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The Canadian Engineer

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PNEUMATIC CAISSON WORK ON THE PETITCODIAC RIVER BRIDGE PIERS*

DESCRIPTION OF AN UNUSUAL PIECE OF FOUNDATION WORK — VELOCITY OF RIVER, RAPID RISE OF TIDE MADE CONSTRUCTION DIFFICULT — METHODS OF CONSTRUCTION

By E. M. ARCHIBALD, A.M.Can.Soc.C.E.

(Concluded from March 1st issue.)

OWING to the first attempt at launching having proved unsuccessful, the second launching was thrown forward into a period of the highest spring tides, when the velocity of current was greatest. However, since the current at the location of No. 1 pier from our observations had never shown as much velocity as at No. 2 pier, on which all the calculations were based, it was decided to proceed with the placing of the caisson. The first tide having been passed through without any trouble developing, it was thought all danger was past. On the second ebb tide, however, after the heaviest run had appeared to be over, a species of tidal wave occurred which was deflected straight across the river when it reached the old piers and caught the caisson broadside on with a heavy surge, parted the breast lines, then snapped the heavy mooring cables like pipe stems. The men on the caisson pumped for their lives to the scow moored alongside, then to the boats, and followed the wreck downstream.

Caisson Design.—In view of the fact that the probabilities were that the bearing under the cutting edge would be very uneven and that the caissons would be subjected to very severe conditions, it was decided to make the design very rigid—much more rigid than the known stresses would warrant. That this decision was prudent, it may be mentioned that the one caisson which went adrift and was tossed around on the mud flats was in perfect condition when finally placed in position. The only damage was the breaking of the 12-in. x 12-in. cross-struts inside the air chamber. These were readily renewed after air had been applied.

Starting from the bottom of the caisson, we first find a 9-in. x 5/8-in. flat plate bolted to the lower timbers and forming a shoe for the cutting edge, which was formed out of an 8-in. x 16-in. hardwood timber bevelled off on the inside. On this were laid the 12-in. x 12-in. hard pine timbers, forming the outer wall of the air chamber. The inner wall consisted of 12-in. x 12-in. vertical timbers, securely screw and drift bolted to the outer timbers with 1-inch iron in all cases and large plate washers under both head and nut. Every fourth vertical timber passed up through the roof and continued well up to low-water elevation on the inside of the cofferdam, as we shall call the portion of the caisson above the roof of the air chamber. By means of 1-inch screw bolts, every 2 feet into the outer walls, this upright timber increased the rigidity and further prevented the tendency of the various timbers to pull apart under displacement when the cofferdam was pumped out.

*Paper read before the Canadian Society of Civil Engineers, February 22nd, 1917.

The roof of the air chamber consisted of two tiers of 12-in. x 12-in. hard pine timbers placed transversely and with staggered joints. Great care was observed in securing tight joints everywhere, but more especially where the verticals passed through this roof, since there was the greatest danger of air leakage when under pressure. Heavy single-ply roofing paper was laid between the two tiers of the roof and all joints well pitched as a further precaution against leakage. Each roof timber was side-bolted to its neighbor with three 1-inch drift bolts.

Eighteen inches of 1:2:4 concrete reinforced with 1-inch rods spaced 12 inches apart, both longitudinally and transversely, was poured on top of the timber roof for additional strength and incidentally to further prevent air leakage. Another very important feature of this concrete roof was the purpose of keeping the centre of gravity as low as possible, resulting in greater stability while afloat.

The weak point in a caisson is the junction of the air chamber with the cofferdam above the roof. We consider the method adopted strengthened our work very materially. This consists, as shown by a reference to the plan, in a 12-in. x 12-in. waling timber immediately under the roof and another on top of the concrete roof, bolted every 2 feet in each direction.

Six 12-in. x 12-in. hard pine struts were placed inside the working chamber as close to the cutting edge as feasible to resist the inward pressure and six 1½-inch rods used to resist any possible outward pressure. In ordinary cases these rods are of doubtful value, but may have been of some benefit in the case of the caisson which went adrift.

Heavy roofing paper was placed between the two tiers of timber in the side walls of the air chamber as well as in the roof to prevent air leakage.

The air chamber was sheathed inside and outside and on the bottom of the roof with 3-inch planed hardwood sheathing with caulked joints.

Two threads of oakum were driven in all joints in the air chamber and well pitched.

All horizontal timbers were drift-bolted with 1-inch drift bolts, 22 inches long, every four feet.

The cofferdam consisted of a single wall of 12-in. x 12-in. timber, hard pine or white birch, half dove-tailed at corners, and drift-bolted every four feet. Six sets of 12-in. x 12-in. timbers served as transverse ties for the outer walls, the ends being dove-tailed in, and one set of longitudinals served the same purpose. At intersections, these ties were screw-bolted together.

The cofferdam was divided into three compartments for convenience in pumping, as previously explained. Both below and above these bulkheads the concrete was poured in a monolithic mass.

The walls of each compartment were pierced with four 4-inch holes through which was passed a 4-inch pipe with an elbow and a 7-foot length of pipe on the inside of the caisson, forming a swinging joint to control the inlet of water for slowly flooding the caisson after concreting, when each tide's work was completed. This stopped the green concrete from scouring when the incoming tide boiled over the top of the cofferdam.

The air chamber roof was pierced with three 36-inch shafts, one being a man-shaft located in the centre of the caisson, the other two for material, one at each end and spaced to handle material with a minimum of handling.

Air was supplied through two 4-inch pipes located at opposite ends of the caisson. Two more 4-inch pipes through the roof were used as blow pipes for blowing water and sand from the air chamber.

A 1-inch whistle pipe was used at each material shaft for signalling purposes.

Two 1¼-inch pipes were installed for supplying fresh water to the air chamber, but were not used for this purpose. They, however, served for supplying compressed air for pneumatic drills used in drilling boulders.

Electric lights were used on removable leads run through the man-shaft, but were removed at the end of each low-tide shift.

Launching.—Both caissons were launched sideways about three-quarters of an hour before high water. Four 12-in. x 12-in. launchways were used, set at a slope of one in ten. Had the slope of the beach warranted it, a lesser slope would have been better. Four 12-in. x 12-in. runningways were placed under the caisson resting on the launchway—each runningway had a 6-in. x 12-in. board bolted on for a guide. All four runningways were roped fast to the launchway at the shore side of the caisson and ropes cut simultaneously when ready to launch. In order to check one end going faster than the other, timber dogs were used with one end made fast to the runningway and the other ready to drive into the launchway, should one end of the caisson start before the other. In addition, a four-part rope tackle was used at each end with the end passing around a snubbing post. With these preventatives and a crew trained to work together, there appeared to be no difficulty in getting the caisson started properly, but after taking water and before becoming waterborne, the caisson in two cases gradually swung off the ways up river in the direction of the river current, indicating that the slight current exerted enough pressure to make the launching a failure. Had launching been attempted at high tide, there seems no reason to doubt its success, but as there is only about twenty minutes of still water, no time would have remained to tow and moor. In one case the caisson, after dropping off the runningways, became waterborne a sufficient time before high-water to tow it across to place and secure the moorings, but in the other case it was necessary to wait a few days for a high tide enough to float.

Tallow was used on the launchways as a lubricant.

The outer ends of the runningways were weighted with rails to clear them from the caisson when afloat.

Towing.—A 35-ton dinkey used in switching operations, was used to tow the caisson to position. A 1⅛-inch steel cable, 1,600 feet long, was stretched across the river previous to launching, passing through a heavy snatch block on a scow, which carried the permanent moorings; the slack of the cable was kept off the bottom of the river by passing over another scow. After launching, the cable was attached to the caisson and the dinkey started towing until the caisson was brought into position alongside the mooring scow, where the moorings were quickly transferred from the scow to the caisson.

Moorings.—The formula used in calculating the moorings was:

$$P = WK\frac{V^2}{2g}$$

W = weight of water per cubic foot — 65.
K = constant (1.47 for square-ended caisson).
V = current in miles per hour.
P = pressure in pounds per square foot on exposed surface normal to current.

Current records taken with a ship's log showed a velocity of 9 knots per hour at spring tides and 6 knots per hour on neaps. These calculations showed a maximum strain of 26 tons had to be taken care of in moorings and two 1⅛-inch wire cables were used up river, one attached to a rock-filled crib in the river and the other to a "dead man" on shore. The downstream mooring was a single 1⅛-inch wire cable from a rock-filled crib in the river and a second 1⅛-inch cable fastened around the old pier adjacent to the final position for the caisson. A socket was attached to the end of each cable and to this a five-part tackle of ¾-inch wire cable was hitched, running through 14-inch diamond blocks, the free end passing around one of the cross-timbers inside the caisson, where it could readily be payed out.

All upstream moorings were carried to a bridle fastened in the end of the caisson. The bridle consisted of four 1⅛-inch wire cables fastened at one end through 1½-inch eye bolts into the caisson and all hitched together to a common shackle at the other end.

In addition to up and downstream moorings, four breast lines were used at each corner of the caisson, consisting of four parts of 4-inch circumference rope through double blocks for adjusting the position sideways.

A framework was built out from the old wooden pier on the line of the new pier, to which the caisson was breasted hard and used as a guide in sinking.

Sinking.—An endeavor was made to level the pier sites by blasting out high spots and filling low spots with small stone but was not attended with any great degree of success, on account of the scouring action of the current. Soundings taken at No. 1 pier showed hard and soft spots alternately and when the caisson was finally sunk, it was out of level as much as three feet and bearing very unevenly. A diver was sent down to try and obtain a more even bearing under the caisson, but very little success attended these efforts. Meanwhile, pumping out and concreting was proceeded with until sufficient weight had been put on to keep the caisson from floating when under enough air pressure to enable the "sand hogs" to go to work levelling up. The locks were installed and eight pounds of air pressure put on at low tide, driving out the water from the air chamber and enabling the men to start work. The entire upper end of the caisson was found open to the action of the tide, the opening being as much as three feet. After finally getting the caisson on a fairly even keel, concreting the top was proceeded with until the right elevation was reached to correspond with the diamond drill borings. Two courses of granite were added, after which old car wheels were used for additional ballast. These were used instead of blocks of granite, which were to be used in erecting the shaft of the pier, on account of their greater specific gravity, reducing the top heaviness of the caisson. Even at that, it was necessary to pile up car wheels to a height of over twelve feet and to indicate how little excess weight there was, may be mentioned the fact that it was necessary to reduce the air pressure eight to ten pounds, even after the cutting edge was cleared, before the caisson would sink. Skin friction was found to run somewhat over 500 lbs. per square foot, the nature of the strata being largely fine sand.

As a precaution against overturning, two 1⅛-inch wire cables were used as a strap around the caisson to the old pier.

It is in order to state that the air work was only carried on at low-tide periods. Air was turned on while the tide had still 6 ft. to fall and the men were called out on the arrival of the bore, permitting six hours work each tide.

This decision as to low-tide work was due to the narrowness of the caisson compared to its height, No. 1 caisson being only 18 ft. wide and the height from the natural ground surface of the river bottom to high water was 50 ft.—the distance from ledge rock as found at No. 1 to high water was 77 ft. Car-wheel ballast to withstand the air pressure for working at any stage of the tide would have reached well above high-tide mark and made the caisson very top heavy and in great danger of overturning in the heavy broad-side current which prevailed at No. 1.

No difficulty was experienced in quickly blowing the water out of the air chamber with air pressure, until a heavy strata of clay was reached, which effectively sealed it, after which it was necessary to use the blow pipes to remove the water.

One of the many difficulties encountered and which caused serious delay, was the entrance of quick-sand into the air chamber on spring tides. This sand carried up on the flood tide, filtered through as much as 20 ft. of cover before getting under the cutting edge and would often fill the air chamber to within 18 inches of the roof. No means was ever found of wholly getting rid of this trouble—it would gradually disappear after the high spring tides were over, but since these high tides reappear at both full and new moon periods, it can readily be understood what a discouraging feature it was.

The average rate per day of sinking No. 1 and No. 2 caissons was 6 and 4.7 inches respectively. A progress diagram is shown in Plate 5 as well as the material passed through.

The slow progress made in sinking No. 2 was accounted for by the fact that the material was boulders of all sizes embedded in sand and clay. It was necessary to shoot these boulders constantly to clear them from beneath the cutting edge and to cut them down small enough to pass through the locks.

No serious difficulties were encountered in sealing the air chambers.

There were no fatalities in this caisson work and, in fact, throughout the entire work—a rather remarkable showing on a dangerous river. There were several cases of "bends" in which it was necessary to resort to the hospital lock.

The air supply was ample for the work, although on a few occasions both machines were operating at capacity.

After the sealing up of the caisson on solid rock, the car-wheel ballast was removed, the top of the concrete cleaned off, levelled up to an uniform bearing at elevation 39.25 and the granite shaft started. Pumping operations were, of course, necessary each tide, since the granite footing course was two feet nine inches below dead low tide, and progress was slow. Only a small section could be attempted each tide on account of the short time available and the enormous amount of cleaning. Plate 6 shows a plan of the granite pier. Granite was laid in each section and hearted up with 1:3:6 concrete. There was 315 cubic yards of granite facing and 300 cubic yards of concrete hearting to each shaft. For protecting the green concrete against scour, wooden shutters were used in sections, secured with rods down the side of the granite shaft to the timber caisson. The heavy current was very severe on these shutters, frequently up-ending them and breaking them in pieces wherever the slightest opening appeared, allowing the tide to get under them. This scheme, however, was the most successful for preventing scour of any used.

The above piers were built for the New Brunswick Government, Mr. A. R. Wetmore, provincial engineer, Mr. R. A. Malloy, assistant engineer on the work.

The contractors were Engineers & Contractors, Limited; Mr. E. R. Reid, president, and the writer chief engineer.

SPECIAL MEETING OF ENGINEERS' CLUB, TORONTO, TO CONSIDER NEW QUARTERS.

A special meeting of the Engineers' Club, Toronto, was held last Thursday, March 1st. This meeting was called to consider the question of new club quarters.

At the time the president, Mr. E. L. Cousins, called the meeting to order there was not a vacant seat in the lecture room. After some preliminary remarks in which the president referred to the history of the club, he called upon Mr. C. H. Heys, chairman of the house committee, to give the members some facts as to the estimated receipts and expenditures which might reasonably be expected in the event of a change of quarters being made.

Following Mr. C. H. Heys, Mr. M. P. White, on behalf of the new quarters committee, outlined the steps that had been taken by that committee in its effort to arrive at some definite proposal. Two were laid before the meeting, one providing for the remodelling of the present quarters by which the floor space would be practically doubled. The other proposal was for the club to occupy the 5th, 6th and 7th floors of the World Building on Richmond Street West. This would give the club a floor area of 15,000 square feet. The discussion was quite general, the consensus of opinion being that the World Building plan was the more desirable. When the vote was taken it was found it was practically unanimous in favor of moving to the World Building, there being only one dissenting vote. At the same time, it was felt that out of courtesy to the members of the club who were not present, a letter ballot should be taken before any definite move was made. The directorate was therefore authorized to send out a letter giving as much information as was thought necessary regarding the two proposals and thus secure an intelligent expression of opinion of all resident and non-resident members. This will be done within the next few days.

The number of companies incorporated under the Companies Act in Canada during the fiscal year ended March 31st, 1916, was 534, with a total capitalization of $157,342,800.

THE NECESSITY FOR ADEQUATE METHODS OF WATERPROOFING IN ROAD CONSTRUCTION.*

By C. J. Morrison.

A WHEEL and a road may be considered as two elements of a machine and the ideal requisites for each determined to be: (1) Perfectly hard and perfectly round wheel; (2) perfectly hard and level road.

The ideal road cannot be maintained but can be approached by constructing a moderately hard road which resists wear and disintegration.

In order to fulfil their requirements, roads must be waterproof, so as to protect them from the flowing, undermining, and penetration of water. Principles of waterproofing are simple, but are neglected.

Roads are constructed under five general conditions: (1) On level ground; (2) on inclined ground; (3) in cuts; (4) on embankments; (5) on side of slopes.

Each condition requires a different method of waterproofing and waterproofing is dependent upon: (1) Location of drains; (2) construction of road; (3) treatment of surface.

Comparative costs of construction and maintenance show that at the end of five years the total cost of a non-waterproof road and a semi-waterproof road are about

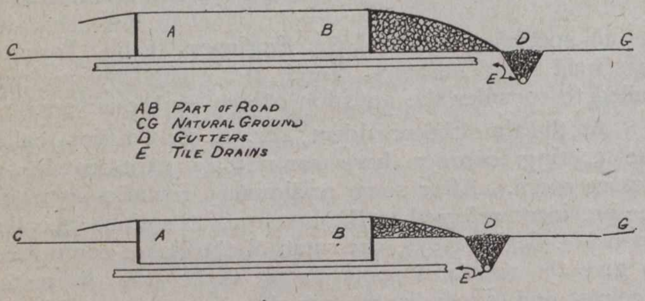

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Fig. 1.—Construction on Level Ground.

equal, but that the former is practically useless while the latter shows little deterioration. Similar comparisons for waterproof roads are not yet available.

The ideal condition of things is obviously that in which a perfectly hard and perfectly circular wheel runs on a perfectly hard and level road. It might be said, therefore, that a steel wheel and a steel road would be suitable as in the case of railway practice. As a matter of fact, quite apart from the practical question of the cost of such a road, there are questions of adhesion, in the matter of gradients as well as storing, that a really hard road cannot be obtained. It may be at once said that if a moderately hard road could be kept level and entirely free from all unevenness of surface there could be nothing better than a truly circular metal wheel, and such a wheel being cheap and durable would doubtless be universally employed.

Ideal Road Impossible.—However, a thing so desirable as a truly level surface is exactly what it is impossible to maintain, and it is in order to mitigate the shocks caused by the tendency to deflect a vehicle from its movement in a straight course that yielding material such as solid rubber or pneumatic tires are employed on the periphery of a wheel. This soft material cannot be used without paying the penalty, not merely of wearing the wheel, but of wearing the road itself, and as a matter of fact, inasmuch as the contact between the wheel and the road departs from a point in the side elevation, or a line looked at in plan, by so much is wear between the surfaces in contact introduced.

Fig. 2.—Plainfield Road.

Conditions Beneath Surface.—In the next place, consider what goes on beneath the surface. If the road is not hard, then a certain amount of deformation must take place.

The injury done by this deformation will depend on two things: (1) The depth to which it extends; (2) the extent of permanent disintegration of the internal substance of the road.

Practical Requirements.—It is therefore obvious that, both as far as the surface is concerned and also the body of the road, what is required is a hard, strong substance which presents great resistance to wear, deformation and disintegration. If it is impossible, on account of expense, to make the whole of a road of such material, then the surface of the road should be of such material, and the

Fig. 3.—Break in Plainfield Road.

body of the road should be bound or cemented together with such material.

Necessity for Waterproofing.—In any case, as the road is exposed to the action of the weather, one of the very first conditions of its efficiency is that it must be waterproof, and that the surface must be sufficiently hard to prevent the formation of mud in wet weather and dust in dry weather.

*Abstract of paper read before the American Association for the Advancement of Science.

Definition of Waterproofing.—The term "waterproof" is used here in the broad sense, meaning both the protection of the road from water, and the rendering of the road itself impervious to water.

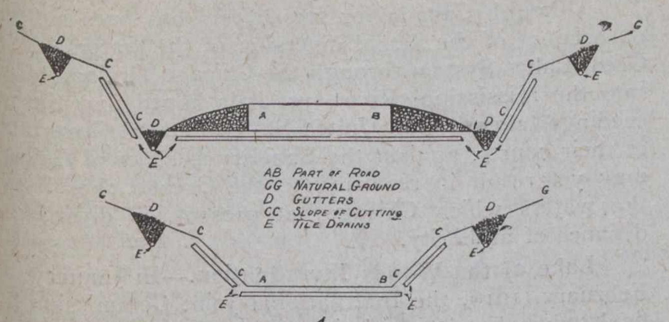

Fig. 4.—Construction in Cut.

Neglect of Waterproofing.—Roads must be waterproofed so as to prevent damage from abrasion, from undermining, from foreign substances being washed onto them, and from water penetrating the mass of the road. Although water is one of the worst enemies of the roads, the fact seems to have been given little attention and as a result, the cost of maintenance has increased enormously. Possibly the condition is due chiefly to the deplorable fact that road building has been largely in the hands of politicians and contractors instead of engineers.

Last winter hundreds of miles of roads were ruined because they were not waterproof. Water penetrated the body of the roads and froze. The result was upheavals and disintegration. Even the most elementary principles of waterproofing have been neglected, as will be illustrated later by photographs of various points on recently constructed highways.

Conditions Met in Construction.—As the elementary principles of waterproofing have been so completely neglected, it may not be amiss to describe them. Roads

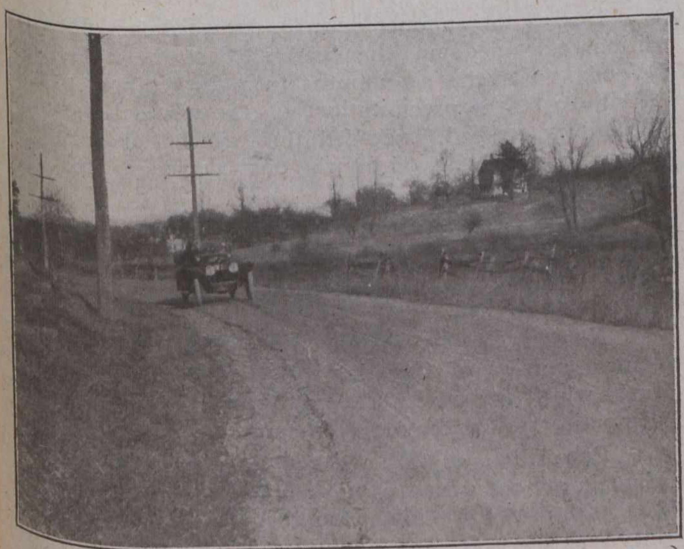

Fig. 5.—Road in Cut Near Englewood, N.J.

are built under five general conditions and combinations of these conditions. The general conditions are: (1) On level ground; (2) on inclined ground; (3) in cuts; (4) on embankments; (5) on the side of slopes.

Roads on Level Ground.—A road built on level ground can be very easily waterproofed by building it slightly above the general elevation, by giving it a crown sufficient to cause any water to flow, by providing ample gutters on each side, by laying sufficient underdrains, and by applying a surface which is impervious to water. This method of construction is shown in Fig. 1. At frequent intervals, trenches or drains should be provided to carry off the water from the gutters.

Although it is so simple and inexpensive to properly waterproof a road built on level ground, the precaution is often neglected.

Sections of a new concrete road near Plainfield, N.J., are shown in Figs. 2 and 3. The body of this road is concrete and the surface is a soft asphalt. A far better road would have been secured by using a topping of integral waterproofed concrete instead of the asphalt. Although there has been no hot weather since this road was opened, the surface is already badly marked by horseshoes and wheels. These indentations will eventually go through to the concrete, water will collect in the depressions and percolate through the non-waterproofed concrete. Moreover, the road is neither properly protected from flowing water, nor adequately drained. We predict that it will not survive the second winter.

The shoulders on the sides of the road are a soft clay and the edges of the concrete have no protection. Already sections are being broken off, as can readily be seen in Fig. 6.

Roads in Cuts.—Roads built in cuts are probably the hardest to protect from flowing water, and there is therefore all the more necessity for a hard surface and integral waterproofing. Fig. 4 shows the general method of protecting a road in a cut and is so elementary that no comment seems necessary. Although so elementary, the

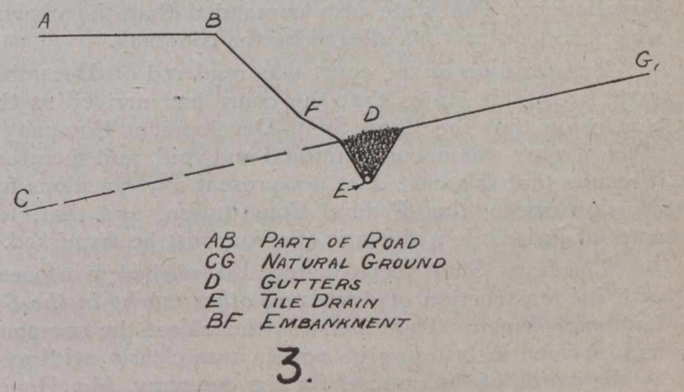

Fig. 6.—Construction on Embankment.

methods are quite generally neglected. A road in a cut at Great Notch, N.J., may be taken as an example. There is no waterproofing whatever and the net result is that the road has been rebuilt three times in three years. It will probably be rebuilt again next spring.

Fig. 5 shows a road in a slight cut near Englewood, N.J. Practically the same conditions prevail as at Great Notch. The picture shows ridges due to upheavals last February which had not yet been repaired on December 7th, when the photograph was taken. The present winter will probably about finish this road.

Roads on Embankments.—Roads on embankments seldom cause trouble if the most elementary principles are observed. These principles are shown in Fig. 6. The two salient features are to build the road so that it is integrally waterproof and so that the embankment is protected from flowing water.

Roads on Sides of Slopes.—Roads on the sides of slopes should be waterproofed in the same manner as roads in cuts with the exception that protection from flowing water is necessary only on one side.

REVIEW OF LAST YEAR'S DEVELOPMENTS ON NIAGARA AND OTHER POWER SITUATIONS.

IMPORTANT REFERENCE TO COAL PROBLEM.*

By **Arthur V. White,**
Consulting Engineer, Commission of Conservation, Canada.

WHILE reference will here be made to the Long Sault Rapids, St. Lawrence River; to the Chicago Drainage Canal; to the Lake of the Woods investigation, and to other water problems which, during the past year have been receiving attention from the Commission of Conservation, special attention will be devoted to a review of the power situation at Niagara Falls, because of the acute situation which has there arisen, and because, also, of its great national importance.

Long Sault Rapids, St. Lawrence River.—The charter of the Long Sault Development Co. has been declared to be unconstitutional. The company has been exerting strong efforts to secure a re-establishment of its status with respect to its former charter. The case was presented for argument before the Supreme Court of the United States during the past year.

The burden of the argument turned upon the question of jurisdiction. The main contention of the State of New York was that the Long Sault Development Company Act is unconstitutional. It has been so declared by the highest court of the state, and it was held that the decision of this court in a matter of this kind cannot be reviewed by the Supreme Court of the United States, being outside its jurisdiction. The state also contended that the charter was not a *contract*, as alleged by the company.

The decision of the court was rendered on December 11th, 1916. It states that the court had arrived at the conclusion that the Long Sault Development Company's "Act of 1907 was unconstitutional and void, and therefore it results that this case does not present any questions for decision under the Federal Constitution, and that, for want of jurisdiction, the writ of error must be *dismissed.*"

The Long Sault Development Co. wished to proceed with its construction of *dams and other works in the St. Lawrence River.* That this was the object the company had in view, in bringing its action, was clearly evidenced by the words of the counsel for the company, Mr. Henry W. Taft, who, before the Supreme Court, stated:

"Since the passage of the act the company has made, without success, diligent efforts to obtain the consent of congress, and, when the present embargo against the building of dams has been raised, will proceed again to obtain that consent."

Water Diversion by Sanitary District of Chicago.—The illegal diversion of water by the Sanitary of Chicago still continues.

The waters along the international boundary between Canada and the United States are a joint asset in which it has been regarded that each country is entitled to receive equal benefits. Nothing should be done in one country that would violate, or even prejudically affect, the interests of the other country. *Boundary waters should be kept within their own watersheds.*

In deciding against the Minnesota Canal Power Co.'s proposed division of the Birch Lake waters from the Lake of the Woods watershed to that of the Great Lakes, the courts of Minnesota have upheld this principle and rendered signal service to the conservation of boundary waters, by having them retained within their own watersheds.

Although Canada for some years has been suffering on account of the illegal diversion of the waters of the Great Lakes System through the Chicago Drainage Canal into the Mississippi River, yet it is hoped that the proceedings taken by the United States Federal Government in their courts, against the Sanitary District of Chicago, may yet result in restoring to the Great Lakes System the waters which Chicago, at present, is diverting in defiance of authority.

Lake of the Woods Investigation.—In January and February, 1916, the International Joint Commission held final public hearings relating to the Lake of the Woods investigation. These hearings were opened at International Falls by a committee of the commission, for the purpose of obtaining evidence respecting land values.

Immediately following adjournment, the hearings were continued at Winnipeg, before the full commission. These hearings at Winnipeg were called largely for the purpose of permitting those interested in power to make their representations. The data and conclusions presented by the consulting engineers in their preliminary report to the commission were considered, and the question of the relation of the regulation of the levels and outflow of the Lake of the Woods to power development was fully discussed by counsel and engineers representing the power interests.

In April, at Washington, D.C., the commission heard the final arguments of counsel representing the various interests affected by regulation of the Lake of the Woods. An executive meeting was held in September at Ogdensburg, N.Y., and at Ottawa in October.

There is now in preparation for transmission to their respective governments, a report by the commissioners respecting the regulation of the Lake of the Woods waters.

During the summer of 1916, extraordinary flood conditions prevailed on the watershed of the Lake of the Woods. For the six months from November, 1915, to April, 1916, the precipitation, on the whole Lake of the Woods watershed, exceeded that which fell during the same six-month period for the past 44 years,—for which records are available.

The flood conditions of 1916 strikingly emphasized the urgent need for an efficient, co-ordinated system of regulation and control of the waters of the Lake of the Woods watershed.

Niagara Power.—The coal problem, especially in the central portion of Canada, is a serious one. The two fuels which for power generation may be considered as competitors of water are petroleum and coal.

Petroleum, so far as large portions of industrial Canada are concerned, is out of the question. Respecting coal, the prices for this commodity are materially increasing year by year, and doubtless this upward movement will continue.

Representations are repeatedly being made by the United States authorities for the conservation of their own coal. Dr. George Otis Smith, director of the United States Geological Survey, in 1916, publicly stated:—

"Of the two fuels that can be considered as the competitors of water in power generation, petroleum has probably already passed its maximum of production, and the life of this source of power is to be measured by only a few decades. The coal resources of this country, on the other hand, are so

*Brief Abstract of Annual Statement to the Commission of Conservation, Canada, to be included in the Commission's forthcoming Annual Report.

large as to promise an abundance of fuel for scores of generations. Yet the price of steam coal shows a steady advance, offset, it is true, by increased efficiency in steam generation and utilization, but eventually the relative importance of water power the country over must increase.

"Already the great development of hydro-electric power in California in competition with oil and in Montana in competition with coal, forecasts the future relation of industry to this source of power. In these and adjoining states, irrigation and mining and transportation depend in larger measure each year upon hydro-electric energy, and it is because of this increasing contribution to the industrial life of the nation that public service and public utilities are more than names when applied to the utilization of water power.'

The United States is well aware of the economic importance of its coal reserves. Dr. Smith States:—

"Cheap power promises to be in some future century this country's largest asset in the industrial rivalry among nations. Our unsurpassed coal reserves reinforced by these water-power resources constitute a strong line of national defence in that they form the real basis for an industrial organization of the nation's workers. It is only through abundant and well-distributed power that the other material resources of the country can be put to their highest use and made to count most in the nation's development. The people's interest in water power is greatest in its promise of future social progress, and such an interest is well worth protecting."

Ten years ago, the Committee on Rivers and Harbors of the United States House of Representatives directed special attention to the industrial value of Niagara Falls, and the importance of this power supply when considered in connection with the supply of coal. It was urged that the chief and most important procedure for improving the power conditions were:—

First—The utilization of every American water power to its fullest extent.

Second—A more general location of manufacturers close to sources of fuel supply.

Third—The adoption of highly economical steam-driven power plants and more efficient methods of distributing and utilizing the energy.

In his statement to this committee, Mr. W. J. Clark said:—

"The enormous advantage which would accrue from the adoption of these last two suggestions will, however, be neutralized in a comparatively few years if some effort is not made to preserve the coal supply of America.

"It would be unfair to place the responsibility for the rapidly increasing use of coal in the United States, which threatens the ultimate exhaustion of the supply, entirely upon the manufacturing industries, for its consumption for transportation and other purposes has increased even more rapidly than for manufacturing uses. Attention should, however, be called to the leaps and bounds with which American coal production is increasing, so that the importance may be realized of preserving the supply by so far as is practical utilizing water power for all industrial purposes."

And again, it will be recalled that a few years ago the director of the United States Geological Survey, in referring to the world's coal supplies, stated:—

"This glance at the world's reserves of coal shows plainly not only that the United States leads all other countries in production, our annual output being nearly 40% of the total, but also that it possesses the greatest reserves. Yet in respect to no mineral is there greater need to emphasize the folly of exporting the raw material. Let us keep our coal at home, and with it manufacture whatever the world needs."

In November, 1916, during the coal shortage in the United States, in the course of the investigation into the alleged coal combine, held at Buffalo on November 28th, the district attorney in charge of the investigation put this question to one of the witnesses:—

"If the Canadians put an embargo on power when there is a power shortage, should we not put an embargo on their getting coal when there is a shortage here?"

Now, if citizens of Canada demand that electrical energy generated in Canada be used exclusively for citizens in Canada, and that its export to the United States be prohibited, then are not citizens of the United States equally justified in contending against the export of coal to Canada, because it is needed for citizens in their own country?

Good Working Basis is Practicable.—No country need be expected to send out of its borders that which is essential to its own existence.* Between the United States and Canada there is exchange of many natural and manufactured products, and no doubt the problems which are sure to arise in connection with such interchange—including the commodities of fuel and power—can be reduced to a good working basis.

Everyone familiar with the course of events which preceded the ratification of the Boundary Waters Treaty of 1910, knows that under the prior—but since lapsed—Burton Act, it was anticipated that some of the electrical energy developed in Canada would be exported to the United States. In fact, some people believed that it would not be possible to utilize in Canada more than a portion of the great amount of electrical energy that might be developed on her side of the boundary, and that consequently the United States market would import from Canada any surplus energy. These expectations have not materialized as was anticipated because the growth of industries dependent upon electrical energy has been so phenomenal in both countries.

Recollecting that the *doctrine of equal benefits* is basis to the Boundary Waters Treaty, each country should watch to see that no purely selfish interests shall operate to work any injustice to the other country. For example, after all factors have been duly weighed, if it is found that that any *bona fides* exist which require the exportation of an amount of electrical energy to the United States in order to enable that country to derive the beneficial use from its equity in boundary waters, such *bona fides* should be fully respected.

United States Fears that Canadian Markets May Absorb Electricity.—Those in the United States who have watched the increasing demand for electric power in their own country, have also observed that there has been an increasing demand for electric power in Canada. Those interested in power consumption in the United States have not hesitated to express the fear there entertained, that Canada on account of her growing manufactures and demands would rapidly absorb the electric energy which has been so much coveted for importation into the United States.†

The Secretary of War exercises jurisdiction over the Niagara River, and through the agency of the United States engineers, the War Department has kept in close touch with the Niagara situation. The restraint which this department has enforced upon the power companies, in order to keep them within treaty requirements, as well as within regulations of a domestic nature, is worthy of best commendation.

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*For comments upon the application of this doctrine to the exportation of phosphate rock and other commodities, consult article by Arthur V. White, on the "Exportation of Electricity," which appeared in the "University Magazine," October, 1910; also, see "Toronto World" of 18th March, 1912; and "The Monetary Times" of 5th January, 1917. Consult, also, "Annual Reports" of Commission of Conservation, Canada.

†The author here quotes a number of views expressed by prominent United States citizens, confirming this statement.

Public Meetings in United States.—In August last, the War Department issued notice of public hearings to be held at Niagara Falls, N.Y., for the purpose of ascertaining what industries dependent upon power generated from the waters of the Niagara River at Niagara Falls, have been, or are likely to be adversely affected by a reduction of power obtained by them from that source. Blank forms for supplying information were also distributed to various companies. The report has not yet been made public.

The Water Power Investigating Committee appointed by the New York State Legislature, has held hearings at Niagara Falls, N.Y., and elsewhere and it is understood that this committee is about to issue a report.

The Hydro-Electric Association of Buffalo, N.Y., an organization seeking to carry out a plan for power distribution fashioned along the lines upon which the Hydro-Electric Power Commission of Ontario operates, has been urging before the Committee on Foreign Affairs their claim to the unappropriated 4,400 c.f.s.

United States Committee on Foreign Affairs.—At a meeting of the committee in July, it was addressed by prominent persons utilizing Niagara power, such as the managers, superintendents and consulting engineers of concerns like the Graphite Company, the Union Carbide Company and the chlorine industries. All speakers emphasized the fact that they were experiencing acute shortage of power. There were present about one hundred representatives.

Directing attention to the effects of the dye shortage, speakers emphasized that the United States was many times more dependent,—even though they did not know it,—upon products resulting from the use of Niagara power, than they ever were on the dye-producing industries of Germany. Speakers went on to demonstrate that it was utterly futile for the United States to devise and attempt to carry out any policy of war-preparedness, without at the same time augmenting the power available for the use of United States industries now located at Niagara. It was emphasized that this applies specially to plants manufacturing such products as chromium, utilized for the steel for battleships, and for high-speed cutting tools, which latter have so materially increased the output of metal-working establishments. There was also pointed out the need for increasing the output of the abrasive industries which supply carborundum and other products now so generally employed in the modern grinding processes which to a large extent have superseded, for many purposes, the work previously performed by lathes and other machine tools. Much attention was directed to the graphite products without the supply of which it would be simply impossible to produce the materials from which to manufacture many of the modern munitions of war.

Statements were made to show that the United States, in order to conserve and advance her industrial position in the world markets, could not afford to permit industries to locate in other countries where cheap power was being offered. Instances were mentioned, such as that of the Union Carbide Company locating in Norway and having available 100,000 h.p.; also a case in Canada where the American Cyanamid Co. had been forced to move out of the United States and locate in Canada at Niagara Falls in order to obtain a block of some 25,000 or 30,000 h.p. Such instances were cited in order to show that it would be extremely unfortunate to the upbuilding of the United States if industries had thus to expatriate themselves because the additional power necessary for their growth could only be obtained abroad.

After another meeting, in August, the committee announced that the hearings had furnished all information it required in order to proceed to "report out" the Cline Bill. Since the Presidential election, no further action has been taken.

In order to relieve the situation, the United States War Department has issued provisional and temporary permits, both to the Hydraulic Power Co. and to the Niagara Falls Power Co., to utilize during the winter months the full 4,400 c.f.s. remaining unappropriated under the Boundary Waters Treaty.

The Power Shortage in Canada.—All the power-producing resources of the Niagara power companies in Canada are taxed to their respective limits. There is no doubt that the use of electricity in Ontario has been greatly stimulated by reason of the activities of the Hydro-Electric Power Commission of Ontario. Rates have been lowered. The commission at present is directing the Niagara, Severn, Wasdell's Falls, St. Lawrence, Ottawa, Port Arthur, Eugenia, Muskoka, Northern Ontario, and Central Ontario systems.

It may be mentioned that during 1916 the Ontario Government purchased, for the sum of $8,350,000, the Central Ontario system. This comprised the entire holdings of the Electric Power Co., which embraced twenty-two subsidiary companies, including transmission lines of 285 miles at 44,000 volts.

In order to show the increasingly great demand for power in Canada, it may be stated that during 1916, *for industrial purposes, in the Niagara District alone*, the commission received *bona fide* applications for over 70,000 h.p. These applications came from companies like the American Dye & Chemical Co., Electro-Chemical Co., Canadian Carbide Co., Norton Emery Co., Carborundum Co., Riordan Pulp & Paper Co., Beaver Paper & Wood Co., etc. For the most part it has been simply impossible to supply such demands. The commission has exclusively furnished electric power to approximately 300 plants making munitions of war.

It may be commented that of the power which the Hydro-Electric Commission has been receiving from the Niagara companies, only about 10,000 h.p. has been derived from energy which was formerly exported. In other words, the additional supply of power from Canadian companies to the commission has been met by the installation of additional units.

This great demand for power in Canada will be met, chiefly, in two ways: First, the more immediate needs will be supplied from the existing power plants at Niagara on the Canadian side; second, by means of the proposed Chippewa development of the Hydro-Electric Power Commission, which is to provide about 200,000 h.p. under a head of 300 to 305 feet.

Canadian Power Plants at Niagara Falls.—The information respecting the three large power plants in Canada at Niagara Falls may briefly be summarized as follows:—

CANADIAN NIAGARA POWER COMPANY.

3 generators rated at 10,000 h.p. each ..... 30,000 h.p.
7 generators rated at 12,500 h.p. each ..... 87,500 h.p.

This makes a total rated capacity of 117,500 h.p. Space has been provided for an eleventh or spare unit. Up to November 1st, last, with eight machines installed having a rating capacity of 105,000 h.p., the company showed a maximum generation of approximately 93,000 horse-power.

ONTARIO POWER COMPANY.

3 generators rated at 10,000 h.p. each	30,000 h.p.
4 generators rated at 12,000 h.p. each	48,000 h.p.
7 generators rated at 13,000 h.p. each	91,000 h.p.
Total	169,000 h.p.

The hydraulic installation comprises two 18-ft. main conduits. A proposed third conduit has not been installed. The maximum total output has reached a little over 163,000 h.p.

ELECTRICAL DEVELOPMENT COMPANY.

4 generators rated at 10,500 h.p. each	42,000 h.p.
7 generators rated at 13,400 h.p. each	93,800 h.p.
Total	135,800 h.p.

It will be observed that the installation of the Electrical Development Co. exceeds its agreed 125,000 h.p., but it has been authoritatively stated that while the agreed quantity has been developed on peak load, it has not been exceeded.

With respect to the exportation of electrical energy from Canada to the United States, the Canadian licenses for a year ago provided for the following:—

	Approximate kilowatts.	Approximate horse-power.
Electrical Development Co. (Toronto Power Co.)	35,000	47,000
Ontario Power Co.	45,000	60,000
Canadian Niagara Power Co..	55,000	74,000
Total	135,000	181,000

The Canadian Government has had under consideration a proposal to reduce the export quantities to the following:—

	Horse-power.
Electrical Development Co.	16,000
Ontario Power Co.	60,000
Canadian Niagara Power Co.	40,000
Total	116,000

United States Power Plants at Niagara Falls.—On the United States side the Hydraulic Power Co. has remodelled its plant. It has two power houses jointly capable of developing about 158,000 h.p..

The Niagara Falls Power Co. has an installation capable of developing 100,000 h.p., but the amount of water apportioned this company by the War Department permitted only the development,—according to various combinations of units,—of from about 65,000 h.p. to 80,000 h.p.

These figures do not include power generated under the temporary winter licenses referred to above.

RAILWAYS IN CEYLON.

From the latest statistics it appears that the length of railway open for traffic in Ceylon at the close of September, 1915, was 692¾ miles as against 672 miles at the corresponding period of 1914. The increase was due to the opening of a section of a line to Chilaw. In the course of 1914-15, rolling stock was increased by 18 new passenger and 86 new goods vehicles.

BEST PRACTICE IN CONCRETE ROAD CONSTRUCTION.*

By H. E. Breed.

In design, the edge of the concrete slab next to the shoulder should be vertical and square cornered. Then if it becomes necessary to reinforce the shoulder with road metal a good joint can be made; and, more important still, if additional widening is required, it can be accomplished with a longitudinal joint of minimum size. We have very satisfactorily widened some miles of concrete roads built throughout the State (New York) in accordance with this design by adding four or more feet to one or both sides of the pavement.

Where the soil for the shoulders is unstable we are entrenching it with crushed stone or gravel four to six inches deep and 1½ to 3 feet wide. Although this gives good results, and makes for additional safety, still, if much traffic must be turned onto them the maintenance cost of these stone and gravel shoulders is so high as to justify the additional first cost of a wider pavement.

Accidents on 16-Foot Roads.—In order to obviate the danger of accidents on our 16-foot roads, we have been widening or mooning out the curves, so that in some cases for those of small radius at the centre the actual curve is as much as 22 to 24 feet wide. We have also considered it good practice to give the outside of these curves a super-elevation in order to make easier the steering of a car, to lessen the likelihood of skidding, and to insure greater safety in taking these curves at speed. This has been objected to as inducing people to travel round these curves at high speed, but speeding seems to be an inherent mania, unrelated to external conditions, and certain it is that banked curves lessen the casualties resulting from it.

Specifications.—Cracking of a concrete pavement is due generally to the unequal settlement of a poor subgrade. If the road is to be satisfactory it is of first importance that a good subgrade be secured. These we consider the essentials of a good subgrade:—

(1) It must have uniform bearing power. If an old road-bed is to be used it must be scarified, reshaped, and rerolled for the entire width of the pavement, removing all large stone to a depth of 6 inches.

(2) It must be dry. Ditches should be low enough to take away the water from under the pavement. With unstable soil good results can be secured by providing subdrains and spreading a layer of gravel—preferably run-of-bank gravel—over the subgrade to increase its stability. Material used for this purpose must be impervious; if it is porous it will act during wet periods as a reservoir, which, under conditions of frost, will break the pavement proper.

(3) It should have metal reinforcements (a) under very bad, i.e., unequal soil conditions; (b) wherever the supporting power of the subgrade changes; as from rock to earth, or passing over a trench.

Our experience indicates that the expense of reinforcement is not justified in gravelly or sandy soils where good natural drainage prevails.

The Mix.—The mix should be proportioned in such a manner as to give the greatest density. With our requirements for materials we have found that the proportions of 1 : 1½ : 3 most nearly do this. Our specifications

*Abstract of paper read before the American Road Builders' Association, Boston, Mass., February 8th, 1917.

provide that the concrete shall be mixed in the proportions of 1 volume of cement to 4½ volumes of sand and broken stone or gravel, and the proportions of fine and coarse aggregate are varied slightly as a result of field void tests so that the greatest density is obtained. Should the size or character of the materials change there would be a corresponding change in the proportioning of the mixture.

The coarse aggregate should consist of a well-mixed product of clean No. 1, No. 2 and No. 3 stone or gravel.

No. 1 size is that retained on ⅜-in. circular and passing a ⅝-in. circular screen.

No. 2 size is that retained on ⅝-in. circular and passing a 1½-in. circular screen.

No. 3 size is that retained on 1½-in. circular and passing a 2¾-in. circular screen.

It is provided, however, that not more than 25% of the total shall be No. 1 size, the proportions being so graded as to give a minimum of voids.

Aggregates should never be used unless they comply with the tests prescribed.

You may note that we allow, as our maximum size, stone that will pass a 2¾-in. ring, whereas most specifications permit only 1½-in. stone as a maximum. This may seem radical, but our reason for the increase in size is that we get equally as good if not better results from the larger stone, and at a cost decidedly lessened by our using more nearly the product of the crusher. Especially is the price to be considered on contracts where the local supply is crushed on the ground, as is the case in most of our work. If you desire economy, this change is worthy of your consideration. We save 15% in crushing costs by this use of stone larger than the previously accepted standards.

From a practical standpoint a pile of stone graded from ¾ to 2¾ ins. has more stability when properly mixed than stone graded from ¾ to 1½ ins. In our 1916 work we used stone up to 2¾ ins. in size; as an indication of the compressive strength per square inch of field cubes tested at an age of 26 days we have a grand average of 3,370 pounds per square inch for 504 cubes of stone and gravel, of which only 13¼% were under 3,000 pounds. Greater density can be obtained by using stone up to 2¾ ins. in size and with the larger size stone there is less probability of spalling at joints and along edges.

Sand.—Concrete pavement sand should be such that 100% should pass the ¼-in. screen; not more than 20% should pass a No. 50 sieve and not more than 6% should pass a No. 100 sieve. However, where more than 20% of the sand passes a No. 50 sieve, where it is well graded to give a low percentage of voids, and where it conforms to all other requisites, special permission for its use may be given by the chief engineer. Sand may be rejected if it contains more than 5% of loam or silt. All sand to be acceptable should have a compressive strength equal to Ottawa sand when tested in a proportion of one part cement to three parts sand at the same age, same consistency and using the same blend of cement as for Ottawa sand in the same proportions. It must be free from organic matter and any coating of grains.

Method of Mixing.—The concrete should be mixed in approved mechanical batch mixers. Mixing should be continued at a speed of not less than ten revolutions nor more than sixteen revolutions per minute, for at least one minute after all materials are in the drum and before any discharge is made.

If at any time during the progress of the work the temperature is so low that in the opinion of the engineer in charge of the work it will within 24 hours drop to 35° F. the water and aggregates should be heated and precautions taken to protect the work from freezing for at least ten days. Should these temperature conditions persist for two consecutive days, permission should be obtained from the chief engineer before proceeding. He will lay down such requirements of procedure as may be permitted; such procedure should be only for emergency work. In no case should concrete be deposited on frozen subgrade.

CANADIAN NORTHERN RAILWAY-HYDRO CONTROVERSY AT HAMILTON.

In connection with the controversy between the Ontario Hydro-Electric Commission and the Canadian Northern Railway regarding an entrance into the city of Hamilton, Ont., a committee of five representative citizens there has recommended that a broad and impartial investigation into the matter be carried on by a board of independent engineers. Until this report is submitted there is little likelihood of any definite action being taken by the city.

The engineers who compose this board are Col. R. W. Leonard, St. Catharines, Ont., formerly chairman National Transcontinental Railway Commission; Sir John Kennedy, Montreal Harbor Commissioner, ex-chief engineer, Great West Railway of Canada; Wm. F. Tye, consulting engineer, Montreal; Dr. Louis Herdt, electrical engineer, Montreal; W. J. Francis, consulting engineer, Montreal.

These gentlemen are all members of the Canadian Society of Civil Engineers. The local committee is urging delay until the board of engineers as above constituted has completed its investigation.

CANADA'S PRODUCTION OF MINERALS.

The tremendous expansion in Canada's production of minerals, particularly copper, iron, nickel, zinc and other ores needed in the manufacture of munitions, was interestingly dealt with by John McLeish, chief statistician of the Department of Mines at Ottawa, in an address to the members of the Royal Canadian Institute, Toronto, on the evening of January 27th. During 1916 the mineral output of the Dominion rose to 175,000,000 tons of ore, as compared with 135,000,000 in 1915, and the increase in production and in the market value of the minerals meant an extra $33,000,000 of money.

The pressing demand for certain metals had resulted in the development of ore bodies that had never been exploited before, owing to the cost of mining. An instance was the mining of molybdenum in Quebec, which last year produced ore worth $300,000. Chromite was another ore now being supplied from Quebec. Before the war the United States secured nearly its whole supply from New Caledonia.

Mr. McLeish stated that the lack of refineries in Ontario was unfortunate, but that they were now being built in a number of places in Canada. The refining of Canadian minerals at home would go on after the war was over.

There seems every prospect of rational coal mining being possible in Iceland, and preparatory work is being pushed ahead with considerable energy. For this purpose a Danish-Icelandish Coal Mining Company has been formed, with a capital of 350,000 kr., privately subscribed, which will be greatly increased when deemed necessary. A Swedish expert has examined and reported upon the Icelandish coal deposits; he estimates them to contain some 180,000,000 tons. The quality is said to be considerably better than hitherto supposed. The coal is reported to be fully equal to Scotch coal, and even if, on account of its large percentage of ash, it is unsuited for steamship boilers, a good market for it will be found for use for domestic purposes and power stations.

THE HYDRO-ELECTRIC POWER PLANT OF THE CEDARS RAPIDS MANUFACTURING AND POWER CO. AT CEDARS, P.Q.*

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

THE development at Cedars Rapids is one of the most extensive which have been made in recent years in Canada, and the different phases of the work are in the first rank of importance in water power projects. The complete story of the work cannot be covered in a single paper, and it has been decided, therefore, to divide the subject into three sections, each being treated separately by the engineers connected with the development.

In the first of these sections Mr. Henry Holgate dealt with the history and legal phases of the organization, and the early stages of the work.

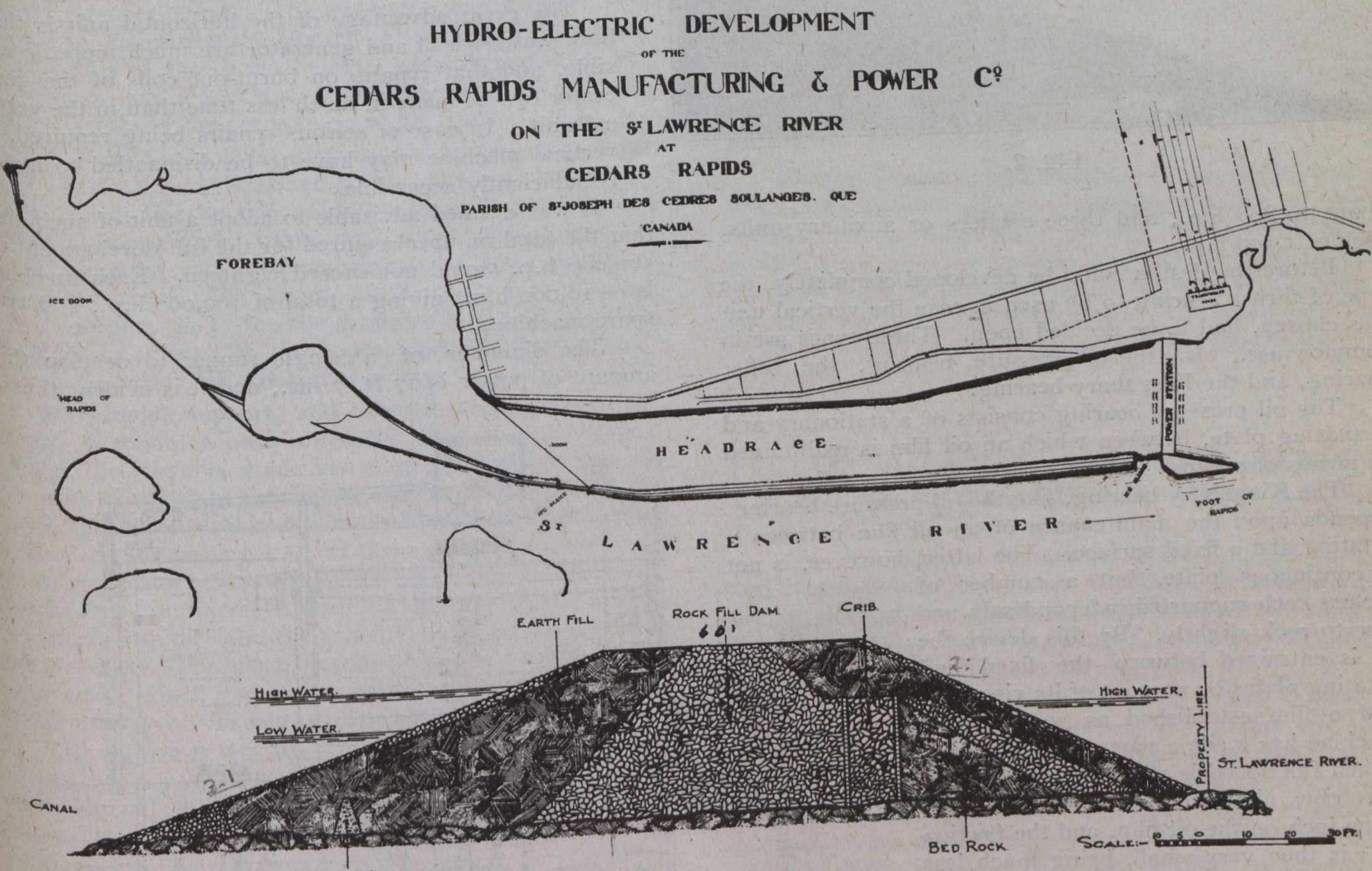


Fig. 1.

The third section will deal with the electrical equipment, installation tests, and the operation of the plant during the year 1915.

Embankment.—A general plan of the area covered by the works and a cross-section of the south bank are shown in Fig. 1. The south bank, extending the whole length of the canal, and separating it from the river, is the main feature of the construction.

The bank consists of rock-fill with clay bank or blanket on the canal side. At the end adjacent to the power house where the head against the bank is large, a concrete core wall extends down to solid rock, but at the upper end where the head is much less, this core wall was omitted and stripping down to rock was not deemed necessary.

Ice Protection.—The plan of the location of the forebay and canal shows that the general direction of the water entering the forebay above Isle aux Vaches is at right angles to the direction of the main stream. A small rapid exists just above Isle aux Vaches, and the velocity in the main stream is probably about 7 or 8 ft. per second, whereas the velocity across the section of the forebay into the canal is only about 2 ft. per second at full load. From the north bank and extending more or less at right angles to the current, a series of cribs has been constructed, with the idea of deflecting the water towards the main stream, thereby reducing the probability of floating material entering the canal.

In addition, two spillways have been provided in the south bank of the canal, one at the upper end, and one near the power house. The upper one consists of seventeen openings, each having a clear width of 15 ft. and closed normally by stop logs with the crest of the concrete sill about 10 ft. below lowest water level. The lower spillway is similar but not so large. The idea is that by adjusting the stop logs to give an overflow of about 2 ft., a high surface velocity can be obtained in the neighborhood of the spillway, so that ice guided by properly located booms will escape.

The power house, at present nearly 700 ft. long, will ultimately be about 1,200 ft. long, and in order to avoid the necessity of passing ice or other material clear across the full width of the power house to the spillway, openings have been provided at suitable intervals to facilitate the removal of such material.

In order to fill the gap between the present construction and the north shore line, a rock-fill crib dam resting

*Abstract of paper read before the Electrical Section of the Canadian Society of Civil Engineers.

on solid rock was constructed. This will act as a coffer-dam when the power house is extended.

Equipment of Power House.—In the substructure, as constructed, provision was made for ten units, each of

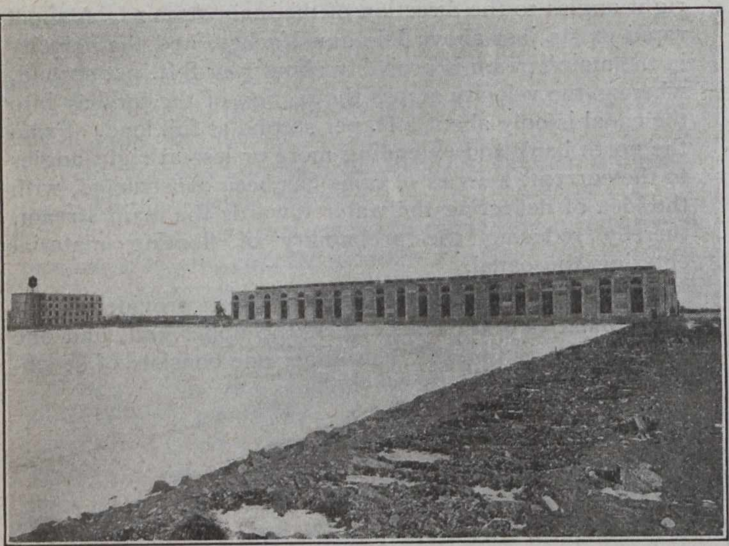


Fig. 2.

about 10,800 h.p., and three exciters or auxiliary units, each of 1,500 h.p.

Before the design could be developed completely, the type of thrust bearing to be used in case the vertical unit was chosen, had to be decided upon. Three types are in common use., *viz.*, the oil pressure bearing, the roller bearing, and the Kingsbury bearing.

The oil pressure bearing consists of a stationary and a rotating plate, between which an oil film is maintained by means of pumps.

The Kingsbury bearing, like the oil pressure bearing, depends upon the maintenance of an oil film between a rotating and a fixed surface. The latter, however, is not a continuous plate, but a number of sectors each supported independently and free to rock slightly. By this device the oil is entrained between the fixed and rotating plates on account of its viscosity, and a film established as soon as the machine has made a part of a revolution. When full speed is reached, the rotating part rises about one or two-thousandths of an inch on the oil film, and the friction loss is then very small, being much less than in roller bearings.

A weak point in the Kingsbury bearing is that when coming to rest or starting up, the oil film is squeezed out, so that the machine starts practically metal to metal. By using a very hard babbit, containing a high percentage of tin, and a carefully machined and scraped surface, no injurious results take place, and with due precautions in starting and stopping the machines, the results obtained have been very satisfactory.

Having adopted the Kingsbury bearing, it was decided to place the bearing on top of the machine, so as to make it accessible and reduce the thickness of concrete required under the machine. If a thrust bearing of any type had been placed between the water wheel and the generator, a tunnel would have been necessary to give access to the bearings, and the floor level of the power house would have been changed.

In order to carry the thrust bearing on the generator, cast-iron brackets were designed by the water wheel company with special regard to rigidity as well as strength, the former being a most important consideration in view of the necessity of having as little vibration as possible, the oil film being, as stated, only from 0.001 to 0.002 inch thick. See Figs. 2 and 3.

Main Units.—It may be of interest to state why a vertical unit was adopted instead of a horizontal one.

Up to the time when the Cedars plant was designed, I had advocated the horizontal unit under almost all conditions, on account of various difficulties with thrust bearings, and the operating experience which many companies have had with vertical units. Nearly all difficulties are attributable to one of two causes: (1) Difficulties with thrust bearings; (2) difficulties with the generator.

The great advantage of the horizontal unit is that both water-wheel and generator are much more accessible, and that repairs on burnt-out coils of the generator can be made in much less time than in the vertical unit. In case of serious repairs being required, a vertical machine may have to be dismantled to make is sufficiently accessible.

It was deemed advisable to adopt a unit of such size that the total number required for the full development of 160,000 h.p. would not exceed eighteen. Each machine is of 10,000 h.p., giving a total of 160,000 h.p., and two spare machines.

The diameter of a single runner to develop this amount of power is 17 ft. 7 ins., and it is evident that a runner of such size cannot be used horizontally when the total head is only about 30 ft. The adoption of a horizontal unit involved the use of at least four runners of smaller diameter. These would run at a considerably higher speed than a single runner, and thus a relatively cheaper generator might be used with them than with the

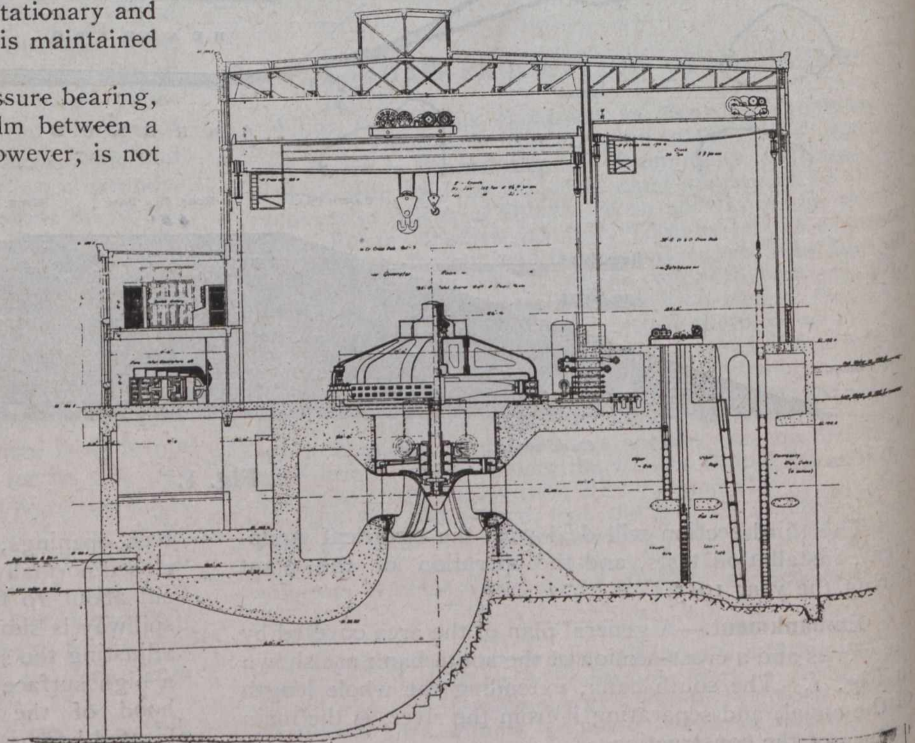


Fig. 3.

single runner. On the other hand, a much larger amount of concrete would be necessary for the water wheel chamber to accommodate four runners, and as the shafts would probably be over 100 ft. long, difficulties would arise in operating them successfully. It also appeared difficult to make a satisfactory design which would admit the water evenly to all four runners. The water wheel efficiency was also an important consideration in this plant where the amount of water is fixed, and it seemed evident that the vertical single wheel would have about 5 per cent. higher efficiency than the horizontal wheel.

An exhaustive study of these alternatives and the results, were so much in favor of the vertical single runner that this type was adopted.

Description of Main Units.—Each main unit consists of a single runner vertical wheel, supported on a thrust bearing carried on top of the generator. The runner is 17 ft. 7 ins. diameter (the largest yet constructed) and develops 10,800 h.p. under 30 ft. head when making 55.6 revolutions per minute. The generator was designed with a view to minimizing the labor required in making repairs. The details of the thrust bearing were designed by Mr. Kingsbury, and a year's successful operation of the bearings has proved the correctness of his work.

The shaft is a solid forging with a coupling at the lower end where it is bolted to the water-wheel runner. It is held in line by two guide bearings, one a babbited bearing immediately below the thrust bearing, and the other a lignum vitæ water lubricated bearing just above the water-wheel. The length of the shaft from the top to the coupling is 32 ft., the diameter in the lower guide bearings is 25 ins., in the upper guide bearing 24 ins., and in the hub of the generator 27 ins.

To provide support, and to guide the water in the proper direction, a cast-iron speed ring was placed just outside the movable guide vanes controlling the amount of water admitted to the wheel, and in some respects the use of this speed ring is unique in this plant. The weight of the rotating parts is carried through the bridge on top of the generator and through the generator frame itself, to cast-iron pit liners, which transmit the load through the speed ring directly to the concrete foundations of the power house. The usual design provides an arch above the runner, which carries the load to piers on each side of the draft tube, instead of distributing it as above.

The control of the water is effected by the usual type of movable vanes. The cranks and links are situated in the wheel pit, above water, so as to be easily accessible, and are operated by two trunk piston engines connected to the rotating ring at points 180° apart.

The dimensions of all the main turbines are the same, and the total weight of the revolving system is 550,000 lbs. in each unit.

A special 300-ton jack was provided for dismantling the unit and for making the fine adjustments necessary in erection, the large cranes being unsuitable for such a purpose.

The jack can be arranged so as to lift the weight from the thrust bearing, and transmit it to the foundations through the cast-iron bridge over the generator as described above. By this means the deflection of this bridge is unaltered, and minute adjustments can be made in the mechanism of the thrust bearing, as the screw of the jack can be moved through any small amount desired.

By coupling the jack to the top of the shaft the weight can be raised so as to allow the thrust bearing to be removed. The weight can then be lowered about an inch until the rim of the generator rests on six blocks. After loosening the generator hub from the shaft, the water-wheel runner can be lowered about an inch more until it rests on a stationary base ring embedded in the concrete. The generator rotor can then be removed, the shaft can be disconnected from the runner, and the runner itself can be removed if necessary.

The arrangement proved of considerable use, particularly in view of the difficulty of making fine adjustments with the cranes.

Governor System.—The governor system was supplied by the I. P. Morris Company and operates by what is known as the open system.

The following regulation was guaranteed with the governors:—

Load change.	Speed change. Load off to zero load.	Speed change. Load on from zero load.
10%	2%	2%
25%	5%	5.25%
50%	11%	11.5%
100%	27%	30.5%

For supplying air to the governor accumulator tanks, two air compressors each delivering 50 cu. ft. of free air per minute were installed.

General Features and Design.—In the choice and arrangement of the auxiliary machinery facility of maintenance and operation were specially considered. All the auxiliary apparatus was therefore located on practically the same level as the main units, so as to be in sight of the men operating the main units. No machinery vital to the operation of the plant is located on lower levels or in tunnels.

FOURTH CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS—APRIL 10-14, 1917.

The prospects for the success of the Fourth Canadian and International Good Roads Congress, to be held under the auspices of the Dominion Good Roads Association in the Horticultural Building, Ottawa, from Tuesday, April 10th to 14th, inclusive, are very bright.

An interesting programme is being prepared and it is expected that papers and addresses by highway engineering experts will be presented, while road builders from all parts of Canada and the United States will be present and take part in the discussions. Profiting by the experience of the past, it is the intention to have the different lecturers and speakers simplify their deliverances as much as possible so that the layman can more readily understand what is meant.

As usual, there will be an exhibition of road machinery. Canadian and United States manufacturers of road machinery have announced their intention of placing on view a full line of their products.

The Dominion Good Roads Association, desirous of obtaining greater legal powers and of broadening its scope and increasing its usefulness, will present a bill before the adjourned session of parliament, asking for Dominion incorporation. The details of this bill, as well as the new constitution and by-laws, will be explained to the delegates, who will be asked to ratify the measures taken by the executive. The constitution will follow the general lines adopted by similar organizations in the United States, with such modifications as are suggested by local conditions.

DEFINITION OF TERMS USED IN SEWERAGE AND SEWAGE DISPOSAL PRACTICE.

THE Committee of Sewerage and Sewage Disposal of the Sanitary Engineering Section of the American Public Health Association at the last annual meeting of the association, submitted a report defining the terms used in sewerage and sewage disposal practice. The report was tentative and was submitted with the hope that it would bring out a full discussion of the subject. It is the purpose of the committee to amend these definitions in accordance with the weight which may be given in the discussions, with the view of establishing terms that may be generally acceptable to all engaged, or interested, in work of this character.

The suggested definitions follow:—

Sewage is the spent water supply containing the wastes from domestic, industrial or commercial use, including such surface and ground water as may enter the sewer.

Domestic sewage is that discharged from residences or institutions, and contains water-closet, laundry and kitchen wastes.

[1]Industrial wastes are the liquid wastes resulting from the processes employed in industrial establishments.

Street wash is the liquid flowing on and from the street surface.

Surface water is that portion of the precipitation which runs off over the surface of the ground.

Storm water is that portion of the precipitation which runs off over the surface of the ground during a storm and for such a short period following a storm as the flow exceeds the normal or ordinary run-off.

Ground water is that which is standing in, or passing through, the ground.

Drain is a conduit intended to carry storm, surface and ground water.

Sewer is a conduit for carrying sewage.

Common sewer is a sewer in which all abuttors have equal rights of entrance and use.

House connection is a pipe leading from a building to a common sewer.

Lateral sewer is a sewer which does not receive the sewage from any other common sewer.

[2]Submain or branch sewer is a sewer into which the sewage from two or more lateral sewers is discharged.

Main or trunk sewer is a sewer into which the sewage from two or more submain or branch sewers is discharged.

[3]Separate sewer is a sewer which is intended to receive only sewage and not storm or surface water.

Combined sewer is a sewer intended to receive both sewage and storm and surface water.

Intercepting sewer is a sewer generally laid transversely to the general sewer system to intercept all the sewage collected by the sewers of a separate system or the dry-weather flow of sewage, and such additional storm and surface water as may be determined, from a combined system.

Relief sewer is a sewer intended to carry a portion of the flow from a district already provided with sewers of insufficient capacity, and thus prevent overtaxing the latter.

[1]In the opinion of the committee the term "Industrial Wastes" is preferable to "Trade Wastes."

[2]The committee is of the opinion that preference should be given to the term "Submain Sewer" rather than to "Branch Sewer.'

[3]In the opinion of the committee the use of the term "Separate Sewer" is preferable to "Sanitary Sewer," which latter term should be discontinued.

Sewer system is the collecting system of sewers and appurtenances, together with such small pumping stations as may be required to lift the sewage from low-level districts.

Combined system is a system of combined sewers.

Separate system is a system of separate sewers.

Sewerage works comprise the sewer system, main pumping stations, treatment works, means of disposal of effluent and sludge, and all other works necessary to the complete collection, treatment and disposal of the sewage.

Manhole is a shaft, or chamber, leading from the surface of the ground to the sewer, large enough to enable a man to gain access to the latter.

Lamphole is a small vertical pipe or shaft leading from the surface of the ground to the sewer, for admitting a lantern or reflected light for purposes of inspection.

Wellhole or drop manhole is a vertical shaft in which sewage is allowed to fall from one sewer to another at a lower level.

Inlet is a direct connection between the surface of the ground and the sewer, for the admission of surface or storm water.

Catch basin is a chamber inserted in an inlet to prevent the admission of grit and other coarse material into the sewer.

Flush tank is a tank in which water or sewage is accumulated, to be quickly discharged later, for the purpose of flushing the sewer.

Regulator is a device for controlling the quantity of sewage admitted to an intercepting sewer.

Outlet is the end of a sewer or drain from which its contents are finally discharged.

Storm overflow is a weir or orifice for permitting the discharge from a combined sewer of that portion of the storm flow in excess of that which the sewer is intended to carry.

Sewage disposal is a generic term applied to the act of disposing of sewage matter by any method.

[4]Sewage treatment is the process to which sewage is subjected in order to partially remove its impurities and render it fit for final discharge.

Contamination is the introduction into a water of bacteria or other substances which tend to render it unsuitable for domestic use.

Pollution is the introduction into a water of substances of such character and in such quantity that they tend to render the body of water or river objectionable in appearance, or to cause it to give off objectionable odors.

Influent in sewage practice is a term which applies to sewage that flows into any sewage treatment device.

Effluent in sewage practice is a term which applies to sewage that flows out of any sewage treatment device.

Putrescibility is the capability of sewage, effluent, or wet sludge, to putrefy under the conditions to which it is subjected.

Stability is the capability of sewage or effluent to resist putrefaction under conditions to which it is subjected.

Relative stability is the ratio of available oxygen to the oxygen required to prevent putrefaction, expressed in per cent.

Clarification is the removal of the suspended and colloidal matters.

Suspended solids are the solids, both organic and inorganic, that are not held in solution in a sewage or effluent; these solids being quantitatively determined in the laboratory by retention on filter paper.

[4]The term "Sewage Purification" should be abandoned.

Settling solids are those suspended matters which will subside in quiescent sewage in any specified length of time.

Colloidal matter is suspended matter which is so finely divided that it is no longer acted on by gravity, and remains suspended indefinitely, yet will not pass through a parchment membrane in the ordinary process of dialysis.

Screens.—A screen is a device containing openings of proper size to retain a part of the suspended matter of sewage.

Coarse screen is one having openings in excess of ½ in. in least dimension.

Fine screen is one having openings of ½ in., or less, in least dimension.

Bar screen is one composed of parallel bars or rods.

Mesh screen is one composed of a fabric, usually of wire.

Grating.—A grating consists of two sets of parallel bars in the same plans, the sets intersecting at right angles.

Perforated plate screen is one made of perforated plates.

Band screen is one consisting of an endless band or belt which passes over upper and lower rollers.

Wing screen is one having vanes, uniformly spaced, which rotate on a horizontal axis.

Drum screen is one in the form of a cylinder or cone, consisting of perforated plates or a wire mesh which rotates on a horizontal axis.

Disc screen consists of a rotating circular perforated disc, with or without a central truncated cone of similar material mounted on the centre.

Cage screen consists of a cage having three sides made of parallel bars or rods, so arranged that it may be lowered into the sewage, and raised therefrom for cleaning.

Tank treatment is the detention of sewage or sewage sludge in tanks, either quiescent or with continuous flow.

Grit chamber is a chamber or enlarged channel in which the cross-section of sewage flow is so designed that the velocity is such that only heavy solids, such as grit and sand, are deposited, while the lighter organic solids are carried forward in suspension.

Sedimentation tank is a tank for the removal of suspended matter either by quiescent settlement or by continuous flow at such a velocity and time of retention as to allow deposition of suspended matter.

Dortmund tank is a vertical sedimentation tank, usually cylindrical, in which the raw or partially treated sewage enters the lower part, flows upward and passes out near the top. The sludge is drawn before it becomes septic from the conical or hopper-shaped bottom.

Hydrolytic tank is a tank in which by biological processes a portion of the suspended matter is converted into liquid and gaseous form.

"Septic" tank is a horizontal, continuous-flow, one-story sedimentation tank through which sewage is allowed to flow slowly, to permit suspended matter to settle to the bottom, where it is retained until anaerobic decomposition is established, resulting in the changing of some of the suspended organic matter into liquid and gaseous substances and a consequent reduction in the quantity of sludge to be disposed of.

Travis tank is a 2-story tank consisting of an upper, or sedimentation, chamber, with steeply sloping bottom, terminating in one or more slots through which the solids may slide as deposited into the sewer or sludge digestion chamber, through which a predetermined portion of the sewage is allowed to pass for the purpose of seeding and maintaining bacterial life in the sludge and carrying away decomposition products, thus inducing digestion of the sludge attended by its reduction in volume.

Imhoff or Emscher tank is a 2-story tank consisting of an upper, or sedimentation, chamber, with steeply sloping bottom, terminating in one or more slots through which the solids may slide as deposited into the lower or sludge digestion chamber—these slots being trapped so as to prevent the rise of gas and solids from the lower chamber—the lower chamber being provided with vents for the escape of the gases, the tank being so constructed as to facilitate the passage of the sewage quickly through the upper chamber and prevent the flow of sewage through the digestion chamber, and so operated that the sludge may be thoroughly decomposed, rendered practically free from offensive odor and so filled with gas that it can be readily drawn off and dried.

Activated sludge process consists in the agitation of a mixture of sewage with about 15 per cent. or more of its volume of bacterially active liquid sludge in the presence of ample atmospheric oxygen for a sufficient period of time to at least coagulate a large proportion of the colloidal substances, followed by sedimentation adequate for the subsidence of the sludge flocculi; the activated sludge having been previously produced by aeration of successive portions of sewage and maintained in its active condition by adequate aeration by itself or in contact with sewage.

Chemical precipitation consists in adding to and thoroughly mixing with the sewage such chemicals as will, by reaction with each other or with the ingredients of the sewage, produce a flocculent precipitant and subsequent sedimentation.

Sludge is the suspended matter of the sewage deposited in tanks or intercepted at the surface of filters, mixed with more or less water.

Sludge digestion is the biological process by which organic matter in sludge is gasified, liquefied, mineralized or converted into stable organic matter.

Separate sludge digestion is the digestion of sludge in tanks entirely independent from the tanks in which it is produced.

Sludge drying bed is a natural or artificial layer of porous material upon which sludge is dried by drainage and evaporation.

Sludge concentration is the process of reducing the volume of sludge and increasing its proportion of solids by allowing it to stand in a suitable tank until the solids settle down and drawing off the relatively clean water at the top.

Sludge drying is the process of drying sludge by natural or artificial heat.

Sludge dewatering is the process of removing a portion of the water contained in the sludge by draining, pressing, centrifuging or by other natural or mechanical processes.

Sludge pressing is the process of dewatering by the exertion of pressure, the solids being retained by a cloth fabric which permits the water to pass through it.

Sludge cake is the mass of dewatered sludge resulting from sludge pressing.

Scum is a floating mass of sewage solids buoyed up in part by entrained gas or grease, forming a greasy mat which remains on the surface of the sewage.

Screenings constitute the material removed from sewage by screens.

Grit is the heavy mineral matter deposited from sewage.

Sleek is the oily film of microscopic thickness present on the surface of waters about and often extending a considerable distance from sewer outlets.

Sewage oxidation is the process whereby through the agency of bacteria, in the presence of air, the organic matter is converted to a more stable condition or into mineral matter.

Irrigation is the generic term applied to the process of sewage treatment in which the sewage is applied to land for the primary purpose of purifying the sewage and the secondary purposes of supplying water and fertilizer to crops.

Surface irrigation is the process in which sewage is applied to and distributed over the surface of cropped ground.

Subsurface irrigation is the process in which sewage is distributed beneath the surface of the ground by means of open-jointed pipes.

Sewage farm is an area of land on which crops are raised and to which sewage is applied on or beneath the surface of the soil and is absorbed by vegetation, evaporates or percolates to the ground water.

Intermittent filter is a natural or artificial bed of sand or other fine-grained material to which sewage is intermittently applied in doses, and which by its capillarity holds the sewage for a time sufficiently long, in the presence of air, to effect by biological processes a high degree of purification.

Contact bed is a water-tight basin filled with coarse material, such as broken stone, in contact with which the sewage is for a time held by control of the underdrains—the cycle of operation involving periods of filling, standing full, emptying and resting empty—so regulated as to secure such contact with the bacterial films adhering to the surface of the coarse material, and such aeration of the bacterial surfaces as may be required to oxidize the sewage.

Slate bed is a tank filled with slabs of slate or other similar material, laid horizontally and spaced an inch or more apart vertically, equipped so that it may be filled with sewage, allowed to stand full for a definite period of time, drained and allowed to stand empty for a time, for the purpose of oxidizing the organic matter deposited upon and adhering to the slates.

Trickling filter is an artificial bed of coarse material, such as crushed stone or clinkers, over which the sewage is distributed as a spray from fixed nozzles or as a film from moving distributors, through which it trickles to the underdrain system, coming in contact with the bacterial films adhering to the surface of the stones, and in which such aeration of the bacterial surfaces as may be required to oxidize the sewage is afforded.

Dosing apparatus is the apparatus used for regulating the application of sewage to filters or for applying the required quantity of chemicals to sewage.

Sprinkler nozzle is a nozzle used for applying sewage in the form of a spray to trickling filters.

Distributor is a movable pipe or channel which distributes sewage upon the surface of a trickling filter. There are two types of distributors—the rotary and the travelling; the rotary moves about a central axis with delivery to a circular filter; the travelling moves back and forth the length of a rectangular filter.

Dosing tank is a tank into which raw or partially treated sewage is introduced and held until the desired quantity has been accumulated, and then discharged at such a rate as is necessary for the distribution essential to the subsequent treatment.

Disinfection is the destruction by the agency of some chemical, of a large percentage of the bacteria in sewage or contaminated water, so as to reduce the danger of infection to a negligible quantity.

Sterilization is the destruction, by the agency of some chemical, of all the bacteria in sewage or contaminated water, including their spores.

Nuisance (in relation to a polluted stream) is a condition which is offensive to the sense of sight or smell.

A clean river in regard to sewage is one which gives no sensuous evidence of sewage pollution and from which a wholesome drinking water can be obtained by practicable methods of water purification.

PEAT AND ITS UTILIZATION.

By R. O. Wynne-Roberts.

It is somewhat remarkable that whilst Canada has experienced considerable difficulty in obtaining coal from the United States, we have great deposits of peat waiting to be utilized. This anomalous situation is doubtless due to our intimate acquaintance with coal and to the absence of practical experience with peat. Peat is used as domestic fuel and for the generation of power on a large scale in Russia and in a smaller measure in Norway, Denmark, Germany, Italy, Ireland and other countries. As stated by Mr. B. F. Haanel, B.Sc., whose report on "Peat, Lignite and Coal," published in 1914, will be freely quoted, "The problem which confronts Canada is not conservation, but the best means of rendering available the various supplies of low-grade fuels. The great coal measures of Canada are situated in the extreme east and west; but, lying between these points is a vast territory devoid of coal measures, which is, at the present time, dependent on some foreign source for a fuel supply. In one sense conservation is being practised to a very high degree, because, in certain parts of the country, practically all the coal required for industrial and domestic purposes is being imported from the United States, while valuable fuel deposits are lying practically intact. But this kind of conservation never leads to commercial or industrial prosperity, and cannot, therefore, be recommended."

Many of the peat bogs, which are peculiarly adapted for manufacture into fuel for domestic and power purposes, are conveniently situated as regards transportation facilities and contiguous industrial communities.

The peat bogs which have been investigated in Ontario are estimated to produce, roughly, about 65 million tons, with 25 per cent. moisture; Quebec, about 40 million tons; Manitoba, about two million tons. The lignite beds of the Prairie Provinces, according to Mr. D. B. Dawling, are capable of yielding about 100 million tons for one thousand years, but at present the quantity mined is insignificant compared with the immense deposits that are available. The economic results of importing coal and exporting our money need not be discussed here, but it is evident that if our peat and lignite fuels were utilized in a scientific manner and on an adequate scale much anxiety, discomfort and loss due to the severity of the weather and the difficulty of obtaining imported coal would have been minimized.

Each class of fuel must, of course, be used in a particular manner if the best results are to be secured, and peat requires special attention, because in its natural condition it contains approximately 90 per cent. of water. When the bog is thoroughly drained the moisture content may be reduced to 88 per cent. Mixing with dry peat or hay and pressing, the percentage of water can be reduced to 70 to 75 per cent., two pressings to 53 per cent., and by subsequent drying to 25 or 30 per cent. The degree to which peat has been humified has a considerable effect on the facility of extracting the water. Peat of recent deposit is more fibrous than the older beds, and water can be pressed out readily, but when humification has been carried to great extent hydrocellulose or gelatinous substance is present, and this absorbs water and increases in bulk until it has the consistency of soft soap. Well-humified peat, which has been thoroughly pulped and repulped, has the appearance, when dry, of a high-class lignite. It has a very fine texture, is hard and dense, and offers considerable resistance to breaking. The separation of the water from the peat has occupied the attention of many, and the data that is available is interesting information to those who are associated with the question of sewage sludge disposal, because the difficulties encountered are much alike.

Owing to the fact that peat is a low-grade fuel, which must be manufactured and sold at a comparatively low cost if it is desired that it should serve as a substitute for coal, or even when it is used in gas producers, the process of excavation, pulping, drying, and so on, must be arranged in such a way that the cost of labor and power is kept as low as possible. If peat can be manufactured successfully in Russia, Germany, Norway and Denmark, where the climatic conditions are not so favorable as those obtaining in Canada, it is within reason to assume that an even greater degree of success could be realized in this country.

The most promising way of utilizing peat is by gasification in gas producers and the recovery of the nitrogen. The total quantity of gas having a calorific value of about 140 B.t.u. per cubic foot is estimated at 90,000 cubic feet per ton of 2,000 lbs. of absolutely dry peat, or, say, 67,500 cubic feet from peat containing 25 per cent. of moisture. If 12,000 B.t.u. are allowed per b.h.p. hour, each ton of moist peat will give approximately 787.5 b.h.p. hours, of which about 75 per cent. will be available for power, that is, 590 b.h.p. hours. As already stated, there are about 65,000,000 tons of peat in Ontario, and the potential power of this fuel if utilized in this manner will be, roughly, 4,570,000 brake horsepower years, which would furnish 45,700 horse-power for 350 days per year for 100 years, so that Ontario has a valuable source and asset which is waiting to be utilized. But this is not all. The average percentage of nitrogen content in the peat beds which have been investigated is about two—it ranges from 1.26 to 2.77 per cent. If the efficiency of ammonia recovery process is assumed to be 70 per cent., the quantity of sulphate of ammonia from 2 per cent. nitrogen content will be about 100 pounds per ton of peat containing 25 per cent. moisture; consequently, the Ontario peat bogs are capable of yielding, through the agency of recovery gas producers, about 6,500 million pounds, or 3.25 million tons, of sulphate of ammonia. Spreading this over 100 years equals 32,500 tons per annum. This sells at present at about $70 per ton, but we will suppose, for the purpose of arriving at a conservative estimate, $60 per ton. Furthermore, let the value of energy be placed at $12 per b.h.p. per annum. Ontario alone possesses a potential gross annual income of:—

Gas power, 45,700 h.p. at $12............	$ 548,400
Sulphate ammonia, 32,500 tons at $60	1,950,000
	$2,498,400

It will, of course, be necessary to pay for the cost of producing the power and sulphate, but it is not pertinent to the object of this article, which is to show that Ontario has a valuable asset in the peat beds, and what applies to Ontario is applicable to the other provinces. Saskatchewan, Manitoba and Alberta have vast areas of lignite which can be utilized, and these also constitute a most valuable natural resource that awaits utilization.

The gas may be used for many purposes—for driving gas-engines, raising steam, industrial processes, domestic heating, etc. As Ontario has a comprehensive hydro-electric system, it is manifest that peat can be used for the development of power only where hydro-electricity is not available at equal cost, but the production of gas will, doubtless, be utilized for other purposes. With regard to ammonium sulphate, it may be stated that it is used in immense quantities as fertilizer, and the bulk of it is derived as a by-product of the destructive distillation of coal. Dr. Lunge, in his fifth edition of "Coal Tar and Ammonia," states that "Synthetical production of ammonia from atmospheric nitrogen must find its limits in the impossibility of producing the requisite enormous amount of electrical energy, whether by water-power or otherwise. The principle source of ammonia will be always the nitrogen of coal," which will include peat and lignite. In 1915 Canada imported $1,087,000 worth of fertilizers of different classes, and, as the soil is reduced in fertility, due to gradual exhaustion, more fertilizers will be necessary. Peat and lignite, therefore, afford excellent local sources for the supply of ammonium sulphate. The following table will show what results are obtained by the use of this class of fertilizer:—

Country.	Sulphate of Ammonia per Acre. Lbs.	Total Crops Raised per Acre. Wheat. Lbs.	Barley. Lbs.	Oats. Lbs.	Potatoes. Tons.
Belgium	17.83	2,228	1,908	2,572	6.58
Germany	9.98	2,012	1,400	1,586	5.25
England	5.35	1,756	....	1,591	5.05
France	2.23	1,238	908	1,154	3.18
United States..	1.34	....	....	....	....

Sulphate of ammonia is especially valuable for the cultivation of beet-root. Its action is slower than that of nitrate of soda, but for that reason it is all the more lasting. It is absorbed by the soil and retained even after heavy rainfalls, whereas nitrate of soda is stated to be washed out. Sulphate of ammonia serves for preparing other ammonium salts, sometimes for liquor ammonia, for making ammonia-alum. A 10 per cent. solution of sulphate of ammonia is employed to render tissues, papers, etc., non-inflammable.

There are several gas-producers which give excellent results. The Mond type has been used in connection with peat in Italy and Germany. The Lymn producer is now taking a prominent position and is highly spoken of.

According to Mr. Haanel, it would be unprofitable to utilize peat for producer gas and the recovery of the ammonia unless the quantity of nitrogen is at least 1.5 per cent. of the dry sample. Fortunately, there are several peat bogs which have been investigated having a higher nitrogen content than 1.5 per cent.

In closing this article the Holland peat bog may be referred to. It is only 42 miles from Toronto, and has an area of about 5,000 acres. The quantity of peat fuel containing 25 per cent. moisture is estimated at 8,218,000 tons, and the nitrogen content is about 2.67 per cent., based on dry sample, or about 2 per cent. based on 25 per cent. moisture standard. The calorific value of this peat (dried) is about 8,510 B.t.u. per pound. Mr. Haanel estimated the total yield of ammonium sulphate at about 507,500 tons, and, assuming 120 tons of theoretically dry peat were consumed per 24 hours, the bog would last for about 147 years. The power gas available would be sufficient to develop about 4,000 h.p. continuously for the above period.

Peat is also used as litter, possessing antiseptic properties and a capacity for absorbing nitrogenous organic matter. It is used in Germany in connection with sewage from pail closets, also for packing fruit, vegetables, etc. It may be used for insulating icehouses and steam pipes. Prof. Bottomley has succeeded in bacterizing peat, in which form it is found to be an excellent fertilizer, whilst the French make paper and cardboard from peat which has undergone but slight decomposition.

FROM CONCEPTION TO COMPLETION—THE WESTERN RAILROAD.*

By J. H. de Stein, M.C.S.C.E.

THE last few years have brought a considerable increase in railway mileage in Canada. The total of steam railway trackage in September, 1907, was about 21,800 miles, while in June, 1915, we had about 35,600 miles under operation.

Let us analyze the making of a railroad, and start with the first part of the title chosen for this paper. This demands in most cases the genius and brains of a "builder," of which creative species we fortunately had, and still have, several representatives in our Dominion.

Military reasons might demand the construction of a road, but, fortunately, we have none of these "strategical railroads," so much in vogue in the Central European empires. I would only refer to the customary procedure there, where the route plans for any railroad have to be approved by the military authorities before construction can start.

We can now summarize and classify the various lines, which classification is necessary before location and construction can proceed, as the various classes demand different treatment.

We have, first, the main line, which in itself is a completed unit. In this respect we are slightly spoiled in Canada. With our three great transcontinental systems we might think that a main line has to be several thousand miles long. None of the railway systems on this continent, outside of Canada, have a line from coast to coast—except, perhaps, the Panama Railway—and yet, of course, every system has its one or several main lines.

I would distinguish two classes of main lines. The main line of the first order, the trunk line, which is built for international or world traffic. It has its strict limitations as to grades and curvature, figuring on a quick through traffic. It can—in a settled country—neglect to touch larger towns, etc., having only one object: to gain its ultimate destination with as short a route as possible. The original survey of the main line of the Grand Trunk Pacific left settlements like Brandon, Yorkton, Regina, Saskatoon, Battleford, etc., many miles from its course. Subsequently the route was changed, bringing the line within short distance of Saskatoon. This was certainly a concession to local conditions entirely unwarranted with the original conception of a trunk line.

The main line of the second order has to consider local conditions to a larger extent. Grades and curvature can be increased, the expenditure per mile being much lower than in the former class. Length of line can be sacrificed in order to touch existing settlements, industrial properties, etc.

The second main classification comprises the various branch lines. The branch lines, by connecting cities and large settlements with a main line, ensures a considerable traffic right from the very commencement of operations

A less important class of branch lines would be one extending from some main line or branch line point to a farming, mining or timbering district without aiming for any particular point, just picking the easiest route and building as cheaply as possible.

As a rule—taking conditions as they are in the Canadian West—the settlement exists ahead of the contemplated branch line, and traffic in proportion to the expenditure can be expected right after completion of the road, though, of course, settlers will follow the railroad and by increasing the traffic and subsequently the earnings, will warrant some annual capital expenditure on betterments of the originally cheaply constructed line.

After this preliminary classification we are coming to the more concrete part of our theme: the survey, which I would group into two main parts: the financial and engineering survey.

Teachers of economics tell us that the ideal railroad would be a Government-owned line, built and operated strictly as a public utility; that is, the revenue merely pays for the operating expenses, while interest on the cost of construction and maintenance charges would have to be covered from public funds. A more modified view allows for operating and maintenance expenses to be covered from the gross revenue, while the third and commonly adopted standpoint sees in the contemplated road only a source of revenue, which, popularly speaking, centres around the question, how little money will have to be spent to get the biggest revenue from operation.

The estimate of the future prospects of the railroad seems sometimes to be treated too slightly, or we might better say, too optimistically. When I say optimistically, I do not necessarily mean that some line in question should not have been built, but that perhaps the anticipated traffic exceeds considerably the actual one; that is, the road has been built too expensively from the start.

In a new country like our West, a financial survey is very difficult and uncertain, which, perhaps, excuses to some extent the recent financial difficulties of some of our roads.

In nearly all of the older settled countries the engineer has an array of data at his disposition, while in Canada we have not had time yet to collect these.

There should be four main factors brought into consideration:—

*Abstract of paper read before the Regina Branch of the Canadian Society of Civil Engineers.

(1) Estimate of anticipated traffic.
(2) Calculation of revenue thereof.
(3) Estimate of operating expenses.
(4) Calculation of necessary capital for construction and operation.

The estimate of anticipated traffic is mostly a matter of statistics. The first reliable and simple tables were compiled by the French engineer Michel, and published in the "Annales des Ponts et Chaussées" in 1868. He concluded quite naturally that passenger and freight traffic are a function of the number of inhabitants of the tributary district, considering to some extent their mode of occupation.

While this may be tabulated and compiled in Europe and the eastern and southern part of our continent, yet it is doubtful if it would bring satisfactory results in Western Canada. Generally, of course, in our time, the settler is ahead of the railroad, but the settlement intensifies with the advent of the track, production becomes greater with easier accessibility to the markets, which all affects the traffic. Then, again, unfortunately in several large portions of our West, the population depends entirely upon the production of one commodity—for instance, grain growing. One or two successive crop failures in a district served by some railroad mean practically no outgoing and very little incoming freight.

It would be interesting, however, to compile a statement for each railroad, giving the passenger and freight traffic in tons per capita in every one of our Western provinces.

On the basis of probable volume of traffic an estimate of the revenue thereof can be made. I have some figures before me, compiled some time ago in the United States. I note that the gross revenue per head of population amounts to about $13 in the populated Eastern States and only $5 in the Southern States. Of considerable value in this respect are the tables compiled annually by the Department of Railways and Canals of Canada.

Lastly, we have to estimate the operating expenses and the necessary capital for construction and operation, which calculations can only be done conjointly with the locating engineer, except, of course, in old settled districts, where, perhaps, a new short route between two larger centres is contemplated, allowing a fairly accurate preliminary estimate of aforementioned financial points without previous or simultaneous engineering work.

Of course, a large amount of operating expenses are fixed charges, independent of the survey of the road, but it is the duty of the engineer to find a line which will keep operating expenses down to a minimum without sacrificing revenue.

SWISS RAILWAY ELECTRIFICATION.

The electrification of 67 miles of the St. Gothard line of the Swiss State Railways, now in progress, is the first step in a project ultimately to operate all the federal-owned lines in that country, aggregating nearly 2,000 miles, by electric power. The single-phase a. c. system, as is now operating on the Lötschberg line, is to be used on this and future electrifications, the commission in charge having decided that it is the only system worthy of serious consideration for a project of such magnitude. While all the usual benefits are expected to accrue from the improvement, the principal item is the economy of utilizing the immense water power resources of the Alps, thereby making the railroads independent of expensive imported fuel, there being no coal mined in Switzerland.

METHOD AND COST OF PLANE TABLE SURVEYS FOR AN IRRIGATION PROJECT.

The cost of plane tabling for an irrigation project in Alberta, Canada, was, according to a recently issued report, approximately 10 cents per acre. The work was carried out in 1915 on the Lethbridge Northern irrigation project by engineers of the Irrigation Branch of the Department of the Interior of Canada.

A party of three plane-tables was organized in Lethbridge and consisted of the following men: Field engineer in charge of party, three assistant engineers, one draughtsman, six rodmen, three teamsters and one cook, with a camp and transport equipment of 8 tents, 2 wagons, 3 democrats and 10 horses.

This party commenced field work on April 29, and finished for the season on November 22, 1915, a period of 179 working days, covering 119,015 acres of topography, which is an average rate of 221 acres per plane-table day. No account was taken of a total of 25 working days which were lost during the season on account of bad weather.

A second party of three plane-tables was put on this work in September. This party commenced plane-tabling on September 17 and finished for the season on November 19, a period of 55 working days, covering 30,500 acres of topography at an average rate of 185 acres per plane-table day.

A total area of 149,515 acres was contoured during the season and in addition 315 miles of levels were run, setting bench-marks for the plane-table work.

The total cost of surveys for the season of 1915 was as follows:—

Wages of party for the field season	$ 8,852.31
Commissary (subsistence, fuel and cook's wages)	2,918.56
Horses (hay, oats and supplies)	619.00
Miscellaneous	625.03
Draftsman (4 months extra to finish plans)...	300.00
Total cost	$13,314.90
Total area plane-tabled, acres	149,515
Cost per acre, cents	8.9

Allowing a depreciation on outfit of $1,500 for the season, the cost per acre plane-tabled would be approximately 10 cents.

Each plane-table party consisted of an assistant engineer, two rodmen and teamster, the teamster acting as recorder to the instrumentman. The scale of the plans was 400 ft. to 1 in., allowing one section to be shown on each plan. Beginning with a measured base line at least 1,200 ft. long, a closed plane-table survey was made of each section. The limit of error of closure allowed was 1/20 in. in plan, which at the scale used equals 20 ft. The limit of error for plane-table levels on each section was 2/10. All plane-table stations were set by triangulation from the base line, as were also all mounds.

The greater part of the work was done by taking spot levels, over the whole area, at distances apart varying from 100 to 400 ft., depending on the roughness of the land. The contours were then sketched on the plans in the field by interpolation In giving the spot levels, care was taken to outline all sinks, knolls, drainage lines and saddle. All buildings, houses and fences were noted, also the character of the soil and the name of the owner of each parcel of land.

LETTER TO THE EDITOR.

Stone-Filled Sheet Asphalt.

Sir,—We read with interest an article on "Stone-filled Sheet Asphalt," by Charles A. Mullen, in your number of 15th instant.

Mr. Mullen makes some very broad claims as to the advantages of stone-filled asphalt, and naturally we take note of them. The advantages claimed are: (1) that it is less slippery; (2) that it marks up less in the summer; (3) it is easier of traction in the summer; (4) it is less liable to displacement; (5) it costs less.

First, as to slipperiness. That can be scarcely more than a matter of opinion. In an earlier part of the article we find the statement made that "this initial roughness passes away after one or two summers' traffic, and leaves a surface almost as smooth as that of the usual sheet asphalt." The lack of slip depends on friction combined with a relationship between the two surfaces concerned; that is, the tendency of one to seize the other. It is frequently controlled by the interposition of a third element. In roads, the third element may be water, ice or snow. Horses slip badly on granite blocks if the load behind is greater than the weight of the horse. The slight marking of a good asphalt pavement is really a desirable feature for horse-drawn vehicles, as the small amount of penetration enables the horse to use his strength with some help from the surface. Stone filling with 30 per cent. of ¼-inch chips seems unlikely to make much difference in slip on dry, bare and cold pavements. When ice and snow are present, differences of composition are not operative factors.

With reference to marking up, we have seen ordinary sheet asphalt pavements that marked up very little, and others that marked up a good deal. This condition, we always believed, was controlled by the filler and the penetration of the bitumen. In this climate we would hesitate to lay, in residential districts, a pavement that did not mark up quite noticeably in the summer.

The claim of ease of traction is, of course, dependent on the first two considerations.

The liability to displacement is important, and we certainly have seen some bad cases due to faulty binder course. We feel inclined to go so far as to say that a pavement laid badly with binder course is inferior in this respect to a stone-filled asphalt laid by the same personnel.

And now we come to the big point: it costs less. Mr. Mullen gives some very convincing figures, showing that two inches of surface mixture costs more per square yard than two inches of stone-filled sheet asphalt. What about the binder course? If, instead of two inches of surface mixture, we had one inch of close binder and one inch of surface mixture (which is quite sufficient) we could make the following comparison:—

	Ordinary sheet asphalt.		Stone-filled sheet asphalt.	
	Lbs.	Cost.	Lbs.	Cost.
Asphalt cement at $.01 per lb.	17	$.17	20	$.20
Filler at $.0025	20	$.050	20	$.050
Graded sand at $.0005	68	$.034	100	$.050
Clean stone chips at $.0008 ..	none		60	$.048
Crushed stone, 20-mesh to ¾ in., at $.0005	95	$.047	none	
	200	$.301	200	$.348

According to Richardson, the binder course was probably introduced to protect the friable, natural cement from the necessary traffic incidental to laying the wearing surface, but it is apparent that the introduction of the binder course was quite a considerable economy. The open binder, taking less bitumen, is even less expensive, and would do well for light traffic in residential districts. A large amount of sheet asphalt with open binder course has been used in pavements under heavy traffic.

On the whole, we cannot see that Mr. Mullen has proved for stone-filled sheet asphalt that "its actual cost is so low that it is the most economical pavement for light residential streets and boulevards. It should, therefore, be adopted by most cities as the standard form of pavement. . . ." Why should it be adopted only "by *most* cities," we might inquire, by the way?

Mr. Mullen may be right in his claims of superiority, but we are "from Missouri." He makes broad statements, but he adduces no proof. The only figures given can be used to show that a two-course pavement will cost less for materials than the stone-filled one-course pavement.

T. LINSEY CROSSLEY, A.M.Can.Soc.C.E.

Montreal, February 20, 1917.

LETTER TO THE EDITOR.

Brushwood as a Medium for Sewage Filters.

Sir,—From the final paragraph of the article in *The Canadian Engineer* of February 8th, 1917, on "Brushwood as a Filter Medium for Sewage Filters," by Mr. George Phelps, it would appear as though the brushwood filter was only "the outcome of previous experiments with a lath filter," and had not been suggested by me.

In order to remove any misapprehension on the point, I would like to state that prior to the North Toronto installation the process had already been patented by myself; that the installation of a brush filter was already in hand at the Morley Avenue experimental sewage disposal plant, and that the conversion of one of the North Toronto stone trickling filters into a brushwood filter was made at my request by the commissioner of works, Toronto, to be operated as an experimental filter to obtain scientific information.

GEO. G. NASMITH,
Director of Laboratories.

Toronto, March 3rd, 1917.

Some very rich deposits of tungsten occur, it is said, in Portugal in the form of wolframite, accompanied by scheelite, and also, frequently, by cassiterite (binoxide of tin). The three principal deposits are the property of independent companies, the first, a French concern, exporting its whole output to France; the second an English company, exporting to England; and the third which is operated exclusively by Portuguese capital. The daily output of the first two averages about one ton of wolframite each, containing 60 per cent. of tungsten trioxide; the output of the other concern is somewhat less. In addition, there are numerous smaller deposits, but the output of these is not known. In 1914 the exports of tungsten ore from Portugal amounted to 1,700 tons. No figures, however, are available as to the quantity produced. At present the exportation is made under the intervention of France and Great Britain, which countries absorb the greater part of the total shipments. A small quantity is exported to the United States.

Editorial

ENGINEERS AS VIEWED BY THE CONTRACTOR.

The relation between engineers and contractors has always been a vexed question and any improvement in the harmony of their relations is made difficult because they represent opposing interests to a considerable degree. It would, of course, be unfair to expect that differences of opinion will not exist at times between these two. It is inevitable when human agencies are involved.

Contractors are in very many instances largely influenced by the opinions of engineers. The engineer who has already earned a reputation for ability, honesty, a disposition to fairness, will always attract bidders for any work with which he may be trusted.

In bidding for work contractors are about as sensitive as weather vanes. They know it is quite possible to make a profit at a given bid under one engineer and impossible to avoid a loss under some other engineer, even when all other conditions are practically the same.

Then, again, if an engineer's preliminary estimate is believed to be too low it tends to drive away bidders and to indifferent high bidding. Under such circumstances some contractors who are over-anxious for work are influenced to bid too low. They may get the work, in which event the engineer has an unpleasant task on his hands during construction. As a result, too, there is almost sure to be a disposition on the part of the contractor to save himself from loss and he is thus tempted to slight the quality of the work. In such a case both contractors and engineers are in some degree injured by the work having been done at less than cost.

The engineer who can make reliable preliminary estimates will always find his services in demand by municipalities, corporations and others.

LITERATURE AND THE ENGINEER.

One great sneer on the lips of so-called superior people is that the present is a machine-made age. Frankly it is; and of all the matters which distinguish and make the age interesting, mechanism and mechanical art generally must have a foremost place.

Each age in history is now considered as distinguished in some one direction and it is rightly assumed that those connected with each age's activity were peculiarly blessed. To be closely associated with the moving motive of the present day need therefore cause no misgivings.

The men who write for universal consumption are, in the main, apart from its leading feature. The engineer's mentality runs less to words than deeds, hence much misconception as to his real importance in the realm of books. Individual craftsmanship has given place to more intensive cultivation, needing collective effort spread through many sub-sections, each of which demand skill equal to that formerly needed in a wider sense. Team effort, organized production on an immense scale has taken the place of isolated manual dexterity. Can no writer of eminence find in such material, scope?

The historian of the future must inevitably turn to the files of the technical press if he is rightly to interpret the last few decades. The history of the world has received an indelible mark from the hand and brain of the engineer which will endure to the end of time.

Wealth, comfort and convenience have all been profoundly affected less by the speech of the politician than by the work of multitudes of unrecorded men with a common end in view. Nothing done in an engineering sense has been devoid of communal good, save that perfected engines of destruction have issued from the same source. Yet, even progress here is ultimately to end war more certainly than diplomacy. Cheap bread, cheap transport, cheap meat, cheap wearing apparel, and the thousand and one essentials which make up the material comfort of modern life have a single hand visible throughout the entire series. It is the hand of the engineer.

Literature, because of its lack of technical understanding, has avoided him—has failed lamentably to analyze his work or popularize his activities. It is high time that the engineer spoke for himself, that his overdue claims in the matter be recognized.

Technical literature of a practical order is surprisingly well done, but is a thing apart from usual literary notice. As a specialist the engineer discusses matters of a particular and not of general interest, and is penalized therefor. He uses terms and phrases not familiar. He is developing a special literature suited for particular consumption, finding keen delight in what must inevitably be puzzling to the outsider. As the activities of the engineer take a wide range the average journalist will be forced into line. He will have to understand at least the broad features of the engineering field so that he may rightly interpret for the more general public.

ONTARIO GOOD ROADS ASSOCIATION.

The suggestion that the Federal, Provincial and municipal authorities co-operate in finding employment for returned soldiers by the construction of highways was embodied in a resolution adopted at the fifteenth annual convention of the Ontario Good Roads Association held at Toronto last week.

Mr. W. Huber, assistant engineer of the Department of Public Highways, in the course of an address on "Reducing Construction Costs by Increased Efficiency," made specific mention of the various factors which governed efficient engineering, as follows: Traffic conditions, freight rates, condition of roads, labor market, etc.

In summing up, Mr. Huber said that the efficiency of road construction depended upon the systematic planning of the work, the careful supervision, the selection of the best and most responsible men, the fair treatment of the workers, and the adoption of a suitable system of records.

The following are among the resolutions adopted:—

1. That the province be asked to pay for 40 per cent. of all roads erected under the Provincial Highways Act.

2. That Legislature be asked to undertake the construction of a provincial roadway from Windsor to

Quebec, and that it be proceeded with as soon as possible.

3. That the province be requested to pay 40 per cent. of the maintenance cost of highways.

The following officers were elected: Honorary presidents, J. A. Sanderson, Oxford Station, and S. L. Squire, Waterford; president, C. R. Wheelock, Orangeville; first vice-president, J. J. Parsons, Caledonia; second vice-president, W. H. Pugsley, Toronto; secretary-treasurer, George S. Henry, M.P.P., Toronto

PERSONAL.

J. H. WHITE, lecturer in botany and forestry at Toronto University, has been appointed assistant provincial forester of Ontario.

Lieut. LEWIS WYNNE-ROBERTS, of the Royal Engineers, son of R. O. Wynne-Roberts, Toronto, left England on February 10th for Mesopotamia.

DANIEL F. COYLE, of Winnipeg, has been appointed industrial commissioner of the newly organized department of resources of the Canadian Northern Railway.

Capt. A. J. LATORNELL, A.M.Can.Soc.C.E., formerly city engineer of Edmonton, Alta., who is now at Kingston, Ont., expects to leave for overseas shortly with a draft from his battery. Mr. Latornell is captain of the 75th Battery of the Canadian Artillery.

EUGENE W. STERN, M.Can.Soc.C.E., a graduate of the Toronto University, 1884, now chief engineer of highways, Borough of Manhattan, City of New York, has been commissioned a major in the Engineer Officers' Reserve Corps, United States Army.

JOHN F. GREENE has resigned as bridge engineer for the city of Calgary and has accepted an engagement with the Carter-Halls-Aldinger Company, of Winnipeg. Mr. Greene was the designing engineer on the reinforced concrete arch bridge over the Bow River in Calgary which has just been completed.

OBITUARY.

Lieut.Col. STANLEY G. BECKETT, who went overseas in March last as commanding officer of the 75th Mississauga Horse Battalion, has been killed in action. Col. Beckett was a prominent Toronto man, having been a member of the firm of Chadwick & Beckett, architects.

CANADIAN SOCIETY OF CIVIL ENGINEERS, TORONTO BRANCH.

The regular monthly meeting of the Toronto branch of the Canadian Society of Civil Engineers will be held in the rooms of the society at the Engineers' Club, 90 King Street W., on Friday, March 9th, at 8 p.m. Capt. D. M. Mathieson, Canadian Engineers, will give an address on "Engineers in France."

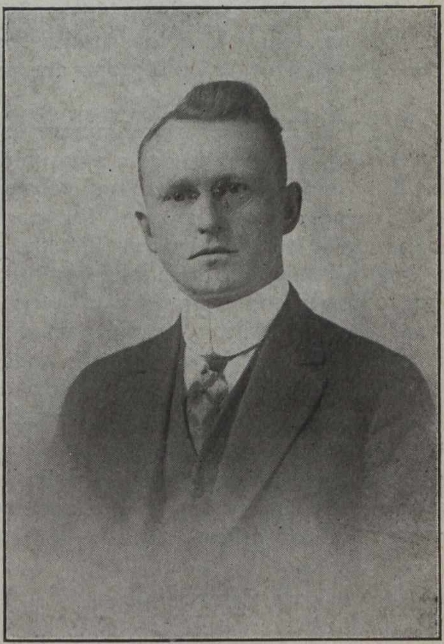
The branch is particularly fortunate in being able to secure the address from Capt. Mathieson. In order to meet the schedule of the speaker the night of meeting has been changed from Thursday to Friday. Will members kindly make note of the change?

THE NEW SECRETARY OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

After serving the Canadian Society of Civil Engineers as secretary for over a quarter of a century, Professor C. H. McLeod, Ma.E., has tendered his resignation. Reference to the record of Professor McLeod and to the time, thought and energy which he has devoted to the Society during the past 25 years was made in the February 1st issue of *The Canadian Engineer*.

He is to be succeeded by Mr. Fraser S. Keith, B.Sc., A.M.Can.Soc.C.E. The new secretary was born at Smiths Falls, Ont., June 8th, 1878. He entered Faculty of Applied Science, McGill University, 1899, graduating with honors in electrical engineering in 1903. A summer thesis which he wrote won the prize in the mechanical section, Canadian Society of Civil Engineers, the paper being incorporated in the Society's transactions of that year.

After spending a year as senior demonstrator in electrical engineering at McGill University, he became



Fraser S. Keith, B.Sc.

editor and later manager of "Canadian Machinery." In 1907 he became editor of "Canadian Manufacturer." Went to Vancouver in 1908, where for several years he was engaged in the manufacture of concrete materials and concrete construction. While in Vancouver he was for six years an active member of the executive of the McGill Alumni Association of British Columbia and occupied the position of Hon. President at the time of leaving that city.

In the spring of 1915 Mr. Keith returned to the east, making his headquarters at Montreal.

During the past eighteen months he has edited "Construction," which position he leaves to take up his new duties.

Mr. Keith has always been a close student of engineering progress, particularly in its relation to the development of Canada's natural resources, and has enjoyed unusual opportunities for cultivating an intimate acquaintance with industrial conditions in practically all provinces in the Dominion.