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HALIFAX OCEAN TERMINALS

DETAILS OF CONSTRUCTION METHODS USED IN BUILDING OF CONCRETE QUAY WALLS—MANUFACTURE OF CONCRETE BLOCKS—MATERIALS OF CONSTRUCTION

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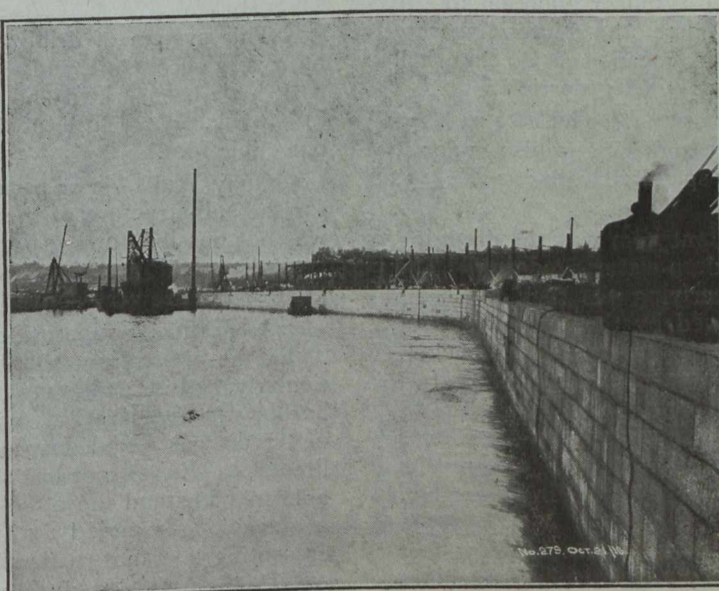
THE terminals consist of a passenger landing quay 2,006 feet long, five piers 1,250 feet long by an average width of 350 feet, and a breakwater about 1,600 feet long, on the north side of which will be constructed later two steamship berths. On the north side of the first basin are two berths, 500 and 700 feet long. With the exception of these two berths, which will have 30 and 35 feet at l.w.o.s.t., 45 feet at l.w.o.s.t. will be provided at all the berths. The whole system will be equipped with modern sheds, freight handling appliances, grain elevators, ample tracks and all requirements pertaining to modern terminals.



Showing Portion of Finished Wall.

In order to provide railway connections with the new terminals an extension of the existing Intercolonial Railway was necessary. Many locations for this extension were studied, and finally, after careful consideration, it was decided to construct a line diverging from the Intercolonial Railway at Fairview. Great care has been taken in the location and design of the bridges, for grade separation of railway and highway traffic to preserve as far as possible, not only the beauties and amenities of the Northwest Arm, which from a tourist point of view is the city's greatest asset, but also of the suburban district through which the railway passes. From the crossing over Chebucto Road the railway follows the east side of the Northwest Arm to Maplewood, and from thence passes in an easterly direction in a deep cutting to the site of the terminals. Grade crossings are eliminated, the railway crossing over the highways at Fairview Road by steel girder spans with concrete abutments and over Chebucto Road by steel girder spans encased in concrete, the remaining highways and streets being carried over the railway on ornamental reinforced concrete arches.

The railway is about 5 miles long and is to be double tracked throughout, with 4 tracks at Bower Road and branching out into the yard with 16 tracks at Tower Road. The maximum grade for east-bound traffic is to be 6/10 per cent. compensated .04 per cent. per degree of curvature and the sharpest curve will be 4 degrees with standard spirals.

Railway.—The work of constructing the new railway was commenced towards the end of July, 1913, at Fairview, and a month later at the harbor end.

The shooting of the rock in the Fairview end of the cutting presented many difficulties, the rock being very faulty, containing pockets of rotten-disintegrated rock, mud, clay, gravel and sand, as well as water. The cut was drilled and shot no less than three times before it could be completely excavated.

The first time holes were drilled with well drills at 9-foot centres in rows 16 feet apart. It was intended to spring these, but most of them caved in and were lost; as many as possible, however, were shot and a shallow cut taken.

The second time the holes were drilled 10 feet apart in rows 8 feet apart to 6 feet below subgrade and shot without springing, but this was not entirely successful.

The third time the holes were drilled 10 feet apart in rows 5½ feet apart, staggered and to 6 feet below subgrade without springing. Even this did not break the bottom of the cut properly, and the further use of piston drills was necessary for that purpose. A low freezing explosive was used on account of the presence of very cold water in many of the drill holes.

Most of the shooting was done in blasts of from 3 to 8 tons of 60% forsite (low freezing) calculated on a basis of from 1⅛ to 2 lbs. of explosive to the cubic yard of material blasted, according to the nature of the rock. It was very clearly demonstrated in the extremely shattered rock encountered that the electrically driven drills were much superior to the steam-driven. Owing to the impossibility of keeping the steam at an even pressure the time of the stroke of the drill constantly altered, and if it was working slowly when it passed from a hard into a seam of disintegrated rock it jammed. With the electric drills, however, as the strokes were steady, very little of this trouble was encountered. It is worthy of record that although most of the blasting was done in close proximity

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to houses and streets, very little damage was caused, and there were no serious accidents either to the general public or to the workmen employed.

Bridges.—In connection with the railway running in from Fairview to the terminals, sixteen bridges are called for. Of these, fourteen are highway bridges, arch type, constructed entirely of reinforced concrete. The one carrying the Halifax Ocean Terminals Railway over the streets at Fairview is to be built of plate girders in a single span. This bridge will have a concrete deck only.

The other, carrying the railway over Chebucto Road, is to be built of plate girders in three spans; that is, two sidewalk spans and the roadway span. This bridge will be entirely encased in concrete.

The single spans for highway bridges vary from 60 ft. to 144 ft.

At Young Avenue, the double span arch is to be approximately 225 ft. between main abutments.

All abutments and wing walls are built on solid rock and are of mass concrete.

The aggregates for the concrete were obtained from a beach at Seaforth, on the eastern shore of Nova Scotia, and shipped in flat cars over the Canadian Government Railways via Windsor Junction to the different bridge sites. There the materials were hoisted to the top of the cut by means of a clamshell bucket, operated by an ordinary stiff leg derrick.

The following mixes of concrete were used: 1:2½:5, 2-inch mesh in main abutment and wing walls; 1:2:4, 1-inch mesh in arch ribs and spandrel walls; 1:1½:3, ½-inch mesh in handrailing.

Dredging.—A very important item was the dredging and especially the rock and deep-water dredging. The more or less soft material overlying the rock in basins Nos. 1 and 2 was first removed by the dipper dredge, "King Edward," equipped with a 5-cubic-yard bucket. This dredge had a maximum dredging depth of 50 feet and a minimum of about 15 feet.

After much consideration and comparison of systems of drilling in various classes of rock and of the results obtained, drill boat No. 1 and afterwards drill boat No. 2 were constructed.

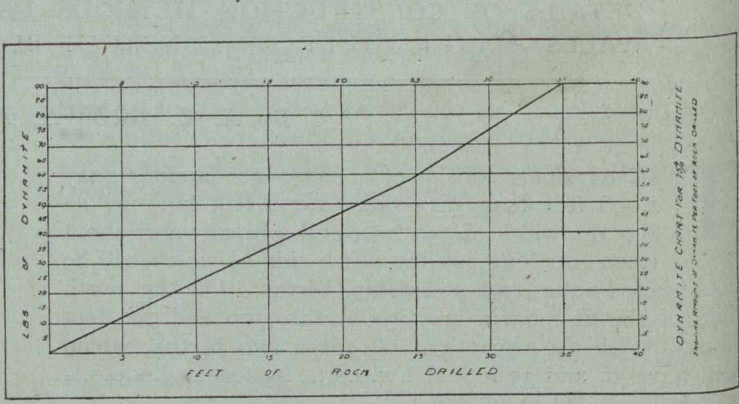
Drill boat No. 1 consists of a wooden scow 35 feet wide by 90 feet long, fitted with 7 steam drilling machines with 5⅝-in. bits and 6-in. cable, 4 spud anchors with spud engines, two winch engines, locomotive boiler and electric light generating set.

Drill boat No. 2 is similar to No. 1 only larger, consisting of a wooden scow fitted like No. 1, but containing 10 drills, 7 feet apart.

The rock encountered is similar to that found on the railway and consists for the most part of slate or shale with iron stone and an occasional trace of trap rock and quartz. It lies in very irregular inclined strata, being seamy and much broken, so much so that it is necessary to case all the holes with a 6-in. case pipe and to drive it sometimes for fully three-quarters the depth of the hole. This effectually cuts off the flow of sand, clay or mud contained in the seams of the rock, and so prevents the drills jamming. The holes are kept clean by means of a sand pump.

When the rock drilling and blasting first started the holes were drilled in rows 7 feet apart, and about 2¼ pounds 60 per cent. dynamite used to the cubic yard of material blasted. This was found to be excessive, and lated the holes where the rock was deep were spaced 10 or 11 feet apart, and about one pound of 75 per cent. dynamite used to the cubic yard of material blasted. The dynamite chart shows the amount of dynamite to be used per foot of hole and is worked out on this basis. (Fig. 2.)

Outside the wall foundations the drill holes are drilled to from four to six feet below grade to ensure that the rock is broken fully to grade and that the dredged depth can be obtained with comparatively easy dredging. On the site of the wall foundations and within 10 feet of them the holes are drilled 3½ feet below grade at 7-foot centres, so as not to injure the foundations.



This system of drilling in the rock encountered has been very successful, and as much as 6,000 cubic yards of rock have been drilled and blasted by the two drill boats in a week. Very little of the broken rock is larger than one cubic foot.

Quay Walls.—For permanent work the use of timber for the sub-structure of the quay walls in Halifax harbor was not possible, owing to the activities of both the "limnoria ligorum" and the "teredo navalis," two marine insects which are very active in attacking timber.

A careful examination of the existing timber wharves along the water front showed that the limnoria was particularly active, and that the life of timber in Halifax harbor was comparatively short. Evidence of the presence of teredo was found, but to a much less degree than the limnoria. Experience has shown that creosoted timber is able to withstand the attacks of these marine insects for a much longer period than untreated timber, but even creosoting does not render timber immune from attack.

Concrete is not subject to attacks from any marine insects and with proper precautions taken as to mixing, proportioning and placing, is in sea water practically free from disintegration. Due to climatical conditions in Nova Scotia, however, concrete between high and low water will break up through mechanical action, due to frost, when the temperature approaches zero. It was, therefore, decided to build the quay walls of concrete and face them with granite from one foot below l.w.o.s.t. to quay level. A careful comparison of designs of open work, reinforced pile and cylinder construction, mass concrete, concrete block and concrete caisson construction led to the design and adoption of a quay wall constructed of cellular reinforced concrete blocks filled with mass concrete and broken rock, whereby it was hoped to combine all the advantages derived from the use of reinforced concrete and to deposit the mass concrete under water under conditions which were as nearly as possible ideal, the blocks acting as permanent forms.

The standard blocks are 31 ft. x 4 ft. 1½ ins. x 21 ft. 10 ins. cellular with diaphragms 8 ins. thick and reinforced principally with ⅝-in. square twisted steel bars.

It will be noticed that the front and middle compartments are square and connected one with another by triangular holes and are to be filled with concrete. The remainder of the compartments are circular and are to be filled with broken rock, being designed circular so as to better withstand the bursting pressure due to the broken stone filling. Each block contains eight 10-in. grout holes. There are only five shapes of blocks. The bottom course 34 ft. x 3 ft. 4 ins. x 21 ft. 10 ins., the second 31 ft. x 3 ft. 6 ins. x 21 ft. 10 ins., the standard blocks 31 ft. x 4 ft. 1½ ins. x 21 ft. 10 ins., the two top blocks 26 ft. x 4 ft. 1½ ins. x 21 ft. 10 ins., these latter being made by leaving out the front compartments of the standard blocks and the special blocks with a rounded corner to form the corners of the pier and landing quay. The blocks, which contain about 30 yards of concrete and from 2½ to 3 tons of reinforced steel and weigh about 62½ tons, are manufactured in a block yard on the site of the works.

Steel forms consisting of four ridged outside pieces and collapsible inside pieces are used. The forms are bolted down to the platforms and held together at the top by means of clamps. In stripping a block, each outside form is lifted independently, and those in each compartment are collapsed and lifted out.

The arrangement of reinforcing steel in the blocks is very simple, consisting mostly of long bars running right through them.

The simplicity of the system of reinforcement is illustrated by the fact that the reinforcement for a block is erected in 30-man hours. Little difficulty is experienced in making ten blocks per day, and under very favorable conditions as many as sixteen have been made in a single day. After seasoning for a month the blocks are either stored in a storage yard or placed into the quay walls. About 3,600 blocks are required to complete the quay walls for the first unit and all but about 800 have now been made in two working seasons.

The quay walls are constructed of stacks of reinforced concrete blocks, placed one directly above the other, and securely bonded and bedded by means of mass concrete in the front and middle compartments and by old railway rails grouted into the 10-in. grout holes.

The method employed in constructing the quay walls is as follows:—

The foundations are prepared and concrete pedestals 5 ft. x 6 ft. from a few inches to several feet deep are constructed every 22 feet along the line of the wall; upon these pedestals the bottom blocks rest, the adjacent corners of successive stacks of blocks resting on the same pedestals.

When the pedestals are more than 4 inches deep they are connected by a concrete wall about 2 feet thick at the top. The wall is left 3 inches lower than the pedestals.

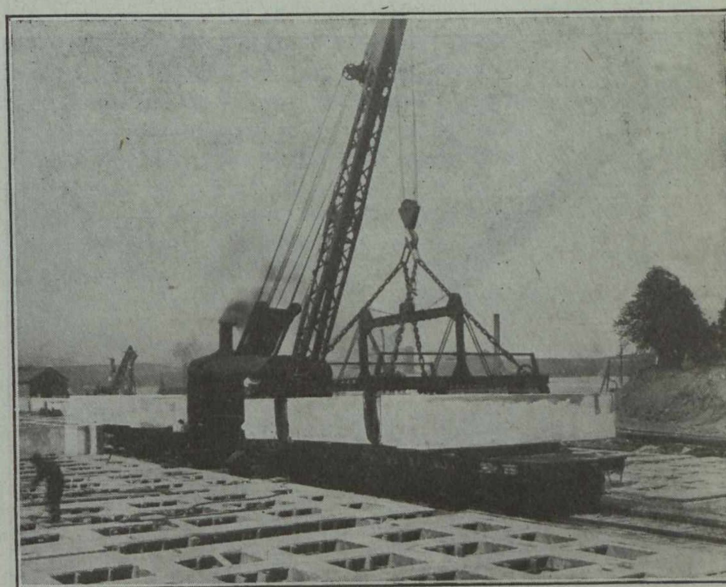
By means of the 150-ton locomotive crane, sufficient blocks are loaded on to flat cars to complete one stack. The crane then travels to the scene of operation and the blocks are sent out to it one by one. They are lifted and put in position just touching the guide posts and then lowered into place. As soon as the block is on the bottom, the boom of the crane is lifted a few inches and the block raised about 2 feet and finally lowered into place. This has the effect of bringing the block hard up against the guide posts. The crane travels out over the empty stacks of shells, a very important construction feature which does much to promote the progress of the work.

Following the block-setting comes the filling of the stacks with concrete. Before concreting takes place, bags of sand or wooden shutters are placed along the bottom of the wall between the pedestals back and front to prevent the concrete running out and a small quantity of rubble is placed between the stacks for the same purpose.

The concrete, consisting of 1 part cement, 2½ parts sand and 5 parts broken stone, is conveyed from the yard mixing plant at night, or when blocks are not being made, in 1 cubic yard bottom-dumping buckets and placed by means of a locomotive crane standing on the walls. Great care is taken that the buckets do not deposit their concrete until they are on the bottom. Two floating mixing plants are also used for this work at times. The concrete in the front pockets of the blocks is left 6 inches below the top of the standard block, so as not to interfere with granite setting. Old railway rails are then placed in the grout holes extending from top to bottom of the stacks of blocks and grouted in with a 1:2:4 concrete.

After the concreting is completed dredged rock is placed in all the circular compartments of the blocks and the wall is then ready for the granite face work and mass concrete top wall.

To commence the block setting timber trestles were built to the shore ends of north quay basin No. 1, the north and south quays of pier "A," and to a point near the centre of the bulkhead passenger landing quay and block setting has taken place from all these points.



Crane Loading Block onto Flat Car. Note Specially Designed Lifting Tongs.

Foundations.—There are three classes of foundations encountered on this work. Most of the walls are founded upon rock; about 600 feet at the centre of the passenger landing quay and the pier head are on rubble mounds, and about 400 feet on the passenger landing quay on a glacial deposit of red boulder clay.

Where rock was encountered above grade it was removed by dipper dredges, the surface cleaned and the pedestals built by means of a large diving bell.

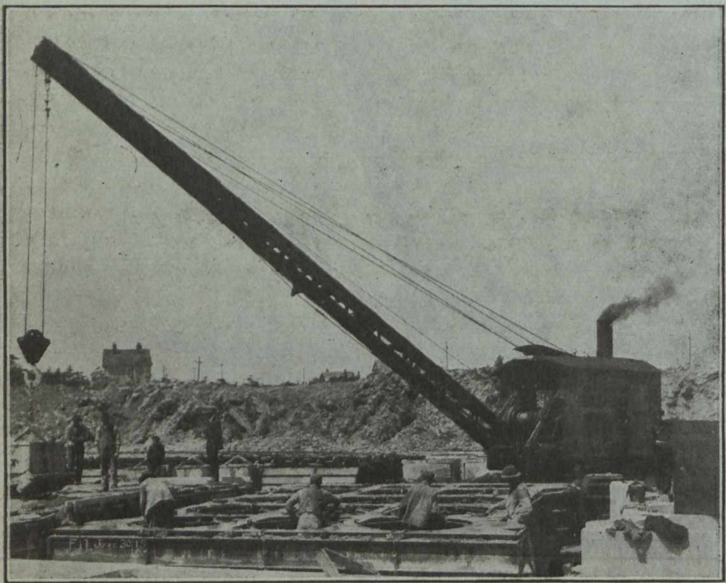
The diving bell consists of a large steel chamber 38 ft. x 26 ft. x 7 ft. high, and is provided with separate man and material shafts and locks. It is capable of sinking and refloating itself by means of a water ballast tank and can work in any depth of water from 25 to 55 feet.

Eight or ten men usually work inside the diving bell, the water being kept out by compressed air. The bell is tended by a wooden scow 100 ft. by 32 ft. 8 ins., fitted with high and low air compressors, pumps, electric light, a ½ cubic yard concreting mixer and a steel frame derrick of 20-ton capacity.

For the first few months clay was packed around the cutting edge of the bell, all the water pumped out and the concrete pedestals constructed in the dry. This mode of procedure, however, took considerable time, and there was always the danger of the clay bank breaking and allowing the water to rush in. It was, therefore, decided not to dry out the working chamber and the bottom was from that time covered with from 6 inches to 2 feet of water.

Immediately under the material shaft the ground was left slightly higher than the cutting edge. On this piece of dry ground the concrete was deposited. Forms made of sacks of material collected while cleaning the bottom were built round the pedestals and concrete shovelled into them commencing at one corner, until it showed above water. The remainder of the concrete was shovelled on to this and allowed to push out until the pedestals were completed, thus ensuring that the cement would not be washed out.

This method gave complete satisfaction. As concrete sets very quickly under air pressure, it was possible to strip the forms off the pedestals in six hours even with a pedestal 3 or 4 feet high. The water was then allowed to rise slowly in the bell and the bell moved.



Blocks Before Leaving Yard.

There was only one foundation which caused any trouble and calls for special mention, and that was for the first stack of blocks on north quay basin No. 1, where it was found that the rock at the front of the wall slipped down suddenly for a depth of 7 feet below foundation level.

In order to set the bell on this foundation the hole was filled with granite boulders, and the bell then set with its front edge resting on them, and its back edge on the solid rock. The water was then expelled from the working chamber and the bell tilted forward by removing pieces of granite until it was 3 feet out of level. Fortunately the front edge of the bell just rested upon two large granite boulders, so all the granite inside the line of the wall could be removed. When this had been done a clay bank 4 feet high was built from the bottom of the hole to the cutting edge and all the water expelled.

By this means it was possible to excavate the rock along the front of the wall forming a level strip 7 feet wide at the bottom of the hole to ensure a good footing. This was a somewhat interesting and delicate operation, as the men were working 4 feet below the cutting edge with only a light clay bank to keep the water out.

Wooden forms were then placed along the front of the bell and a concrete wall 8 feet thick constructed up to the level of the remainder of the foundation, and on this wall the front pedestals were made. It was found in connection with the bell work that if the rock had been properly dredged to grade by the dipper dredge 22 lineal feet of foundation could be prepared with the bell per day.

Materials of Construction.—Cement: All the cement used on the works is manufactured in Canada, at Montreal and Belleville. The Belleville cement, which contains a low percentage of magnesia, was used in concrete which would come in contact with the salt water.

Aggregate for Concrete: Beach sand and gravel is used in all concrete work. This material is obtained from a beach purchased by the contractors at Lawrencetown, about 16 miles east of Halifax. With careful inspection it was found possible to use run of beach material for all the mass concrete work.

Reinforcing Steel: The reinforcing steel is manufactured at New Glasgow and Sydney, Nova Scotia.

Granite: All the granite is obtained from Purcell's Cove Quarry.

Cast Iron: The castings for the mooring hooks are all made locally.

Features of Design.—The smoothness and facility with which the harbor works have been carried out and the general standard of excellence attained have so far amply justified the main features of the design of the quay walls and breakwater and the location. The principle of using the largest possible blocks for quay wall construction, providing the weight does not exceed the capacity of reasonable and, if possible, standard equipment, has been further illustrated and the results have even exceeded expectations. It would be impossible to set smaller blocks with greater accuracy and at a faster rate. Experience has shown that the large reinforced concrete blocks can be set as quickly as the small granite corbel course blocks.

The cellular construction of the blocks has made it possible to manufacture a block about three times as large as a mass concrete one of the same weight, and has thus cut the amount of block setting to one-third.

The width of the wall, namely, 31 feet, has eliminated the use of expensive temporary staging for carrying the block setting cranes and at the same time has provided foundations for the front row of freight shed columns, which otherwise would have to be provided independently at considerable cost. Perhaps the most interesting and certainly the most important feature of the design of the blocks is that an enormous saving in foundation work has been effected. Whereas it is usually necessary to carefully construct a level foundation for the full width and length of the wall, by means of concrete in bags or mass concrete carefully levelled, all that is necessary with the cellular blocks is to level the small areas on which the corners of the bottom blocks rest, that is, a pedestal 5 ft. x 6 ft. back and front of the wall is constructed every 22 feet, and the remainder of the foundation allowed to remain as left by the dredges, with the exception of a little cleaning, as previously described.

The harbor works are also sufficiently advanced for it to be safely recorded that the main features of the design are even better suited to conditions found at the site of the terminals than was anticipated.

CANADIAN RAILWAY PROBLEM.

SIR THOMAS TAIT has just written a paper offering a new solution of the Canadian railway problem, advocating one united system of railways in Canada. Sir Thomas has had long and valuable experience in railway management in Canada and Australia, so his paper is authoritative and well worthy of due consideration along with any other schemes suggested. His paper in full is as follows:—

The Dominion of Canada at the present time owns or controls and operates a railway system, the main lines of which extend from Sydney, Halifax and St. John on the Atlantic seaboard to Quebec and Montreal, and from Quebec to Fort William and Winnipeg, and there is, therefore, to-day in Canada the administration by the State of about 4,000 miles of railway and competition between company railways and a State owned and operated railway system extending more than half way across the continent.

In view of certain conditions which, it is to be regretted, prevail in this country and in which there appears no promise of early improvement, the efficient administration along business lines of State railways in Canada by the government, even by means of a so-called "independent" board of commissioners can not be confidently anticipated. It is generally the experience in democratic countries having State railways that it is impossible to eliminate political influence, exerted if for no other reason than to promote and advance the interests of the political party in power, and, undoubtedly in such countries as the United States and Canada, where political partisanship runs so strong and political patronage has so long been the custom, prudent and efficient management of railways by the State would be found sooner or later to be impracticable owing to political interference and influence.

Competition between State owned and operated railways and company railways is inequitable and unfair to the private investor in the latter. Money for construction and equipment can, generally speaking, be borrowed or obtained by the State on considerably better terms than by companies, and, therefore, State railways are not expected or required to earn as large a return on their cost as investors in company railways, especially shareholders, look for and should receive. If everything else, therefore, be equal, an important and improbable proviso—the rates and fares on State railways do not require to be as high as on company railways. Due to the exercise of political influence, rates and fares on State railways are liable to be reduced and indeed as a rule are reduced, and train services and other facilities are provided beyond what the traffic and other conditions warrant, and these lower rates and fares and these unjustified facilities must be conceded by competing company railways if they are to retain their fair share of the traffic.

In view of the possibility, if not the probability, of the Dominion being compelled to take over the Canadian Northern system and the Grand Trunk Pacific Railway from Winnipeg to Prince Rupert with its branch lines, the question arises whether in such event the difficulties and disadvantages of State administration, on the one hand, and the injustice of State competition with private enterprise, on the other hand—both of which will be greatly aggravated and increased should the present State railway system be extended from Winnipeg to the Pacific Coast and throughout our Western Provinces—might not be avoided.

The following is an outline of a scheme whereby both the advantages which may be derived from the ownership of railways by the State and the good results which should accompany efficient administration by a company may be obtained and to these be added the great advantages, including a very large saving in operating expenses, which would result from all the more important railways of Canada being managed and operated as one great system:—

(a) It is assumed that the Dominion can acquire all the common stock of both the Canadian Northern and the Grand Trunk Pacific Companies for possibly a nominal consideration or, having regard to the magnitude of the scheme, for a comparatively small sum.

The Dominion to take over all the assets and assume all the liabilities of the Canadian Northern and the Grand Trunk Pacific systems and to guarantee interest on their bonds and debenture stock—supplemental to and not in cancellation of existing provincial and other guarantees of such securities.

(b) The Dominion to lease the Canadian Pacific Railway system in perpetuity for a rental equivalent to an agreed annual return on its common stock and to guarantee the payment of all dividends or interest on all the securities of that system which are senior to its common stock and to assume all the liabilities of that company, including all its guarantees on the securities of other railway companies, and the payment of all rentals for which the Canadian Pacific Railway is responsible. The Dominion to take over all the assets of the Canadian Pacific Railway Company, except those which are not closely connected with the operation of its railways and connections, which assets would be transferred to a separate company for the benefit of the Canadian Pacific shareholders.

These excluded assets would include: All lands, except those specified as "Surplus Lands" in Schedule "B" of the Company's Annual Report; interest in town sites; timber and mining rights; collieries and timber mills; improved farms and live stock; natural gas and petroleum rights; investments in Consolidated Mining and Smelting Company and in West Kootenay Power and Light Company; investments in coal and other mines; balance at credit of special income account; proceeds of land sales; deposits and loans; cash on hand and in banks, etc., in excess of current liabilities.

(c) The Dominion to lease the Grand Trunk system in perpetuity for a yearly rental equivalent to certain rates of dividends per annum on its preference and common stocks to be agreed upon, and to guarantee the payment of all dividends or interest on all the securities of that system which are senior to its preference and common stock, and to assume all the liabilities of that company, including all its guarantees on the securities of other railway companies and the payment of all rentals for which the Grand Trunk Company may be responsible. The Dominion to take over all the assets of the Grand Trunk Company.

(d) The five systems, *viz.*, the existing Government system, the Canadian Northern, the Grand Trunk Pacific and the Canadian Pacific and Grand Trunk systems (hereinafter called the "Whole System") to be administered for and on behalf of the Dominion, under an agreement with the Dominion, by a company known as the "Canadian Railways Company," to be incorporated and constituted as follows:—

(e) The company to be incorporated as above to have a capital of, say, ten million dollars and a board of directors of nine members, hereinafter called the "Board."

Fifty-one per cent. of the capital to be subscribed and paid for and to be held by the Dominion, and the balance —forty-nine per cent.—to be subscribed and paid for and to be held exclusively by citizens of Canada.

The Dominion to guarantee five per cent. per annum dividend on the stock of the said company.

Four of the nine directors to be appointed by the Governor-General-in-Council, four by the citizen shareholders of the company, representing forty-nine per cent. of the stock, and the ninth director to be appointed by the Supreme Court of Canada. The directors appointed by the Governor-General-in-Council and by the Supreme Court not to be interested directly or indirectly in the stock of the company.

No corporation, firm or individual to be interested directly or indirectly in more than one hundred shares of the citizens' stock. No stock to be transferred without the consent of the board.

The directors appointed by the Governor-General-in-Council to hold office, one for five years, one for six years, one for seven years and the fourth for eight years, and to be eligible for re-election—subject, however, to dismissal by the Governor-General-in-Council in the event of misconduct or incapacity, with right to appeal in such case to the Supreme Court of Canada. These four directors to be the most capable railway administrators obtainable—one of them with experience in operating, one of them in traffic, one of them in finance and accounting and the fourth in legal work.

The directors appointed by the citizen shareholders to be elected annually.

The director appointed by the Supreme Council to hold office for ten years and to be eligible for reappointment, subject, however, to dismissal by the Governor-General-in-Council in the event of misconduct or incapacity with right of appeal in such case to the Supreme Court.

Vacancies due to death or resignation to be filled by the Governor-General-in-Council in the case of a director originally appointed by him, in the case of a director appointed by the citizen shareholders by the other three similarly appointed directors until the next annual meeting of the company and by the Supreme Court in the case of the director appointed by it.

The chairman and vice-chairman of the company to be appointed by the Governor-General-in-Council from among the four directors similarly appointed and to hold office for eight and seven years, respectively. The chairman to be the chief executive officer of the company. The vice-chairman to assist the president and to represent him in his absence.

The salaries of the members of the board of directors appointed by the Governor-General-in-Council to be sufficient to secure the best men for the positions and the salaries of the other directors to be such as to make it worth the while of able and reliable men to become members of the board.

The board to control and direct the policy of the company and to have complete control of the appointment and work of the officers and employees of the company.

In any year in which the net revenue of the whole system is sufficient to pay all the rentals and other charges payable by the Dominion in respect of the whole system, including interest at an agreed rate on the amount invested in the existing government system and the interest payable on additional capital expenditure (see Clause "f"), all hereinafter called "fixed charges," the chairman and vice-chairman and other members of the board shall receive a bonus equivalent to an agreed percentage of their respective annual salaries and the citizen shareholders an agreed increase in their dividend, and in the event of the net revenue exceeding the said fixed charges in any year by a percentage to be fixed, the said members of the board shall receive an additional bonus equivalent to an agreed percentage of their respective salaries, and the citizen shareholders shall receive an agreed additional increase in their dividend for that year. Maximum salaries for the respective directors and a maximum dividend for the shareholders to be fixed.

(f) The Dominion to finance the whole system including the provision of the funds for new railways, for all additions and improvements to existing lines and for rolling stock and other equipment chargeable to capital account, as may be stated to be required by the board. In the event of a difference of opinion between the board and the Minister of Railways (representing the Dominion) in respect of any of such capital account requirement, the question to be submitted to the authority referred to in Clause "g" for investigation and report—the decision of such authority to be final.

(g) The construction of a new railway not to be undertaken nor any commitment to it given until an investigation and report it regard to it have been made and the report laid on the table of the House by a competent authority—independent of politics—say, a board of three members thoroughly well qualified for the purpose.

(It might be interjected here that a similar procedure should be followed in all cases involving large expenditures or disbursements of public money on or in connection with works, such as new railways, canals, docks and harbors, dredging, important buildings, etc., and the authority above mentioned might also be utilized to investigate and report in regard to such projects. Every member of Parliament would thus have knowledge based on independent and competent authority as to what he was voting on and the public would know what their representatives in Parliament had voted for.)

(h) Rates and fares and other charges for transportation and other services not to be increased without the approval of the Dominion Board of Railway Commissioners.

Except as hereinafter specified in Clause (i) rates and fares and other charges are not to be reduced without the consent of the board until a substantial reserve guarantee fund has been provided out of net revenue (in excess of the fixed charges, bonuses to directors and extra dividends to shareholders) and the net revenue has been sufficient in three successive years to pay all such fixed charges, bonuses to directors and extra dividends to shareholders, and then only to the extent which, based on the average traffic of the said three years, shall represent a reduction in the net revenue equal to the net revenue in excess of the said fixed charges, bonuses and extra dividends.

(i) The Dominion may by Order-in-Council declare a matter (such as a reduction in transportation or other charges for services rendered or the construction of a new railway) to be one of general policy and direct the board to give effect to such policy, but in the event of the board not concurring in whole or in part in such direction, the Dominion shall reimburse annually to the whole system seventy-five per cent. of the yearly increase in expenditure or of the decrease in revenue of the whole system occasioned by the carrying out of such direction in excess of such increase or decrease as would have been occasioned by the carrying out of such direction to the extent only to which the board concurred in it.

(j) The accounts and books of the company to be continuously audited by an auditor to be appointed by the Governor-General-in-Council, who shall certify to the balance sheet, profit and loss account and other annual statements of the company.

The Grand Trunk Company has never paid any dividend on its common stock, but it would be necessary under this proposal to guarantee a small dividend on that stock in order to secure the consent of the holders of it to the inclusion of the Grand Trunk system in this scheme. It would also be necessary, in order to avoid legal and other complications and serious delay to guarantee the interest and other fixed charges (not already guaranteed by the Dominion and Provincial Governments) of the Canadian Northern and Grand Trunk Pacific Systems.

The idea which is in mind in providing for bonuses for the chairman, vice-chairman and other members of the board and increased dividends to the citizen shareholders, in the event of certain results in net revenue being obtained, is to make it in their financial interest to efficiently administer the whole system, thus increasing the net revenue. This incentive to efficient management is an important factor in the scheme.

It would be highly desirable to have a large number of representative citizens of the Dominion interested financially and otherwise in the administration of the railways of the Dominion and through the appointment by them of four out of nine directors of the operating company to have a voice in such administration. A scheme can easily be devised by which the citizen stock in the operating company will be equitably distributed and held by all classes of the community throughout all the provinces of the Dominion and

The provision and maintenance of a substantial reserve guarantee fund is advisable to avoid possible disarrangement in the Dominion budget owing to the need of making provision therein to meet any deficit in guarantees, etc., in a year of unfavorable railway results, due, for instance, to a failure or partial failure in the harvest.

What is in mind in Clause (i) is to prevent a deadlock between the government of the day and the board in the event of the government considering it desirable in the interest of the public and the country to have effect given to some matter of general policy, which policy in whole or in part is not concurred in by the board (such as, possibly for instance, a reduction in rates). In such event, the Dominion, representing the public and the country to be benefited, should be willing to sacrifice the larger proportion of the loss in net revenue of the whole system occasioned by giving effect to such policy.

The interests of the public can be safeguarded by preserving the present Board of Railway Commissioners, in whose jurisdiction and authority, however, consequential restrictions and modifications would be necessary if effect were given to this scheme, as, for instance, in the matter of reducing rates and fares. The Board of Railway Commissioners might also be charged with the duty of seeing that the lines, equipment, etc., are maintained in a safe and efficient condition, and that the train and other services are such as the business justified.

Very large economies in operation and maintenance can be effected if the five systems herein included in this scheme are worked as one for the good of the system as a whole. The utilization of the shorter or easier and therefore cheaper routes for traffic, the taking up or temporary abandonment of useless lines or lines of little value where the public would not be appreciably affected, the ability to use all motive power and rolling stock freely on any part of the whole system, thus saving much unnecessary movement, especially of freight cars, and obtaining greater service out of such shipment, reductions in train services without appreciable disadvantages to the public by avoiding at present duplicate services, joint instead of separate stations, terminals, offices, etc., with consequent reduction in staff, concentration of work in shops and elsewhere, larger purchases and therefore lower prices of all materials and supplies, etc., etc. The savings which could be effected in these and other directions are so many and the aggregate would represent such a large amount that they might go a long way towards paying the deficit in the earlier years resulting from the operation of the Canadian Northern, Grand Trunk Pacific and Government systems.

Another advantage in combining all, or most of the railways in one system to be worked for the good of all is that the construction of competing lines would be prevented and that new lines would be so located that the least possible mileage would serve the greatest possible area or population, and that railway subsidies with their evil influences would disappear.

It may be urged as an objection to the foregoing scheme that there would be an absence of competition, but competition between railways as it has existed, has been wasteful and far from efficient in the true sense of that word. As has been mentioned, the Dominion Board of Railway Commissioners can and should be clothed with the necessary authority to safeguard the best interests of the country and its trade and of the public generally and to insure the proper maintenance and safe working of the railways and the provision of as good and efficient service of every kind as the business offering and other circumstances justify.

Under this scheme it would not be necessary to raise any large sum of money to purchase any of the railways—a great advantage in these war times.

No matter how independent a board of commissioners for the administration of State railways may be made by the legislation under which such a board is originally constituted and appointed the time will surely come, and at no distant day, when the board owing to its very independence will incur the displeasure, if not the hostility of the government or of parliament and when this occurs the independence of the board from political control or interference will surely be taken away or modified by amending legislation. In such a scheme as is here suggested, however, there would be an agreement between the Canadian Railways Company and the Dominion confirmed by legislation which could not be interfered with by the government of the day or by parliament, even if the inability to use the railways for political purposes be resented. This is an important feature of the scheme.

Eventually, perhaps before many years, lower rates for transportation and other services rendered by the railways would be possible and commercially justified under some such scheme as this than if the railways continued to be administered and operated as separate units—some of them by the State and some of them by companies—or than if combined in one great system, they are administered and managed by the State under a board of commissioners originally intended to be independent of politics.

A scheme can, it is believed, be worked out on some such lines as the foregoing under which all the important railways of Canada can be combined and worked as one great system with enormous savings in working expenses and other beneficial results, under which competition between the State and private enterprise and interference thereby with vested interests can be avoided and under which there would be the advantage of such efficient and prudent administration of our railways as that of a well-managed company.

W. F. TYE ADDRESSES OTTAWA BRANCH OF CANADIAN SOCIETY OF CIVIL ENGINEERS.

W. F. Tye, past president of the Canadian Society of Civil Engineers, and formerly chief engineer of the Canadian Pacific Railway, addressed the members of the Ottawa Branch of the Canadian Society of Civil Engineers on March 29th at a luncheon at the Chateau Laurier. "The only way in which you can get any good out of anything in this world is by work," said Mr. Tye to a large and representative audience. "The only way in which you can get any public recognition whatever is by work. If you want recognition from the public, you must work for the public. If you do not want to work for the public, you won't get recognition. If you do not take your fair share in the load of governing this country, you can't expect to get public recognition, and I do not know of any body of men in all Canada who are better fitted by their training to guide public opinion than the engineers of Canada, more especially as so many of our great public problems are engineering problems."

Mr. Tye referred to his paper on Canada's railway problems and said that his object in putting it out was simply to bring before the people of Canada the gravity of the railway situation, and that if it accomplished that purpose he would consider that he had been amply repaid for his work.

Objection was taken by Mr. Tye to the appointment of lawyers, farmers, etc., on engineering commissions, and he impressed upon his hearers that the government must appoint more Canadian engineers on commissions. He also referred to the employment of American engineers and intimated that the fault lies with the Canadian engineers in not bringing their own merits forward; in other words, in not successfully selling their own services to the government.

"I am quite sure," said Mr. Tye, "that man for man we Canadians are just as good engineers as the Americans are. There may be, of course, some particulars in which they have experience in which we as a younger country have not had experience and therefore in this respect it may be all right for the government to go there for men. But if we want our fair share in this business of advising the government, we must firmly—very nicely and politely, but firmly—tell the government that we do not propose to stand for that sort of thing. We have rights, but in this world if you want your rights you have to fight for them. You have to tell every government in power that we are just as good engineers as the Americans and we propose to have our fair share of the business that is going.

"The reason that this condition exists is that while the engineer has in private life a very good standing, and his standing is improving at all times, yet in public estimation I am not quite sure we are not going backward; that is, our standing is not as good as it used to be. In the old days, thirty or forty years ago, there were some outstanding engineers who had considerable say in the government, or things having to do with the government. I am not quite sure that the engineers nowadays have not that standing, and I say again, I think it is entirely our own fault, because we do not take part in public discussions.

"I do not think that in the parliament of Canada today there is a single engineer; there may be, but I do not know of any. I do not believe there is one in the senate. One reason, it seems to me, why we are in this condition is that we are leading what I might call lives that are entirely too self-centered. Every one of you is thinking of your own particular little job, whatever it is, whether it is work in one of the departments, or whether you are chief engineer of a railway, or working for a railway or canal or private company. You are thinking of that and giving your whole undivided attention to that and serving the private interests to the best of your ability, but you are not taking part in the public discussions. It seems to me that among all the different people in Canada the engineer by his training is the one best qualified to lead and direct public opinion. This is the engineer's age."

CONTROL OF PAVEMENT OPENINGS.*

By E. P. Goodrich,
Consulting Engineer, New York City.

The best way to treat a pavement opening is not to make it. In order to accomplish this end, several things have been worked out to advantage:

(a) Place sub-surface structures under sidewalks and grass strips. This is the German method, and has been demonstrated more efficient economically than the construction of pipe galleries.

(b) Whenever a pavement is to be replaced over a large area, all sub-surface structures should be renewed, or at least carefully examined and repaired; all house connections similarly treated, and the ground restored to as nearly virgin condition as possible under the new pavement. To secure this result, corporations owning sub-surface structures should be notified in ample time to permit them to do this work. Householders should be notified to examine their structures, signs should be posted upon the street stating that the street is to be repaved, and sub-surface at structures must be carefully examined and prepared, and the fact further advertised by newspapers and handbills, if necessary. This practice was followed in the Borough of Manhattan for several years, but some of the corporations found that it was costing so much that they refused to continue the practice. The number of cuts in the new pavements increased perceptibly. Some effort should be made to force the corporations and property owners to make all needed repairs to their structures while the pavement is open. This may mean a revision of the franchise law, and it may mean a change of ordinance.

Except in cases of emergency, permits to open a newly laid pavement should be rigidly refused. The period of such refusal might extend to several years. Hartford, Conn., is said to allow no openings in new pavements until after action by the city council during a period of 10 years. Taking for granted that some cuts must be made, it is obviously essential to know where the sub-surface structures are actually located so that it will not be necessary (as is now often the case) that the corporation or the plumber will have to explore, making three or four openings in order to discover a leak.

This can be accomplished through an adequately financed and administered Bureau of Sub-Surface Structures. Starts toward such a bureau have been made in each of the boroughs in New York City, but their development has not yet been carried so far as to make the work of that department of very much importance except in Brooklyn.

*Abstracted from a paper read before the Citizens' Street Traffic Committee of Greater New York.

THE TRANSPORTATION OF MATERIALS.*

By George Hogarth,
Provincial Engineer of Highways, Ontario.

IN the construction of highways where a surface of a more or less permanent character is to be prepared the moving of the construction materials to the site of the work deserves the closest attention of those in charge. This applies to sand clay road construction; also to the building of gravel and macadam roads and pavements of concrete or bituminous materials, since in each of these types of construction a great deal of hauling has to be done. For the gravel and macadam roads, gravel and crushed stone must be moved in fairly large quantities; for the bituminous pavements, crushed stone and bitumen are required, while for the concrete pavement, sand, crushed stone and cement are essential.

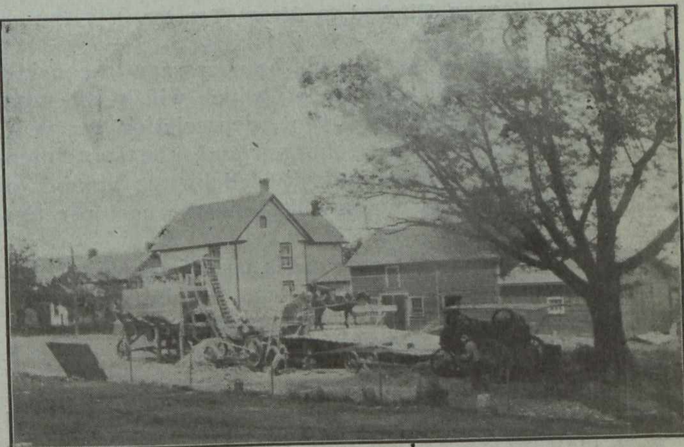
In laying out the work of road-building the sand or gravel pits or stone quarries from which the materials will be secured are probably located so that wagons can be loaded at the plant and despatched directly to the road. At times material may be secured from distant sources of supply which will require that the railways deliver the cars at stations convenient to the road. A proper selection of unloading points will facilitate construction, and due regard should be given to the choice of roads leading away from the railway stations in order that serious damage to the surface of such roads may be avoided.

An important point in the handling of all materials is to see that the loading and unloading of all wagons is carried out with the least possible delay. At the loading end, bins may be made use of, since by that means a wagon is easily and rapidly loaded. This avoids delays to the teams and a better showing will be made in the daily tonnage hauled. The manner of unloading the wagons also calls for some care, and the type of box used will to a great extent determine what can be done at that end of the work. There are two types of wagons used for hauling, the slat-bottom wagon and the bottom-dump wagon. The bottom-dump wagon seems to be in general use to-day, as it has been shown to be the handiest for quick unloading.

Where materials are moved by power, such as on industrial railways or with tractors or motor trucks, it is necessary that well-equipped yards be provided to facilitate rapid unloading and handling. Large storage bins will be required so that on arrival of empty wagons an ample quantity of material can be quickly loaded by gravity. If bins cannot be provided, then mechanical means should be obtained for loading and a crane installed. A large saving can usually be effected by careful attention to the quick loading of the wagons.

No matter how small or how large the work in hand may be, the superintendent should endeavor to keep an accurate check on the work done in order to arrive at the cost of the hauling. Cost data is very useful in preparing estimates and in comparing the work of different gangs or outfits and every opportunity should be taken to arrive at the cost of the various parts of the work. Each superintendent will find that his charges for doing the same kind of work will probably vary from those of his neighbor doing exactly the same work, and the investigation pursued in finding out the reason for any large differences will usually result in certain reforms or betterments being made. By all means keep cost data, as it is the only way in which the work can be proved to be efficient.

Hauling by Teams.—For the greater percentage of road construction to be carried on for some years there is no doubt but that we must depend upon teams for the hauling of all material. Teams furnish a slow method of transportation and have a number of advantages and disadvantages. In some cases it might be found advisable for the county to own a few teams in order to set the working pace and always have teams available when wanted. When purchasing a team buy only the best horses and see that they are properly looked after. While a county might own a few teams, it is usually advisable, for economic reasons, to hire locally whatever other teams may be required. That is one advantage of teams, they can be obtained almost everywhere in sufficient numbers to do almost any ordinary job, and where a job is of small proportions it can be done most economically with teams hired at the site. Teams do their best work during summer when the temperature is moderate and when the roads are dry and in good condition for hauling. When hot weather arrives teams will be found to slow down in pace and to tire more readily, so that rest periods must be provided. That is a disadvantage possessed by teams and is a weakness to which mechanical transport is not subject.



Typical Loading Outfit on County Road Work.

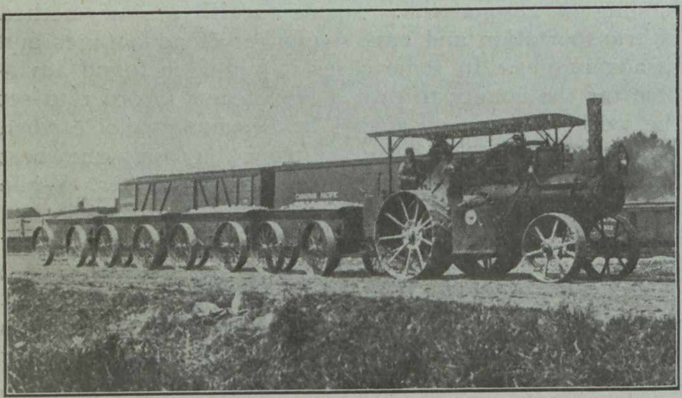
The cost of hauling materials by teams will be affected by the state of the weather, by the kind of roads over which teaming is carried on, by the nature of the country, whether hilly or level, by the capacity of the team for work, and by the rate per day paid for teams. In view of the number of important factors entering into the cost of hauling by teams it will be seen that costs may differ considerably in various parts of the country. On ordinary roads it will be found that a team will average about 20 miles per day for round trips, or, say, 10 miles per day with a load. Over easy grades a team should be able to move from 1½ to 2½ tons at a load, or an average of, say, two tons hauled 10 miles at a cost of $5 per day. The cost of hauling by teams is, therefore, on an average about 25 cents per ton mile.

Mechanical Haulage.—Where a large system of roads is mapped out for construction and the building of these roads may extend over a term of years the question of hauling by mechanical means should be examined into and an estimate of cost made of using such machinery. The types of mechanical haulage available to-

*Paper read before the Third Annual Conference on Road Construction, Toronto, March 27th to 30th, 1917.

day are as follows: (1) Road rollers. (2) Steam tractors. (3) Motor trucks. (4) Industrial railways.

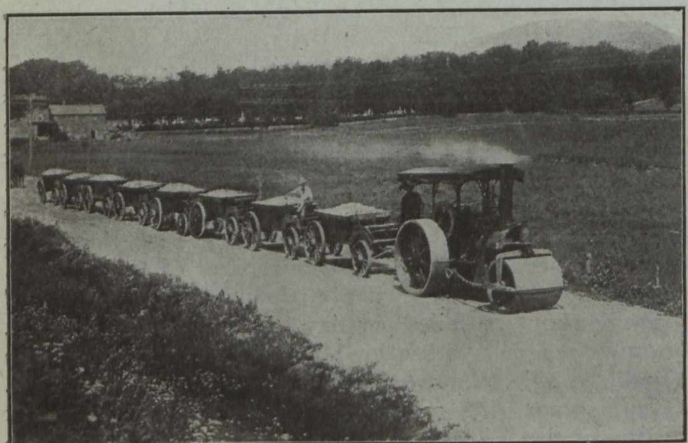
In estimating on using any of these means of hauling a number of vital points enter into the calculations. One of the most essential details to the estimate is the first cost of the equipment. In order to arrive at the cost of moving the unit, one ton, one mile, or the ton-mile, as it is commonly known, it will be necessary to consider the annual cost of the equipment, which will be the total of the interest on the investment, depreciation per year, cost of repairs, operating charges and the superintendence. The total of that sum divided by the number of ton-miles hauled per annum will show the cost per ton-mile.



Wagons Hitched to Steam Tractor.

Road rollers are in some cases used for hauling, but because of slow speed they are not economical. However, in an emergency they may be of considerable use.

Steam tractors capable of hauling a train of five or six dump-cars have been of use in road construction. The first cost of one outfit, consisting of one tractor and five cars, is about $3,700, and the annual charge is in the neighborhood of $4,100. In working 150 days per year the machine should move on an average about 30,000 tons one mile, so that the average cost of hauling by this means would be from, say, 7 to 10 cents per ton-mile. These figures are based on 6 per cent. interest on investment, a depreciation of 15 per cent. per year, repair bills of 5 per cent. per annum, operating charges $6.75 per day, and superintendence 5 per cent. The steam tractor is usually easily kept in a good condition of repair, is of simple construction, with strong details, and may be operated by almost any intelligent mechanic.



Train of Wagons Hitched to Road Roller.

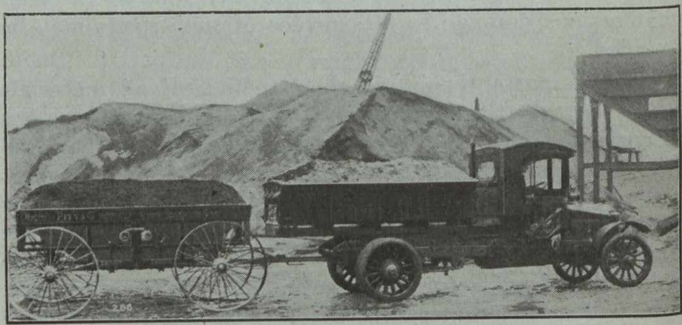
The figure of 7 to 10 cents per ton-mile is calculated upon operating the engine for 150 days per year, and on any ordinary job it is possible to obtain efficient operation and costs as low as those quoted.

This low cost of hauling is made possible by the use of probably five or six trailers, each of which may have a capacity up to four yards or more. Such a train will be in charge of two men, and 25 or 30 tons would be hauled per trip. On short hauls, with good roads and no hills, a very low rate for hauling by this means would be obtained.

Motor Truck Haulage.—Hauling by means of motor trucks has come into general use in the cities during the last few years, and to-day nearly all tradespeople and warehouses deliver and transport their goods by motor truck. In view of the popularity enjoyed by the motor truck for this class of work it is advisable that we look closely into its methods of operation and costs for building roads in the country.

One advantage enjoyed by the truck in the city is that everywhere good pavements are found, and a low-powered truck is able to move a large load satisfactorily under all weather conditions and practically for 300 days per year. Such pavements are ideal for truck operation.

It is well to point to this fact, and also as a comparison to call attention to the general state of country roads during spring, autumn and winter months of the year, when impassable conditions exist. For hauling by truck in the country it is believed that 150 working days per year will be about the maximum that truck operation is possible. The capacity of truck to purchase is important. Practically every size from 1 to 6 tons is manufactured and sold to-day. The heavier truck is seen at its best when operating over good roads, but for general hauling purposes the lighter truck will give better satisfaction, and experience indicates that the 3 or 3½-ton truck is the largest capacity that should be considered. The military authorities favor 1½ and 3-ton trucks, and these sizes have given satisfaction over what are described as horrible roads. Contractors on road work in the States claim that a 5-ton truck will usually spend a good deal of time extricating itself from ruts or broken bridges or culverts, and during wet weather pulling itself out of the ditch. They have had trouble with the heavy truck, and to-day they believe the 3 or 3½-ton truck is the best to use. For one reason or another the heavy truck is frequently delayed on the road. Delays to such equipment decrease the efficiency greatly, as in order to get proper results a truck must be operated continuously.



Hauling Wagons by Motor Truck.

In operating a truck on road construction it is often impossible to choose turning-places, and in some cases turns must be made in very close quarters. For that reason it is well to consider the wheel base of the truck being purchased. A long wheel base may prove awkward.

With a truck having a wheel base of 124 inches it is possible to turn around on a 12-foot road with a sand shoulder.

In road construction one 3½-ton truck will usually replace six teams, and with that data and some experience in the operation of trucks it is possible to estimate the cost of motor truck hauling. It will usually be found that on road construction the cost of tire renewals is fairly high and will amount to 5 to 5½ cents per mile of run.

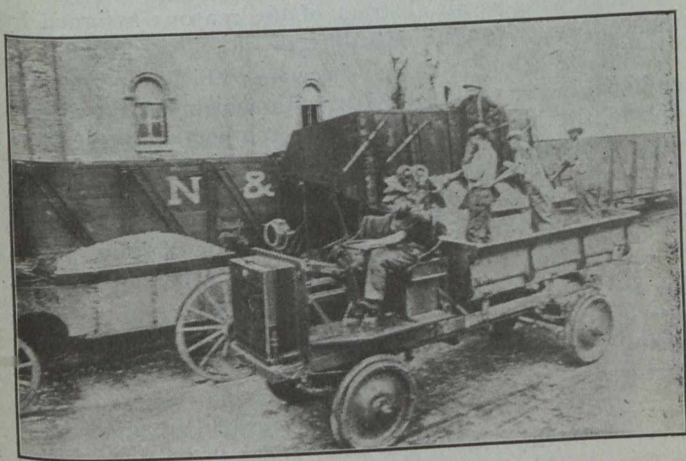
An estimate of hauling by 3-ton motor truck, based on 150 days' operation per year, is as follows:—

Cost of truck, $6,000.

Annual Cost.

Interest on investment, 6 per cent. on $6,000.		$ 360.00
Depreciation per year, 20 per cent.		1,200.00
Repairs		200.00
Operating charges—		
Chauffeur, six months at $80	$ 480.00	
Gas and oil, $4 per day	600.00	
Tires	375.00	
		1,455.00
Superintendence, 5 per cent. of $3,215		160.75
Total		$3,375.75

In one season's operation under favorable conditions the truck will haul about 20,000 ton-miles at a cost of $3,375.75, or 17 cents per ton-mile.



Loading From Railroad Car to Motor Truck.

Such a truck may be good for a life of more than five years, and in some cases ten years is the economical life of well-built trucks, so that the cost per ton-mile for moving materials by motor truck will probably be from 12 to 15 cents per ton-mile.

Haulage by Industrial Railway.—Narrow-gauge industrial railways have been used for years in the operation of coal mines, and our steam railways of to-day are a compromise between the narrow and broad gauge of 50 years ago.

Industrial railways are adapted to the haulage of large quantities of material required in important undertakings, and their use may be particularly advantageous for road purposes under certain conditions. Points in their favor are that they can run over soft ground wherever a track two feet wide can be laid, they do not rut or tear up the road over which they operate, and wet weather has little or no effect on them.

Light rails having a weight of about 20 pounds per yard are used, and these are fastened to steel ties by bolts and clips, so that two men can handle a section of track. The cars used are usually steel, and of "V" shape, having a capacity of about two tons, and arranged so as to dump to either side of the track. The cars weigh about 1,000 pounds, and, depending on the grades, 16 to 30 loaded cars may be hauled in a train. By this means 32 to 60 tons of material are moved to the destination at one trip and at a speed of from 5 to 8 miles per hour. As a long-haul outfit the industrial railway is to be recommended, but the investment necessary to provide the equipment is many times the cost of any other method of hauling.

The outfit will usually require a length of track from 6 to 18 miles, and the total first cost of track, locomotives, cars and accessories will be anywhere from $35,000 to $60,000.

With such a large investment there is a heavy charge for interest and depreciation, while at the same time overhead expenses, operating expenses and incidentals may be heavy. The cost per ton-mile for moving material by this means may be anywhere from 17 to 25 cents per ton-mile.

Such a railway on a large work will frequently prove economical, but in order to do so efficient operation is required and a heavy expenditure for yards and quick-loading apparatus must be incurred.

STEEL COMPANY OF CANADA.

The satisfactory report of the Steel Company of Canada shows that, after deducting charges for repairs, maintenance and improvements and providing for war tax for the years 1915 and 1916, the net profits were $5,021,391. These were dealt with in the following manner: Interest on bonds, $525,819; deferred dividends on preferred stock for two quarters of 1915, $227,370; dividends on preferred stock for the year 1916, $454,741; distribution on ordinary shares for the year 1916, $460,000; reserve for bond sinking fund, $165,454; reserve for depreciation, $601,624; transferred to betterment and replacement reserve, $953,526; credited to profit and loss account, $1,632,855; total, $5,021,391. The amount now standing to the credit of profit and loss is $4,647,497.

The company's balance sheet shows assets aggregating $38,178,921, current assets amount to $12,385,492, current liabilities are shown as $2,896,719, and the reserves total $3,116,104.

The allotment to the bond sinking fund was $88,500 in 1915 and $165,454 in 1916. In 1913 $56,738 was set aside for dismantling Sunnyside works, and in 1911 the sum of $39,000 for underwriting loans, and in 1914 $104,475 for a similar purpose. During the past year dividends on common stock took $460,000 and $953,526 was allotted to a betterment and replacement reserve.

Mr. R. Hobson, president, in his remarks, drew attention to the difficulties which Canadian industrial concerns have to surmount. He said the company's plants were fully occupied, but like all other companies, the Steel Company were hampered by the shortage of labor, and the difficulty of getting delivery of raw materials, supplies, etc., from firms who have also experienced labor shortage, and by reason of the congestion on the railways.

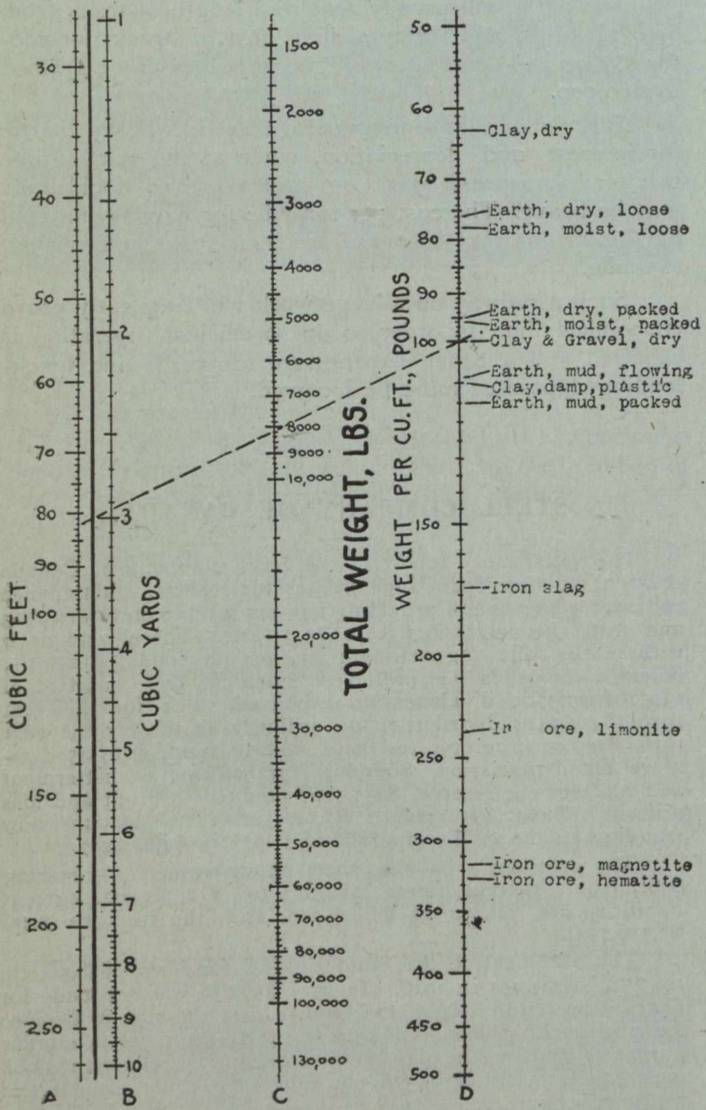
The President of Bolivia has been authorized by Congress to undertake, under the direct supervision of the State, the construction of the Uyuni-Tupuiza Railway between Atocha and Tupiza. The Atocha-Tupiza section is all that remains to be constructed of the line which eventually will connect La Paz with Buenos Aires. It is believed that this through Bolivian route will become an important rival of the Panama Canal, since it will offer quicker and more direct transportation from Europe to the west coast of South America.

A HANDY CHART FOR WEIGHING EXCAVATED MATERIALS.

Simply lay a straightedge across this chart once and the weight of any excavated material may be found by reading the middle column, column C.

For example: What is the weight of three yards of dry clay and gravel?

Find the 3 in column B and from its point on the heavy black line between columns A and B run a line to the 100 (column D), which is the weight of dry clay



and gravel per cubic foot, and the result—8,100 pounds—is found in column C. (See the dotted line on this chart.)

Whether the volume of material is given in cubic feet or in yards makes no difference, either is worked in the same way—always find the corresponding point on the heavy black line first and then connect with the weight per cubic foot.

In case the volume is 30 cubic yards instead of 3, all you have to do is to add another cipher to the result and the weight is 81,000 pounds instead of 8,100 pounds. This chart is, therefore, capable of taking care of any yardage, no matter how great or small.

Even though you are excavating a material that is not listed here, the chart is usable, provided you know the weight of the material per cubic foot. Thus dry, loose sand and gravel weighs from 90 to 105 pounds per cubic foot, and, therefore, cannot be listed on this chart with definiteness, but it is a simple matter for the engineer in charge of the excavation to determine the average weight of the particular material he is excavating and then apply the chart. Dry, packed sand and gravel weighs from 100 to 120 pounds per cubic foot. Riprap weighs from 80 to 105 pounds per cubic foot, depending upon fineness or largeness, and whether it is sandstone, limestone or shale.

This chart, therefore, serves a double purpose. It gives the weights of the most common excavated materials per cubic foot and it is ready at any time for weight computations.—"Excavating Engineer."

McGILL UNIVERSITY AWARDS DEGREES.

Honorary degree of LL.D. was recently awarded to seven scientists and educationalists by McGill University. Those honored were Sir John Kennedy, of Montreal, Dr. W. H. Ellis of the University of Toronto, John J. Carty of New York, Hon. F. Carter-Cotton, chancellor of the University of British Columbia, Prof. Jas. Cappon, dean of Faculty of Arts of Queen's University, H. S. Pritchet, president of the Carnegie Foundation for the Advancement of Teaching, and Sir Cecil Arthur Spring-Rice, G.C.M.G., British Ambassador to the United States.

Following is an abstract of the reasons assigned by the University for the awarding of these degrees:—

"To Sir John Kennedy because of his eminence as a civil engineer, of the fidelity with which he has always upheld the highest ideals of the engineering profession, and of his long and distinguished services in developing the port of Montreal and the transportation routes of Canada, services which His Majesty has graciously recognized by conferring upon him the honor of knighthood.

"To John J. Carty in consideration of his high standing as an engineer, for his work in connection with the development and successful operation of wireless telephony, and for his energetic support of pure scientific research as an aid to industry.

"To Dr. W. H. Ellis on the ground of his eminent services in developing scientific and industrial chemistry in Canada, his literary attainments, his life-long devotion to scientific education in connection with the School of Science, of which he was one of the founders at the University of Toronto, and his valuable services and investigations in medico-legal chemistry and toxicology, in which field he stands pre-eminent in Canada.

"To Prof. Jas. Cappon on the ground of his long and honorable record as a member of the teaching staff of Queen's University, and of the distinguished quality of his literary work.

"To Hon. F. Carter-Cotton on the ground of his support of and interest in higher education of the Province of British Columbia, and the zeal he showed for many years in the development of the McGill University College of British Columbia."

Building permits for the month of February, 1917, for 38 cities of Canada amounted to $1,503,939, as compared with $662,135 in the corresponding month in 1916, an increase of approximately 125 per cent. The greatest gain was in Eastern Canada, the figures being $1,365,497, as against $553,406. The figures for the four Western provinces total $138,442, as against $108,729.

DEMANDS MADE UPON SEWER PIPES.*

THE committee is of the opinion that before final conclusions may be reached regarding the specifications and tests for clay and cement sewer pipes there must be substantial agreement as to the demands made upon them under ordinary service conditions. With these demands established it will then be possible to consider the necessary properties of the several materials and to recommend practical tests which should be applied in order to determine the compliance with the demands.

In order to state the general demands upon sewer pipes the committee decided to consider separately those which relate to strength, durability and serviceability.

Conditions Affecting Strength of Sewer Pipe.—The static forces applied to the outside of a pipe are those resulting from the loads or quiescent pressures acting upon it. These loads or pressures are made up of the weight of the body of material resting vertically over the pipe, either with its weight in entirety or reduced by the cohesion with the adjoining material, and transmitted as components of forces deviating from the vertical, and acting outside of the body resting vertically over the pipe.

The trench filling is usually kept free from large stones and consists of clay, loam, gravel, sand or of their mixture. A compacting of this material is produced by ramming or watering of the trenches, which increases the weight per cubic foot and thereby the pressure upon the pipes. The maximum weights which cause vertical pressure upon the pipes, and which must be sustained by them, are therefore determined by knowing the weight per cubic foot of the compacted superincumbent material, its depth in feet and the weight of any possible load that may rest on the surface above the trench.

If the material above the pipe were a liquid without cohesion we could obtain the exact pressure upon the pipe in the manner above indicated. Where the cohesion of the material is great, as in rock,—in other words, if the pipe is laid beneath a roof of rock,—there would be no pressure at all upon the pipe.

In the usual trench filling, we therefore have all possible degrees of cohesion varying from a puddled filling which may act as a liquid, and transmit the full weight of the material upon the pipe, to a material such as hard-pan or rock which sustains itself and transmits no weight to the pipe.

In practice, therefore, we can expect great differences in the pressures of the materials over pipes, which fact explains the differences of opinion prevailing as to the proper weight allowance upon pipes and of the formulas suggested (Frühling, Barbour, Marston and others) therefor to determine such pressures. Table I. gives the weights of various trench-filling materials for different heights of fill.

The material on both sides of the mass resting vertically over the pipe,—unless it is hard-pan or rock,—may by sliding press upon the pipe in directions other than vertical. In other words, the pressure will act by its components. One set of these components will always be horizontal and if the pressure is alike on both sides of the trench, the two opposing components will completely balance each other. The other set of components will be vertical and their action is resisted by the friction against the original trench wall on each side of the pipe. Where the original components act upon the pipe itself they will again be divided into components; one set will act at right angles to the exterior surface thereof,—in other words, press towards the centre of the pipe. They will, therefore, press horizontally at the horizontal diameter of a circular pipe; they will press downwards above it and upwards below it. The other set will act within the shell of the pipe and parallel to the surface.

Dynamic Forces.—The dynamic forces are those which may result from bodies moving either quietly or suddenly, and in such manner that the resultant force, or its components, can act directly upon the body of the pipe. Such dynamic forces are caused by a heavy moving load passing over the trench in which a pipe is laid. They may be the effect of a body of earth sliding or settling in or near the trench; or they may be the impact of a body upon the pipe, as that of a falling stone or of the pipe itself falling upon the ground.

Table I.—Weight in Pounds of Trench-Filling Materials.

Height of Fill, ft.	Loose Top Soil	Top Soil Clay	Dry Sand	Damp Sand	Top Soil, Tamped	Clay and Sand, Tamped	Sand, Tamped	Sandy Loam, Tamped
2 ...	140	160	194	182	226	218	230	192
4 ...	280	320	388	364	452	436	460	384
6 ...	420	480	582	546	678	654	690	576
8 ...	560	640	776	728	904	872	920	768
10 ...	700	800	970	910	1,130	1,090	1,150	960
12 ...	840	960	1,164	1,092	1,356	1,308	1,380	1,152
14 ...	980	1,120	1,358	1,274	1,582	1,526	1,610	1,344
16 ...	1,120	1,280	1,552	1,456	1,808	1,744	1,840	1,536
18 ...	1,260	1,440	1,746	1,638	2,034	1,962	2,070	1,728
20 ...	1,400	1,600	1,940	1,820	2,260	2,180	2,300	1,920

The maximum static equivalent of live loads which may pass over a sewer trench should be 300 lbs. per square foot of surface. This load may be increased by 87 per cent. for impact. Bodies falling upon the pipe which cause greater stress than those produced by the drop-weight test need not be considered as a condition to be guarded against by greater strength of pipe.

Internal forces which are imposed upon sewer pipes under conditions of use are hydrostatic pressure and water hammer.

Hydrostatic Pressure.—Hydrostatic pressure, as usually expressed, is the weight in pounds of a column of water of 1 square inch section, having a height which extends from the point where the pressure is to be measured, up to the highest elevation of any connecting water standing outside of the pipe. Table II. gives the hydrostatic interior pressures per square inch at various depths to which sewer pipes may be exposed in practice.

Table II.—Hydrostatic Interior Pressures.

Depth, ft.	Pressure, lb. per sq. in.	Depth, ft.	Pressure, lb. per sq. in.
2	0.868	16	6.94
4	1.73	18	7.81
6	2.50	20	8.68
8	3.47	22	9.54
10	4.34	24	10.41
12	5.20	26	11.06
14	6.07		

Tests made of the resistance to bursting pressure of well-made pipe show it to be so much greater than the sewer pipe is subjected to, that the demands for this purpose may be neglected. This is the more true, since the

*Abstracted from report of Committee appointed by the American Society for Testing Materials.

hydrostatic pressure will usually receive less resistance in the joints than in the pipes themselves.

Water Hammer.—A water hammer in a pipe is caused by the shock against the barrel of a pipe of a sudden stoppage of the flow of water within it. This stoppage may result from a sudden closing of a valve or a sudden clogging by floating or suspended material, or by a break of the pipe and caving in of the trench.

The maximum force of a water hammer tending to break the pipe depends on the mass of water in motion and its velocity.

Properties of Raw Materials.—The clays or shales used for the manufacture of sewer pipes should possess those physical and chemical properties which will secure strong, tough vitrification at moderate heat, and absence of excessive warping, shrinking, fire cracks and other objectionable defects in the finished product.

The committee will present more complete and detailed statements with respect to these required physical and chemical properties when the necessary data are supplied by those most familiar with these properties.

Adulterants, such as fine grindings from well-burned clay, may be used to reduce shrinkage, etc., provided the strength or durability of the finished pipe is not thereby diminished.

The water used in tempering the clays or shales snould be free from salts, alkali, acid, mineral and gaseous impurities in quantities such as have been found in practice to render the water unsuitable for this special purpose.

The cement used for cement-concrete pipe should be Portland cement, whose physical and chemical properties comply with the proposed American Specifications and Methods of Tests for Portland Cement (Serial Designation.....) of the American Society for Testing Materials.

The sand used should consist of grains from hard, tough, durable rock, and be free from soft, decayed, and friable material. It should be free from lumps of clay, loam or other foreign material. It should not contain more than 2.5 per cent. by weight of finely divided clay, loam or other suspended matter. The grains should have rough, unpolished surfaces, and be well graded in size from the finest to the coarsest. Not more than 8 per cent. by weight, including suspended matter, should pass the No. 100 sieve, and not more than 60 per cent. should pass the No. 16 sieve. None of the grains should be retained on the No. 4 sieve.

Mortar in the proportions of 1:3 by weight when tested at the age of 28 days, should develop a tensile strength at least equal to the strength of a similar mortar made of the same cement and standard Ottawa sand tested at the same age.

The broken stone used should be irregular pieces of crushed trap or other hard, tough, durable rock in graded sizes. None of the pieces should be less than ¼ inch in minimum diameter, and none larger in maximum diameter than three-tenths of the thickness of the sewer pipe in which it is to be used. The stone should be washed if necessary to remove dust, dirt or other foreign substances.

Gravel of the same degree of hardness, toughness and durability, and of the sizes specified for stone, may be used in place thereof if free from dust, dirt and other foreign substances.

The stone and sand, or the gravel and sand, should each be of such graded sizes that, when mixed with cement in definite proportions, and with the required amount of water, they will produce a mass of maximum weight and density.

The water used for the concrete should be fresh (not salt) water, free from excessive turbidity, sulphur, carbonic acid and other mineral or organic substances detrimental to its use for this special purpose.

Waterproofing compounds, if used, should possess such physical and chemical properties as are necessary to render the concrete impervious to water without adversely affecting its strength or durability.

Manufactured Pipe.—The proportions of ingredients of cement-concrete pipe shall be at least equal to that of first-class gravel concrete of proportions, 1 part of first-class Portland cement, to 1 part of clean, coarse graded sand, to 1 or 2 parts pebbles.

A pipe which is very porous will allow passage in and out of water or sewage through its shell. This passage or slow percolation of water is, from a sanitary point of view, of little moment in all but rare cases and then it requires special consideration. The porosity of the shell is, however, of importance with reference to its bearing upon the strength of the pipe, when this is subject to either external or internal forces. As affecting the strength of a pipe the degree of its allowable porosity will depend upon the character of the material and the process of manufacture of the pipe. The stronger the final product, the less objectionable will be a greater degree of porosity. In the case of cement-concrete pipe we must, however, consider the effect of percolation of acid or alkali water which tends to disintegrate the hard carbonate of lime. Experience has shown that the greater the porosity the quicker is the disintegration. It has also shown that for normal sewage the effect is negligible if the material is uniformly compact and the percolation extremely slight.

It is, therefore, the opinion of the committee that the actual effect of porosity upon the strength of a pipe should be determined by more experiment and that, therefore, tests should be made so as to indicate the most economical relations between strength and porosity for the principal classes of material and manufacture now in the market. The results of such tests should be published for each make, indicating the actual porosity for tested strengths of pipe. When subjected to an internal pressure of 10 lbs. per square inch, sewer pipe shall show no percolation.

The quality of toughness in the material of sewer pipes, which is the opposite of brittleness, is important, as it affects their being readily broken by handling before they are laid, or broken by internal forces, such as water hammer, after they are laid.

The toughness of pipe is best ascertained and measured by the impact of a body having a fixed weight and drop distance, when striking the centre of a pipe fixed in a horizontal position. The degree of toughness as thus measured should be sufficient to prevent rupture under the above-stated ordinary conditions, which demands a somewhat arbitrary standard depending more or less on local practice. The committee recommends a drop test as follows:—

When supported on a dry sand bed 2 ins. deep, all pipe shall withstand, without cracking, the impact from two blows of a cast-iron ball weighing 8 lbs. falling 18 ins. Spurs shall resist, without fracture, the impact from two blows of such a ball falling 6 ins. and striking on the extreme end of the hub of the spur.

Vitrification of Clay Pipe.—The vitrification of clay pipe should be carried as far beyond its first indication as practicable, because it increases the strength of the pipe. But it should not be carried to a degree that would lower the desired degree of toughness.

The standard for vitrification must, therefore, also be arbitrary, and it depends not only upon the degree of desirable toughness, but also upon the properties of the raw materials used.

Defects in clay pipe are fire cracks, blisters and laminations. These imperfections should be avoided so far as practicable, because to some extent they reduce the strength of the pipe. The reduction is found particularly when the fire cracks in a pipe are abundant and extend far into the shell. It is also found when the material is laminated and particularly when the breaking shows splitting between layers of material. Blisters, unless very deep, do not affect the strength, but rather the serviceability, of a pipe.

The permissible limits of these defects should, therefore, also be arbitrary standards, depending upon the purposes for which the pipes are to be used.

Where high strength is required, fire cracks should be rare. Where they occur they should never extend into the shell more than ⅛ in., irrespective of the test for strength. Where laminations occur in pipes such should cause rejection, unless the tests for strength are quite satisfactory for the proposed use of the pipes.

Hair cracks are caused by shrinkage of the cement during the process of drying and setting, and when exposed to a material drop in temperature soon after setting.

The permissible limits must be arbitrary and should depend upon the purposes for which the pipes are to be used. Such cracks unquestionably lower the strength of the pipe. They should therefore be rare, and never destroy the continuity of the material of a section of the shell more than 1 sq. in., and such depreciated cross-sections should not be less than 6 ins. apart. Such individual hair cracks should not exceed 0.1 mm. in width, and should not be more than 2 ins. long, and not penetrate the shell more than ⅛ in.

Thickness of Shell.—The thickness of the shell of a pipe, to resist external and internal forces, strictly speaking, should vary with the qualities of the original material from which the pipe is made and with the treatment during its manufacture. A thinner shell of tougher and denser material may resist greater pressure than a thicker pipe which is less tough and compact.

The committee therefore believes it would be unsafe to specify a definite relation between diameter of pipe and the thickness of shell, and that it must be left to the guarantee of the manufacturer that the pipe which he offers for sale shall be, in all cases, of sufficient thickness to withstand the standard crushing loads specified.

The committee favors the establishment of a minimum thickness for each size of sewer pipe and submits, as a result of all the available information, Table III. for consideration.

The committee is of the opinion that there may be a demand at times, for cheaper pipes with thinner shells than those above specified, but it believes that in such cases the understanding should be clear that such pipe is not classified as standard pipe.

There may also be a demand at times, for pipe which must safely sustain a greater weight than the above standard. In such exceptional cases, means should be provided for securing the necessary increase of strength, either by embedding standard pipes in concrete or by surrounding them with concrete of sufficient thickness to resist the greater weight.

Ends of Pipe.—The ends of pipe should be so shaped as to permit the making of a joint which, in strength, approaches the strength of the pipes in resistance to shear, bending moment and crushing stresses, and which is also sufficiently impervious to the passage of water. In vitreous materials it is impracticable to obtain that accuracy of dimensions which will permit close contact at all points of the pipe ends, and for this reason the strength of jointed pipes in these materials is to be secured by means of the jointing material. For this purpose it is best to have space for ample jointing material such as is furnished by extra wide and deep sockets. The outside surface of the spigot end and the inside surface of the hub or socket end should be unglazed, or else these surfaces should be scored with V-shaped depressions to provide for a bond with the jointing material.

Where the ends of pipes can be finished to true surfaces, as with cement-concrete pipes, it is practicable to shape these ends as male and female bevels which can be brought into close contact throughout. Such a joint, when covered with a suitable layer of cement mortar to increase the rigidity and to prevent the passage of water, is quite as satisfactory as the hub-and-spigot type with extra wide and deep sockets, although it does not appear to have any particular advantage over the latter except possibly some economy in handling and laying. The ends of cement-concrete pipe furnish good bonding surfaces for the jointing materials and, therefore, do not require to be scored. Table IV. gives minimum values for depth of socket and annular space for various diameters of pipe.

Table III.—Minimum Thickness of Shell.

Diameter of Pipe, in.	Minimum Thickness of Shell, in. Vitrified Clay Pipe	Cement-Concrete Pipe
6	⅝	¾
8	¾	⅞
10	⅞	1
12	1	1¼
15	1¼	1½
18	1½	1¾
20	1⅔	2
22	1⅚	2¼
24	2	2½
27	2¼	...
30	2½	...
33	2⅝	...
36	2¾	...
42	3½	...

No pipe should be used until pipes cast in the same factory of equal age are strong enough to meet the specified crushing test.

Recommendations with respect to the making of joints have been furnished in the proposed Tentative Recommended Practice for the Laying of Sewer Pipe, as heretofore reported by the committee and published in the 1915 Year-Book.

Gasket and mortar joints, in vitrified pipe sewers, shall be made in the following manner:—

A closely twisted hemp or oakum gasket of suitable diameter, in no case less than ¾ in., and in one piece of sufficient length to pass around the pipe and lap at the top, shall be solidly rammed into the annular space between the pipes with a suitable caulking tool. Before being placed, the gasket shall be saturated with neat cement grout. The remainder of the space shall then be completely filled with plastic mortar mixed 1 : 1 and the joint wiped inside and finished to a smooth bevel outside.

Joints of sanitary pipe sewers below the normal water table shall be made with a compound approved by the chief engineer. The compound shall preferably have a bituminous base, shall adhere firmly to the glazed surfaces of the pipes, shall melt and run freely at a temperature as low as 250° F. and when set shall be sufficiently elastic to permit of a slight movement of the pipes without injury to the joints or breaking the adhesion of the compound to the pipes. The compound shall not deteriorate when submerged in fresh or salt water or normal domestic sewage; it shall show no deterioration of any kind when immersed for a period of five days in a 1-per-cent. solution of hydrochloric acid or a 5-per-cent solution of caustic potash.

Table IV.—Minimum Depths of Socket and Annular Spaces.

Diameter of Pipe, in.	Depth of Socket, in.	Annular Space, in.	Diameter of Pipe, in.	Depth of Socket, in.	Annular Space, in.
6	2½	⅝	22	3¾	⅝
8	2¾	⅝	24	4	⅝
10	2¾	⅝	27	4	¾
12	3	⅝	30	4	¾
15	3	⅝	33	5	1¼
18	3¼	⅝	36	5	1¼
20	3½	⅝	42	5	1¼

After a joint is properly caulked, a suitable runner shall be placed and the compound, heated to a temperature of approximately 400° F., shall be poured into it in such a manner that the annular space shall be completely filled to within ½ in. of the outer rim of the bell of the pipe.

Unless otherwise permitted, at least four finished joints shall be left exposed for inspection throughout the working day, and the necessary staging for the protection of the exposed sewers and for the handling of excavated material shall be provided. The joints on the inside of all pipe sewers larger than 15 ins. in diameter, shall be carefully filled with mortar and wiped smooth and flush with the surface of the pipe.

TO ACT ON NICKEL REPORT

That nickel refineries can be successfully operated in Ontario, and that a tax should be made on the net profits of the producing companies, are important suggestions contained in the report of the Ontario Nickel Commission, made after eighteen months' research.

The legislation to be based on the commission's report will provide for taxes on all Ontario mines the annual profits of which exceed $10,000, which are to be raised from 3 per cent. per annum to 5 per cent. per annum upon the annual profits in excess of $10,000 and up to $5,000,000. On all annual profits over $5,000,000 and up to $10,000,000, the tax will be 6 per cent. per annum; on all annual profits over $10,000,000 and up to $15,000,000 the annual tax will be 7 per cent.; and on the annual profits in excess of $15,000,000 a percentage increasing with each additional $5,000,000 in the same proportion as in the case of the second and third five million dollars.

On nickel and nickel-copper mines the new taxation is effective as from the 1st January, 1915.

SLAG AS AN AGGREGATE FOR CONCRETE.

INVESTIGATIONS and tests made to determine the availability of slag as an aggregate for concrete were described by Mr. Sanford E. Thompson, Consulting Engineer, Boston, Mass., in a paper presented at the thirteenth annual convention of the American Concrete Institute. The investigation by Mr. Thompson covered the following:—

The use of slag for plain and for reinforced concrete.

The relative value of slag versus gravel for building construction.

The relative characteristics of slag made from different processes.

The relative value of the same slag under different conditions of age, size and porosity.

The strength of slag concrete, with the permissible proportions and stresses to adopt.

The durability of slag concrete.

To properly treat these various questions, several series of tests were undertaken. The data derived from these tests and from a study of previous investigations are summarized in the paper as follows:—

The strength of concrete made with slag, such as is obtainable commercially in eastern and northern Ohio, was on the average about 50 per cent. higher at the age of 28 days than gravel concrete made with first-class materials.

Using the same proportions by volume as for gravel concrete, about 15 per cent. more cement on the average was required per cubic yard for slag concrete than for gravel concrete of the same proportions.

No authentic cases of deterioration of slag concrete made with Portland cement or of rusting of steel embedded in such concrete have been discovered.

Porous slag produced a concrete of substantially the same strength at 28 days as dense slag. At later ages, the dense slag is probably stronger.

Slag made by different processes and under different conditions showed no marked difference in strength and other characteristics.

An extremely hard, dense, acid slag did not produce a concrete of greater strength than porous, basic slag on a 28-day test.

The weight of the slag concrete tested averaged about 6 per cent. lighter than an average gravel concrete. On the other hand, very dense acid slag concrete was heavier than gravel concrete.

Granulated slag sand produced a mortar of inferior tensile strength on short-time tests.

Crushed slag screenings produced a mortar appreciably higher in strength than standard sand mortar.

No tests of watertightness of slag concrete were made in this series nor of protection of metal. Tests by other authorities and examinations of structures of slag concrete and tests made with concrete of other aggregates show that when properly laid the steel is protected from rust, even although the aggregate is porous.

Tests thus far made of permeability of slag concrete are insufficient to determine its availability for thin, watertight work, such as tanks.

The weathering qualities of slag concrete are indicated as satisfactory by examination of structures which have been built for a number of years, but further experimental investigations along these lines with different types of slag are needed before the conclusions as to its use can be considered final.

CANADA'S WORK IN FOREST RESEARCH.*

MANY of the investigations now under way at the Forest Products Laboratories are intended only to cover the immediate problem before us, but others are designed to proceed until a knowledge of the basic principles of the subject is obtained. Such, we consider, is the most real purpose of our institution. The wood-using industries of our country are not of such size as to warrant their establishing individual laboratories of this kind, and if the Forest Products Laboratories of Canada can furnish to these industries scientifically accurate information concerning their materials and products and the manufacture of these products, then we of the laboratories will consider that we have not only earned our salaries, but that we have done our little bit to promote the industrial greatness of Canada.

A very brief mention of a few of the investigations which are now being carried on will suffice to show what we are attempting at present, though we are considerably handicapped by the absence of some of the best of our staff who are at the front and the impossibility of getting other suitable men at this time.

Some of the leading investigations now on hand are as follows:—

A comparative study of the mechanical strength and physical properties of all Canadian woods. Tests are made on a large number of small, clear specimens cut in the same way from several trees of each species selected in the forest by Forestry Branch experts. These tests are being made on the same system as a similar series of tests under way at the United States Forest Products Laboratory, so that our results will be directly comparable with theirs, and when both series are complete the data will cover all the North American woods.

A study of the comparative value and characteristics of mine timbers available for use in the coal mines of Nova Scotia. This includes strength tests and a study of the decay of such timbers, both in the mines and in storage. Already considerable improvement has been made in storage conditions so as to greatly decrease the loss from rotting in the piles.

A study of the fundamental factors involved in the drying of wood and phenomena related to change of moisture content, such as shrinkage, hygroscopicity, migration of moisture in the wood, heat conductivity, etc.

A study of methods looking for the utilization of waste sulphite liquor. About 600,000 tons of wood per year is consumed in the manufacture of sulphite pulp in Canada, and approximately one-half of that amount of organic material is thrown to waste in the liquor. The problem of finding a use for this material is a very complicated one, and, although a great deal of research has been done on the subject by various English, German and American chemists, only results of moderate value have been obtained. At present the work of these laboratories is confined to the compilation of all available information in connection with this subject, leaving experimental work to be done later on.

A study of the fundamental factors involved in the beating of paper pulp. This beating process is a very important one in the manufacture of paper, particularly in the case of finer grades, and is one concerning which very little is known. A full understanding of the reactions involves a very complete knowledge of the colloidal characteristics of cellulose, thus leading to very involved questions of physical chemistry. This research is one of the type mentioned as being of so complicated a nature as to necessarily extend over several years, but is one which we are peculiarly well situated to attempt.

A study having for its object the discovery of a commercially feasible process of creosoting Jack pine and Eastern hemlock for use as railway ties.

An investigation as to the feasibility of chipping, drying and baling pulpwood for shipment and a determination of the value of chipped and dried wood as compared with round wood. There is a possibility that there may be a saving in freight effected which will make possible the utilization of forest areas which are now going to waste.

An investigation of the chemical composition of wood, particularly of those woods which may be of use for paper pulp. This work involves the testing and standardization of methods of analysis and the examination of the composition of several important species, both in the green condition and after different degrees of seasoning.

An investigation of the possibility of treating prairie grown woods so as to make possible their use as fence posts.

A study of the oils produced by the destructive distillation of wood, both resinous and hardwood, with reference to their use in ore flotation.

A study of the relative durabilities of Canadian woods when exposed to various kinds of wood-destroying fungi.

A study of the fibre dimensions of Canadian woods. This is particularly important to the paper industry, but is also of value in other work as well as being of considerable scientific interest.

A study of the sulphite cooking process and the factors involved in cooking various species of wood for pulp. It is hoped that a thorough study of the process from a scientific point of view combined with practical experience will point out ways in which the process can be improved.

The investigations mentioned do not include any but the outstanding problems. Besides these there is submitted to the Laboratories a continuous flow of minor questions which the laboratory equipment enables us to answer quite readily. Questions regarding the identification of wood from samples, for instance, are answered daily for people all over the country at no cost to them.

*Brief excerpts from an address by W. B. Campbell, Assistant Superintendent, Forest Products Laboratories, McGill University, Montreal. Delivered before the annual meeting of the Canadian Forestry Association.

According to the statistical report of the Quebec Provincial Mines Branch, of the Department of Colonization, Mines and Fisheries, of which the Honorable Honore Mercier is Minister, the total value of the mineral production of the Province for 1916 is only one-half of 1 per cent. less than in 1913, the figures of which still constitute the highest record. The report also shows that the total value of the mineral production of the province for the year ending December 21, 1916, amounted to $13,070,566, an increase of 14 per cent. as compared with the previous year. The main item in the list is asbestos, which figures for a value of $5,182.905. Asbestos mines here produce about 90 per cent. of the world's supply. Other items which show very substantial increases are lead and zinc ores, chromite, magnesite, mica and molybdenite.

LETTERS TO THE EDITOR

Municipal Consulting Engineers.

Sir,—In connection with your postscript of the 28th ult. re an editorial in your March 15th issue entitled "Municipal Consulting Engineers," we had read this editorial and were much surprised to learn its contents.

Our firm considered answering the editorial several times, but we did not do so, partly owing to the fact that Mr. Godfrey's deduced statements contained therein were so evidently erroneous that we did not think them worthy of consideration, and partly owing to the fact that we had been rather busy of late, and could not take time to discuss them.

We may say that in our experience in the West we have very seldom exceeded our estimates. In one town in which we were engaged as consulting engineers the town informed our firm that they were prepared to expend $200,000 on municipal improvements, and we were accordingly requested to prepare their improvements to accommodate this amount. When the contracts were awarded they totalled to $198,000.

In another town in which we were engaged as engineers we gave them an estimate of $130,000 on the proposed works, and the contracts were awarded at $125,000. In no case in our experience have we exceeded our estimates more than a very small percentage of the actual amount expended, and as you will know, conditions often arise which could not be provided against when making the estimates, but creep in during the progress of the work.

Of late years, or since the money market became so stringent, and particularly since war broke out, many of the municipalities in the West have been compelled to sell their debentures at a discount, the by-law having already been prepared and voted on before the war started; some of them sold as low as 20 per cent. discount. This, you can see, would create quite a deficit in, say, a $200,000 by-law. Also, in almost every case while the work is progressing the councils decide on further improvements or additions which makes it necessary for them to prepare a new by-law. The people often receive the impression that the amount of the new by-law should have been included in the original estimate, and it has been observed that when the actual cost exceeds the original estimate by a few thousand dollars, that some councillors, we must say, have made capital of this small amount as an excuse for having to go to the people again, rather than explain to them that they had approved of certain additions, as well as selling their debentures below par.

We were very pleased to learn that in your answer to Mr. Godfrey you did not consider that his statements should be taken seriously, and we feel certain that your remarks will be appreciated by many qualified engineers throughout the Dominion.

We are also disposed to consider that other consulting engineers acting throughout the West will have had much the same experience as that cited above, and in our opinion it would be quite preposterous that any reputable firm of consulting engineers should deliberately underestimate on any proposed improvements for the purpose of having the people carry a particular by-law, which they knew would not furnish the required amount to complete the work.

MURPHY & UNDERWOOD,
Per J. E. UNDERWOOD.

Saskatoon, Sask., April 2nd, 1917.

Sulphur in Road Oils.

Sir,—The clause regarding the sulphur and acid content of road oils, referred to in your editorial of the 29th inst., and the opinions of chemists on this clause as contained in the same article, once more raises the question of the desirability of more co-operation between engineers and chemists. Much has been wirtten in the past on this subject with evidently but little avail.

So long as the chemists are called upon to make examinations of materials used for engineering purposes it is only reasonable to expect that they should be consulted when the specifications for these materials are prepared, but at present this course is the exception rather than the rule. It occurs all too frequently that, owing to the nature of the specification, the value of the analysis is largely nullified and no redress can be had from the contractor. Specifications are too often made up in a patchwork manner from other specifications and put together without considering whether the parts are compatible with one another. As an example of this I might mention one specification that I came across some time ago. This was for asphalt, and one clause stated that Trinidad and other asphalts could be tendered upon, whilst another clause excluded Trinidad by specifying that the asphalt must contain at least 90 per cent. of bitumen, soluble in carbon bisulphide.

Some specifications merely state that the material shall be of the best quality, a statement that is delightfully vague and open to many (mis)interpretations. Others go to the other extreme, and contain a number of clauses defining with great minuteness the physical and chemical attributes of the material required. More often than not, no attempt is made to ascertain if the material is in accordance with the standards set forth, with the result that the contractor quickly develops contempt for these clauses and ultimately ignores them.

The obvious remedy for these difficulties is closer co-operation between engineers and chemists, and a step which, I think, is in the right direction was made last year by the Society of Chemical Industry by the appointment of a committee to study and recommend standard methods of analysis. When this matter was discussed in Montreal I was successful in having a resolution adopted asking for the co-operation of societies engaged in kindred work, and amongst those named was the Society of Civil Engineers. Standard methods of analysis are largely chemical matters, but when the material examined is used in engineering practice the engineers are vitally interested. This is especially so when chemical and physical constants are referred to in contracts and standard methods are specified. As an example of this I would cite the contract for the new filtration plant in Toronto. This, I believe, states that certain efficiencies are to be guaranteed when the tests are made in accordance with the standard methods of the American Public Health Association. The contract was let in 1914, and since that date the methods of analysis have changed very materially in some respects, and if the present standard methods were used it is possible that they might show very different results. It is, therefore, in the interest of engineers to endeavor to keep methods of analysis as stable as possible and to prevent yearly changes that are often evanescent and futile.

JOSEPH RACE,
City Bacteriologist and Chemist.

Ottawa, March 31st, 1917.

Editorial

IS THE HYDRO ARBITRARY?

Sir William Mackenzie and Sir Adam Beck have been providing the Toronto daily press with reams of free copy of late. Sir William has responded directly to few, if any, attacks during the past several years. Withdrawing into his knightly armor, he has suffered the swords to beat upon the metal, telling himself that they were merely lath-sticks and harmless. But Sir Adam found a hole in the armor a couple of weeks ago—a hole, by the way, which Sir Adam bored months previously by means of anticipatory legislation. Sir Adam's thrust was strong, and it aroused Sir William and his associates to denial, denunciation and dentiloquy.

The Hydro's head had accused the Electrical Development Co. of stealing water from the Niagara River. As president of that company, Sir William Mackenzie denied the charge, which, he said, is based upon the Hydro's own arbitrary interpretation of the company's agreement with the Victoria Park Commission.

Is it a fact that the Hydro is arbitrary? We believe that it is, but we also believe that the Hydro, as the trustee of the water resources of the province, must be and should be arbitrary in respect to allotments of water from the Niagara River.

The well-known treaty of 1910 allows Canada 36,000 sec.-ft. at Niagara. It is a point of national honor that not a drop more than that be taken. To stay rigidly within that limit and yet supply the enormous demand for power throughout Southern Ontario, it is imperative that the existing power companies be restrained from wasting water. Additional water passed through any of the three existing Canadian plants means waste. It would be developed at 136 to 180 ft. head, whereas the Hydro would develop it in their new Queenston plant at over 300 ft. head, and every second-foot used by any of the present companies means a second-foot less available for development at Queenston.

The Electrical Development Co. was organized under an agreement executed in 1903 with the Victoria Park Commission, stipulating that the company would be permitted to divert sufficient water from the river to develop 125,000 electrical horse-power. While this agreement was under negotiation it was represented to the province by the company's counsel that the operating head would not be less than 140 ft. The company also agreed not to instal turbines and electrical equipment for the generation of more than 125,000 electrical h.p., although each company at the Falls actually installed one spare unit. The Electrical Development Co. has eleven machines, each supposed to be 12,500 e.h.p. capacity, and at least one is supposed to be idle at all times. It appears that the Hydro is of the opinion that these machines are largely in excess of 12,500 e.h.p. and that the plant as a whole is being operated to the fullest extent of its installed capacity. Whether or not this is true, investigation under the terms of the Water Powers Regulation Act will no doubt reveal. The Victoria Park Commission, in its annual report just issued, accuses the Electrical Development Co. of developing 136,000 electrical h.p., and says that it has reached between 140,000 and 150,000 h.p. on peak load.

As the 1910 treaty assigned the water in terms of cubic feet per second, the evident intention of the Hydro is to define the rights of the three companies uniformly in the same terms. If the rights of the Electrical Development Company are properly stated above in the matter of capacity and operating head, the amount of water necessary to give effect to these rights, assuming an overall plant efficiency of 81.5%, would be about 9,650 sec.-ft.

The Province of Ontario, through the Hydro as its agent, has the right to require any reasonable efficiency from any water power plant in Ontario under the terms of the Water Powers Regulation Act, an appeal to the Lieutenant-Governor-in-Council being allowed to the water power owner. If extensive alterations or reconstruction are necessary to the carrying out of the province's efficiency requirements, the Lieutenant-Governor-in-Council fixes the amount of the compensation, if any, to be allowed to the company for such work. The idea appears to be not the infliction of hardships on operating companies, but the conservation of the power resources of the province.

The whole trend of the argument between Sir Adam and Sir William, and of the Hydro legislation introduced during the past couple of years, and particularly during the last session, shows that it is the Hydro's ultimate intention to buy one, two or all three of the Canadian power companies at Niagara in order to be able to develop more water under the 300 ft. head at Queenston. The whole 36,000 sec.-ft., if developed at Queenston, would mean over a million h.p. for Ontario, compared with about 405,000 electrical h.p. now permissibly developed by the three Canadian private companies. The handwriting on the wall must have been apparent to Sir William for some years past.

ECONOMICS AND THE ENGINEER.

The subject of economics in its modern aspect may be said to be the application of reason to industry; that is, as time advances the economics of industry represent a larger proportion of the alleged science.

It is well to bear in mind the fact that the science so limited is far from exact and is yet only groping toward the light. Its theorems and axioms are susceptible to controversion and argument. One man, breaking almost every commandment, may yet survive in business to give pause to the acceptation of academic and accepted theory. It is never safe to dogmatize unless you know, and not so very safe then.

It is, however, certain that in its real aspect the knowledge of economic matters cannot be neglected; its foundations are in the very human cement, common or garden sense. What most surprises the engineer brought into contact with it as a subject for the first time is that he has practised its precepts without subscribing to its formulæ in ignorance that any principles existed. Another surprising thing is that what the theoretical student finds most difficult to comprehend is as clear as daylight to the intelligent engineer.

If the nomenclature in which every specialist loves to enshroud his subject be reduced to common terms the definitions re-worded and the arguments made clear by specific example, the subject so stripped of its mystery is readily grasped.

If economic argument is developed by specific instance, then every engineer can from experience find the material from which to argue. A knowledge of essential economic fact combined with intuitive appraisement of human nature, serves to supplement and add greatly to technical ability.

The engineer is, in short, the true economist; if he were not, there would exist no engineering science at all. Unless the product of his inventive genius resulted in economy of time, saving in actual cost, or added to public convenience its decay would be inevitable if it had ever developed at all. On the grounds cited, it does exist and expand, hence those in contact therewith are already economists if not economic experts, whether they are conscious of the fact or not.

While all this is true, a great many technical men fail to realize that the subject is worth their attention. While it is generally considered a commercial subject of a business nature the engineer who takes trouble to read a few treatises on the subject finds his interest quickened and his powers improved.

The weakness of most technical training is want of commercial realization. The study of economics supplies in the main this deficiency to the ultimate advantage of the practical man when called upon to face larger issues. As a useful corrective to exclusive concentration upon distinctly technical matters its value can scarcely be overstated and the engineer is already prepared and usually proves an apt pupil. Short of a grasp of essential facts concerning exchange and finance and other related phenomina of trade and commerce, the highly trained technical man finds that superior positions are filled exclusively from the commercial side. It is realized that this is unjust but technical capacity is of value only in technical matters and there is a technique of business whose name is economics.

C.P.R. SCHOLARSHIPS AT McGILL UNIVERSITY.

George Bury, vice-president, Canadian Pacific Railway, has issued the following circular: "Three free scholarships, covering four years tuition in chemistry, civil, mechanical or electrical engineering at McGill University, are offered, subject to competitive examination, to apprentices and other employees enrolled on the company's permanent staff and under 21 years of age, and to minor sons of employees. The competitive examination, which will be the regular entrance matriculation examination provided for in the University's annual calendar, will be held at the University, Montreal, and at other centres throughout Canada, in June. The candidates making the highest average and complying with the requirements of admission will be awarded the scholarships and have the option of taking any of the above courses. Scholarship will be renewed from year to year, to cover a period not exceeding four years, if, at the close of each session, the holder thereof is entitled, under the rules, to full standing in the next higher year. In case a scholarship holder finds it necessary to interrupt his course for a year or more, notice must be given at the close of the session to the company and to the Dean of the Faculty of Applied Science of the University, in order that the scholarship may be open to other applicants. In order to establish prior claim to the next available scholarship, notice of the students' intended return must be given to the company and to the Dean not later than January 1 preceding the opening of the session in which such scholarship will be available. Applications for certificates entitling eligible persons to enter the competition should be addressed to C. H. Buell, Staff Registrar and Secretary, McGill University, Montreal.

PERSONAL.

P. J. VENOIT has been appointed Minister of Public Works of New Brunswick.

F. ROBERTS, town electrician of Pincher Creek, Alta., has resigned in order to enlist for overseas service.

T. T. AUSTIN has been appointed manager of the waterworks department, Belleville, Ont., in succession to J. W. Evans.

C. J. HUNT, who until recently was chief contract engineer to Bruce Peebles & Company, Limited, Edinburgh, has been appointed chief engineer to the company.

J. RUSSELL ELLIS, acting city engineer of Regina, Sask., has resigned. D. A. R. McCannell, formerly assistant engineer, will succeed him, and R. W. Allen will succeed Mr. McCannell.

C. B. HUYCK, formerly with Mussens Limited, of Montreal, who enlisted as a private with the 6th Company Divisional Engineers, which was recruited from Queen's University, Kingston, and who has been in France for two years, has just recently been granted his commission.

WILLIAM TANSLEY, formerly assistant superintendent of the London, Ont., division of the C.P.R., has been appointed superintendent of the company at Montreal. He will be succeeded by E. WILLIAMS, superintendent of the Brockville Junction Division, who in turn will be succeeded by H. J. HUMPHREY, who has been acting superintendent of the Laurentide division with headquarters at Montreal.

H. S. PHILLIPS, A.M.Can.Soc.C.E., of the engineering staff of the Canadian Nitro Products Co., has received a commission as a lieutenant in the Tunnelling Section of the Canadian Engineers. Mr. Phillips was formerly assistant engineer in the sewer section of the Department of Works, Toronto, and was loaned by that department to Prof. Phelps to assist in the preparation of the latter's report on "Pollution of Boundary Waters," recently presented to the International Joint Commission.

OBITUARY.

JOSEPH GEROUX, a Quebec contractor, died on April 4th at the age of 52.

ALFRED BATHO, a Toronto contractor, died recently at the age of 70 years.

HUGH RUSSEL, president of Hugh Russel & Sons, Limited, iron and steel merchants, of Montreal, died recently at his home at the age of 73 years.

CORRECTION.

In our issue of March 15th, 1917, there appeared an article on the "Don Incinerator," Toronto. It was stated that "The plant is equipped with three high-temperature "Sterling" furnaces of modern design, which have been installed by the Canadian Griscom-Russell Company, Limited. There are three furnaces of four units each. Each furnace has a grate area of 25 square feet," etc. The foregoing should read, "There are three furnaces of four cells each. Each cell has a grate area of 25 square feet."