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The Canadian Engineer

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UNIQUE CHIMNEY CONSTRUCTION

A DESCRIPTION OF THE MONNOYER SYSTEM OF REINFORCED CONCRETE CHIMNEY CONSTRUCTION, WITH SOME DETAILS OF CONSTRUCTION CONCERNING THE FIRST EXAMPLE TO BE ERECTED IN THE DOMINION OF CANADA.

By C. V. JOHNSON, A.M.Can.Soc.C.E.

Engineer for Jos. Gosselin, Contracting-Engineer.

OF recent years an agitation has been on foot with a view to the improvement of factory and machine shop buildings from an architectural standpoint. Much time and money has been spent in preparing plans of buildings which would combine the desired utility with a pleasing harmony of appearance. This to escape the end, which has too often been the result of a lack of artistic sense in design, of these structures becoming a blot on the landscape. Time and money thus spent is well repaid in the results obtained, and no doubt many proprietors have already come to realize this. It may be argued that an artistically designed factory building will not bring any larger return for its output than one of similar capacity but less pleasing exterior. Nevertheless, it would appear that there must be an advertising value in the impression conveyed on the public mind by the appearance of the place in which the products are prepared for use: such an impression being undoubtedly a factor in influencing the selection of the article desired.

Any large manufacturer will spend considerable sums on advertisements designed to please the consumer, and what more efficient advertisement can there be than an artistically beautiful structure with harmonious surroundings?

Considering the question again from a larger aspect, not only is there a benefit to be obtained by the community from the prosperity of its individuals, but the appearance of the structures by which it is surrounded undoubtedly plays a large part in its value to the country at large.

Admitting, then, the value of appearances, it remains for us to consider the question of means; and when these means are placed at our disposal without having to resort to an increase of expenditure, it behoves us to take advantage of them. It is one of the purposes of this article to show that these objects may be attained, at least in the case of a structure which is, in almost every city and town, one of the most prominent features; that is to say, the inevitable tall chimney, which is almost sure to obtrude itself on the eye at every turn.

So often is the aesthetic sense offended by the sight of an ungainly, though mathematically correct, monstrosity, towering high above the surroundings, with apparently no regard for anything but its utility as a means of polluting the atmosphere with dense clouds of smoke and gases. True, in many instances proprietors have risen above the consideration of mere dollars and cents, and succeeded in erecting chimneys which combine both utility and a fairly pleasing appearance. These chimneys are

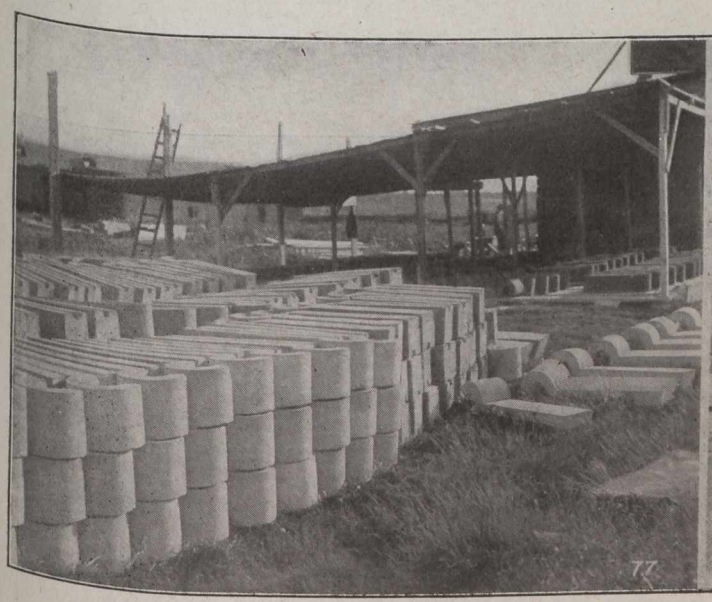


Fig. 1.—Blocks Ready for Use.

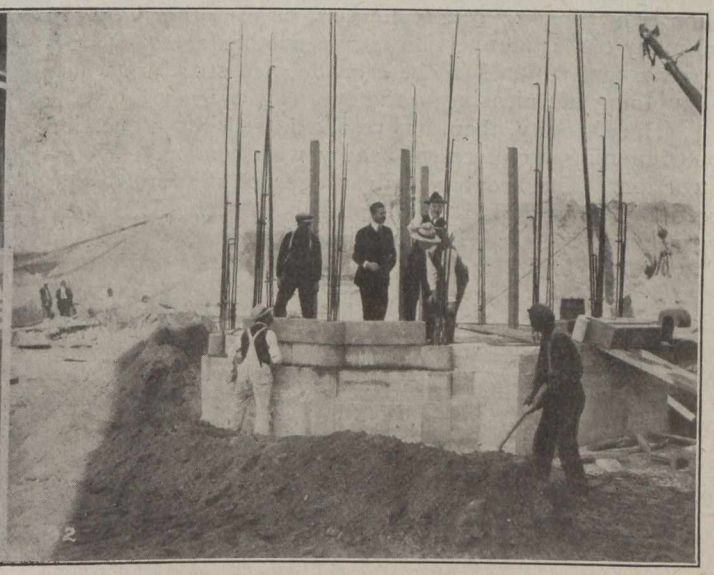


Fig. 2.—Laying the Blocks.

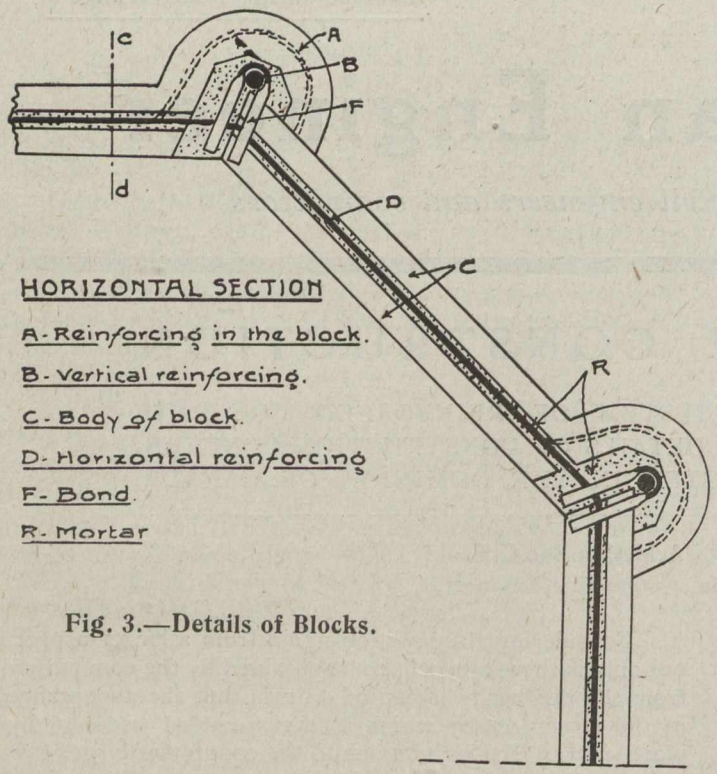
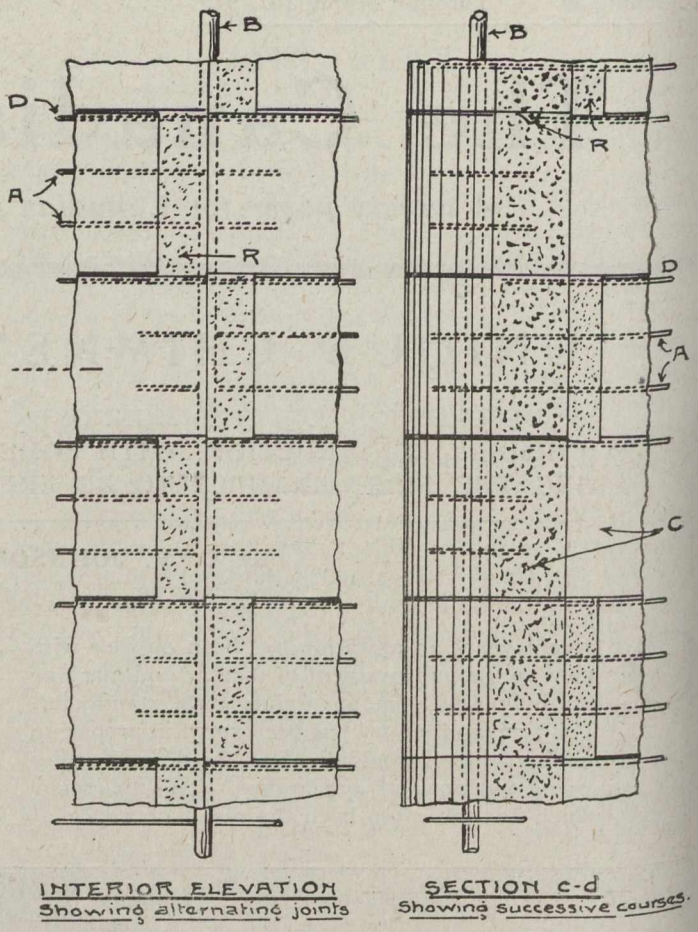


Fig. 3.—Details of Blocks.



generally of brick construction, brick having, until recently, lent itself more readily to the attainment of this object than either steel or concrete. But, on the other hand, in so many cases the question of expense has acted as a deterrent, and resulted in the erection of a structure which is anything but pleasing to the eye.

The difficulty, then, has resolved itself into a question of combining architectural beauty with economy of construction. The economic advantages of reinforced concrete are indisputable, this having been recognized some years since by our neighbors across the line, with whom

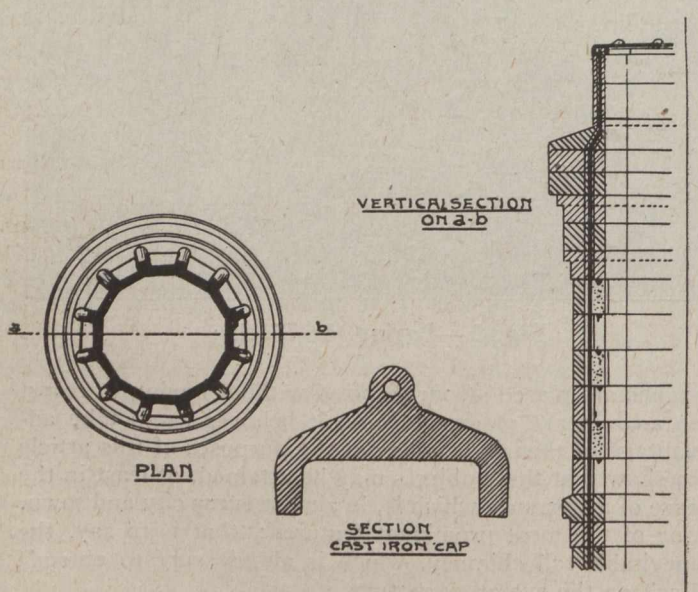


Fig. 4.—Details of Chimney.

rests the credit of first carrying out chimney constructions by means of reinforced concrete. The system first adopted was a chimney of cylindrical form, consisting of two distinct shafts separated by an air space of from three to four inches. This design was generally used until the year 1909, when the conical chimney was adopted as being more stable, less costly, and of better appearance. It was,

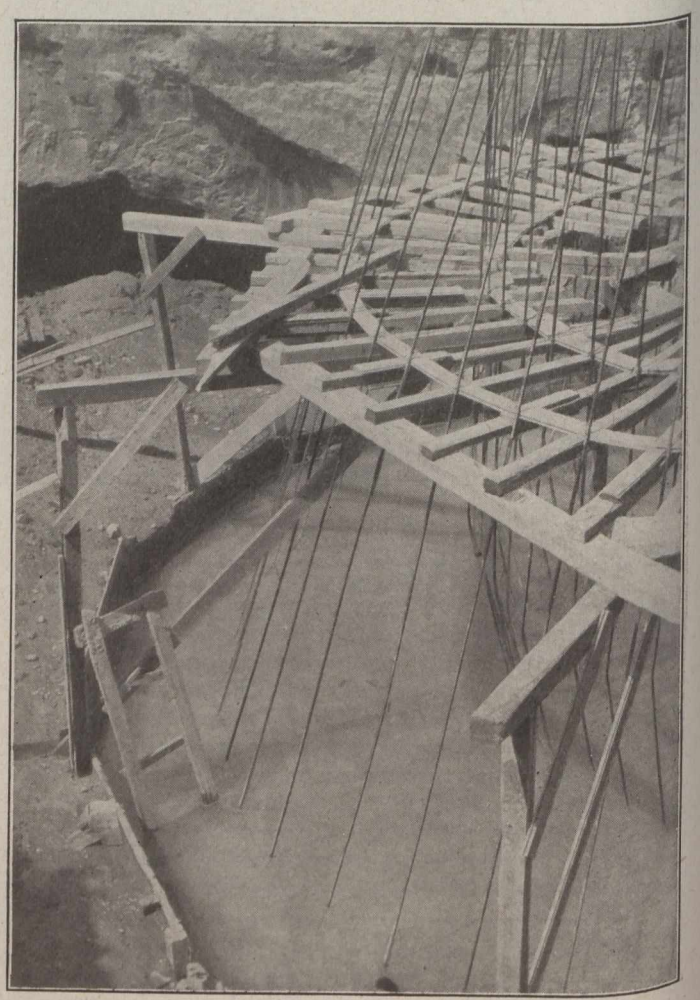


Fig. 5.—Foundation Reinforcing.

however, some years before this—to be exact, in the year 1906—that our Belgian confreres had evolved a reinforced concrete chimney construction which combined stability, and economy and rapidity of construction with an artistic appearance unequalled by any other design.

In 1914 the first chimney of this type to be erected in Canada was constructed for the National Transcontinental Railway shop plant at Quebec. Of this chimney a more detailed description will follow.

General Construction.—For a general description of the Monnoyer chimney a translation of the information imparted by the Belgian engineers themselves will be given. On general lines it is as follows:—

Fig. 6.—Forms for Foundations.

"The basic principles of the construction is, in the larger aspects, similar to other designs; that is to say that they are composed of a foundation, a base, and a shaft, all of which are of reinforced concrete.

"The foundations and footings being constructed at, or in the vicinity of, the ground level, do not present any unusual problem, but it is the shaft itself wherein rests the niceties of construction.

"The shaft is constructed of blocks 10 ins. in height for the current diameters. These blocks, which vary in number in accordance with the diameter of the chimney, constitute by their assemblage a course which is then 10 ins. high. Each one of them is formed with a hollow projection or hook at one end (Fig. 1), which is set immediately over the corresponding projection on the block below. These projections constitute also the vertical ribs of the chimney, and it is in these ribs that the vertical reinforcing bars are placed (Fig. 2). The reinforcing bars are carried up continuously by means of joints the full height of the chimney, and are at the same time firmly anchored in the foundations.

"The blocks themselves, which may be constructed in a work-shop or any convenient place, are reinforced with steel rods to make them capable of enduring the strain of transportation and placing. Each block has in its upper surface a groove, in which is lodged the horizontal reinforcing rod, forming a bond sunk in the joint.

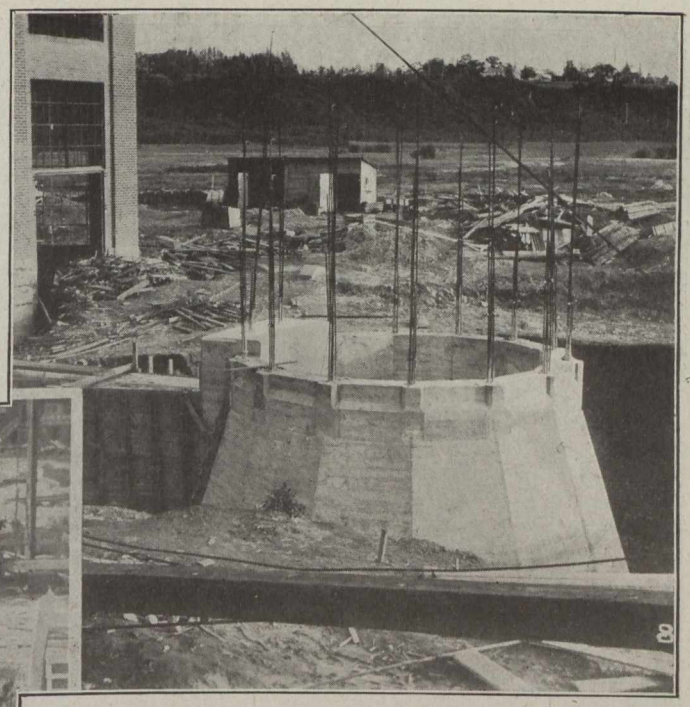


Fig. 7.—Foundations with Forms Removed.

"The square end of the block is set in the head of the block adjoining; that is to say, the portion which constitutes the rib; and as this method of placing allows of considerable latitude in the setting of the blocks, it permits a variation in the diameter of each course, thus obtaining the conical shape so indispensable to a favorable appearance.

"The operation of erecting is effected very rapidly; masons working in the interior of the chimney, receive their blocks ready to lay, put them in place, mortar the 10 inches in the interior of the rib, prepare the joints for the new blocks, and continue very rapidly to lay them.

"The chimneys are, in general, terminated at their summits by one or two bands of specially constructed blocks, and a cast iron coping."

Fig. 8.—Backfilling Around Foundations with Hayward Bucket.

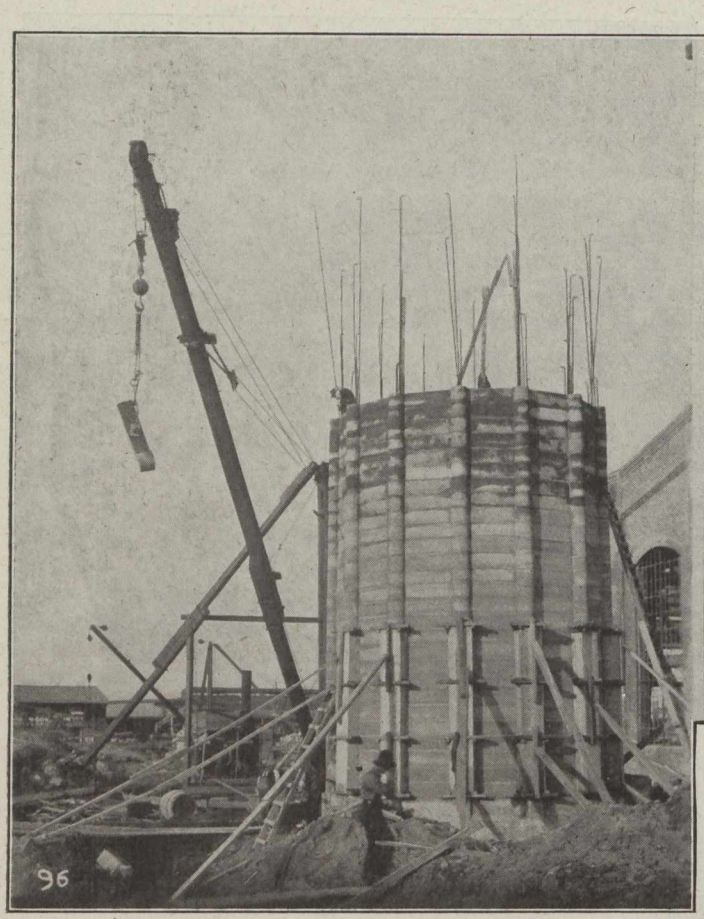


Fig. 9.—Placing Blocks with Derricks.

The Canadian Example.—The chimney constructed at Quebec for the locomotive shop plant of the National Transcontinental Railway is 200 feet in height above the ground level. The inside diameter at the summit is 9 ft., and at the base 14 ft. The foundations were carried down to solid rock, which was encountered 19 ft. below the surface. The smoke flue, which opens into the chimney below the ground level, is 11 ft. 5 ins. high by 5 ft. 6 ins. wide inside, and is constructed of reinforced concrete.

The vertical reinforcing rods in the foundations were carried into the footing almost to the base, and continued to the top of the foundation, overlapping and bonding those of the superstructure for a length of from four to five feet.

In constructing the foundation the footing was first poured for a depth of one foot, then the vertical rods were set and held in place by means of wood framing, as shown in Fig. 5. After these rods were placed the balance of the footing, about 3 ft., was poured, and allowed to set. The framing was then removed from the rods, and the forms for the balance of the foundation constructed (Fig. 6). The concrete in the footings was poured by means of a derrick and a bottom-dumping bucket; but for the upper portion it was found more convenient to use barrows, owing to the limited space between the forms, and the quantity of steel which had to be held in place during the work. Before reaching the top of the foundation the reinforcing rods for the superstructure were placed and the concrete poured around them. The concrete was then allowed to set and the forms removed before commencing to lay the blocks. An illustration of the foundation ready to receive the blocks is shown in Fig. 7; and the backfilling of the earth around it with a Hayward orange peel bucket in Fig. 8.

Fig. 10.—Tamping Concrete in the Forms.

In the meantime the making of the blocks was proceeding in an adjoining shed, so that by the time the foundation was completed there were sufficient blocks on hand to keep the erection going continuously.

The blocks were made in four collapsible forms, these being so constructed that they served equally for all blocks from 4 ins. to 9 ins. in thickness, and any length desired. The labor employed consisted of two masons and three helpers, the concrete being mixed in a small gasoline-driven mixer. The concrete, which consisted of a 1 : 2 : 4 mixture, was placed in the forms in a semi-dry state, the reinforcing rods inserted, and the whole well tamped (see Fig. 10). Immediately upon the completion of a block it was removed from the form and placed to one side, to be sprinkled daily for a period of about two weeks or until ready for laying. It is perhaps needless to state that the forms were well cleaned and soaped after each operation. The whole operation of making the blocks, 3,290 in all, occupied 82 working days, or an average of approximately 40 blocks per day.

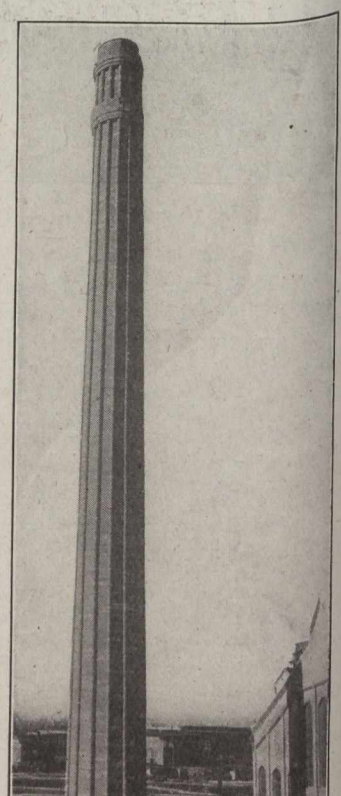


Fig. 11.—Completed Chimney.

On September 16, 1914, the first blocks were laid

on the foundations, and the chimney completed on December 10th following. The construction could have been carried on much more rapidly, but as there was no particular hurry the men worked only in fine weather, and occupied themselves in bad weather making blocks under shelter. The labor employed in erecting the chimney consisted of two masons and five helpers. With this force it is possible to lay six courses of fourteen blocks each in one day.

In the erection the blocks were at first hoisted into place by means of a steam-driven derrick (Fig. 9), and the mortar hauled up in buckets with a rope. When the chimney had attained too great a height for the derrick a hoist was installed on a platform in the interior, and a gasoline engine placed at the end of the smoke tunnel in the power house. By this method the blocks and mortar were hoisted up inside the chimney, and the construction continued thus until the finish. Fig. 11 is a view of the completed chimney taken in the summer following its erection.

For the mortar forming the bonds between the blocks a mixture of one of cement to two of sand was used. The chimney was lined inside with 4 ins. of firebrick set in fireclay, to a height of 50 ft. above the top of the smoke flue. A sectional steel ladder was built up along with the erection of the chimney, the supports being tied into the vertical reinforcing rods. The whole was surmounted with a cast iron cap, similar to that shown in Fig. 4, into which was set the lightning rod.

The design for the shaft of the chimney was prepared in Paris, France, by the engineers of the Monnoyer Company. The foundations were designed by, and constructed under the supervision of, the engineers of the general contractor, Jos. Gosselin, of Quebec and Levis. The subcontractor for the erection of the superstructure was the firm of Ed. Pelletier & Fils, of Quebec, which firm holds the patent rights for this system in Canada and the United States.

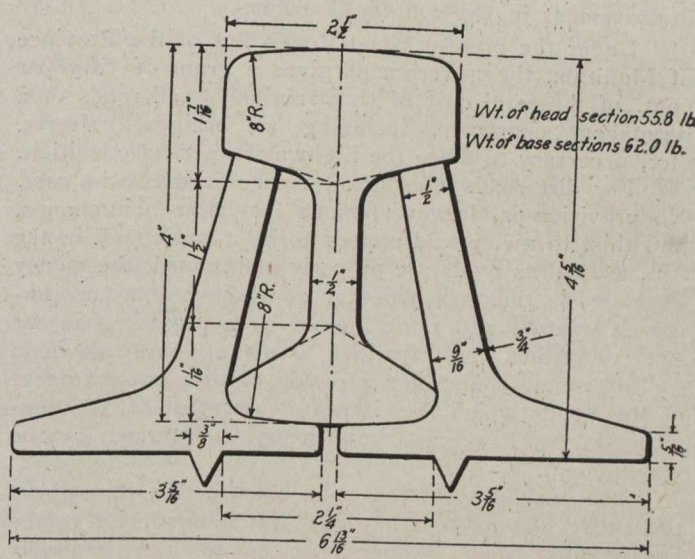
In conclusion it might be stated that this system of reinforced concrete is also successfully used in the construction of water tanks, condensers, and dust towers, many beautiful examples of which may be seen in the various countries of Europe.

The offices of the Mexican Petroleum Company, the Huasteca Petroleum Company, the Petroleum Transport Company and the Caloric Company have been moved from 52 Broadway to 120 Broadway, New York City.

The estimated value of the forest products of Canada in 1914 was $176,672,000, as compared with $177,120,000 in 1913, $182,300,000 in 1912, and $170,600,000 in 1911. The total of $176,672,000, representing the value of the production of 1914 was made up as follows: Lumber, lath and shingles, $67,500,000; firewood, $60,500,000; pulpwood, $15,500,000; posts and rails, $9,500,000; cross-ties, $9,000,000; square timber exported, $400,000; cooperage, $1,900,000; poles, $700,000; logs exported, $850,000; tanning materials, $22,000; road mining timbers, $500,000; miscellaneous exports, $300,000; and miscellaneous products, $10,000,000. Spruce is the most important wood in Canada for the production of lumber and pulp. Maple is used for firewood as well as for furniture, cars, agricultural implements, hardwood flooring and distillation. Cedar is the most important wood in Canada for poles, fence-posts and rails, cross-ties and shingles. White pine and Douglas fir are important lumber species. Beech, poplar and jack pine are used in large quantities for fire wood. Red pine, hemlock, and tamarack are lumber woods of less importance. Balsam fir is an important pulp-wood. Yellow pine grows in the interior of British Columbia, and covers a large area in the dry belt. Elm is an important cooperage wood, together with oak, ash, and basswood.

A NOVEL RAIL SECTION.

A marked departure from the commonly accepted designs of rails is seen in a rail now in use in 40 ft. of track on the main line of the Minneapolis, St. Paul & Sault Ste. Marie near Minneapolis, Minn. The rail is made up of three separately-rolled members, as shown in the accompanying cross-section. The central portion, shaped like the English bullhead rail, is enclosed except the head, by two T-shaped supporting sections, the three pieces being of such proportions that the central part is supported on the underside of the head and also on the base. Holes are provided in the outstanding legs of the supporting sections for spiking or bolting the rail to the ties. No other fastenings are used either to hold the three portions together or to splice the joints. One advantage claimed for this rail is that by staggering the joints in the centre or tread section with reference to those in the supporting sections, no splices of any kind are required. Another advantage suggested is that the portion subject to wear com-



Dimensions of the Compound Section.

prises only one-half the weight of the composite section and can be renewed independently of the supporting portions which are not subject to wear.

The rails in use on the "Soo" were installed in November, 1914, and consist for each rail of a 20-ft. length of head section in the centre with a 10-ft. length on either end, supported on two 20-ft. lengths of base sections, thus breaking the joints. A special compromise joint was provided for the connection to the standard rail on either end. Owing to the small amount of this rail used it was not rolled, but was planed out of solid material, a bloom serving as a blank for the head section, while an I-beam served the same purpose for the base section. The track has been inspected frequently, but the length of service has been too short to demonstrate the true merits of the new section. Future developments will be watched with interest. The rails were furnished by the American Safety Steel Rail Company, Bismark, N.D.

German chemists have been trying to find a use for "carbide-mud," or the residue from the union of calcium carbide and water. The "Chemiken Zeitung," Berlin, now states that when mixed with 40 per cent. of building sand this residue makes a very usable mortar, which hardens well and binds stones firmly together.

THE ATTITUDE OF LEGISLATURES TO THE GOOD ROADS MOVEMENT.*

By A. C. Emmett, Winnipeg.

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

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

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

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

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

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

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

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

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

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

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

*Paper read before the 3rd Canadian and International Good Roads Congress, Montreal, March 6-10, 1916.

At a case argued before the North Carolina Supreme Court it was established that a power company that owns land on one side only of a stream is not entitled to build a dam to the middle of the stream and divert one-half the water through a flume for use in developing power, although the water be returned to the channel before leaving the company's land. In reaching this decision the court cites New York and Maine cases as upholding the principle that each of opposite riparian owners has an indivisible right to the enjoyment of the full flow of the stream.

The Nord Railway of France has suffered more through the war than any other French railway. In September, 1914, only 414 miles, or 18 per cent. of the total network of 2,324 miles, was actually being operated by the company, which indicates the invaluable military services which the Nord rendered during the earliest stages of the war. To-day the company is operating a total length of about 1,200 miles, or 51.5 per cent. of the entire system. Of the 768 stations on the system, 346 are at present either occupied by the enemy or closed to traffic. Not all the remaining 412 stations are open to the public, a certain number being exclusively reserved for military purposes. The actual situation is that for over a year the Nord has been deprived of the use of most of its great arteries, and the only double-track main line now available is that from Paris to Creil, Amiens, Boulogne, Calais and Hazebrouck.

THE USE OF AMMONIA IN THE CHLORINATION OF WATER.

By Joseph Race, F.I.C., City Bacteriologist, Ottawa.

In the course of some experiments on the effect of color, turbidity, and temperature on the chlorination of water, the writer thought it would be interesting to determine the relative efficiencies of various hypochlorites. Nothing worthy of mention was observed until ammonium hypochlorite was used; this was prepared in solution by the double decomposition of calcium hypochlorite and ammonium oxalate, and great care was exercised to prevent the addition of an excess of oxalate, which, if present, would introduce a factor of unknown value. It was anticipated that the reaction would proceed somewhat along the lines represented by the following equation:

$Ca(OCl)_2$		$(NH_4)_2C_2O_4$		CaC_2O_4		$2NH_4OCl$
Calcium	+	Ammonium	=	Calcium	+	Ammonium
Hypochlorite		Oxalate		Oxalate		Hypochlorite

The calcium oxalate was deposited by centrifuging at a high speed and the supernatant liquid removed for experimental work.

In testing the effect of this solution on a culture of B. Coli Communi or seeded into raw Ottawa River water, the author was very surprised to find that the germicidal value was very much in excess of the hypochlorite of calcium, sodium and potassium. The velocity of the reaction as calculated by the formula

$$K = \frac{\log \frac{N_1}{N_2}}{t_2 - t_1}$$

in which N_1 represents the number of organisms at t_1 and N_2 at t_2, showed that with 0.3 parts per million of available chlorine in each instance, the value of K for ammonium hypochlorite was twenty to thirty times as great as that of calcium hypochlorite. This experiment was confirmed by others which gave similar results.

In searching for an explanation of this phenomenon it occurred to the writer that it was probable that ammonium hypochlorite was exceedingly unstable in dilute solution and spontaneously decomposed into chloramine and water as represented by the following equation:

NH_4OCl		NH_2Cl		H_2O
Ammonium Hypochlorite	=	Chloramine	+	Water

Chloramine has been shown by Rideal (Journal R.S.I., 1910, 31, 33-45) to have a much greater germicidal action than an equivalent of chlorine. Rideal deducted this fact from experiments on the chlorination of sewage in which he found that "the first rapid consumption of chlorine or hypochlorite was succeeded by a slow action which continued for some hours, even days, and was attended by a germicidal power after free chlorine or hypochlorite had disappeared." . . . "It became evident that chlorine, in supplement to its oxidizing action, which had been exhausted, was acting by substitution for hydrogen in ammonia and organic compounds, yielding products more or less germicidal." Rideal supported this by determining the carbolic coefficients of hypochlorite, and of hypochlorite with the addition of an equivalent of ammonia. These gave values of 2.18 and 6.36 respectively. Although Rideal seems to have made this experiment merely for the purpose of explaining an observed phenomenon, it is curious that the possibilities of its practical application to water and sewage disinfection seem to have either been entirely overlooked or discarded on account of economic considerations.

After noting the above-mentioned facts in connection with ammonium hypochlorite, the writer followed up Rideal's work and produced dilute solutions of chloramine by the addition of ammonia to calcium hypochlorite solutions. These had the same germicidal power as the chloramine produced by double decomposition and were approximately three times as efficient as an equal quantity of hypochlorite.

The next step was to determine the relative proportions of hypochlorite and ammonia that would yield the greatest efficiency. The results obtained, though not entirely conclusive as to the most efficient ratio, showed that an increase in the ammonia beyond an equivalent of the chlorine (available chlorine : ammonia as NH_3 = 2 : 1 by weight) did not produce results commensurate with the increase of ammonia. Half an equivalent of ammonia, or chlorine : ammonia = 4 : 1 gave inferior results but the reduction in efficiency was very much smaller than the reduction in the ammonia. The relative proportions of chlorine and ammonia must also be considered from the economic standpoint and when this process is carried out on a large scale, these various considerations will demand a rather fine adjustment.

A remarkable feature of the treatment of water with a mixture of hypochlorite and ammonia is the almost entire absence of absorption. On adding bleach to the Ottawa River water so as to produce a mixture containing 10 parts per million of available chlorine, about 35 per cent. is absorbed in 5 minutes at 60° F. and 60 per cent. within one hour. If an equivalent of ammonia is first added to the bleach, only 1.4 per cent. of the available chlorine is absorbed in one hour and 3.2 per cent. in 20 hours. As there is practically no absorption of the germicidal agent, the longer the contact period the better will be the results obtained. For instantaneous sterilization the relative efficiency ratio of 3 : 1 for the mixture of chlorine and ammonia as compared with chlorine cannot be obtained, but with the increase of contact period the efficiency ratio also increases and after about 40 minutes the ratio becomes greater than 3 : 1. The germicidal action of the mixture continues to persist on account of non-absorption and for a comparatively long time, and as a consequence of this no aftergrowths are produced.

Cost.—Basing the calculations on a ratio of one equivalent of ammonia to one equivalent of available chlorine (0.5 part per million NH_3 to 1.0 p.p.m. available chlorine) a very conservative estimate of the most efficient ratio, this process becomes economical when the price of hypochlorite exceeds $2.08 per 100 pounds. This statement is based on the mixture produced being three times as efficient as hypochlorite: that 33 per cent. of available chlorine can be obtained from bleach and that ammonia can be purchased for 25 cents per pound. The efficiency ratios of 3 : 1 can be obtained under the conditions of chlorination usually found and no alteration in the point of application will be required. Bleach containing more than 33 per cent. of available chlorine can be obtained but very few plants actually extract more than this amount as there are certain losses which are unavoidable. The present price of ammonia (aqua 16° B.) is quoted in the United States at 2¼ to 2½ cents per pound. This solution contains 10.3 per cent. of NH_3 and the anhydrous ammonia is therefore worth 22 to 25 cents per pound. In Ottawa bleach can be obtained for $3.70 per 100 pounds, and by the adoption of the ammonia process the heavy dosage of one part per million of available chlorine re-

quired to treat the Ottawa River water (color 40 p.p.m. platinum scale) can be reduced to 0.33 p.p.m. with a saving of about $7 per day or $2,500 per annum if the laboratory results can be duplicated under service conditions. In the United States, where much higher prices prevail for bleach, the advantage to be gained by the substitution of the ammonia process is, of course, even greater.

Aesthetic Conditions.—For some years it has been considered as at least probable that the fishy odor and taste of heavily chlorinated water was caused, not by the chlorine or hypochlorite, but by substituted nitrogenous compounds. At first sight it would appear that by the addition of the substituted nitrogenous compounds contained in the ammonia mixture, this objection would be accentuated and deprive the process of its practical value. In practice no such result is obtained, and no trace of the added mixture can be detected. As the total amount of chlorine added to the water is only about one-third of the usual dosage, the total amount of chlorine compounds, nitrogenous and otherwise, is only one-third also, and complaints regarding taste and odor should be reduced and not increased by the adoption of the new process unless the compounds produced are totally different in the two cases.

Since writing the above, the author has applied the process to a small plant treating 200,000 Imperial gallons per day and has met with unexpected difficulties. When a 10 per cent. solution of bleach was made and strong ammonia (0.880) added, a rapid loss of available chlorine resulted. This was reduced considerably by diluting the hypochlorite solution before adding the ammonia, but even then the results were not satisfactory. Laboratory experiments confirmed the loss produced by mixing comparatively concentrated solutions and also that the loss could be obviated by immediate dilution with large volumes of water. The arrangements in the experimental plant are now being altered so that the ammonia and hypochlorite will only mix for a few seconds before dilution with the raw water in the intake pipe.

Although various details have yet to be worked out, these notes are published in the hope that others will take up this work and endeavor to work out a process that will give some relief from the present exorbitant price of hypochlorite.

IMPROVEMENTS IN COAL-HANDLING PLANTS.

A COAL-HANDLING plant recently installed at Southend-on-Sea for the Corporation Electric Works, presents some interesting engineering features. It was built by Ed. Bennis & Co., of Little Hulton, Bolton, who were successful in the competition which was held prior to awarding the contract.

The arrangement consists of a series of overhead storage bunkers with a capacity of 500 tons. A bucket elevator raises the coal from a dumping hopper and it is distributed to the bunkers by a conveyer. The dumping hopper is equipped with a Bennis rotary safety feeder, which keeps a steady supply of coal filling the buckets. The elevator is 70 ft. long and will raise 20 tons of coal per hour. It is practically dust-proof. The elevator delivers coal through a chute to a Bennis steel chain conveyer. This consists of a series of mild steel bars pressed into the form of a "U". The chain moves along a rectangular trough and carries the coal with it.

The bunkers are built up of mild steel plates and sections riveted together to form a series of rectangular bins with hopper bottoms. A number of openings are placed in the bottom of each bin and are provided with outlet chutes and radial cut-off valves. The cut-off valves are operated by chains from the firing floor. A swing chute is suspended beneath each outlet for guiding coal from the bunkers to the stoker hoppers. The chutes are made to swing back out of the way when boiler tubes are being cleaned or renewed.

The bunkers have a total length of 106 ft. Their vertical sides are 11 ft. deep, and their top is about 39 ft. above the firing floor level. They are carried on twelve stanchions formed out of rolled steel joists, 27 ft. long, resting on concrete pillars built level with the firing floor. A superstructure is built on top of the bunkers to carry the conveyer, which works in a chamber carried the full length of the bunkers. The sides and roof of the chamber are formed with corrugated sheet in which continuous windows are set in each side. Access is obtained to the conveyer chamber by a ladder on the elevator frame. The extreme height from the bottom of the stanchions to the top of the superstructure is about 56 ft.

Another case which required a different arrangement of the conveying plant was at Wigan. Here the coal is unloaded from barges at a point about 80 ft. away from the boiler house and in the interests of economy it became necessary to provide some effective mechanical means for conveying the coal from the canal to the boiler house. The scheme put into operation is to load the coal by hand from the barges into skips, which are hooked on to a travelling electric transporter running along an overhead track; extending between the boiler house and the canal. The transporter raises the loaded skips and carries them along the overhead track, after which they are emptied into a receiving hopper placed above an automatic weighing machine. The weight of the coal is automatically recorded, and it passes on into a second hopper with two outlets. These outlets feed two chain conveyers, similar to the one in use at Southend-on-Sea, which discharge into two overhead coal bunkers placed about 100 ft. apart.

At this plant the bunkers are 7 ft. 6 in. wide by 7 ft. 9 in. high by 80 ft. long. They are constructed with a framework formed of rolled steel sections with the space between filled in with panels of brickwork and concrete, the whole being braced together to form a rigid structure. Small hoppers are built in the bunker floor, above each chain-grate stoker, and the coal passes by gravity from the bunkers to the stokers through a series of chutes, arranged similarly to those at Southend-on-Sea, so as to swing back and allow access to the boiler tubes. The bunkers are supported on rolled steel joists, built into the boiler house wall, at one end, and supported on stanchions at the other end.

The Orillia Molybdenum Company, Orillia, Ontario, has made its first shipment of two tons of concentrates of molybdenum to the British War Office. This is the first time that such ore has been treated in Canada. The company has received instructions from the War Office to make weekly shipments.

At no time in the history of the pulp and paper industry in Canada was business better than it is at the present time, according to "Pulp and Paper Magazine." It may be true that a few years ago there was a boom and a number of new companies were formed, but their inception was largely the work of promoters and speculators rather than a result of the natural expansion of the industry. To-day, however, business is improving as a result of increased demands. There are nearly a dozen Canadian mills making additions to their plants, increasing their output or preparing to build new mills. A number of other companies are being formed for the purpose of building plants in Northern Ontario and Northern Quebec.

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

By Francis P. Smith, Ph.B., M.A.S.C.E., M.A.I.C.E.

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

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

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

On account of their smoothness, sheet asphalt pavements are not suitable for use on excessive grades. Generally speaking, streets carrying a fair amount of traffic can be paved with asphalt if the grade does not exceed 6 per cent. In some cases, where the traffic was very light and a smooth pavement was considered essential, it has been laid on grades running up to 10 per cent. and 12 per cent., but this is rather exceptional. Where the traffic is heavy, a 3 per cent. to 4 per cent. grade is usually considered as the limit. In most of the largest cities of the United States the maximum grades on which this type of pavement is laid vary from 4½ per cent. to 8 per cent., regulated largely by the traffic and climatic conditions.

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

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

Hot-mixed bituminous pavements differ from each other chiefly in the size and kind of the mineral aggregate, the bituminous cement or binder being substantially the same in each case. Sheet asphalt pavements have a mineral aggregate which contains no particles which would be retained on a one-quarter-inch sieve. Topeka mixture pavements consist of a standard sheet asphalt mixture to which has been added from 15 to 25 per cent. of stone passing a one-quarter-inch screen and retained on a ten-mesh screen and 10 per cent. or less of stone passing a half-inch screen and retained on a one-quarter-inch screen. It is really a type of bituminous concrete pavement, although in certain sections this term is only applied to pavements having a mineral aggregate consisting wholly or largely of stone of varying sizes, from 1½ inches down. The coarser the aggregate used, the rougher will be the surface of the finished pavement. On grades, therefore, where the traffic is not excessively heavy, coarse aggregates are to be preferred. Generally speaking, the heavier the traffic the finer should be the mineral aggregate used, owing to the fact that the coarse particles are more liable to fracture than the smaller particles. Where fracture takes place to any considerable extent rapid deterioration of the pavement will ensue, as the bituminous cement ordinarily used is not sufficiently fluid at atmospheric temperatures to re-bond and re-coat the fractured particles.

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

The character of the foundation required will depend upon the traffic, climate, character of subsoil and drain-

*Read before the 3rd Canadian and International Good Roads Congress at Montreal, March 6-10.

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

A number of different types of foundations have been successfully employed, such as old macadam; broken stone, rolled dry or cemented together with some form of bituminous cement; old cobblestone, Belgian block or granite sett pavements; old brick or asphalt block pavements; bituminous concrete; natural cement and Portland cement concrete. Where the traffic is light, as on country roads which are not main arteries from or between large cities, and in some residential streets, old macadam roads have proved to be suitable foundations for bituminous surface mixtures.

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

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

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

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

Concrete foundations vary according to conditions from 4 to 9 inches in depth, and in every case before laying them the subsoil should be thoroughly compacted. In certain localities in the north-western portion of the United States and Canada very heavy clay soils are found which in winter frequently develop cracks 4 to 5 inches in width and heave very badly. In such cases cross-trenches should be dug every 25 or 30 feet and filled with coarse broken stone and connected with longitudinal trenches at the side of the street similarly filled and draining to catch-basins. Concrete should not be laid directly on such a soil. Sand or gravel should first be spread upon it to such a depth that when rolled it will form a layer 3 to 4 inches in thickness, and the concrete should be placed on this.

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

Sand should be clean-grained, hard and moderately sharp. The grains should be chiefly quartz, and should have rough, pitted surfaces. Where necessary the proper grading of the different-sized grains must be obtained by mixing several sands, or in certain cases by the addition of unweathered crusher screenings. When using the ordinary type of bituminous mixing plants the presence of clay is undesirable, either as a coating to the grains or disseminated throughout the mass. For medium or heavy traffic pavements all particles retained on a 10-mesh screen should be discarded. For light traffic 3 to 5 per cent. of 8-mesh particles can be incorporated in the pavement with advantage, or broken stone of the sizes and in the amounts described under "Topeka Mixture." Sands containing a large amount of flinty grains should be avoided.

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

Broken stone should be freshly crushed, preferably in cubical-shaped particles. The size and hardness required depend upon the traffic which the pavement is to carry. Dense, hard limestone will carry medium and light traffic satisfactorily. Where the traffic, even though comparatively light in volume, is composed of heavy, iron-tired units, a dense, hard trap is required. Trap is now commonly used in the manufacture of asphalt block, although in the past a large number of asphalt blocks made from limestone gave excellent service under light

traffic. Granite is not usually satisfactory as it is too coarse and uneven in texture, and much of it is friable and it is liable to shatter in crushing. Mesh composition or grading of the various-sized particles is just as important as with sand. It is not suitable for use in pavements carrying very heavy traffic.

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

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

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

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

Measured or weighed (preferably the latter) amounts of the various ingredients are then mixed together in a twin-shaft mixer of the pugmill type. This mixer should have a speed of from 65 to 85 revolutions per minute, and for ordinary work each batch should receive a full minute's mixing. Where the service conditions are very severe it may be necessary to increase the time allowed for mixing, and also raise the temperature at which the mixing is done in order to ensure a thorough coating of the surface of all particles with a firmly adherent film of bituminous cement. Great care must always be taken not to overheat either the mineral aggregate or the bituminous cement, as this will injure and harden the latter. Too low a heat will result in imperfect coating of the mineral particles. Certain asphalts are fluid at much lower temperatures than others, and certain asphalts are very readily injured by overheating while others are not. In the type of plant which we have been considering clay or clayey particles are objectionable, owing to the fact that they either become partly baked on the grains of sand or pieces of stone, or form into lumps which do not detach themselves or break up under the action of the mixer blades. This prevents the bitumen from adhering to the grains, or else results in coating the outside only of the clay balls. Under traffic these balls break up and the bitumen becomes detached from the coated grains, tending toward more or less rapid deterioration of the pavement.

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

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

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

Topeka mixture pavements are laid from 2 to 3 inches thick, and are frequently placed directly on the foundation. Much better results are obtained by using a binder course 1½ inches thick next to the foundation, with a 1½ to 2-inch wearing surface. This greatly reduces the tendency of the finished pavement to shove. With a well-graded mixture a squeegee coat is unnecessary, although it is frequently employed.

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

The standard sheet asphalt construction of the present day is 1½ inches of binder and 1½ inches of wearing surface. The binder should be of the "close" type; i.e., should contain approximately 25 per cent. of material passing an 8-mesh sieve.

A close binder, properly made and laid, will be superior in many respects to the mixtures which have been laid on a large number of country highways, and will carry a fair amount of traffic for a considerable time without suffering any serious damage. Poor binder will break up very easily—sometimes it can be kicked up—and the hauling of the hot surface mixture over it will damage it very seriously. Surface mixture laid on a binder of this kind which has been badly broken up might almost as well be laid on loose broken stone, and will not give satisfactory service under heavy traffic. The binder should, of course, be thoroughly compressed with a steam roller before laying the wearing surface on it. Lack of compression will produce an unsatisfactory foundation for the wearing surface, and binder which is too cold, or made with too hard an asphalt cement or an insufficient quantity of asphalt cement, cannot be properly compressed into a dense, tough mass. In hauling the binder to the street over long distances or in very cold weather, it may become chilled below the danger point. During the hauling process a certain amount of surplus asphalt cement usually drains off of the stone

and accumulates on the bottom of the cart or wagon. If these excessively rich portions be laid on the street, what are called rich or fat spots in the binder course will be produced. As the name implies, these are places carrying an excess of asphalt cement. If these are permitted to remain, the surplus asphalt cement will be absorbed by the hot surface mixture when it is placed over them. This will make a soft spot in the finished pavement, which will be displaced by traffic, and eventually produce a hole or depression in the pavement. They should, therefore, be cut out and replaced with normal binder.

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

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

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

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

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

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

COBALT ORE SHIPMENTS.

The following are the shipments of ore, in pounds, from Cobalt Station for the week ended February 25th, 1916:—

Dominion Reduction Company, 88,000; McKinley-Darragh-Savage Mines, 86,762. Total, 174,762 pounds, or 87 tons.

The total shipments since January 1st, 1916, are now 4,253,414 pounds, or 2,126.7 tons.

RAILROAD EARNINGS.

The following are the weekly railroad earnings for February:—

Canadian Pacific Railway.

	1916.	1915.	
Feb. 7	$1,876,000	$1,440,000	+ $436,000
Feb. 14	1,912,000	1,634,000	+ 278,000
Feb. 21	2,093,000	1,614,000	+ 479,000
Feb. 29	2,665,000	1,815,000	+ 850,000
Month's increase =	31.4%	or	+ 2,043,000

Grand Trunk Railway.

Feb. 7	$ 937,937	$ 786,158	+ $151,779
Feb. 14	957,195	817,255	+ 139,940
Feb. 21	963,484	823,436	+ 140,048
Feb. 29	1,174,099	899,187	+ 275,912
Month's increase =	21.3%	or	+ .....

Canadian Northern Railway.

Feb. 7	$ 429,400	$ 357,100	+ $ 72,300
Feb. 14	453,100	380,500	+ 72,600
Feb. 21	559,000	418,200	+ 140,800
Feb. 29	647,700	446,400	+ 201,300
Month's increase =	30.3%	or	+ 487,000

The Canadian Pacific Railway January returns compared with returns of a year ago are as below:—

	1916.	1915.	
Gross	$ 8,588,826	$ 6,109,026	+ $ 2,479,799
Expenditure	6,498,417	4,968,793	+ 1,529,624
Net	$ 2,090,408	$ 1,140,233	+ $ 950,174

For the seven months ended January 31st, the comparisons are:—

	1916.	1915.	
Gross	$75,058,989	$62,047,152	+ $13,011,837
Expenditure	43,344,394	41,233,342	+ 2,111,051
Net	$31,714,595	$20,813,809	+ $10,900,785

THIRD CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS AND EXHIBITION

DELEGATES FROM ALL PARTS OF CANADA AND UNITED STATES MEET IN MONTREAL MARCH 6 TO 10.

THE most successful congress of the Good Roads men, under the auspices of the Dominion Good Roads Association and the Canadian Automobile Federation, was held last week in Montreal. The convention opened on Monday, March 6th, and concluded on Friday, the 10th.

Equalled in importance by few other annual conventions, inasmuch as the deliberations which will result, and the practical suggestions which must come as a matter of course, entail the advancement, the improvement and perfecting of one of the country's great assets —good roads—which must be carried along to that standard towards which other endeavors are being aimed if the promised all-round prosperity is to come to Canada.

The chairman of the convention was the president of the congress, B. Michaud, Deputy Minister of Roads for Quebec Province. The list of prominent men in the provincial life of Canada who attended the opening were many, there being present the Lieutenant-Governor, Hon. P. E. Leblanc; Hon. J. A. Tessier, Minister of Roads; Hon. J. E. Caron, Minister of Agriculture; U. H. Dandurand, honorary president of the Dominion Good Roads Association; Hon. Jeremie Decarie, Provincial Secretary; Monsignor Roy, representing Archbishop Bruchesi; Bishop Farthing, Controller Thomas Cote and I. A. Sanderson, representing the Ontario Good Roads Association.

The delegates came, from all parts of the country and many were present from the large centres of the United States, where the good roads problem is considered a vital one. President B. Michaud, Deputy Minister of Roads for Quebec province, formally welcomed the delegates, and remarked on the honor it was for the convention to be opened by the Lieutenant-Governor, Hon. P. E. Leblanc. Mr. Michaud laid stress on the importance of the many scientific addresses to be heard and discussed. He said he was exceedingly glad to welcome delegates from sister provinces and from the United States.

His Honor the Lieutenant-Governor said the good roads question was one of vital importance. They provided the means of communication, placed citizens of the various municipalities in the position of relationship which was the basis of the progress and the welfare of the country. He paid tribute to the Roman road-makers and the builders of good highways in the time of Napoleon, remarking that these roads were still the objects of admiration in Great Britain and in France. The Lieutenant-Governor said that the Province of Quebec was now delving energetically into the good road work and wished for the co-operation of everyone interested in the advancement of these great national assets.

U. H. Dandurand, honorary president of the Dominion Good Roads Association, remarked on the increase year by year which he had noticed at conventions. He said such a widespread interest in the good roads movement was bound to be productive of great results, and must surely bring the ardent advocate of a well-built highway nearer his aspirations. He said results could even be seen to-day throughout the province, where improvement in roads is already growing apace. Many other speakers took part in the opening ceremonies, the theme of all their statements being the benefits accruing from good roads.

The annual banquet was held at the Place Viger Hotel, nearly two hundred citizens and visitors sitting down to a sumptuous repast. The toast to his Majesty the King was fittingly honored. The toasts to the "Guests" and the "Press" were responsible for several neat speeches.

Alderman Leslie Boyd, K.C., dealt on the aim of the Provincial Government to make the roads in the home province second to none in the Dominion, but he urged that the money of the public spent on this road development be expended wisely. Turning to Montreal, the speaker said the lines of communication with other municipalities must be improved; there must come better facilities for entering the city. He pointed out the extreme importance of the improvement of the roads of the province so that some of the beauties of our interior could be reached by the wealth of tourists who every year streamed in across the border. He extended the best wishes of the city of Montreal to the roads congress.

Mr. B. Michaud paid tribute to the business men of the province, who are lending every assistance to the good roads campaign, while Mr. Tessier gave some interesting information as to the progress in road work which the Provincial Government had made in the past two years. He predicted even more and better roads this year.

Hon. Jeremie Decarie laid stress on the importance of the road—one of the national means of communication. "When we are building up the roads," said Mr. Decarie, "we are building up the country." He then went on to a scathing denunciation of the contractor on road work who would aim for personal profit before a good product, saying that the conscience of the contractor must be equal to the task he had to do.

G. W. Levesque, M.L.A. for Laval county, proposed the health of the "Press," making a neat and eloquent speech, which was responded to by one of the representatives of the press present.

The convention got down to real business on Tuesday morning, when the technical papers and discussions took up the delegates' attention. At this session, presided over by B. Michaud, Deputy Minister of Roads for Quebec, the chief feature was one not on the programme, it being an address by Thomas Adams, the English town-planning expert, on "Town Planning and Good Roads in Rural Municipalities." After declaring that the farmer's interests should be dominant in the rural regions, he met the objection that town-planning had no connection with the farmer by pointing out that in its larger sense town-planning meant the regulating of the use and development of land in the light of future needs. Neglect of this precaution meant waste and loss on capital, and this meant loss for the farmer, who in the end suffered as much from bad government in nearby

cities as the city dweller himself. Referring to the fact that city roads, particularly in the suburbs, were often worse than those through the country, Mr. Adams pointed out the need for closer co-operation between the road-makers of the city and the country. As a means to this, he made two suggestions, one being that the province give municipalities the power to adopt town-planning schemes fitting in with the government's skeleton plan for through highways and radiating rural roads, and the other being the creation of a provincial department of municipal affairs to co-operate with the department of roads.

W. Huber, engineer of the Ontario Highways Department, emphasized the importance of maintenance in macadam roads. "Any scheme of macadam road is highly incomplete," he said, "which does not provide for constant maintenance." Owing to the heavy motor traffic in the present day, he said, stone screenings, as a binder for wearing surfaces, had reached the end of their usefulness.

Francis P. Smith, consulting engineer, of New York, read his paper, "The Hot-Mix Method of Bituminous Construction, Using an Asphaltic Binder," which is published in another part of this journal.

The paper on "Road Maintenance, Materials and Methods," by Mr. W. H. Connell, chief of the Bureau of Highways, Philadelphia, emphasized the same point made by Mr. Huber in the morning, as to the importance of maintenance. A good organization was essential to proper maintenance, he said, but this organization should be a part of the construction organization, as otherwise there would be overlapping and shifting of responsibility, while the intimate knowledge of minute details of each separate piece of construction possessed by the builders would help them immensely in securing proper maintenance. In many sections, where the good roads out-number the bad, maintenance work and cost take a predominant place over construction, and this condition will increase as the good roads movement spreads and achieves its results. Mr. Connell pointed out that in one regard maintenance work was more difficult and intricate than construction, for the builder has standard specifications and the experience of others to guide him, and cannot easily go wrong, but each problem of maintenance and repair brings its own individual difficulties to be solved by those in charge. After speaking of the vital importance of close personal observation of the effect of traffic, climate and other conditions upon pavements as an aid to their maintenance, Mr. Connell treated specifically of methods under the three heads of routine, general and emergency maintenance.

J. W. Levesque, M.L.A., spoke in French on provincial aid for roads, as they have it in Quebec province, and E. Fafard, superintendent of the plants branch of the Highways Department of Quebec, in the French langauge, pointed out how to handle and take care of road machinery.

The concluding paper of the day was an especially valuable contribution to the available data on road maintenance. Its title was "The Cost of Maintaining New York State's Highways," the author being F. W. Sarr, Deputy State Highway Commissioner. After pointing out that the State had paid in 1915 the sum of $4,210,575 under the head of maintenance and repairs, Mr. Sarr gave the following statistics of the average expenditure for maintenance, repair and reconstruction per mile per year for each of seven types of road: 193 miles of gravel roads cost $955 per mile; 2,298 miles of water-bound macadam roads cost $1,055 per mile; 2,387 miles of bituminous macadam, penetration method roads, cost $510 per mile; 63 miles of bituminous macadam, mixing method roads, cost $181 per mile; 295 miles of concrete bituminous roads cost $1,050 per mile; 84 miles of first-class concrete roads cost $129 per mile; 291 miles of block pavement roads cost $190 per mile. The 5,611 miles of all types cost $750 per mile.

At the Wednesday morning session, A. C. Emmett, whose paper appears in this issue, secretary of the Automobile Club, of Winnipeg, spoke on the attitude of legislatures to the good roads movement, which is becoming much more favorable as the economic value of good roads is realized. For many years the grants made were meagre, but many provincial governments had now passed good roads acts, and the various municipalities can obtain substantial grants towards definite and well-defined plans of road improvement in country districts.

The paper of Gabriel Henry, Quebec Government Engineering Department, dealt with gravelled roads, and was read by J. Duchastel de Montrouge, of Outremont. Mr. Henry pointed out that one of the advantages of well-constructed gravelled roads was that they could be made to serve later as foundations for a more costly top course, and one of greater resistance if traffic increased and circumstances demanded, just as earth roads made an excellent foundation for gravelled roads. He emphasized the importance of a perfect drainage for the surface and subterranean waters, these two conditions being indispensable for any road.

The congress unanimously passed a resolution endorsing the establishment of a Dominion Labor Bureau system, permanently administered by a non-political commission, as a national organization indispensable to the adjustment of post-war conditions and the replacing of thousands of able-bodied soldiers in civilian employment when peace is declared.

J. Duchastel de Montrouge, city engineer of Outremont, gave a paper, which is reproduced in these pages, on the laying of brick pavements in Outremont, emphazing the need of the strictest supervision in laying them, and claiming that when properly constructed they will wear smooth without being slippery. They are the most sanitary pavements known, being easily cleaned and absolutely dust-proof; they are practically noiseless, and are economic in the long run, as they required very little attention and maintenance, and can be easily cut through when required and repaired at small cost without any cumbersome plant.

The great war and the good roads issue were intimately associated in a brief but vigorous communication read at the afternoon session. The writer, Oliver Hezzlewood, is president of the Canadian Automobile Federation, and has been in the forefront of the good roads movement since its inauguration in Canada. Unless aggressive action was taken by the Dominion and provincial governments, he said, the carrying out of the plans for good roads was likely to be as haphazard and capricious as the present plans for recruiting for overseas service. The latter system, he claimed, was proving but a repetition of the experience of the promoters of the good roads movement, for many individuals and communities were obviously shirking their plain duty and their responsibility to others and to themselves. Mr. Hezzlewood said that he was rapidly coming to believe in the principle of conscription in all matters of grave public concern, and not alone in recruiting. Canada's whole energies for the time must be devoted to aiding the

Allies to triumph, but when that was accomplished, the Dominion and the provinces should set themselves to carrying out a country-wide scheme of improved roads, thereby taking one of the most necessary steps toward developing fully the resources of Canada. In the meantime, it would not be wise to project any great public works, even such desirable ones as good roads, which might prove a detriment to recruiting. To put 500,000 Canadians into khaki and carry on necessary industries at home would take every available ounce of man-power in Canada, and it would be folly to divert farm labor, for instance, to the making of roads. One form of labor available for the latter work, however, was that of the thousands of enemy aliens interned in Canada, and Mr. Hezzlewood urged that they be employed for this purpose. Reverting to his growing conviction that some form of national service should be imposed for the general welfare, Mr. Hezzlewood said that control over the roads should be taken from county councils and small municipal bodies, and handed over to central organizations, so that in time Canada should have a comprehensive system of highways.

Papers on the allied subjects of "Highway Bridges" and "Highway Culverts" were read, the former by the author, Lucius E. Allen, engineer for the county of Hastings, Ontario, and the latter, in French, written by Alex. Fraser, engineer of the Highways Department of Quebec Province, and read by J. Duchastel de Montrouge, of Outremont. As bridges constitute so large a proportion of the cost of many highways, said Mr. Allen, careful study of their design and construction was necessary. A bridge should be practically permanent in its construction, and, to secure this, careful design, selection of proper materials and expert workmanship must be combined. Solid foundation was the first desideratum. There was no standard type of bridge, and traffic, climate, geographical features and other local conditions must govern a selection. Future developments must be anticipated, as, for instance, the denudation of forests, increasing the possibility of freshets. As a rule, increases of traffic and heavier loads must also be provided for. Reinforced concrete construction was being largely favored in England, being economical both in first cost and in maintenance. In adopting this type, artistic design and finish should not be neglected. If steel bridges were adopted, constant painting was essential, and Mr. Allen said he had seen good steel bridges practically destroyed in 12 to 15 years by neglect of this precaution. In conclusion, he expressed satisfaction that the study of bridges was receiving the consideration it deserved, as this meant that, when the Canadian system of national highways was inaugurated, the bridges built would be worthy of such a great undertaking.

Mr. Fraser's paper on culverts stated that the average cost of permanent culverts on provincial roads in Quebec varied from $800 to $1,500 per mile. Concrete culverts only were used, and, while the Quebec makers in the past had not always adopted the best methods of manufacture, a movement was now on foot to organize in order to secure a standard product. No matter how good the quality of the product, there was danger of failure unless it was properly placed, and the need for intelligent and experienced foremen was imperative. To safeguard traffic, the culverts should be the full width of the road surface, and to secure the unobstructed flow of water, right angle connections between ditches and culverts must be avoided.

Mr. A. E. Cunningham, representing the Lethbridge Board of Trade, spoke briefly. The importance of highways to the country, he said, would be understood when it was remembered that practically every bushel of Western Canada's 300,000,000-bushel yield must pass over some highway in its first stage of transportation. Great interest was being taken in roads in Alberta, and, when the Canadian National Highway was built, it would find Alberta's good roads ready to be linked up with it. The West was eager to secure the next congress for Winnipeg, and an invitation to that effect might be expected before the present gathering closed. Good roads were a magnet that would draw the whole Dominion closer together.

The closing feature of the afternoon was an illustrated lecture by Prof. J. Crandell, of the Pennsylvania State College, on bituminous roads. "You wouldn't put an $8,000 house on a mud foundation," he said early in his lecture, "and it would be equally foolish to use a mud foundation for a road that costs $8,000 a mile." After getting a good foundation, thorough rolling was half the game in building the road. The modern bituminous road was the result of a happy combination of the chemist, the manufacturer and the engineer. The lantern views and moving pictures accompanying the lecture were watched by hundreds of the delegates.

The Canadian Automobile Federation, which was allied with the Dominion Good Roads Association in promoting the Congress, held their annual meeting in the Place Viger Hotel on Wednesday evening.

On the motion of U. H. Dandurand, seconded by L. B. Howland, Toronto, it was decided to change the name of the organization to the "Canadian Automobile Association." L. B. Howland, president of the Ontario Motor League, was elected president; Frank Carrol, Quebec, and A. C. Emmett, secretary of the Manitoba Motor League, vice-presidents; W. G. Robertson, secretary of the Ontario Motor League, secretary-treasurer; Oliver Hezzlewood, the retiring president, was chosen honorary president. The executive committee named is G. A. McNamee, secretary of the Automobile Club of Canada; L. C. Beaupre, secretary of the Quebec Automobile Club; W. G. Robertson, secretary of the Ontario Motor League; A. C. Emmett, secretary of the Manitoba Motor League; and L. B. Howland, president of the Ontario Motor League.

Committee appointments were: J. A. Davis, of Montreal, chairman of Good Roads Committee; E. A. Cunningham, of Lethbridge, chairman of Touring Committee; and U. H. Dandurand, of Montreal, chairman of the Legislative Committee.

The association represents one hundred automobile clubs. The financial state is very satisfactory. At Thursday's session the attendance of delegates was as large as at the previous session and close attention was given to the proceedings.

A snowstorm was responsible for a delay in the commencement of the morning session, proceedings not beginning until 11 o'clock, while several speakers on the programme did not arrive until the afternoon.

Mr. B. Michaud, Deputy Minister of Roads, addressed the delegates on the methods employed in Quebec to construct roads. The various types of roads and the need of economy were covered by Mr. Michaud in his address.

An able paper was read by Mr. Duchastel, entitled "Road Drainage and Foundations." The paper was written by Major W. W. Crosby, consulting engineer, of Baltimore, Md., who was unable to be present.

President Michaud occupied the chair at the afternoon meeting, and some informative addresses and papers were delivered. The first speaker was Mayor Lavigueur, of

Quebec, who told of what was being done in that city, and its vicinity.

One of the most interesting papers of the congress was given by Col. W. D. Sohier, chairman of the Massachusetts Highway Commission, Boston, whose subject was the selection of the type of road surface as governed by the volume and class of traffic. Col. Sohier has been at previous congresses, and his addresses have always been most popular because of his wide knowledge of the subject of roads, and the close study he has made of traffic conditions on the state highways across the border. He pointed out that it was often a difficult matter for an engineer to decide what kind of road he was going to lay down, not merely because of the question of cost, but because often the materials that would give the best results were not always available or to be secured at reasonable expense. He said that without adequate drainage, any road would soon be destroyed and would become a series of pot-holes and ruts with a horse path in the middle full of mud. That did not constitute a road, even if the public had to travel over many miles of such abominations in both countries.

"You must expect in Canada," said Col. Sohier, "when you get an even reasonably passable road leading from New York and the New England States into your beautiful country, that the motorist will soon find it out and you will probably, on a few main roads, have as much traffic as on the average state highways in the United States—500 or more cars every day during the season. You must anticipate this traffic and build your roads accordingly."

Col. Sohier said that with increasing traffic the width of the hardened surface had to be increased, and therefore it was important, if engineers were laying out a road, to be sure to secure a sufficient width to avoid costly extensions afterwards. He mentioned that some of the roads built in Massachusetts, which gave every indication of being economical and extremely satisfactory for any reasonable volume of traffic, were made of clean gravel almost free from loam or clay, heated and mixed with a hot asphaltic residuum or asphalt, the cost of which was about the same as waterbound macadam road when the gravel could be obtained near the road.

Col. Sohier said that when once a road had been treated with some bituminous binder on the top it was not the automobile traffic on pneumatic tires that wore it out, but the crushing weight of heavily loaded teams and trucks. If these were in sufficient number to wear out the stone in a macadam road in five or six years, there was no question that such a road was not only not economical, but was never in good condition for the traffic, and a more expensive and durable type of pavement should be used.

One mile of road in good order was a better argument for good roads and would produce more votes, more money and more good road advocates in one year than all the conventions and speeches delivered in thirty years. Col. Sohier paid a graceful tribute to the knowledge of the deputy ministers for Quebec and Ontario, who were frequent visitors to the United States, where their advice was always welcomed. He generally complimented the engineers and committees doing the road work in Canada.

"Snow Removal in Montreal" was the subject of Chief Engineer Mercier's paper. The average snowfall for 41 years had been 119 inches yearly, and there was snow on 79 days in 1915, with rain on 28 of these days. Mr. Mercier described the methods by which the city and the Tramways Company co-operated to clear the streets, speaking of the Tramways organization under Superintendent A. Gaboury as "wonderful." The cost of cleaning sidewalks was 7½ cents per running foot, and clearing the roads cost $2,500 per mile.

"Concrete Highways and Streets" was the title of a paper by Percy H. Wilson, consulting engineer, Philadelphia. The increase of motor over horse-drawn traffic in the past 15 years, he said, had forced recognition of the fact that "good roads" were synonymous with "hard-surface" roads. He illustrated the increase in motor traffic by citing Ontario, with one auto to every 4,000 inhabitants in 1905, and one to every 75 in 1915, a 5,000 per cent. increase in ten years. The resultant increase in maintenance of macadam roads had created a demand for a hard-surface, all-year, moderate first cost and a minimum maintenance road, and this, Mr. Wilson said, was found in the concrete road. He then went thoroughly into methods of using cement for road-making.

W. A. Magor laid before the gathering the details of the proposed Queen Alexandra Highway, running north of the C.P.R. from Montreal West to Ste. Anne's, being a continuation of Sherbrooke Street to the west end of the Island of Montreal.

At the annual meeting of the Dominion Good Roads Association held on Friday, Winnipeg was decided on as the place of meeting for the 1917 convention. The officers elected for the ensuing year are:

J. Duchastel de Montrouge, Outremont, president; S. L. Squire, Toronto, vice-president; George A. McNamee, Montreal, secretary-treasurer.

It was decided to create an advisory board, which will be composed of the past presidents of the association, as follows: W. A. MacLean, Deputy Minister of Highways for Ontario, Toronto; U. H. Dandurand, Montreal; B. Michaud, Deputy Minister of Roads, Quebec, and O. Hezzlewood, Toronto.

The executive of the association will be composed of: E. A. Cunningham, Lethbridge; A. C. Emmett, Winnipeg; Howard W. Pillow, Montreal; J. A. Sanderson, Oxford Station, Ont.; Thos. Adams, Ottawa; E. N. Desaulniers, M.P.P., Chambly; W. A. Levesque, M.P.P., Montreal; George Hogarth, Toronto, and A. F. Macallum, Hamilton.

The exhibition of the manufacturers of apparatus for good roads making and for materials used in construction was one of the best of its kind ever seen in Canada. Prominent among the exhibitors were: The Asphalt & Supply Co., Limited, Montreal; The Canada Cement Co., Limited, Montreal; The Canadian Fairbanks-Morse Co., Limited, Montreal; Creosoted Block Paving Co., Limited, Toronto; The Dunn Wire-Cut-Lug Brick Co., Conneaut, Ohio; The Imperial Oil Co., Limited, Montreal; T. A. Morrison & Co., Montreal; The Paterson Manufacturing Co., Limited, Montreal; The Pedlar People, Limited, Montreal; Sawyer-Massey Co., Limited, Hamilton, Ont.; Trussed Concrete Steel Co. of Canada, Limited, Montreal.

A correspondent of the "Freeman's Journal," who has visited the British front in Flanders, states: "It is natural to suppose that where there is such an enormous amount of heavy traffic the roads would be greatly cut up and in winter weather soon rendered impassable. So they would were their repair and constant attention neglected or overlooked. But it is not by any means. The roads receive constant attention. If there are soldiers in the trenches and soldiers in the billets, there are also soldiers looking after the roads, and these men perform duties quite as important as those in the actual fighting line. The older men or those who are incapacitated from active military duties are engaged in road-mending and road-making, with the result that all the roads are in a good state and quite fit for heavy traction."

CONSTRUCTION AND MAINTENANCE OF BRICK ROADS AND STREETS.*

By J. Duchastel, M.Can.Soc.C.E.

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

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

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

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

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

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

(1) The proper and efficient drainage of the subsoil, most important in our climate.

(2) The careful compacting of the sub-soil and the shaping of same to a grade to correspond with that of the finished pavement.

(3) The construction of a proper concrete foundation. Most necessary in cold climates and in localities where the drainage of the sub-soil is sluggish.

(4) The adoption of a cushion layer between the concrete foundation and the bricks.

(5) The careful laying of the bricks with the smoothest surface up and lugs laying in the same direction.

(6) The thorough rolling of the ungrouted bricks to an even surface.

(7) The thorough application of a proper cement filler.

(8) The protection of the filler from rapid setting.

(9) The prevention of traffic over the new pavement for a period of two or three weeks.

(10) The competent supervision of the whole work by efficient men.

*Paper read before the 3rd Canadian and International Good Roads Congress, Montreal, March 6-10.

Allow me to discuss these important items in detail in describing to you the manner in which a wire cut lug brick pavement was constructed on Laurier Avenue, in Outremont, Que., last year, under my supervision, by day labor.

Laurier Avenue is the main commercial street in Outremont; it runs in a southwesterly direction from Hutchison Street to Cote St. Catherine Road. The distance between the curb lines is 57 ft. 6 in. and its length is 1,092 ft. The grades of this street vary from 2.65% to 4.52%. A double line of car tracks occupies its centre.

The paving work was carried out in the following manner:—

The old macadam pavement on the northwest side was first excavated and both car tracks were pulled over to this side overnight; then the Tramway Company installed new 115-lb. grooved rails on new cedar ties on a concrete slab 18 feet wide by an average thickness of 8 inches, constructed by the city. The pavement between the tracks was then completed, and after a period of fifteen days the street cars were allowed to run over the new tracks. After the old rails had been removed from the northwest side, the paving operations were immediately started. Traffic was allowed to circulate throughout these

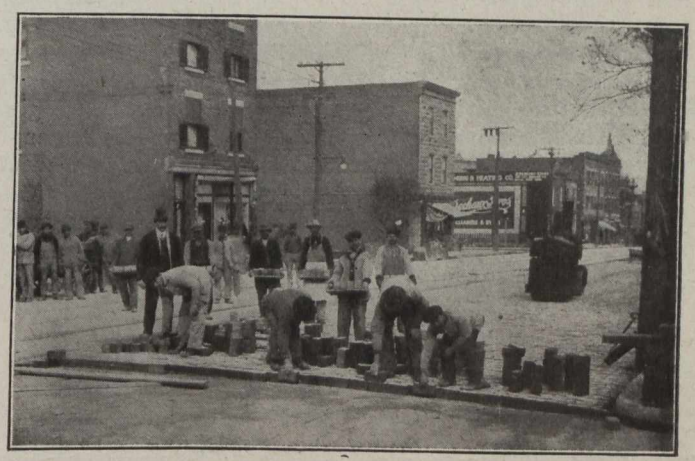


Fig. 1.—Laying Brick at Outremont, P.Q.

operations on the opposite side, and as soon as the pavement on the northwest side had properly set it was transferred over to this side and the paving operations begun on the southeast side.

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

(1) **Drainage.**—The sub-soil encountered in the excavation was quite varied; bed rock at one end and common dirt excavation at the other with rock underlying. This sub-soil had been many times disturbed by the construction of sewer, water, and gas services in separate cuts, as well as the connections to same from the dwellings along this street. Three lines of porous drain pipe 4 ins. in diameter were laid; two at the curbs at an average depth of 12 inches below their level and connected to the catch basins; the third line was laid in the centre of the street below the concrete slab under the ties and connected to the manholes. The shallow trenches of these tile pipes were carefully filled in with 1½-in. broken stone, insuring thereby the proper drainage of any ground water.

(2) **Compacting of Sub-soil.**—The sub-soil was carefully shaped and thoroughly rolled with a 15-ton roller until it was well compacted and its shape corresponded as closely as possible to that determined for the pavement

itself. Special attention was given to freshly opened cuts, and quite a number of the old ones were also thoroughly rolled. We observed that many of these old cuts settled down considerably under the roller, demonstrating the necessity of this rolling before the construction of any type of pavement.

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

(4) **Cushion Layer** (now more appropriately called the bedding course).—When the concrete foundation had properly set, two guide timbers, 1½ ins. thick by 4 ins. wide, were laid directly on the concrete, one on the curb line and parallel to it, and the other along the rail, then the sand and cement cushion, which had previously been mixed dry, in the proportions of one of sand to four of cement, was spread evenly over the concrete foundation to a depth of about 2 inches. A heavy templet having the exact cross-section of the finished roadway was then drawn over this on the wooden rails levelling down the cushion and compacting it to a thickness of about 1¾ inches. This operation was carried on in stretches of about 20 to 30 feet in length; when found necessary, more of the cement and sand cushion was distributed and the templet drawn over again until an even surface was obtained. Then, a hand roller weighing about 250 pounds was rolled up and down over the cushion until it was thoroughly compacted. After this the templet was again put in use, but this time the ¼-in. iron shoes at each end were removed, thus allowing the templet to shape and compact the cushion to a thickness of 1½ ins. When these operations were completed, the wooden guide timbers were removed and the cushion materials placed and compacted in the depressions they had occupied. The importance of properly shaping the sand cushion will be readily seen, as the final shape of the pavement depends entirely upon its success. The addition of cement in the cushion adds but very little to the final cost of the full work, and affords a stable foundation for the bricks, which cannot be disturbed by any cause.

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

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

It is well recognized to-day that many failures in brick pavements can be traced to the non-uniformity of the sand cushion or the lack of proper compactness of same. It is claimed by some that a brick pavement should have a cushion so as to keep its resiliency under heavy traffic. It is very doubtful in my mind if the sand contained between concrete foundations and the brick pavement has really any elasticity, and my opinion is that this plain sand cushion can shift or be compacted by heavy traffic, and that the brick pavement itself may spring somewhat under this heavy traffic, but the sand cushion will not follow and small air spaces between the sand and the brick pavement may be formed, introducing weak spots which may cause serious trouble later. It has also been claimed that the sand cushion prevents the crushing of the brick pavement under heavy traffic. This idea, in my mind, is not well founded. If bricks well grouted are not able to sustain the load of modern pavement, the sooner they are discarded as paving materials, the better it will be.

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

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

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

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

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

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

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

(5) **Laying of Bricks.**—The bricks, which had been neatly piled on the sidewalk edge or at any convenient points, were carried to the droppers or pavers on wooden pallets, five at a time, and placed behind them in piles, five bricks high, and in such position that each brick could be handled so as to bring its lugs always in the same direction with its best edge up. The droppers, on dropping the bricks down in place, could proceed with their work by standing on the newly laid bricks and dropping the bricks ahead with the lugs away from them on the sand cushion. The brick joints were broken at least three inches, and nothing but whole bricks were used, except in starting and finishing courses. Every fourth or fifth course it was found necessary to straighten up or close up the courses. This was done by tapping them lightly with a sledge, using a 4-in. by 4-in. timber 3 or 4 feet long. At all times the bricks were clean and entirely free from chips, dirt or other foreign matter.

(6) **Rolling.**—After a certain stretch of bricks had been laid, and the surface thoroughly swept, a small 3-ton steam roller was used to roll them down. This was done in the following manner: The rolling was commenced near the curb at a slow pace and continued back and forth up to the rail, then the operation was repeated at a quicker pace. Next the rolling was done transversely at an angle of 45 degrees with the axes of the pavement, and then repeated in the opposite direction; then the bricks were rolled again parallel to the curb lines. During rolling the bricks were carefully inspected and all broken or chipped ones were immediately removed and replaced. Those bricks having settled too much, as well as those sticking up, were removed and replaced by other ones. The rolling operation was really a very attractive one to watch

as the smoothing out of the brick surface was very noticeable after the first trip of the roller. The rolling of all the bricks laid in one day was completed every night, so that if the weather became rainy there was no chance of the cushion setting before the bricks had been properly rolled. It is needless to say that we did not mix any more cushion materials than was required for one day's work.

(7) **Cement Grouting.**—The grouting was done as soon as possible after the bricks had been rolled down. These bricks were first thoroughly sprinkled, with the double object of supplying enough water to the cushion for setting purposes, and the thorough wetting of the bricks themselves. The sand and cement of the grouting were mixed dry in equal proportion, one to one, and to a uniform color. Batches of about two cubic feet were placed in specially constructed portable mixing boxes, having one corner lower than the others, the water being added very slowly and the mass thoroughly mixed with a hose until its consistency was liquid enough to allow it to flow without separation of the ingredients. This grout was then poured on the bricks with large scoop shovels and spread well into the joints with hand-squeegees, and the operation gone over until the joints were completely filled. The grout was always sufficiently fluid to thor-

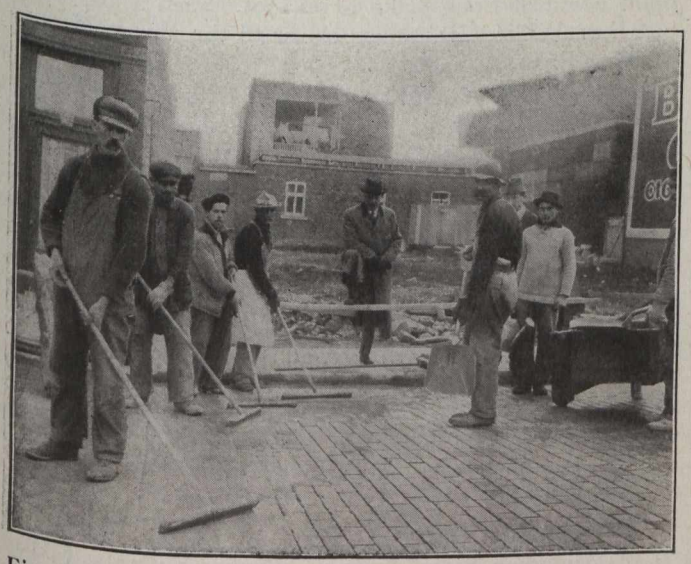


Fig. 2.—Applying Cement Grout Filler at Outremont, P.Q.

oughly fill the lower part of all joints and flow several joints ahead of the squeegees, oozing up to the surface as more grout was pushed ahead. I am perfectly sure that every joint was filled up with the grouting from top to bottom, and that none of the cushion material partly filled the joints.

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

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

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

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

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

Abrasion test averaged thin blocks: At 600 revolutions, 8.55%; at 1,200 revolutions, 12.00%; at 1,800 revolutions, 14.21%.

Absorption test: 1.21%.

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

(1) When properly constructed with the right materials, they will wear smooth without being slippery.

(2) They are the most sanitary pavements known, being easily cleaned and absolutely dust-proof.

(3) They are practically noiseless.

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

(5) They can be cut through when required and easily repaired at small cost without any cumbersome plant.

Charcoal is almost an ideal furnace fuel. It is nearly free from sulphur, having only a few hundredths of 1 per cent. in coke and about 1 per cent. of ash against about 10 per cent. for coke.

There is a remarkable tendency observable in tissues and cotton when moistened with oil, to become heated when oxidation sets in, and sad results often follow when the tendency to take fire is neglected. A wad of cotton used for rubbing a painting has been known to take fire when thrown through the air. The waste from vulcanized rubber, when thrown in a damp condition into a pile takes fire spontaneously. Masses of coal stored in yards frequently take fire from spontaneous combustion without any spark of fire being applied to the mass. It is good to know such things and to guard against mysterious fires.

In an action against a railroad it appeared that the plaintiff was walking on a parallel track used by another road and upon the ends of the ties next to the defendants track, about 5½ feet from the ends of the ties on the defendant's track, when he was overtaken and run over by a heavy freight train drawn by two engines on an upgrade and a partial curve. The train, which had stopped for water at a tank about 485 feet back, was running from 3 to 25 miles an hour. The plaintiff testified that he was drawn under one of the cars by the suction caused by the speed of the train, and his leg smashed. There was evidence that no suction could have been produced at the speed the train was going, and that even at a greater speed than 30 miles an hour, trains had frequently passed close to section hands repairing the track without any such effect being produced; also that the effect produced by a rapidly moving train would be merely to split the air and drive objects away from it, such as dust from the track and hats from the heads of men standing near it, the force of the wind being away from the train rather than towards it. The jury returned a verdict for the plaintiff, which the trial court set aside, for the reason that there was no evidence to support it, and entered a judgment of non-suit. On appeal this was affirmed by the North Carolina Supreme Court in an exhaustive opinion. The court held that the plaintiff's injury, if occurring as the result of suction created by the rapidly moving train, was an unusual occurrence such as the engineer could not have reasonably expected would result from the rapid movement of the train, and hence such movement was not negligence.

COAST TO COAST

Montreal, Que.—The government has authorized a small advance to provide for the continuance of the work on the harbor.

Montreal, Que.—At a meeting of the Chamber of Commerce the question of raising the Grand Trunk tracks was taken up.

Edmonton, Alta.—The Oliver, St. Paul de Metis Railway, according to Sir William Mackenzie, will be in operation before the end of June.

Trenton, Ont.—The steelwork on the new bridge over the Trent River is almost completed. The structure is expected to be ready for traffic very soon.

Montreal, Que.—Plans have been submitted to the Board of Control for a tunnel estimated to cost $1,200,000 under the Lachine Canal at Wellington Bridge.

Owen Sound, Ont.—The secretary of the board of trade announces that engineers will soon commence surveys on the harbor for dredging purposes.

Toronto, Ont.—A trial trip has been made over the newly-electrified Schomberg division of the Metropolitan Railway. A regular service will be inaugurated shortly.

New Westminster, B.C.—The annual report of City Engineer J. W. B. Blackmore shows that the work carried out under the supervision of his department cost $371,020 for 1915.

Toronto, Ont.—It is learned that the government's bill on hydro-electric development at Niagara Falls will provide for an ultimate expenditure of $14,000,000 to be supplied as the work proceeds.

St. John, N.B.—Engineers of the Canadian government are engaged in locating a new line from near Fredericton across York county to connect with the Maine Central Railway at Vanceboro', Me.

Toronto, Ont.—The foundations on the new Union Station are being rushed ahead in order to be ready for steel erection. It is expected that the steel construction work will commence about April 10.

Montreal, Que.—Pavement was laid on 45 miles of streets in the city last year. The total cost of the work was $1,934,408. Asphalt for the most part was used as surfacing, the total quantity being 7,145 tons.

Hamilton, Ont.—Arrangements have been made with the Dominion Power and Transmission Company by which the hydro radials will run over the tracks of the Hamilton Street Railway on their route through the city.

Victoria, B.C.—Legislation will be introduced within the next ten days looking towards the aiding of shipbuilding to the extent of a sum not exceeding $2,000,000 by way of guarantee. It is planned to lay down ten ships at once.

Brantford, Ont.—The city has been granted the right to operate the Grand Valley Railway under the name of the Brantford Municipal Railway System. The line runs from Brantford to Galt through Paris and Dumfries.

Victoria, B.C.—At a meeting of the reorganized Canadian Puget Sound Lumber Company it was decided to begin operations at the Victoria Mill and Jordan River timber limits at once. Five lumber-carrying ships will be built by the company.

Hamilton, Ont.—Mayor Walters advised the Board of Control to postpone until after the war the question of an entrance into Hamilton for the Toronto-Hamilton Highway, unless a satisfactory agreement could be made with the Commission.

Toronto, Ont.—The provincial government has purchased the Seymour interests in Central Ontario, comprising over twenty companies. This will give the hydro-electric commission complete control of power in the province. The price paid was $8,350,000.

Sarnia, Ont.—Engineer J. J. Jeffreys, of the Ontario Hydro-Electric Commission, advises that when Sarnia installs a street lighting system a good set should be put up. The system suggested by Mr. Jeffreys would cost $12,000 a year, in place of the present $7,000 a year.

Fort William, Ont.—A proposal for the government railway to link up to the Canadian Northern Railway and run over the latter's line from Fort William to a point north of Long Lake is on foot. Such a line would put Fort William 215 miles closer to the new gold camp at Kow Kash.

Fort William, Ont.—The inter-cities committee of Port Arthur and Fort William passed a resolution recommending that the two city utilities committees get together to frame up a proposal to get the hydro-electric commission to expropriate and operate the Kaministiquia power plant or allow development at Nipigon or Dog Lake.

Ingersoll, Ont.—That it is the intention of the gas company to furnish Ingersoll with purified natural gas was the welcome news received recently. A representative of the company was in Ingersoll and conferred with the special committee of the council appointed recently to deal with the situation in consequence of the purifier at the gas plant having been destroyed by the recent explosion and fire.

Winnipeg, Man.—Dredging an 18-foot channel in the Assiniboine River, from its junction with the Red to Assiniboine Park, is a feasible plan, City Engineer Brereton said recently, and the Board of Contral seemed to favor approaching Hon. Robert Rogers to see if the Dominion Government would not do this work. The purpose of the channel would be to make motor boating to the park possible.

The Pas, Man.—That the Hudson Bay Railway will be completed in time for the 1917 crop shipment is the belief of builders here. The summer construction programme concludes plans to have the steel track laid to Kettle Rapids, 90 miles from Hudson Bay, by August 1st. Construction of the cantilever bridge over the Nelson River at this point is expected to be finished in time to allow further steel-laying before frosts set in.

Calgary, Alta.—A decision of the Supreme Court affecting farmers on the Canadian Pacific irrigation block has just been handed down by the Supreme Court, in which the court dismisses the action by the farmers, in which the latter claimed that the contracts with the railway company were made under misrepresentation, in that irrigation has been a detriment in some sections of the irrigation belt, and alleging other reasons for their request for the annulling of the contracts.

Editorial

HARNESSING THE TIDES.

In an address before the Commercial Club of Halifax recently a scheme to harness the Bay of Fundy tides for the development of hydro-electric power was outlined by Dr. Geo. B. Cutter, president of Acadia University. The scheme, which has been worked out by Dr. Cutter, in conjunction with Prof. R. P. Clarkson and Ivan Curry, has been often talked of, and should give a supply of power which would be cheap and practically unlimited.

The proposal is to place strong current motors at the base of Cape Split by which power would be generated to elevate sea water to reservoirs, which would be built on the top of the cliffs. The water would then be conducted to the power-house at the base of the cliff and returned to the sea. On examining the tidal flow in the Bay of Fundy a remarkable variation was found, the rate in the middle of the Bay being between one and two knots. The maximum at Digby Gut is four knots, and the highest rate is in Minas Channel, where the flow is between eight and ten knots, or between nine and eleven miles per hour. This rate of flow is greater than the swiftest streams, and is equalled by tidal current at only two other spots on earth. For this reason Minas Channel is the most favorable location for the development. Difficulties of developing tidal power are due to the unevenness of flow, necessitating storage of some kind to keep the output of power uniform. Also, power schemes must not interfere with navigation.

The power plant suited to even such a favorable tide as the Bay of Fundy must be so adjusted as to give continuous, regular and sufficient power, with low cost of installation and operation, and at the same time not interfere with navigation.

The site chosen as the most suitable for reservoir is at Cape Split, where the perpendicular cliffs rise over 300 feet. The greatest problem of the development is to get the water up on top of these cliffs. The scheme proposed to accomplish this is to install specially designed current motors at the foot of the cliff. These motors would supply power to operate pumps, which would elevate the sea water to reservoirs placed on top of the cliff. The water would then be delivered to the power-house at the base of the cliffs. By this method the flow from the reservoir would be continuous and regular whether the pumps were operating or not.

The motor designed for the work has already been constructed in the form of a model, which develops 27 horse-power, and is so light as to be carried by two men. As the motor is very simple in design, the cost of installation and operation will be very low. Multiple units will be arranged, both for motors and reservoir, so that in case of one unit breaking down there will be another ready to step into the breach. As a central distribution point Cape Split could not be surpassed. Within a radius of 125 miles are Antigonish, Yarmouth, Fredericton, Newcastle, and most of Prince Edward Island. Transmission lines of about 85 miles each would reach Digby, New Glasgow, Moncton and Halifax. In comparison with Ontario, where power is transmitted 250 miles, these distances seem short. This would be a very valuable acquisition to the Maritime Provinces, whose development, industrially, would be assured. At present the total available water power is 34,500 horse-power, while this scheme would make possible a development of 2,000,000 horse-power.

SPRING CLEAN-UP FOR THE RAILROADS.

For the next few months the section gangs of our railroads will have their hands fully occupied in repairing and rehabilitating the various sections of roadbed under their supervision which have been more or less temporarily ballasted, or on which the rails have been brought to even grade with wood shims during the winter season, which is now nearly over.

If it were possible to do this work during the winter a great amount of labor could be saved which could be put to trimming slopes, planting grass on sides of earth-cuts, and doing other work which would be preparing the line for summer traffic. As it is, the work now is crowded, so that it is almost impossible to do anything toward making the line attractive from the viewpoint of the travelling public.

To the engineer, a well-prepared roadbed has certain qualities which do not present themselves to the layman, who has come to look upon the track and roadbed more as something which mars the natural beauty of the landscape.

If it were practicable, and there is no real reason why it should not be so, to employ extra men in such numbers that the whole line of roadbed and everything adjacent should be given a sort of spring cleaning—new sodding done, nicely-moulded shoulders put on the grades, gardens at all station grounds, and lots of fresh paint and whitewash, it would without doubt repay the railroads, inasmuch as it would make travelling much more pleasurable. If this were more generally done in the spring, the period of usefulness of the passenger to the railroad, and incidentally to the "monthly railroad earnings," will not have lapsed; on the contrary, it will perhaps have increased when his journey is over and he has elbowed his way through the crowded station once more. For while travelling over the road he has been the sightseer, awed with the grandeur of the scenery presented to his gaze in an endless panorama of natural beauty. We say natural beauty advisedly, because it is only nature's work that he sees, while the hand of man is hidden by careful landscape work, or at least it is unobtrusive, and does not seem to mar the natural scenery so much as when it is left as the construction gangs left it, showing the hand of man as a ruthless destroyer. It is after the trip that the tourist does his best work for the railroads in that he tells his friends of the beauties of the various railroads over which he has travelled. Again, if the tourist has been over a road that has not done any beautifying he will loudly denounce it. The railroad will be a blotch on the landscape, and he will advertise it as such. It would not take so very much labor to make this road more presentable from a beauty standpoint. One cannot paint

the lily is a very true saying, but a little touch of white paint over any disfiguring marks will make it a great deal more presentable—at a distance, anyway, and that is how our tourists see things.

When the returned tourist talks is when his value to the railroads is at its highest. His friends may be just waiting to settle the much-discussed question of "where to go" when he tells of his travels. They probably only need a little encouragement in certain directions in order to make them decide.

Some work is done on the railroads in the spring, but it is generally of a utilitarian nature. It is usually summer before the efforts of trackmen and station agents are evident, at least to the travelling public.

ALTITUDES IN CANADA.

The Board of Railway Commissioners have taken a step in the right direction in their recent order, in which all railroad companies when submitting profiles of their roads or extensions, must base all elevations shown thereon to Mean Sea Level. This will apply to all lines, commencing, terminating or intersecting with any of the lines as listed in White's "Altitudes in Canada," a work which has been widely distributed. This will tend to spread the network covered by "Altitudes in Canada," and will be of inestimable use to engineers who will in the future be commencing some work from a point which is already listed in the book. The order also stipulates that any line touching tide water must show elevation above Mean Sea Level.

It would be of advantage to engineers if all works were carried on with a common datum, and it would be in our own interests to include not only railroads but any engineering work in the above order. Of course, we will still have to resort to the old stump B.M. We usually assume it to be elevation 100.00 in out-of-the-way places, but wherever possible we should carry on the elevation in respect to Mean Sea Level.

SASKATCHEWAN LAND SURVEYORS.

The officers of the Saskatchewan Land Surveyors' Association elected at the annual convention in Regina are: W. R. Reilley, Regina, president; R. W. E. Loucks, Regina, vice-president; H. G. Phillips, Regina, secretary-treasurer. Four councillors were elected as follows: W. M. Stewart, Saskatoon; E. W. Murray, Regina; W. Thompson, Grenfell; and F. Lamb, Saskatoon. P. W. Brown, of Saskatoon, and S. Young, of Regina, were appointed auditors.

PERSONAL.

E. E. FORGEUS has been appointed purchasing agent of the Eastern Car Co., New Glasgow, N.S.

T. V. McCARTHY, B.A.Sc., of the Waterworks Department, Toronto, has enlisted for overseas in the 43rd Howitzer Battery.

H. S. PHILLIPS, formerly chief draftsman in the Sewer Section, City Hall, Toronto, has accepted a similar position with the Canadian Nitro Products Company.

Lieut.-Col. CHARLES H. MITCHELL, C.E., M. Can.Soc.C.E., Toronto, has received from the French government the officer's cross of the Legion of Honor.

SAMUEL G. ALLEN has been elected president of the Franklin Railway Supply Company, and Mr. Joel S. Coffin, formerly president, is now chairman of the board.

J. E. RICHARDS, general auditor of the London and Port Stanley Railway, has been appointed manager and treasurer of the road, succeeding F. T. LEVERSUCH, who resigned. Mr. Richards was formerly with the Chatham, Wallaceburg and Lake Erie Electric Railway.

OBITUARY.

CHARLES H. CONERY, well known as a paving contractor, died last week in Guelph.

WM. NORRIS, manager of the Chatham, Wallaceburg and Lake Erie Electric Railway, died in St. Joseph's Hospital, London. He was fifty years old, and was formerly connected with the London Street Railway Company.

THOMAS TOMLINSON, head of the firm of Thomas Tomlinson & Son, iron founders, Frederick Street, Toronto, died on February 22 in the Western Hospital, following an accident. The deceased was 45 years of age.

MANITOBA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

At a meeting on March 6th of the General Section of the Manitoba Branch of the Canadian Society of Civil Engineers Messrs. W. G. Chace and M. V. Sauer gave an interesting review of the present and proposed hydro-electric development in the Niagara Falls district. The differences in the various plants were pointed out, special features were discussed, and the advances made in electric power transmission within the last twenty years were dealt with.

VANCOUVER BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

Detailed description of the government's great floating drydock at Prince Rupert, largest but one of all Canadian docks of a similar type, the Montreal construction being slightly more imposing was given by J. H. Pillsbury, of the engineering staff of the Grand Trunk Railway and engineer in charge of the construction of the northern dock, before the members of the Vancouver branch of the Canadian Society of Civil Engineers at their meeting in the Board of Trade rooms.

The dock has a lifting capacity of 20,000 tons, about the tonnage of a steamer of 650 feet. It is in three sections, each one capable of being sunk and lifted independently for the accommodation of smaller vessels. In connection with it there is a very complete plant, including light and power plant, machine shop and ship-building plant. The cost of the whole plant, dock and all, had been $2,600,000, but the cost of the dock and its accessories was about $800,000.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-sixth annual convention to be held in New York City, June 4th to 8th. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.