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The Canadian Engineer

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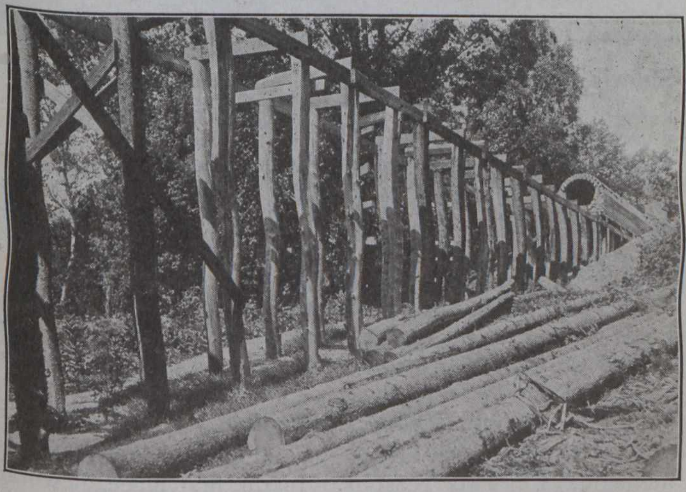
Two Toronto Sewers Built on Piles and Timber Bents

Involved Problems of Shifting Dead Weights and Strengths of Substructures Instead of the Usual Sewer Problems of Stationary Dead Weights and Nature of Ground Traversed

By W. G. CAMERON

Assistant Engineer on Construction, Department of Sewers, Toronto

THE trunk sewer for the southwestern section of the West Toronto sewer system passes east along Bloor Street from the west city limit at Jane Street to Pacific Avenue. From here it is diverted in a southeasterly direction, across the northeast corner of High Park and terminates at the stand-by tanks. (See article published in *The Canadian Engineer* of January 6th, 1916, for a description of the tanks.) During storms the excess storm water is diverted over a weir into the stand-by tanks, and the remainder is discharged into the trunk sewer on Keele Street which forms part of the high level interceptor that terminates at the main sewage disposal works located nine miles to the east. The Clendenan Avenue sewer, which is an outlet for a large district to the north of Bloor Street, is connected to the Bloor Street sewer. A large ravine crosses diagonally at the intersection of these two streets. The bottom of this ravine was much lower than the necessary elevation of the future sewers. It was, therefore, necessary to fill in the ravine at this point to provide a foundation for the sewers and a roadway over them. The problem then arose as to whether it would be more economical to build a temporary pumping station to serve until this fill would have settled sufficiently, to provide a firm foundation for the sewers, or to drive piles at once to support them. It was decided that the latter would be much the cheaper method and this plan was accordingly adopted.



Piling and Sewer Under Construction

Piling and Timbering

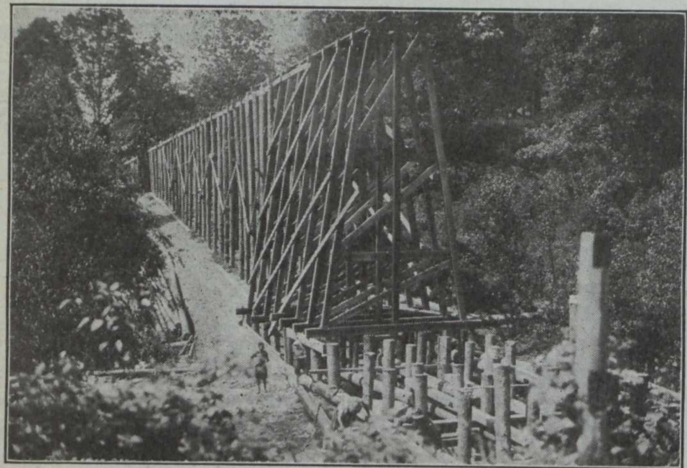
The original plan provided for piles 10 ins. in diameter at the small end to be driven at 5-ft. centres and lengths given that provided for a penetration of from 12 ft. to 15 ft. These lengths proved to be sufficient on the high ground, but near the bottom of the ravine, where the ground was of a soft, boggy nature, piles of as great a length as 50 ft. were required, and these were driven to the surface of the ground. In odd places even this length was not sufficient and it was necessary to splice the piles with 1½-in. steel dowel pins. Four rows of piles were driven here where two had been planned, and timber bents were used to bring them up to grade. Often the piles at this low place would sink several feet with their own weight, a thin clay seam would then intervene, and the pile would drive hard for a few blows, then would drive easily again, and so on till the minimum penetration was reached, which was a resistance of 1 in. per minute.

Material was Dumped Over Banks of the Fill Instead of Being Raised by a Donkey Engine

The sewer on Clendenan Avenue was built by Messrs. John Maguire & Son, while the Bloor Street sewer was built by the Orpen Contracting Company. Two outfits of pile drivers were therefore used. The former firm used a 500-pound drop-hammer with 50-ft. leads, while on Bloor Street the contractor used a 3,000-pound steam hammer with an 18-in. piston striking 120 1,000-pound blows to the minute, and leads 50 ft. long. Generally six 50-ft. piles driven was considered a good day's work, while the maximum reached was nine on Bloor Street. Many delays were caused owing to the location of the work, necessitating a constant raising or lowering of the engine and leads, while ascending or descending the sides of the ravine.

As before mentioned, it was necessary to build timber bents when the piles were driven below grade. These timber bents were in some cases 30 ft. high, but the same sized timber was used for all. They were built of 6-in. x 8-in. uprights, 8-in. x 10-in. caps and sills, 2-in. x 6-in.

cross and side braces and 3-in. x 8-in. runners. These runners were let into the sides of the piles or timber bents at the top 1½ ins. and were spiked to them. These caps



Piles Driven to Ground Level and Erection of Timber Bents Under Way

were bolted to the piles or timber bents by 1-in. x 15-in. bolts. Where sills were necessary they were attached to the tops of the piles by ⅞-in. x 24-in. drift bolts for which holes were bored to prevent splitting. The piles which came to grade and the timber bents were held in place by sway or side-braces.

When the piles were all driven and the bents erected, the filling, which will be described in detail later, was commenced, and was carried on till the tops of the bents were reached. A floor of 2-in. plank was then built on top of the bents and piles to serve as a temporary platform for the green concrete of the proposed sewer. The bents had been left 2 ins. low to allow for this, and care had been taken to leave the caps exposed so they would be embedded in the concrete.

Construction of the Sewers

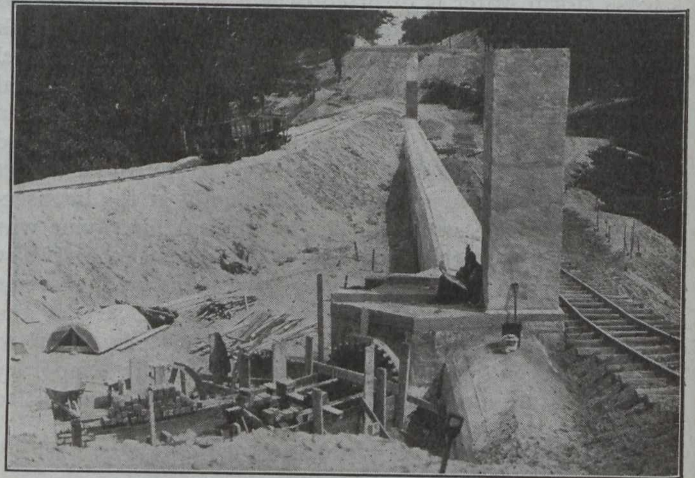
The sewer on Bloor Street was built of concrete and was of the culvert type size, 5 ft. x 6 ft. 6 ins. The invert and crown were of 1 : 2 : 4 concrete, the former 15 ins.

Showing Completed Pile and Timber Bents; Fill Partly Made and Manhole Built to Future Grade

and the latter 10 ins. thick, while the sides were of 1 : 3 : 5 concrete and 11 ins. thick. It was reinforced on the invert with ⅝-in. round steel rods 10-in centres and on the crown with .75 sq. in. per square foot mesh which was laid so that it would be 1½ ins. above the inside surface at the crown and gradually come to a similar position with regard to the outside surface 15 ins. below the springing line of the arch. The invert was dished and was lined with one thickness of paving brick for a wearing surface. The material for constructing this sewer was brought in over the new fill.

The Clendenan Avenue sewer, or that part of it which was on piles, was 4-ft. circular with two rings of brick for a crown and with a concrete invert which was made square outside to set properly on the caps. The concrete was 8 ins. thick, reinforced with ⅝-in. round steel rods 12-in. centres and a ring of paving brick was built inside for a wearing surface. The filling had progressed to such an advanced stage before the sewer was completed that it was finished in a trench (Fig. 2). This, of course, led to an alteration in the method of handling material which, instead of being raised by donkey engine and skip as had been planned, was dumped over the banks of the new fill.

Care was taken when building these sewers, to provide for the future shrinkage of the fill which, of course, would leave a considerable space under the sewer. With



Showing Cut at Top of Slope. Manhole Built to Grade. Fill Partly Made

this in view, a 3-in. tile pipe was placed through the bottom of the sewer every 5 ft. or between the bents. The space left by the shrinkage was afterwards filled from the inside of the sewer with sand through these pipes, and the pipes were then sealed up with concrete.

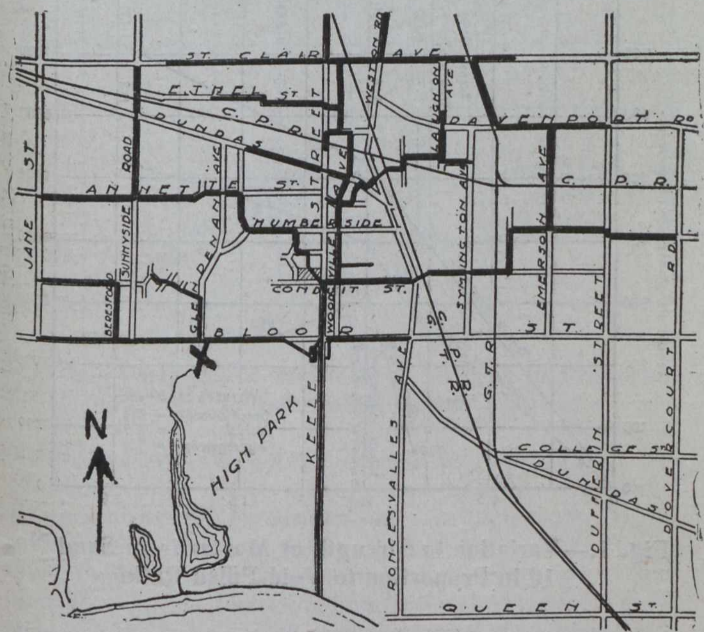
At the time of the construction of the sewer, the manholes were built up to the future grade of the street and looked rather odd projecting into the air 20 ft. above the exposed sewer.

Filling the Ravine

As we have mentioned, the filling of the ravine was advisable for two reasons. In the first place, it would improve the grade on the street, and secondly, it would not only provide a covering for the sewers but, what was more important, it would provide a foundation for them when the piles and timbering would have decayed. It was accordingly proceeded with as early as the sewer construction would allow. A large bank of sand about one-quarter mile away had been secured and the necessary 215,000 cubic yards of earth to make the filling were taken from it. Two steam shovels were located at the borrow bank and small construction engines with trains of cars were used to haul the material which was deposited as uniformly as possible on either side of the sewers.

The sides of the ravine rose 95 ft. above the bottom, and as it was proposed to continue Bloor Street over the fill, which was only 60 ft. deep, cuts had to be made through the top of each bank in order to ease the grade for the future street. The top of the fill was 60 ft. wide and a slope of 1½ to 1 was provided on each side. This 60-ft. fill buried the sewers completely under 20 ft. of sand and later when the fill had settled sufficiently gullies were built in order that the storm water would be taken by them into the sewer instead of being allowed to wash out the sides of the fill.

The filling in this ravine had to be carefully done with a view to the effects which the settlement of the fill would have on the sewers. As we have mentioned, the lower 400 ft. of Clendenan Avenue sewer is in the ravine and so had to be filled in as well as Bloor Street. The completed fill, therefore, had a much greater volume on the north side of Bloor Street than on the south. In addition to this fact, the natural grade of the bottom of the ravine is towards the south, southeast. It may reasonably be supposed then, that, should all the fill be made



Sketch Plan of Keele Street Storm Overflow Area

from the north side, the side nearest the spoil bank, the resultant settlement would be toward the south and would bear the piles and sewer with it. This was foreseen and the heavy part of the fill was as evenly distributed as possible. It was even tried to have a greater part of the filling made from the south side in order to counteract the southward trend of the settlement. This method gave the best results at the time and has since proved to be entirely satisfactory.

This piece of work was interesting on account of the peculiar conditions under which it was carried out, because of which, problems arose different from those met with in the usual course of sewer construction. Whereas, in the usual sewer the problems have to do with stationary dead weights and the nature of the ground traversed, here the problems dealt with were those of shifting dead weights and the strengths of the substructures. The handling of material alone required an unusual organization on account of the fact that work was done at such a height above the ground, and because of the location of the work in a ravine where the approaches were difficult. In addition to this, in the ordinary sewer work, the problems are present and tangible, and may be largely dealt with as they are encountered, whereas here the problems were largely of the future and had to be estimated and the solutions planned in advance.

ECONOMICAL PROPORTIONS FOR PORTLAND CEMENT MORTARS AND CONCRETES*

By J. A. Kitts

A MORTAR is a mixture of sand, cement and water in various proportions. The question of scientific interest is: What determines the mixture of maximum efficiency?

Sands vary in physical, chemical and mechanical structure, causing a variation in the specific gravity and percentage of voids, and these latter cause a variation in the weight per cubic foot or aggregate specific gravity. An important consideration in the study of a large number of mortars from a large number of aggregates is that of comparison. A study of the characteristics of various sands will show that mortars are not comparable either in arbitrary weight proportions or in arbitrary volumetric proportions. What, then, determines the conditions for comparison of the mortar from one sand with that of another?

An analysis of the results indicated in Prof. M. O. Withey's paper on "Tests of Mortars Made from Wisconsin Aggregates," throws considerable light on the two preceding questions. In these tests mortars were made in 1:2, 1:3, 1:4 and 1:5 weight proportions and the following tests made: Unit tensile strength; unit compressive strength; leakage of water through specimens 2 ins. thick with pressures of 10 and 40 lbs. per square inch; density; yield; and compressive strength in proportion to cost. Tables I. and II. show the physical and mechanical characteristics of eleven of the sands used in these tests.

Tables III. and IV. show the variations of the volumetric and void conditions common to simple weight proportioning.

Table III. is computed by the following equation:

$$\frac{\text{Agg. Volume Sand}}{\text{Agg. Volume Cement}} = \frac{\text{Wt. Proportion Sand}}{\text{Wt. Proportion Cement}} \times \frac{\text{Agg. Sp. Gr. Cement}}{\text{Agg. Sp. Gr. Sand}}. \quad (1)$$

$$\text{Aggregate Specific Gravity} = (1 - \text{Proportion of Voids}) \times \text{Specific Gravity.} \quad (2)$$

$$= \frac{\text{Weight, in lbs. per cu. ft.}}{62.5}$$

$$= 110/62.5 = 1.76 \text{ for cement.}$$

Table IV. is computed by the following equation:

$$\frac{\text{Vol. of Cement Paste}}{\text{Vol. of Voids in Sand}} = \frac{\text{Agg. Sp. Gr. of Sand}}{\text{Agg. Sp. Gr. of Cement} \times \text{Wt. Proportion of Sand} \times \text{Voids in Sand}} \quad (3)$$

Table III. shows that the volumetric proportions corresponding to the 1:2 weight proportions vary from 1:1.77 to 1:2.41, the 1:3 weight from 1:2.65 to 1:3.62 volume, 1:4 weight from 1:3.54 to 1:4.82 volume, and

*Abstracted from paper read before the American Society for Testing Materials.

the 1:5 from 1:4.42 to 1:6.03. Table IV. shows the proportions of voids in the sands filled with cement paste varying from 0.91 to 2.03 for the 1:2 weight proportion, from 0.61 to 1.35 for the 1:3, from 0.46 to 1.01 for the 1:4, and from 0.37 to 0.81 for the 1:5 proportion. Nothing could better illustrate the fallacy of the practice of comparing work sands with standard sand in 1:3 weight proportions.

Neither is there a basis of comparison in a fixed volumetric proportion. In 1:3 volumetric proportions the proportions of the voids in the sands filled with cement paste would vary from 0.73 to 1.20 for the 11 sands, as shown in Table V. It must be admitted, from a scientific or practical consideration of a mortar, that a very important function of the cement is to fill the voids in the sand; and it cannot be expected that a mortar in which the volume of cement paste is equal to only 73 per cent. of the volume of voids in the sand is comparable with that in which the cement paste is equal to 120 per cent. of the voids.

TABLE I.—PROPERTIES OF SANDS. (FROM WITHEY'S TABLE I.)

Sand. No.	Weight per cubic foot, lb.	Specific Gravity.	Voids, per cent.	Silt, per cent.	Absorption, per cent.
Standard	104.1	2.65	37.0	...	...
Sd. 1	105.2	2.66	36.5	3.0	0.19
Sd. 2	106.9	2.74	35.2	1.3	0.49
Sd. 3	101.8	2.68	38.2	0.8	0.27
Sd. 4	98.9	2.63	39.8	1.2	0.04
Sd. 5	91.2	2.67	45.3	0.5	0.17
Sd. 7	105.2	2.78	36.6	1.6	0.41
Sd. 8	105.3	2.70	36.4	1.5	0.18
Sd. 9	105.5	2.75	36.0	0.7	0.51
Sd. 10	120.3	2.77	27.9	7.7	0.29
Sd. 11	108.7	2.72	35.0	0.4	0.11

TABLE II.—SIEVE ANALYSIS OF SANDS. (FROM WITHEY'S TABLE II.)

Sand No	Percentage by Weight Passing Sieves Nos. 10	20	30	40	50	74	100	Uniformity Coefficient
Standard	100.0	100.0	0.0	....	....	....	....	....
Sd. 1	86.4	65.5	39.0	25.0	9.1	5.4	2.8	3.0
Sd. 2	81.2	70.9	61.4	52.4	34.5	17.9	9.7	2.6
Sd. 3	91.9	72.7	39.7	26.4	13.7	4.2	1.2	2.4
Sd. 4	100.0	99.5	95.8	88.8	62.5	22.1	8.6	1.8
Sd. 5	100.0	99.9	99.8	99.1	67.6	18.2	5.7	1.8
Sd. 7	67.7	44.5	25.9	17.8	11.2	3.8	2.2	4.7
Sd. 8	82.0	72.5	55.3	38.6	16.1	3.6	1.9	2.6
Sd. 9	66.8	22.7	13.9	10.3	4.9	2.4	1.4	3.7
Sd. 10	69.7	48.8	34.0	26.3	17.4	8.7	6.5	6.9
Sd. 11	72.0	47.7	23.8	12.0	4.3	0.7	0.5	3.4

TABLE III.—VOLUMETRIC PROPORTIONS FOR SIMPLE WEIGHT PROPORTIONS.

Sand No.	Weight Proportions. 1:2	1:3	1:4	1:5
Sd. 10	1:1.77	1:2.65	1:3.54	1:4.42
Sd. 2	1:1.98	1:2.97	1:3.96	1:4.94
Sd. 11	1:1.99	1:2.98	1:3.97	1:4.97
Sd. 7	1:2	1:3	1:4	1:5
Sd. 9	1:2	1:3	1:4	1:5
Sd. 8	1:2.05	1:3.07	1:4.10	1:5.12
Sd. 1	1:2.08	1:3.12	1:4.17	1:5.20
Standard	1:2.11	1:3.17	1:4.22	1:5.27
Sd. 3	1:2.13	1:3.20	1:4.27	1:5.33
Sd. 4	1:2.23	1:3.34	1:4.46	1:5.57
Sd. 5	1:2.41	1:3.62	1:4.82	1:6.03

TABLE IV.—RATIO OF VOLUME OF CEMENT PASTE TO VOLUME OF VOIDS IN SAND FOR SIMPLE WEIGHT PROPORTIONS.

Sand No.	Weight Proportions. 1:2	1:3	1:4	1:5
Sd. 10	2.03	1.35	1.01	0.81
Sd. 11	1.44	0.96	0.72	0.58
Sd. 2	1.43	0.96	0.72	0.57
Sd. 9	1.39	0.93	0.70	0.56
Sd. 7	1.37	0.91	0.68	0.55
Sd. 8	1.34	0.90	0.67	0.54
Sd. 1	1.32	0.87	0.66	0.53
Standard	1.28	0.85	0.64	0.51
Sd. 3	1.23	0.82	0.61	0.49
Sd. 4	1.13	0.75	0.56	0.45
Sd. 5	0.91	0.61	0.46	0.37

TABLE V.—RATIO OF VOLUME OF CEMENT PASTE TO VOLUME OF VOIDS IN SAND, FOR SIMPLE VOLUMETRIC PROPORTIONS.

Sand No.	Volumetric Proportions 1:2	1:3	1:4	1:5
Sd. 5	1.10	0.73	0.55	0.44
Sd. 4	1.25	0.84	0.63	0.50
Sd. 3	1.31	0.87	0.65	0.51
Standard	1.35	0.90	0.68	0.54
Sd. 7	1.35	0.91	0.68	0.55
Sd. 1	1.36	0.91	0.68	0.55
Sd. 8	1.37	0.92	0.69	0.56
Sd. 9	1.39	0.93	0.69	0.56
Sd. 2	1.42	0.95	0.71	0.57
Sd. 11	1.43	0.95	0.71	0.57
Sd. 10	1.79	1.20	0.90	0.72

$$\frac{\text{Volume of Cement Paste}}{\text{Volume of Voids in Sand}} = \frac{1}{\text{Vol. Prop. of Sand} \times \text{Prop. of Voids in Sand}} \quad (4)$$

Assume, for example, that six mortars of a certain sand and cement are made in which the ratio of the volume of cement paste to the volume of voids in the sand has, respectively, the values of 0.50, 0.75, 1.00, 1.50, 2.00 and 3.00. It is reasonable to anticipate that the strength of the mortars will increase at a rapid rate until the voids in the sand are filled with cement paste, after which the strength will increase at a lesser rate until the sand particles are so widely separated by the cement paste that the strength of the mortar will closely approximate the strength of the neat cement. In other words, as the cement content is increased, the rate of increase of strength is greater before the voids are filled than it is after the voids are filled, and in some finite proportions the strength of the mortar approximates the strength of the neat cement. Fig. 1, which shows the compressive and tensile strengths and the strength in proportion to cost for sand No. 10, plotted against the void-filled ratio, illustrates these assumptions very well. This sand, unfortunately, is the only one of this series of tests which has a proportion (1:4 by weight) closely equal to that in which the volume of cement paste is equal to the volume of voids in the sand, and which has more than one proportion in which the volume of cement paste is greater than the volume of voids in the sand.

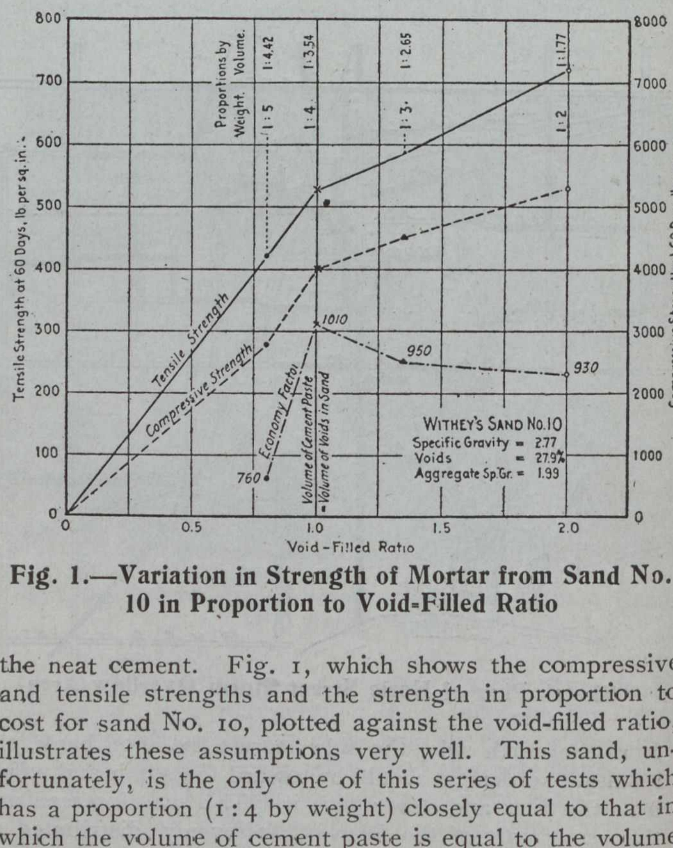


Fig. 1.—Variation in Strength of Mortar from Sand No. 10 in Proportion to Void-Filled Ratio

Fig. 2 shows the compressive strengths plotted against the void-filled ratio. The curve of averages supports the assumption as to the rate of increase of strength. The curve of averages is fairly uniform, and would appear to indicate that the void-filled ratio has a similar effect on all the sands. This, then, appears to establish the principle that the properties, strength, efficiency, etc., of mortars are properly compared on the basis of the void-filled ratio.

The final and most important consideration of a mortar is the strength in proportion to the cost. This may be expressed as an "economy factor," equal to the compressive strength in pounds per square inch divided by the cost of the mortar in dollars per cubic yard. This factor may be expressed by the following equation:

$$\text{Economy factor} = \frac{\text{Compressive Strength (lbs. per sq. in.)}}{\text{Cost of Mortar (dollars per cu. yd.)}}$$

$$= \frac{\text{Compressive Strength} \times \text{Yield}}{C_s + \dfrac{P_c X C_c}{P_s}} \quad (5)$$

in which P_c and P_s are the volumetric proportions of cement and sand, C_c and C_s are the costs, in dollars per cubic yard, of cement and sand, and the yield is based on the volume of the sand as unity.

This factor is plotted in Fig. 10 of Withey's paper previously referred to. The cost represents cost of materials only, cement being estimated at $1.50 per barrel and sand at $1.25 per cubic yard. In Fig. 3 these

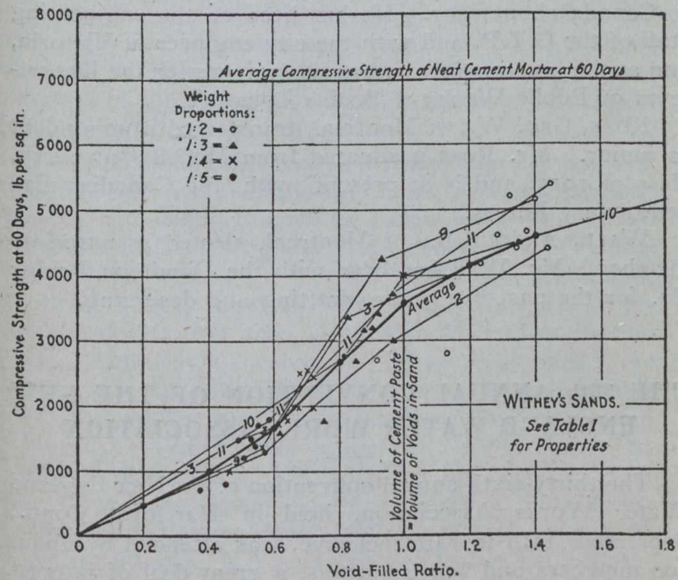


Fig. 2.—Variation in Strength of Mortars in Proportion to Void-Filled Ratios

factors for all 11 sands have been plotted against the void-filled ratio. The average compressive strength of the cement used in these tests was less than 7,000 lbs. per square inch at 60 days. The economy factor for the neat cement mortar would then be approximately 7,000 ÷ 10.14 = 690*. The highest economy factor shown on the curve of averages is 860. This and the curve of averages indicate that the economy factor decreases when the void-filled ratio is somewhat in excess of 1.5. The results of these tests, therefore, indicate that the most economical mixtures lie between proportions giving a void-filled ratio from 1 to 1.5.

As an illustration, Fig. 3 shows that the most economical proportion for sand No. 10 is that in which the volume of cement paste is equal to the volume of voids. From Fig. 1, it is seen that this proportion is 1 cement : 3.58 sand by volume giving a tensile strength at 60 days of 525 lbs. per square inch, a compressive strength of 4,000 lbs. per square inch, and an economy factor slightly over 1,000.

The equations for economical mixtures, as indicated by this series of tests, may therefore be written:

$$\frac{\text{Volume of Sand}}{\text{Volume of Cement}} = \frac{1}{(1 \text{ to } 1.5) \times \text{Proportion of Voids in Sand}} \quad (6)$$

$$\frac{\text{Weight of Sand}}{\text{Weight of Cement}} = \frac{\text{Agg. Sp. Gr. of Sand}}{(1 \text{ to } 1.5) \times \text{Agg. Sp. Gr. of Cement} \times \text{Voids in Sand}} \quad (7)$$

If the properties of mortars from all sands vary with the variation of the void-filled ratio, the leakage, density and yield should show similar effects for all sands. Fig. 4 shows the leakage of the various mortars plotted against the void-filled ratio; and this is another proof that the void-filled ratio is the proper basis of comparison of the properties of mortars.

Conclusions Regarding Mortars

1. Sand-cement mortars are not comparable in simple weight proportions because of the wide variations in the corresponding volumetric proportions and the variations of the void-filled ratios.

2. Sand-cement mortars are not comparable in simple volumetric proportions because of the wide variations of the void-filled ratios.

3. The void-filled ratio has a general effect upon the strength, permeability and economy of a mortar and undoubtedly affects the density and yield.

4. An important function of the cement paste is to fill the voids in the sand.

5. Sand-cement mortars are properly comparable on the basis of the void-filled ratios.

6. The economical proportions for sand-cement mortars depend upon the void contents of the sands and may be expressed by Equations 6 and 7.

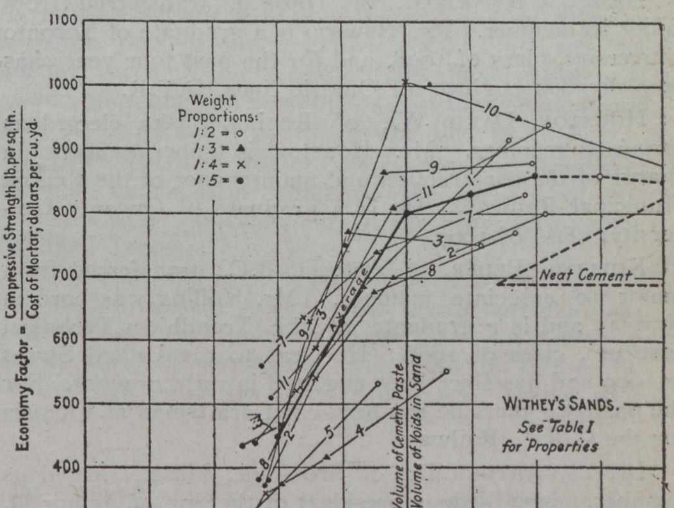


Fig. 3.—Variation in Economy Factor in Proportion to Void-Filled Ratio

7. The economy factor expresses the relative efficiency of mortars and may be determined by Equation 5.

8. The writer finds no general relation of silt content, uniformity coefficient, and absorption to the efficiency of sands.

(To be concluded in the next issue)

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*It should be noted here that this value for the "economy factor" of neat cement mortar, as well as the other factors in Fig. 3, is based upon the assumption that one bag of cement gives 1 cu. ft. of cement paste. If, as has been done in this paper, it is assumed that it requires 110 lb. of cement to make 1 cu. ft. of neat cement paste, the cost of a cubic yard of cement mortar would be $11.85 instead of $10.14, giving an "economy factor" of 590.

It has been decided to carry out improvements of the Port of Antofagasta in Chili at a cost not exceeding £1,700,000.

It is stated that from boring operations made last year in the province of Novara, Italy, the existence of an important seam of coal has been found.

CANADIAN SOCIETY OF CIVIL ENGINEERS ELECTIONS AND TRANSFERS

At a postponed meeting of the council of the Canadian Society of Civil Engineers held September 25th, the following elections and transfers were announced:—

Archibald, C. B., of West Wabana, Nfld., transferred from junior to associate member. Mr. Archibald is a graduate of Kingston R.M.C. and has been with the Nova Scotia Steel & Coal Co. for the past seven years, latterly as chief engineer in charge of the civil, mechanical and electrical departments, including mine surveying.

Boswell, Maxfield L., of Victoria, P.E.I., elected as junior. Mr. Boswell is a graduate of McGill University, class of 1914. For about eighteen months he was assistant to the resident engineer of the Halifax Ocean Terminals. For the past year he has been stationed at St. Johns, P.Q., as lieutenant in the Canadian Engineers, C.E.F.

Coke, Reginald N., of Jamaica, B.W.I., elected as junior. Mr. Coke is a graduate of McGill University, class of 1914. He was formerly head power house operator for the Northern Ontario Light & Power Co. He was for a time officer in charge of searchlights in four district searchlight areas in England, and is now a mechanical transport officer in France.

Gosselin, Joseph (Jr.), of Levis, P.Q., elected as an associate. Mr. Gosselin is vice-president and general manager of Joseph Gosselin, Limited, general contractors of Quebec and Levis. He has constructed various bridges, churches, powerhouses, grandstands and other important structures in Quebec Province.

Hewson, Ewart G., of Toronto, transferred from junior to member. Mr. Hewson is a graduate of Toronto University, class of 1908, and for the past four years has been division engineer of Ontario lines, G.T.R.

Houston, David W., of Regina, Sask., elected as associate member. Mr. Houston is superintendent in charge of the construction and maintenance of the Regina Municipal Railway. He is a graduate of Queen's University, class of 1907.

Kolling, Peder, of Victoria, B.C., transferred from junior to associate member. Mr. Kolling was born in Norway and is a graduate of the Trondhjem Technical Institute, class of 1908. He went to the United States in 1909 and has since been engaged in railway work. For the past two years he has been chief draftsman at Victoria for the C.N.P. Railway.

Little, Arthur D., of Brookline, Mass., elected as member. Mr. Little is president of the firm of Arthur D. Little, Inc., chemists and engineers, of Boston, with branch in Montreal. He is a director of the American Institute of Chemical Engineers.

Martyn, Oscar W., of Swift Current, Sask., transferred from junior to associate member. Mr. Martyn is a graduate of the University of Toronto, class of 1911, and is a member of the firm of Martyn & MacDonald, consulting engineers, for several rural municipalities in Saskatchewan.

McCannell, Donald A. R., of Regina, Sask., transferred from student to associate member. Mr. McCannell is a graduate of Queen's University, class of 1914. He is acting city engineer of Regina.

McKie, Ernest P., of Victoria, B.C., elected as associate member. Mr. McKie was recently appointed to a position with the Water Rights Department of the British Columbia Provincial Government. He had previously been with the city engineer's department of Victoria, B.C. He was born in Wales in 1870 and came to Canada in 1911.

Morgan, Arthur L., of Montreal, elected as associate member. Mr. Morgan graduated from Queen's University in 1912 as a mechanical engineer. He is now assistant inspector of shells for the Lachine District for the Imperial Munitions Board.

Pepin, Albias, of Quebec, P.Q., transferred from student to associate member. Mr. Pepin is a graduate of Laval University, class of 1914, and for the past two years has been inspector of concrete highways for the Highway Department of the Province of Quebec.

Philip, Patrick, of Kamloops, B.C., elected as associate member. Mr. Philip was born in Ireland and came to Canada about 1907. He has been on the engineering staff of the G.T.P. and with the city engineer of Victoria, and at the present time is district engineer for the Department of Public Works of British Columbia.

Ross, Geo. W., of Montreal, transferred from student to junior. Mr. Ross graduated from McGill University, class of 1915, and is at present with the Canadian Expeditionary Forces.

Wall, Arthur S., of Montreal, elected as associate member. Mr. Wall has been with the Dominion Bridge Co. for the past five years, drafting and designing.

THE 36th ANNUAL CONVENTION OF THE NEW ENGLAND WATER WORKS ASSOCIATION

The thirty-sixth annual convention of the New England Water Works Association, held in Hartford, Conn., September 11th to 14th inclusive, was attended by about 200 members and was a success, a great deal of interest being manifested in the topics discussed at all of the sessions. In all, there were nineteen papers at the six sessions.

The delegates were welcomed by addresses from Mayor Hagarty, Mr. C. H. Clark, editor of the Hartford "Courant," and James T. Berry, acting president of the Hartford Water Board.

To these, Mr. C. M. Saville, chief engineer of the Hartford waterworks and president of the association, responded with a fine address.

At Wednesday morning's session Mr. Geo. A. Johnson, of New York, read his paper entitled "Rapid Sand Filtration" (an abstract of which appeared in our issue of last week).

Following this, Mr. R. Spurr Weston, of Boston, read a paper on "Filter Bottoms and Strainers," in which he outlined the development in this branch of filter operation. Mr. Weston closed his paper with a review of the various types of filter bottoms in different cities in the United States.

John W. Gaitenby, superintendent of filtration, Evanston, Ill., read a paper on "Care and Operation of Rapid Sand Filters," which proved quite interesting. He described a plant which was built by the Norwood Engineering Co. in 1913. As showing the efficiency of the plant, Mr. Gaitenby stated that whereas previous to the installation of the filter plant the death rate due to typhoid fever was 26.6 per 100,000, since January, 1916, there has been but one death from typhoid fever. He suggested that a definite schedule should be followed in the operation of filter plants for the most efficient results, and the superintendent in charge should insist on having reliable help at all times, so that accurate records may be kept of the operation and results. Only in this manner can the chemicals necessary be computed.

At Wednesday afternoon's session Delas F. Wilcox, deputy commissioner, department of water supply, gas and electricity, New York City, read a paper entitled "Regulation of Private Water Companies in New York City." Following this reading, the city engineer of Waltham, Mass., presented a paper entitled, "Water Rate Revision in Waltham, Mass."

Other papers read at the different sessions of the convention were as follow: "Experiences with Trench Machines," by Geo. W. Batchelder; "Northampton's Waterworks Shop," by H. W. Horsford; "Operating Problems of a Small City Department," by Homer R. Turner; papers describing Hartford's waterworks system, by six members of the Hartford engineering staff; "Results of the Use of Meters in Boston," by S. E. Killam; "Pollution of Streams in Connecticut," by J. L. Jackson; "Methods of Operation and Results Obtained with Slow Sand Filters," by T. L. Cady.

The usual exhibition of waterworks equipment and materials was held and the following firms were represented: American Bitumastic Enamel Co., New York—Pipe coating. Builders' Iron Foundry, Providence, R.I.—Venturi meters; Globe castings. Central Brass Co., Cleveland, O.,—Brass goods. Central Foundry Co., New York City—Universal cast iron pipe. Chapman Valve Co., Indian Orchard, Mass.—Gate valves. Chicago Pneumatic Tool Co., Chicago, Ill.—Air hammers. Joseph Dixon Crucible Co.—Paints, lubricants and pencils. East Iron and Machine Co.—Waterworks equipment. Eddy Valve Co.—Valves and hydrants. Electro Bleaching Gas Co., New York.—Water sterilizing apparatus. Hersey Manufacturing Co., South Boston, Mass.—Water meters. Kennedy Valve Co., Elmira, N.Y.—Valves. Leadite Co., Philadelphia, Pa.—Pipe joint compound. Lead Lined Iron Pipe Co.—Lead lined wrought iron pipe. Lock Joint Pipe Co.—Concrete pipe. Alexander Milburn Co.—Portable lighting; 10,000 candle power light. Mueller Manufacturing Company, Decatur, Ill.—Brass goods. National Meter Co.—Water meters. National Water Main Cleaning Co., New York—Cleaning equipment and incrusted mains. Neptune Meter Co., New York—Water meters. Norwood Engineering Co., Florence, Mass.—Filters. Pitometer Company, New York—Pitometers. Pittsburgh Meter Co., Pittsburgh, Pa.—Water meters. Pratt & Cady Co., Inc., Hartford, Conn.—Valves. S. E. T. Valve Co., New York—Valve boxes. Chris D. Schramm & Son, Philadelphia, Pa.—Air compressors, etc. A. P. Smith Manufacturing Co.—Tapping machine. Thompson Meter Co., Philadelphia, Pa.—Water meters. Union Meter Co.—Water meters. United Brass Co., Cleveland, O.—Brass goods. U.S. Cast Iron Pipe Co., Burlington, N.J.—Cast iron pipe. Wallace & Tiernan Co.—Chlorinating plant. Warren Foundry & Machine Co.—Cast iron pipe. R. D. Wood Co., Philadelphia, Pa.—Hydrants and valves. Worthington Pump and Machine Corporation, New York—Water meters and pump.

Sweden is estimated to have available water power equal to 6,000,000 horse-power, of which approximately 15 per cent. is in use. In 1915, timber and pulp industries used 260,000 h.p., iron 235,000 h.p., electro-chemical 90,000 h.p. and textile, 40,000 h.p. The total power developed from coal and oil for industrial purposes is approximately 400,000. Of the installed water and steam power about 60 per cent. is transformed into electric power.

TORONTO ENGINEERS' CLUB IMPROVED

The Toronto Engineers' Club held an informal dinner last Thursday evening to celebrate the opening of the club's remodelled quarters. For the past three months the club has been closed in order to facilitate extensive alterations to the building.

About $14,000 was spent in enlarging the premises and for new furnishings, and the improvement is very great. There is a large, attractive dining room, and the service has been improved. A new billiard room, with four new tables, is spacious and well arranged. The lounge room has been enlarged and redecorated, and a new open stairway has been built which adds very greatly to the charm and attractiveness of the new arrangement of the rooms. The coat and wash rooms, kitchen and card rooms have been enlarged and refurnished; in fact, the whole quarters are vastly improved.

There are now 390 resident and 125 non-resident members. About 100 new members, either resident or non-resident, will be needed to ensure the financial success of the club with its new and heavier overhead expenses. The entrance fee for resident members is $35, for non-resident $15. The dues are $40 per annum net for resident members, and $15 per annum for non-resident members.

At the informal dinner last Thursday no speeches were made excepting by E. L. Cousins, chief engineer and manager of the Toronto Harbor Commission, who is the president of the club, and by Charles H. Heys, of Thos. Heys & Son, chemists, who is chairman of the house committee. In recognition of the services rendered by Mr. Heys, who has been a leading spirit in the club for many years past, and who gave a great deal of valuable time to the work of directing the remodelling and refurnishing the club, an honorary life membership was bestowed upon him at the suggestion of the president and by vote of the members present at the dinner.

The architect who had charge of the re-arrangement of the club quarters on behalf of the owners of the property, was A. H. Chapman, of the firm of Chapman & McGiffin, Toronto.

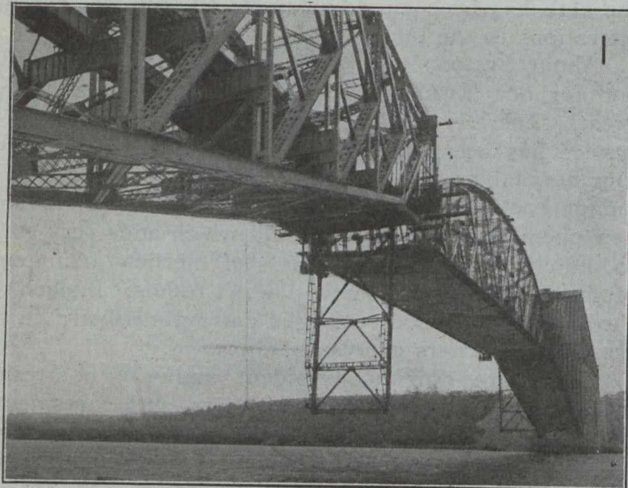
A formal opening night is now being arranged and will be held in two or three weeks, when the executives of the Albany and Ontario clubs will be the guests of honor, as those two clubs extended their facilities to the Engineers' Club members while the latter club was closed this summer.

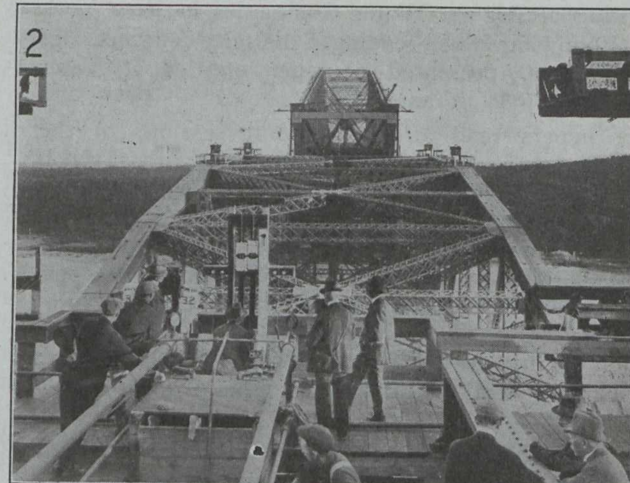
The available water power of Scotland has been estimated at 1,000,000 horse-power.

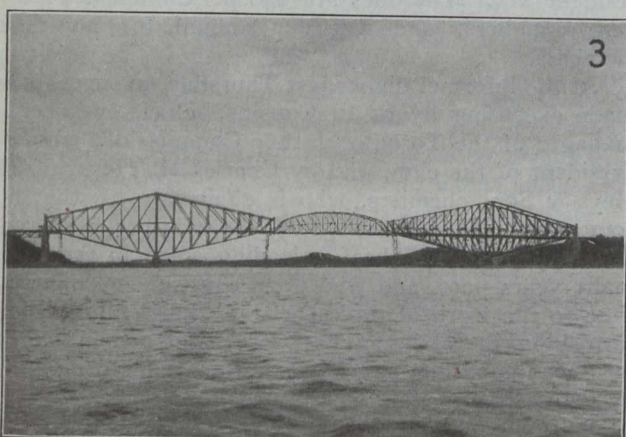
According to a bulletin issued by the American Iron and Steel Institute, based on statistics furnished by the various manufacturers, the total production of rails in the United States during 1916 was 2,854,518 tons. This is 650,315 tons more than the production of 1915, and nearly double that of 1914.

In its report for the year ended June 30th, the Public Services Commission for the First Division of the State of New York stated that the Commission is constructing a system of rapid transit, involving an expenditure of between 350 million and 400 million dollars, about one-half of which is being contributed by the city of New York. This system, including the third tracking of some of the elevated lines, will add 345 track miles to the existing subway and elevated rapid transit mileage, and will give New York City somewhat more than 600 track miles of such lines—more, it is said, than all the other cities of the United States put together. The system is nearing completion, and there is a prospect that a large proportion of the most important lines will be in operation before the end of the year.

Three Official Quebec Bridge Photographs







By Eug. M. Finn, Staff Photographer, St. Lawrence Bridge Company.

(1) Central span at 53rd lift. Note the unusual view of the track system afforded by this photograph.

(2) View across central span from end of north cantilever. Span at 32nd lift.

(3) Central span in place. View taken from the St. Lawrence River, upstream elevation, before removal of mooring trusses.

QUEBEC BRIDGE NEWS NOTES

According to a daily newspaper dispatch published this week, the first train will cross the Quebec Bridge on October 19th. It is understood that the directors of the St. Lawrence Bridge Co., Limited, and a number of guests, will attend the opening ceremony.

* * * * *

There is a rumor to the effect that Phelps Johnson, president of the St. Lawrence and Dominion bridge companies, is to retire from all active connection with either concern just so soon as the Quebec Bridge is completed and its affairs all settled. *The Canadian Engineer* wrote to Mr. Johnson for confirmation of this rumor, asking whether he intended to surrender the presidency of the Dominion Bridge Co. as well as that of the St. Lawrence Bridge Co., and enquiring whether he would remain a director of the Dominion Bridge Co. or withdraw from it entirely. With characteristic humor, Mr. Johnson telegraphed the following reply: "I don't know the answers to all of your questions, but I sure intend to take things easy hereafter."

* * * * *

Even had more difficulty been encountered than was expected in connecting the hanger chains to the stub links of the lifting girders, there was no danger of the span falling with the tide to such an extent that it would have been out of reach of the chains. Enough extra length of hanger chains had been provided to connect with the span at any time down to low tide, even had the low tide been at the extreme of 2½ ft. less than the height expected from the tide tables.

* * * * *

"Engineering News-Record," of New York, says editorially in last week's issue: "The greatest of cantilevers stands closed across the St. Lawrence. . . . Before closing the final chapter in the design and erection of this remarkable structure, it is proper to record the debt that bridge-builders owe to the work at Quebec. It has advanced greatly our knowledge of the problems of large compression members and of tension bars. The effects of distortion in trusses were explored farther than before and means devised for dealing with such effects. Much knowledge has been added to our store of experience on the assembly of heavy members, while new standards were set as to degree of precision and finish in shopwork. Then there is, beyond all this, a great gain in our general grasp of the problem of very large bridges as to practicability and cost.

(Concluded on page 308)

Multiple Arch Dam Design

In Building Multiple Arch Dams the Most Practical and Economical Span Is About 40 Feet—Spans Should All Be the Same Length So As To Facilitate the Form Work

By L. JORGENSEN

DURING the last few years several multiple arch dams have been built in various parts of the country, and they have so far been very successful in operation. Many more would undoubtedly have been constructed had a thorough knowledge of their design and construction been more general among dam-building engineers. There are places where rock or earthfill dams, or a combination of the two, are now built, where multiple arch dams could have been constructed cheaper and more substantial.

While a rock or earthfill dam can, under ordinary conditions, be constructed with a sufficient, although unknown, factor of safety, such dams are absolutely unsafe under abnormal conditions, such as when water accidentally passes over their crest. It is a well-known fact that nearly all failures in the past have been due to this cause. Water passing over the crest of a multiple arch dam would not destroy the dam, and for a more or less limited time would not hurt the foundation, if this was otherwise at all safe for such a structure. A multiple arch dam requires a good foundation, as the load is concentrated on buttresses and settlement of these would be liable to cause the collapse of adjoining arches. Whenever the foundation is solid rock, however, a multiple arch dam can be constructed as substantial as any type of dam, and more substantial than most types. The stresses and dimensions can be calculated with a large degree of accuracy. The factor of safety of such a structure is therefore known within narrow limits, assuming first-class construction work, and precedence should, on that account, not be given so much consideration as with rock and earthfill dams. These latter cannot be subjected to calculation of stresses, and therefore have to be built mostly along lines dictated by precedence. In general, it can be said that a multiple arch dam of small and medium height (less than 100 feet high) will cost less to construct than a rockfill dam, and especially a rockfill provided with something better than a wooden upstream face for the watertight cut-off. Only, perhaps, in rare cases would there be occasion for comparing the relative cost of a multiple arch dam and the cost of a strictly earthfill dam, because if there is enough suitable earth to construct an earth dam, a sufficient good foundation for a multiple arch dam and sufficient good building material for the same is not likely to be found at the same place, and vice versâ.

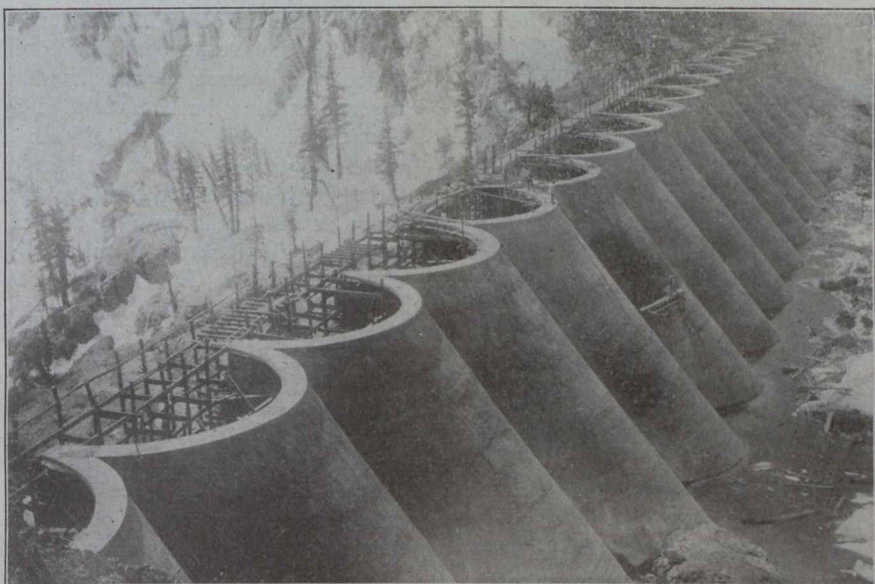


Fig. 1.—Gem Lake Dam; 84 Feet High, 700 Feet Long

For multiple arch dams above, say, 130 feet high, the amount of building material required, and therefore the cost of such a structure, increases quite rapidly, due mainly to the fact that the buttresses become very large and require more bracing. A limit of height is therefore eventually reached where it will be more economical to build one single arch across the canyon, unless the canyon be very wide. Where this limit of height for any dam lies can only be found by trying all the types possible of application, as the shape of the dam site has also quite an influence in the matter.

The first thing to be determined is the length of each individual span. Unless there should be strong reasons for using different span lengths for the several arches making up the complete structure, all spans should be made the same, to facilitate the form work. Theoretically, the shorter the spans are chosen, the less material is required for the arches. The material required for the buttresses remains theoretically the same, no matter what length of span is chosen. While a dam consisting of small spans takes less material than one where larger spans are used, it may not necessarily be cheaper to construct. The form work becomes more extensive and it is more difficult to place the concrete and reinforcing steel in the resulting narrow space between the form boards than in a wider space. Thin arch walls are more liable to collapse than thicker walls, and thin buttresses would require elaborate bracing to prevent collapse of same before anywhere near crushing strength had been reached. It is the arch that holds the water back, and therefore the watertightness of the dam is to some extent a function of the thickness of this wall, although to a much larger extent it depends upon the quality of the building material (concrete) used.

Taking all these facts into consideration it can be said that the practical, most economical span, lies somewhere between the limits of 30 feet and 50 feet. For high dams the economical span is near the upper limit, and for low dams, near the lower limit. A 40-foot span would be a good average value for ordinary cases, and is chosen in the present instance.

Next to be determined is the length of the upstream radius. It is known that the most economical arch* is the one that subtends an angle of 133½° and that for variations of about 10 per cent. on either side of this angle the difference in economy is very small. For the dams to be described in this article the subtended central angle

*For further information see *The Canadian Engineer* for March 9th and 23rd, 1916, on "The Constant Angle Arch Dam."

at the upstream face has been chosen 120°, or to be exact, 119° 57 ft. The volume of the arch has thereby been increased approximately 1 per cent. above the theoretical minimum, but the thickness has, at the same time, been increased 6 per cent., thereby decreasing the ratio of thickness of arch to length of arch, which is a desirable feature for structural reasons, at least towards the crest where the thickness is small compared with the length. This also decreases the tendency of percolation by decreasing the area of the wetted surface, and by increasing the thickness of the wall.

With the subtended angle (120°) and the span (40 ft.) decided upon, the length of the upstream radius is calculated to be 23.1 ft. To facilitate formwork the length of this radius is kept constant from crest to foundation, except as noted later. Incidentally this gives also the most economical arch as the subtended angle is thereby kept practically constant. The arch is given a slope with the horizontal of 50°, in order that the water pressure, acting upon the vertical projection of this slope, may tend to cut down the shearing stress on the buttresses to zero or to some insignificant value.

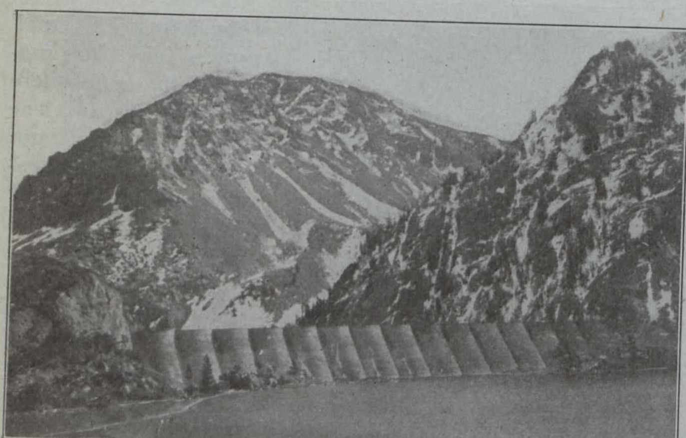


Fig. 2.—Gem Lake Dam, Upstream View

The arch carries the total waterload, and a large part of the load due to its own weight. A preliminary arch thickness may be found by means of the simple formula

$$P \times Ru = q \times t \qquad (1)$$

in which P equals the water pressure in pounds per square foot, Ru equals the length of the upstream radius in feet, q equals the average stress in pounds per square foot of the area of the dam section under consideration, and t equals the thickness of the dam at any given horizontal elevation.*

After the thickness t has been determined, at as many points as thought necessary, say, at every 10 feet apart in elevation, the weight of the arch can be calculated and the additional arch stress due to this load determined. If the total stress is found to be excessive a new thickness will have to be decided upon.

Due to the inclination of the arch, the water pressure is not uniformly distributed between the crown and the abutments of any imaginary arch slice perpendicular to the slope. The crown is located at a higher elevation, and therefore sustains less water pressure than corresponding points at the abutments.

For the case under consideration, where the length of the upstream radius is 23.1 ft., the subtended angle 120° and the inclination of the arch 50° with a horizontal plane, 40° with a vertical plane, a point at the crown will always be $\frac{Ru}{2} \times \sin 40° = 11.55 \times 0.64279 = 7.424$ feet above a corresponding point at the springing line. Towards the crest this difference in elevation makes a large difference in the distribution of the load on the face of the arch, and therefore also in the location of the line of pressure in the arch ring. Take, for instance, an arch slice 1 foot wide with the middle of the crown at elevation 5, and with the middle of this slice at the springing line at elevation $5 + 7.424 =$ elevation 12.424. With reservoir full to the crest, the waterload at the middle point of the crown would correspond to $5 \times 62.5 = 312.5$ pounds per square foot, whereas the water pressure at the corresponding point at the springing line would correspond to $12.424 \times 62.5 = 776.5$ pounds, or nearly 2.5 times more than at the crown.

In order to more fully develop and utilize the Rush Creek water resources for power and irrigation purposes, it became necessary to construct two storage reservoirs on the upper drainage area. Two natural lakes, Gem and Agnew, already existed, and the owners of the water rights, the Pacific Power Corporation, of California, decided to develop these two lakes by building dams across their outlets, and to utilize the water in a power house located at Silver Lake, some 1,800 feet (in elevation) below Gem Lake.

To fully equate the stream in an ordinary year, it was found that an artificial storage of 17,000 acre-feet would be necessary at Gem Lake. This necessitated a dam 84 feet high and 700 feet long at the original lake outlet. The available drainage area is 22½ square miles, and it is estimated that this area will yield an average of 2 second-feet per square mile. It is all located between elevations 9,000 and 12,000 feet above sea level on the eastern slope of the Sierra Nevada Mountains.

This drainage area is covered with a fair growth of pine trees up to elevation 11,000. From these trees the form lumber used in the construction of the two dams was cut to the amount of about one million board feet. The quality of the timber was not the best, but answered the purpose.

For the dams it was decided to use the multiple arch type, and have the two dams nearly alike, except as to size.

The largest of the two dams is the one at Gem Lake, and consists of sixteen full arches and two fractions at the ends. Each arch has a span of 40 feet, making the total distance across the crest approximately 700 feet. The height of this dam is 84 feet to a point where arch action ceases, but the foundation extends down 112 feet below the crest elevation (9,053) on two arches, across what was apparently an old creek bed. The accompanying plans show the details of the structure. The upstream face of the dam slopes 50° with the horizontal plane, and has the shape of a true cylinder from the bottom up to within 15 feet from the crest. From elevation 15 to the crest, the shape gradually changes to a typical ellipse, in order that the centre line (axis) of the arch may coincide with the centre line of pressure, or at least the two be brought very close together.

*The thickness of any horizontal arch slice (elliptical with major axis $= \frac{Ru}{\sin 50°}$ and with minor axis $= Ru$) is made constant from abutment to abutment, and therefore the circular arch perpendicular to the slope must have its thickness increase from the crown towards the abutments.

On account of the slope given to the arch for purposes of stability, the load is not uniformly distributed on same from the springing line towards the crown, but is greatest at the springing line, due to the fact that any point here is submerged 7 feet deeper than any corresponding point at the crown. This has a large effect on the stability of the arch towards the crest and necessitates the changing of the shape of the arch from circular to elliptical above elevation 15, or necessitates the making of this portion vertical.

The downstream face of the buttresses is shaped such that the centre line of pressure coincides with the centre line of the buttresses, at least in the lower portion. In the upper portion the centre line of pressure lies upstream relative to the middle line of the buttress to avoid having the buttress appear too slender.

Fig. 3.—Guniting Arches on Gem Lake Dam, Using Cement-Gun

The buttresses are tied together by means of struts, as shown on the plans, and are reinforced, although not to any great extent. The arches are more heavily reinforced, the steel being placed in such a way as to prevent cracks in the concrete with reservoir empty in cold weather. For the purpose of watertightness the upstream face is plastered by means of a cement-gun. This plaster as put on is ¾-inch thick at the bottom and ¼-inch thick at the top. Several plaster slabs from ⅝ to 1/5 inch thick were tested and it was found that a 1-inch thickness would withstand a waterhead of 1,600 feet for many hours without leakage.

The outlet from the lake is a 48-inch diameter pipe laid through a short tunnel underneath the dam. The floor of the tunnel is 20 feet below the original natural lake level.

The Gem Lake dam contains 8,537 cubic yards of concrete. For the buttresses, 1¼ barrels of cement per yard was used, and for the arches 1½ barrels per yard. Good sand, with about 3½ per cent. of clay mixed in it, was found at the lake shore near the mixing plant. Rock was taken from a slide about ½ mile away and hauled on a tramway to the works. This rock was crushed to about 2 inches maximum size, and screened into two sizes, and sand. These three piles were again mixed with additional lake sand.

A mushy mix, using about 10 per cent. of water, was put into the arches where the concrete would have to flow around the reinforcement. For the buttresses, concrete of a somewhat dryer consistency was found permissible, and about 9 per cent. of water to total weight of aggregate was used for this mix.

The concrete was tested at intervals, and the crushing strength of 8-inch diameter cylinders averaged about 900 pounds per square inch when 14 days old. The tensile strength of mortar briquettes 1 : 2½ averaged a little less than 200 pounds per square inch when 24 hours old, and 575 pounds per square inch when six months old. In this connection it should be mentioned that the maximum stress in the structure is about 340 pounds per square inch compression with reservoir full to the crest at elevation 9,053.

The small dam at Agnew Lake is of similar design, and consists of seven arches. It has a maximum height of 30 feet. The outlet is a 30-inch pipe through one of the deepest arches, with a slanting grizzly in front. This reservoir is considered as a forebay for taking care of peak loads. It is situated about 550 feet lower in elevation than Gem Lake, and has a drainage area of 1⅝ square miles of its own.

The design of the two dams was made by L. Jorgensen, of San Francisco, who also acted as construction engineer. Mr. C. O. Poole was chief engineer for the whole development. Mr. E. J. Waugh was resident engineer, and Mr. F. O. Dolson, superintendent of construction. Messrs. Duncanson Harrelson Co., of San Francisco, were the contractors on the dams.

ONTARIO'S MINERAL PRODUCTION FOR SIX MONTHS

The following is a record of the mineral production of Ontario for the first six months of 1917:—

Product.	—Quantity— 1916.	1917.	—Value— 1916.	1917.
Gold, ounces	235,069	228,673	$4,822,740	$4,586,941
Silver, ounces ...	10,267,743	10,073,787	6,188,269	7,584,439
Cobalt (metallic), lbs.	121,817	162,250	103,677	237,004
Nickel (metallic), lbs.	13,933	45,864	5,899	19,073
Nickel oxide, lbs.	....	153,498	....	175,308
Cobalt oxide, lbs.	410,408	....	204,638	175,308
Other cobalt and nickel compounds, lbs. ..	....	122,076	....	15,879
Molybdenite, lbs..	12,631	36,777	13,075	47,942
Lead, lbs.	....	912,934	....	114,953
Copper ore, tons.	922	1,543	14,368	45,688
Nickel in matte, tons	20,651	20,230	10,325,766	10,115,000
Copper in matte, tons	11,426	10,381	4,207,620	4,152,400
Iron ore (exported), tons	....	24,332	....	85,135
Pig iron, tons...	....	40,968	....	715,912
			$25,886,052	$27,897,322

THE QUALITY OF WATER AND CONFIRMATORY TESTS FOR B. COLI*

By Abel Wolman

THE reliability of the presumptive test as an index of the presence of B. coli in water in the light of recent investigation, has been seriously questioned. The United States Hygienic Laboratory in its Potomac River report finds that the presumptive test varies in its importance as a measure of pollution, with the degree of pollution itself. Dr. Frost, in the Ohio River investigation, concludes that the error in the presumptive test is greatest in the examination of treated waters. A. H. Creel and Edward Bartow, working on waters of similar character, that is, on drinking water from railroad trains, obtained results entirely at variance. The former, for instance, confirmed only 21 per cent. of positive tests for gas formation, while the latter isolated B. coli in 83 per cent. of the tubes showing gas formation. Graf and Nolte conclude, on the other hand, that the bile test is a better index of the presence of B. coli the more polluted the water.

The author, having at hand analyses of various types of waters in the State of Maryland, made during periods in 1915 and 1916, thought it would be of interest to tabulate the results obtained in colon determinations and to attempt to draw possible conclusions regarding the efficacy of presumptive tests as an index of the presence of B. coli. In Table I. the results for the raw waters and plant effluents of three filtration plants have been tabulated.

Table I.—Raw Water and Effluents of Three Filtration Plants

Rating.	Number of samples.	Per cent. of samples. Positive presumptive.		Per cent. of samples. Positive isolation.		Total No. of tubes showing gas.	Per cent. of tubes confirmed.
Raw water. A	56	96.7	89.5	87.7	69.8	152	82.3
Raw water. B	31	83.7	77.3	70.8	64.4	75	75.8
Raw water. C	168	100.0	77.9	72.5	51.2	383	67.9
Effluent ...A*	106	50.9	30.2	40.5	18.9	95	70.3
Effluent ...B*	58	12.0	1.7	6.9	1.7	9	66.6
Effluent ...C†	169	60.9	7.1	10.7	4.1	266	23.7

*Untreated. †Treated.

The raw waters of all three are from surface streams, the pollution of the watersheds of each varying in intensity according to the rating given in the table. This rating has been based upon a knowledge of sanitary conditions resulting from a study of the three watersheds. It is of striking interest to note that the percentage of tubes confirmed arrange themselves in the same grouping, A, B, C, as the sanitary survey of the streams, in a qualitative manner only, had already indicated. If we were to attempt to rate these raw waters by presumptive tests alone, it is at once obvious that the arrangement would be different and apparently not as accurate, since a study of the isolation tests indicates that the measure of the pollution of the streams varies in the same way as determined upon by the percentage of tubes confirmed. In the effluent samples from these same plants, the order of decreasing purity, as determined by presumptive tests, is C, A, B; by isolation tests, A, C, B, and by percentage of tubes confirmed, A, B, C. Assuming that isolation tests for B. coli serve as a legitimate quantitative index of pollution, an apparent discrepancy in the scoring of the plant effluents would seem to appear. The explanation for such a discrepancy, however, would seem to the writer to be due to the insufficient number of tubes showing gas in plant B effluent, making its use of little statistical value.

*Read before the Richmond Convention of the American Water Works Association.

Table II. offers material for an interesting study of the interrelation of the quality of water and the percentage of presumptive tests confirmed.

Table II.—Comparison of Condition of Water with Percentage of Tubes Confirmed

Rating.	Condition of water.	Number of tubes.	Per cent. confirmed.
1	Raw untreated	610	75.4
2	Filtered untreated	227	68.5
3	Unfiltered treated	37	44.7
4	Mixture of treated filtered and unfiltered	775	24.3
5	Treated filtered	266	23.7

In this table the percentage column was first arranged in the order as given and the types of water from which the results were obtained, were then noted opposite each value. The order in which the various characters of water fall is, in four of the five instances, in agreement with what we should expect from a qualitative judgment of water unsupported by analyses. The assumptions in grading of waters 1, 2, 4 and 5 are borne out by the percentage of tubes confirmed. The position of water 3 (unfiltered, treated) on the same basis of scoring by percentage confirmed, is predetermined and its location is a curious one, establishing as it does the conclusion that an unfiltered treated water is somewhat less polluted, judged by this arbitrary method of scoring, than a filtered water which is not treated. Water 4, as noted in the table, is a mixture of treated filtered and unfiltered water. A qualitative estimate of this type of water would place it in a position between untreated filtered and treated filtered waters. The percentage of tubes confirmed establishes water 4 in such a position, and here again corroborates the accuracy of a method of scoring upon a "percentage of confirmatory tests" basis. It is of more than passing interest that water 3 is situated as it is, when we note that its score, 44.7, is almost the exact mathematical mean of the scores of filtered treated and filtered untreated. This would seem to indicate that in the particular waters under discussion the efficiency of filtration about equals that of disinfection in the removal of the colon bacillus.

After having tested the qualitative estimates of waters by the above system of scoring, it was further elaborated by comparing the scores obtained in Table II. with a grouping according to total bacterial content. Unfortunately a change in routine analytical determinations, within the periods used by the writer, had occurred, which necessitated the use of both 37-degree and 20-degree C. counts. The arrangement of the different waters as made in Table III. seems to be justified, in spite of the lack of adequate total counts of similar temperature growth, particularly since a transition point was obtained by the fortunate existence of both 20-degree and 37-degree C. counts in the case of water 3. In this table, too, the indications of pollution by the quantity of bacteria are borne out entirely by the percentage of tubes confirmed.

If the percentage of tubes confirmed is a real index of pollution, it would be expected to vary in the same way and with the same degree of sensitiveness as those factors which predetermine it and are, de facto, indicative thereof. Of the factors producing abrupt changes in colon content,

Table III.—Relation Between Average Counts and Percentage of Tubes Confirmed

Rating.	Condition of water.	Average 37°.	Count 20°.	Per cent. confirmed.
1	Raw untreated	18,200	...	79.1
2	Filtered untreated	570	...	68.5
3	Mixture of treated unfiltered and treated filtered	45	534	24.3
4	Filtered treated	..	194	23.7

none is perhaps relatively more important than the rainfall. It can with justice be assumed that colon content in a general way varies simultaneously with the degree of rainfall. Here, then, we have another basis upon which to test our assumption of variability of pollution with concomitant variability of confirmation tests for colon. In Table IV. there have been arranged, for a particular plant A, temperature, rainfall, colon content, and confirmation determinations for a period extending over eight months. With almost no exception, every increase in percentage of tubes confirmed occurs with an increase of total rainfall, and vice versâ. A failure of this agreement in April is explained when we observe that during this month the temperature had arisen to a large degree, producing a condition of thawing and a consequent increase

Table IV.—Mechanical Filter Plant; Comparison of Atmospheric and Raw-Water Conditions

Date, 1915.	Temperature, °F.	Rainfall, inches.	Per cent. of samples isolated in 1 cc.	Per cent. tubes confirmed.
October	57.9	2.86	62	61.3
November ..	45.2	1.48	34	42.3
December ...	33.5	3.36	67	77.0
1916.				
January	38.0	1.36	27	52.5
February ...	32.6	2.79	38	71.7
March	36.0	3.26	45	56.2
April	51.5	2.69	73	78.4
May	65.2	4.65	69	97.8

of colon content. The agreement of the colon content determinations by isolation in 1 cc. with the rainfall data is not as well defined throughout the period as is that of the percentage of tubes confirmed. In other words, upon this basis, the percentage of tubes confirmed shows a more sensitive effect of rainfall than do the actual colon contents. The results discussed here are shown graphically in the chart.

The conclusions which the above data seem to justify are, that:

1. A water showing the highest degree of actual pollution, as determined by the highest percentage of samples giving a positive isolation test for colon, in general gives the highest percentage of presumptive tests confirmed.

2. A water showing the lowest degree of actual pollution in general gives the lowest percentage of presumptive tests confirmed.

As a result of the above conclusions, a rough quantitative test for pollution, in a general study of a water, might with safety consist only of a determination of the presumptive tests confirmed, rather than of a detailed estimate of the percentage of samples showing isolation tests in varying dilutions. In such a procedure as outlined in the preceding pages, one might establish as bases for comparison a maximum and minimum percentage of tubes confirmed, using for this purpose waters grossly polluted in the first case, and unquestionably pure in the second. With these maximum and minimum values as standards, the relative position of the water under consideration could be determined with ease by the use of the "percentage of tubes" scoring method.

The use of such a system of scoring as above outlined should, the writer believes, bear more intensive study, although the method is of passing interest as an additional indicative factor of water pollution.

CHARTS FOR THE USE OF ROAD-OILING INSPECTORS*

By E. Earl Glass

THE accompanying charts were prepared by me to facilitate the solution of the ordinary problems connected with road-oiling work. By using them the inspector can dispense with computations in the field almost entirely.

An example will illustrate the method of using the charts: Suppose a partly filled tank of hot oil containing 90 per cent. asphalt is received and it is to be sprayed on

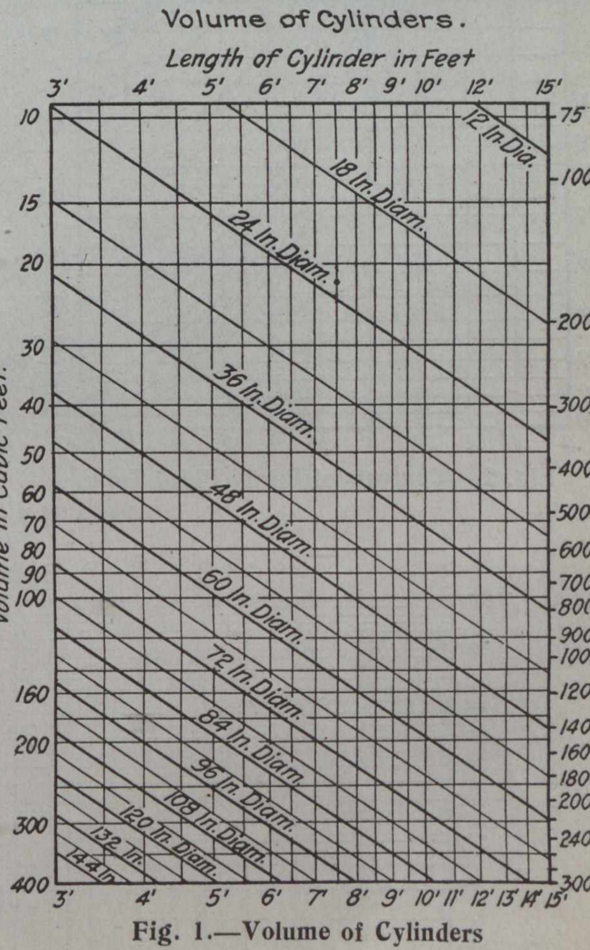


Fig. 1.—Volume of Cylinders

a strip of pavement 6 ft. wide at the rate of ⅜ gallon of cold oil per square yard of surface. The tank has a diameter of 4.5 ft. and a length of 9.5 ft. The depth of oil in the tank is 3.5 ft. and the temperature is 380° F.

*"Western Engineering."

1. Chart No. 1 gives 152 cu. ft. or 1,130 gallons as the capacity of a tank of the dimensions noted.

2. $\frac{3.5}{4.5} = 0.73$. Chart No. 2 shows that an 1,130-gallon tank will contain 880 gallons of oil when the depth of oil equals 0.73 diameter.

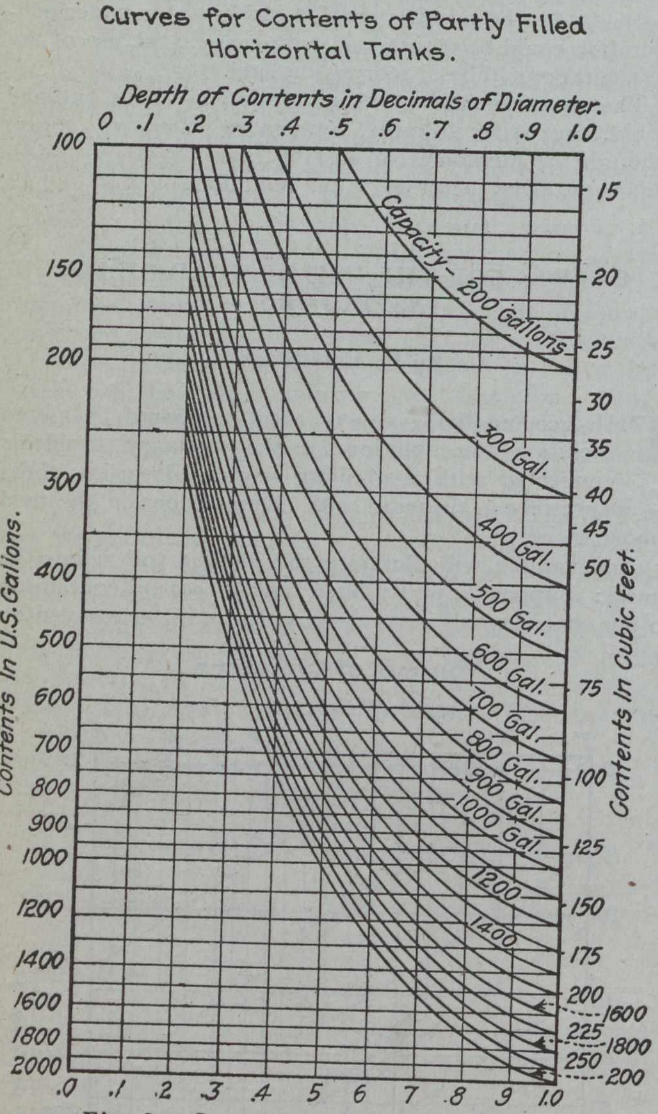


Fig. 2.—Contents of Partly Filled Tanks

3. Chart No. 3 gives the correction for temperature according to the formula approved by the Los Angeles county road department. The horizontal line at the intersection of the vertical temperature-ordinate and the diagonal line for the hot-volume gives 790 gallons of cold oil as the amount in the tank.

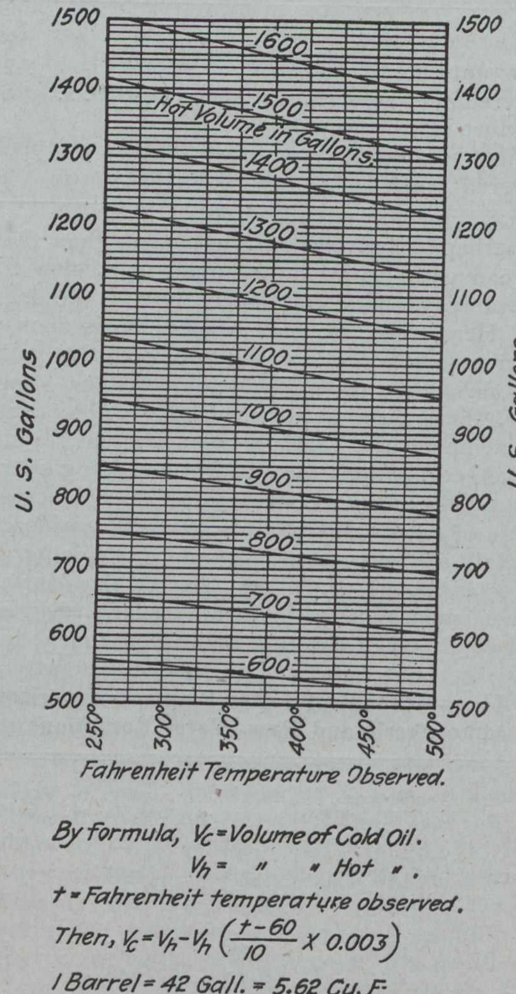


Fig. 3.—Thermal Corrections

4. Chart No. 4 shows that this amount of oil will cover 3,200 lin. ft. of pavement 6 ft. wide at the rate of ⅜ gallon per square yard.

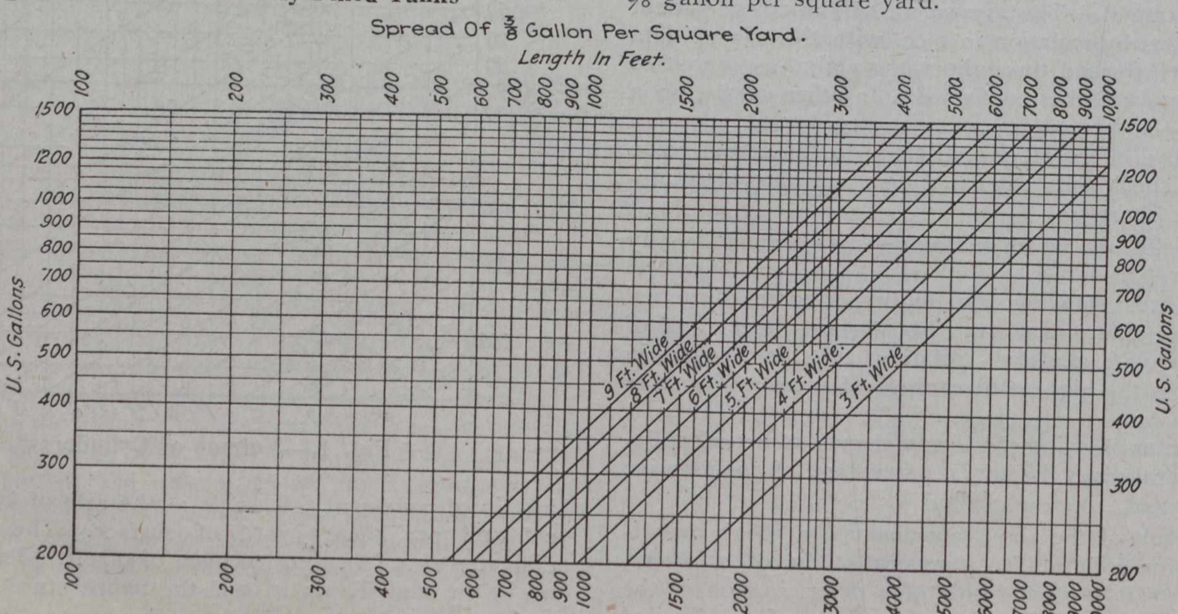


Fig. 4.—Area Covered with Road-Oil at Rate of ⅜ Gallon Per Square Yard

USEFUL LIFE OF UNITS IN WATERWORKS PLANTS

A COMMITTEE of the American Waterworks Association recently prepared a report on "Depreciation," which includes a quantity of useful data on waterworks units. The following general conclusions are taken from this report:

Storage Reservoirs and Heavy Earthen or Masonry Dams—Large Masonry Conduits and Tunnels.—All structures of earth or earth and masonry are very durable, and in some cases reservoirs, aqueducts, and dams have lasted thousands of years. Undoubtedly such construction, well maintained, is ordinarily good for some hundreds of years, physically often far outliving their functional usefulness.

Functional.—All structures holding or conveying water are subject to accident from rupture, floods, burrowing animals, ice pressure, windstorms, leaks, insecure foundations, polluting influences, and malicious destruction.

Physical and contingent losses of value will be made good ordinarily by operating maintenance. This being thoroughly done, such structures should, in addition, be amortized about as follows:

Large storage reservoirs, well located	75-150
Heavy earthen or masonry dams	75-150
Large masonry conduits and tunnels	75-150

Conduits and Distribution Pipe of Cast Iron of Large Diameter.—Cast-iron pipe coated and buried in the ground is a very durable structure. We have little knowledge of its final effective life from a physical point of view. There are some instances of 200 years' life for uncoated pipe. Largely, we must amortize such durable material, kept clean and well maintained, again by consideration of the possible changes in public need, functional usefulness, and the burden of a reasonable amortization, say, 75-125.

Conduits and Distribution Pipe of Wrought Iron or Steel of Large Diameter.—Thickness of shell and sensitiveness to a greater range of deteriorating influences must of necessity bring the life of wrought-iron and steel physically below that of cast iron, and in many cases below functional considerations, 35-75.

Conduits and Distribution Pipe of Wood Stave of Large Diameter,—Ultimate experience somewhat limited, but thought to be about in same class as steel, when well protected and constantly saturated, 30-60.

Distribution Pipe of Small Diameter.—(*a*) Cast Iron: Limitations of size increase difficulties in interior cleaning and maintenance. Such smaller mains are at times removed in rapidly growing cities to make way for larger pipe. Often they are only supplemented, 30-70.

It should be noted that in slow-growing and smaller cities small mains are less liable to be outgrown than in larger cities, 50-90.

(*b*) Wrought Iron and Steel Mains: Affected by kind of water carried, soil, and coating. Liability of replacement probably greatest influence in shortening useful life, 25-40.

(*c*) Services: Wrought iron and steel	15-30
Lead	40-60

Of services, it should be noted that character of water carried, soil, and coating are influential, but changing needs are also important.

Small Distribution Reservoir.—Physically, these structures are very permanent. Changing needs often destroy or impair their usefulness and value; they are often surrounded by growing population and increasing land value, which, in connection with decreasing need, make it desirable to abandon them. They sometimes lose value on account of need for increased head, 50-75.

Standpipes.—Are affected by most of the influences mentioned above, and lose value in rapidly growing towns by insufficient proportional storage capacity with increased consumption. They often have value as regulators, however, long after their storage usefulness is diminished:

Wrought iron and steel	30-60
Reinforced concrete	50-60

Valves.—Valves physically should be amortized on the basis of the life of the valve body, the working parts being subject to operating maintenance. Fundamentally, they are more subject to change and improvement than the pipe in which they are set, and therefore should have shorter life, 40-60.

Hydrants.—Theoretically should have the average physical life of the hydrant body, the same as valves, but being in part exposed and more liable to accident and injury, and more often operated, may be considered to have somewhat shorter life than valves, 30-50.

Meters.—Physically they should be amortized on the basis of the life of the meter casing, the working parts being subject to renewal and repair, chargeable to operating maintenance. Fundamentally, being of delicate construction and of necessity exposed to frost, clogging, and other adverse influences and often renewed, suggested life, 20-30.

Pumping Machinery.—Pumping machine units are functionally sensitive to changes in consumption, growth of population, improvements in the art, influences affecting sources of supply, amount of use, character of water, etc., and these are the conditions that ordinarily fix their useful life.

Where function does not control physical life for amortization purposes it should be predicated on the probable useful life of the stationary and heavier casting, all working parts being cared for annually by operating maintenance:

High duty, large units	35-60
High duty, small units (say, below 6 m.g.d. cap.)	25-50
Ordinary direct acting	20-40
Centrifugal, not geared	20-30
Centrifugal, geared	15-25

Boiler feed and auxiliary pumps usually take the life of the units to which they are attached.

Steam Engines.—About the same considerations as above, 20-40.

Boilers.—Are affected by water used, care and attention, changes in station, and changes in pressure. They may often have a long period of usefulness in reserve, 15-30.

Electric Generators and Motors.—In general, follow the reasoning on pumps, but are shorter lived, 20-30.

Filter Plants.—Now well standardized. Life should be predicted on general usefulness of station and source, as well as function of the filters themselves:

Masonry filters	30-50
Wood filters	15-30

Buildings.—Must be reviewed in the light of the probable life of the station as a whole. In rapidly growing towns they are frequently outgrown, but can often be enlarged. They lose value often in a general way because of changes in the style of architecture. Where function does not control their lives physically it should be based on masonry walls, foundations, and roof supports, all other parts being removed from time to time by operating maintenance account:

Masonry	30-60
Wood	20-40

Stacks.—Are limited in life to conditions of power production directly; somewhat affected by style and general appearance:

Masonry	25-50
Steel	10-25

PROPOSED TOUGHNESS TEST FOR ROAD-BUILDING WORK

BEFORE the recent annual meeting of the American Society for Testing Materials the following modified test for the toughness of rock for road construction was submitted. It is the intention to publish these tentative proposals for a year before being referred to letter ballot of the society for adoption:—

1. Toughness, as applied to rock, is the resistance offered to fracture under impact, expressed as the final height of blow required of a standard hammer to cause fracture of a cylindrical test-specimen of given dimensions.

2. Quarry-samples of rock from which test-specimens are to be prepared shall measure at least 150 mm. on a side and at least 100 mm. thick, and when possible shall have the plane and structural weakness* of the rock plainly marked thereon. Samples should be taken from freshly quarried material, and only from pieces which show no evidences of incipient fracture resulting from blasting or other causes. The samples should preferably be split from large pieces by the use of plugs and feathers and not by sledging.

3. Specimens for test shall be cylinders prepared as described in Section 4, 25 mm. in height and 24 to 25 mm. in diameter. Three test-specimens shall constitute a test-set. The ends of the specimen shall be plane surfaces at right angles to the axis of the cylinder.

4. One set of specimens shall be drilled perpendicular and another parallel to the plane of structural weakness of the rock, if such plane is apparent. If a plane of structural weakness is not apparent, one set of specimens shall be drilled at random. Specimens shall be drilled in a manner which will not subject the material to undue stresses and which will insure the specified dimensions.† The ends of the cylinders may be sawed by means of a band or diamond saw,‡ or in any other way which will not induce incipient fracture, but shall not be chipped or broken off with a hammer. After sawing, the ends of the specimens shall be ground to a plane surface with carborundum or emery on a cast-iron lap until the cylinders are 24 mm. in length.

5. Any form of impact-machine which will comply with the following essentials may be used in making the test:—

(*a*) A cast-iron anvil weighing not less than 50 kg., firmly fixed upon a solid foundation.

(*b*) A hammer weighing 2 kg., arranged so as to fall freely between suitable guides.

(*c*) A plunger made of hardened steel and weighing 1 kg., arranged to slide freely in vertical direction in a sleeve, the lower end of the plunger being spherical in shape with a radius of 1 cm.

(*d*) Means for raising the hammer and for dropping it upon the plunger from any specified height from 1 to not less than 75 cm., and means for determining the height of fall to approximately 1 mm.

(*e*) Means for holding the cylindrical test-specimen securely on the anvil without rigid lateral support, and under the plunger in such a way that the centre of its upper surface shall, throughout the test, be tangent to the spherical end of the plunger at its lowest point.

6. The test shall consist of a 1-cm. fall of the hammer for the first blow, a 2-cm. fall for the second blow, and an increase of 1-cm. fall for each succeeding blow until failure of the test-specimen occurs.

7. The height of the blow in centimetres at failure shall be the toughness of the test-specimen. The individual and the average toughness of three test-specimens shall be reported when no plane of structural weakness is apparent. In cases where a plane of structural weakness is apparent the individual and average toughness of the three specimens in each set shall be reported and identified. Any peculiar condition of a test-specimen which might affect the result, such as the presence of seams, fissures, etc., shall be noted and recorded with the test-result.

*The plane of structural weakness may in certain cases be the rift, cleavage, or bedding plane.

†The form of diamond-drill described in Bulletin No. 347, U.S. Department of Agriculture, pp. 6-7, is recommended, and should prove satisfactory if the instructions are strictly followed.

‡A satisfactory form of diamond saw is described in Bulletin No. 347, U.S. Department of Agriculture, pp. 7-9.

BIG NEW ELECTRICAL CATALOGUE

The new general supply catalogue, just issued by the Northern Electric Co., Ltd., is a compliment to the electrical business of Canada. The book, which is one of the largest electrical catalogues issued on the continent, contains no less than 1,485 pages and weighs 6½ pounds ready for mailing. It contains the most complete listing of up-to-date electrical specialties of every description, classified in twenty-two sections, each section commencing with a four-page colored insert printed on heavy coated paper. Some idea of the material covered by this book may be had from the titles which have been assigned to the various sections as follows: Telephone section, wires and cables, pole line hardware, insulators, tools and construction appliances, insulating materials, conduit and conduit fittings, small electric light wiring devices, fuses and knife switches, lighting fixtures and accessories, socket devices and electric ranges and fans, light sources and applications, house goods and novelties and flashlights, batteries and accessories, switchboards and panelboards, protective and power control devices, meters (indicating, recording, integrating and testing), generators (including motors, transformers and motor applications), low voltage outfits, railway electrical supplies, automobile electrical devices and accessories, and miscellaneous.

This catalogue contains many improvements and innovations over previous issues but the big improvement in this issue is the method provided wherever practicable whereby prices f.o.b. Halifax, Montreal, Toronto, Winnipeg, Calgary and Vancouver can quickly and easily be obtained.

Electrical supply catalogues as heretofore issued have given only the manufacturer's list prices and discounts, usually making it necessary for the purchaser to estimate his own freight (or freight and duty), where costs were required f.o.b. various destinations. In this catalogue, the Northern Electric Co. have taken care of these two very important elements entering into the cost of electrical supplies delivered to Canadian points. To accomplish this, they have used Montreal and Toronto as basing points and the list prices found in the catalogue apply to goods sold f.o.b. Montreal or Toronto, except in cases otherwise noted. For other points at which the company has warehouses, the approximate delivered prices can be obtained by adding, to the list prices shown, the necessary percentage as explained in a footnote on each page.

Letters to the Editor

Glare from Concrete Sidewalks

Sir,—That concrete is so rarely tinted or colored is rather remarkable, all things considered. The reflex effect of bright sunlight upon a white or light grey surface of large area cannot but be detrimental to human eyesight. A recent correspondent points out this defect and invites suggestions as to experience or remedy.

The Associated Portland Cement Manufacturers (England) publish a book entitled "Everyday Uses of Portland Cement," from which the following data are taken. Apart from this the book is almost unique in its practical utilitarian aspect and the major portion of its contents were originally contributed to a journal known as "Concrete and Constructional Engineering." The price of the book is 1s. 6d. paper covers, and 2s. 6d. cloth-bound, and its office of publication is Portland House, Lloyds Avenue, London E.C., England. There is probably no other publication which affords quite the same information, and its value is greatest to engineers who have not specialized in ferro-concrete construction or are inexperienced in the matter of cement. Further than this, it affords a fund of interesting fact and knowledge which, in the form given, helps to popularize cement construction in a general way. It was for this purpose mainly that it came into existence.

The data taken from this book regarding the coloring of concrete are as follow:—

"For the coloring of moulded concrete, the coloring matters in proportions depending upon the right shade, should be thoroughly mixed with the dry Portland cement before it is added to the coarse material. The following are suitable proportions: Three parts of silver sand to one part of the following mixtures:

"Red—86 parts finely ground Portland cement, 14 parts red oxide of iron (ferric oxide).

"Yellow—88 parts finely ground Portland cement, 12 parts yellow ochre. Alternative—90 parts finely ground Portland cement, 10 parts barium chromate.

"Blue—86 parts finely ground Portland cement, 14 parts azure blue or ultramarine.

"Green—90 parts finely ground Portland cement, 10 parts oxide of chromium.

"Chocolate—88 parts finely ground Portland cement, 6 parts black oxide of manganese, 4 parts red oxide of iron, 2 parts black oxide of iron or copper.

"Black—90 parts finely ground Portland cement, 10 parts black oxide of manganese or any carbon black.

"White—67 parts finely ground Portland cement, 33 parts powdered chalk or barium sulphate (common barytes).

"Pink—97 parts finely ground Portland cement, 3 parts best quality crimson lake (alumina base).

"Experiments made to determine what effect these colors had upon the setting time of the cement showed that ferric oxide, yellow ochre, ultramarine, and chromium oxide had little effect, very slightly quickening it, but crimson lake made it quick-setting and barium chromate quickened it very considerably, while manganese oxide, red ochre and Chinese red had a slowing effect."

No data are given as to abrasion tests but in the writer's own experience red slabs colored with the cheapest of all the ingredients quoted, namely, oxide of iron, are durable and quite sightly.

In the making of concrete tiles it is fairly usual practice to place a rich mixture of pure concrete and color in the first instance into the mould before the cement and sand backing is filled in. The facing is made of two parts of iron oxide to one of cement, made very fluid and poured into the moulds. This gives a very rich red color to the surface.

This points to the fact that similar methods in sidewalk work might prove good practice, one inch of facing being applied for colored surface. Red is undoubtedly the cheapest color to apply.

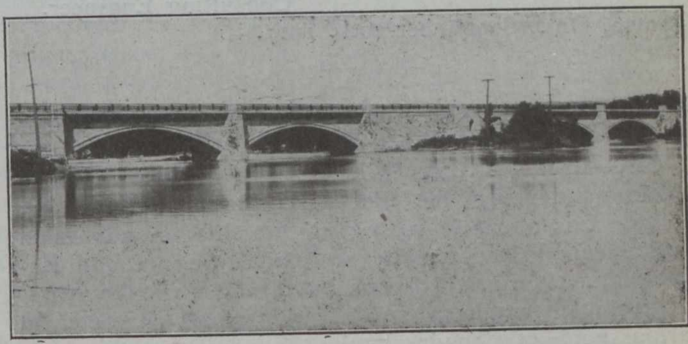
Experimental work to determine shade fancied is quite easy and as the cost largely depends upon the shade and proportion of material, this is in the hands of the contractor, who can determine by simple experiment the extra cost involved. Colored concrete is unusual, but for tile roofs a decorative effect can be obtained by contrast and pattern and considerable variation can thereby be made.

A. L. HAAS.

London, England.

Lemieux Island Bridge, Ottawa

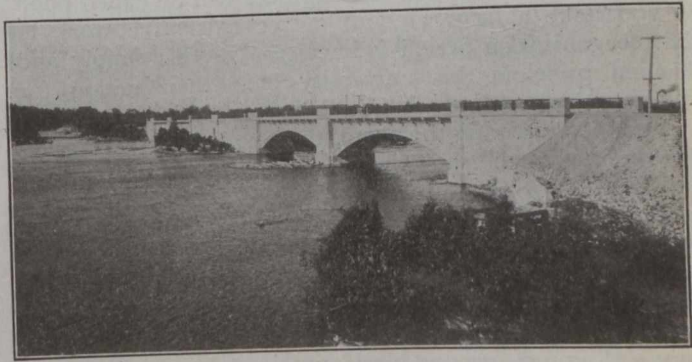
Sir,—From time to time your publication has emphasized the importance of aesthetic considerations in the design of engineering structures. I think that the accom-



Downstream Elevation, Lemieux Island Bridge

panying photographs of the recently completed Lemieux Island Bridge, indicate that your precepts have been taken to heart.

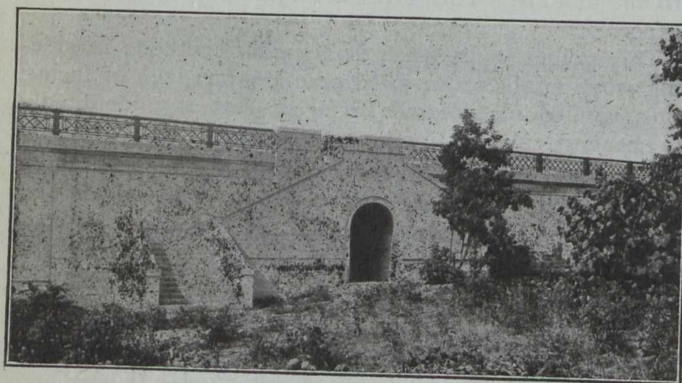
This bridge was constructed primarily to carry the two 51-inch mains from the Ottawa city pumping station on Lemieux Island to the Ontario mainland. It also



Upstream Elevation, Lemieux Island Bridge

forms a link in the Ottawa Improvement Commission's plans. Ultimately it is proposed to extend the bridge to the Quebec side, thus giving the shortest possible route to the only available reservoir site, as well as facilitating traffic between the western part of the city and the towns on the Quebec side.

The total length of the structure is 765 feet, being made up of four arches of 106 feet clear span, together with abutments and a walled section crossing Bell Island.



Detail of Bell Island Stairway, Lemieux Island Bridge, Ottawa

The clear width of road is 20 feet. The construction of the bridge entailed the use of 4,275 yards of concrete. The total cost was $59,500, including engineering. The contractor was Thos. McLaughlin, of Ottawa.

JOHN B. McRAE,
Consulting Engineer.
Ottawa, Ont., September 20th, 1917.

Reducing Standards for Admission to Engineering Schools

Sir,—In the Toronto "Globe" of this date I notice an article announcing the fact that Queen's University, Kingston, is about to reduce the standard of admission for students in the Faculty of Applied Science and Engineering. As a graduate in science, with some ten years' experience in engineering work of varied character in various parts of Canada, I take the stand that this University has taken a step which is backward, rather than forward, in the best interests of the engineering profession as a whole.

It is a fact that the militia requirement for technically trained men in engineering work has been large, and judging from the present outlook the demand in the future will in all probability be greater than at any previous time. Even assuming an early termination of hostilities, there is no doubt but that the engineer will be called upon to undertake a large amount of reconstructive work in the reorganization period following. On this supply and demand principle this university base their action for lowering the standard. While their total requirements for a degree may remain the same, there is bound to be a deficiency due to the crowding of a larger volume of work and more subjects into the same period for study. I will wager to say that any engineer of good standing in the country will tell you that the fundamental and higher mathematics, which are the basic studies for an engineering career, should be taken in the secondary and high schools before proceeding to universities. It is only there that a thorough grounding is obtained by working out problems covering the practical application of the theory. It is only in exceptional cases that students who take the lectures in the university apply the theory to the working-out of practical problems during their course, and if they have not had the drilling on the fundamentals previously, they are that much less proficient when they walk out from the university to compete with their fellow-students in the same profession. To my mind, it is not a question of time, but of proficiency, and it is upon this that not only the engineer, but also the university stake their reputations.

To offset the impression that there is going to be a big dearth of engineers in the near future, I would refer one to the last issue of "Engineering News Record," in which the opinions of some of the heads of American universities are expressed. In short, they state that while the demand is good, they do not anticipate a shortage for future requirements.

Much has been written lately on the status of the engineer and the place he should take in the national life of the country. Why has the engineer not taken a lead in the national life? Why is he and his profession not better understood by the general public? Why is his income on the average about half that of managers of manufacturing concerns, other professional men, and in many instances less than that of the mechanic and artisan whom he directs and teaches? The answer is,—simply because the standard has not been raised high enough to demand the best in proficiency for the calling, so as to exclude the non-proficient and untrained man who of recent years has called himself an engineer in the hope of demanding a larger income for his services.

Recently I was asked by the manager of a manufacturing concern why I stuck to the engineering profession, and my reply was to the effect that I hoped that in the course of a few years the profession of engineering would be recognized by the public as one truly worthy of its calling. During the past few years the trend of sentiment and opinion has been in this direction and to those who have taken an interest in engineering work it has been a hopeful sign for the future. The announcement of to-day is certainly a rude jolt to future hopes, and to be frank, brings to mind the advertisement "Shorthand in thirty days." Were it not for the standards set by the Canadian Society of Civil Engineers I fear that the engineering profession would never rise to par value with the other recognized professions, if left to the will of the universities.

A. RIVERS WHITELAW,
Engineer of Construction,
Calabogie Light & Power Co., Ltd.
Calabogie, Ont., September 22nd, 1917.

More Provincial Aid Needed

Sir,—During the past few years the increase in the number of privately owned automobiles has been considerable, resulting in a large increase in the revenue from licenses collected by the Ontario government.

With such an increase in automobile traffic, the wear and tear on roadways also shows a considerable increase, more particularly on roadways of the macadam type, making the question of financing the maintenance of such roadways a matter of deep concern to those responsible for this work.

It therefore would appear that the time has arrived when the municipalities of the province should approach the Ontario government with the view of obtaining a yearly grant towards roadway maintenance, such grant to be in proportion to the amount collected yearly for automobile licenses.

H. J. PADDINGTON,
Superintendent of Streets.
Fort William, Ont., September 27th, 1917.

Editorials

TORONTO STREET CLEANERS' STRIKE

Five hundred street cleaners and garbage collectors in the city of Toronto are on strike, demanding the removal of Street Commissioner Wilson, claiming that he has been unfair and arbitrary in the conduct of his department. The men have not made public any details regarding their specific complaints, so it is difficult to judge the righteousness or otherwise of their cause, but at least their method of righting their wrongs cannot be commended. To go on strike without notice, and without giving the city council any chance to hear the detailed story of their complaints and to adjust same, incidentally leaving filth to accumulate upon the streets, to be blown throughout the city, spreading disease and death, is not a course of action which will commend itself to any public-spirited or right-thinking man.

There is a lesson in this strike, however, for Commissioner Wilson and for every other street cleaning commissioner, and that is to eliminate the human element to the greatest possible extent. As pointed out in an editorial in our issue of July 19th, 1917, street cleaning as it has been done in Toronto is not a job which any man should be asked to undertake. The white wing who pushes a disease-spreading, dry hand-brush, is a relic of the dark ages when the dread power of street germs was not fully appreciated.

We would repeat what we have so often before urged editorially,—that the only absolutely sanitary method of street cleaning is by flushing; and that every city and town should depend as much as possible upon motor-driven or horse-drawn flushers.

With the use of these machines, the self-respect of the cleaners or operators can be maintained and much better conditions can be obtained in every way, largely obviating such troubles as Toronto is now experiencing. Commissioner Wilson is now advertising for men to replace the striking cleaners. The money, in our opinion, would be better spent as a bonus to some reputable maker of flushing equipment to deliver a number of machines immediately.

The situation in Toronto is serious. At the time of this writing, when the strike has been in progress only two days, the streets have already become very dirty. If this condition is allowed to continue, an enormous increase in the many diseases, mentioned in our July editorial, which are attributable to street dirt, will rapidly become evident. A board of conciliation, constituted in the usual manner, should be appointed at once.

THE TECHNICAL PRESS AND POLITICS

In the discussion as to how the engineer is to benefit by the inevitable change impending in political representation, the technical press will be a factor. When a new party or interest hitherto unrepresented in the State begins the rather thankless task of finding adherents to the new cause, the first step on the road, if the contemporary press will not give attention, is to start an organ to represent its views. It enlists the power of the press to further its ends.

It is not often that a new cause finds a press already existing, circulating freely and widely read by the particular class to which their appeal needs to be made. The technical press exists for reasons of technicality, to talk shop, and represents the professional interests of the engineer. The men who support it are the most alert and up-to-date, the front rank of the most thoughtful among the entire crowd.

While to subvert the technical press to ordinary political propaganda would be to lower its dignity and prostitute its power, such criticism cannot be passed upon a definite attempt to make the engineer recognized as a power in the state.

To the credit of the legal fraternity, they, like the practitioners of medicine, are a close and compact corporation and are in the possession of means to discipline the recalcitrant. Were the professional engineers consolidated in a similar manner, the chance of their representing the electorate would be enhanced, for there is no engineer but is convinced that he is more or less penalized by his profession in the sense that his interests are not regarded or recognized.

The present plea is not for an engineer or two to represent definite engineering interests. The proclamation needed is that the engineer is worthy of widespread public support as a public man representing general national interests.

To this end the technical press can contribute largely and the readers thereof, by discussion and effort in other quarters, can make the general public more acquainted with the underlying idea.

Once the value of engineering character is assessed by the voter, one will immediately see a difference in the handling of local, provincial and federal matters. The profession of an engineer is the finest clearing house for character ever seen. It is character as much as technical ability which makes for success in a professional capacity. If the engineering character can be impressed upon the public by the engineers through the medium of their press, radical changes will be effected.

THE ENGINEER'S CIVIC MISSION

Mayor Fisher, of Ottawa, struck an unusual note in his address at the conference of charities and corrections in Ottawa last week, showing a clarity of thought and breadth of vision in regard to engineering matters which might well be emulated by other municipal officials. "The tendency among some groups of well-meaning social workers," said the mayor, according to the "Ottawa Citizen," "is to ask for new offices, with consequently more officials, in municipal, provincial and national government, to supervise and inspect and regulate the lives of people. But it is time people were led to give more thought to causes, and how to improve conditions, rather than to remedies after the wrong conditions have been set up."

Mayor Fisher expressed the opinion, from the experience he has gained in the exercise of his official duties, that the city engineer is the most effective health officer in any city. "With proper sewage, pure air, good garbage collection and clean streets," he said, "the work of what is particularly known as the health department must be light. And good general health means less work for charities.

"Proper town planning, light, air, good buildings, water service, cleanliness, and the right environment for children—the citizens of the future—are peculiarly the mission of the city engineer. They go more to the root of public welfare, while too many of the ideas in vogue among social workers—such as medical inspection of school children—are merely lopping at branches, dealing with effects instead of rooting out the causes.

"The engineer's mission is to improve the environment, to build with efficiency and mathematical accuracy, to design better service in the public works and enterprises of the community. He promotes the health of the community, not by inspecting and regulating the people, but by inspecting and regulating the machinery the people use.

"National conferences on such engineering matters as how to prevent river pollution and how to advance town planning would do much to promote the health of the nation, and to make fewer the charities and corrections and inspections of other people. Given the right environment, free from poverty and with time to think for themselves, and the Canadian people are quite competent to work out their own salvation. It is, indeed, the only way forward."

Other city engineers throughout Canada will envy Works Commissioner Macallum, of Ottawa. It must be an unusually happy experience for a municipal engineer to work under a chief executive who has such a broad comprehension of the possibilities of civic engineering and such an adequate idea of the importance of the city engineer in the community.

PERSONALS

ERNEST DRINKWATER, of St. Lambert, Que., has been elected an associate member of the American Society of Civil Engineers.

JOHN J. HARTY has been appointed president of the Canadian Locomotive Co., Kingston, Ont. Mr. Harty was previously vice-president and general manager of the company.

GEOFFREY PORTER, chief electrical engineer for the British Columbia Electric Railway Co., Vancouver, has resigned and will enter into private practice.

MILNE MARTIN TODD, son of the late Martin N. Todd, has been elected to succeed his father as president of the Galt, Preston and Hespeler Railway and vice-president of the Lake Erie and Northern Railway.

J. B. CHALLIES and J. T. JOHNSTON, of the Water Powers Branch, Department of the Interior, Ottawa, and B. H. HAANEL, engineer of the Mines Department of the Dominion Government, were in attendance at the Canadian Bureau of Information at the National Exposition of Chemical Industries recently held in New York City.

B. E. NORRISH, A.M.Can.Soc.C.E., until recently chief draughtsman of the Dominion Water Power Branch, has been given an important position with the Department of Trade and Commerce in connection with certain motion picture propaganda to advertise Canada's natural resources and industrial development. It is understood that Mr. Norrish will also be curator of a new commercial museum to be located in the government buildings in Ottawa.

OBITUARIES

RUSSELL THOMAS GARDNER, an undergraduate of the School of Applied Science, Toronto, of the year 1919, has been killed in action in France. He enlisted with the 53rd Battery, and went overseas with the rank of lance-corporal. At the time of his death he was serving as bombardier with an artillery unit.

D. F. BURK, who became prominent twenty years ago by promoting colonization and railroads in Ontario, died on September 29th at his home in Port Arthur, Ont. He was born at Bowmanville 68 years ago and in 1884 he joined his brother as a railway contractor. He was vice-president and director of the Port Arthur, Duluth & Western Railway Company up to the time of its completion in 1893, and became president and director of the Ontario & Rainy River Railway Company in 1898. He was also president of the St. Joe Railway Company and secretary and manager of the Lake Superior Dock Company. He also did important work as general manager of the New Ontario Colonization Association.

QUEBEC BRIDGE NEWS NOTES

(Concluded from page 296)

"But these are the gains of the profession as a whole. To the individual engineer the great value of the achievement lies in the inspiration emanating from the courage of the men who have erected on the failure of 1907 and the loss of 1916 this greatest of bridges—and in so doing not only have erected a monument to themselves and their courage and ability, but have vindicated the profession before a doubting world."

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To the list of firms who supplied equipment for the Quebec Bridge, the following are added by E. C. Kerrigan, the purchasing agent of the St. Lawrence Bridge Company:—

Air compressors, for substructure work, for driving the hydraulic pumps used in hoisting the central span, and for all other work for which air was required throughout the job, supplied by the Canadian Ingersoll-Rand Co., of Montreal and Sherbrooke, P.Q.

Telephone equipment for connecting ends of central span while floating and for connecting cantilevers to office and to each other during hoisting, supplied by the Northern Electric Co., Limited.

Mr. Kerrigan is very busily engaged at present, but we have requested him to compile, just so soon as he can find time to do so, a complete list of all firms who supplied material and machinery for use in this greatest of Canadian bridge jobs, and we hope to be able to publish this list at an early date. The success of this huge undertaking depended to such a great extent upon the faithfulness and integrity of the men who supplied the material, that we feel there should be two bronze plates on the Quebec Bridge, one bearing the name of every man who worked on the bridge or at its design, and the other bearing the name of every firm that supplied material, services or machinery responsible in any way for the Canadian engineering triumph at Quebec.

Coast to Coast

Calgary, Alta.—The present year is the best in regard to building that has been experienced for practically four years. Building operations completed, under way, or assured for already total more than $2,200,000. In addition to this the Alberta Flour Mills, Ltd., will erect a $1,500,000 structure.

Fredericton, N.B.—It is reported that anthracite coal has been discovered at a point not more than fifty miles from the city. Capt. Russell Bellamy, of New York, is carrying on the investigation.

+—**Granby, P.Q.**—The Southern Canada Power Co. is building 88 miles of high tension transmission lines, connecting up the cities of Sherbrooke, Magog, Waterloo, Granby and St. Johns. It is expected that these lines will be completed this fall. When completed this will give the company over 160 miles of high tension transmissions, principally 50,000 volt. The company have recently purchased property on the main street in Granby, almost opposite the post office, and are erecting a $30,000 substation, office and store for the sale of electrical equipment, contract for which was let to LOOMIS DAKIN & CO., Sherbrooke.

Guelph, Ont.—A short course in highway economics (construction and maintenance), under the direction of the highway department, has been opened at the Ontario Agricultural College. C. R. Wheelock, of Orangeville, president of the Ontario Good Roads Association, delivered the opening address.

Hamilton, Ont.—A new map is being prepared of Wentworth County, which will be the most comprehensive yet published.

Hamilton, Ont.—City Engineer E. R. Gray and Engineer J. Bain have appealed to the Board of Control to have the proposed turbine pumps installed at the Beach pumping station without any further delay. It appears probable that the matter will be left over until the January elections when a by-law will be voted on to sanction the necessary expenditure.

Hamilton, Ont.—The members of the Good Roads Committee of the Board of Trade lined up solidly in favor of the proposed new Owen Sound to Hamilton highway at their recent meeting. It was decided to recommend the council to act in conjunction with Guelph, Mount Forest and other interested municipalities and proceed with the project as soon as possible. A committee consisting of Controller Tyrrell, City Engineer Gray and Secretary Brown, of the Board of Trade, delegated to secure information and data on the alternative scheme, which proposes to cut Hamilton off and connect with the Toronto-Hamilton highway at Port Credit.

London, Ont.—The Car-Bex Brick Co., Ltd., has been incorporated and will deal in building materials of all kinds.

London, Ont.—There will be a meeting of the London Railway Commission shortly to consider the proposition of George B. Woods, Toronto, to sell the London and Lake Erie Traction Company for $504,000. The commission some months ago offered approximately $300,000, but this was refused. The Traction Company has a much larger offer now for the line, but the directors thought it would be good business to give London and the other municipalities a chance to purchase the road. If the London Railway Commission does not recommend its purchase, negotiations are off.

+—**Montreal, Que.**—Announcement has been made in Washington, D.C., that the trinitrotoluol contract which the British Government had let to Curtis and Harvey, Canada, Ltd., and which they were unable to fill because of the blowing up of their plant at Dragon, Que., has been turned over to CANADIAN EXPLOSIVES, LTD., of Montreal. The contract is for several million dollars.

Montreal, Que.—The Canada Foundry and Forgings Company is going into the shipbuilding industry extensively, and contemplates purchasing the plant of the Delaney Iron and Forge Company at Buffalo. The Canadian concern will operate in Buffalo as well as in Welland.

Ottawa, Ont.—Representatives of leading iron and steel importers and users were in conference on September 28th with Sir George Foster, minister of trade and commerce. The position in relation to the embargo placed by the United States on the exportation from the United States of certain iron and steel products was discussed at length and the difficulties outlined. The iron and steel men will now meet together with a view to suggesting a line of action to the department. Among the interests represented at the conference were: G. White & Sons Company, London; Goldie & McCulloch Company, Galt; Hamilton Bridge Works, Sawyer-Massey, Hamilton, and the Cockshutt Plow Company, Brantford.

Ottawa, Ont.—The appointment of a supervisor of metal and fibre by the Dominion Government is indicated in an order-in-council, which also authorizes the Minister of Customs to fix the price of scrap iron and scrap steel, waste and other materials of metal or of mineral fibre. The supervisor is authorized to make such enquiries as the Minister of Customs deems necessary into the quantity, location and ownership of such materials, as well as into the prices at which they are held for sale.

Owen Sound, Ont.—Messrs Green & Woolrich have completed the construction of the dock at the Malleable Iron plant. The dock, without its approaches, is ninety by one hundred and fifty feet. The approach is fifteen by two hundred feet.

Portage la Prairie, Man.—The civic authorities are still anxious to secure more electrical power for industrial purposes, according to Mayor S. R. Marlatt, who stated that the terms offered by Winnipeg recently to extend the hydro-electric system to Portage la Prairie were acceptable to his city, and the scheme has not been dropped. It will be taken up after the war. The capacity of the Plains City electric plant is far short of industrial demands, Mr. Marlatt states, and the civic authorities are endeavoring to devise ways and means to increase the output of power until the Winnipeg project can be taken up.

Rigaud, Que.—It is understood that Curtis and Harvey will not rebuild their plant at Dragon near here.

Sarnia, Ont.—The work on the London Rd. pavement is now nearly completed. The pavement is of concrete 7½ inches thick, reinforced with woven wire.

Sherbrooke, Que.—It is understood that the firm of MacKinnon, Holmes & Co., of this city, have recently received from the Imperial authorities a large order for marine work which will keep their plant in operation for many months to come.

St. John, N.B.—A delegation waited on Hon. J. D. Hazen with petitions for river improvements.

Toronto, Ont.—City Architect Pearse reported that 448 permits for the erection of new buildings of the approximate value of $650,271 were issued during the past month, as compared with 387 permits for buildings of the value of $643,272 in September last year, an increase in values of $6,999. The new buildings erected during the first nine months of this year are valued at $5,588,854, as compared with $5,008,649 in the corresponding period last year, an increase in values of $580,205. Mr. Pearse considers this is very satisfactory in view of the higher cost of materials and labor.

Toronto, Ont.—The Bloor Street viaduct is now nearing completion. The entire deck of the structure has been finished, only a few touches being necessary to finish off the steel girder work. Everything is now waiting for the laying of the road, which will be of tarvia construction. It is expected that the western bridge, extending from Castle Frank Road to the corner of Parliament and Howard Streets, will be completed in a week or two.

Toronto, Ont.—The laying of the rails on the Bloor Street car line extension is now proceeding. The objection to putting down the tracks on other than a ballasted road has been waived, and the ties are being placed on the sand roadbed. Already about twenty rods of steel have been laid, and it is expected that, at the present rate, the extension will have been completed as far as Runnymede Road in the course of two or three weeks, and that by November 1st the cars will be running over the new section of the line.

Welland, Ont.—The new hydro sub-station is now in operation. The voltage in the system has been increased to 46,000 volts.

Weston, Ont.—At a special meeting of the Weston Water, Power and Light Commission held recently steps were taken to increase the capacity of the present machinery in the sub-station by exchanging three of the present 50 k.w. transformers for three of 100 k.w. development.

Winnipeg, Man.—The Dominion Government will erect an explosive store and magazine on the St. Charles rifle range property. Major T. W. Hawker, Great West Permanent Loan Building, Winnipeg, has the matter in hand.

Construction News Section

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or projected, contracts awarded, changes in staffs, etc.

▲—Denotes an item regarding work advertised in *The Canadian Engineer*.
+—Denotes contract awarded. The names of successful contractors are printed in CAPITALS.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue.

Further information may be had from the issues of *The Canadian Engineer* to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Kent County, N.B., erection of bridge	Oct. 5.	Sept. 27.	46
Maisonneuve, Que., erection of factory	Oct. 15.	Sept. 13.	50
Mimico, Ont., construction of sanitary sewer	Oct. 8.	Sept. 27.	54

FACTORIES AND LARGE BUILDINGS

Alexandria Bay, Ont.—The Edgewood Hotel, at Edgewood Park, near Alexandria Bay, was destroyed by fire recently. The hotel was under the management of Bert Freeman. Estimated loss, $75,000.

Aylmer, Ont.—Fire destroyed the warehouse owned by A. W. Pierce. Loss, $25,000.

Brockville, Ont.—The Redemptorist Order of Catholic Priests plan erection of a college on the River St. Lawrence, near Brockville.

+—**Chambly Canton, Que.**—THE OTIS-FENSOM ELEVATOR CO., LTD., 368 St. James St., Montreal, have the elevator contract for $250,000 plant for the Canadian Leatherboard Co.

Edmonton, Alta.—Tenders will be called by the Swift-Canadian Co. for the erection of a recreation building.

+—**Elmira, Ont.**—The general and carpentry contracts in connection with the erection of a $6,000 factory for the Great West Felt Co., Ltd., have been let to W. H. DUNKER & SON, Kitchener.

+—**Emerson, Man.**—The following contracts have been awarded in connection with the erection of court house and municipal buildings costing $38,000, for the Department of Public Works, Provincial Government: Steel, DOMINION BRIDGE CO., LTD., Winnipeg; plumbing and heating, BOWYER-BOAG, LTD., 50 Olivia St., Winnipeg. The general contractors, Gray and Davidson, 621 Wall St., Winnipeg, will carry out the masonry, carpentry, plastering and painting.

Fergus, Ont.—The Monkland Mills, owned by James Wilson & Son, destroyed by fire. Loss about $50,000.

+—**Foxwarren, Man.**—The following contracts have been awarded in connection with the erection of a school costing about $50,000 for the Municipality of Birtle: Mill work, McDIARMID & CLARK, Princess and 7th Streets, Brandon; electric wiring, J. ROLLER, 439 Selkirk Ave., Winnipeg; plumbing and heating, H. A. MANWARING, Birtle. The general contractors, the Progress Construction Co., Ltd., 88 Provencher St., Winnipeg, will carry out the roofing, plastering and painting.

+—**Fredericton, N.B.**—The contract for the erection of the buildings in connection with the Soldiers' Convalescent Home to be established on Old Government House grounds, has been awarded to WILLIAM J. SCOTT, of this city, and ROBERT D. FORBES, of Devon, who submitted a joint tender. Their tender was in the vicinity of $100,000.

+—**Halifax, N.S.**—The NOVA SCOTIA CONSTRUCTION CO. have the contract for the erection of the new building for C. W. Outhit on Barrington Street. The building will be 62 x 39 feet and of concrete and pressed brick construction.

+—**Hamilton, Ont.**—Contract let to ROBT. CAMPBELL, 117 Duke St., for $4,000 one-story addition to machine shop for Toronto, Hamilton and Buffalo Railway Co., Hunter and James Streets.

+—**Hamilton, Ont.**—Contract let to the PIGGOTT & HEALEY CONSTRUCTION CO., 36 James St. S., for the masonry, steel, carpentry, painting and electrical work, and to A. CLARK, 7 Main St. W., for the plumbing work for $40,000 brick ice plant for Armour and Co., Wentworth St. N.

Hamilton, Ont.—D. A. Brebner Co., Burlington St. E., will erect a $5,000 one-story brick office building.

+—**Hamilton, Ont.**—GEO. E. MILLS, 614 King St. E., has the general contract, masonry, steel, carpentry and roofing for round house stalls, costing $8,000, for the Toronto. Hamilton and Buffalo Railway Co.

Hamilton, Ont.—Tenders will be received by S. H. Kent, City Clerk, addressed to Charles G. Booker, Esq., Mayor, Chairman Board of Control, up to four o'clock p.m. on Wednesday, October 3rd, 1917, for the several works required in the erection of a weigh scale building at site on T., H. & B. spur, at Barton Street, according to plans and specifications to be seen at the office of E. R. Gray, City Engineer, City Hall.

+—**Hamilton, Ont.**—The following contracts have been awarded in connection with the erection of a $125,000 addition to factory for the American Can Co., Emerald St. N.; Steel, carpentry and roofing, W. H. COOPER, Clyde Building; plumbing and heating, ADAM CLARK, 7 Main St. W.; plastering, WATSON BROTHERS, 6 Sanford Ave.; painting, P. THOMSON, 13 Walnut St. N.

+—**Hamilton, Ont.**—THE HAMILTON BRIDGE WORKS CO., LTD., Bay N., have the steel and roofing contract for $10,000 factory addition for the Acme Stamping and Tool Co., Sydney St., who will carry out the painting and electrical work.

+—**Hamilton, Ont.**—THE PIGGOTT & HEALEY CONSTRUCTION CO., Piggott Building, James St., have the general contract, masonry, steel and carpentry for alterations costing $12,000, to building for the Spectator Printing Co., James St. S. H. H. New, Room 608, Spectator Building, will likely let smaller trades.

+—**Hamilton, Ont.**—THE PIGGOTT & HEALEY CONSTRUCTION CO., 36 James St. S., have the general contract, masonry, steel, carpentry and roofing for alterations costing $10,000 to hotel for office building for Armour and Co., Wentworth St. N. General contractors will let plastering, painting and electrical work.

Joliette, Que.—The Acme Glove Works, Ltd., St. Charles Borromee, plan erection of factory addition.

Kentville, N.S.—The Arena Rink, owned by the Kentville Arena Company, Limited, was totally destroyed by fire.

Leaman, Alta.—Sealed tenders will be received by the Board of Trustees, School District No. 3434, Leaman, Alberta, at the office of (Rev.) Aykroyd Stoney, Secretary-Treasurer, up to noon, October 11th, 1917, for the erection of a frame school building. Plans and specifications may be obtained from the secretary-treasurer.

+—**London, Ont.**—Contract let to JOHN HAYMAN & SONS CO., LTD., 432 Wellington St., for interior remodelling of car barns costing $5,000, for the London and Port Stanley Railway.

+—**London, Ont.**—The A. B. ORMSBY CO., LTD., 48 Abell St., Toronto, has been awarded the steel sash contract for hydro offices, costing $100,000, for the Utilities Commission.