the kind of gravel that can be used on different roads varies exactly as the soil upon which it is placed. In other words, on a heavy clay soil you want a sandy gravel, and if it does not consolidate for six or eight months, there is no cause to worry; it has been our experience that the longer it takes to consolidate, the better wearing surface you are going to have.

Clay, Gravel or Sand

On a sandy base you want a clay gravel, the difference being that on a clay base the gravel is pushed down and in by a capillary action. On a sandy base you cannot use sandy gravel because there is none of that action which will finally consolidate it. These are things that we have found when we get gravel roads: First, the finer the gravel is, within reasonable limits, the better; second, that a sandy gravel is the best to place upon a heavy clay base; and third, that clay gravel is the best for a sandy soil.

We used to specifiy that every gravel road should be rolled until it was compacted. After two years, we do not specify that our gravel roads should be rolled at all. We finish our gravel roads in what we consider a much better way, under this patrol and maintenance system, by having a patrol man constantly go over them and work them with a road machine and road planer and allow the travel to compact them little by little.

At the end of a few weeks, or months at the most, we get a surface which is much better than the surface which we get by rolling. It must be conceded that they are a little inconvenient to travel on for a few days. We put on about 8 miles of sandy gravel on an old clay road near Madison last year. It cost us about $800 a mile. Given constant attention by patrol maintenance, two or three inches of fine crushed gravel will make a wonderful road if you build it wide enough. That may surprise you; it surprised me.

About three years ago I went up into one of our counties where we were building a gravel road. It was late in the fall, just before the freeze up, and I found 20 miles of sand about 3 ins. deep on top of Lake Superior red clay. I could not get in touch with the county highway commission, and I guess it was a good thing I could not, because my language would not have been parliamentary, but I wrote a letter which is still preserved in the archives of that county, to the effect that any man who would assume that that was a road, did not have any brains. The material was nothing but sand; there was nothing in it larger than a quarter of an inch.

Sand Made Fine Road

The next spring I went up there again, and found that that stretch of road was (and still is, after three years), one of the finest stretches of road in the state. Our speed limit of 30 miles an hour is not sufficient on that road. I consider that is one of our most valuable discoveries: That a light application of two or three inches of sand on clay will produce a road which is wonderfully satisfactory to travel over a good many months in the year. Now, I do not claim that this two or three inches of sand will hold up a twelve or fifteen-ton motor truck in the spring. That kind of road is not designed to do that. In some cases these roads become

impassable if used by trucks, but they can be whipped back into shape as soon as the weather permits them to dry out. If you have not tried this you should do so. Put the road down eighteen or twenty feet wide, and make it three inches thick in the centre, going out to a feather edge, and put the planer or road machine on it for a few days or few weeks until the travel consolidates it, and I will guarantee that you will be astonished at the result.

The water-bound stone macadam road has given us an infinite amount of trouble. We built many hundreds of miles of it 9 ft. wide, and as soon as the automobile travel came, it unravelled these roads and they went all to pieces. We then started to treat the surface with tars and asphalts, and after one or two treatments, we found that these narrow surfaces got very rough. At the present time the roughest roads we have in Wisconsin are our water-bound macadam surface-treated roads, and we have practically given them up. We are now scarifying these old 9-ft. macadams down a good depth, spreading them out to fifteen or sixteen feet, and putting on top of them two or three inches of fine, crushed gravel, and maintaining them as gravel roads. We can do that much cheaper than we can surface-treat them, and they are much more satisfactory. This is especially the case if there is sand in the gravel. I say sandy gravel, for the reason that a clay gravel is dusty; it is inconvenient and a nuisance, whereas sandy gravel is very seldom dusty, and will give very little trouble after it is down two or three days or a week, while the clay gravel will always give trouble.

Three Classes of Roads

We are endeavoring to build and maintain practically only three classes or types of road. First, the earth road,—not necessarily the earth road as the Lord put it there, but as we have improved on His handiwork. I mean that where it is a sand earth road, we cover it with clay as fast as we can get it there. We find that this clay top—three or four inches of it—will give us a very satisfactory road on a sand base. Where the road is too clayey, we put two or three inches of sand on top of the clay, and it makes one of the best earth roads you can have. More than that, for the average traveller the earth is still the best road in the world when it is in good condition. I would rather travel 50 miles over good earth roads than 50 miles over any other type of road we have. There is no road that beats it; there is no road that is as restful.

If we have a place where the earth road absolutely fails to serve the traffic, and if we cannot build any of these expensive new types of road, we are building almost entirely gravel roads if we have gravel in the neighborhood. Where we have not money enough to build what we think is the final type of road, we build what we call semi-penetration stone macadam; that is, we build the old water-bound macadam road up to about the point where you commence applying the water, and we then put in about 1½ gals. of tar or asphalt, finishing first with coarse screenings and then with fine screenings, and then about ¼ gal. of asphalt or tar and finish it off with chips. We build these roads only where we cannot get gravel and where we cannot afford to build the final type.

Construction of Trunk Highways

For roads which are ultimately going to take over a heavy truck traffic, which are really state trunk highways, main market roads and main commercial roads, especially in congested districts, there is no road which will give the ultimate service like the concrete road or a road on a concrete base. I am convinced of that from what I have seen in several states, and my experience of 16 years tells me that the ultimate road for heavy traffic must be the concrete road or another top surface on a concrete base. These roads in Wisconsin are costing us to-day between $30,000 and $50,000 a mile. The gravel roads in our gravel districts are costing us about $8,000 a mile for 15-ft. and 16-ft. roads, and in a great many cases we are building the $8,000 roads and letting the $30,000 and $40,000 roads wait, because we think we can figure out on the basis of pure economics that the cheapest road may after all be the most economical road in certain cases.

Our public sentiment is best expressed by the legislation or action of constituted bodies. We started this patrol system in the spring of 1918. We put on that 5,000 miles about 700 patrol men. In the fall of 1918, the very first year, about 15 of our counties selected what we call the county trunk system and put patrol men on them. They were so impressed with the first year's operation of this patrol system of maintenance, that about 15 counties established the patrol system on their secondary roads or improved county roads. Last year we maintained about 5,000 miles of state trunk roads and about 1,000 miles of county roads by the patrol system.

Legislature Likes Patrol System

The legislature of 1919, after one year's experience with this patrol system, almost unanimously provided that we should lay out 2,500 additional miles and maintain them, starting in 1920. The vote on that measure in the senate consisted of 33 members, of whom 32 voted for it and one against it; and if that fellow had voted for it, I would have been sure that the measure was wrong. In the assembly, with 84 members present, 79 voted for it and 4 against it. So it may be admitted that the people of Wisconsin, as represented in the legislature, are satisfied with this patrol system.

Last November 45 of our 71 counties adopted the county patrol system, and these counties will maintain this year 5,000 miles by that system in addition to the 7,500 that we are maintaining. In other words, there will be patrol maintenance in the state, in 1920, of 12,000 miles of road. It seems to me that the best verdict on the success of this proposition is the verdict of the people themselves.

Last year the average pay of a patrol man with a team and wagon was $140 a month. We hired them from about April 15th to about November 1st. If their service is satisfactory, and if they serve until the end of the year, they are given a bonus of $5 a month, and about two-thirds of the patrol men got the bonus, which amounted to $35 or $40. This year our average scale for patrol men will be about $150 a month, with a bonus of $5 for good service.

We have available for state trunk highways this year about $1,500,000 and the counties have added to that, voluntarily, $700,000 more, and in addition they have granted nearly $1,500,000 for patrol maintenance of secondary highways. We have available for patrol and gang maintenance nearly $4,500,000 this year. While we have that money in the maintenance pocket, we have $20,000,000 in the construction pocket, yet until we are sure that that $4,500,000 of maintenance is going to be spent, we are not going to draw on the construction pocket at all, because I believe a dollar spent intelligently for maintenance is worth two or three dollars spent for construction.

"May be Unduly Pessimistic"

I think the pendulum has swung up to the point where it is going to commence to swing down again, and I believe the possession by any state or province of a large construction fund, for use two or three years from now when things become normal, is going to be quite an advantage in tiding over the inevitable crisis which is coming. We will be able to get more roads for our money at that time, and we will be able to help the public by keeping the people busy. I may be unduly pessimistic about it, but I am convinced that the pendulum is going to swing the other way within two years.

If we have not one kind of problem in this road business we have another. For years Mr. McLean and I could not get any money to spend, and now they are throwing more money at us than we can spend and do it right, and I believe the thing for all of us to do is not to spend it until we can spend it right. On the other hand we have this to think about: We have in Wisconsin a certain number of men whom we have developed to build roads, especially concrete roads. I assure you that if you had in this province, and I am sure you must have, numbers of men who make a business of road building, and who have built up an organization and who have machinery for road building, I believe it is a good policy to keep these men moderately busy this

year at almost any price so that you will not lose these organizations that have been built up during the past several years.

We have in Wisconsin as many as 400 or 500 day-labor outfits that have been building roads for 5 or 6 years. We have developed several hundred foremen and several hundred roller men and firemen, and we intend to keep them busy on our most important work and I believe it would be a mistake for us not to do so.

Discussion

Q. Do the patrol men put all their time on the road? A. During the time they are working, they do. They furnish the wagon and team, and we furnish the road machine, small tools, planer or drag.

Q. What kind of drainage do you use? A. Drainage, of course, is important. Tiled drainage has been stated to be the panacea for all evils. We have soils in Wisconsin that you could put tile drains in until you could not put a sheet of paper between and it would not do a bit of good because the soil is so impermeable that in the spring, with the frost going out, the water will not pass through the tile.

Q. What about an open ditch? A. It should be most carefully considered on every type of road. We are coming more and more to build wider grades, much along the line of railroad grades, with a sharp declivity into the ditches. We are trying to get a greater distance between the bottom of our ditch and the surface of our road and we are building wider grades and deeper ditches. We have no standing water on the edge of our roads except in marshes.

Q. Would your road commission be responsible if a man ran into one of your ditches? A. Our grades are 24 ft. wide on top at least, and on a straight stretch, now that we have a bone-dry law, they are pretty safe. While you and I may not agree about prohibition, yet I believe it is going to cut out a lot of irresponsible and reckless driving and that accidents are going to decrease. So far as I know, there did not come to my attention one suit last year against a county for damages on the state trunk highways. That does not say that there were no accidents, because I, myself, saw a good many cars piled up, but there was no chance to bring an action for negligence. I am a crank on the subject of maintenance. Every day in the year, have a man out on the road.

Q. How many miles would you give to each patrol man? A. That would depend upon the travel on the road and the condition of the road, but he can look after from six to ten miles.

Q. What kind of material do you use? A. We put clay on the sand roads and gravel on the clay roads. We use the same material that the road is built with.

Q. One man would have from six to ten miles to keep in repair? A. Yes; if he has a big job such as widening or making a fill, he is allowed to hire a certain amount of help. Our average help on a patrol section last year was about $150 for the season.

Q. Does the patrol man have a horse and cart or a car? A. A wagon and two horses. We have a few truck patrol sections, but they have not been as satisfactory to us as the team patrol section. For gravel or macadam, use the truck, but not for dirt roads.

Q. In grading an old road do you take it from the centre or from the sides? A. We usually have to widen them and we grade into the centre.

Q. You never grade out? A. If we have a road that is fairly ample and that has a ridge on the side, we throw that sod over in the ditch. Usually our work is widening a road from 15 ft. to 28 or 30 ft.

Q. Would you not fill the ditch with that sod? A. We throw it out.

Q. How deep would the ditch be? A. They average about 2 ft. That is what we are coming to.

Q. How do you provide for the farmer getting into his property? A. The farmer must make his own entrance. In other words the Wisconsin law is that the state is responsible to the public to put a road past a man's place, but if he wants to use that place, it is his own business. If we commenced to put culverts for the farmers or the people in the villages, the farmers would have an entrance to their fields a rod apart if it did not cost them anything.

Q. How do you standardize the class of culvert they use? A. The only thing we stipulate is that they must pass the water.

Q. Some farmers might put in a lot of old rails? A. That is all right if they will pass the water and not wash out our road. The farmers are using almost entirely corrugated culverts.

Q. If a gravel road is gone down the centre, and if there is a clay shoulder on the sides, do you approve putting that clay shoulder in the centre and putting gravel on top? A. Absolutely not. We used to think that when we had a piece of macadam or gravel road, that we had something sacred that we ought never to disturb, and that if we did anything to it we should put it on top of it. We have no more respect for a gravel road surface than we have for a cat. We are using scarifiers and tearing them up three, four and five inches, and re-shaping them again, and then if we are going to do something to them we add it on top of that gravel. You will find no trouble in tearing these gravel roads to poeces from end to end. We are using scarifying graders and we rip these gravel roads up from end to end and reconstruct them, and that is the reason we are so favorable to the gravel road,—because it never gets to the point where you cannot rebuild it for a very small amount of money. If a macadam road gets full of holes it is pretty expensive and difficult to rebuild it.

Q. Where do you get your patrol men? A. We get our best patrol men from the retired farmers. We have men who retired three or four years ago with $15,000 or $25,000, thinking they had a competence for the rest of their lives, and now they find it just about half enough, and these are the best men we can get, because if they had sense to accumulate $25,000 on the old farm, they have got sense enough to make good patrol men.

Q. In delivering the gravel upon the highway in the first place, do you use dump wagons or ordinary farm wagons? A. We use the ordinary flat-bottom wagon. If we have to haul the gravel 10 or 15 miles, we are using trucks to haul from the central crushing plant.

Q. Do you throw the clay shoulders into the ditch and then shovel them out again? A. We throw them out into the ditch, and with certain types of graders we can cut the ditch out and throw it up on the bank.

Q. A ditch 4 ft. deep? A. Yes, 3 or 4 ft. deep; we can do that with a heavy steel grader.

Q. How much gravel do you put on? A. Our standard 9-ft. road takes 1,400 yds. of gravel to the mile. Up to a haul of 3 miles, the team is the cheapest, and for a longer haul than that the truck is the cheapest.

Q. What load do you expect a team to haul? A. The average load is 1½ yds.

Q. What drag do you use? A. A small one-man road machine and a planer.

Q. You have two kinds of roads, the state road and the county road? A. Yes.

Q. When you come to a village do you skip over and not touch it at all? A. State and federal aid extend to villages, and they both go into cities up to a point where the population stops and the land may be considered as agricultural land.

Q. Do you screen the crushed gravel? A. If we have gravel that is running excess clay or sand, we take that out before it is sent through the crusher.

Q. How do you set your crusher jaws? A. As close as we can get them. We do not want the material any larger than an inch.

Q. Do you ever use lake gravel? A. No, we have not, but it would be all right if used on clay soil.

Q. What about using pebbles? A. Clean pebbles are pretty hard to bind and keep bound.

Q. Would you recommend 2-in. rocks to go on a clay

road first? A. We are using them much larger for the first course. We are using a stone as high as 4 ins.

Q. What is the pay per hour for a man with a team, drawing gravel? A. Last year, working close to cities, our price for a man with a team was $1 per hour, and in less settled districts the price was $6.50 per day.

Q. Do you work ten hours a day? A. On most of the roads we do, but near cities they will only work nine hours a day.

Q. Do you use crushed stone screenings to mix with the gravel? A. I think I would; we are very much impressed with fine crushed material of all kinds. We do not find that the top quarter-inch of pea gravel or crushed stone on top of a road is a detriment.

Q. Do you oil your roads? A. No; we tried oiling gravel roads and we oiled as much as one hundred miles two or three years ago, but it was not successful.

Q. What about stone roads? A. If you get a macadam road when it is young, and oil it almost the week you build it, you can maintain the oil surface and get pretty good results.

Q. Can you keep a macadam road good by one application? A. Yes, unless the traffic is heavy.

Q. What if it gets full of small holes? A. Tear it up and start over again. If we have just a few holes, we cut them out and fill them with tar and put screenings in, and we try to finish it as near to the other surface as we can, but if there are many holes per mile it is better to tear it all up and resurface it.

Q. Did you ever try to keep your macadam roads in order with a heavy grader? A. We have about 30 miles of limestone road in one county and they maintained it last year with a heavy grader and nothing else, and they got a very good result. Another thing we have found about macadam roads is that an application of good coarse sand on top is a good way to maintain it.

Q. Will screenings take the place of sand? A. Yes, up to a quarter of an inch. We always scarify if we are going to re-gravel.

Q. Would it not be just as good to put on a good coat of gravel? A. No; if you are going to re-surface, scarify before you put on the new surface.

MAINTENANCE OF ROADS IN ONTARIO*

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

FOR the last twenty years I have been telling the people of Ontario to drain the roads; and Mr. Campbell, who was formerly provincial instructor, used to tell the township people to drain the roads; and Macadam, 100 years before us, told the people to drain the roads, because that was the foundation of macadam.

The worst slander macadam roads have to-day is that they are called macadam roads when they have not the first principle of Macadam about them, and that is good drainage. It is not a macadam road because you simply spread some stone on the road; unless you have a well-drained road, you have not a macadam road.

We have all told you to drain the roads, and everybody said, "Yes, that is the thing." The next year we go out to look at the roads and we ask why you did not put in a ditch, and the answer is, "Well, the people of our county want to see us putting stone on the road; it makes a better showing than putting in a drain." So you put the stone on without the drain, and in the spring the mud spews up, and the stone goes, and then they say in a few years, "We have been putting stone and gravel on that highway for the last twenty years, and we know there is a lot of stone and gravel on there, but we cannot find it."

The Disappearing Gravel

I know county road officials who tell our men that for years they have been piling gravel on certain roads, but they cannot tell where it goes. I know of a hill on the Kingston road; they told our men out there that they had been piling gravel onto that hill and they knew it was there yards deep. Our men ran sacrifiers over it, and after going down three inches, they were in the mud. We can hardly say what happened to the stone they had been putting there. Some of it wears out, some of it spreads out and settles into the mud, but when we come to search for what we and our ancestors have been putting on, it cannot be found, because we have been putting it onto an earth surface that would not sustain it.

We have not applied the first principles of economy in handling our material, because we have not kept the subsoils dry enough to hold up the material. I heard somebody on the Queenston and Grimsmby road, shortly after we started working there, kicking, and he said, "The idea of your men building roads over here seems to be to dig ditches; ditches are not roads." Perhaps not, but you cannot get roads without proper ditches.

Then there is the question of superintendence. Under our municipal system, councillors go, go, go; and unless you have a man on the job permanently, a proper system cannot be applied on the road. It is exceedingly important that every municipal organization that expects to maintain its roads should have a permanent superintendent, a man who is active and energetic, and who has initiative, and who will go ahead and do the work on the road in a practical way.

Utilizing Telephones in Maintenance

The question of maintenance has been referred to. It seems to me that the first thing for us to do is to undertake to maintain the road. For years I have been advising councils that instead of starting a system of construction on their highways, they should start a system of maintenance and repair of the roads they have to look after, and then go on with their construction as fast as they can. The councils that have followed that advice are the ones that have made a success of their job, and that have satisfied their people. Some counties are more favorably situated than others for establishing a good system of maintenance. I speak more especially of those which have a plentiful supply of gravel. If they have gravel they are a considerable stage ahead. The road grader is the implement to start with; the road drag is the implement to maintain the road and hold it there. I contend that when you once put up an earth grade it should stay there, because you should maintain it there by use of the drag.

Mr. Hirst referred to a special kind of drag they are using in Wisconsin; that kind is not, so far as I can find, manufactured here. We have advised the use of the regular drag. It is not as effective as the steel kind that they are using in a few of the states.

An implement which is not commonly spoken of for highway maintenance is the telephone. It can be used in this way: Your superintendent, as soon as he sees that weather conditions are as they should be for dragging, can make most effective use of the telephone by calling up every one of his patrol men and asking them as to the state of the road and whether he should not be out dragging it. A patrol man who is responsible for the dragging should not wait for any such instruction, but the superintendent can stimulate the work by calling the men by the 'phone.

In the case of gravel roads, the old-fashioned way was described by Mr. Hirst. We know that the gravel was piled in the centre and it stayed there until somehow it got spread; it was piled up so high in the centre that vehicles could not get up on it, so they kept along the side, until in the fall the sides of the road were churned up deep with mud; then they had to get on top of the gravel and it was forced out. That

*Address at the 18th annual meeting of the Ontario Good Roads Association, March 5th, 1920.

is a most wasteful way of using this material, and gravel is disappearing from many parts of Ontario because of the wasteful way in which it has been used.

To use gravel properly, the material should be spread evenly, and while a 3-in. thickness is a good start, it is only a start. In order to get something that will stand up under the heavier traffic that will go over the road, the gravel must be made thicker from year to year; but each year when you put it on, spread it in a thin coat and keep it in shape and see that your patrol men drag it as fast as it gets uneven. That is the function of the patrol man,—to see that the gravel becomes consolidated evenly and smoothly.

Crown Can Be Reduced

By having it spread out wider, it is not necessary to have as great a crown on the road. If you have only a single-track road, it is necessary to have a sharp crown, because the wheels track continually in two lines, whereas if it is spread more flatly and uniformly, the rigs can go all over the road and they do not have to track, and it should be the duty of the patrol man to see that they do not track. He can put obstacles to compel them at times to spread out over the road. That is why a thin crust, widely spread on a comparatively low grade, will stand up under more traffic than will a heavier thickness piled up in the centre of the road.

Stone roads have been spoken of, and from what has been said one would question whether we should construct stone roads or not. Should we always use some bituminous material in the top instead of having a great deal of water-bound macadam road? I consider that where we are putting in macadam of any importance, that we should put it in as a foundation for a future bituminous surface. No greater mistake in my opinion has been made than where stone roads are constructed indiscriminately, and they immediately put in the bituminous material, because a bituminous surface in order to stand up fairly uniformly and stay that way should be free from depressions that will hold the water. If you put macadam over a new earth foundation, unequal settlement is certain to take place and pockets will appear, and there is no more fruitful source for failure in a bituminous pavement than these depressions appearing in the surface of the road.

The future of macadam, as I see it on the more important highways, is as a foundation for a bituminous top; but, for a few years perhaps, maintained by use of oil or some other material which will keep the surface as fair as possible. Other speakers have said, "Don't oil gravel roads; don't oil stone roads." There are gravel roads and there are stone roads, and there are oils, and you can use them in proper combination. We have used oil on gravel that is a continuous pleasure to the people who have to use that road. We have used it on other gravels where it was a complete failure due to the particular quality of the gravel and the foundation of the road; for instance, there was a certain sandy substratum and a peculiar quality to the gravel; when the traffic commenced to go over that road. the sand shifted underneath and pockets inevitably appeared in the surface. In other cases we have had a firm gravel oil surface which has given excellent service.

Oiling That Is Satisfactory

There are certain macadam roads in Ontario, in the fruit country, under the control of our department, which must be oiled at a certain hour on a certain day, or there is trouble. If you get the macadam at a certain time when the fine material is swept off and when the coarser stone has shown up, and if you get your oil over that clean stone, you will have something that will stand.

I think that the provincial highways will do good in various ways; I think that they will put into practice some of the principles that we have tried to emphasize and spread over Ontario. I feel that they will have a good influence on the county and other roads. I do not expect that we will do all this work without some mistakes. In starting this organization, we have to get new men and we have to train men, and we have to get men of good judgment, but perhaps not always with the mature experience that they will ultimately have. I want some mistakes, because I find that an engineer who makes no mistakes never makes anything else. He has to make some mistakes.

We are going to do a good job in Ontario on the provincial highways. We are going to do the best we can, and we are going to give Ontario something they have never had before, and they are going to be satisfied with it when it is finished. In the meantime, while the job is being done, don't kick too hard.

BITUMINOUS PENETRATION SURFACES*

By A. B. Manson
City Engineer, Stratford, Ont.

THIS subject, "Bituminous Penetration Surfaces," readily divides itself into two classes or groups: (1) The superficial; and (2) the other more permanent. Under the superficial class comes all surface treatments such as dust palliatives, while the more permanent class are bituminous-bonded roads and pavements.

One of the most disastrous happenings to a road is the loss of the dust or binder in it, and one of the most disagreeable conditions to the travelling public is the dust nuisance. If it is possible to remove one evil, both are removed. Up to date, possibly the most efficient means to this end has been the use of road oils. Road oils are indeed a blessing, though sometimes a rather expensive blessing.

First of all, make sure that what you are buying is the true quality represented; and further, apply the proper quality to the proper type of road. Every quality of oil is neither economical nor useful to every type of road. It may be taken that the harder and cleaner the road, the higher the bituminous content that may be used with impunity.

Should Use Mechanical Distributors

For satisfactory practice the road should be in good condition as to crown, grade, etc., and cleaned as free from dust as possible. The road should be warm and dry and the oil applied with the better class of mechanical distributors, evenly and in sufficient quantity that the road will absorb. To secure the best results, the oil should then be covered lightly with sharp sand or clean stone chips. In time, and after a number of applications, if the road is not knocked to pieces with traffic, a covering of this bitumen and stone will be formed that is impervious to water and satisfactory in the prevention of dust.

Turning to the more important bituminous penetration pavements, we have a subject that deserves close attention.

The economic development of any country demands road improvements. Traffic demands development of roads. Every country by evolution passes from one state to another,—from the original clay road to the finished pavement. This country has now reached the state of development when its rural as well as urban roads require more than the lesser types of permanency on its main highways, and yet may not have so far advanced to stand the expensive pavement. The bituminous penertation pavement is one of the types that bridges the two extremes. The advent of the automobile in all its forms is doubtless the chief visible propagandist of improved roads backed by the real demand for improvement as an economic necessity. The idea of the bituminous penetration road is to get something of a more permanent nature—something with a bond more enduring than water and stone dust—something that will prevent the very life of the road from being thrown over the neighbor's fence every time a motor car passes, without the bankrupting cost of the expensive pavement.

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*Paper read at the conference of county road superintendents and engineers of Ontario, March 1st-3rd, 1920, Toronto, Ont.

Several reasons might be advanced for the use of bituminous penetration roads. It is an old and tried method and for its purpose has stood the test. In Old London 100 years ago, builders constructed bituminous pavements by the penetration method. Since then hundreds of miles have been added, and this process is still used for construction and maintenance.

Its simplicity of construction lends itself admirably to road building distant from cities and centres of population. No extensive plant and equipment is necessary. Skilled labor is not absolutely necessary, though skilled supervision is a real demand here as everywhere. Thoroughfares need not be kept closed for such long periods as in some types of construction.

Every Road an Individual Problem

With the above items considered, it readily follows that the cost is not excessive or prohibitive. The question is at once on the tongue of every supervisor of experience, "What about maintenance?" We will refer to that question later.

This meeting is doubtless much more interested in road building as it relates to the country rather than in city paving, and although there is much in common, there are a great many details in city paving that have no place on the country highway. However, for comparisons and costs, we may be continually dealing with both.

The great problem is, how can we construct and permanently maintain on our country highways a serviceable pavement surface at a cost that will not mean bankruptcy to the community or country in general, or confiscation of the abutting property by reason of special assessments?

While seeking an answer, we must not lose sight of the fact that every pavement has its faults and that no one is the panacea of all road ills. We must treat every road, or part of a road, as a separate individual proposition and spend our money in the purchase of a pavement just as we would about any other good purchase, obtaining the best value for the least money.

Choosing the Wearing Surface

Among the items to be considered in choosing this wearing surface are that it should be smooth, easily cleaned, not dusty, not noisy nor slippery, easy to construct and repair, attractive in appearance, and (above all) suitable to the traffic to which it will be subjected.

A word about the construction other than the surface might be in order, as the preliminary or foundation work is always the prime prerequisite of every pavement. As one hears echoed and re-echoed, and yet not always heeded, every roads needs drainage—the more perfect the better. Be sure your side drains are good and lead somewhere. Too often a bad outlet wrecks the whole system. Give particular attention to the hillsides and places where poor or indifferent material exists for foundation; and once the foundation material is in place, consolidate it as perfectly as may be by rolling until there is no movement of the base.

Before placing the first course of stone, all excess dirt and fine material should be swept from the surface of the foundation. This promotes a closer bond between the pavement and the foundation and tends also to prevent the stone being dust coated and thus interfere with the proper adhesion of the bitumen to the surface of the individual fragments.

Preparing the Base

If tar be used as the cementing element in the road, a covering or coat of tar is applied to the base thus cleaned. This tar penetrates to a degree and also forms a close binder between the base and surface.

If asphalt be used as the binder, this first or paint coat is not employed. As the completed thickness of the pavement is usually 2 to 3 ins., the broken stone should all pass a 2-in. ring. It should consist of sound, tough and angular fragments of uniform quality, free from dirt and other objectionable matter either occuring loose or adhering to the stone. If stored in piles along the roadside prior to use, particular precautions should be taken to prevent its becoming mixed with dirt.

The stone should be as nearly a uniform size as possible, so as to produce a course of uniform texture which, when rolled, will have the voids evenly distributed. Wide variation in sizes, particularly running to small sizes, result in the formation of spots which become so dense that uniform penetration will be very much hindered or prevented altogether. Such places may not be readily discernible in the newly finished pavement, but will ravel and disintegrate under traffic long before the pavement has attained its normal life. For this reason special care should be taken in the choice of stone, and to secure the desired stone is no small difficulty. The stone should also be sufficiently durable to prevent the excessive formation of dust during the first rolling and before the application of the bitumen.

For securing the best results the broken stone should be shovelled and not dumped in place on the foundation. The common practice of dumping loads where the stone is required, and spreading out the piles, results in the segregation of the fine material, which hinders penetration and makes the uniformity of the surface amost impossible. This is due to the fact that the centre of the space originally occupied by each load, received upon dumping a compacting effect much greater than the surrounding area, and the rolling leaves such place slightly higher. An uneven road will be the natural result. Best practice, which is possibly seldom followed, calls for dumping the stone on dumping boards from which it is spread by shovelling.

Rolling

After the stone has been uniformly spread to a depth of 3 ins. loose, it is rolled dry until the fragments are well set. A 12-ton three-wheel roller usually is satisfactory and is operated as in ordinary water-bound macadam construction. The rolling should be carefully watched and discontinued when the stone is thoroughly keyed together and before dust begins to accumulate on the surface or the stone is crushed. If the stone be crushed, the voids are filled and penetration is prevented. However, the tendency is to under-roll rather than over-roll, and in either case an inferior pavement results. If irregularities appear on the rolled surface, the spots should be dug out or otherwise brought to the required level.

Possibly the most satisfactory, or at least excellent, results are obtained from the use of mechanical distributors for applying the bituminous binder, provided that they are of good design and properly operated.

Most of the modern distributors are of heavy construction and apply the heated bitumen either by a single nozzle operated at the rear or by a set of nozzles set in a row close to the road. The single nozzle requires considerable skill on behalf of the operator, but on the other hand has a wider scope. As the distributor passes over the compacted stone, it is very important that rutting does not occur. It is essential, therefore, that sufficiently wide tires be used on the machine. The American Society for Municipal Improvements gives a specification for such mechanical distributors which covers important features and is in part as follows:—

Specification for Mechanical Distributors

"The pressure distributor employed shall be so designed and operated as to distribute the bituminous materials specified uniformly under a pressure of not less than 20 lbs., nor more than 75 lbs. per sq. in. 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 shut off at once.

"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 be not 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 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 inch being allowed for each additional 3 ins. in diameter."

Operating the Distributor

In operating a mechanical distributor it is important that applications should not overlap either at the ends or sides, and that at the completion the nozzles should not drip on the road. Care should be taken that the nozzles are kept clean so that no strips are left to be later closed in by the hand-pouring pot. By calculation and experience, the proper amount of bitumen may be delivered on the road with reasonable precision. Adjustments as to speed of travel and in feed to the nozzle may be readily arrived at by an experienced operator.

Immediately after this first application of bitumen, a uniform layer of small size broken stone should be spread over the surface in such quantity as to fill the surface voids. The road should then be rolled with the addition of more stone if necessary. The size of this stone is about ¾ in., and should also be clean and free from dust and dry, so that the bond with the road will not be interfered with and will present a proper surface for the reception of the final or seal coat.

Applying the Seal Coat

The bitumen surface should also be kept free from dust, dirt or foreign substances while this ¾-in. stone is being spread. Good practice is to deliver the stone by a side swing of the shovel, which spreads the stone evenly and gives more opportunity for the stone to come to rest in the voids. Just sufficient of this course should be used, otherwise the roller will crush the excess and form a blanket or mat with little wearing ability, and also prevent the penetration of bitumen. The surface is then swept to remove excess of stone and fine material not held firmly in place.

The seal coat is then applied in exactly the same manner as the previous applications except that the quantity is less, there being much less penetration. The surface is uniformly coated, care being taken to avoid excess which would form a thick, undesirable mat.

Immediately after the bitumen is applied, it should be covered with a thin layer of small broken stone of good, clean, hard quality, or clean, sharp sand. The amount placed should be just enough to fill any remaining voids and act as a thin covering over the bitumen to prevent it sticking to the wheels of traffic. Rolling then finally compacts the road and forces the particles of sand or stone together, leaving a finished smooth surface.

Rolling of the pavement after it is completed is a matter which appears to be slighted frequently. The rolling of a penetration road is a vastly different proposition from the rolling of sheet asphalt or of bituminous concrete having a well graded mineral content. It should be rolled when sufficiently warm, so that the road is somewhat plastic. This rolling should be carried on for some time after the pavement is opened to traffic,—possibly for two weeks. Too much stress cannot be laid on the rolling or compacting of the road and the reduction of voids to a minimum.

Finish Contracts in Summer

It goes without saying that all this work should be done in the heat of summer, but in practice very often this is not the case, and frequently contracts run unto late fall, which, of course, gives rise to many difficulties. The stone is cold and chills the bitumen, causing improper penetration. The stone is more apt to be damp, preventing proper adhesion. After the first frosts, leaves from trees along the roadside, more particularly in city streets, fall on the loose stone and if not removed prevent penetration.

The final dressing of small stone or sand above referred to should be left on and if necessary kept on and swept about for the first year, which very materially assists in filling the surface voids, which is most essential and vital to the life of the pavement. Traffic will iron a dressing of sand, if properly spread, to a very smooth surface, and there we have one of the factors in paving—it is smooth. Being smooth, it readily lends itself to ease in cleaning, which in turn prevents dust.

One of the most desirable features of penetration pavements is the ease of construction. Practically all the machinery required besides dump wagons is the heater, distributor and a roller. If material is to be hauled any great distance, the use of motor tractors will be found most economical.

"The Roof of the Road"

Following the capital cost of any pavement, the most important consideration is the question of maintenance. Ordinarily a properly designed and constructed penetration road should require small repairs. A rejuvenation of the seal coat, or its renewal when worn away, should be the limit unless traffic is exceedingly heavy or the dirt hauled on the road has been ground into the surface before cleaning. However, no attention should be required for from three to five years, and then a light dressing of bitumen covered with stone chips or sharp sand will replace or renew the life of the seal coat. Care should be taken that too thick a mat is not formed, which will have quite a tendency to shove under traffic and form waves.

Just as the seal coat forms the roof of the road, it should never be allowed to wear out. It forms a waterproof blanket, preventing water from penetrating and spelling destruction. If proper adhesion to the road is secured and traffic is at all uniformly distributed, it will wear away very slowly and uniformly. When sufficiently worn, a coat or dressing should be applied in a manner exactly similar to the original seal coat.

If, on the other hand, breaks occur anywhere in the seal coat, they should be promptly repaired. Broom and clean out the weak spots to allow proper adhesion, then apply the bitumen and stone chips and tamp back level with the original road.

Life of Road Indefinite

By maintaining the seal coat, the life of the road is continued indefinitely. Frequently a break in the surface is due to lack of support from below. The cause of this may be weak foundation, poor subgrade or faulty drainage. Under such circumstances, it is obvious that the proper procedure is to remove the cause of failure before attempting a repair on the surface. Further causes of failure may be unsound stone and improper distribution, as well as the use of bitumen damaged or unsuitable for the purpose. Ruts appearing may be the result of improper rolling or the rutting of the stone while the bitumen is being applied, or the use of too much or too soft binder.

So it will appear that although a penetration road is possibly the simplest to build, it nevertheless requires eternal vigilence on the part of the superintendent if he wishes to turn out a finished road and avoid the many waiting pitfalls which will spell destruction to the best intentions.

Costs Have Nearly Doubled

Costs at the present time are the most problematical element entering into road construction of any kind, and it is scarcely safe to hazard an estimate due to the varying scale of wages paid and the uncertain cost of materials. Citing the city of Stratford as an example, the cost of laying a 3-in. bituminous penetration surface on a prepared base was 81.6 per square yard during 1919, as compared with 47 cents during 1915. We anticipate that the cost for 1920 will be considerably higher.

In conclusion, we would just like to add that though the penetration road may not represent the finest product in so-called permanent pavements, it is still worthy of due consideration as the go-between, and we feel it has a proper place to fill in the advancement of our highways, and that place will be no mean proportion of the very comprehensive scheme now being contemplated.

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PRINCIPAL CONTENTS

ONTARIO GOOD ROADS ASSOCIATION

WHEN 327 members of the Ontario Good Roads Association lunched at "Government House" last week as the guests of Lieutenant-Governor Clarke, they reached another milestone in the official recognition which that association has enjoyed ever since its formation eighteen years ago. Membership in the association is mostly municipal rather than individual; all of the counties and most of the towns, townships and cities pay dues and send representatives to the annual meetings. Those meetings are therefore practically provincial road parliaments, and have proven very useful to the various governments in Ontario since 1894 in advising on highway legislation.

Among the regulations and statutes that have been sponsored by the association, the following are outstanding: In 1896, the appointment of A. W. Campbell as provincial instructor in road-building; 1901, Highway Improvement Act, providing provincial subsidy of 33% for county roads; 1912, $5,000,000 grant for colonization roads; 1913, appointment of Public Roads and Highways Commission; 1915, Ontario Highways Act, under which the Department of Public Highways was formed, "suburban areas" were authorized, provincial county roads were given 60% aid, county roads were bonused to the extent of 40%, and a maintenance grant of 20% was declared; 1917, Provincial Highways Act, inaugurating a system of provincial roads subject to 70% aid from the province. The association can also reasonably claim to have had considerable influence upon the 40% federal aid granted last year, the increase in maintenance subsidy from 20% to 40%, and last but not least, the extension of Ontario's provincial highway system from 422 miles to more than 1,800 miles.

Undoubtedly the keynote of this year's meeting was the declaration of policy made by Hon. F. C. Biggs, the newly-elected provincial minister of public works and highways. His announcement that the U.F.O. government has designated 1,824 miles of provincial highways instead of the 422 miles designated by the Hearst government, means that the money of the federal and provincial governments will be spread over more roads than was originally intended. It means that many roads which were formerly designated as provincial county roads are now designated as provincial highways; it means that 1,402 miles of roads which previously would have received little or no help from the federal appropriation and only 60% from the province, will now receive 40% from the federal government and 40% from the provincial government. The expenditure of the counties and municipalities is, therefore, reduced from 40% to 20% on 1,402 miles of highways. Whether this will prove to have been a wise move or not will depend entirely upon these two things: (1) Whether the counties, towns and township will spend on other roads the money that they will save in regard to these 1,402 miles, or whether they will devote that money to other purposes or else lower the tax rate and not raise the money at all; and (2) whether the money available can be spread over 1,800 miles of road instead of 422 miles and result in equally satisfactory standards of construction.

To build 1,800 miles to the same standards will obviously require more money than to build 422 miles, and the success of Mr. Biggs' whole scheme depends upon how sincere his government will prove to be, and how much money they actually raise and appropriate for highway construction. His scheme on paper is good; 1,800 miles of roads will be more popular than 422 miles if they are good roads; the public likes Mr. Biggs' promises and awaits with interest his performance of them. It is hoped that he will provide an ample amount of butter and not attempt to spread it too thin.

No reference to the convention of the Ontario Good Roads Association would be complete without mention of the allied meeting that has been held just ahead of it and in conjunction with it annually for the past six years. The annual conference of county road superintendents and engineers of Ontario has proven to have been a splendid innovation. It gives an opportunity for exchange of ideas between the county officials and the officials of the Department of Highways, and has resulted in enthusiastic co-operation that could have been obtained in no other way. W. A. McLean, deputy minister of the department, and his chief engineer, George Hogarth, are to be congratulated upon the success of these conferences.

Letter to the Editor

CONSISTENCY OF CONCRETE

Sir,—In the editorial on "Consistency of Concrete" in your issue of February 26th, 1920, you credit us with the use of a "chute test," for measuring consistency. While it is true that we have made such tests, your reference to it might lead some of your readers to believe that this is our standard test for this property. This is far from being the case. As yet, we have no standard test for consistency. We have tried most of those so far proposed and have found them to be wanting in some important particular.

R. B. YOUNG,
Assistant Laboratory Engineer,
Hydro-Electric Power Commission of Ontario.

Toronto, Ont., March 8th, 1920.

The practicability of the establishment in British Columbia of an iron and steel industry was the subject of a recent interview between G. Lewis Casey, president of the Smelters Steel Co., Seattle, Wash., and Hon. Wm. Sloan, minister of mines for British Columbia.

PERSONALS

DUNCAN W. FRASER, managing-director of the Montreal Locomotive Works, Ltd., has been elected vice-president in charge of sales of the American Locomotive Co. and the Montreal Locomotive Works, Ltd.

E. J. OWENS, formerly office engineer of the St. John and Quebec Railway, has been appointed office engineer of the highway division of New Brunswick's department of public works. Mr. Owens will also continue to act as office engineer of the railway.

L. M. JONES, city engineer of Port Arthur, Ont., has been appointed chief engineer of the Warren Bituminous Paving Co. of Ontario. Mr. Jones has been city engineer of Port Arthur for the past nine years. He was at one time engineer of the Winnipeg Electric Railway Co.

W. H. SLINN, who has been employed as assistant city engineer of Kingston, Ont., on roads and pavements, has accepted a position with E. G. M. Cape & Co., Ltd., contractors, Montreal, as assistant engineer on the construction of one of the Canadian Connecticut Cotton Co.'s mills at Sherbrooke, Que.

C. A. BOULTON has joined the staff of E. G. M. Cape & Co., Ltd., contractors, Montreal, and is now in Sherbrooke, Que., as assistant engineer on the construction of Mill No. 2 for the Canadian Connecticut Cotton Co. Mr. Boulton was formerly on the staff of Murphy & Underwood, consulting engineers, Saskatoon, Sask.

RICHARD WAUGH, chairman and treasurer of the Greater Winnipeg Water Commission, who was recently appointed a member of the Saar Valley Commission, has been elected chairman of the latter commission at a salary of 150,000 francs per annum and an expense allowance of 30,000 francs per annum. Mr. Waugh has resigned from the Winnipeg commission.

H. SPRINGER, formerly municipal engineer of St. Vital, Man., who recently returned from overseas, has been appointed engineer in charge of road building for the municipality of Dauphin, Man. Mr. Springer went to England with the 184th Battalion, but crossed to France with the Canadian Engineers and was officer in charge of a party of engineers attached to the heavy artillery.

CHAS. W. TARR has resigned as vice-president and general manager of Morris Knowles, Ltd., consulting engineers, Windsor, Ont. Mr. Tarr will rejoin the firm of Morris Knowles, Inc., of Pittsburgh, Pa., as resident engineer on the construction of a water filtration plant in Elyria, Ohio. Mr. Tarr has been general manager of the Canadian branch of the Knowles company since its incorporation, and has had charge of the design and construction of sewers and water works for the Essex Border municipalities. Morris Knowles, the president of the company, has not yet appointed Mr. Tarr's successor at Windsor.

OBITUARY

SAUL MERCIER, age 26 years, of St. Gregoire, Montmorency county, Que., a surveyor in the employ of the Quebec government, was stricken with scurvy while exploring in the wilds of the Hudson bay region. A tribe of Indians endeavored to help him and drove him 250 miles on a dog sledge to St. Felicien in the lake St. John district, whence he was taken to Quebec by train, but he was beyond medical aid and died last week.

The C. P. R. has ordered equipment valued at $15,000,000. Much of this will be constructed in the company's own shops, but the Canadian Car and Foundry Co., Ltd., has secured a large order. The new equipment will include 2,500 box cars, 500 refrigerator cars, 500 automobile cars, 67 ore cars, 12 diners, 53 sleepers, 24 baggage cars and 13 compartment cars.

DRAINAGE FOR SHOAL LAKE AQUEDUCT

DETERMINATION of the best method of carrying out the work of underdraining the portions of the Shoal Lake aqueduct which have been affected by alkali, will be made by a sub-committee appointed a few days ago by the Greater Winnipeg Water Board. W. G. Chace, chief engineer of the board, urges that the work be begun at once, stating that the disintegration will have increased at least 40%, as compared with the ¾-in. depth of affected material found last April.

Three lump-sum bids were received by the board, as follows: Carter-Halls-Aldinger, $140,963.90 per mile; Fowler and Young, $148,409.50 per mile; Northern Construction Co., $158,004.50 per mile. The estimate of the chief engineer was $99,277 per mile.

The sub-committee above mentioned will determine whether it is best to accept one of these tenders or to select a contractor upon a "cost-plus" basis. J. G. Sullivan, consulting engineer, who is now an alderman of the city of Winnipeg, and who was one of the engineers who reported on the disintegration last year, advises the latter course.

The Northern Construction Co. have offered to do the work at cost plus 9%, and Thomas Kelly and Son at cost plus 12½%. Fowler and Young refuse to assume any liability for keeping the aqueduct intact while underdraining.

"Only that portion of the conduit which is known to have suffered most can be treated this year," says Mr. Chace in his report to the board. "That mile and a half and slightly more was built during 1916. At the date of my report of April, 1919, it had lain under influence of the soil waters for two and one-half years. It was discovered that, over certain areas exposed for examination, the concrete had been softened to a depth of ¾ in., and that injurious influences had penetrated even deeper in places. Another year has passed and the injuries noted last spring must have progressed by at least 40% and possibly to greater degree. In places the reinforcing steel may now be exposed to rust and decay. Even brief delay in proceeding with the work of preventing further injury will prove very serious."

CANADA MAY GET THIS TROPHY

AT a meeting of the New York section of the American Water Works Association held recently, Secretary John M. Diven announced that the Hill trophy, to be held for one year by the section showing the greatest percentage of increase in membership during the previous year, would again be in the field for competition. The score as it now stands is as follows:—

Section.	Increase %	Section.	Increase %
California	13	Illinois	10
Canada	20	Iowa	28
Central States	21	Minnesota	18
Four States	14	New York	16

At the monthly luncheon of the Ottawa branch of the Engineering Institute of Canada, held last Thursday in the Chateau Laurier, Alex. Johnston, deputy minister of marine, delivered an address on Canada's mercantile marine. Mr. Johnston declared that the cost of Canadian-built boats has not been excessive. He read a letter showing that the English price last June was £33/10 per ton at the time contracts were placed in Canada at $167.50 per ton.

At the eighteenth annual meeting of the Ontario Good Roads Association, held last week in Toronto, Lucius W. Allen, civil engineer and contractor, of Belleville, was elected president for the ensuing year. Other officers elected were: Vice-presidents, T. J. Mahoney, Hamilton, and W. H. Brown, Chelsey; secretary-treasurer, Hon. George S. Henry, Todmorden. Directors—F. A. Senecal, Plantagenet; J. A. Sanderson, Oxford Station; William Nugent, Belleville; W. H. Pugsley, Richmond Hill; Major T. L. Kennedy, Dixie; J. E. Jamieson, Singhampton; John Currie, Strathroy; J. E. Waters, Niagara-on-the-Lake; and S. L. Squire, Toronto.