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The Canadian Engineer

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Reinforced Concrete in Harbor Works

Causes of Disintegration or Disruption and Means of Preventing Same—Description of Pier No. 2 and of Furness Withy Pier at Halifax—Practice Adopted in Various Ports of the World—Paper Read This Month at Engineering Institute's Halifax Meeting

By A. F. DYER

Engineer, Furness Withy Co., Halifax

MASS CONCRETE has been used in the development of harbors for practically as long a time as it has been used on land, but the use of comparatively light concrete structures, reinforced with steel embedded in them, only commenced with the present century, and there are few, if any, reinforced concrete marine structures of a greater age than fifteen years. In that short time, however, it has been used extensively in every continent and in every harbor and port of importance.

At first harbor engineers went ahead and used this new form of construction with apparently little or no fears for the future, but of late years their eyes have been somewhat rudely opened, and now it is being realized more and more every year that successful use of reinforced concrete in marine works depends not only on very careful designing and the first-class quality of the workmanship, which means a most rigid inspection

Fig. No. 1—Furness Withy Pier at Halifax, N.S.

of the materials and work, but also on the means taken to protect the structure against the elements and other harmful agents.

R. J. Wig, of the U.S. Bureau of Standards, and L. R. Ferguson, of the Portland Cement Association, have recently made a very extensive examination into the condition of nearly every important marine concrete structure in the United States and Canada. In their report they state that "the majority of all reinforced concrete marine structures on the American coasts, subjected to sea water action, are now showing evidences of deterioration or failure, due to the corrosion of the embedded reinforcement above the water line."

That is a very serious and important statement. The structures reported on were in practically all cases less

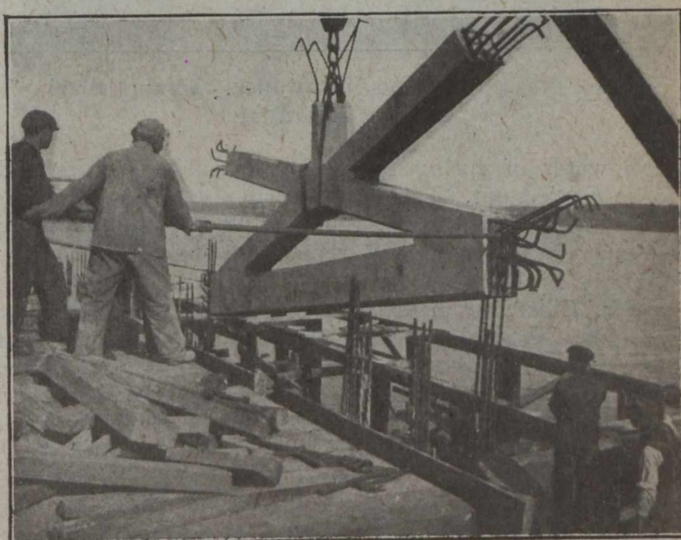

Fig. No. 2—Furness Withy Pier—Reinforced Concrete Brace Member

than ten years old at the time of their examination. Many of them had been but recently completed. It means that in the majority of cases in America the use of reinforced concrete in marine structures has not been an unqualified success up to the present time.

These gentlemen further state that their investigations led them to believe that reinforced concrete of excellent quality, designed according to recommendations of engineering societies and present-day practice, is subject to relatively rapid deterioration in most localities. They found, however, that below low water level, reinforced concrete appeared to be safe.

Other investigators have found similar conditions in other parts of the world. S. H. Ellis, in a paper published in Vol. 199 of the "Minutes of Proceedings of the Institution of Civil Engineers," describes finding much corrosion taking place in a steel and concrete wharf in Hong Kong harbor. The wharf was a structural steel wharf encased in 1:2:4 concrete. Four years after the wharf was built it was found that the steel was badly corroded above high water mark, even where protected with 2½ inches of concrete. Three-sixteenths inch round lacing was practically corroded away. Below mean tide level no signs of corrosion were found. A reinforced concrete lighthouse, built in 1908 in the Malacca Straits, in which the steel had a covering of from 1½ to 2½ inches of concrete, was found in 1914 to be so much corroded from low water of neap tides to 85 feet above

Fig. No. 3—Furness Withy Pier—Tipping Steel Cylinder into Water

high water of spring tides, that extensive repairs had to be carried out. The corrosion in this case may have been helped by vibration caused by wind and wave action, as the structure is reported to have been rather light.

Mr. Ellis also mentioned several reinforced concrete wharves which he had examined in the East, all of which showed more or less corrosive action taking place above high water level. In one case so bad was the corrosion that the concrete had flaked off the underside of the deck beams, leaving the tension steel entirely exposed.

The disintegration or disruption of the concrete above high water level is apparently due to the absorption by the concrete of salt water carried in suspension in the air, which moisture eventually finds its way to the steel and causes the corrosion. High temperatures are favorable to this action. To prevent, or at least retard, this action taking place, it is necessary to have the reinforcing steel covered by an ample thickness of concrete of maximum density, which means generous designing in the size of members, securely tieing the reinforcing steel in its proper place before the concrete is poured so that it will not be pushed aside by the liquid concrete, but be properly embedded where intended, the careful selection of materials, and possibly the painting of all concrete surfaces above high water mark with waterproof paint.

In some cases failure of reinforced concrete structures has taken place between low and high water levels before any signs of disintegration appeared above high water. In cold climates this type of failure is usually due to the mechanical action of frost freezing the water absorbed by the concrete, and thus bursting the outer skin of concrete, aided by the abrasion of the concrete by floating ice and the chemical action of the sea-water on the interior concrete. This chemical action is particularly severe on concrete from which the outer surface has been removed by frost or other means, even when the temperature is low. In certain cases, however, failure between tides has been due to the fact that low water brace members were introduced which necessitated the pouring of the concrete above that level "in situ." Concrete which is allowed to come in contact with seawater while setting does not have the same power of resistance against the chemical action of the water as concrete which has matured on shore, and, therefore, so far as possible, precast members should be used to at least extreme high-water level.

The mechanical action of frost and ice may be prevented by protecting the concrete surfaces between tides with timber sheathing. Concrete bridge piers in this country which have been so protected have been found in perfect condition under the planking after 25 years' service.

It will thus be seen that the use of reinforced concrete in marine works is attended by some risk, and that protective measures must be taken to preserve its life. This does not mean that reinforced concrete should not be used for harbor works any more than that structural steel should not be used for making bridges. Both are vulnerable, but both can be protected.

It may now be of interest to consider for a few minutes some of the uses to which reinforced concrete has been put in various harbors. The following descriptions have been derived from articles and papers published in technical journals and proceedings of technical societies, with the exception of the works in Halifax, with which the author was connected:—

One of the first uses made of reinforced concrete was in the manufacture of concrete piles to take the place of timber piles, which are so vulnerable to the ravages of the teredo and limnoria. The first piles made were, as a rule, comparatively small, being not more than 12

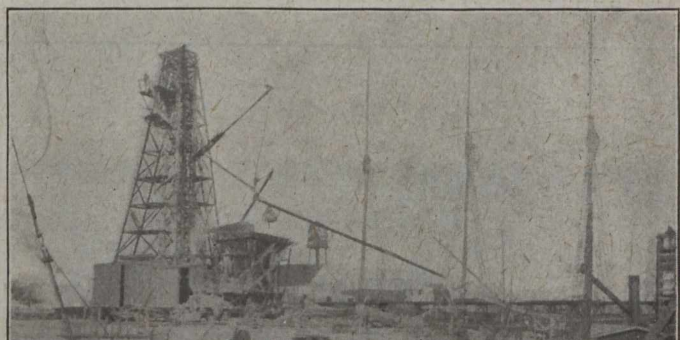

Fig. No. 4—Furness Withy Pier—Concreting Plant

inches, round or square, and their life in consequence did not prove long.

When in England in 1914 the author was informed by one of the foremost concrete engineers in London that he had just completed the rebuilding, from low water level up, of the majority of the concrete piles which supported a reinforced concrete pier built in 1903. Reinforced concrete piles are still being used in English ports, large numbers of 14-inch and 16-inch piles having been used in the improvement works of the Port of

London since 1911, but the tendency there of late years has been to drive the piles in groups of two, three, four or more piles, which are enclosed in reinforced concrete cylinders sunk to a level below dock bottom and filled solid with concrete. These cylinders reach to high water level and support the posts and braces carrying the pier deck.

A jetty built recently at Tilbury Docks, London, is 1,000 feet long by 50 feet wide, and is supported on three longitudinal rows of such cylindrical piers. The centre row cylinders are 7 ft. 6 in. in diameter, containing eight piles, while the outer rows are of 5 ft. 6 in. diameter cylinders, with four piles in each.

In Senegal, French West Africa, previous to the war nearly 4,000 lineal feet of reinforced concrete pile wharves were built entirely by the native African labor under the supervision of a few French engineers. The piles used were 13-inch and 16-inch octagonal, spaced 13 feet and 16 feet apart, and carrying a reinforced concrete deck of beam and slab construction. Salt water was used in mixing the concrete for this work, which practice is not one to be recommended in reinforced concrete work.

In a paper read before the Institution of Civil Engineers, and published in Vol. 188 of the Proceedings, S. H. Ellis describes the construction of a reinforced concrete wharf, 1,160 feet long by 174 feet wide, at Lower Pootung, Shanghai. The bottom there consists of mud to a depth of over 400 feet, the top 25 feet of this as a rule forming a fairly solid crust of stiff, sandy clay, which has to be depended on for carrying loads.

The piles used are 14-in. square, driven in groups of four, 15 feet centre to centre of groups. The heads of the piles were cut down to a level between low and high water and there capped with a concrete cap and braced with a system of precast longitudinal and transverse beams. The pier deck, of reinforced concrete beam and slab construction, is supported on 15-in. square columns, resting on the pile caps. Diagonal bracing is introduced between the pile caps and the deck.

Fig. No. 5—Furness Withy Pier—Interior of Shed

The piles were driven by a single-acting steam hammer, operating a weight of 7,800 lbs., dropping 6 ft. to 8 ft. A final set of 1 in. per blow was usually obtained, which was found by tests to have sufficient resistance to carry the designed load of about 25,000 lbs. per pile without appreciable settlement. Further driving of the piles into the soft mud below decreased their resistance. The water at Lower Pootung is fresh, and after three years no rust stains or cracks were visible on the pile heads or superstructure.

At Los Angeles, reinforced concrete piles have been used to support a timber floor pier. The piles are 20 inches square at their bases, tapering to 14 inches and 17 inches at their tops. They were not driven, but a hole having been jetted into the hard, sandy, clay bottom, the piles were set in the hole base downwards and then consolidated by several blows from a 4,500-lb. hammer. As a contrast to this may be mentioned the practice in New York harbor, where neither the teredo nor the limnoria is to be found, of using timber piles to support a reinforced concrete deck and structural steel shed.

Fig. No. 6—Furness Withy Pier—Bent of Cylinders Filled and Braces Set

Reinforced concrete sheet piles to form low retaining walls have been extensively used in various ports. One form of pile wall has been described by Sir Francis Spring. The walls were built in Madras Harbor and consisted of 15-in. and 18-in. square reinforced concrete piles, driven by water jet at 8 to 10 feet centres, depending upon conditions, and anchored back by steel ties. Reinforced concrete slabs varying in thickness from 6 ins. to 15 ins. were placed at the back of the piles, the lowest slab having a chisel-shaped edge and being sunk into the sand bottom. The height of these walls varied from 10 to 16 feet above dock bottom.

The use of reinforced concrete cylinder piers was first started at San Francisco about 1906 when two shipping piers each 686 feet long by 130 feet wide were commenced. The cylinders are 3 ft. 6 ins. in diameter, spaced 13 ft. 4 ins. apart transversely, and 15 ft. longitudinally. They were formed by sinking to hard bottom circular wooden forms built strong enough to withstand driving and the water pressure when emptied. All soft mud and water were then removed from inside the forms before they were filled with concrete. Each cylinder is reinforced with eight 1-in. square bars hooped at 9-in. centres with ¾-in. by ⅛-in. bands. The decks are of structural steel I-beams and concrete. Later piers built at San Francisco are of the same type but with all reinforced concrete decks.

At Valparaiso, a coaling pier 655 feet long by 98 feet wide has been lately completed. This pier is supported on 76 reinforced concrete cylinders 13 feet in diameter and varying from 46 to 82 feet in length. In this case the forms were made of reinforced concrete in sections from 6 ft. 6 ins. to 13 ft. high having a shell thickness of 8 ins.

The bottom section of each cylinder is provided with a cast-iron cutting edge, and into each section are moulded cast-iron jointing rings for the purpose of bolting the sections together. The sections, after seasoning, were built up and bolted together inside a steel tower supported on pile staging and fitted with hydraulic gear, so that when sufficient length to come above the water level had been bolted together the cylinder could be lowered to sea bottom. The cylinder was then sunk to the required depth by excavating inside and weighting, further sections being

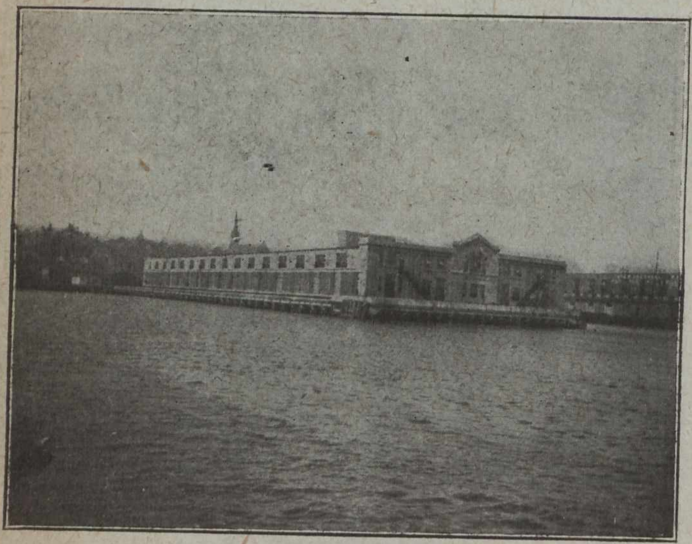

Fig. No. 7—Pier No. 2 at Halifax, N.S.

bolted on as it went down. Eight reinforced concrete piles were then driven inside each cylinder after which the cylinders were filled with concrete, the lower portion of which was put in under water to form a seal and the remainder was put in after the water had been pumped out of the cylinder. The heads of the cylinders were then joined by a transverse girder of reinforced concrete, cast in place, on which rested a deck system of precast beams and slabs.

Reinforced concrete retaining walls of different types have been much used. When properly designed, these are very suitable in places where stable foundations are not easily obtained and where no great depth of water alongside the wall is desired.

At Lower Pootung, where the deep mud foundations exist, a retaining wall 495 feet long and with a height of 21 ft. 6 ins. above dock bottom was built in the following manner:—

Cross rows of three 12-in. square piles were driven, the front piles of which serve as king piles to a continuous line of concrete sheet piles, which in turn form the face of the wall up to a height of 12 feet below quay level. At that level the heads of all the piles are connected together by a reinforced concrete platform supporting a nearly vertical slab tied back to the deck by counterforts 7 feet apart. Anchor ties were found to be necessary and were put in at 20-ft. centres being carried back to the foundations of a shed alongside the wall.

In Australian ports a type of precast wall called a reinforced concrete trestle wall has been used for some years with apparently good results. These walls are formed with precast L-shaped buttresses, which are set at regular intervals on a prepared level foundation. These buttresses are flanged to hold precast reinforced concrete slabs, which fill in the spaces between the buttresses. This type of wall has been used up to 27 feet in height and the advantages claimed for it are economy, stability on bad foundations, flexibility where settlement occurs in the foundations, rapidity of erection and greater resistance to the chemical action of sea water, as all its parts are seasoned on shore.

The ordinary type of reinforced concrete retaining wall, having inside buttresses and vertical and horizontal slabs all cast in place, was used in the construction of a pier at Padstow, Cornwall, England, which is 800 feet in length by 40 feet wide and which carries two railway tracks. The rise and fall of the tide at Padstow is about 20 feet. The foundation slab consists of mass concrete resting on solid rock and it varies from 3 to 9 feet in thickness in order that it might be finished 12 ins. above low water of spring tides. The height of the vertical wall is 23 ft. 6 ins. Cross-ties connect the two side walls at intervals, and the space enclosed by the walls was filled in with earth, etc. It will be interesting to know how long this structure will last, as its location is a very exposed one.

Reinforced concrete cribs or caissons have been used for a number of years, both in Europe and America, in the construction of quay walls and breakwaters. At Norresundby Harbor, Denmark, concrete caissons 32 ft. 6 ins. long, 8 ft. 4 ins. wide and 25 ft. high, and with a thickness of wall of only 5.1 ins. at their base and 3.5 ins. at their tops, were built on shore and launched sideways into the harbor. No failures from cracking during launching occurred, but the wall thickness appears to be too light for permanent marine work.

At Copenhagen, a quay wall 3,300 feet in length has been constructed using reinforced concrete cribs of an average length of 162 feet each. These cribs are 32 feet

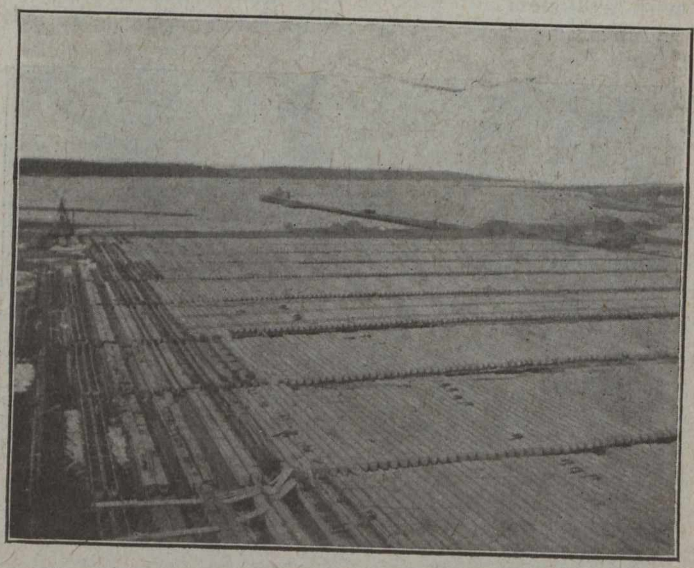

Fig. No. 8—Pier No. 2—Pile Yard—Camber Piles

in height by 16 feet wide, but with their bottom slab spread to a total width of 23 feet. The front and back walls average 10½ ins. in thickness and are stiffened by cross-beams and struts. These cribs were filled with sand and capped with a granite-faced wall 7 ft. in height projecting 13½ ins. beyond the face of the crib below. The granite facing is carried down 4 ft. 3 ins. below the top of the crib, for which purpose the front wall of the crib was recessed. These cribs were built in a temporary drydock large enough to accommodate three at one time, and the concrete used in their construction was mixed in the proportions of 1 : 2 : 3.

Some large reinforced concrete cribs have been lately used at Victoria, B.C. These averaged 80 feet long, 35 feet wide, 39 feet high and 2,500 tons launching weight. They were built on a timber pile skeleton wharf and launched on a cradle down a slipway situated at one end of the wharf. Five construction platforms mounted on rollers were used. When a crib was launched the remaining four cribs on the wharf were pulled along one space and the empty platform taken from the crib just launched was towed to the far end of the wharf and pulled up on the tracks by means of a short incline ready to receive the forms and reinforcement for another crib.

At Valparaiso reinforced concrete monoliths 66 feet long, 53 feet wide, 50 feet high, and with a launching weight of 2,300 tons, were used in the construction of a breakwater.

Lighthouses in different countries have been built either in part or wholly of reinforced concrete, which material is specially suitable for such works when properly protected.

Reinforced concrete has not yet entered the field of drydock construction to any great extent. Several docks lately built have their walls or floors reinforced in part, but they are really mass concrete docks into which reinforcing steel has been introduced to take care of some probable tensile stresses. The writer is not aware of any drydock with reinforced concrete walls and floor in the usually accepted meaning of the term, but there is no doubt that such a dock can be and will be built with advantage in due time.

In Halifax Harbor, since 1912, there have been used three types of reinforced concrete construction. The reinforced concrete pile wharf is exemplified by Pier No. 2, the concrete cylinder wharf by the Furness Withy Pier

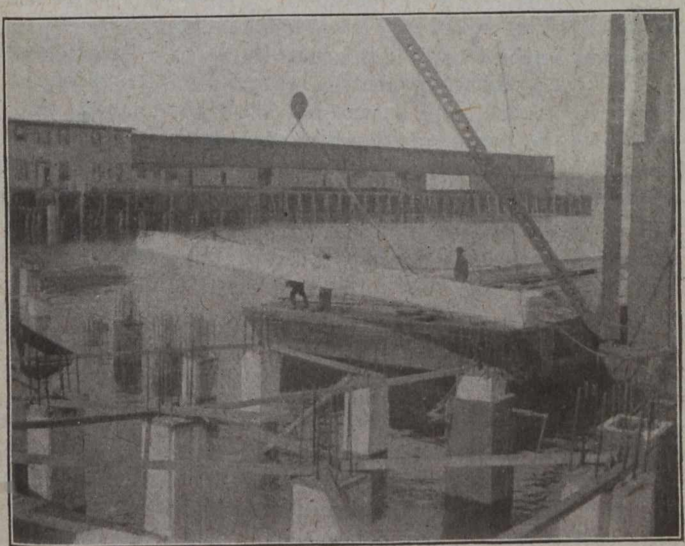

Fig. No. 9—Pier No. 2—Swinging Concrete Pile

and a new type of reinforced concrete hollow-block wall has been successfully used at the Halifax Ocean Terminals.

This last type of construction has been fully and interestingly described by A. C. Brown, resident engineer on the Halifax Ocean Terminals, in a paper read before the Canadian Society of Civil Engineers at Montreal in April of last year and published in the April 12th, 1917, issue of *The Canadian Engineer*.

These hollow cellular blocks are 21 ft. 10 ins. on face, 31 ft. from back to front and 4 ft. 1½ ins. high. They have reinforced concrete walls 8 ins. thick and are divided by internal partitions into twelve cells or compartments. A standard block weighs 62½ tons and is reinforced with 1.49 per cent. of steel. These blocks are set on a prepared foundation and built one on top of another to the required height. The three front compartments and the centre compartments running from front to back are filled with concrete. The remaining compartments are filled with concrete up to the centre of the second block above the foundations, the remainder being filled with dredged rock.

At a level of one foot below low water of spring tides, the blocks are reduced in depth, being set back 4 ft. 8 ins.

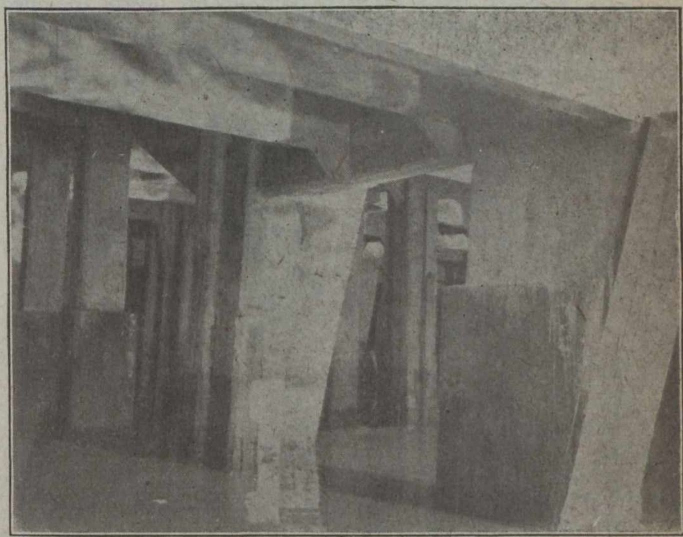

Fig. No. 10—Pier No. 2—View Under Pier Deck, Frost Protection Not Completed

from the face to allow of the building of a granite-faced concrete coping wall. In this type of construction no concrete, plain or reinforced, is exposed above low-water level.

The construction of Pier No. 2 was described by the writer in a paper read before the Nova Scotia Society of Engineers in December, 1914, but it may not be out of place here to mention some of its chief features.

The length of the structure is 800 feet, its width 235 feet and the depth of water alongside varies from 34 feet to 57 feet below low water of spring tides.

All the piles used are 24 ins. square in cross-section, reinforced with eight round rods of size varying from 1 in. to 1¼ ins. in diameter according to the length of the pile. The lengths of the piles ranged from 47 feet to 77 feet and a total of 1,801 piles were used.

These piles were cast at the contractor's yard, seven miles from the site of the pier, and were made of concrete mixed approximately in the proportion of 1:1½:3, the cement containing not more than 6.5 per cent. of alumina. The alumina content was kept low so as to lessen the chemical action of sea water on the concrete, it being generally held at that time that the magnesium sulphate contained in sea water attacked cements high in alumina much more readily than those having a low percentage.

It is interesting to note here that Messrs. Wig and Ferguson, in their report mentioned above, state that the percentage of alumina in the cement appears to have no effect on the concrete's durability in sea water.

At all times an endeavor was made to procure as dense a concrete as possible. The reinforcement of the piles was designed to take care of the bending stresses when they were being lifted in a horizontal position. In order to keep these stresses at a minimum it was specified that the pile should only be lifted at points one-fifth of their length from each end. No piles were cracked while being properly handled. The few piles that were cracked by accidents were discarded. The piles were cast in pairs and the concreting of a pair once started was continued without interruption until completed. Three feet of the reinforcing rods were allowed to project out of the head of the pile for bonding into the superstructure. No shoes were used on the pile points, the concrete, heavily reinforced, being formed to a blunt point.

As a pier with vertical piles only has small lateral stiffness, bracing piles were driven at an angle of one horizontal to three vertical, and in order to increase the

Fig. No. 11—Pier No. 2—Driving Batter Pile

stiffness of these raking piles they were cast with sufficient camber that when driven and built into the pier with their convex side upwards and under an axial load of 80 tons, the stresses on the cross-section of the concrete due to this load, plus the bending moment stresses due to the weight of the pile, would be uniform. The amount of camber required varied from 2 ins. in a 45-ft. pile to 5½ ins. in a pile 75 ft. long.

Each bent consists of 33 vertical piles and six brace piles, three of which latter lean towards the north side and three towards the south side of the pier. The vertical piles are driven singly and in groups according to the concentration of the loads from the superstructure, and the brace piles are driven in such positions that their heads were built up along with the group of piles under each shed column. The bents were driven 18 ft. centre to centre. The total number of brace piles used in the work is 238.

As the piles ranged from 12 to 23 tons in weight, special pile-driving apparatus had to be built to handle them. This apparatus was placed on a strongly built wooden scow 112 feet long overall by 56 feet wide over spud leads and 12 feet deep at the bow.

The drums and machinery for handling the piles in the leads and operating the hammer are supported on a heavy structural steel carriage, mounted on rollers which travel on a track, and the whole is moved by means of a rack and pinion drive. The front of the carriage is provided with two heavy girders. The upper girder carries a trunnion bearing which supports the weight of the leads, while on the lower girder is a specially designed cross-head attached to the leads in such a way that they are held firmly. Trunnion bearing and cross-head are connected to independent screw shafts driven by an engine; hence simultaneous operation of both shafts will move the leads laterally across the carriage, while operation of either shaft alone will cant them. In this way a transverse motion of eight feet as well as a fore and aft play of seven feet is provided and canting of the leads to take care of the brace piles is also made possible.

Largest Pile Hammer of Its Kind

Two forward spuds and one stern spud, each provided with an independent engine, hold the driver in position when in action. These spud engines are controlled by the engineer in his position in the travelling leads carriage by means of levers. The pile hammer used was a double-acting steam hammer made by the Union Iron Works, of Hoboken, N.J. The combined weight of hammer, follower and follower guide is about 16 tons. The cylinder has a diameter of 14 ins. and a stroke of 36 ins. The weight of the piston and ram is 4,150 lbs. With a mean effective steam pressure of 80 lbs. per square inch in the cylinder, the hammer is rated to develop 3,916,000 foot-lbs. per minute when the hammer is striking 80 blows per minute.

Owing to the fact that this was the largest hammer of its kind ever built, considerable trouble was experienced at first in its use, and it was not until June, 1913, that the last of the hammer difficulties were overcome and the driving of the piles could proceed without interruption by serious breakdowns of the hammer.

Two 30-ton derricks were placed at the forward corners of the scow for handling the piles to the leads from the scows on which they were brought up to the work.

Three separate cushions were used between the concrete and the ram of the hammer. On top of the pile was placed 3 ins. of spruce planking on which rested a cast steel follower about 4 ft. high, consisting of a hollow cylinder with top and bottom flanges, the bottom flange having eight holes through which the rods projecting from pile head passed. The top flange had formed on its upper side a rectangular depression in which was placed a hardwood block about 15 ins. thick, bound round with a heavy steel band. This block received the direct blows of the hammer and had to be frequently renewed.

From 200 to 1,800 Blows

The materials through which the piles were driven consisted of from 5 to 27 feet of soft mud and from 2 to 12 feet of hard clay, gravel and stones overlying the rock. The weight of the pile and hammer was sufficient to penetrate the soft mud, while from 200 to 1,800 blows were required to drive the pile to refusal. Although the driving was very hard, the last few inches of penetration being at the rate of 1 inch to 30 or 40 blows, the pile heads suffered practically no damage. Nine piles, at various times, were pulled up after having been driven and on examination were found to have suffered no material damage either at their points or any part of their length. Test loads of from 90 to 120 tons were applied to individual piles with no resultant settlement where the pile had been driven to refusal.

The piles, after being driven, were extended up to deck level and the reinforced concrete deck system was built on them. This consists of transverse girders along the heads of the piles in each bent, and longitudinal beams spanning from bent to bent, carrying the floor beams and slab, which was designed for a safe live load of 1,000 lbs. per square foot.

Sheathed With Creosoted Plank

In order to protect the concrete against the action of frost and ice, all surfaces between low water of spring tides and 18 ins. above high water of spring tides were sheathed with 4 ins. of creosoted plank.

The pier carries a two-story reinforced concrete shed 676 ft. long by 200 ft. wide and four railway tracks, one on each side of the shed and two down the centre inside the shed.

By the kind permission of R. H. Smith, resident engineer at Halifax for the Canadian Government Railways, the writer was given an opportunity last month of examining the condition of the structure below deck level. In a few places only did there appear to be corrosion taking place in the reinforcing steel above high water, and in these cases the reinforcing steel had been evidently misplaced during construction.

This was particularly noticeable on the underside of the deck slab, where the placing of reinforcing steel and holding it in correct position during the placing of the concrete is liable to be less carefully attended to than in the beams, but where a good covering of concrete is just as necessary and should always be allowed for and insisted upon. An extra one inch of concrete on the underside of the deck not only gives additional protection to the steel but it adds to the stability of the structure by increasing its inertia, which is an important point in these days of 40,000 and 50,000-ton vessels. In no place was any sign of corrosion discovered where the steel had been properly covered with 2 ins. of sound concrete. The greater port of the structure was five years old when the examination was made and the whole pier had been completed four years.

Collisions Cause No Damage

The frost protection sheathing, where it had been undisturbed by vessels, was in good condition. In a few places this sheathing had been knocked off by vessels, and where this had occurred previous to last winter and had not been repaired, the action of frost and ice on the concrete below high water could be seen. At one of the outer corners of the pier the lower part of one of the stiffening gusset walls had been attacked by frost until the concrete had been entirely removed from around the reinforcing rods. The concrete in this gusset wall had been poured in place at low water, and as a contrast to its lack of durability when unprotected was the case of a pile which, having been broken while being placed, had been discarded and allowed to remain standing free and unprotected under the pier. This pile, made of 1:1½:3 concrete, had seasoned for nearly twelve months before being placed in the water and after five winters only a slight amount of abrasion had taken place between tide levels, and this was little more than a rounding off of the corners. In no place was the steel exposed nor had any rust stains appeared; succeeding winters, however, will have a greater effect, as part of the hard outer skin has now been removed.

Since the pier has been in use it has received several severe blows from vessels of all sizes, but in no case has there been any but local damage suffered by the structure. A few months ago a vessel with a displacement of over 40,000 tons collided with the pier while docking, and although several of the side plates of the vessel were bent, the concrete was damaged for a distance of not more than five feet in from the fender beam.

The work was designed by Sir John Kennedy of Montreal, for whom the writer acted as assistant and resident engineer. The contractors were the Nova Scotia Construction Company, of Halifax and Sydney, and the cost of the structure was about $1,000,000, exclusive of the interior fittings of the shed.

The Furness Withy Pier

The Furness Withy Pier at Halifax, completed last year, has a length of 590 ft. and a width of 90 ft. It is supported on 76 reinforced concrete cylinders in 19 rows of four cylinders each, and a solid concrete retaining wall under the shore end. The depth of water alongside ranges from 13 feet to 46 feet below low water of spring tides. One-quarter inch steel plate cylinders rivetted together were used as forms for the concrete supports and were left in place as a protection to the concrete.

The contract plans called for the driving of reinforced concrete piles within the steel cylinders except where the steel cylinders could be sunk to solid rock, in which cases the piles were naturally to be omitted. The contractors decided that they would excavate to rock in every case and so eliminate the need of pile driving.

In shallow water a Harris excavator, operating a Hayward orange peel bucket, was used for excavating the cylinder foundations.

For about 200 feet out from the bulkhead this excavation had to be carried through old timber cribwork and a very tough boulder clay, which it was found necessary to blast. Towards the outer end of the pier, silt and stone filling only were found overlying the rock, and these were easily removed by an orange peel bucket.

The two side cylinders in each bent are six feet in diameter and the two interior ones seven feet, and they are spaced 25 ft. 9 in., 30 ft. 0 in. and 25 ft. 9 in., centre to centre. The bents are placed 30 ft. 3 in. apart, centre to centre.

Probings to rock were taken at the location of each cylinder and the required length of cylinder sent to the bridge company, who made up the cylinders and shipped them by rail to Halifax.

Placing the Cylinders

The foundations for a bent of cylinders having been excavated to rock, guiding timbers fastened to the pier falsework were placed so as to hold the cylinders in correct position when being set. The cylinders, as required, were then tipped endwise into the water and raised into a vertical position by a floating derrick, which set each in its location as marked by the timber frames.

A helmet diver was then sent down each cylinder to thoroughly scrape and clean the foundation, and also to close up any apertures which might exist around the bottom edge of the cylinder.

Owing to the distance of 30 ft. 3 in. between the bents of cylinders, it was necessary to drive temporary wooden piles to support the formwork for the pier deck. Two rows of piles at ten feet centres were driven between each bent, capped with 10-in. x 10-in. timbers parallel to the bents and braced with diagonal bracing.

Before filling the steel cylinders, a number of wooden piles were driven east of the newly-set bent, so that the empty cylinders might be held securely in a vertical and correct position by bracing to these piles.

Filling Cylinders With Concrete

The concrete used for cylinder filling was mixed in the proportions of 1 part cement, 2½ parts sand and 5 parts broken gravel, and it was deposited under water by a bottom dumping bucket, which held one batch of 20 cubic feet. One and one-quarter-inch square, twisted rods were set vertically inside the cylinders as the concrete came up. These rods were placed towards the north and south sides of the cylinders, and their tops extended up into the superstructure of the pier in order to stiffen the work against lateral shocks. Eight-inch square, twisted rods were placed in a similar manner on the west and east sides of the two inside cylinders to give longitudinal stiffness. The number of reinforcing rods placed in each cylinder and their lengths varied with the length of the cylinder.

The concrete filling of the cylinders was brought up to fully two feet above the level of low water of spring tides in one operation. The laitance was then cleaned off and the necessary holes cut in the sides of the cylinders for the setting of the low water concrete braces.

These reinforced concrete braces consisted of two intersecting diagonal members, 18 in. x 18 in. in section, joined at their lower extremities by a horizontal member, 18 in. x 24 in., and having a short, vertical strut projecting upwards from the intersection of the diagonals. These members are heavily reinforced with 1 in. and 1¼ in. square, twisted bars, whose ends were bent and extended beyond the concrete to allow of their being thoroughly bonded into the cylinders and superstructure. Three braces were required in each bent, the centre one weighing about 14 tons and the two outer ones 12 tons each. In addition to bracing the pier, they acted as trusses and stiffened the transverse girders of the deck. They were cast on shore and were well set and seasoned before being used.

Pier Deck Construction

The two centre cylinders of each bent were made of such lengths as to bring their tops to about the level of the underside of the braces, and from that level to 7 ft. 6 in. above low water they were continued in timber in two thicknesses, the inner 1 in. being untreated spruce and the outer 2 in. of creosoted hard pine. The outside cylinders were carried up to 7 ft. 6 in. above low water in steel.

After the setting of the braces and the completion of the centre cylinders, the concrete filling was brought up to the level of the underside of the deck girders.

All parts of the concrete braces below the level of 7 ft. 6 in. above low water are sheathed with 3-in. thickness of timber in two layers, as described above.

The pier deck, of slab and beam construction, consists of a 6-in. concrete slab, carried by floor beams, longitudinal beams and transverse girders. The transverse girders, 20 in. x 50 in., extend from side to side of the pier across the tops of the cylinders and concrete braces. The longitudinal girders, 18 in. x 44 in., run from bent to bent at ten feet centres, and the floor beams, 9 in. x 18 in., running parallel with the transverse girders, divide the deck into ten feet squares. The deck slab is reinforced in both directions with three eighths round rods at 6 in. centres.

This arrangement of beams and girders lent itself well to the locating of the construction joints where these were least objectionable, which was midway between two bents. No longitudinal construction joints were allowed in the pouring of the pier deck, it being an unbroken rule that a complete strip, 30 ft. 3 in. wide, extending from side to side of the pier, had to be poured in one operation. Such a strip contained 140 cubic yards of concrete and was usually completed in less than nine hours.

The surface of the slab was graded, screeded and floated as the work proceeded, no top finish being put on afterwards. This insured a compact slab of at least the required thickness, with no horizontal joints between concrete and finish. The centre 15 feet of the pier floor was laid level and grooved to furnish foothold for horses; the remainder of the floor is laid with a grade of 1 in 90 to each side.

Reinforced Concrete Shed

The pier carries a reinforced concrete shed, 514 feet long by 70 feet wide. The walls of the shed are of 6 in. concrete, stiffened with pilasters. There are two interior columns, 14 in. in diameter, in each bent, dividing the shed into 20 ft., 30 ft. and 20 ft. bays. The height of the shed at the eaves is 16 feet, rising to 18 feet along the centre-line. The transverse girders are 12 in. x 30 in., the longitudinal beams 10 in. x 21 in., and the roof slab is 3½ in. thick, reinforced with wire mesh and waterproofed with tarred felt, pitch and gravel roofing.

The doorways through the end walls are 18 ft. wide by 14 ft. high, and are provided with steel frame and plate sliding doors. The side doors are 12 ft. wide by 14 ft. high at 30 ft. 3 in. centres, provided with metal-covered wooden doors. All doors are carried on R-W overhead doorhangers and tracks.

Offices for customs and shipping clerks are provided at the shore end of the shed, also a heated storeroom for perishable goods. The shed is lit inside and out with electric lights.

The main concreting plant used for the work was a one-yard Ransome concrete mixer, mounted on a travelling tower. The tower travelled on tracks laid on the pier deck, and was equipped with separate hoppers for stone and sand. It also carried a loading derrick fitted with a ½-yard clamshell bucket for handling the stone and sand, which were brought alongside the work on scows. The concrete was elevated to the top of the tower and from there distributed by chutes.

The pier deck was designed for a live load of 600 lbs. per square foot, the beams and girders being figured as T-beams, with a maximum compressive stress in the concrete of 650 lbs. per sq. inch and a tensile stress of 16,000 lbs. per sq. inch in the steel. The roof of the shed was designed for a live load of 30 lbs. per sq. foot. The concrete of the pier deck and shed was proportioned 1:2:4.

Explosion Severely Felt

The work was carried out by the Nova Scotia Construction Company under the superintendence of Hamilton Lindsay, to whom the suggestion of the type of construction used is due. The details of the design were worked out by the writer, who acted as engineer-in-charge for the Furness Withy Company.

The effects of the great explosion of last December were heavily felt at both Pier No. 2 and the Furness

(Concluded on page 289)

ROAD CONSTRUCTION IN ALBERTA*

By J. D. Robertson
Engineer of Highways, Province of Alberta

OUR experience with regard to the improvement of rural roads of sand, gravel, etc., has convinced us, fully, that we cannot fix hard and fast methods of construction. Conditions vary so much they control the method that must be followed to get results. However, there are a few general principles that we endeavor to follow.

The first, and most important, is to get the water off, and second, after the road is constructed, to keep it maintained.

The prevailing defect in earth roads is poor drainage, which should receive first consideration. To obtain best results, we believe, the side ditches should not be over twenty-four feet centre to centre and the roadway sixteen feet from between shoulders, with a crown of one inch to the foot. There is often strong objection raised to this width as being too narrow. However, we find that it is much easier to keep a narrow road in shape for traffic.

Ditches and Culverts

Although the grade line of a road is very important, and we endeavor at all times to have a maximum grade of seven per cent., many of our foremen are always anxious and working to obtain easier grades without any thought of the grade line of the side ditches; especially where the country is slightly rolling and the work is being done with a blade grader, they take great care that the side ditches are carried through with a uniform depth. The result is that the bottom of the side ditch is the same depth in the depression as on the knoll. This is pleasing to the eye when the work is finished, but the result is self-evident. After every fall of rain these ditches, which were supposed to be a benefit to the road, are a detriment. Instead of getting the water away, they act as a reservoir to hold the water until it either seeps into the road or evaporates.

Another point that is given careful consideration is the placing of culverts. We often find culverts are not placed at the point where they would do the most good. The proper point may be low, damp and disagreeable to work in, whereas a few feet either direction it is better footing and we find the latter point is often chosen, with damaging results.

Get Water Away Quickly

We find it very necessary to have off-take ditches to carry the water away from the side ditches, and believe there cannot be too many of these, as it is, without a doubt, a poor policy to carry water along the side of the road any farther than is absolutely necessary. The quicker it is taken away, the less chance of seeping into the road.

Too much attention cannot be paid to the construction of culverts and off-take ditches, and they should be considered together and not separately. Where an off-take ditch is necessary, a culvert or culverts are also very likely needed. Where a road runs across the general slope of the country, frequent culverts are necessary, otherwise the water is carried far too great a distance along the upper side of the road. If this is done, it naturally follows that a certain amount of the water seeps into the road, hence the necessity of a culvert across the road wherever necessary, and an off-take ditch to carry the water away from the ditch along the lower side of the road.

In passing, I might mention the necessity for having culverts large enough. If a culvert is so small that it becomes completely full with the first thaw in the spring, it is very liable to freeze solid, with the result that it will be full of ice just when it is most needed to prevent the flow of melting snow from cutting away the grade. Whereas if the culvert were a little larger this might not happen.

The Farmer's Objections

In connection with constructing a grade across a slough in which there is open water, the general desire of a great many of our inspectors is to build a grade across the slough, without any attempt at trying to get the water away. Of course, we realize there are often many objections to this. A ditch might easily be put in that would take all the water away but it might mean an open ditch through a grain field, which is not a desirable thing to have, and almost without exception it is rather difficult to convince a farmer that the benefit of having a good road will off-set any damage to his field. He, being human, naturally believes that it would do less damage to his neighbor if it could only be carried the other direction. As we do not wish to establish a precedent of putting in closed drains, you can therefore realize our difficulty. The inspector who has talked with the owner of the land through which the ditch should be constructed and heard his tale of woe, recommends that a grade can be maintained through the slough for less money than by drainage and grading, and after the grade has been under water and the road impassable every spring for a few years, we finally have to put the ditch through where it should have been in the first place, and drain the slough, or at least control the height of water. There are such places, however, that it is not possible to drain, in which case we always aim to have the grade at least two feet above the high-water level.

Maintenance of Earth Roads

Before going into the question of maintenance, I wish to mention a few very common practices which make it rather difficult to keep our roads maintained. The pasturing of cattle on the roads does a great deal of damage to the side ditches, also to the approaches to bridges or culverts, especially if they go to these points for water. Of course, in certain parts of the country, where the land is unfenced, it is rather difficult to prevent such damage, but under these conditions the damage is not great in comparison to other sections where the road allowance is fenced on both sides and is considered a very convenient public pasture. We also frequently find that when entrances to private property are opened, the side ditches are filled with poles, straw or manure, which form a dam.

Constant maintenance of an earth road is absolutely necessary, and is much less expensive than reconstructing it every two or three years. In the case where a road is properly maintained, it is available for traffic the year around, but where it is constructed and then forgotten about for a few years, the usual result is that it is hardly fit to carry traffic during that period and then has to be reconstructed. Our method of maintenance is by going over the ground with a drag after every rain. The result obtained depends almost entirely on whether or not it is dragged at the proper time. It should not be dragged when too wet or should not be allowed to get too dry and bake. An earth road that is drained and crowned, as it should be, can be kept in good condition for traffic the

*Paper read August 8th, 1918, at the Saskatoon Meeting of the Engineering Institute of Canada.

year around, so far as injury from moisture is concerned, if dragged at the proper time after every rain. There is one factor, however, that we have to consider and that is a long dry period. It is rather difficult to do much with an earth road during long periods of dry weather. Our roads are kept in much better condition with frequent rains.

We try to divide the roads into sections of about ten miles each and employ someone living about the centre of the section to work five miles each way. Of course, the length of the section depends on whom we get to do the work, as some of our men look after as much as twenty miles, but with this distance to travel they very often cannot get over it all when they should. But with a ten-mile section, and living in the centre, a man should keep the road in good condition. If the soil is lighter in one direction, it makes an ideal condition. He goes over the light end first, which dries quicker, and then over the heavier soil. Under normal conditions we have had this work done for seventy-five cents per mile for each time the road is dragged. Now the cost is higher.

Intelligence Needed in Dragging

We are now coming to our greatest problem, the one which is the cause of more complaints than all others together, especially from the man who uses a motor car, and that is our difficulty to obtain the services of men to drag our roads who will take an interest in the work, who will do it at the proper time and not wait days until they have nothing else to do, and who will stay off the road when it is so hard and dry that they are wasting time and money.

In conclusion, I wish to say that in Alberta, at least, owing to the rapid development of the province, I believe that for years to come we will have to be satisfied with earth roads; with a little surface of sand on clay where necessary; or clay on sand where the sand will not carry traffic during dry weather; or gravel surfacing where such material is available. However, in Alberta, as yet, we have done very little of even this class of work. Almost all our roads are constructed and top dressed with material from the side ditches or by balancing cuts and fills.

The Reid-Newfoundland Co. are operating a cold storage plant at St. Johns, Newfoundland, with a present capacity of 6,000 tons of fish, and it is their intention ultimately to increase the capacity of the plant to 25,000 tons, making it one of the largest in the world, says Sir Frederick N. McGrath, chairman of the Food Control Board of Newfoundland. The British Government has contracted for practically the entire output of the present plant until the end of the war.

Sir H. Dalziel, in the British House of Commons, on July 1st, asked the Prime Minister whether Mr. Chauvin, managing director of the Siemens Co., who are government contractors, is a German naturalized since the outbreak of the war? whether his name was previously Von Chauvin? whether, on the winding up of the business as an enemy concern, it was a condition of purchase that Mr. Chauvin's services should be retained? whether, in view of the close relations of this firm to the government in the production of war material, he will consider the possibility of employing a manager who was British-born? and whether Mr. Chauvin was also a director of the Deutsche Bank? In replying, Sir A. Stanley said: "The Prime Minister has asked me to answer this question. Mr. Chauvin, whose name was previously Von Chauvin, is of German birth and has been naturalized since the outbreak of war. So far as I am aware he has never been a director of the Deutsche Bank. On the sale of the shares of Siemens Brothers and Company, Limited, there was no condition with regard to the retention of Mr. Chauvin's services, and the agreement under which he now acts as managing director of the company was, I understand, entered into by the new directors appointed by the purchasers of the shares."

LEAKAGE FROM HIGH-PRESSURE MAINS AND ITS VARIATION WITH THE PRESSURE*

THE high-pressure fire system in the Borough of Manhattan, New York City, due to the fact that New York has not permitted any private connection to its fire mains, gives an opportunity to make tests on a distribution system of 128 miles of mains, 2,728 hydrants and over 4,748 valves, covering an area of 3,675 acres. The system has received during its 10 years' life most trying tests. Each year it has had the pressure raised from, say, 35 lbs. to from 125 to 250 lbs., an average of over 2,000 times a year, due to fire alarms within the district, and for each period of 12 hours in duration which no fire alarm has sounded, the pressure has been raised for one-half hour to 200 lbs. for testing out. It is hard to believe that any other water system in the world has gone through similar service conditions. The system includes the following pieces:

	Number.	Per cent.
Pipe, full lengths, 8 ins. to 24 ins...	44,134	54.4
Bends and offsets	10,834	13.3
3-ways, 4-ways	4,279	5.3
Short pieces	21,950	27.0
Total	81,197	100.0

The mains were all laid in the lower portion of Manhattan Island, where subsurface conditions are most congested. This subsurface congestion shows readily in the figures given in the table by the large number of bends and short pieces of pipe used, even after the city had availed itself of its right to order moved gas mains and other interfering subsurface structures.

After the mains were laid they were subjected to an acceptance test of 450 lbs. for a period of 10 minutes for the earlier contracts and for 20 minutes for the later ones, the leakage being measured and for acceptance had to come within the limit of 4 gallons per linear foot of pipe joint per 24 hours.

Leakage Has Increased Considerably

In testing, the test sections were in all cases between valves and doubtless a portion of the loss was due to water passing the valves limiting the section under test.

The mains were limited in the acceptance test of 450 lbs. per square inch to a leakage at the rate of about 800 gallons per minute for the entire 128 miles. The actual gross leakage of all the tests was 452 gallons per minute. To-day there is a leakage, as shown on the Venturi meters, of 950 gallons per minute at an average pressure of 33 lbs.

Investigations have been made to locate the leaks, but due to lack of force the work has not been systematically carried on. However, due to the wide range in pressure, property owners have themselves reported eight connections which had been placed evidently by mistake. There may be others not placed by mistake in which advantage is taken of the higher pressure available at times to fill tanks. The occasional erratic movement of the pen in the Venturi chart may be an indication of this.

An aquaphone test of each hydrant made by a most careful and competent inspector who covered every one of the 2,728 hydrants showed but 51 (1.9 per cent.) on which any sound could be detected, indicating leakage which could not be stopped by tightening the valves.

Of course, it might be said that a certain number of hydrants might be not tightly closed at all times in such

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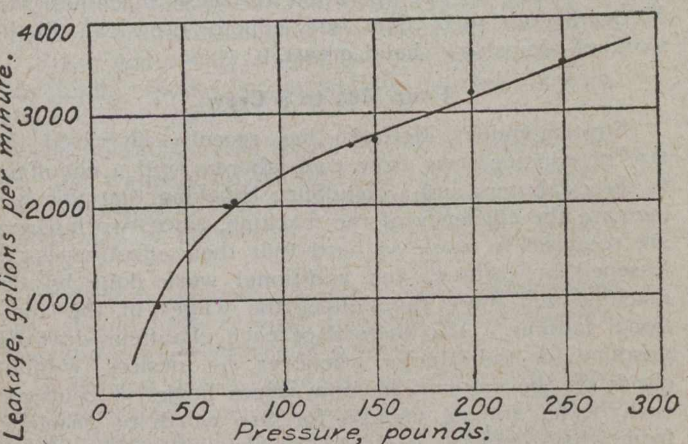
*From Journal of American Waterworks Association.

a large number, but the system of maintenance is such that each hydrant is examined and repaired if necessary immediately after going out of service at a fire by an experienced machinist who reports to a follow-up system that the hydrant has been examined by him and left in good condition. The firemen, after an alarm, are the only users of the hydrants. Should any one else open a hydrant it is immediately known by an alarm bell operated by the Venturi meter recorder on the priming line.

During the past six years many miles of streets have been opened for the construction of the rapid transit subways, exposing over 54,000 lin. ft. of the high-pressure mains. No leakage has been found in the joints except an occasional sweat and from this evidence the Bureau of Water Supply is inclined to believe that the loss of water is not at the joints.



Results of Test Under Varying Pressures

The above chart gives the result of a test under varying pressure made Dec. 8th, 1916. Attention is called to the almost straight line of the upper portion of the curve, which seems to indicate that the leakage is not from fixed openings, from which a leakage varying as the square of the pressure should be expected.

It may be that the symmetrical results obtained and shown on the curve are but accidental; that as the pressure increased the main valves of the hydrants, which close under pressure, closed more tightly, reducing the leakage in the hydrant; that at the same time stuffing boxes in valves which are tight under low pressure might leak under the higher; that cracks in the pipe or steel casting not open under low pressure open under the higher.

Light charges of dynamite were used with success in breaking up reinforced concrete columns at the Colorado State College of Agriculture. The columns were 4 ft. square and 3½ ft. long, and were intended originally for cores of ornamental posts. They were built with twisted steel reinforcing bars, and conduit pipes for electric wiring were placed in the centre. In addition to the rod reinforcing, there was an extra reinforcing of wiring in portions of the posts. In breaking up the columns it was necessary to use small shots because of the nearness of buildings,—one structure being within 100 ft. of where the posts lay. The charge consisted of a ¼ stick of dynamite, which was inserted in a hole drilled in the column. This method broke the posts to pieces so successfully that the reinforcing and electric conduits were removed intact without injury. The cost in labor was about $4 for all of the posts. To this labor cost must be added the cost of the dynamite. About eight sticks were required for the whole job.

CATCH-BASIN CLEANING

THE following facts relating to catch-basin cleaning are taken from the annual report of the superintendent of the Bureau of Sewers, Chicago, and describe work done in the seven districts into which that city is divided:—

"6,755,100 feet of sewer flushed at a cost of $40,596.60; 542,400 feet of sewer scraped at a cost of $49,948.79; 41,231 catch-basin cleanings by hand at a cost of $116,500.55; 1,729 catch-basin cleanings by auto-eductor at a cost of $1,552.31; and opening inlets, answering complaints, etc., at a cost of $57,069.14; to which costs are added $3,697.15 for supplies, materials, etc.

"The costs given include a proportional part of salaries of district foremen and assistant foremen. Of the total cost, $185,907.29 is for salaries and wages and $79,760.50 for teams, horses and carts. In the case of the auto-eductor the amount given is for wages of crew, to which should be added $475.51 for supplies and repairs, interest at 4 per cent. (for the five months after it went into operation) $116.66, and depreciation at 10 cts. per mile, $229.30. This gives a total cost of $2,373.78, giving an average per basin cleaning of $1.375 and per cubic yard removed of $0.81; as compared with a cost of $2.83 per cleaning by hand. In cleaning the 1,726 basins and removing 2,929 cubic yards of material the auto-eductor traveled 2,293 miles and hauled 490 loads to the dump.

Otterson Eductor

"On the 1st of August the Bureau of Sewers placed into service in the First Cleaning District a catch-basin cleaning device known as the Otterson Eductor. This is, in general, a Kelly-Springfield 5-ton motor-driven vehicle, on which is mounted a centrifugal pump. The vehicle and the pump are driven by the same motor. The cleaning is done by the use of a jet in the discharge pipe of the pump, a flexible loop of the discharge pipe containing the jet being lowered into the basin. By this method the solids from the basin do not pass through the pump itself. The wastes are discharged into a box mounted on the eductor, the box being of sufficient size to contain the material taken from three or four basins.

"Water for the pump is drawn from the wagon box, the solids in the box being retained by the use of baffles. Thus a continuous circulation is maintained from box to pump and from pump to box until the capacity of the box for solids is reached, at which time the machine is run to a dump and unloaded, the unloading being accomplished by a tipping device operated by the vehicle motor."

Costs by Hand and Machine

The success of the machine may be best given by a statement of costs of hand cleaning and machine cleaning in the First Cleaning District, the machine-cleaning covering a period of five months. These are as follows:—

Costs per catch-basin cleaning in the First Cleaning District: By hand, $3.37; by auto-eductor, $1.37. "In addition to being approximately 60 per cent. cheaper, it is a more sanitary and cleanly method," says the report.

At present the Bureau of Sewers has seven-auto-eductors in service. The first was placed in commission in July as an experiment, and given a thorough test, following which six more were brought and placed in service in April of this year. The result of their operation is such that Mr. McGrath has recommended to the city council the purchase of four more. Those in use save the city, he reports, an average of $6,000 a month, which would otherwise be expended for hand labor. Some of the details of their operation given by him are as follows:—

From August 1st, 1917, to August 1st, 1918, the first machine working all of the 12 months, the other six operating but three months, the period of one year broken by a vacation totaling 32 days, the number of catch-basins cleaned was 10,847 and the number of cubic yards of dirt removed 13,064. With full gangs of men during the same period 21,601 catch-basins were cleaned and 25,473 cubic yards of refuse removed by hand. To clean a catch-basin by eductor cost $1.51; by hand $2.98. To remove each cubic yard of dirt costs by eductor $1.26; by hand $2.53. In the eductor costs are included all overhead charges—gasoline, oil, grease, repairs, one-fifth of the maintenance charge in the sewer district to which each eductor is detailed and 10 cents per mile for depreciation.

Catch Basins Cleaned by Eductors, June, 1918, Seven Districts

Dist.	No. C. B.'s Cleaned.	No. Yds. Dirt.	Salaries and Wages.	Supplies Gas, Oil, etc.	Miles Run.
*1	308	384	$ 430.90	$ 54.74	308
2	390	427	464.90	57.80	420
†3	309	304	372.90	49.58	346
4	482	485	464.19	66.44	397
5	470	504	471.80	63.92	453
6	471	533	471.80	66.64	556
‡7	554	536	458.10	70.26	515
	2,984	3,173	$3,134.59	$429.38	2,993

*Off 6 days for repair.
†Off 8 days for repair.
‡Dumping facilities enabled this machine to keep at cleaning work more constantly than the others.

Number of catch basins cleaned	2,984	
Number of cubic yards dirt removed..	3,173	
Cost of labor, salaries and wages ...		$3,134.59
Cost of gas, grease, oil, etc.		429.38
Miles run	2,993	
Depreciation, 10c. per mile		299.30
Cost of repairs of 7 eductors for month of June		269.79
Total cost of operation		$4,133.06
Cost of cleaning per basin		$1.39
Cost per cubic yard dirt removed		1.30

Catch Basins Cleaned by Hand in June, 1918

Number of catch-basins cleaned	479	
Number of cubic yards dirt removed..	544	
Average cost per catch-basin		$3.48
Average cost per cubic yard		3.06

Each machine cleans an average of 365 basins in a month. In this record is included time lost in vacations for the crews and for repairs. The department of sewers shows that by hand labor (gangs of three men each working eight hours a day) seven catch-basins are cleaned daily or at the rate of 168 a month. It will thus be seen that an eductor can do more than twice the work of a hand crew at about half the cost.

It is necessary that at least 45,000 catch-basins be cleaned every year. The Bureau of Sewers expects to clean 31,000 of these at the rate of about 4,500 to each machine, and about 15,000 basins by hand.

The average mileage of each eductor is 450 a month, traveling on streets which as a rule are straight, level and paved. The unusually great distance from catch-basins to dumps operates against a more favorable showing by the eductors and constitutes what is termed an insoluble problem. The average haul is two to three miles for each load. The average number of loads is three to four a day, five to six cubic yards of dirt composing a load. Carts drawn by horses or mules haul, on an average, two to three loads of two cubic yards each a day.

A test was held recently to learn the least time required to empty a standard basin, 10 feet deep and four feet in diameter, and it was found to be exactly six minutes. Motion picture cameras photographed the operation. Similar work by hand would have taken 2½ hours. From careful study of the operation of these machines Mr. McGrath concluded that one eductor crew can do the work of almost 2½ hand crews.

Four Men to a Crew

Superintendent McGrath has recently increased the size of eductor crew from two laborers and a chauffeur to three laborers and a chauffeur, believing that this will increase the efficiency of the machine, since two laborers are required to work so hard that their effectiveness is lessened by fatigue, and additional work done by the machine will more than offset the wages of the additional laborer. Also instead of each chauffeur drawing gasoline for the eductor whenever he desires without check on the amount, he now issues books of coupons, each book carrying enough for $10 worth of gasoline, from which coupons are taken covering the value of the gasoline put into the tank, and thus a record is kept of each machine and it is calculated that waste is eliminated that would amount to at least $6,000 a year.

The average pay of each chauffeur is $125 a month, that of the man in charge of the eductor is $4.60 a day, and the two laborers receive $3.80 a day.

The area of Chicago is about 200 square miles divided into seven districts, in each of which an eductor was placed, each district in charge of a foreman. Three police stations, recently abandoned, serve as barns for the apparatus. Each foreman has an assistant who patrols his territory and with a rod determines the depth of dirt in each catch-basin. These data, reported by him to his foreman, indicate where cleaning is needed. It is the duty of the assistant foreman to see that every detail in his reports is observed. His reports show, also, how much time is required to clean the basins in his district.

Some Basins Cleaned Monthly

In each district there are, on an average, 17,000 catch-basins. The frequency of cleaning these depends on their location, being greatest where traffic is heaviest or where street improvements are lacking. In the downtown districts, where traffic is congested, the basins are cleaned at least every 30 days. This is done at night. Outlying basins require cleaning every six months or twelve months. Many are never cleaned, apparently, since the number of cleanings per year is only 36 per cent. of the total number of basins.

When hand cleaning is employed, telescopic shovels are used for bringing the dirt to the street surface, from which it is shoveled into wagons of two cubic yards capacity, each drawn by two horses, in which it is taken to the dumps. Where the catch-basins are unusually deep, buckets are used for removing the dirt.

REINFORCED CONCRETE IN HARBOR WORKS

(Continued from page 284)

Withy pier. Steel and wooden doors were bent and twisted, windows were blown in and interior partitions shattered, but the concrete structures themselves came through undamaged, even the light roof slab showed no signs of failure. An examination of the piles in Pier No. 2 below water level made by divers shortly after the explosion failed to disclose any damage either from the explosion or from the sea water.

Points Requiring Particular Attention

In closing, the writer wishes to impress the following points which require particular attention in the successful carrying out of reinforced concrete marine structures:—

1.—Only rich, dense concrete of first-class quality in every respect of materials and workmanship should be used. Fresh water only should be used and excess of water in mixing should be particularly guarded against, as also too dry a mixture.

2.—The building of the forms should be carefully inspected, and watertightness, so far as possible, sought after, so that stony streaks from which the liquid cement has leaked may be eliminated. A smooth face is very desirable.

3.—All reinforcing steel, whether in piles, slabs, beams or walls, should have at least 2 ins. of sound concrete covering, and more wherever practicable.

4.—In climates where ice occurs, all concrete surfaces between low water of spring tides and some distance above high water should be protected by timber or other sheathing. In warmer climates a similar protection would probably be found beneficial as a protection against the continual drying and wetting of the concrete, which action appears to have a tendency to increase its porosity. The sheathing would also protect the concrete against abrasion by floating debris and the chemical action of the sea water.

5.—Precast members are better than concrete cast in place, especially below high-water level. Concrete piles should always be long enough to reach above high water after being driven.

Painting or Guniting Needed

6.—The painting of all concrete surfaces above high water and below deck level with a waterproof paint, in order to exclude the salt moisture laden air, should be considered, especially in warm climates. In place of paint, a more permanent waterproof protection might be obtained by applying a good coat of "gunite," shot on with a "cement-gun." This question is a very important one to the life of reinforced concrete in sea water.

7.—That careful periodical examinations, at least twice a year, should be made of every reinforced concrete marine structure, so that deterioration of the concrete, corrosion of the steel or displacement of the protection sheathing may be discovered as soon as possible and the necessary repairs be made at once before serious trouble sets in. The idea that a reinforced concrete structure is one which can be left to look after itself and which will require no maintenance, is not only a mistaken one but a very dangerous one.

Steel has met steel between Seward and Anchorage, and the government-owned Alaska Railroad has been joined between those two points.

CRITICIZES COMMISSION'S DECISION

UNDER the title "A National Power Policy," the Toronto Globe this week published the following editorial criticizing the recent decision of the International Joint Commission in the Long Sault Weir case:

The recent decision of the International Joint Commission, a semi-judicial, semi-diplomatic body which has under its jurisdiction matters affecting the international waterways of the United States and Canada, conferring upon the St. Lawrence Power Co., which is a subsidiary of the Aluminum Company of America, the right to place a weir in the St. Lawrence Channel on the "South Sault" for the purpose of increasing the flow of water to its power plant, The Globe believes to be bad law, bad politics, and bad business. Bad law because the Commission wrongly arrogated to itself power to alter the Ashburton Treaty, which specifically provides that nothing shall be done by either of the high contracting parties to obstruct navigable channels; bad politics because it will make Canada very loath to enter into international agreements that may be set aside as the result of the pressure of powerful business interests in the United States, and bad business because it should be a cardinal feature of the policy of both countries to develop and operate water powers for the benefit of all the people—so that electrical energy shall be cheap and abundant rather than to give perpetual water-power privileges to private corporations which capitalize them at enormous sums and force the public to pay interest on this bogus capital.

"Pretext" Says the Globe

The pretext under which the St. Lawrence Power Company secured its new rights was that the Government of the United States was urging the company to provide all the aluminum it could produce at its Massena, New York, plant for military purposes. The output, it was asserted, was decreased 7,000,000 pounds during the months of December, January, February and March by frazil ice troubles in the South Sault Channel on the American side of the river, from which its power is derived. The proposed works, it is claimed, will prevent the formation of frazil ice and so permit of a maximum output. The construction of the weir and other works has been authorized on the condition that the dam which will obstruct the channel shall be taken out five years hence, or at the end of the war, whichever is the later date. Experience in the past, however, has taught Canada that when such structures are put in they are not taken out, no matter what limitations of time have been agreed upon. It is a safe prediction that the Aluminum Company will install additional turbines and electrical units to develop the 114,000 horse-power which its engineers claim can be obtained from the additional water and increased head obtainable from the dam. When we ask for the removal of the dam we shall be told that we cannot demand that this great and important industry be crippled and its output reduced by such action. If there was no intention to grant extra generation rights, why did the decision of the International Joint Commission omit to order that no additional units be installed by the Aluminum Company in its plant at Messena, N.Y.?

Other Companies Have Power

That the frazil ice difficulty was only a pretext to secure, by the intervention of the United States War Department, privileges that could not be secured in any other way becomes apparent when it is seen that the St. Lawrence Power Company and the Aluminum Company have intimate relations by interlocking directorates with Canadian companies which could have supplied enormously more power to the Messena plant than would have been required to make up the shortage of output caused by frazil ice. Instead of constructing the proposed dam or submerged weir to prevent the alleged shortage of 10,000 to 15,000 horse-power, it is understood that the required amount of power could have been purchased from the Cedars Rapids or Laurentide or other power-producing company. At the present time there are transmission lines from the Laurentide Company's plant at Grand Mere to Montreal, from Montreal to Cedars Rapids, and from Cedars Rapids to the St. Lawrence River Power Company's plant at Messena, N.Y. The Cedars Rapids Company has six wheel pits completed, but the turbines and dynamos are not yet installed. If completed, this company would have 64,800 horse-power to dispose of, although the Aluminum Company claim that they require only 10,000 to 15,000 horse-power.

Laurentide Could Supply Deficiency

The Laurentide Power Company, Grand Mere, Que., has a present capacity of 120,000 horse-power and a demand of only 75,000 horse-power, having a present available surplus of 45,000 horse-power, or three times the amount required to fill the alleged shortage at the Messena plant. In addition, this company has three wheel pits completed. If the dynamos and turbines were installed, the company would have a surplus power of 105,000 horse-power, or seven times the Aluminum Company's alleged requirements. The pole lines from the Laurentide Company's plant are already constructed, and the only possible new construction required would be a new wire and insulators.

Arthur Davis, of Pittsburg, the president of the Aluminum Company and the St. Lawrence Power Company, is also a director of the Cedars Rapids Power Company and of the Montreal Light, Heat & Power Company. A word from him that there was urgent need of power at Massena for war material production would have secured a supply on the Canadian side, and the Government of Canada would assuredly not have opposed the export of such power temporarily to aid our neighbors and allies. But that remedy for the power shortage would not have meant an extension of the franchise privileges of the St. Lawrence Power Company. What the concession granted by the International Joint Commission involves may be seen from the following statement of an expert in hydraulics to The Globe:

Big Profits for Company

"The St. Lawrence River Power Company's engineer stated that the dam and appurtenant works would cost $350,000. Assuming that the penstocks, turbines and dynamos for the 114,000 horse-power, made available by these works, cost $1,500,000, the total cost would be $1,850,000, or a capital cost of about $16 per horse-power, as compared with upwards of $75 per horse-power at that specially favored power site, Niagara Falls. It is a fair assumption that power is as valuable to the Aluminum Company at Massena as at Niagara. If this be correct, and if the St. Lawrence River Company is permitted to keep its dam in the South Sault, it has been presented with a clear gift of about $6,750,000 plus whatever 114,000 horse-power is worth at Niagara. It is not an unfair assumption that the St. Lawrence Company will make a profit of five cents per pound on its aluminum. On this assumption, the product from this 114,000 horse-power will yield a profit of over $2,500,000 per annum."

The Globe believes the time has come to make an end of this sort of exploitation of the public domain. The waters of the St. Lawrence are the joint property of the people of the United States and Canada. They should be used at the Long Sault, and at the other great sources of power, for the production of power that will be available at cost to all who need the power in reasonable quantities instead of being put at the disposal of great corporations that take no thought of the power needs of the mass of the people. The Government of Canada cannot control the power policy of the United States, but it can control its own policy. Announcement should be made to the public on both sides of the border, and notice should be given to the authorities at Washington, that immediately after the close of the war the Dominion of Canada proposes to develop or to authorize the development by Provincial Hydro-Electric Commissions of the St. Lawrence water powers as a public enterprise, owned, controlled and operated for the benefit of the people. Let us have a national power policy as well as a national system of transportation. If we are to compete with success in the world's markets we must have both.

ENGINEERING SOCIETY STARTS SEASON

WINNIPEG, September 21st.—The opening meeting for the season of the Manitoba Division of the Engineering Institute of Canada was held in the Engineering Building of the University of Manitoba on Thursday evening, September 19th, with about 35 members present. W. P. Brereton, city engineer of Winnipeg, acted as chairman in the absence of W. A. Duff.

A letter was read from J. C. Holden, of the C.P.R., saying that on account of much absence from the city, he was forced to resign as a member of the executive committee. His resignation was accepted with regret.

M. A. Lyons, of the Provincial Highways Department, presented a report on "Good Roads," arising out of the discussions at the recent Saskatoon convention. (Mr. Lyons' report appears, practically in full, on page 291 of this issue.)

C.N.R. TUNNEL NOW IN USE

FORMAL ceremonies were held last Saturday afternoon to mark the opening of the new $3,000,000 tunnel which was built at Montreal by the Mount Royal Tunnel and Terminal Co., Limited, a subsidiary of the Canadian Northern Railway. The first passenger train to pass through the tunnel carried a party of engineers and officials representing the Dominion Government and the C.N.R. From the divisional yards at Cartierville to the new modern depot at Dorchester Street, Montreal, the road is electrified. A daily train service between Montreal and Toronto, via Ottawa, will be inaugurated next month. There will be two trains daily each way. Connection from the Dorchester terminal to the water front at Montreal is planned by means of proposed overhead street crossings.

The first concrete ship built at the Barrow shipyards, in England, was successfully launched this week, being the first of the 1,000-ton barges now under construction for the Controller of Merchant Shipbuilding. The Barrow Shipyards did not begin operations until the beginning of 1918. Another 1,100-ton barge was launched last Saturday at the new shipyards at Barnstaple. Like that launched at the Barrow yards, its construction occupied four months. The site of the Barnstaple yards was a marshland last March.

DISCUSSION OF PROVINCIAL ROAD POLICIES IN WESTERN CANADA*

By M. A. Lyons
Chief Engineer, Manitoba Good Roads Board

ROAD construction in Western Canada is a problem in which, until recently, the Canadian Society of Civil Engineers, as a body, took very little interest. Nearly all forward movements have been due to outside bodies, while the engineer generally follows. In the meeting held at Saskatoon, the problem was given a prominent place and the interest displayed by those present shows that the members of the Institute were alive to the importance of road development and that the Institute would in future be a leader rather than a follower in this matter.

The papers read at the Saskatoon meeting present an opportunity to compare the different lines which road development has taken in the three western provinces, where one would think that the problems would be quite similar.

General Provincial Policies

In Alberta, under the Public Highways Act, assented to on April 13th, 1918, the Minister of Public Works is required to place all highways in one of three classes: (*a*) Main highways; (*b*) district highways; (*c*) local highways. Main highways are denoted by the minister after consultation with every municipal authority through whose area the highway runs. District highways are denoted by the minister after agreement made with and ratified by by-law of every municipality through whose area the highway runs.

On main highways 75 per cent. of the cost of construction is borne by the department and 25 per cent. by the municipalities. The cost of maintenance is borne by the department, which also has full charge of the construction. On district highways, the department bears only 25 per cent. of the cost of construction and the local authorities maintain the road. On local highways the local authorities pay for construction and maintenance.

In Saskatchewan, a system of main highways was drawn up on paper and the cost of construction of those built was borne by the government on other roads, and the cost of construction was borne equally by the municipality and government. Saskatchewan has now under consultation the preparation of an act along lines somewhat similar to the Manitoba act. In Manitoba, roads on which the government give assistance under the Good Roads Act are divided into two classes, provincial highways and main market roads. Provincial highways are selected by the Good Roads Board and confirmed by order-in-council. The government pays two-thirds of the cost. Main market roads are selected by the municipality and approved by the Good Roads Board. Main market roads are divided into two classes, gravel or other surfaced roads (on which the government pays one-half the cost), and earth roads (on which the government pays one-third the cost).

Under "Aid to Municipalities," the government also makes direct grants to municipalities for road work.

Organization

The Alberta Act makes no provision for organization for the carrying out of the act, nor was this organization mentioned in the papers from that province. In Saskatchewan, up to 1917, the main roads were constructed by a government construction organization working directly under the control of the department. Other roads on which the government pays a portion of the cost are carried out by the municipal organizations. I should imagine that very little, if any, of the work has been done by contract. In Manitoba the engineer is given a more prominent part than in the other provinces. A staff of engineers is provided for by the act and all work must be done under the direction of, and to the satisfaction of, the engineer. All works must be done by contract unless a special arrangement is made between the Good Roads Board and the municipality.

The three provinces agree in that the great majority of roads will for some time be earth roads and that the most of the energy should be concentrated in a study of the proper method of their construction.

The great waste incurred through methods used in municipal road construction by municipal authorities was strongly emphasized and the need for proper engineering supervision was strongly brought out. More than one member emphasized the need and duty of the institute to take up the question of road construction and lead the way, not only in actual construction but in general road policies. A committee of three was appointed to make a study of road specifications and road policies and to report to the next western professional meeting.

*Report made September 19th, 1918, to Manitoba Branch of the Engineering Institute of Canada.

PORT OF ST. JOHN WILL DEVELOP, SAYS INSTITUTE SECRETARY

ON his way back to Montreal from Halifax, N.S., where he attended the general professional meeting of the Engineering Institute of Canada, Fraser S. Keith, secretary of the Institute, gave an interview to the St. John newspapers in which he emphasized the importance of that port and its prospects for development. "Canada," said Mr. Keith, "is regarded by the Engineering Institute as comprising four great divisions for technical consideration, the respective centres of which are St. John, Halifax, Montreal and Vancouver. These four cities are certain to be the big commercial centres of Canada. Of these, St. John has the advantage over Montreal of being an all-year-round port and for this reason should participate to a marked degree in the greatest industrial development the world has ever seen in the after-the-war period.

"There is a real harbor here," said Mr. Keith, "and the Federal government has approved of a greater contemplated expenditure for St. John than it has for any other city in Canada. I have travelled east from the Pacific Coast, and despite only a brief and hurried observation of conditions here, I am convinced that St. John is enjoying an excellent period of activity and is certain to develop to a remarkable degree among the leading cities of the Dominion during and especially after the war.

"The Engineering Institute of Canada is going after legislation in New Brunswick, as elsewhere, through the University of New Brunswick and other universities, in order to protect the public from reckless expenditure due to unskilled engineers, and will endeavor in every way to bring the public to realize the importance of the engineering profession as represented by the responsible and thoroughly competent engineers who aim and who are working with might and main through the Institute to raise the engineering standard, to get for Canada in the most efficient, quickest, most reasonable and most economical manner, development and results proportionate to the marvellous resources of the Dominion and in keeping with the splendid opportunities offered at present and certain to follow in the golden age after the war."

Mr. Keith referred to the fact that about 1,000 members of the Engineering Institute, or nearly one-third of the membership, are or have been in active service at the front.

PROVINCIAL POLICY OF ALBERTA IN FINANCING ROADS*

By L. C. Charlesworth
Deputy Minister of Public Works, Alberta

I HAVE been asked to say something with regard to "The Provincial Policy of Alberta as to the Financing of Roads." I am not just sure what phase of the question it is desired that I should discuss, but there are several different angles from which the subject may be approached, any one of which opens up a wide field. At first thought, "the provincial policy of Alberta as to the financing of roads" appears to mean the question of raising the money which is spent on roads by the province. This leads us to the question of what roads the province is to assume responsibility for, and the extent of that responsibility.

There is also the question of how good, *i.e.*, how expensive, a road is justified in each particular case.

In practice generally, the commonest financing question to be solved is, how to build a road costing two or three thousand dollars, which is absolutely needed, with one thousand dollars, which is all there is available for the purpose.

So far as Alberta is concerned, the passing at the last session of the legislature of an act entitled "The Public Highways Act," has settled for the time being some of these questions. This act provides for the division of all the highways in the province into three classes—main highways, district highways, local highways, and the responsibility for the cost of construction and maintenance of a highway of any class is specifically set out in the act, as is also the proportion of the cost to be borne by the province and by the local authority of the municipality within which the highway lies.

Main Highways

Main highways are defined as "Such highways as the minister of public works deems to be of prime importance, either by reason of being trunk channels of communication between the more important cities and towns of the province, or with the main travelled roads, situate outside and adjoining the province, or for other good reasons." The location of these main highways is established only after consultation with the municipal authorities in the municipal districts within which they lie, and the route is then laid down exactly upon a map. This map forms the basis of an order-in-council establishing the road as a "main highway" under the act.

The cost of construction of these main highways is to be borne jointly by the Department of Public Works and the local authorities in the proportion of seventy-five and twenty-five per cent. respectively, and the cost of maintenance is to be borne entirely by the department.

"District highways" are those which the minister considers to be of less importance generally than main highways, but still of considerable local importance. Their location is to be established by order-in-council in the same manner as main highways, but only after agreement with the municipal authorities of the districts through which they are intended to run. The cost of construction is to be borne by the department and the local authorities jointly in the proportion of twenty-five and seventy-five per cent. respectively, and the cost of maintenance is to be borne entirely by the local authorities. In the case of district highways, the minister may direct that districts through which the highway does not in fact pass, shall contribute towards both the original cost of construction and the cost of maintenance. This provision is made because the case may frequently occur where the people most in need of a particular road to a market town reside in another municipal district.

Local Highways

"Local highways" are all such highways in the province as are not classified as main or district highways, and they are to be constructed and maintained entirely at the expense of the local authorities within whose district they are situated.

The control of construction shall, in the case of main highways, be under the Department of Public Works, and in the case of district highways, either under the department or the local authorities as agreed upon, and in default of agreement, under the department, and in the case of local highways, under the local authorities.

Provision is made in the act for recovery by the department from the local authorities of their proper proportion of the cost of highways constructed.

Provision is also made that where the local authorities fail to properly maintain a district highway after sufficient notice, the department may step in and properly repair and maintain the same, and recover the cost of so doing from the local authorities.

A highway under the act by definition includes any bridges thereon, but a special clause in the act provides that the department may repair any bridge on any highway in case of flood or accident, and where the legislature votes the money for the purpose may build or rebuild any bridge. This provision was made, doubtless, because it was felt that in many cases bridges of the larger sizes were often beyond the financial ability of the local authorities, and that they had not sufficient experience or equipment to deal with such matters as efficiently as the department.

The minister is given power to make rules for the control of all traffic and vehicles on any highway. These rules will probably include some regulations as to the permissible load upon tires of different widths.

The act does not come into force in its totality until the first day of January, 1919, and in the meantime preparation is being made for the classification of the highways of the province.

Not Yet in Operation

As we have not yet operated under the act, we are not in a position to give any idea as to where its weaknesses lie. Doubtless it has faults, which can only be made apparent by its application, but we believe it to be a step in advance towards a system of roads in the province.

These remarks seem to have developed into an explanation of The Public Highways Act of Alberta more than a discussion of the financing of roads, but I trust they may be of some interest.

So far we have only earth roads, and there is no question but that for a long time to come the great majority

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*Paper prepared for the Engineering Institute of Canada, and read by J. D. Robertson at the Saskatoon Meeting.

of our roads must be of that nature, but with the motor car coming into use by nearly every farmer in the country, the value of the smooth road is being realized more widely, and the time is probably not far distant when the people will ask—and will be willing to pay, which is the big thing—for more permanent forms of construction, at least on main highways. Permanent highways cost considerable money, however, and the community must first be educated up to a willingness to bear this increased cost.

If one goes into figures it seems that it should be easy to convince the most pessimistic, for when one considers the saving in cost of hauling farm products, the saving in the cost of operation of motor cars, the saving on depreciation in value of vehicles of all kinds, and the lengthening of the effective life of horses, and the increase in the value of lands, there is without question splendid return for the investment in good roads, without taking into consideration their moral, civic and educational value.

"Hydro" Calls For Tenders on Four 52,500 H.P. Turbines

First Units For Chippawa-Queenston Power Development—Summary of the Specified Requirements—Thoroughly Modern Governor Equipment

TENDERS are being called until 4 p.m., October 1st, by the Hydro-Electric Power Commission of Ontario, for the initial hydraulic equipment of the Chippawa-Queenston power development. The work required consists of the design, fabrication, delivery, erection and test, ready for operation, of four single-runner vertical turbines, with spiral casings, arranged for direct connection to electric generators; also the supply and erection of the distributors or supply pipes, governors, governor pressure systems and all other accessories and attachments necessary for the generation, regulation and control of the required amount of power.

The site of the power house, as stated in *The Canadian Engineer*, issue of June 20th, 1918, in the article descriptive of this development, is at Smeaton's Curve on the Niagara River, about one mile south of the village of Queenston.

Each turbine is intended to drive at full gate one 3-phase, 25-cycle, 12,000 volt, internal revolving field generator of 43,900 k.v.a., 85 per cent. power factor, maximum rating. The generators will be arranged for parallel operation and will supply the Commission's Niagara system over a 110,000-volt transmission line.

The water will reach the turbines through riveted steel penstocks 14 feet in diameter and approximately 500 feet in length. The specifications for the turbines state that the normal net head available shall be taken to be 305 feet, the maximum gross head 323 feet, and minimum gross head 300 feet. This gross head is the total head between the forebay water level outside the gate house wall and the water level in the tailrace immediately outside the power house wall.

The constant speed of each unit will be 187.5 revolutions per minute. Each unit will have a full gate capacity of 52,500 mechanical horse-power at the generator coupling when operating under a net effective head of 305 feet, and at the above-mentioned speed.

Normal Load 47,000 H.P.

The generators will normally be operated at from 50 per cent. to 60 per cent. of full rated load. It is desired that the size and type of wheels be so selected that the best efficiency will be obtained at the normal load of approximately 47,000 horse-power on the turbine. Each runner will be a solid one-piece steel casting, the vanes being cast integrally with the crown and band. Alternative tenders will be received for the supply of cast iron or bronze in place of cast steel for the runners.

Alternative propositions are also desired on the basis of provision for the removal of the runners from below, through the draft tubes by lowering the runners from position by means of tackle passed through the hollow shafts, and removing them through the foundations by lowering the upper sections of the draft tubes.

Each speed ring will be made of cast steel in two sections, and will consist of upper and lower flanges on crowns, connected by approximately twelve stationary vanes, cast integrally with the flanges. These vanes will be formed in such manner as to direct the water efficiently through the casing of the guide vanes and will also act as stays to tie the upper and lower flanges together, to resist hydrostatic pressure acting upon the casing and to support all superimposed weight.

Tested at 260 lbs. per Square Inch

Each casing will be of spiral or volute type, of circular cross-section and made of cast steel. Its form will be such that the area of the water passages will be decreased in proportion to the discharge, so that the velocity will remain constant while producing a minimum of hydraulic loss. The casings will be tested in the contractor's shops hydrostatically to a pressure of 260 lbs. per square inch.

Alternative tenders will be received based on the supply of plate steel casing, the specified material for which is open hearth steel with maximum phosphorus .04 per cent., if made by basic process; .06 per cent., if made by acid process; sulphur shall not be over .05 per cent., and manganese between .3 and .6 per cent. The casings must be amply strong to withstand the strain due to sudden variations in hydraulic pressure due to governor operation or other causes, and will be designed to withstand twice the normal static head under working conditions due to sudden closing of the gates by the governors.

The upper portions of each draft tube will be made of cast iron, so designed that it may be set in exact conformity with the alignment of the shaft. It will be embedded in the concrete and will support the lower distributor plate. As mentioned above, alternative propositions will be received based on a telescopic draft tube, in which case the tube will be made in two sections, the upper conical section telescoping into the lower in order to permit the removal of the runner.

The cast iron split guide bearings will be of the water lubricated lignum vitae type. The piping connections will be such that water may be fed under ordinary conditions from each turbine casing to the lignum vitae bearing. Two filters will be provided, so arranged that cleaning or flushing may be accomplished without cutting off the bearing lubrication.

The turbine shafts will be of open hearth forged steel, with the following physical characteristics:—

Ultimate tensile strength not less than 75,000 lbs. per square inch; elastic limit, 37,500 lbs. per square inch; elongation under 2 inches, at least 25 per cent.; reduction of area, at least 40 per cent.

The governors will be of the water pressure type and will be supplied with distant speed controllers, hand controls, gate limiting devices, over speed shut down devices, manual speed adjustments, gate opening indicators and tachometers.

The governors will be adjusted to normal time of 3 seconds for closing the gates of the turbines.

Devices will be provided which will close the gates automatically if a governor belt breaks or other similar accident occurs. The governors must readjust the gates whenever the speed varies more than one-half of 1 per cent. from normal. The specifications state that they must not race or hunt, but must come to rest quickly when not again disturbed by changes of load or head.

Tenderers are asked to specify the data on which they can deliver the turbines and governors, and tenders are being asked in the following six ways:—

(1)—Lump sum tender, erected complete; (2)—lump sum tender, f.o.b., works; (3)—cost plus ...... per cent., giving estimated cost complete; (4)—cost plus ...... per cent., giving estimated cost f.o.b., works; (5)—cost plus fixed sum of $......, giving estimated cost complete; (6)—cost plus fixed sum of $......, giving estimated cost f.o.b. works. Tenderers are allowed to quote on one, two or three units, or on all four units. Quotation is also asked on spare runners.

COMBINED OR SEPARATE SEWER SYSTEMS

In an effort to lay down somewhat definite principles for guidance in determining whether the combined or separate sewage system should be adopted, the Engineering Department of the Bureau of Industrial Housing and Transportation of the U.S. Department of Labor has issued the following tentative instructions:—

Conditions Favoring Separate System

The separate system of sewers is indicated as most desirable when the following conditions obtain:—

Where storm water does not require extensive underground removal or where it can be concentrated in a few shallow underground channels.

Where drainage areas are short and steep, facilitating rapid flow of the water over street surfaces to the natural water courses.

Where the sanitary sewage must be pumped and additional cost of pumping even of a small amount of storm water is great.

Where the sanitary sewage must be purified and storm water is a combined system either purified or by-passed—either scheme requiring large purification plant capacity or creating nuisance due to the overflow of objectionable refuse.

Where the sewers are being built in advance of a city's development to encourage growth, the separate system often provides a maximum number of miles of sewer for a minimum of expenditure.

The storm sewers, if ever required, may be gradually introduced later and rarely need to cover over about one-half the area covered by a sanitary system. This consideration, however, is not always applicable to the present intensive and complete housing development schemes.

A combined system of sewers must usually be relatively of larger capacity than a separate storm drain for the same area, because the storm drain may be overloaded at long intervals with slight inconvenience, whereas in a combined sewer any overflow is accompanied by a great nuisance and complaint owing to basement connections and consequent liability of flooding.

In general, rather rough topography with marked natural drainage and open spaced residential settlement not likely in the future to become dense, together with the desirability of sewage treatment indicates the separate system as the method most desirable.

Conditions Favoring Combined System

The conditions that indicate that the combined system is the one most desirable are as follows:—

Where it is evident that both storm water drains and sanitary sewers must be fully and completely installed throughout the entire length of the street in the district, it is obvious that the total cost will be far greater for the separate than for the combined system.

Where no pumping or purification is required at present or is anticipated in the future.

In general, flat topography without natural drainage and with dense settlement, or future liability to dense settlement, together with the lack of necessity of sewage treatment indicates the combined system as the method which is desirable.

Combination of Two Systems

The selection of system to be adopted should not follow hard and fast rules. Often in the same development it may be desirable to provide in one part the separate system, in another part the combined system, and still in another part a combination of the two methods. Occasionally a combined sewer may be introduced in a separate system to advantage with interception of its natural flow at some point before the outlet is reached. The economical and efficient method is only arrived at by outline design and cost comparisons of different projects.

Combined Systems and Treatment Plants

It does not always follow that where sewage treatment is involved the selection of the separate system is imperative. It is usually desirable but cases may arise where the combined system should be adopted although sewage treatment in some form is necessary. This latter condition will be the same ordinarily where—

(1) All streets must have storm water removal.

(2) Where very complete treatment is not necessary.

(3) Where high-grade effluent from the treatment plants is not warranted.

(4) Where storm flows can be safely and properly by-passed into flooded streams.

(5) And in general where cost of treatment works (considering operation as well) for a somewhat large normal flow are obviously less than the cost of duplicate sewers in full throughout the district drained.

Green, Dods and Co., Royal Bank Building, Toronto, have been appointed Canadian agents for Anderson and Co., 165 Broadway, New York, who are the American representatives of the French Mercantile Marine, and have recently placed in Canada contracts for wooden ships aggregating over $7,000,000.

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JAMES J. SALMOND — *President and General Manager*
ALBERT E. JENNINGS — *Assistant General Manager*

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr

Principal Contents of this Issue

LEGISLATION AND THE "MINERS"

SINCE the publication of the editorial regarding the Canadian Mining Institute which appeared in *The Canadian Engineer* for August 22nd, 1918, officials of the Engineering Institute of Canada have assured Secretary Lamb, of the Mining Institute, that there is no ground for his fear that legislation sought by the Engineering Institute would put the Mining Institute "out of business."

In the month that elapsed between the publication of the August Bulletin and of the September Bulletin of the Mining Institute, Mr. Lamb apparently altered his views considerably, at least regarding the attitude of the Engineering Institute toward the Mining Institute. It is interesting to read what he published, as editor of the Bulletin, in his August issue, and then to read the following leading editorial, entitled "Legislation and Engineering," in his September issue, just published:—

"One of the questions considered at the professional meeting of the Engineering Institute of Canada at Saskatoon, early in August, was the important one of the desirability of securing in the various provinces in the Dominion, the passage of legislation to govern the status of engineers in Canada.

"It may be admitted frankly that in certain quarters suspicions have been entertained that the Engineering Institute of Canada had ulterior motives in proposing the introduction of legislation of this character; that in short it had hegemonic aspirations which it hoped to satisfy by using the lever of legislation to force all engineers in Canada into its ranks under the threat that if they failed to come in they would be debarred from practising their profession. From the sentiments expressed by the executive officers and other leading members of the Society at the Saskatoon meeting any suspicions of this kind may now be laid at rest. To be able to make this statement is eminently gratifying.

"Every member of the Institute will approve, without doubt, of the general proposition that legislation is needed for the better regulation of the practice of engineering in this country, with a view, not only to affording the engineer himself a greater measure of protection, but also for the protection of the public. The Engineering Institute of Canada has signified its intention to seek the co-operation of the Canadian Mining Institute in the carrying out of these proposals for the introduction of such legislation, the main object of which is to ensure that only properly qualified engineers shall be permitted to practice in the Dominion.

"The present evidence of goodwill on the part of the Engineering Institute of Canada will undoubtedly be appreciated by our members. Manifestly, it is to the common advantage that the relationship between the two societies should be of the most friendly and cordial nature. Such a spirit should be fostered. The activities of both societies are primarily inspired by disinterestedness, a desire to serve. This purpose can be accomplished in many directions most effectively by co-operative effort. In fact, never was the time more opportune than at present for the organization in Canada of the technical bodies for united endeavor for the advancement, not only of the special interests they represent, but for national service.

"In the United Engineering Society of New York we have an example of the splendid results that may be obtained through organization on these lines. Most fortunately, we have already in the Canadian Engineering Standards' Committee, recently established under the chairmanship of Sir John Kennedy, a national organization representing the various engineering interests and principal technical and industrial societies of the Dominion. While this committee was appointed to undertake a specific work, it is eminently qualified to serve the wider purposes and assume the more comprehensive duties of a Canadian Engineering Council; and to enable it to do so it is merely requisite to clothe it with the necessary authority and to change its designation.

"The establishment of a properly constituted Engineering Council to advance the engineering arts and sciences in all their branches, to co-ordinate the work of the societies it would represent for the promotion of the common good and for national service, is in the highest degree desirable—more, it is an imperative need."

CLOSING THE PROFESSION

IT can be taken for granted that steps will be taken soon —probably by joint action of the Engineering Institute of Canada and the Canadian Mining Institute—to secure legislation in the interest of the engineering profession. At the recent meeting at Saskatoon, and at the meeting of Toronto engineers held last April, the sentiment was almost unanimously in favor of such legislation being sought.

While the Engineering Institute of Canada will be the prime mover in securing such legislation, and rightly so, no institute should be the medium through which the law is put into actual effect. In *The Canadian Engineer* for April 25th, 1918, we commented upon Mr. C. E. W. Dodwell's assertions that membership in the Engineering Institute should be required as an indispensable condition precedent to appointment in the Public Works service and that such membership is "the *only* guarantee, test, diploma or certificate that a man is a qualified engineer." In commenting upon these statements at that time, we suggested some of the difficulties in the way of creating the condition outlined by Mr. Dodwell. It is evident that these difficulties are now fully recognized by the authorities of the Engineering Institute of Canada, as we are informed that the members who are actively supporting the movement for legislation feel that no legislation should be sought which is not eminently fair to all qualified engineers, whether they be members of the Engineering Institute or not. That is the proper attitude for the Institute to take, and is the one which we felt sure would be taken by the broad-minded men who form nine-tenths of the membership of the Institute. Education—theoretical and practical—is the test of an engineer's ability more certainly than membership in *any* society. Memberships can be gained on flukes at times; on the other hand, well-educated and well-trained men may have private reasons for remaining outside of various societies. Membership in societies does not make an engineer any more than membership in a church makes an honest man. If he is a church member, a man is likely honest, but not necessarily so. If he is a member of a recognized engineering society, a man is likely a qualified engineer, but not always so. And just as there are honest men who are poor church attendants, there are also good engineers who do not belong to this or that engineering society.

Engineers can be and should be compelled to have education and practical experience before being entrusted with responsible engineering work. But engineers should not be compelled to join societies. It may be good for them to fraternize with their fellow men, to listen to the reading of papers, to attend meetings, to pay dues and to march with the times, but these matters should remain optional and voluntary, not compulsory.

Licensing of engineers is desirable. Licensing of engineers will come and must come,—the engineers are agreed upon that. But licensing of engineers is a State function, carried out by provincial or Dominion governments, by means of impartial examining boards, without reference to creed, nationality, color or society membership.

The Dominion Government has announced the personnel of the new board of directors of the Canadian Northern Railway as follows:—D. B. Hanna, president; Major Graham A. Bell, Deputy Minister of Railways and Canals; A. J. Mitchell who has been comptroller of the C.N.R. for a number of years; Robert Hobson, executive head of the Steel Company of Canada; F. P. Jones, general manager of the Canada Cement Co., and vice-chairman of the War Trade Board; E. R. Wood, financier, Toronto; R. T. Riley, a prominent business man of Winnipeg; and C. M. Hamilton, farmer, of Weyburn, Sask.

Robert Harmer, president of the Sawyer-Massey Co., Ltd., of Hamilton, Ont., speaking for the tractor manufacturers of Canada, has protested against the present attitude of the Canadian Government in regard to the removal of the duty on the tractors from the United States without any compensating arrangement for fixing the prices of raw materials for Canadian manufacturers. The Sawyer-Massey Co. have been manufacturing engines, threshing machinery and other farm apparatus for the past eighty years, and have been very successful for a number of years in the manufacture of tractors. Mr. Harmer believes that the Canadian manufacturers could supply all Canadian demands for tractors. He says that if the present discrimination continues indefinitely without any definite announcement from the government regarding its policy, Canadian tractor manufacturers will have to consider the removal of their plants to the United States.

PERSONALS

J. A. Cook has been appointed assistant superintendent, Smith's Falls Division, C.P.R., in place of H. J. Main, transferred.

F. A. Dallyn, engineer of the Ontario Board of Health, will accompany the Canadian expeditionary forces to Siberia. He will have charge of the water supply.

Dr. J. W. S. McCullough, Medical Officer of Health for Ontario, has reconsidered his decision to join the Siberian expedition, as he has been urged by the provincial cabinet to remain in his present position, where he is doing work of national importance.

Chas. A. Magrath, fuel controller of Canada, has assumed, at the request of the Dominion Government, additional duties as director of coal operations for Nova Scotia and New Brunswick, with power to make all necessary investigations, regulations, etc., to increase the quantity of coal being mined in those provinces.

Parkhill & Hanson, Limited, is the name of a new firm of power and fuel engineers in Winnipeg. J. H. Parkhill is the president; E. C. Hanson is the engineer, and Dr. R. D. McLaurin, of the University of Saskatchewan, is the consulting chemist of the company. Mr. Hanson was for a number of years electrical engineer of the city of Saskatoon.

Robert Hobson, president of the Steel Company of Canada, has been appointed a director of the Canadian Northern Railway. Mr. Hobson has been intimately connected with the production of iron and steel for many years. He is a member of the American Institute of Mining Engineers. In 1908 he was president of the Canadian Manufacturers' Association.

Frank P. Jones, Montreal, vice-chairman of the War Trade Board and general manager of the Canada Cement Co., has been appointed to the reconstituted directorate of the Canadian Northern Railway. Mr. Jones was born at Brockville, Ont. For some years he was in the employ of the Nova Scotia Steel & Coal Co., and afterwards general manager of the Dominion Iron & Steel Co., and then became manager of the Canada Cement Co.

Lucius E. Allen, consulting and constructing engineer, Belleville, Ontario, has been appointed consulting engineer to the Nitrate Division, Ordnance Department, U.S. Army. Mr. Allen will have the rank of captain, and will have charge of important work in connection with the Ordnance Department. Mr. Allen was county engineer of Hastings County for seven years, and has frequently contributed papers on highway bridges and road problems before various associations in Canada.

Joseph Race, city bacteriologist of Ottawa, has resigned in order to accompany the Canadian expeditionary force to Siberia. Mr. Race has obtained a commission as captain in the Canadian Army Hydrological Corps and will be in charge of the hygienic laboratory of the base hospital. He is a fellow of the Institute of Chemistry and is well known for his research work in water chlorination, and is the originator of the chloramine method of sterilization. A book on chlorination by Mr. Race is now on press.

OBITUARY

Richard R. Baugham, who was for fourteen years street commissioner at Windsor, Ont., died last week at the age of sixty-seven.