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Progress in Toronto Harbor Development

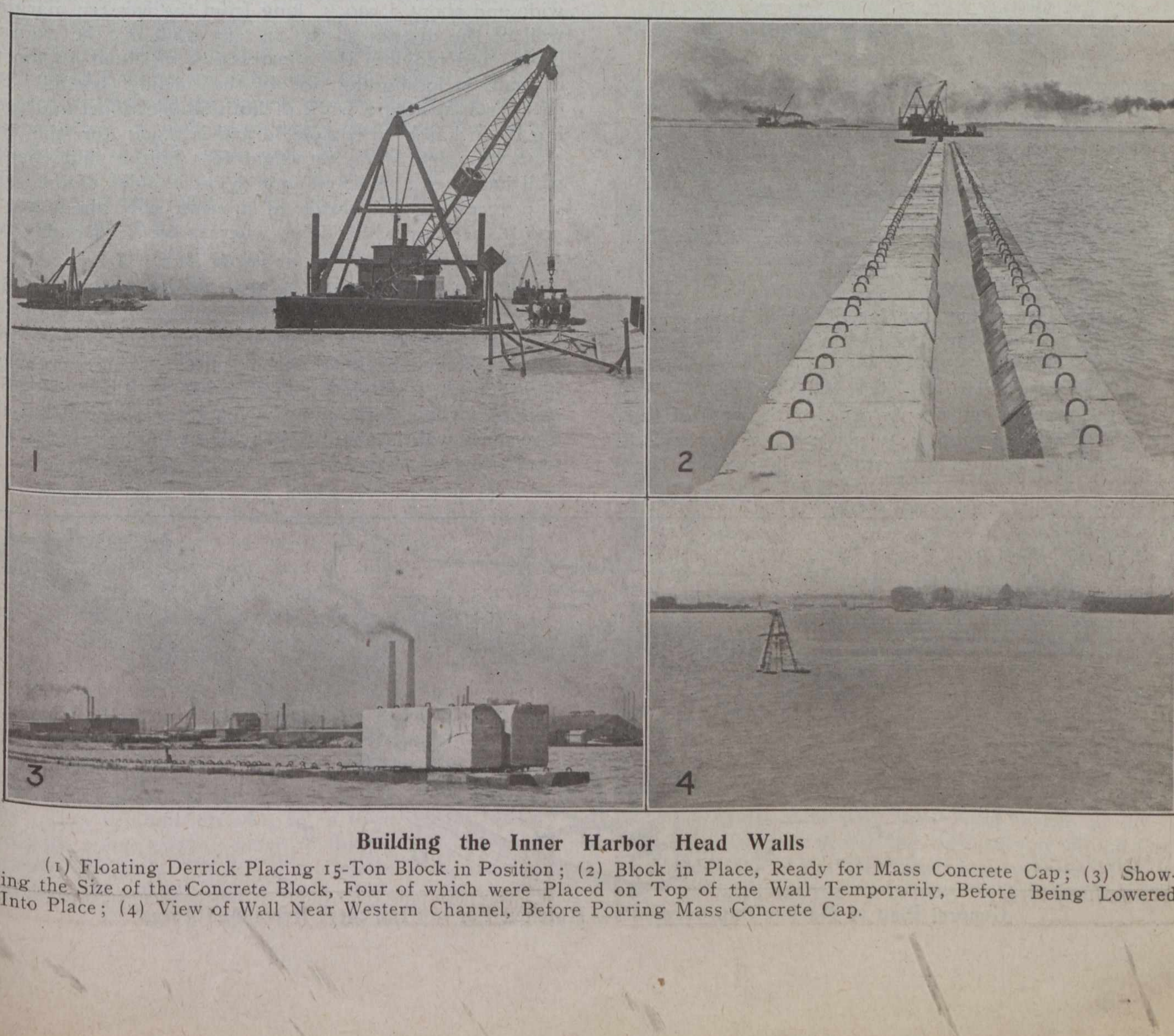
Commission's Energies Now Concentrated on Completion of the Harbor-Terminal District and Inner Harbor Dock Construction, in Order to Provide Sites and Facilities for New Industries—Review of Work That Has Been Done and Outline of Plan for Future Activities

CONSIDERABLE progress has been made this year in the Toronto Harbor work, especially in regard to the more utilitarian portion of it—that is, the Toronto Harbor Industrial District in the Ashbridge's Bay section of the city, or, as it is officially called, the Harbor-Terminal Industrial District.

The reclamation of two hundred and fifty-seven acres of land in that district has been fully completed and, of these, 171 acres have already been leased to industries upon a valuation of from twenty to thirty thousand dollars an acre. Most of the leases have been for a period of twenty-one years, at an annual rental of 5 per cent upon the valuation. Longer leases than twenty-one years can be arranged with the commissioners, but where longer leases are demanded, a higher average annual valuation is placed upon the property.

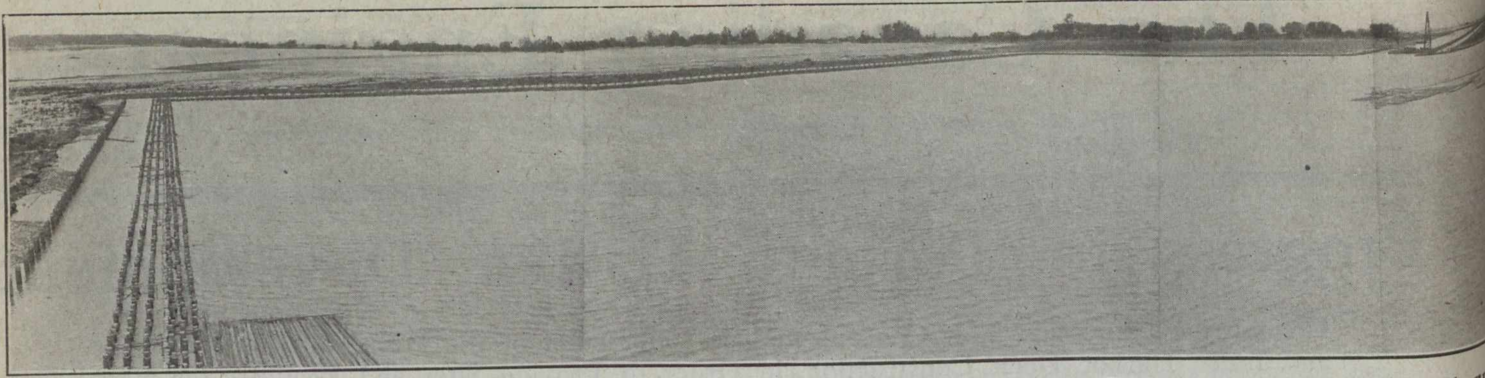
Two miles of streets have been laid out in the industrial district and these streets are now being sewered and paved and sidewalks constructed. There will eventually be a total of about 1,000 acres in the district, of which 700 acres will be available as industrial sites. The commission will also have about 190 acres of sites for lease at other points along the harbor north of Toronto Bay and south of the proposed railroad viaduct and adjoining or near the slips which are now under construction in Toronto Bay.

Only one dock has been completed in the harbor terminal district and that has been leased to the Canada



Building the Inner Harbor Head Walls

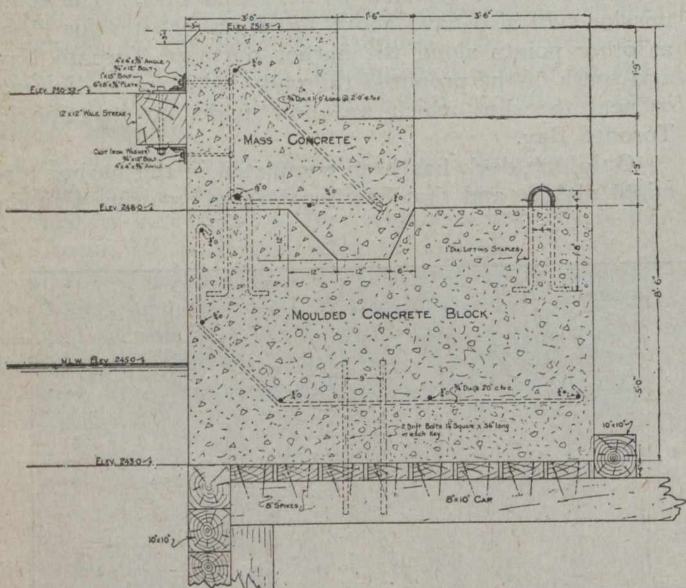
(1) Floating Derrick Placing 15-Ton Block in Position; (2) Block in Place, Ready for Mass Concrete Cap; (3) Showing the Size of the Concrete Block, Four of which were Placed on Top of the Wall Temporarily, Before Being Lowered Into Place; (4) View of Wall Near Western Channel, Before Pouring Mass Concrete Cap.



Panoramic View of Turning Basin and Ship Chann

Steamships Co. for a period of ten years as a coal terminal and is called Industrial Dock No. 1 and extends southwesterly from the western marginal wall of the district.

To August 3rd, 1917, the dredges had placed 2,978,010 cubic yards of material in the process of reclaiming the

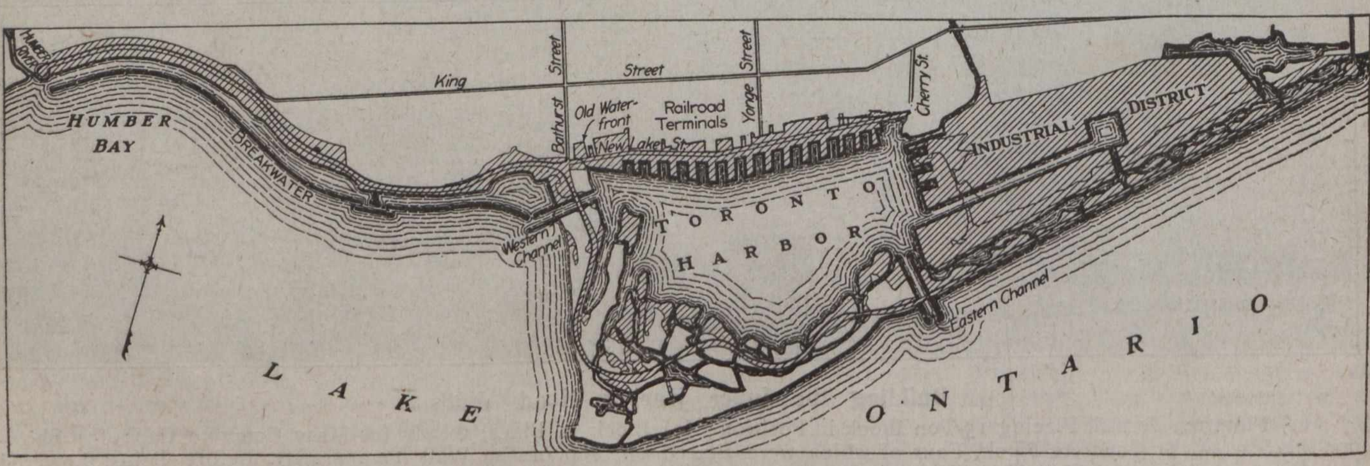


Concrete Superstructure for Standard Cribs, Inner Harbor Head Walls

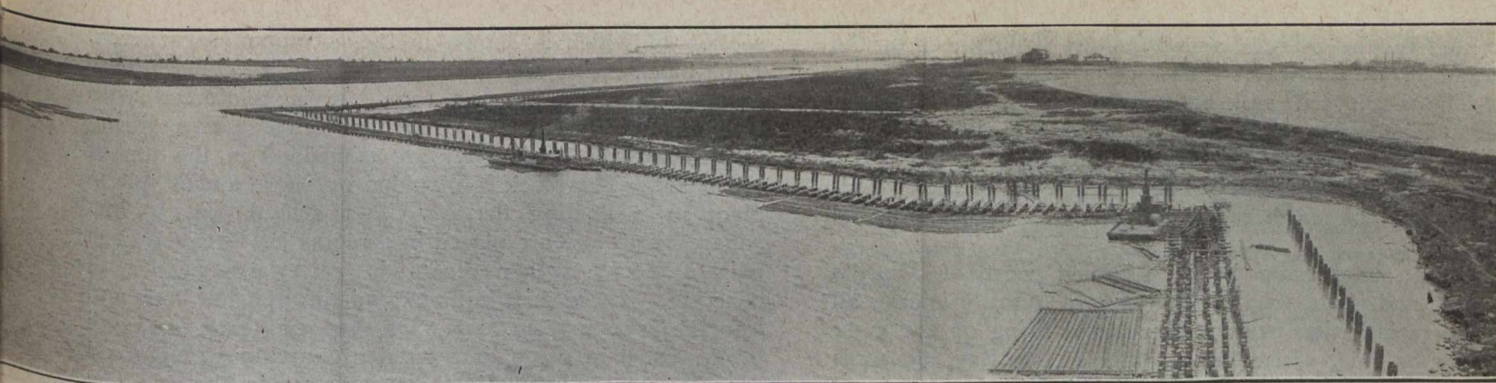
industrial-terminal district. This amount of fill has partially reclaimed about 60 per cent. of the area of that district, but the remaining 40 per cent. of the area is under a greater depth of water, and will require from 4,000,000 to 5,000,000 cubic yards of fill. The difference between the 600 acres, the reclamation of which has been partially accomplished, and the 257 acres mentioned above as having been fully completed (a difference of 343 acres), can be finished within a comparatively short time after the walls of the ship channel have been completed by the contractors, so that very soon after the completion of that contract, which is being handled by the Canadian Stewart Co., Limited, for the federal government, about 600 acres will be immediately available in the industrial-terminal district.

The accompanying plan gives a rough indication of the layout of the work. The ship channel can be noted running northeasterly from Toronto Harbor and ending in a square turning basin. This ship channel is 400 ft. wide and about 7,500 ft. long from the western marginal wall of the district to the eastern wall of the turning basin, and requires the construction of about 16,400 ft. of wall, including the wall of the turning basin. The entire sub-structure work of both ship channel and turning basin has been completed and is ready for the wall superstructure. Ten thousand feet of the ship channel wall has been completed, but the remainder of the work is progressing but slowly at present, only about 250 to 300 ft. per day being done, whereas 600 ft. per day was the amount hoped for by the commissioners.

The ship channel wall is mass concrete on 40-ft. piles with 12-in. x 12-in. x 40-ft. sheet piling in front, and with 2-in. anchor rods, 50 ft. long, every 10 ft., these rods being fastened back to anchor piles. The concrete cap is 8 ft. high, a slab being 21 ft. 2 ins. x 18 ins. extending over the whole deck, upon which the main wall is built. The main wall is about 9 ft. wide at the bottom by 3 ft. at the top, as shown in Fig. No. 2.



General Plan of Harbor Improvements— Hatched Portion Indicates Reclaimed Areas



Harbor-Terminal District, Toronto Harbor Improvement

Besides the improvement of the harbor-terminal district, the Toronto Harbor general plan includes boulevards, parks, bathing pavilions, beaches, restaurants, amusement parks and all of the other attractions necessary to the beautification and enjoyment of a modern water front, but owing to present conditions it is thought advisable to concentrate first on the completion of the harbor-terminal district so as to provide sites for the industries which wish to locate in Toronto, many of which are connected with munitions manufacture.

The other portions of the work have not been entirely neglected, however, and a certain amount of preliminary work has been accomplished throughout from the very easterly boundary of the Harbor Commissioners' jurisdiction, which is at Kew Beach just east of the Woodbine race-course, and just east of the harbor-terminal district, to the westerly limit, which is at the Humber River.

The harbor front will end, at the Humber River, in a neat curved bastion, or retaining wall, which has been designed to improve the appearance of the mouth of the Humber River as well as to retain the fill at that point. The design of this wall and the necessary stability analysis has been completed, and work had started on the pile foundation when it was held up by litigation over property ownership.

From the Humber River to Bathurst Street, or the western channel, the Harbor Commission's work consists of the construction of a breakwater and the reclamation of the land along the water front necessary for the boulevard, parkways, board walk and amusement areas which it is proposed to locate along this section.

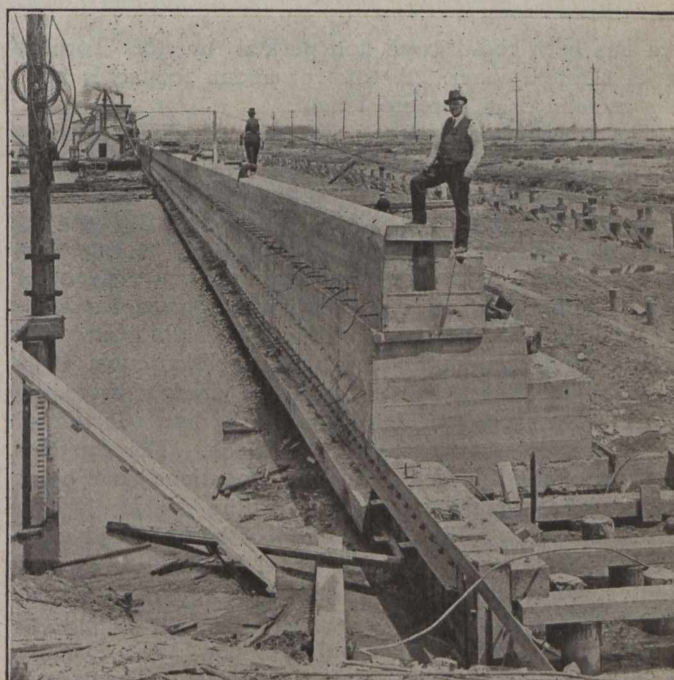
Ninety per cent. of the reclamation work or fill has been done from the Humber River to Beatty Avenue, or a little more than two-fifths of the way from the Humber to the western channel. The Keele Street, and Roncesvalles Avenue storm sewers have been extended to the new beach line and beyond, so as to discharge south of the breakwater. The breakwater along the western section is being constructed at an average distance of about 350 ft. from the new beach line and will be about 19,700 ft. long from the Humber River to the western channel. The cribs for 4,500 ft. of this breakwater have been completed (in 4½ sections of 1,000 ft. each) and are ready for the superstructure, which will be mass concrete. The top of the cribs have been floored as the bottom form for the concrete.

The cross-section of the cribs is square, 16 ft. x 16 ft. wide. They are built up of 10-in. x 10-in. bolted timber, filled with stone varying from 10 lbs. to 200 lbs. each. The concrete cap is 8 ft. high, the whole being standard close-face crib construction.

By fall, four million yards of fill will have been placed between Beatty Avenue and the Humber River, completing the reclamation work in that territory. Just north and west of the western channel, 1,700,000 cu. yds. of fill are being placed, of which about 1,000,000 yds. are for park purposes. At this point the Garrison Creek and Bathurst Street sewers are being jointly extended beyond the breakwater. The Spadina Avenue sewer is also being extended and in the eastern section of the city, the Booth Street, Logan Avenue, Morse Street, Carlaw Avenue and Leslie Street sewers will soon have to be extended.

The three most westerly sections, of 1,000 ft. each, of the western breakwater cribs will be capped this year. Another 1½ sections of cribs have been completed, adjoining the western channel, and may also be capped this year.

In order to accommodate the various aquatic clubs which will eventually locate on the Harbor Commission's



Ship Channel Wall, Typical Construction Mass Concrete on Piles

property, and more particularly to facilitate access for the present to the Parkdale Canoe Club House, a small steel foot bridge extending from King Street, at the foot of Wilson Avenue, across the right-of-way of the Grand Trunk Railway to the lake front, was erected. The steel was fabricated by the Dominion Bridge Co., and was erected by the bridges and buildings department of the Grand Trunk Railway. The foundations are of concrete.

The boulevard will be carried across the western channel by means of a bascule bridge and will be continued right around the island and over the eastern channel by another bascule bridge and on to the Woodbine along the southern margin of the harbor-terminal district.

Fifty acres have been reclaimed west of Ward's Island, and about twelve acres east of Ward's Island, all of the reclamation work at the Island being on the inner or harbor side. Just east of Blockhouse Bay, 65 acres have been reclaimed and at Toothpick Island a reclaimed section of which is shown in the accompanying sketch. Each block contains about 200 cubic feet of concrete and weighs approximately 15 tons. It is reinforced with ¾-in. rods placed every twenty inches. Two lifting staples 1 inch in diameter are embedded in the top of the block. The block is moulded on shore and is put in place by a floating derrick. Two drift bolts 1¼ ins. square by 36 ins. are placed in a recess left between each pair of blocks, which recess is afterwards filled with concrete. These drift bolts extend through the floor and into the 8-in. x 10-in. cap. On top of these concrete block, when in place, is poured a continuous reinforced concrete cap, as shown in the accompanying sketch. The

September 22nd, 1916 June 22nd, 1916

Looking East from the Humber River, Showing Reclamation

area has been top-dressed and parked by the Toronto Parks Commissioner. A total of about 200 acres have been reclaimed at Toronto Island.

The improvement of the water front along Toronto Bay has also been started, the work progressing easterly from the western channel. A series of slips or docks will be constructed along the water front as indicated on the accompanying plan. It is intended to build fourteen slips along the north harbor front, extending for a distance of approximately 2¼ miles. These will require the construction of about 88,000 lineal ft. of harbor head walls on cribs, and from six million to eight million cubic yards of fill. This fill will be sand and clay dredged from the harbor. No shoals will be left in the harbor. It will all be either deep water or sloping beach. The easterly terminus of the fourteen slips above mentioned will be at the foot of Parliament Street, near the National Iron Works property. The first section of harbor head wall, about 1,700 ft., was awarded to R. Weddell & Co., of Trenton, Ont., and the second section of 2,300 ft., to John F. Russell, of Toronto. These two firms have completed about 4,000 ft. of the cribs and have placed the concrete block superstructure on about 3,000 ft. The cross-sections of these cribs vary from 18 ft. x 18 ft. on the land end to 22 ft. x 22 ft. on the outer end, the harbor faces of the docks being the larger sections and the bulk-head faces of the docks being the smaller sections, the slip faces gradually increasing in size of section as they extend out from the bulk-head wall. These cribs are made up of 10-in. x 10-in. timbers, bolted together and filled with heavy stone. The cribs are floored with 4-in. plank spiked with 8-in. spikes to an 8-in. x 10-in. timber cap. On this floor rest moulded concrete blocks, cross-

mass concrete carries a 12-in. x 12-in. wale streak along its face, supported by angle irons which are bolted to the concrete. The reinforcing consists of ¾-in. diameter by 11-ft. long rods, placed every two feet. The portion of the mass concrete resting on each block weighs about 5 tons.

The bill of material for 100 lineal feet of concrete superstructure includes two 4-in. x 4-in. x ⅜-in. angles, 9.8 lbs. to the ft.; forty 6-in. x 8-in. x ⅜-in. plates, 5.1 lbs. to the ft.; and 12 lbs. of rivets; making a total of 2,176 lbs. of structural steel. Also 400 spikes, 120 bolts, 20 drift bolts and 40 cast-iron washers, making a total of 832 lbs.; 40 pieces of 4-in. x 10-in. planking, 12-ft. long; and one 12-in. x 12-in. waling streak. Also one hundred and ten ¾-in. bars, 11 ft. long, weighing 1.5 lbs. per ft.; eight ¾-in. bars, 100 ft. long, weighing 1.5 lbs. per ft.; one 1½-in. bar, 100 ft. long, weighing 6.008 lbs. per ft.; and eighty 1-in. bars, 5 ft. long, weighing 2.67 lbs. per ft.; or a total of 4,684 lbs. of reinforcing steel, all round bars. The 100 ft. of concrete superstructure of which this is the bill of material, contains 3,825 cu. ft. of block and 1,484.4 cu. ft. of mass concrete, so that per running foot the superstructure of the wall will contain approximately 1.42 cubic yards of block and .55 cubic yards of mass concrete, or a total of approximately 2 cubic yards of concrete per running foot.

All of these cribs in the inner harbor will be toe-pinned to rock, on the outer or harbor side, with 3-in. lug pins, to prevent buckling when back-filled and surcharged.

The Don diversion has been completed, as has also the northern slip which extends from Cherry Street to the Don River, and which affords 4,500 ft. of dockage along the northwestern corner of the harbor-terminal district.

This slip was constructed with 35-ft. arch web section Lackawanna steel sheet piling with mass concrete top. The streets that have been completed in the harbor-terminal district are the main arteries in the western section of the district adjoining or near this slip. Two-thirds of the Don diversion work was accomplished by the Harbor Commission's own forces, the Canadian Stewart Co. completing the other third of their government contract. The breakwaters are being built by the Canadian Stewart Co. under government contract and the reclamation work is being done jointly by the Harbor Commission and the Canadian Stewart Co.

The Harbor Commission own two 15-in. dredges and one 12-in. dredge and the Canadian Stewart Co. own two 24-in. dredges, the "Cyclone" and the "Tornado," built by the Polson Iron Works, Toronto. The length of the discharge line of the "Cyclone," during the year 1916, ranged from 900 ft. to 4,552 ft., averaging 3,673 ft. per hour of pumping. That of the "Tornado" ranged from 1,600 ft. to 4,317 ft., averaging 2,963 ft. per hour of pumping. During the same year, the average pumping rate of the "Cyclone" was 623.3 cubic yards per hour, and that of the "Tornado," 626 cubic yards per hour. The dredge berths measure 795 square feet. The specifications for these dredges called for a maximum discharge of 600 cubic yards per hour at 6,000 ft. The average length of discharge throughout the job is estimated to have been nearly 4,000 ft. These two dredges were described in a four-page article, with twelve illustrations, in the August 5th, 1915, issue of *The Canadian Engineer.*

The three Harbor Commission dredges were transferred to the commission by the city of Toronto. The 12-in. suction dredge is built of wood throughout, equipped with a tandam compound main engine, 10-in. x 17-in. diameter cylinder by 15-in. stroke, approximately 107 h.p. The centrifugal pump is of cast steel, 12-in. suction and 12-in. diameter, and is belt-driven. The other two dredges have steel hulls and are equipped with triple expansion main engines, 8¼-in. x 13½-in. x 22-in. diameter by 16-in. stroke, 210 h.p. The centrifugal pump shells and impellers are of cast steel. The pumps are driven direct from the engine. They have 15-in. diameter suction and 15-in. diameter discharge.

Besides these dredges, the commission own seven derricks, two pile drivers, two tugs, one floating concrete mixing plant and eleven scows.

The Canadian Stewart Co. have done most of the reclamation work in the industrial district. The commission hope to have the entire industrial area completed before the end of the year 1918, and while the commission will go ahead as readily as conditions permit with the completion of the harbor-terminal district and the inner harbor development, they will slacken up on the park work and other less productive portions of the plan as being unnecessary in war time. It is not likely, therefore, that much of the 11.19 miles of the proposed boulevard will be built until after the war. From the Humber River to the western channel the plan calls for 4.14 miles of boulevard, 3.71 miles on the Island and 3.34 miles from the eastern channel to the Woodbine. As the crow flies, it is 8.66 miles from the Humber to the Woodbine.

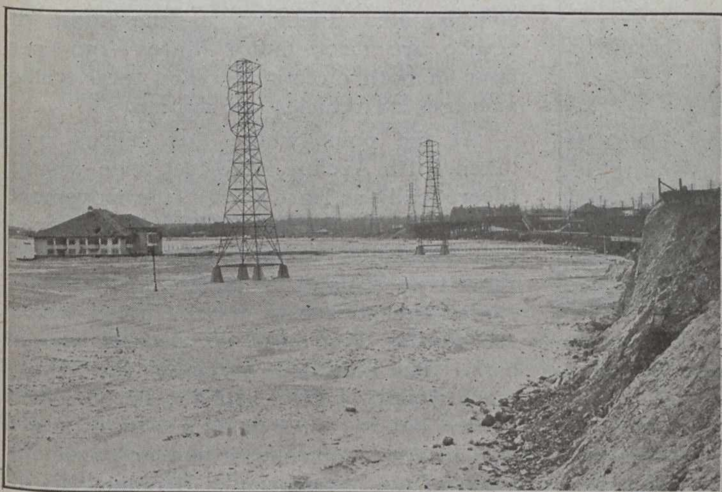
The roads and sidewalks in the industrial district have been built by the commission, as have the storm sewers, which are from 18 ins. to 30 ins., some concrete and some tile. The pavements are of concrete. It is planned to lay concrete pavements throughout the industrial district and either asphaltic macadam or concrete for the boulevard.

A bridge is being built across the Don diversion at the foot of Cherry Street. The Harbor Commission's forces have completed the foundations, and the steel is now being fabricated by the Dominion Bridge Co. The bridge is a single leaf Strauss trunnion bascule with 120-ft. span. The span rests on the concrete walls of the channel when lowered. The entire weight of the bridge is borne on four concrete piers on the south side of the channel, steel sheet piling circular caissons having been sunk to rock.

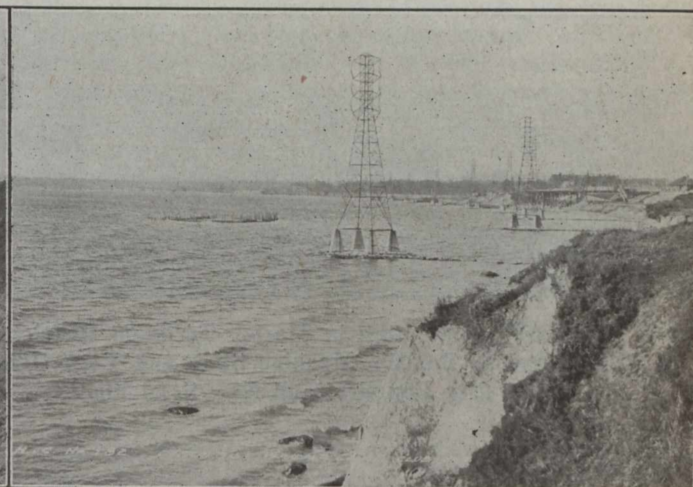
To carry the G.T.R. railway tracks over the Don River just north of the Don Diversion, a plate girder bridge will be built. This bridge has been designed by the Harbor Commission and an order-in-council is now being awaited for calling for tenders for its construction. This will be a Dominion government contract. Another bridge, to carry the wide roadway over the river at about the same place, is being designed.

A marine railway had been designed for the Don yard, but now that Toronto has a floating dry-dock, the plans for the marine railway have been abandoned.

All of the government work on the harbor is under the direction of an advisory commission, consisting of Roger Miller, contractor, of Toronto and Ingersoll; Fred.



May 21st, 1917



December 19th, 1913

Showing Reclaimed Area Near Parkdale Canoe Club, Looking West

Hand, resident engineer for the government in charge of the ship channel work; and E. L. Cousins, chief engineer and manager of the Toronto Harbor Commission.

Lionel H. Clarke is chairman of the Toronto Harbor Commission; E. L. Cousins, chief engineer and manager; James R. Wainwright, assistant chief engineer; George T. Clark, designing engineer; A. C. Mitchell, superintendent of construction; N. D. Wilson, engineer of surveys and lands; J. E. Hollaman, assistant on special works; H. S. Bedell, chief draftsman; John Lee, secretary; J. S. Murray, comptroller; J. S. Cole, purchasing agent; and A. H. Chapman, consulting architect.

Type of Structures Being Built in Harbor-Terminal District. From Left to Right, Harbor Board's Machine Shop and Yard Offices, Queen City Foundry, and New Steel Plant

We are indebted to Messrs. Cousins, Wainwright and Lee for the above information, to Mr. Clark for the diagrams, and to Mr. Hollaman for the photographs.

Among other illustrated articles that have appeared in *The Canadian Engineer* regarding the Toronto Harbor work, are the following:—November 21st, 1912 describing the general scheme; October 1st, 1914, describing 1913 engineering features of the work and giving synopsis of 1914 activities; June 10th, 1915, reviewing the previous work and that then under way; August 5th, 1915, describing the "Cyclone" and "Tornado" dredges.

STATE SUBSIDIZED STEEL PRODUCTION IN NORWAY

For some time means have been discussed for increasing Norway's production of iron and steel, so as to make the country more independent of foreign supplies, a shortage of which might prove a most serious matter, not only for the Norwegian industry, but also, and even more so, from a military point of view. The Strömmen works will receive a subsidy of 51,200 kroner, so as to be able to increase their production of steel from 5,000 tons to 10,000 tons per annum. In order further to increase the Norwegian production of steel from 12,000 tons to 24,000 tons and to put down a rolling mill having a minimum annual production of 10,000 tons of rolled products, the Christiania Spikerverk is to receive, for a period of five years, a premium of 8 kroner per ton of rolled steel made. The new installations at the Strömmen works are not supposed to commence operations until war mobilization takes place, and the steel to be produced there will be ingots for projectiles, etc. The Christiania Spikerverk, on the other hand, is to start under the new scheme in peace time only, and its rolled products are to be mainly for use in ferro-concrete work.

The total imports of English coal into France during the first four months of this year amounted to 5,500,000 tons, as against 6,409,000 tons during the corresponding period in 1916, and 5,892,780 tons in 1915.

NEW TRAFFIC RECORD ESTABLISHED

Fifth Avenue at 42nd Street, New York, has long been known as the heaviest traffic centre in the United States, says a bulletin issued by the Barber Asphalt Paving Co. A traffic census just completed by the Fifth Avenue Association shows that in spite of every effort to divert vehicles to other streets, the Avenue is maintaining its reputation. According to the association figures, which represent vehicles of all kinds passing the Public Library, between 41st and 42nd Streets, the volume of traffic totals in 10 hours (from 8 a.m. to 6 p.m.) 16,960 vehicles. Northbound and southbound traffic is about the same—8,513 northbound and 8,447 southbound. Included in the total of 16,960 are 1,296 motor 'buses—130 per hour in both directions. The total traffic averages 28 vehicles per minute.

At the point where this census was taken Fifth Avenue is 50 feet wide which, theoretically at least, permits the movement of six lines of vehicles. The count showed that passenger motor vehicles composed about two-thirds of the traffic, but these included the ponderous motor 'buses which are heavier than most commercial motor cars. The pavement carrying this enormous weight is sheet asphalt, 1½-in. close binder and 1½-in. top, on a 6-in. concrete base. It was laid in 1913, replacing a similar pavement which was 17 years of age when relaid. The analysis of the top mixture used in this pavement shows a high percentage of bitumen and a correspondingly high proportion of fine material. An average of 11.7 per cent. of Trinidad asphalt was maintained throughout the laying of the pavement, although 10.5 per cent. was all that was required. The complete analysis of the surface mixture is as follows, the standard being given for comparison with the actual composition of the Fifth Avenue pavement:—

	Standard.	Fifth Avenue.
Asphalt	10.5%	11.7%
200 mesh	13	17.3
100 "	13	10
80 "	13	22
50 "	24	23
40 "	11	5
30 "	8	8
20 "	5	2
10 "	3	1

The box measurements for the top mixture were 720 lbs. of sand, 105 lbs. of dust, and 175 lbs. of asphalt cement. For the binder course the measurements were 600 lbs. of stone, 310 lbs. of sand and 90 lbs. of asphalt cement.

By a recent decision of the court of appeals at Albany, N.Y., the International Bridge Company must live up to the literal terms of its American charter, and erect a foot and carriageway addition to the International Bridge at Niagara.

The collieries of India, and especially those in the Bengal coalfield, have, during the past few years, been gradually adopting electricity as a motive power in place of steam. Companies owning a number of collieries have recently effected an economy by installing units at a central station and distributing electricity to the various collieries. Coal cutting machines have not made much headway, but there are several in use, chiefly of the "hammer" type worked by compressed air.

Effects of Grading of Sands and Consistency of Mix Upon Strength of Concrete

Tests of Cylinders in Which Twelve Sands of Predetermined Gradings Were Used, Cylinders and Beams of Five Consistencies of Mix, and Cylinders for Which Time of Mixing Varied from One-Quarter to Two Minutes—Paper Presented at Last Annual Meeting of the American Society for Testing Materials

By L. N. EDWARDS
Supervising Engineer of Bridges, City of Toronto, Ont.

THE rapid development and the wide application of plain and reinforced concrete in modern construction is without parallel in the history of materials. This change of status, from a minor material to one of first importance, has not been characterized by the degree of constructive criticism and conservatism which accompanied the adoption of iron and steel in the construction of bridges, buildings, and allied structures.

Laboratory experiments have multiplied to such an extent that the available data so produced are greater than those existing for any other single construction material. Engineers have sifted, culled and graded this information, and from it have evolved our modern practice in plain and reinforced-concrete design. Concrete has thus been studied mainly as a single material rather than as a combination of constituent materials and mechanical operations; each of which, taken individually, exerts a distinct influence upon the character of the combined product.

A definite knowledge of all the factors which tend to produce widely varying results, affecting the strength and permanence of structures composed wholly or in part of concrete, in the opinion of the author, is necessary to a thorough understanding of the full range of its usefulness. This necessarily involves not only the properties, selection and proportioning of the materials, but also the amount of water to be used, the method and thoroughness of mixing, the manner of placing, the temperature of seasoning, and various other factors affecting the practical operations involved in field construction. In former years the quality of the cement was considered as paramount in the production of concrete, but in the past few years the importance of the careful selection of other materials and of the field conditions attending the mixing, placing, etc., has been more generally recognized. However, aside from the limited investigations of a few individuals, very little information is available.

This paper presents the results of three series of tests made by the City of Toronto, Department of Works, in 1916, under the direct supervision of the writer.

Object and Scope of Tests

The tests were undertaken with the object of securing information relating to (1) the influence of the grading of sand, (2) the effect of the consistency of mix upon the strength and physical characteristics of the concrete produced, and (3) the effect of varying the time of mixing.

In so far as consistent with available facilities, the proportioning of concrete materials, the mixing of the concrete, and the preparation of test specimens were to be carried on under conditions which duplicated those usually accompanying actual field construction work under good supervision.

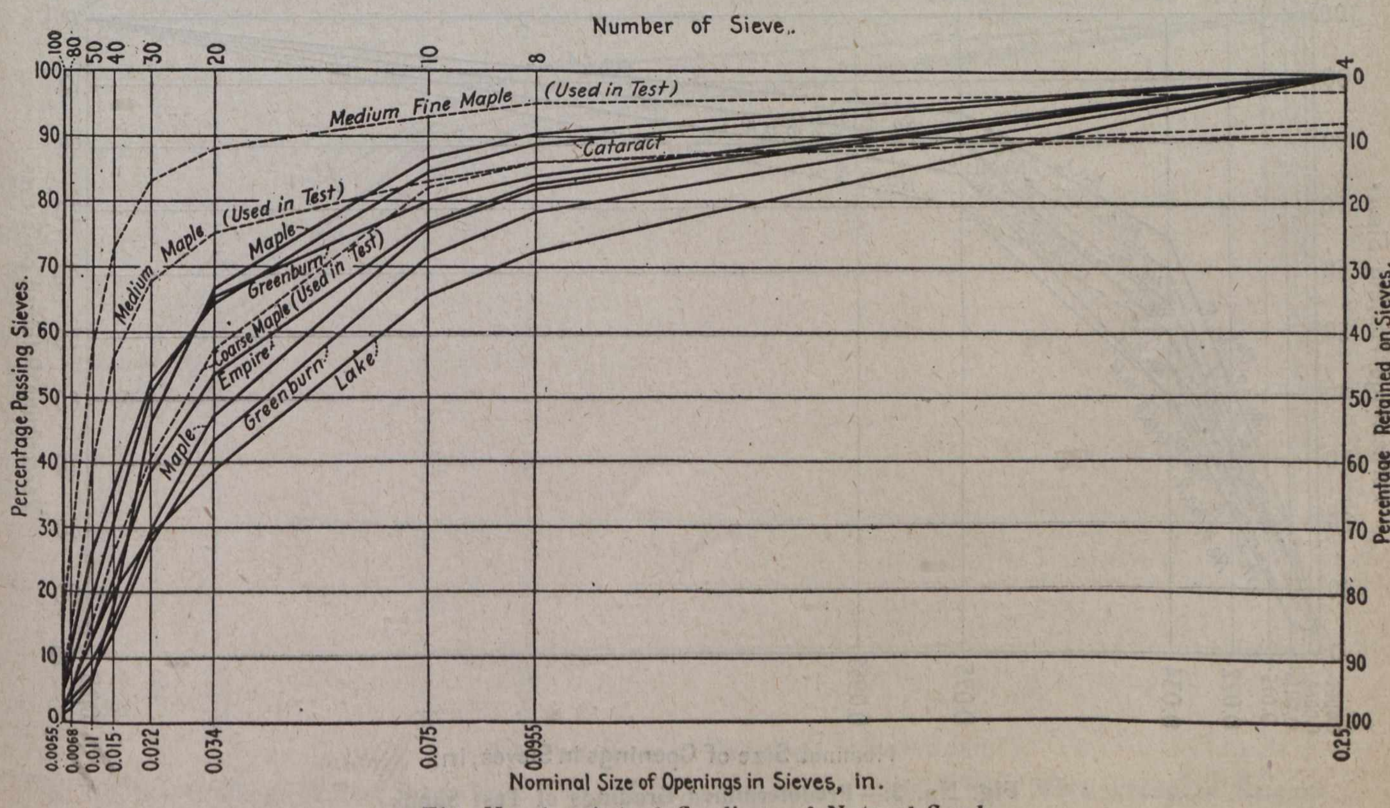


Fig. No. 1.—Actual Gradings of Natural Sands

For sand tests, all sands were to conform to predetermined gradings. The usual requirements of sharpness, cleanliness, etc., were to be carefully maintained.

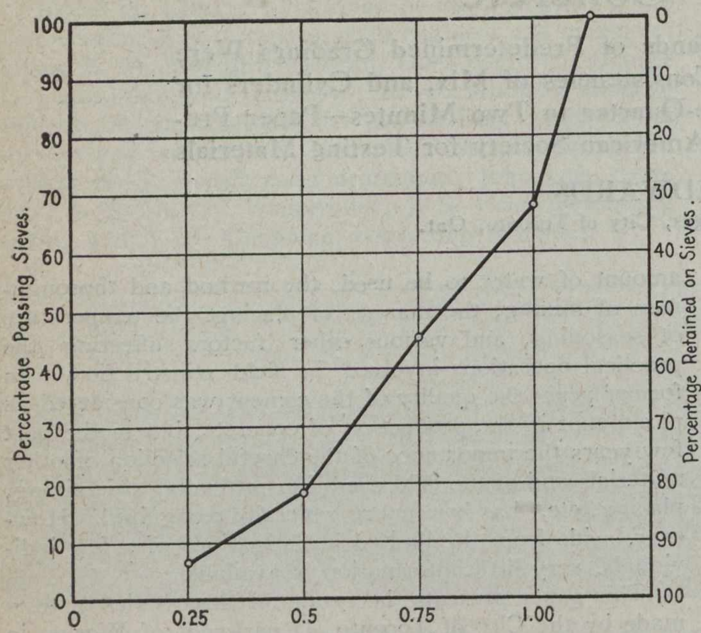


Fig. No. 2.—Grading of Broken Stone

The range or scope of the tests as planned and carried out was divided as follows:

1. To secure information covering the chemical and physical properties of all materials used;
2. The preparation of 12 sands to conform to predetermined gradings and the securing of information showing their relative values in concretes and mortars;
3. To ascertain the influence of varying the quantity of water used in mixing concrete for both plain and reinforced construction;
4. To ascertain the effect of varying the time of mixing; and
5. To secure miscellaneous general information and data pertaining to the foregoing phases of the tests.

The investigations herein described involve tension, compression and bend tests upon 366 concrete cylinders, 6 ins. in diameter by 12 ins. long; 75 reinforced-concrete beams, 4 by 6 ins. in cross-section by 4 ft. long; 82 standard briquettes; and 120 2-in. cubes.

Materials Used in Tests

The properties of the cement, sand and stone aggregates, and of water used in the preparation of test specimens were as follow:—

Cement.—The Portland cement was of Canada brand, manufactured by the Canada Cement Co., Limited. At the beginning of the work, a sufficient quantity for all tests was reserved from a single carload lot.

Following are the physical and chemical properties determined in accordance with the standard specifications of the Society:—

PHYSICAL PROPERTIES

Constancy of volume			O.K.
Specific gravity			3.10
Initial set, minutes			150
Final set, minutes			405
Fineness, per cent. retained on	No. 100 sieve		2.2
	No. 200 sieve		22.0
Tensile strength, lb. per sq. in.	neat	24 hrs.	419
		7 days	656
		28 days	863
	mortar	7 days	284
		28 days	451

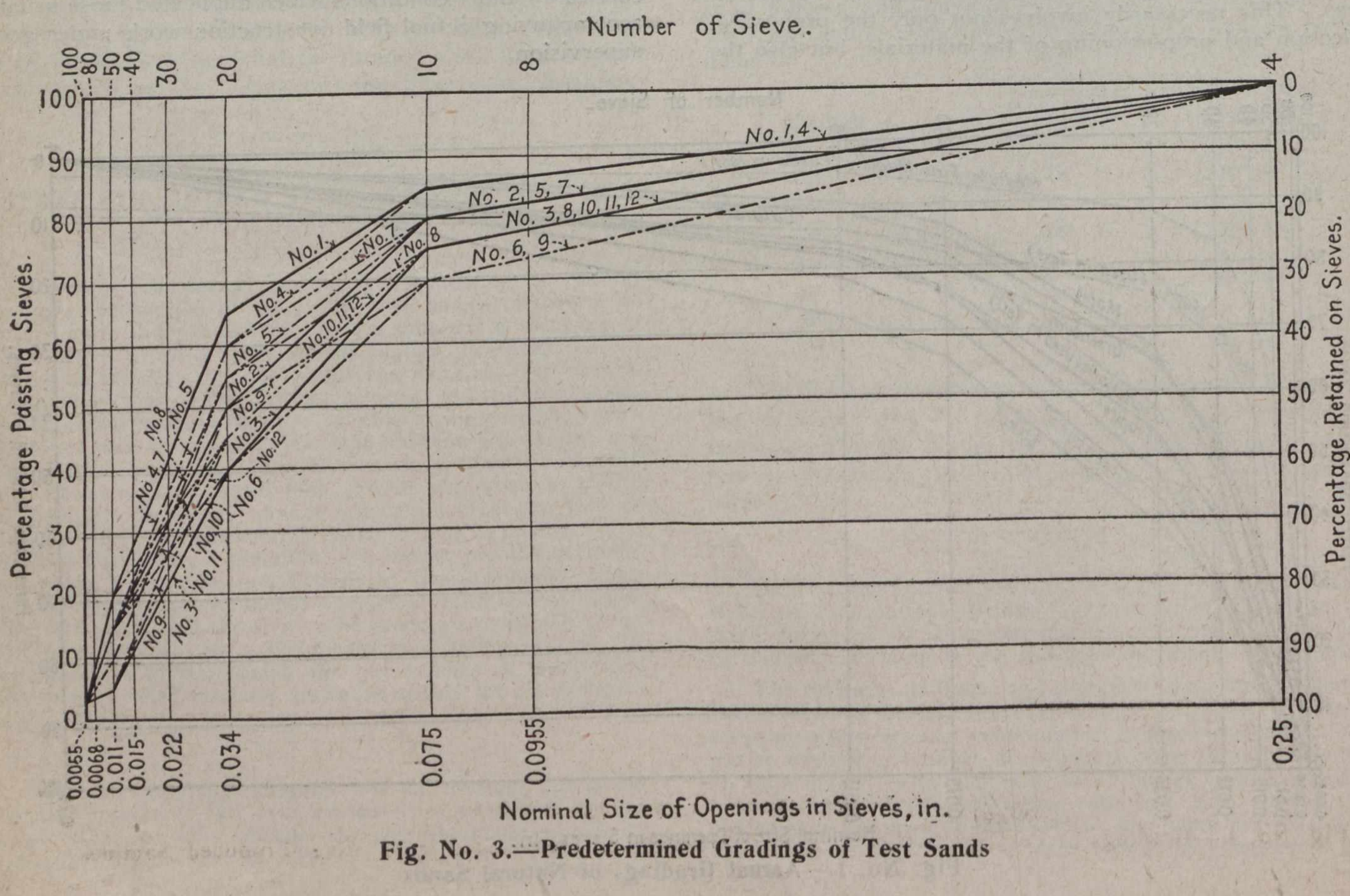


Fig. No. 3.—Predetermined Gradings of Test Sands

Chemical Properties

Loss on ignition, per cent.	2.68
Insoluble residue, per cent.	0.81
Sulphuric anhydride, per cent.	2.17
Magnesia, per cent.	2.78

Sand.—All sand used in the tests was of limestone origin, secured from a chosen section of the pits of the Maple Sand and Gravel Co., Maple, Ontario. In its original state the sand existed in three clearly defined strata, which to all appearances, varied only in the degree of fineness of the sand grains. The terms "medium fine," "medium" and "coarse" have been applied to the original sands as indicating, in a general way, their character of grading. The actual gradings as determined by tests are shown graphically in Fig. 1.

The following is the chemical composition of a composite sample of the three original sands:—

Loss on ignition, per cent.	16.32
Silica, per cent.	46.97
Iron and alumina oxides, per cent.	13.06
Calcium oxide, per cent.	15.71
Magnesia, per cent.	4.22

The specific gravity of the composite sample taken at 70° F. was 2.684.

The original sands were used only for the purpose of securing therefrom the portions which, when thoroughly mixed together in definite quantities, would produce composite sands agreeing very closely in texture with the predetermined gradings fixed for the test sands.

From each original sand all material passing a sieve having four meshes per linear inch was divided into four parts or portions, as follows:—

1. All materials retained upon a No. 10 sieve;
2. All materials passing a No. 10 sieve and retained upon a No. 20 sieve;
3. All material passing a No. 20 sieve and retained upon a No. 50 sieve; and
4. All materials passing a No. 50 sieve.

The parts so secured were placed in bags and carefully labeled for identification.

Prior to making the division above described the original sands were thoroughly dried upon a metal heater, since the sands as received from the pit were damp. With the object of determining the shrinkage in volume and weight due to drying, 4 cu. ft. of medium sand were measured and weighed, dried, and again weighed and measured. Following are the results of the test:—

Average weight of sand, lb. per cu. ft.	wet	92.55
	dry	85.25
Loss in weight (7.30 lb.)		7.9 per cent.
Loss in volume (324 cu. in.)		18.7 per cent.

Stone.—All crushed stone used in the tests was secured from the Point Anne Quarries Co., Limited, Point Anne, Ontario. The stone supplied by this company is a uniformly dense, dark-colored limestone. Its chemical composition is as follows:—

Calcium carbonate, per cent.	96.0 – 98.0
Silica, per cent.	2.0 – 2.5
Iron and alumina oxides, per cent.	0.5
Magnesia	trace
Phosphorus	trace

The size of stone used was that commercially known as 1-in. stone. The average grading of this material as received from the storage bins of the company is shown graphically in Fig. 2. The voids in the stone were found to be 43.85 per cent.

The maximum size was approximately 1¼ ins. All stone was carefully screened over a ¼-in. screen before using, thus removing all material under ¼ in. in size. With this exception the stone aggregate was used in the concrete mix in the condition in which it was received

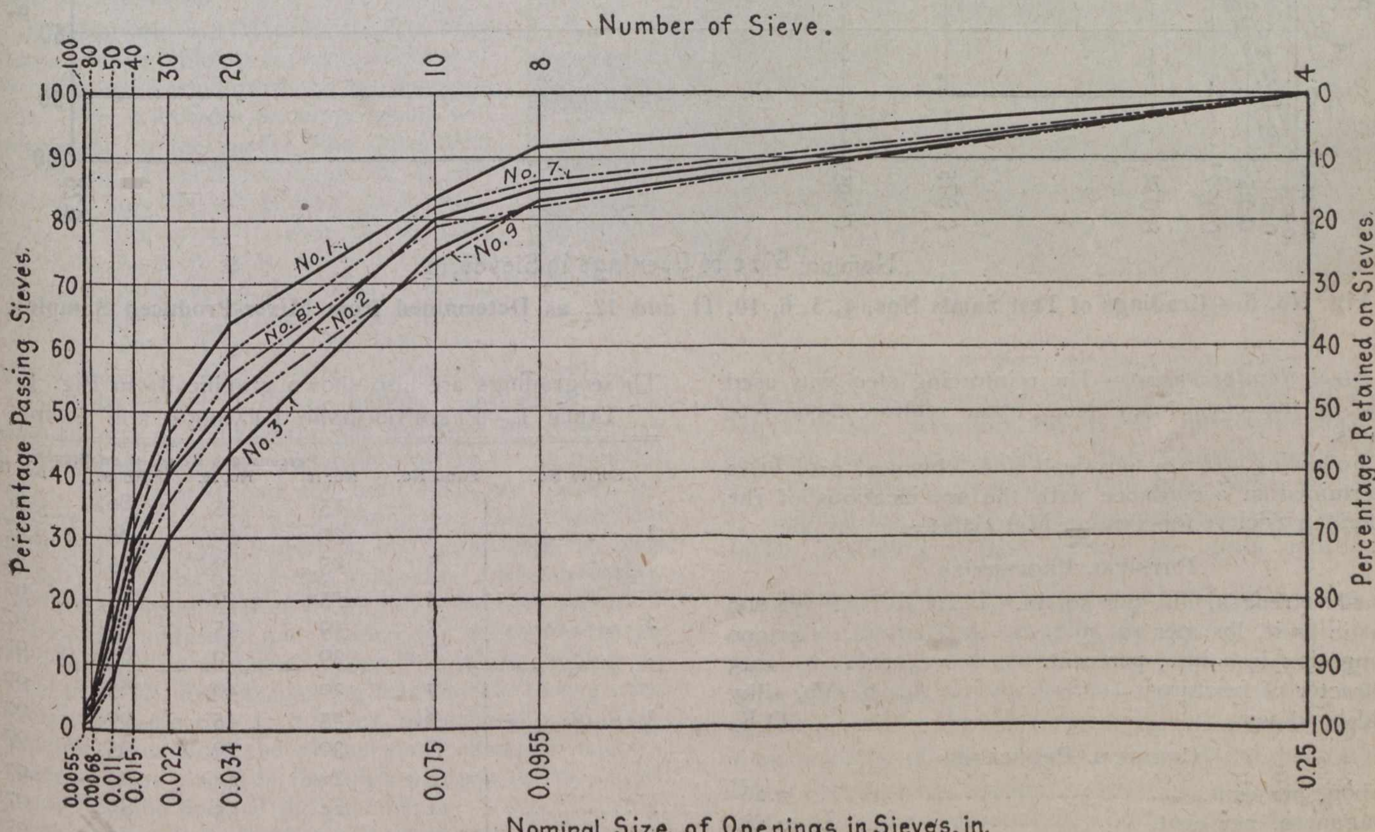


Fig. No. 4.—Gradings of Test Sands Nos. 1, 2, 3, 7, 8 and 9, as Determined from Mixer-Produced Samples

from the bins. Its uniformity was such that a careful grading seemed unnecessary.

Water.—All water used in the tests was taken from the city water mains, the source of supply being Lake Ontario. The chemical analysis is as follows:—

	Parts per million.
Total solids	120.0
Alkalinity (lacmoid) bicarbonates 103; carbonates 2	105.0
Permanent hardness	32.5
Total hardness	137.5
Silicious matter	3.84
Iron oxide, alumina and phosphates	0.17
Lime (CaO)	43.4
Magnesia (MgO)	12.2
Sulphates (SO_4)	18.5
Chlorides	9.0

All steel reinforcement was rolled material. Its surface condition was excellent, showing little evidence of either mill scale or incipient rust.

Composition and Preparation of Test Sands

Within a radius of, say, 25 miles from Toronto good limestone sands having a large variety of gradings may be secured with little difficulty. The actual grading of a considerable number of these sands provided a range of grading within which, for practical reasons, it seemed advisable to limit the predetermined gradings of all test sands. Fig. 1 shows graphically the gradings of several natural sands; also, the gradings of the three original sands secured for the tests.

The practical range of sand gradings as above described having been fixed, the compositions for 12 different sands were predetermined as shown in Table I.

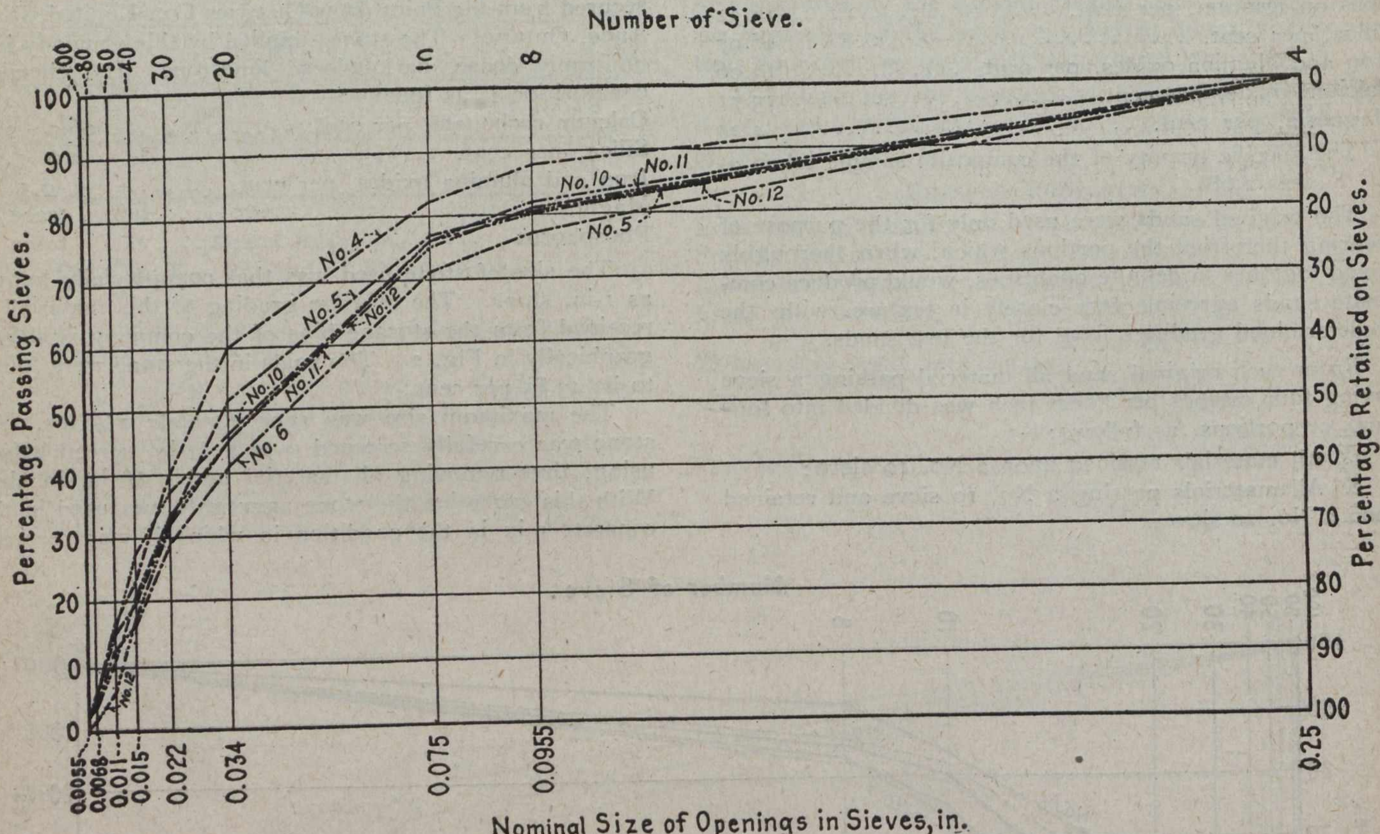


Fig. No. 5.—Gradings of Test Sands Nos. 4, 5, 6, 10, 11 and 12, as Determined from Mixer-Produced Samples

Steel Reinforcement.—The reinforcing steel was used only in the consistency tests upon reinforced-concrete beams.

Following are the physical and chemical properties determined in accordance with the specifications of the American Society for Testing Materials:—

PHYSICAL PROPERTIES

Tensile strength, lbs. per sq. in.	72,860
Elastic limit, lbs. per sq. in.	41,090
Elongation in 2 ins., per cent.	19.5
Character of fracture	½ cup, silky
Cold bend test	O.K.

CHEMICAL PROPERTIES

Carbon, per cent.	0.26
Manganese, per cent.	0.38
Phosphorus, per cent.	0.027
Sulphur, per cent.	0.033

These gradings are also shown graphically in Fig. 3.

TABLE I.—PREDETERMINED GRADINGS FOR SANDS

Series No.	Sand No.	Percentages Retained on Sieves. No. 10.	No. 20.	No. 50.	No. 100.
1	1	15	35	80	97
	2	20	50	85	97
	3	25	60	95	97
2	4	15	40	85	97
	5	20	45	85	97
	6	30	60	85	97
3	7	20	40	85	97
	8	25	45	90	97
	9	30	50	95	97
4	10	25	55	80	97
	11	25	55	85	97
	12	25	55	95	97

(*Continued on page 145.*)

A FLOATING STRUCTURE OF 3,700 TONS DISPLACEMENT*

HAVING found it necessary to establish a marine testing range, where torpedoes could be discharged and regulated, in order to enable them to pass the official tests conducted on delivery to the French navy, Messrs. Schneider & Co., of Creusot, resorted to a particularly novel solution of the problem, by creating in the Mediterranean a kind of artificial island of which an illustration is given in Fig. 1.

Several alternative projects were taken into serious consideration. One of these contemplated the installation in the sea of a steel platform supported on metal piers, and to which would have been moored for the purpose of torpedo trials a workshop-lighter carrying torpedoes, air compressing plant and other auxiliaries, while the torpedoes would have been discharged from the platform. However, the scheme which appeared best suited to requirements was one prepared by M. Hennebique, of Paris, providing for the construction of a huge ferro-concrete caisson, with ample accommodation for work-shops, landing stages, and chambers for discharging torpedoes, for observing the course of the torpedoes, as well as for offices and for occupation by the resident staff.

The execution of the work involved the novel operations of building a large floating structure on shore, towing it out to sea, and then sinking it on a levelled bed in deep water. The successful completion of this unprecedented task incidentally serves to illustrate the adaptability of ferro-concrete to the building of ships and other floating structures.

The Batterie des Maures consists of a caisson, above which is a superstructure of two stories, surmounted by a spacious deck. Fig. 2 includes drawings which will make clear to the reader the structural details and general arrangement of the battery. This caisson is over 50 ft. high by 77 ft. long by 45 ft. wide at the base, and 65 ft. long by 35 ft. wide at the top. The outer walls are 6 ins. thick, and the interior walls or partitions only 4 ins. thick, the whole being in monolithic connection strongly reinforced by a network of steel rods.

The superstructure of the battery rises about 20 ft. above the top of the caisson, the end over the port-holes of the discharging chamber projecting 17 ft. as a cantilever. The opposite end and both sides are carried by cantilever extension of the caisson, thus facilitating the hoisting of boats and materials, and permitting the convenient manipulation of the gangways communicating with the landing stages at either side. Further provision for hoisting materials and particularly torpedoes to be tested is made by means of a travelling crane running on a steel beam (P, Fig. 2), passing transversely through the battery and projecting 11 ft. 6 ins. at each end. Another travelling crane over the discharging chamber enables torpedoes to be placed in the tubes or upon the carriages provided on the floor of the chamber.

The discharging chamber measures 45 ft. long by 18 ft. wide. It is furnished with three tubes, the bronze armatures of which pass through the wall of the caisson. In order to afford facilities for the examination and maintenance of the armatures provision is made for forming a lock in front of the three tubes. Between the consoles (*c*) supporting the cantilever portion of the superstructure are two ferro-concrete guide rails (*n*) extending above water level. Between these and the consoles, timber gates can be inserted in grooves formed for the purpose, thus shutting off from the sea a compartment which can be easily pumped dry, and then furnishes convenient means for the inspection or repair of the tubes.

Above the three submarine tubes are two others at the height of nearly 10 ft. above water level, and situated immediately above the two ferro-concrete guide rails. These tubes are placed in embrasures, protected by steel shutters that can be closed to keep out the waves in rough weather.

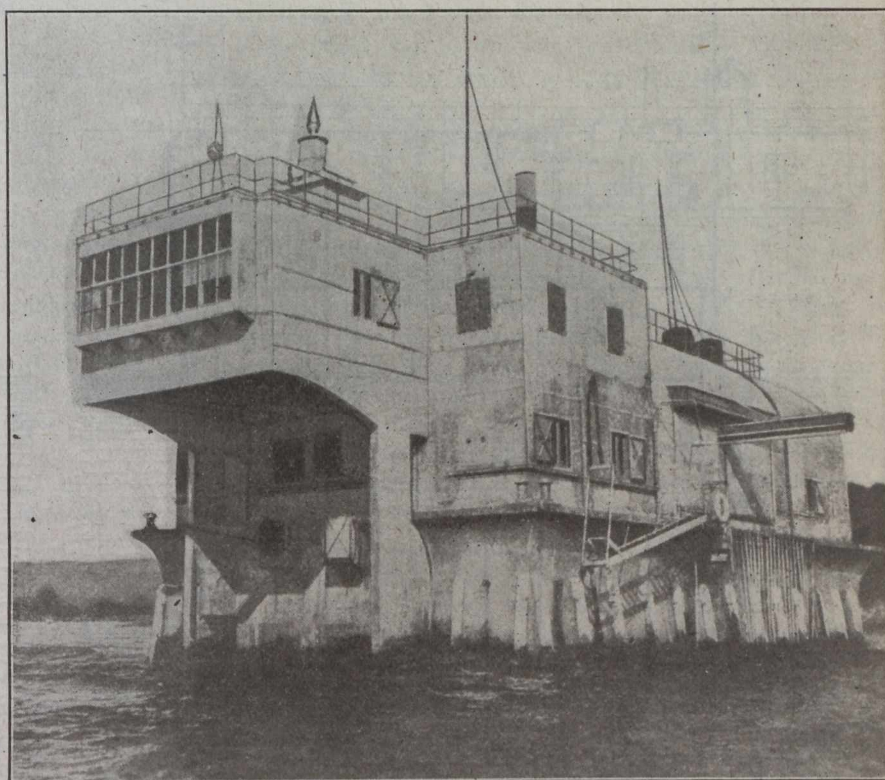


Fig. 1.

At the level (A) of the lower floor of the superstructure a gangway passes around the upper part of the discharging chamber, providing means of intercommunication between the various rooms. In the machine-room there are two electricity generating sets from which electricity is supplied for operating the air compressors, hoisting tackle, travelling cranes, pumps, and other appliances.

The observation chamber, for watching the course of torpedoes discharged, occupies the interior of the cantilever projection, and at the seaward end is furnished with a verandah having movable window sashes, while glazed panels in the floor enable the officials to observe what is taking place at the outer end of the torpedo tubes. From this chamber access is obtained by means of an iron ladder to a ferro-concrete turret on the upper deck serving the purpose of a look-out box. On the deck there are flagstaffs, lanterns, and ventilation shafts.

*From "Ferro-Concrete."

Above the discharging chamber and around the central opening is a large apartment devoted to the storage and handling of torpedoes. At each side of this apartment is a wide bay (B) with doors for the admission of torpedoes hoisted and transported by the electric travelling crane running on the transverse steel beam. The landing-stages at the sides of the battery are accessible from the water by means of the stairways. The outer windows of all the rooms in the superstructure have metal shutters with port-holes for use in stormy weather.

As foundation work by the aid of pneumatic caissons appeared to involve serious difficulties, it was decided to construct the greater portion of the battery in a dry dock, then to float it bodily to the site, and sink it upon a bed of stone prepared at the bottom of the sea.

For the purpose of constructing the caisson, the contractors secured a dry dock belonging to the Forges et Chantiers de la Méditerranée, where the caisson was only brought immediately over its foundation bed, water was admitted to the interior compartments by means of three pumps supplied with steam from the boilers of one of the tugs. The delivery of water was regulated so as to cause the caisson to descend with perfect regularity.

After the caisson had been sunk, concrete was deposited into those compartments which had to be filled up, and gave further stability to the construction. The large blocks of stone forming the outer protection to the foundations were deposited around the caisson to a sufficient height.

The study of the stability of a work such at the Batterie des Maures is a problem so difficult that it is practically impossible to determine precisely the horizontal resultant of the forces due to the forces exerted upon the walls by waves in case of storm. The damage done by violent tempests to massive jetties which appear to be incapable of injury show that it is impossible to be over-

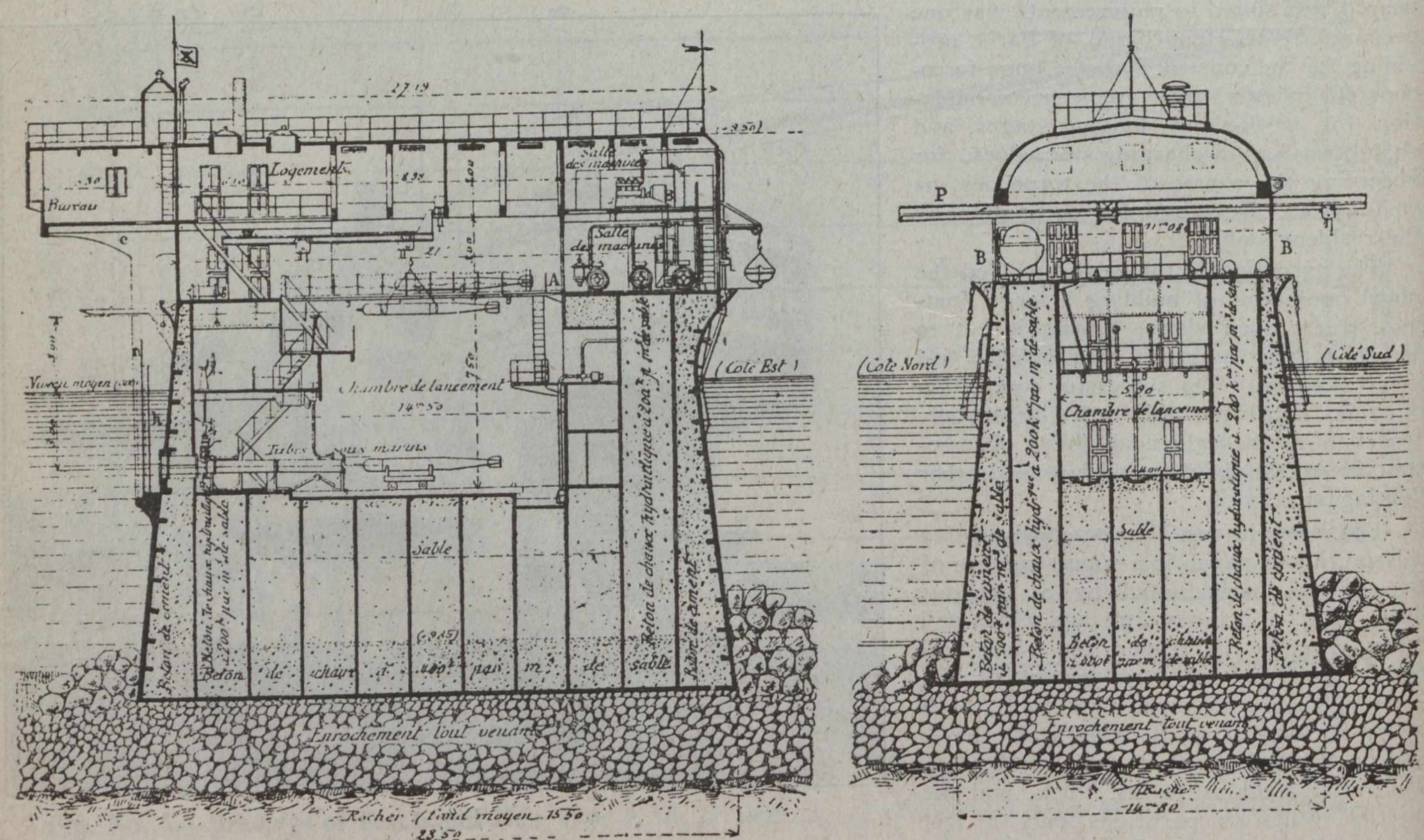


Fig. 2.—Side and End Elevations: Batterie des Maures

partly built, leaving some of the interior partitions for carrying the observation chamber to be finished outside, and the superstructure to be completed after the caisson had been placed on its foundation in the sea.

As soon as the first stage of the work had been completed, water was admitted gradually into the dock until the caisson was floated. Ballast was then placed in the interior compartments as necessary to bring the caisson to an even keel, when by the aid of two steam tugs it was towed outside and moored.

Then the construction of the inner partitions was continued and after its completion, the caisson, then having a displacement of 2,600 tons, and drawing about 26 ft. of water, was towed through the sea for a distance of about 40 kilometres, the passage occupying fifteen hours.

The foundation bed at the bottom of the sea had already been prepared, and when the caisson had been prudent in maritime works. The ferro-concrete construction adopted for the Batterie des Maures consolidates all the walls, and justifies the conclusion that the caisson acts as an indeformable monolith under the attack of the waves. Moreover, the risk of undermining is obviated by the way in which the foundation bed is constructed. Further, it may be pointed out that as the total weight of the battery is 9,000 tons, and the weight of water displaced is only 3,700 tons, there remain 5,300 tons as an assurance of stability.

The power transmission lines of the Nevada-California Power Company's system are said to form the longest chain yet projected, being about 666 miles from north to south. The current is generated by water power, an interesting feature of the plant being the utilization of two high heads differing by 530 ft. in the same power house and on the same 8,000 horse-power impulse wheel.

HYDRO DOES NOT FAVOR C.N.R. NATIONALIZATION

Deputation Presents Resolution of Protest to Sir Robert Borden—Mr. German, of Welland, Hits Hard at White and Rogers.

AT a joint meeting of the executives of the Ontario Hydro Radial and Municipal Electric Associations held last week in Toronto, the following resolution of protest was adopted in regard to the government's $7,500,000 grant to the G.T.R., and the proposed purchase of the C.N.R.:—

"Whereas the municipalities of Ontario, through the Hydro-Electric Railway Association and the Ontario Municipal Electric Association on June 19th last passed resolutions which were duly forwarded to the honorable the prime minister and other members of the federal government opposing the granting of any further sums of public money or the extension of public credit to any of the private railway companies.

"And whereas the municipalities of the province, to the number of several hundred, have endorsed this action and passed resolutions along similar lines, which were also duly forwarded.

"And whereas many of the municipalities further requested that before any action be taken by the government in regard to approving any such aid, the municipalities be given an opportunity to present protests.

"And whereas the honorable the finance minister, on Wednesday, August 1st, presented to the House a proposal providing for the taking over of the Canadian Northern Railway as a public undertaking and paying for the common stock of the company on a basis to be arrived at by arbitration.

"And whereas the taking over of the Canadian Northern on the lines suggested is absolutely opposed to the recommendations of the Royal Commission, which was appointed by the government and which, after careful study of the railway situation in Canada, stated emphatically that the common stock of the Canadian Northern Railway had no actual value. (Page xliv.-xlvi.).

"And whereas the Dominion Act of 1914, chapter 20, relating to the Canadian Northern Railway, provides that upon default in the payment of their obligations under any of their securities, all their equity rights, properties and holdings shall be forfeited, and by order-in-council the government shall replace the board of directors, taking absolute control of the road.

"And whereas, by the resolution of the honorable the finance minister, the recommendations of the Drayton-Acworth reports are disregarded and a situation presented which involves upon the country a liability to pay for stock which was admitted to have no value. The country would, in addition, be called upon to assume all obligations of the Canadian Northern Company.

"And whereas the Canadian Northern Railway Company will not only retain its entity, but may also be under the same control and management as heretofore, which is again contrary to the recommendations of the Drayton-Acworth reports.

"And whereas the honorable the finance minister, on the same date, presented to the House a proposal to loan the Grand Trunk Pacific Railway the sum of seven and one-half millions of dollars.

"And whereas the granting of this loan is in direct opposition to the recommendations of the Royal Commission, as well as being against the wishes and best interests of the people of Canada.

"Be it therefore resolved that the municipalities, members of the Hydro-Electric Railway Association, representing the majority of the electors of the province of Ontario, vitally interested in transportation problems, strongly protest against the method of taking over the Canadian Northern Railway, believing that the provisions of the mortgage given by the Canadian Northern Railway in 1914 should be enforced, and that the present management should be divorced completely from further control or management of the system under whatever name it may be taken over.

"And further protest against the granting of any further sums to the Grand Trunk or the Grand Trunk Pacific Railways or the releasing of the Grand Trunk from any of its obligations in connection with the Grand Trunk Pacific and demand that the Grand Trunk should be called forthwith to carry out its agreement respecting the Grand Trunk Pacific Railway."

The above resolution was presented to Sir Robert Borden and the cabinet by a large deputation headed by Sir Adam Beck.

Says G.T.R. Should Be Included

J. W. Lyon, of Guelph, who presided at the meeting, declared that if the government had the control of the Grand Trunk Railway System it would save the building of a thousand miles of railways, the duplication of lines and expenditure of a great deal of money. In 1914, he said, the government had secured a mortgage whereby the C.N.R. could be taken over by an order-in-council in case of failure to meet their obligations. He was sorry to say that in the government's recent proposals no mention was made of that mortgage, and instead of taking over the road by order-in-council an arbitrated sum of money was to be paid to Mackenzie and Mann.

The Hydro and the municipalities object to paying the Grand Trunk any money, he said. If the Grand Trunk and Canadian Northern were both to be taken over, they would form a fine system with which to compete against the C.P.R., but he said that the present proposals were not attractive to the people of Ontario.

Mayor Church, of Toronto, said that the recommendations of the Drayton-Acworth Commission should have been adopted. The proposals of the government were a black-eye to the Hydro Radial interests in Ontario.

T. J. Hannigan, of Guelph, said that the capital stock of the C.N.R. has no value on a cash basis or earning power.

Debate in Parliament

The plan to acquire the C.N.R. was the chief topic of debate in parliament last week. Sir Thomas White was the main speaker in defence of the plan, while the attack was carried on chiefly by Hon. Wm. Pugsley and Hon. W. M. German, of Welland.

The plan to decide the value of the C.N.R. stock by arbitration met with strenuous opposition from Mr. German, who said that there would be strong influence behind the arbitrators. He accused the minister of public works of having been associated with Mackenzie and Mann throughout their careers, and said that the men who would benefit by the government's proposals are personal friends of that minister and had placed him in office. He asked that the valuation be made by Sir Walter Cassels, senior judge of the exchequer court.

The Drayton-Acworth report, he claimed, said nothing as to arbitrating the value of the Canadian Northern stock, declaring that stock to be of no value. The Drayton-Acworth report had, on the other hand, suggested a means of finding by arbitration the proportion of the stock to which Mackenzie and Mann would be entitled, and the proportion of the future earnings of the road that should be paid to Mackenzie and Mann.

What Drayton and Acworth Recommended

Under the heading of "Arbitration Recommended," on page 62 of the Drayton-Acworth report there is stated:—

"Under the scheme we propose, the trustees will operate the Canadian Northern lines as part of a combined system. It will be impossible, therefore, for the Canadian Northern Company, as such, ever to earn a dividend on its separate stock. We suggest that, if it is decided to permit the present shareholders to retain a portion of their holding, the Act of Parliament constituting the Board of Trustees shall contain a provision for arbitration between the Trustees and the Canadian Northern Company and establishing an arbitration board to act forthwith. The Trustees should appoint one arbitrator and the Canadian Northern shareholders the other, and the two arbitrators should agree on the appointment of an umpire; failing agreement, an umpire should be appointed by the Chief Justice of the Exchequer Court; and the decision of the board should be final.

"The arbitrators should be empowered to decide two questions:—

"(1) What proportion of the Canadian Northern common stock may fairly remain the property of the present holders;

"(2) What proportion of the earnings of the Dominion Railway Company may fairly be regarded as attributable to the Canadian Northern lines.

"To illustrate our meaning, we will assume that the arbitrators decide that 5 per cent. of the Canadian Northern shares shall remain the property of the existing holders, and further decide that one-half of the total earnings of the Dominion Railway Company will be fairly attributable to the Canadian Northern lines. Then their decision will mean that, out of any dividend declared in future by the Dominion Railway Company, 2½ per cent. (one-half of 5 per cent.) will be payable to the existing Canadian Northern shareholders or their transferees. We think the arbitrators should fix this resulting percentage once for all. It should be made a condition of the settlement that the minority shareholders of the Canadian Northern should by deed irrevocable appoint the trustees as their proxy to vote their shares. Care will of course be taken to provide that the Arbitration Board shall have regard only to the Canadian Northern lines, as they exist at the date of the passing of the Act, and that any subsequent increase of revenue due to the expenditure of additional public money shall be excluded from consideration."

Impeaches Sir Thomas White's Motives

In his remarks before the House last week Mr. German stated that it was the first time in his experience that anybody had suggested arbitration to determine the value of something admitted by everybody to have no value whatever. Of course, Mr. German was incorrect in that statement, as his "everybody" cannot include Sir William Mackenzie and associates, who claim that the capital stock of the Canadian Northern is worth par.

There is a grave danger that the suggested board of arbitrators may give an excessive price for the Canadian Northern stock, said Mr. German. In 1914 the government had accepted a par value of $40,000,000 worth of stock as security for a loan of $45,000,000. Mr. German said that the board of arbitrators which was likely to be appointed would certainly be unanimous in its finding and that there would be no appeal. He said that there would be the strongest kind of influences at work behind the board.

He then embarked on a strong personal attack on Hon. Robert Rogers, minister of public works, and also upon Sir Thos. White, minister of finance. The creditors of the C.N.R. who would benefit by the government proposals were, he said, personal friends of Sir Thos. White, whose influence had made him a cabinet minister.

Let Exchequer Court Settle It

Instead of leaving the adjustment of the value of the stock to a board behind which the people would use such influences as these, Mr. German suggested that the matter be referred to Sir Walter Cassels, senior judge of the exchequer court. His decision, whatever it might be, could be accepted without question, said Mr. German. If the government persists in its arbitration proposal, the country will believe that there is some ulterior motive behind the plan, said Mr. German, and in any case it is not the value of the stock that should be arbitrated, but the question of what proportion of the stock should be allotted to Mackenzie and Mann.

Suggests Centralized Control

In closing, Mr. German suggested that the government should have a policy which would place in a single management the Canadian Northern, Intercolonial, the National Transcontinental, and the Hudson Bay Railway. These should be administered by a board chosen from all parts of Canada, consisting of fifteen business men of high standing, independent of political influence. They should be elected yearly, said Mr. German, by joint ballot of the Senate and House of Commons.

NEWSPAPER COMMENT RE C.N.R.

"While the public will doubtless sympathize with Sir William Mackenzie in his estimate of par as the value of Canadian Northern stock," says the Montreal Star, "the Street will have little faith in individual-made estimates. It would prefer the broad public market plan, which is, after all, the most satisfying way of getting its values.

"Sir William has spent a considerable part of a very busy career in trying to build up a commensurate value around the shares of the road, in which he and his partner, Sir Donald Mann, hold the majority interest.

"It is very easy for the street to appreciate the angle from which those gentlemen would view the value, and it is only human to place it well up.

"The general public will say: 'Look what we did to make whatever value there is in Canadian Northern shares possible,' meaning the large advances made by the government to the company in the way of bonuses and guarantees.

"The Street will look at the cold facts of the case, and ignore a lot of interesting history in framing up its valuation. What are the company's earnings in relation to its capital liabilities? What does it owe? How much working capital does it need to place it in the proper shape to adequately fulfil its duty to the territory from which it must derive its support. What are the prospects for future growth?

"These and other questions are the principal ones which the market would look at in placing a valuation on the shares. The task of the arbitrators will not be a soft one. Two extremes will have to be trestled."

WORTH AT LEAST PAR, SAYS MACKENZIE

Interviewed by a daily newspaper reporter regarding the purchase of the C.N.R. by the government, Sir William Mackenzie recently said that he was of opinion that the $60,000,000 stock in the hands of the company is worth at least par, and that the company, in the event of its purchase through arbitration, would make every effort to get as much as possible for it. It is a great property, he said, the stock representing great prospects, and, speaking for himself, and, he believed, for his associates, they would be reluctant to part with it. The success of government operation of the road, he thought, would depend entirely upon the men appointed as directors.

THE FUEL PROBLEM*

"Not only food but fuel is a vital need of this country and of our Allies—coal to run the ships and railroads, to feed the iron furnaces, and furnish steam for all the manufacturing plants, coal in greater quantities than have ever been mined in the United States, or in any part of the world; and this is being met in truly American fashion by the operators and owners of the mines and by the diggers of the coal."—Secretary of the Interior, Franklin K. Lane.

A new record was set for the first six months of this year; 270 million tons of bituminous coal were mined. This is 20 million tons more than in the first six months of 1916, and if maintained during the summer (when the mines usually shut down for a time) will produce 540 million tons for the year, as against 442 millions for 1915.

Continuing, Secretary Lane says: "The difficulty of distribution now so great will be intensified, however, in the coming winter months. Just as consumers of foodstuffs are being urged to eliminate all waste and to practice sensible economy, so the consumers of coal must do their share in working out the coal problem by unloading every car as fast as it is received, and in improving their plants so as to utilize to the fullest the heat value of the coal that reaches their bins. In stopping the coal panic and in expediting a condition of fuel sufficiency, every consumer can do his bit."

Ways in which the consumer in the electrical and allied industries can help by adopting methods for more efficient utilization of our fuel resources include:—

(1) More extensive development of water power.

(2) Utilization of the less concentrated sources of kinetic energy, such as tides, waves, wind, solar heat, and terrestrial heat (although these cannot be utilized on a large scale during the present emergency),

(3) Utilization of by-product fuels, such as coal-mine waste, coke-oven and blast-furnace gas, and wood waste.

*From the General Electric Review.

(4) Utilization of local resources of low-grade fuel in territory now dependent upon transportation of high-grade coal from distant sources.

(5) More efficient means of utilizing the latent energy in fuel for generating heat and power.

(6) Concentration of the production of power from fuel in central stations where the most economical methods may be utilized, and its distribution electrically to consumers.

(7) The use of electric vehicles, charged by central-station power, to help relieve the great demand for gasoline for urban transportation.

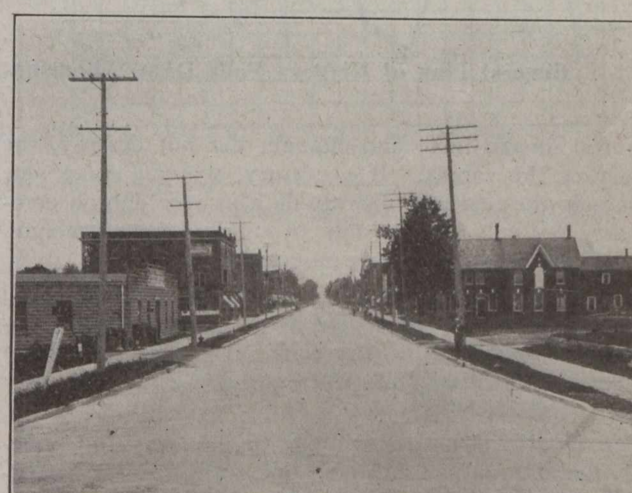
Owing to the war and the high cost of materials and shortage of labor, there has been little done recently in the way of initiating new enterprises for the transmission of power from hydro-electric plants, and from steam power-plants located at coal mines. At the same time there has been a steady increase in the demand for power and for fuel.

QUEEN STREET PAVEMENT, TILBURY, ONT.

By N. J. Goebelle,
Town Engineer, Tilbury, Ont.

THE construction of the Queen Street reinforced concrete pavement at Tilbury, Ont., was commenced September 1st and completed November 2nd, 1916. The pavement is 40 ft. wide, 8 ins. thick at the centre and 6 ins. at the sides, with 5-in. crown. The mix was one part of cement, one and one-half of sand and three of gravel. There is a quarter-inch Elastite joint every 35 ft.

The concrete curb is 15 ins. deep, 6 ins. wide at the top and 8 ins. wide at the bottom, laid on a foundation of gravel 12 ins. in depth, with 4-in. field tile.



Queen Street Concrete Pavement, Tilbury, Ont.

Link & Winter, of Leamington, Ont., were the contractors, the pavement being laid under the supervision of A. W. Moore. The writer, as town engineer, had charge of the engineering and inspection.

The cement was supplied by the Canada Cement Co.; the sand and washed gravel, by the Windsor Sand & Gravel Co.: No. 20 wire mesh reinforcing, by the Page Wire Fence Co., of Walkerville; and the duplex catch basins, by Marshall & Co., of Windsor.

Letters to the Editor

Ice Jams at Niagara

Sir,—Referring to your editorial comment, entitled "Ice Jams at Niagara," on page 83 of your July 26th issue.

Truthfulness is, of course, far better than consistency, but in this case I can fortunately be both truthful and consistent, for I have always contended that the Thomson-Porter plan is the only project which will preserve the beauty of the Niagara.

All the other schemes will either destroy the falls or the rapids or both; while we will preserve the falls; make the whirlpool bigger and grander by increasing the depth from 160 to 210 feet; and change, but not destroy, the scenery of the rapids. If necessary, we can make new and much more spectacular rapids after our dam is completed. We will also be able to supply the maximum amount of power at the minimum cost.

We offer the province and state each an annual rental of one thirty-second of a cent per kilowatt-hour as developed, or $2,000,000 a year each. We offer to sell out at cost plus a reasonable interest when either country wants to buy its half.

We would also be willing to pay, say, one one-hundred-and-twenty-eighth of one cent per kilowatt-hour, or $500,000 a year, to an international park commission to preserve and enhance the beauty of both shores of the entire river.

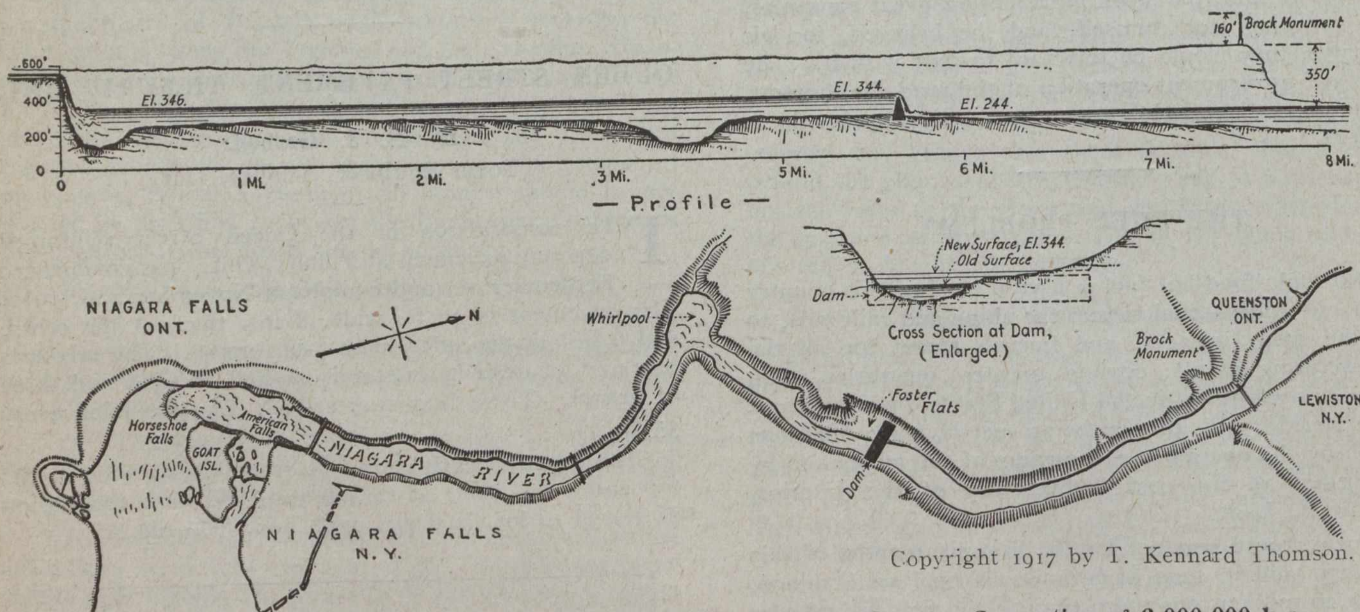
All the other projects combined will be unable to develop as much power as ours, in spite of the vandal-like destruction of scenery they would cause; and all of the money spent for such undertakings will simply be money thrown away, from the consumer's standpoint, when the Thomson-Porter dam is completed.

As nearly every engineer I have spoken to recently, and many laymen, have asked me how I am going to build my dam in the Niagara River, I think that the accompanying plan showing the location will be of much interest to many of your readers.

Almost everyone remembers the lower Niagara River as running through a narrow gorge which is about 500 feet wide at the waterline and about 1,000 feet between the top of the banks, standing from 300 to 350 feet above the water; and they realize the naturally great difficulty of a dam in such a location.

They do not notice, or else forget, the place called Foster's Flats, a beautiful spot on the Canadian side, where there is quite a low shelf, with easy slope to the top of the bank. As a boy I visited this place every year, as it was and is still noted for its wild flowers, and also used to abound in rattlesnakes.

A glance at Foster's Flats on the map will show at once how this simplifies our work; more than half of our dam can be built on dry land. This first half will then afford an easy means of diverting the water from the present channel before building the rest of the dam, where the water now flows.



General Plan of Niagara Falls Dam, Thomson-Porter Cataract Co., for Generation of 2,000,000 h.p.

There is a 102-foot drop in the Niagara River from the base of the old falls to Lewiston, with a minimum flow of 220,000 cubic feet per second. Now, this total head and volume should be developed as a unit—in my one large dam. Otherwise the public would have to pay for a number of disconnected power plants which could not develop anything like the full value of the river, and would result ultimately in the destruction of all the power plants below the falls by ice. The most economical method in developing the river, of course, is to use as much water at the falls as the governments will allow, afterwards returning the water to the river directly below the falls so that it can be used over again at our proposed new falls made by the dam at Foster's Flats.

Regarding other plans: Why build canals on the top of the bank—which it will be difficult to make safe? Besides, much valuable land will be destroyed; many bridges, etc., will be required. When nature has given us such a magnificent channel in the gorge of the Niagara River, with banks (from the bottom of the river to the top) from 350 to 500 feet in height, why do we refuse it? Moreover, we all know that the power is directly proportional to the height of the fall and that it is safer to use two turbines having a head of 200 feet and 100 feet, respectively, than one turbine with a head of 300 feet. The amount of power developed in each case is practically the same.

For one concern to build a canal from the falls to Lewiston to obtain the 300-foot head, is like a man who tries to build a house 10 feet from the curb line in the middle of a block where all the other houses are placed, say, 30 feet back from the curb line. He knows, of course, that such a house would have better light and air than his neighbor's; and does not object to destroying the adjacent property. But the neighbors will either prevent him carrying out his plans or, if they cannot, they will do likewise, thereby spoiling the street for all.

As I have often previously stated, no further developments should be permitted at Niagara without a carefully worked-out international plan.

T. KENNARD THOMSON,
Consulting Engineer.

New York City, August 6th, 1917.

Glare from Concrete Sidewalks

Sir,—The glare from light-colored concrete sidewalks, station platforms, etc., is exceedingly trying upon the eyes. Could not an improvement be effected, at negligible cost, by taking nature's hint and tinting the concrete green? Perhaps some of your readers may have had experience or may have suggestions which would lead to improvement.

ARTHUR CRUMPTON,
Assistant Valuation Engineer,
Grand Trunk Railway.

Montreal, August 1st, 1917.

The American production of steel ingots and castings in 1916 was 42,773,680 gross tons, or 33 per cent. more than the output in 1915, which exceeded by a small percentage the output in 1912 and 1913.

Electrolytic zinc works are to be established near Hobart, in Tasmania. It has been arranged by the Tasmanian Government to lease about 77 acres of Crown land at Risdon, on the River Derwent, to the company as a site for its works. The State Hydro-electric Department has undertaken to supply the company with energy aggregating 50,000 horse-power from the Department's Great Lake plant, of which not more than 40,000 horse-power is to be utilized in the production of electrolytic zinc. The remaining 10,000 horse-power is to be used in the manufacture of other electro-chemical or electrometallurgical products.

Early in 1910 seven electric furnaces were at work in Great Britain. Eighteen months later the number had increased to 16, which figure remained stationary for another year and a half. At the beginning of 1916, 46 furnaces were in operation, and during the year an additional 42 furnaces were set to work, making a grand total of 88 in operation or under construction at the beginning of 1917. This amounts to about 19 per cent. of the world's total. The corresponding figures for the United States are:—At the beginning of 1910, 10; in July, 1913, 19; in January, 1915, 41; January, 1916, 73; and at the beginning of 1917, 136. During the last three years Germany has increased her furnaces from 34 to 52, and Austria from 10 to 18. According to a booklet issued by the Society for Electrical Development, of the furnaces installed, the Héroult type leads, the number installed being 181 out of a total of 471. The Rennerfelt comes next, with a total of 70. The induction type takes the third place with 50, and the fourth place is taken by the Grönwall-Dixon (Electro-Metals) type, with 29. Amongst the remainder, there are 24 Stassano, 23 Girod, and 20 Greaves-Etchells furnaces.

DIAGRAM FOR COMPUTING QUANTITY OF MATERIALS FOR HIGHWAY BRIDGES

THE accompanying diagrams, taken from the "Bridge Manual," issued by the Oregon State Highway Department, may be used for computing the quantity of material required for steel highway bridges for both medium and heavy traffic. The bridges are of the

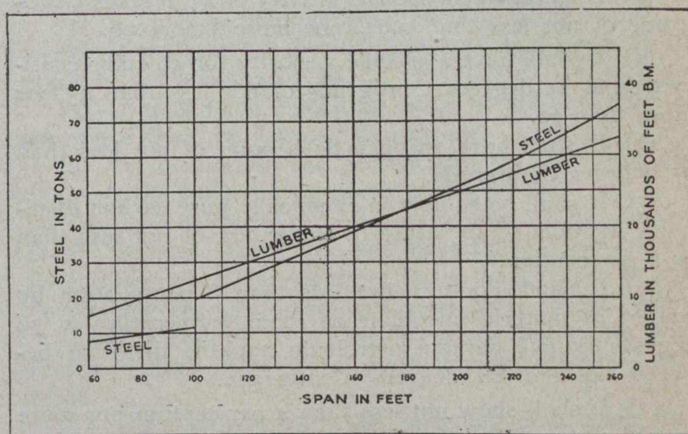


Fig. 1.—Materials in Medium Traffic Bridges

pony-truss type for spans from 60 to 90 ft. and through Pratt trusses for the longer spans. Roadways are taken at 16 ft. wide. Live loads for medium traffic are assumed at 60 lbs. per sq. ft. for spans up to 150 ft. and 50 lbs.

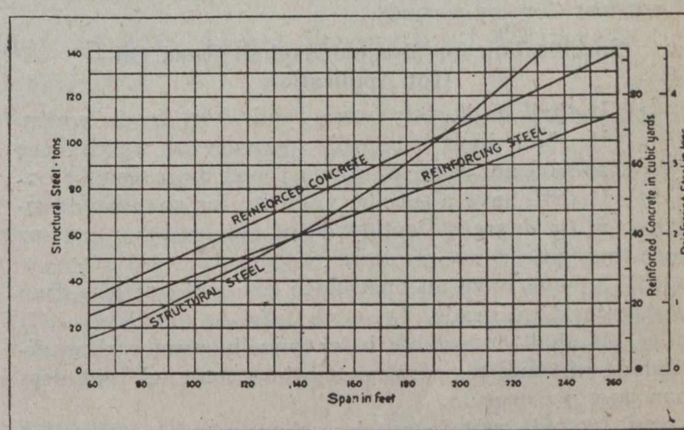


Fig. 2.—Materials in Heavy Traffic Bridges

for longer spans. For heavy traffic the live load was assumed at 100 lbs. for spans up to 150 ft. and 75 lbs. for longer spans. Allowance was made for impact in both cases. Medium-traffic bridges are designed for wood floors and joists, heavy-traffic bridges for concrete floor.

According to the export tables issued by the Board of Trade, London, England, the amount of railway material exported from the United Kingdom during the first five months of the present year was as follows, the figures in brackets being those for the corresponding period of 1916:—Locomotives, £633,543 (£527,389); steel rails, £273,751 (£238,532); carriages, £95,296 (£198,937); wagons, £205,767 (£248,800); wheels and axles, £70,957 (£138,006); tires and axles, £248,100 (£213,789); chairs and metal sleepers, £40,834 (£52,403); miscellaneous permanent way material, £201,114 (£192,368). The total permanent way exported was of a value of £518,021 (£519,604). The tonnage of rails was 17,207 (25,035), and of chairs and sleepers, 2,895 (4,965). The countries to which the exports are sent are no longer given in the Board of Trade returns.

SPECIFICATIONS FOR BITUMINOUS MATERIALS

THE following specifications for bituminous materials have been issued by the Ontario Department of Public Highways:—

Specification for Light Asphaltic Road Oil—Cold Application

(1) It shall be homogeneous and free from water.

(2) It shall have a specific gravity of 25 degrees Centigrade of not less than 0.92, nor more than 0.96.

(3) It shall have a specific viscosity for 50 cubic centimetres at 25 degrees Centigrade of not less than 45 nor more than 70.

(4) It shall have an open flash point of not less than 55 degrees Centigrade.

(5) It shall be soluble in chemically pure carbon disulphide at room temperature to the extent of not less than 99.5 per centum.

(6) It shall contain not less than 6 per centum by weight of material insoluble at room temperature in 76 degrees Baumé paraffin petroleum naphtha distilling between 60 and 88 degrees Centigrade.

(7) It shall show not less than 4 per centum nor more than 8 per centum by weight of fixed carbon on ignition.

(8) When fifty grams of the material are heated in a cylindrical vessel 5.5 millimetres in diameter and 3.5 millimetres deep for 5 hours at a temperature of 163 degrees Centigrade, the loss in weight shall not be more than 25 per centum nor less than 10 per centum, and the residue shall show a float test at 25 degrees Centigrade of not less than 40 seconds.

Specification for Medium Asphalt Road Oil—Hot Application

(1) It shall be homogeneous and free from water.

(2) It shall have a specific gravity at 25 degrees Centigrade of not less than 0.94 nor more than 1.00.

(3) It shall have a specific viscosity for 50 cubic centimetres at 65 degrees Centigrade of not less than 25 nor more than 50.

(4) It shall have an open flash point of not less than 70 degrees Centigrade.

(5) It shall be soluble in chemically pure carbon disulphide at room temperature to the extent of not less than 99.5 per centum.

(6) It shall contain not less than 10 per centum nor more than 17 per centum by weight of material insoluble at room temperature in 76 degrees Baumé paraffin petroleum naphtha distilling between 60 and 88 degrees Centigrade.

(7) It shall show not less than 7 per centum nor more than 12 per centum by weight of fixed carbon on ignition.

(8) When fifty grams of the material are heated in a cylindrical vessel 5.5 millimetres in diameter and 3.5 millimetres deep for 5 hours at a temperature of 163 degrees Centigrade, the loss in weight shall not be more than 20 per centum nor less than 8 per centum, and the residue shall show a float test at 50 degrees Centigrade of not less than 60 seconds.

Specification for Heavy Asphaltic Road Oil—Hot Application

(1) It shall be homogeneous and free from water.

(2) It shall have a specific gravity at 25 degrees Centigrade of not less than 0.96 nor more than 1.20.

(3) It shall have a specific viscosity for 50 cubic centimetres at 100 degrees Centigrade of not less than 25 nor more than 40.

(4) It shall have an open flash point of not less than 160 degrees Centigrade.

(5) It shall be soluble in chemically pure carbon disulphide at room temperature to the extent of not less than 99.5 per centum.

(6) It shall contain not less than 12 per centum nor more than 20 per centum by weight of material insoluble at room temperature in 76 degrees, Baumé paraffin petroleum naphtha distilling between 60 and 88 degrees Centigrade.

(7) It shall show not less than 8 per centum nor more than 15 per centum by weight of fixed carbon on ignition.

(8) When fifty grams of the material are heated in a cylindrical vessel 5.5 millimetres in diameter and 3.5 millimetres deep, for 5 hours at a temperature of 163 degrees Centigrade, the loss in weight shall not be more than 8 per centum nor less than 2 per centum, and the residue shall show a float test at 50 degrees Centigrade of not less than 100 seconds.

Specification for Asphalt Binder—Penetration Method

(1) It shall be homogeneous and free from water, and shall not foam when heated to a temperature of 150 degrees Centigrade.

(2) It shall have a specific gravity at 25 degrees Centigrade of not less than 0.98.

(3) It shall have an open flash point of not less than 190 degrees Centigrade.

(4) It shall have a penetration (No. 2 needle, 100 grams, 5 secs., 25 degrees Centigrade) of not less than 130 degrees nor more than 180 degrees.

(5) It shall have a ductility at 25 degrees Centigrade of not less than 75 centimetres.

(6) It shall be soluble at room temperature in chemically pure carbon disulphide to the extent of not less than 99.5 per centum by weight in the case of oil asphalts, and native asphalts shall show a percentage of material soluble in carbon disulphide characteristic of the products of the fields from which they come.

(7) Of the material soluble in carbon disulphide not less than 14 per centum nor more than 30 per centum by weight shall be insoluble at room temperature in 76 degrees, Baumé paraffin petroleum naphtha distilling between 60 degrees and 88 degrees Centigrade.

(8) It shall show not less than 10 per centum nor more than 18 per centum by weight of fixed carbon on ignition.

(9) It shall contain not more than 5 per centum by weight of paraffin scale with a chill point of —18 degrees Centigrade when calculated on the basis of distillate.

(10) When fifty grams of the material are heated in a cylindrical vessel 5.5 centimetres in diameter and 3.5 centimetres deep, for 5 hours at a temperature of 163 degrees Centigrade, the loss in weight shall not exceed 5 per centum, nor shall the penetration of the residue (No. 2 needle, 100 grams, 5 secs., 25 degrees Centigrade) be less than 50 per centum of the original penetration.

Specification for Refined Coal Tar—Cold Application

(1) It shall be homogeneous and free from water.

(2) It shall have a specific gravity at 25 degrees Centigrade of not less than 1.14 nor more than 1.18.

(3) It shall have a specific viscosity for 50 cubic centimetres at 40 degrees Centigrade of not less than 20 nor more than 30.

(4) On distillation the percentages by weight of distillate at the following temperatures shall be:

To 170 degrees Centigrade not more than 5 per centum

To 235 degrees Centigrade not more than 18 per centum
To 270 degrees Centigrade not more than 25 per centum
To 300 degrees Centigrade not more than 32 per centum

(*a*) The residue from the foregoing distillation shall have a melting point of not more than 70 degrees Centigrade.

(*b*) The distillate from the foregoing distillation shall have a specific gravity at 25 degrees Centigrade of not less than 1.01.

(5) It shall be insoluble in chemically pure carbon disulphide at room temperature to the extent of not less than 4 per centum nor more than 12 per centum by weight.

Specification for Refined Coal Tar—Hot Application

(1) It shall be homogeneous and free from water.

(2) It shall have a specific gravity at 25 degrees Centigrade of not less than 1.20 nor more than 1.27.

(3) It shall show a float test at 50 degrees Centigrade of not less than 65 seconds and not more than 85 seconds.

(4) On distillation the percentages by weight of distillate at the following temperatures shall be:

To 170 degrees Centigrade not more than 0.0 per centum
To 235 degrees Centigrade not more than 10 per centum
To 270 degrees Centigrade not more than 17 per centum
To 300 degrees Centigrade not more than 22 per centum

(*a*) The residue from the foregoing distillation shall have a melting point of not more than 75 degrees Centigrade.

(*b*) The distillate from the foregoing distillation shall have a specific gravity at 25 degrees Centigrade of not less than 1.03.

5. It shall be insoluble in chemically pure carbon disulphide at room temperature to the extent of not less than 10 per centum by weight nor more than 22 per centum.

Specification for Refined Coal Tar Binder—Penetration Method

(1) It shall be homogeneous and free from water.

(2) It shall have a specific gravity at 25 degrees Centigrade of not less than 1.20.

(3) It shall have a melting point of not less than 28 nor more than 35 degrees Centigrade.

(4) On distillation the percentages by weight of distillate at the following temperatures shall be:

To 170 degrees Centigrade not more than 0 per centum
To 235 degrees Centigrade not more than 3 per centum
To 270 degrees Centigrade not more than 11 per centum
To 300 degrees Centigrade not more than 15 per centum

(*a*) The residue from the foregoing distillation shall have a melting point of not more than 75 degrees Centigrade.

(*b*) The distillate from the foregoing distillation shall have a specific gravity at 25 degrees Centigrade of not less than 1.03.

(5) It shall be insoluble in chemically pure carbon disulphide at room temperature to the extent of not less than 12 per centum nor more than 25 per centum by weight.

Effects of Grading of Sands and Consistency of Mix Upon Strength of Concrete

(Continued from page 136.)

By comparison with Fig. 1, it will be noted that sand No. 2 represents approximately an average of the natural sands, while sands Nos. 1 and 3 represent averages of the finer and coarser grades, respectively.

With the original sands, divided as already described, the quantities of each required to produce a given sand of the above series was determined by trial. The composition of 100 lbs. of sand No. 2 following is typical of the results thus obtained:—

Medium fine	retained upon a No. 10 sieve, lbs....	26½
Medium fine	retained upon a No. 20 sieve, lbs....	23½
Medium	retained upon a No. 50 sieve, lbs....	17¾
Coarse	retained upon a No. 50 sieve, lbs....	17¼
Medium	passing a No. 50 sieve, lbs....	15
Total	....	100

The actual grading of the sands used in the tests as determined from "mixer-produced" samples (described later) are shown graphically in Figs. 4 and 5. In this connection, it is of interest to note the relatively small difference existing between the predetermined gradings and the actual gradings.

The art of photography does not readily adapt itself to the reproduction of the impressions obtained by a visual examination of these sands. However, Fig. 6 gives a close approximation of their actual appearance.

The "mixer-produced" samples of test sands used for making granulometric analyses, and for the determinations of voids, were each spread out in a thin layer and divided into small squares from which composite samples were taken for use in the tests.

For the granular analysis tests a standard set of 8-in. diameter hand sieves was used, having 8, 10, 20, 30, 40, 50, 80 and 100 openings per linear inch.

The method used for the determination of voids was as follows:—

Into a graduated glass cylinder containing 800 c.c. of water 1,500 c.c. of sand were slowly poured, the water being agitated as the addition of the sand proceeded. The sand was allowed to stand in the water for 3 to 5 minutes, when the water level was read. The percentage of voids was then determined as follows:—

$$\text{Percentage of voids} = \frac{800 + 1{,}500 - \text{Final volume}}{1{,}500} \times 100.$$

No correction for absorption was made.

Concrete Proportioning, Mixing and Placing

The materials entering into the concrete mix were proportioned by volume reduced to a unit-weight basis. The unit weights were as follow:—

One cubic foot of cement assumed at	100 lbs.
One cubic foot of sand (dry) assumed at ...	106.56 lbs.
One cubic foot of stone (dry) assumed at ...	89.31 lbs.
One cubic foot of water assumed at	62.37 lbs.

The unit weights for sand and stone aggregates were determined by taking the average weight of four measures of 1 cu. ft.

As already described, all sand was freed from moisture by heating upon a metal plate. Similarly all broken stone was surface dried whenever found to contain surface dampness.

Proportioning.—To conform with common practice, the ingredient materials of the mix were arbitrarily proportioned by volume for all tests. The only exception to this practice was the use of unit weights instead of the corresponding volumes, for the reason that greater uniformity was thus secured. The following mixes were used for the purposes indicated:—

For all compression test cylinders used in the sand and the consistency tests, 1:2:4 and 1:2½:5;

For all reinforced-concrete beams used in the consistency tests, 1:2:4.

The standard Canadian bag of cement weighs 87.5 lbs. net. The quantities of ingredient materials for a 1-bag batch of concrete were therefore:—

	1:2:4.	1:2½:5.
Cement, lbs.	87.5	87.5
Sand, lbs.	186.5	233.4
Stone, lbs.	312.6	391.2
Water	As under heading "Mixing."	

amount of sand, cement, and water to the first batch mixed each day. A test batch indicated that approximately 56 lbs. of mortar were required for this purpose. The sand was, therefore, fixed at 50 lbs. and the amounts of cement and water were varied to suit the mix. This amount was used for all sand tests and for the first, second and third consistency tests. For the fourth and fifth consistency tests the sand was reduced to 25 lbs. to allow for the lesser quantity of mortar adhering to the drum.

As previously stated, sand No. 2 represents approximately an average of good quality sands for use in concrete available in the Toronto market. For this reason it was chosen as the sand to be first used in the tests for grading of sands. For the same reason it was used throughout the tests for consistency of mix.

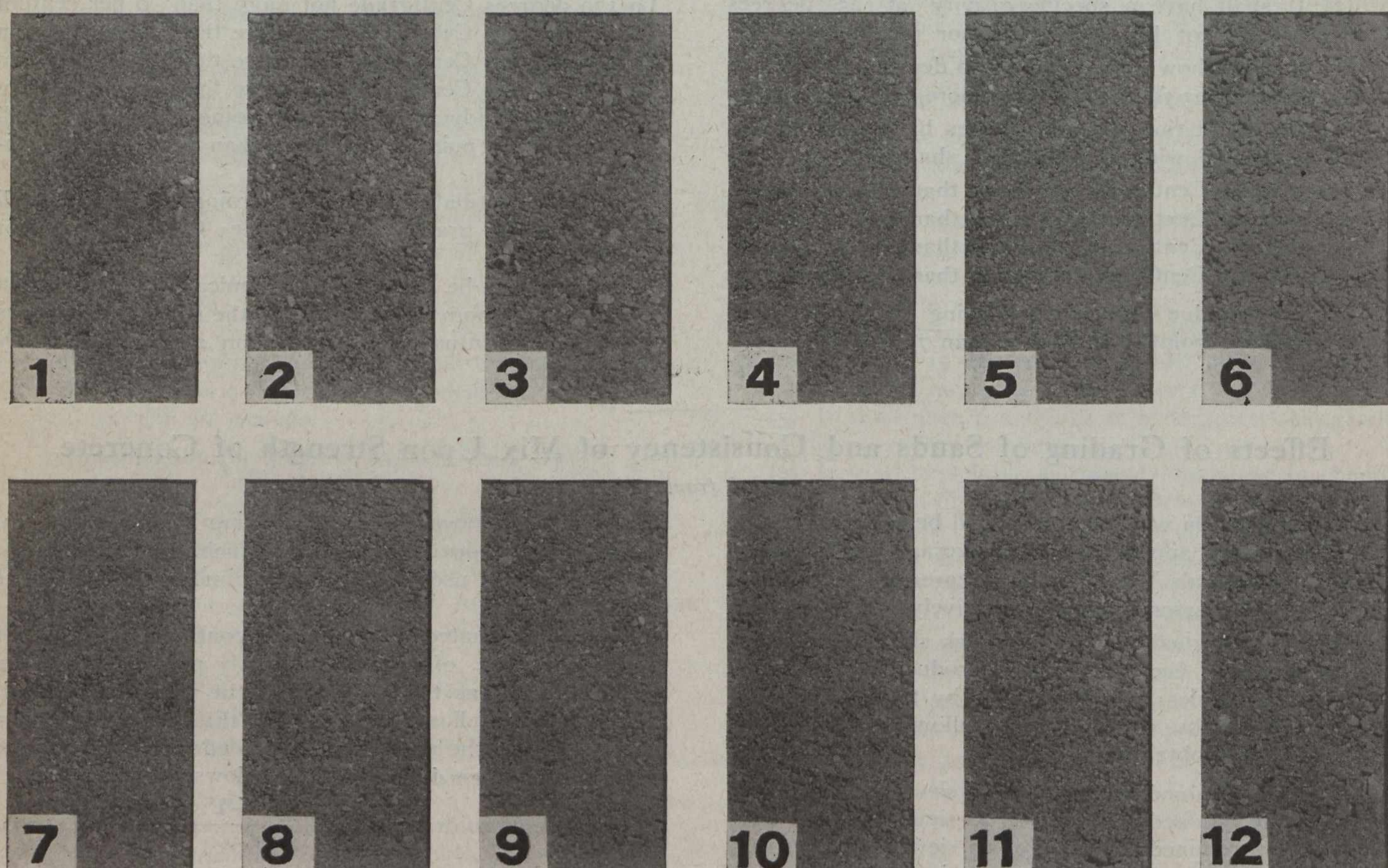


Fig. No. 6.—Sands Used in Tests

Mixing.—The composition of a given test sand having been determined as already described, the quantities necessary for the sand aggregate of a batch of concrete were carefully weighed and placed in the mixer skip, raised, and deposited in the mixer drum. The incorporation of the portions of the original sands to form a uniform composite sand was produced by revolving the drum for a period of not less than five minutes. The "mixer-produced" sample for laboratory use was then taken from the drum and the remaining materials of the batch, except the water, were added in the ordinary way. The drum was permitted to make two revolutions or more before the water was added to the mix. Each batch was mixed one minute after all materials, including the water, had been deposited in the drum.

The mortar required to coat the inside of the mixer drum was provided by the addition of the necessary

The quantities of water used in the 1:2:4 mix and the 1:2½:5 mix were not predetermined. For the first batch of each mix three large pails of water were weighed before the mixing was begun; from these a sufficient amount of water was placed in the mixer to render the batch of the degree of wetness desired, and from the weight of the water remaining in the pails the amount placed in the mixer was determined. This quantity was used as a standard for all succeeding batches in the tests for grading of sands and for the first-consistency batches of the tests for consistency of mix.

Regarding the consistency, or degree of wetness, of the mix used as a standard, it may here be explained that it was the intention of the observer at the mixer to produce a concrete in which the stones were thoroughly covered with a thick coating of sticky, semi-plastic

(*Continued on page 148.*)

Editorials

THE LAWYER AND THE ENGINEER

The mind of the engineer is essentially a creative mind. He walks warily among the teeming possibilities which surround him. He is a cautious selector, never prone to haste, but progressive in general trend. Sufficiently conservative not to adopt unproven remedies or devices, he is willing to consider any new possibility in the light of past experience and technical judgment. He looks to the future more than to the past, while he does not despise precedent,—more often than not he creates precedent by further advance. No other modern mind has quite the same cast. The distinctly scientific individual of high mentality has no commercial instinct; he creates, but usually cannot apply. The latter is the province of the engineer who reduces scientific discovery to utilitarian ends. As a consequence, he is by logical sequence a born mediator between advanced thought and popular consumption. He adapts, adjusts, re-values and selects from among innumerable expedients the particular process or method which suits the exact circumstances of the case. He has no universal panacea for every difficulty, no specific prescription for all troubles,—so soon as practice becomes fixed it is obsolete by process of time alone.

Wherein does this differ from the evolution represented by public administration? The ideal representative of national affairs needs just such a mind as outlined above. He must be cautious, since he must not advance beyond the collective popular mind; he must be acute enough to make selection from among a multitude of remedies just as does an engineer. One capable engineer recently remarked that he didn't care what new phase became apparent in the matter of labor, its adjustment and control, for nothing yet to come could be more complex or difficult than the troublous events of the war era. He had met and conquered all along the line the adjustment to new conditions.

On the other hand, the average lawyer's mind is dilatory, bound with red tape, tied by precedent. It does not create, it takes advantage of minute divisions and side issues. It is bound by the shackles of the past in an extraordinary manner. It cannot organize, and its achievements are verbal triumphs, not executive deeds. Yet it is the lawyer who predominates in public affairs to the public disadvantage. In translating his prior training to a new viewpoint necessitated by entry into public life, he must first exorcize the demon of precedent. That there have been fine minds in the legal profession able to separate their legality from their publicity, cannot be denied, but the question at issue is whether they would have been greater public utilitarians had their training been in some other profession. A lawyer's concentration is more upon the letter of the law than the spirit and intention of its devising. This must hamper free development along novel lines. Governmental administration is not the working out of detail, but the provision of broad tolerances wherein the individual finds scope. The lawyer is deficient in this business view. Keeping within the exact letter of regulation to avoid trouble, while adopting a policy which hampers its spirit, is too prevalent in governmental departments all the world over.

No engineer could do his best work under such control; he must have a free hand within his limits. And this forms another link in the chain of reasons why engineers should be in positions of public authority in administrations, rather than under the complete rule of the political legal mind.

SANDS AND CONSISTENCY OF CONCRETE

In this issue appears the first instalment of a paper on the effects of grading of sands and consistency of mix upon the strength of plain and reinforced concrete, by L. N. Edwards, supervising engineer of bridges of the city of Toronto. The reader will note that Mr. Edwards conducted his tests under the field conditions usually accompanying high-grade concrete construction, and not by laboratory methods. The samples were not hand-mixed, but were made up with the aid of a concrete mixer.

The methods and operations used in the making of concrete are vital factors in the production of conditions affecting the density, strength and permanence of the concrete mass. The materials are too frequently a means to an end without consideration of the end itself. Mr. Edward's paper shows the influence of the grading of sand, the effect of the consistency of mix upon the strength and physical characteristics of the concrete produced, and the effect of varying the time of mixing. The results of his investigations in regard to the latter two points are of especial interest.

Tests were made upon cylinders in which twelve sands of predetermined gradings were used as sand aggregates, cylinders and reinforced-concrete beams in the preparation of which five consistencies of mix were used, and cylinders for which the time of mixing was varied from one-quarter to two minutes.

The results obtained show a wide range in the strengths of concrete produced from sands of different gradings; important variations in the strength of both plain and reinforced concrete, depending upon the consistency of the mix; and the inconsistency of common field methods and operations, and of the usually specified requirements for sand, as opposed to the generally accepted and specified requirements in design. Mr. Edward's paper also shows the reasons why concrete that is too wet is not of as great strength as concrete which is of the proper consistency.

WHY NOT A MAXIMUM LIMIT?

Sir William Meredith has been appointed as the government arbitrator to determine the value of the C.N.R. capital stock. Sir William is a man of honor and a member of a famous family. He has just the right mixture of socialistic tendencies and capitalistic upbringing to ensure an attitude of fairness both to the people and to Mackenzie and Mann. But should even Sir William be endowed with unlimited authority to commit the country irrevocably to the payment of any huge sum for the C.N.R. stock? What is the objection to fixing a maximum limit, say, $30,000,000, beyond which no award can be made? Sir Thomas White tells the House of Commons that the arbitrators will take prospective earnings into consideration. That means that the roof is off and the sky is the limit.

PERSONALS.

Robert W. Thomson, B.A.Sc., M.E., has been appointed by the provincial government of British Columbia to the position of district engineer with headquarters at Kamloops. Mr. Thomson was born near Toronto in 1868 and graduated from the University of Toronto in 1893.

Major Frank O. Tidy, Toronto, has been appointed as officer in command of the Railway and Construction Battalion depot at Ottawa. He was formerly with the 3rd Battalion and later was senior major of the 198th Buffs Battalion. He was awarded the Military Cross for gallantry in capturing a German patrol.

J. E. McAllister, C.E., consulting engineer, of Toronto, has been appointed vice-president and general manager of the National Steel Car Co., Limited, Hamilton. Mr. McAllister is a graduate of the School of Applied Science, Toronto, and of the Michigan College of Mines. He was formerly superintendent of reduction works of the Tennessee Copper Co., and later was general manager of the British Columbia Copper Co. He is consulting engineer to the British-America Nickel Corporation.

F. F. Longley, formerly in charge of construction of the slow sand filtration plant at Toronto, Ont., has been commissioned as major in the United States army, and has been sent to France to assume entire charge of water supply for the American expeditionary force. Mr. Longley is a graduate of the U.S. Military Academy, class of 1902. He was connected with the construction and operation of various sewerage systems and water filtration plants until 1909, when he became associated with the Toronto work. In 1912 he became a member of the firm of Hazen & Whipple, consulting engineers, New York City.

ENGINEERS AT IRRIGATION CONVENTION

The Canadian Society of Civil Engineers was represented at the eleventh annual convention of the Western Canada Irrigation Association, at Maple Creek, Sask., August 1st, 2nd and 3rd, by R. J. Burley, F. H. Peters, S. G. Porter, C. M. Arnold and M. H. French. The Calgary branch was represented by Wm. Pearce and J. S. Tempest.

RESEARCH WORKERS VISIT CALGARY

Dr. McCallum, Dr. Ruttan and Dr. Adams, of the Honorary Advisory Council of Research, were in Calgary on July 17th and 18th. A committee from the Calgary branch of the Canadian Society of Civil Engineers met them and escorted them over the city, pointing out manufacturing plants and other establishments which would be of interest to them in their investigations. The committee, together with members of other technical organizations, afterwards met with them in conference to discuss the distribution of the questionnaires and other matters pertaining to the work of the Advisory Council in Southern Alberta. The members of the Advisory Council also addressed a representative gathering at a luncheon given by the Calgary Board of Trade.

SANDS AND CONSISTENCY OF CONCRETE

(Continued from page 146.)

mortar, or in other words, a concrete of a consistency that, although saturated, shows no free water when taken out of the mixer; that can be transported in barrows, chutes, etc., without appreciable segregation of the component materials; and that when deposited in the forms will settle into place and become thoroughly compacted with a comparatively small amount of spading, slicing, or other manipulating.

Having determined the quantity of water for the first consistency of each mix, the quantities of water for four other consistencies were arbitrarily fixed by the percentages of increase for each, namely, 10 per cent. for the second, 20 per cent. for the third, 35 per cent. for the fourth, and 50 per cent. for the fifth.

For the tests for grading of sands, the quantity of

Table II.—Percentage of Water Used in Tests for Grading of Sands and Consistency of Mix

Test.	Kind of Specimen.	1:2:4 Percentage of Water to Dry Weight of Cement and Aggregates.	1:2:4 Cement.	1:2½:5 Percentage of Water to Dry Weight of Cement and Aggregates.	1:2½:5 Cement.
Grading of sands....		6.17	41.14	5.99	48.76
Consistency:					
First.....	Beam	6.48	43.36	...	...
	Cylinder	6.17	41.14	5.99	48.76
Second...	Beam	7.13	47.70	...	...
	Cylinder	6.75	45.25	6.59	53.64
Third....	Beam	7.78	52.03	...	...
	Cylinder	7.37	49.37	7.19	58.51
Fourth...	Beam	8.75	58.52	...	...
	Cylinder	8.28	55.54	8.09	65.83
Fifth.....	Beam	9.72	65.04	...	...
	Cylinder	9.26	61.71	8.99	73.14

water used, when expressed in relation to the total dry weight of the cement and aggregates and to the cement alone, is given in Table II.

Table II. also gives the percentage of water used in the tests for consistency of mix.

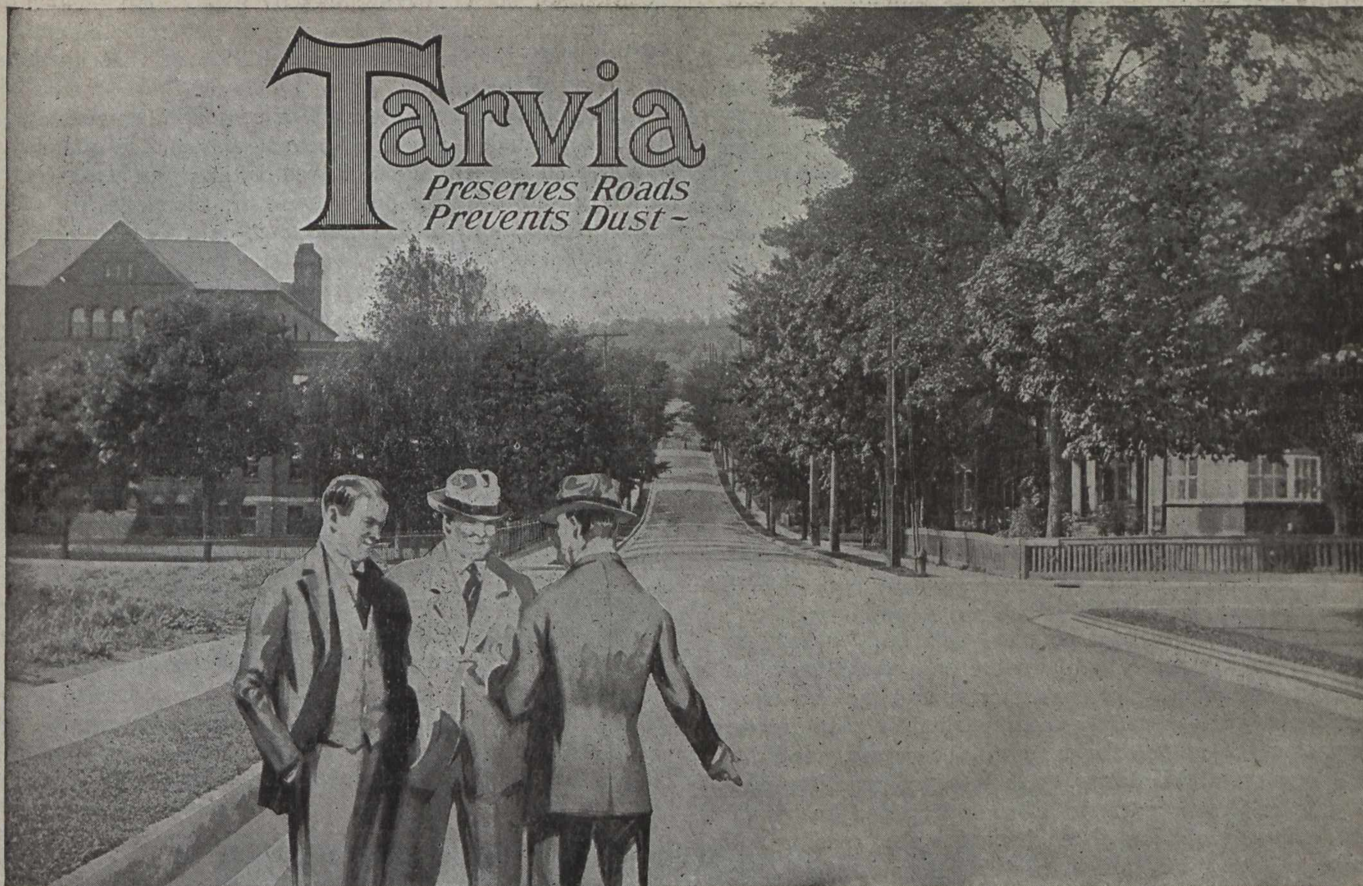
In connection with the data given in Table II., it must be borne in mind that all concrete materials were thoroughly dry when deposited in the mixer drum.

The detail of the test beams rendered it necessary that the concrete of first consistency for this work be slightly more mushy than that for the test cylinders.

The quantity of concrete mixed for each set of test specimens was sufficient to fill all molds and to give a residue of from 1½ to 2 cu. ft. The last test specimens made each day were, therefore, in no sense composed of scrapings from the mixer. In this connection, it is of interest to note that, although a less quantity of materials was provided for coating the inside of the drum with mortar, the quantity of concrete left over from the very wet mixes was approximately double that left over from the first or standard consistency. This increase was mainly due to the increased volume of water used.

A steam-operated Foote mixer of ⅓-cu. yd. capacity was used for the mixing of all concrete.

Placing.—The concrete was removed from the mixer as required for placing in the cylinder and beam forms. Usually about 2 cu. ft. of concrete were removed at a time and deposited in a barrow, from which it was



Argyle Avenue, Westmount, Que., surface maintained with "Tarvia-A." Road in background has a 14% grade, yet offers excellent traction for vehicles.

Civic Pride and Economy in Tarvia Roads—

HERE'S a group of citizens in a certain progressive town. They own cars, vehicles, horses, and they are taxpayers.

For their business and pleasure they have wanted smooth, dustless and mudless streets.

They've got them now, *because their roads are being built and treated with Tarvia.*

They are very proud of the result. Tarvia has made their streets smooth as a dancing-floor and so dustless that there's no more use for the watering-cart, and the streets are free from mud as well.

What pleases them most *as taxpayers* is the fact that the use of Tarvia is really an economy, not an expense.

Its use adds years to the life of the road, and it saves so much in maintenance expense that in the long run it reduces road taxes.

The only maintenance required is an occasional coating of Tarvia spread on when the road begins to show wear. Such treatment is very inexpensive.

What Tarvia is

Tarvia is a coal-tar preparation, shipped in barrels or tank-cars. It is made in three grades, to be used according to road conditions, *viz.:* "Tarvia-X," "Tarvia-A," "Tarvia-B." The chief use of Tarvia is for constructing and treating macadam roads to make them durable, smooth, resilient, dustless, mudless, waterproof.

"Tarvia-X"

is always to be used when you are building a new macadam road, both as a binder and surface-coating. With Tarvia-bound macadam in place of water-bound macadam, you have a road resilient enough for rubber tires to grip on without skidding or for horses to trot on without slipping; without dust in dry weather; without slime in wet weather. You have a road that *lasts.*

"Tarvia-A"

is practically a thin "Tarvia-X," used for recoating the surface of a macadam road already built. It is applied hot and adds greatly to the life of the road.

"Tarvia-B"

is a much more widely used preservative. It is applied cold. It is thin enough to sink quickly into the road, yet strong enough to bind the surface particles together into a dustless, durable surface.

"Tarvia-B" offers the lowest cost of road maintenance yet invented.

Booklets describing the Tarvia treatments free on request.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems.

The advice of these men may be had for the asking by any one interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

Made in Canada

THE PATERSON MANUFACTURING COMPANY, LIMITED
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THE CARRITTE-PATERSON MANUFACTURING CO., LIMITED
ST. JOHN, N. B. HALIFAX, N. S. SYDNEY, N. S.

shovelled into the forms as required for puddling. Before each succeeding barrowful was taken out, the mixer drum was given two or more revolutions to overcome any segregation of the ingredients of the concrete remaining in the mixer due to the action of gravity.

No special provision was made to prevent evaporation losses in the mixer drum and in the barrow. The mixing and placing was carried on in the open air and the usual variations of temperature and humidity of atmosphere existed from day to day as the work progressed. The mixing of batches was done from 7.45 to 8.30 a.m. The maximum variation in temperature was therefore only 46° F. In this connection, the writer desires to mention the valuable information contained in Bulletin No. 81, "The Influence of Temperature on the Strength of Concrete," University of Illinois Engineering Experiment Station.

In the puddling of the concrete in the forms, a special effort was made to do the work with the greatest dispatch, consistent with the securing of uniform results, special attention being given to thorough compacting and the uniform distribution of the broken stone and mortar throughout each cylinder and beam.

Bars having a diameter of 5/16 to 3/8 in., flattened to form a comparatively thin blade-like end, were used for puddling. Compacting of the concrete and the exclusion of entrapped air was mainly accomplished by tapping the exterior surface of the forms with a hammer. In the consistency tests this latter method of compacting was used only in the preparation of cylinders and beams of the first and second consistencies. In the placing of concrete of the third, fourth and fifth consistencies the puddling bars were mainly used to uniformly distribute the stone aggregate.

All molds were filled at the mixing machine and were removed as soon as filled to the storage shed, a distance of about 100 ft. The top surfaces of cylinders and beams were here troweled slightly to remove irregularities.

Time of Mixing.—Information indicating the effect of varying the time of mixing was desired, and the specimens for this investigation were prepared as follows:—

The ingredients necessary for a 1½-bag batch of 1 : 2½ : 5 concrete were placed in the mixer drum and a sufficient quantity of water to produce concrete of first consistency. The mixing was timed from the completion of placing all concrete materials in the mixer drum. When the mixing had continued ¼ minute a sufficient quantity of concrete was removed to mold the ¼-minute group of cylinders. As soon as these cylinders had been puddled, the mixing was continued an additional ¼ minute to mix the concrete for the ½-minute group of cylinders. In a similar manner the concrete was mixed for the 1 and 2-minute groups of cylinders.

The uncontrollable conditions of temperature, humidity, evaporation, etc., above mentioned constituted the main factors of a foreign nature, tending to produce irregularities in the mixing and placing, the personal equation being reduced to a minimum by reason of the fact that the work was performed by the same men from day to day.

In a few cases it was found that the water content fixed upon in the first batch of each mix was insufficient to produce a plastic mortar. A greater amount of labor was required in such cases to produce a uniformly compacted mass.

Sands having little fine material, with a considerable proportion of coarse, were found to be unadapted to the production of a "sticky, semi-plastic mortar." The water content of such mortar sinks by gravitation below the surface and doubtless takes with it some of the cement, thus producing an uneven distribution of that important element of the mix.

In relation to the volume of cement (assumed at 100 lbs. to produce 1 cu. ft. of cement paste), the quantity of sand used in each mix was greater than that used in common practice. As already shown, the shrinkage in volume due to thorough drying amounted to 18.7 per cent. per cubic foot of wet sand.

To eliminate possible irregularities throughout the work, two men prepared the ingredients of the specially graded sands and apportioned the concrete materials for each batch. These men with two others mixed and placed the concrete. In general, all placing of concrete in the forms was the work of three individuals. The troweling of the top surfaces of cylinders and beams was done by one of these. The main variables, namely, the gradings of the sands and the consistency of mix, were thus as clearly defined as practicable.

Storage.—The forms as soon as filled were placed in a corrugated-iron covered shed.

In general, the forms were removed from the test specimens 24 hours after filling. The few exceptions to this rule were due to slow setting of the concrete, resulting from cold or wet weather. As soon as removed from the forms the test specimens were marked for identification and placed in beds of moist sand, where they remained until required for the compression or bend test.

The reinforced-concrete beams were handled with special care in order not to produce incipient fractures.

Mixing of concrete was commenced on March 30th, 1916. It was, therefore, necessary to maintain artificial heat in the storage shed during the night and at times during the day for a period of from two to three weeks.

(Continued in the next issue.)

Coast to Coast

Barton Tp., Ont.—Papers and reports that three years ago cost the township over $3,000 have been lost. The missing articles include the reports, tracings and blue prints having to do with the proposed water and sewer system of Barton on the mountain.

Beeton, Ont.—The ratepayers voted on August 6 on the hydro enabling by-law and also on a by-law to raise $15,000, which sum, it is estimated, will be necessary to put the transmission plant in good order.

Edmonton, Alta.—Building permits for the month of July amounted to $44,400, as compared with $2,800 for the same month last year.

London, Ont.—The annual convention of the Union of Canadian Municipalities will be held here on August 27th, 28th and 29th.

Mimico, Ont.—Three miles of new steel will be laid, in addition to that already laid, and other improvements made this year by the Toronto and York Radial Railway Co. along the Lake Shore Rd. Charles L. Wilson is assistant manager.

Montreal, Que.—A syndicate has been formed in Montreal and plans are about completed for the building of concrete steamships on the local water front. The Atlas Construction Co., of Montreal, are the prime movers in this enterprise, and the members of the syndicate which will provide the initial working capital are well known business men of Montreal. The cost of the first vessel to be constructed here will be well within $100,000. The engines for this vessel have been contracted for, and it is expected that it will be launched before October 1st.