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Sandwashers of Drifting Sand Filters

Construction and Method of Operation — Overcoming Erosion of Metal Parts—Losses of Head in Typical Drifting Sand Filters—Detailed Observations — Two Further Difficulties Overcome — Performance of Sandwashers

By WILLIAM GORE

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SUCCESSFUL application of the drifting sand filter system which has been established at Toronto and elsewhere depends upon the efficient working of continuously operated sandwashers. These sandwashers have something in common with the ejector sandwashers developed for use with slow sand filters, but differ to the extent that they form part of a closed hydraulic system, and are required to work with a minimum water pressure, with water practically unlimited in quantity. While water pressures of 120 lbs. per square inch are commonly adopted with slow sand ejector washers, these are called upon to work with pressures of 1/100th of that amount.

The system with a sandwasher applied to a single unit is illustrated in Fig. 1. The treated raw water enters the filter partly by a standpipe running through the centre of the unit, passing up through a separator or sandwasher in the bottom and delivering above the sand at the top of the pipe, and also partly through a by-pass. Within the sandwasher the raw-water pipe is made similar to that of the tube of a Venturi water meter, and the drifting sand, after being collected and washed in the sand-washer, is inducted into the raw-water at the throat of this Venturi tube. This sand passes up the standpipe with the raw coagulated water, and is delivered with it above the top of the sand already there. It forms a volcano-like cone that continuously drifts away and is continually being replaced with the washed sand from the sandwasher, leaving a round topped body of stationary sand below, resting upon the filtered water collecting system. The body of stationary sand does the final filtration. The surface of this body is more than twice the plan area of the unit, and is the actual filtering surface, thus economizing the plan area of the filters. The drifting sand passes down all round the boundary of the stationary sand to a system of slots and continues through a system of converging ports to the outlets on the external extractors and thence by a system of pipes to the sandwasher.

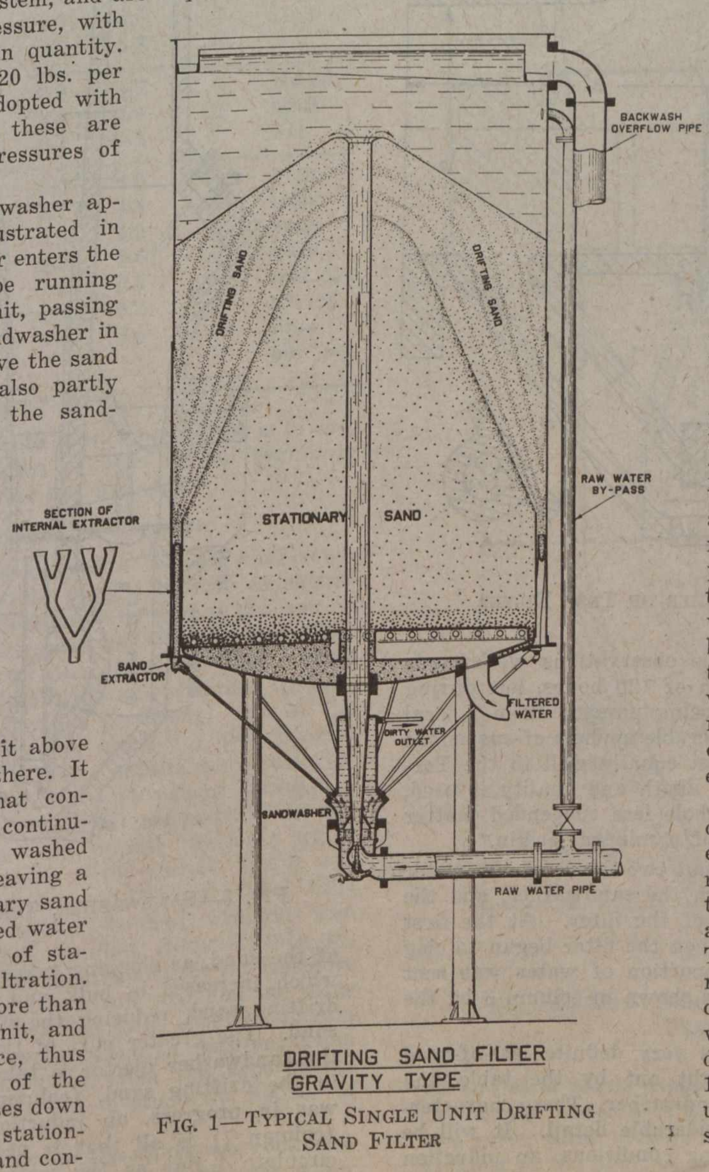

FIG. 1—TYPICAL SINGLE UNIT DRIFTING SAND FILTER

At the sandwasher, the sand falls to the bottom through a current of raw-water, and is thus freed from its impurities. It is picked up by the inductor and is carried on to the filter as previously described. The dirty water, impurities or suspended matter pass upward and out at the top of the sandwasher by an outlet suitably controlled. In the external extractors, sand traps are placed of such a form that the sand is kept out of the piping system, except when the inductor is in full operation. That is to say, the sand moves only when there is an abundance of running water to carry it forward to the sandwasher and from the sandwasher back again into the filter.

The main difficulty so far experienced with this system has been the erosion of the metal parts of the handwasher where the sand and water are moving at high velocity or with unsteady motion. The erosion has taken place in the throat of the Venturi tube, in the sand nozzle which conveys the cleansed sand from the bottom of the washer to the throat, and in the bottom of the washer itself, and a good deal of research work has been carried out in order to get rid of this erosion.

In the earlier washers, side delivery of the sand to the ejector throat was adopted, but more recently the longitudinal or trailing nozzle delivery has been adhered to, except for small units. The adoption of the trailing sand nozzle arose from experiments carried out at Toronto in 1915 with a filter unit 8 ft. 7 in. in diameter, similar to that of Fig. 1, and equal in area to one of the units, thirty of which make up a single filter in the Toronto plant.

The more important part, that is, the base, of the sandwasher, as finally developed by these experiments, is shown in Fig. 2. A run at the full rate during four hundred hours, using this sandwasher did not disclose any scour whatever. It was believed that the problem of scour had been satisfactorily solved, and subsequent events have proved this to be the case.

Losses of Head in Typical Drifting Sand Filter

In order to make clear the nature of the work the sandwasher is called upon to do, the following table is given which shows observations of the various losses of head in the typical drifting sand filter. The observations were made upon the test filter during a run of 120 hours, but during working hours only, the water being pumped from a local pond in which there was a considerable amount of suspended matter. The figures apply almost equally well to the Toronto plant, as sand of the same depth and quality is used, with water containing on the whole less suspended matter of a vegetable origin but more of a mineral origin.

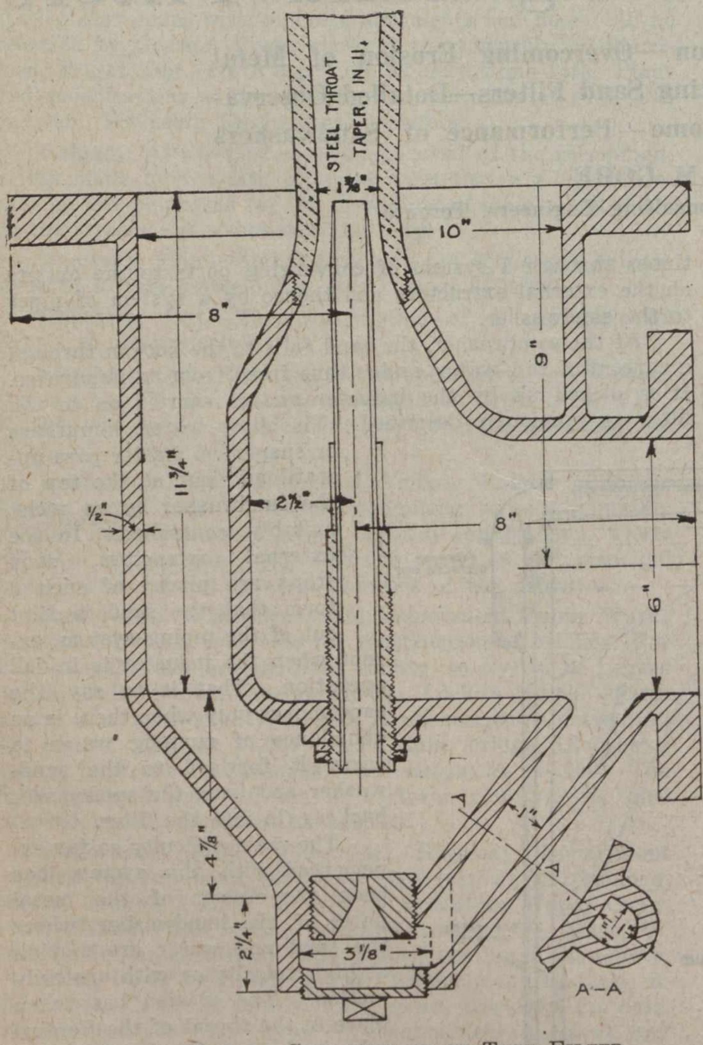

Fig. 2—Base of Sandwasher of Test Filter

During most of this test, about two-thirds of the water being filtered was passed through the sandwasher, and the remainder by-passed to the top of the filter. At the first set of observations, and again when the filter began to clog after 110 hrs., an increased proportion of water was sent through the sandwasher. This is shown in column 3 by the increased losses of head.

The drifting sand filter has very definite loss-of-head characteristics which are brought out by the table and these affect the working of the sandwasher. These characteristics have been studied in considerable detail. It will be noted that under normal working conditions, an induction head (column 6) of less than 5 ft. is required in the sandwasher body. During the early hours of a run, a maximum slowly develops and fades away again. This is due to the effect of the flat sand surface remaining immediately after a backwash. Another maximum develops towards the end of the run. This appears to be due to a less effective drift of the sand, as clogging takes place in the stationary sand which increases in bulk and area at the expense of the drifting sand, reducing the filtration area of the drifting sand. The greater part of the induction head provided by the sandwasher ejector is taken up by the filtration losses in the drifting sand, (column 4). Thus, if no filtration was in progress, an induction head of one foot or less (column 7) is all that is necessary to cause the sand to circulate. But as the water passing through the sand-

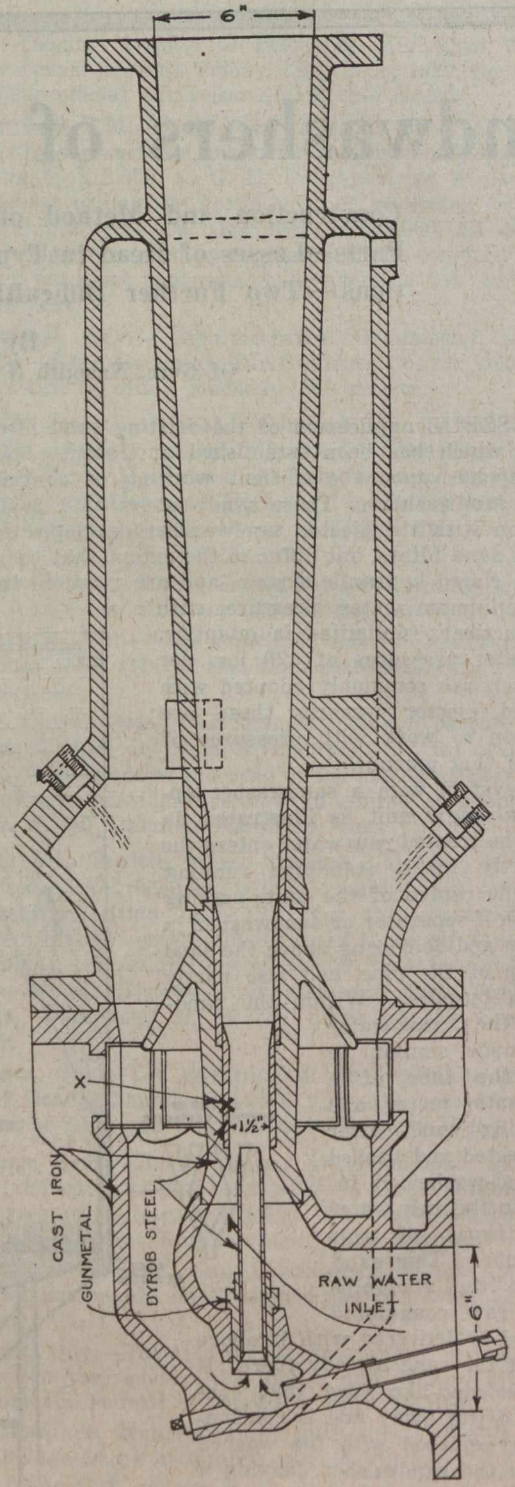

Fig. 3—Sandwasher, Toronto Filtration Plant

washer throat has to be filtered, or sent to waste, the practical minimum limit with a normally designed plant is about 50% of the rated output, and the simplest working conditions are found at about 66% of the rated output. The loss of head in the stationary sand (column 5) has very little effect on the operation of the sandwasher. This loss follows the normal law of filtration loss of head, that is to say, there are slow increased losses of head at the beginning of a run which increase as the run proceeds.

TABLE—OBSERVATIONS ON LOSSES OF HEAD IN A TYPICALLY DRIFTING SAND FILTER

1	2	3	4	5	6	7	8
Duration of run in hours	Rate of fitration in millions of Imperial gallons per acre per day, based on plan area	Loss of head in sandwasher in feet	Loss of head in filtering through drifting sand in feet	Loss of head in filtering through stationary sand and underdrains, in feet	Induction head provided by sandwasher in feet	Diff. of head at bottom of drifting sand and in washer in feet. Col, 6 less Col. 4	Remarks
0	150	3.0	3.6	2.3	5.1	1.5	1 gr.
5	150	2.6	5.2	1.7	6.1	.9	per
10	150	2.6	5.1	1.9	6.0	.9	gal. of
15	150	2.5	3.8	1.8	4.8	1.0	alum
20	150	2.5	3.3	2.1	4.3	1.0	
25	150	2.5	3.2	2.4	4.1	.9	
30	150	2.4	4.0	2.4	4.7	.7	
35	150	2.4	4.1	2.5	4.8	.6	
40	150	2.5	3.9	2.8	4.7	.8	
45	150	2.5	4.0	2.8	4.8	.8	
50	150	2.5	3.7	2.6	4.3	.6	
55	150	2.6	3.7	2.7	4.4	.7	
60	150	2.4	3.4	2.7	4.2	.8	
65	150	2.5	3.3	2.7	4.0	.7	
70	150	2.4	3.2	2.7	3.8	.6	
75	150	2.4	3.7	2.9	4.3	.6	No co-
80	150	2.3	3.3	2.9	3.9	.6	agul-
85	150	2.3	3.4	3.2	4.1	.7	ant
90	150	2.5	3.8	3.5	4.6	.8	1 gr.
95	150	2.6	3.5	3.7	4.4	.9	iron
100	150	2.6	4.1	4.0	4.9	.8	sulp-
105	150	2.8	4.9	4.2	5.6	.7	hate
110	150	4.2	5.6	4.6	6.5	.9	and ½
115	150	4.2	5.3	4.5	6.2	.9	gr. of
120	150	4.2	5.4	4.8	6.4	1.0	lime per gal.

Two Further Difficulties Overcome

In summing up the experience with the test filter sandwasher, two points appeared to require further consideration. One was that the irrigation water jet at the bottom of the washer would foul with sand occasionally after shutting down the filter, and the other that the sand nozzle, (13½ in. in length), was rather long and absorbed by friction more head than was thought necessary; and in the design for the actual sandwasher bases for the Toronto plant shown in Fig. 3, both of these defects were removed.

Some experience with Toronto sandwashers disclosed a local erosion in the throat at the point marked "X" on the vertical plane of the section and opposite the main water inlet which reduced the efficiency of the ejector, and it was found necessary to line the throat of the Venturi tube. This has been conveniently done with carbonized wrought iron pipe in steps as shown. The smallest diameter tube required renewal about every four months and the intermediate one yearly. The sand nozzles last a full year and the scour at the bottom of the washer has had to be repaired once in three years. These experiences being so different from what might have been anticipated from the experiments with the test filter, it was decided to study the matter in further detail.

A sandwasher base from one of the filters was connected up to an independent source of water supply with the water jet and sand nozzle exposed, and it was found that the velocity of the water at the jet varied from point to point in a given plane normal to the direction of motion; it being greatest at the point of maximum scour and least at a point

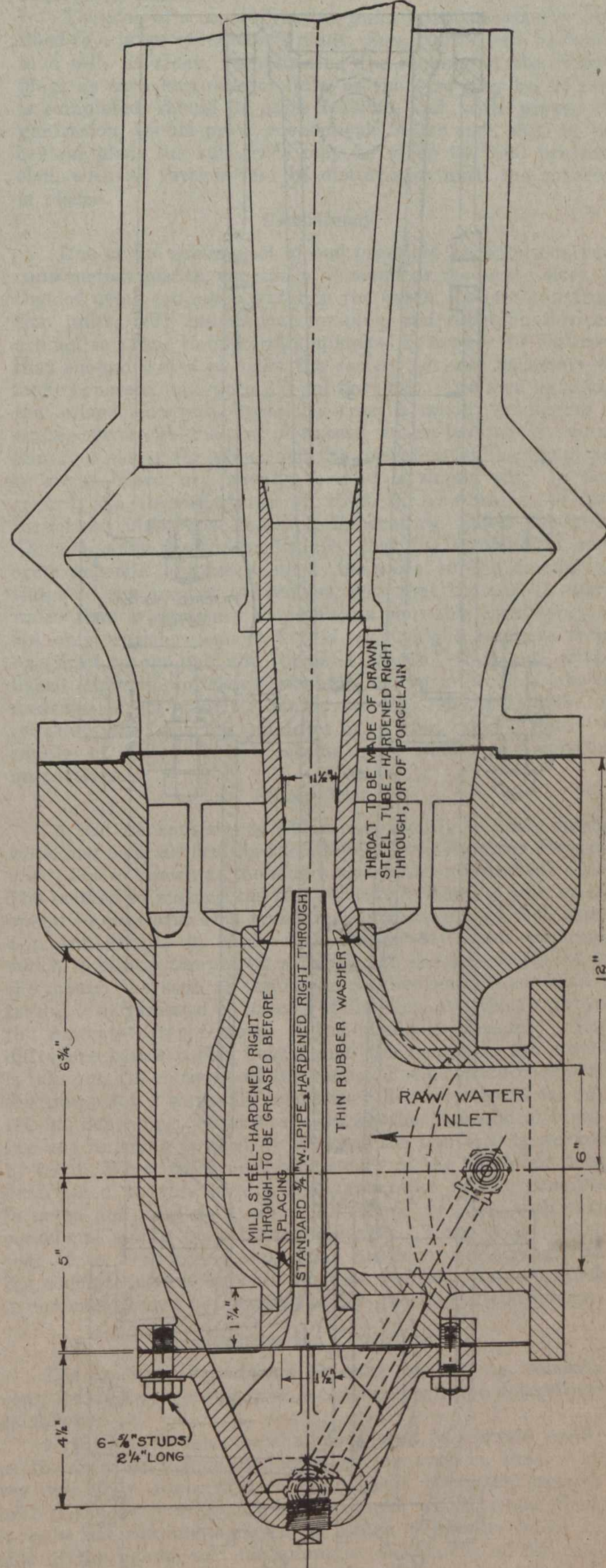

FIG. 4—NEW SANDWASHER BASE, FILTRATION PLANT, TORONTO

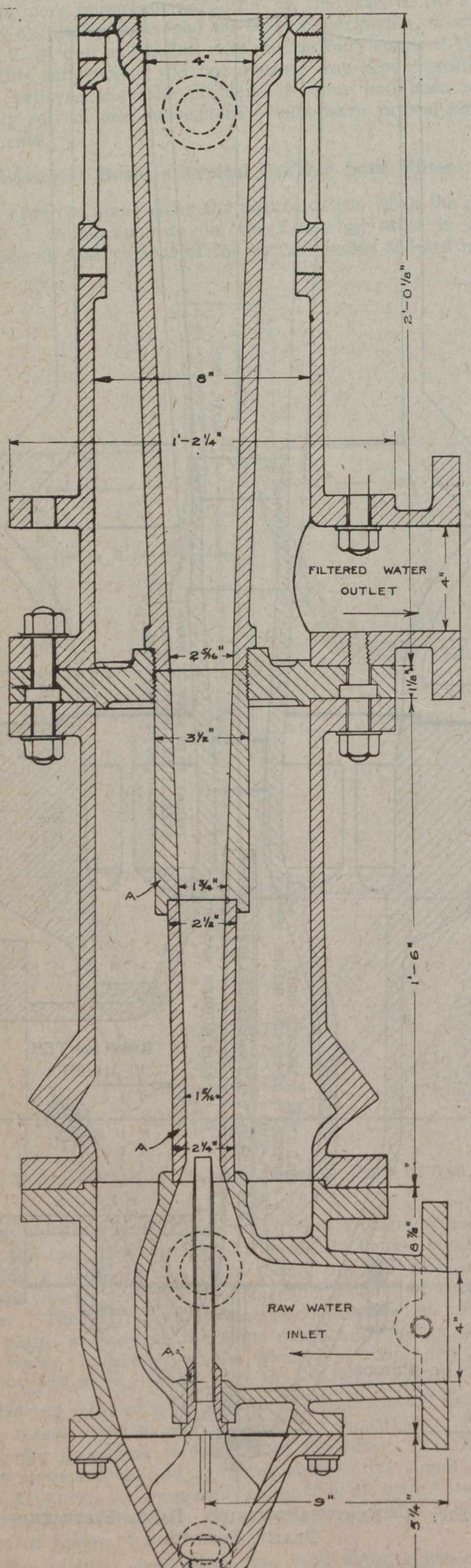

Fig. 5—Sandwasher Applied to Pressure Filters at Rockland, Ont.

diametrically opposite. At the point of highest velocity, there was the greatest suction, with the result that the sand coming out of the nozzle was drawn toward that point. There was also at this point, considerable turbulence owing to it being on the line of coalescence of the two streams of water formed by the sand nozzle acting as an obstruction in the fairway of the water. By comparing the two designs, the cause of the difference in the experiences is apparent. In the test filter design the water passing to the throat does so from a comparatively quiescent large body of water, and forms a comparatively steady jet, while in the adopted design the spaces provided were restricted, and the water passed at moderate velocities past the sand nozzle and up around the bend, hugging its periphery, producing the disturbances noted.

It was decided to introduce at two points in one of the Toronto filters sandwasher bases corresponding in the form of the water passages closely to those of the test filter. The actual design is shown in Fig. 4. A considerable improvement in the bottom of the sandwasher base was introduced and the sand nozzles were formed so as to be drawn out from below. These have been in operation over twelve months and show very little scour, in fact none at the bottom of the washer. They run without attention.

Performance of Sand Washers

As a matter of performance, each of these sandwashers during the twelve months they have been in operation has properly washed and cleaned about five thousand tons of sand, withdrawing it from, and delivering it again to, a height of about 18 ft., with practically no attention. The throats and sand nozzles are still in good condition. This is considered to be highly satisfactory, and shows that these sandwashers are highly efficient machines. The work of installing new sandwasher bases and throats throughout the whole plant is now in progress.

Fig. 5 shows a section through a sandwasher recently applied to pressure filters at Rockland, Ont., in which the raw-water supply pipe as is enters the sandwasher is widened out to reduce the velocity of approach, with the same idea of maintaining the steady jet at the throat of the sandwasher.

LIGNITE BRIQUETTES SAID TO BE CHEAPEST FUEL

By the first of August the lignite briquetting plants established by the Research Council to fit for use the coals obtained at Souris, Man., and at Estevan, southeast Saskatchewan, will be producing. It is expected that 30,000 tons will be produced this year at a cost much less than anthracite.

Dr. A. B. Macallum claims that the new fuel will not only be cheaper, but so much more efficient than anthracite that he is hopeful that the new demonstration will lead private capital to enter the same field, with the result that Pennsylvania coal will not be needed in the west in the course of time. Western Canada has imported more than 500,000 tons annually from Pennsylvania, and it would be of great benefit to this country to obviate the necessity of getting this foreign coal. Strikes and railroad congestion south of the line have so often made supplies insecure of late that the new development will be regarded as a very necessary one.

The new fuel will burn in the ordinary furnaces constructed for anthracite, but there are no clinkers or pieces of slate. It burns to an ash, and gives a higher degree of heat than anthracite. All the carbon is used, which is not the case with anthracite.

Because the cost of materials has soared since contracts were awarded to construct the eastern and western intercepting sewers to serve Windsor and neighboring municipalities, the Essex Border Utilities Commission is now asking for a further loan of $117,000.

THE CEMENT CONCRETE ROAD*

By W. P. Near
City Engineer, St. Catharines, Ont.

PERHAPS in no other type of road construction has there been such marked improvement in methods of construction and in standardizing of specifications as has been accomplished with the cement concrete road during the last ten years. It had been advertised that mixing and placing of concrete was the work of an unskilled workman, but the experiments of these years have proven that the intelligence of skilled workmen and trained foremen and engineers are needed, and pays for itself in results attained. During this ten-year period concrete roads have grown in popularity, as shown by the fact that in 1909 they had been laid in only one province (Ontario), and to the extent of 72,000 sq. yds., while at the end of the year 1919, concrete roads had been constructed in every province in Canada to the total of 3,970,459 sq. yds. In the United States, during the year 1919, there were constructed 53,459,934 sq. yds., making a total yardage at the end of 1919 of 167,015,086 sq. yds. In the presence of these figures, it is not my intention to use this paper to describe concrete roads or methods of construction, as they have been standardized, and are, no doubt, familiar to all of you. But with all of our experience, there always remain some features of specifications and construction methods which require to be kept constantly before us if we are to secure best results. I will attempt to bring a few of these features before you, and in doing so lay no claim to any originality for the suggestions made.

Preparation of Sub-Grade

It has been usual to bring the sub-grade to proper contour, leaving it a little high to allow for rolling, and then to consolidate by rolling and re-rolling with a heavy steam roller, filling up the depressions and re-rolling until the entire sub-grade is consolidated.

Now, many engineers contend that the sub-grade should receive little or no rolling. Particularly is this true for heavy clay and gumbo soils. They recommend that the side forms should be accurately set and the sub-grade should be brought to within one or two inches of the desired elevation, the remaining portions of the sub-grade then be carefully scraped or honed to desired contour. On clay and gumbo soils, which shrink and swell excessively with variations between dry and moist conditions, it is recommended that a layer, three or four inches in thickness, of cinders or fine gravel, be placed upon the sub-grade before the concrete is laid.

Where the usual methods of ploughing and rolling are adopted for preparation of sub-grade, it is recommended that the ploughing should extend ten or twelve inches below sub-grade. The surplus material then is excavated and removed and the sub-grade consolidated. This will produce a sub-grade of a more uniform bearing capacity than that secured by attempting to plough only as deep as the finished sub-grade. It is also claimed for this method that it is economical from the contractor's point of view, in that the materials are more easily excavated resulting from the deep ploughing.

Care of Sub-Grade before Placing of Concrete

So often it happens that the sub-grade is prepared in a perfectly satisfactory manner, and while materials for the concrete are being hauled and distributed, a few wet days will cause the sub-grade for long stretches to be rutted and cut up and previous preparation destroyed. Then the sand and stone become mixed with the grade; much of it is lost and the quality of the remainder very much lowered. The remedy for this is in the central mixing plant and the industrial railroad; and such good results to the concrete can be secured, as well as economies in the handling of materials, that I think the day is coming when specifications will require that when the sub-grade is once prepared that all driving and traffic over such sub-grade shall be prohibited until the concrete is placed.

The idea of a central mixing plant is not necessarily confined to a large contractor's plant. Small units, with half-mile to a mile of track, necessitating the moving of the central plant as each half-mile or mile, as the case may be, of road is completed, should be quite feasible, and, with proper organization, should prove economical. After each shift of the central plant the sub-grade may be given its final preparation, with no further fear of disturbance until the concrete is placed.

Consistency

One of the commonest of bad practices amongst concrete construction plants, especially of small or moderate sizes, is that of using too much water in the batch. Larger construction units, with mechanical tamping and finishing devices, are not so prone to make this mistake. It used to be assumed that enough water to make the cement set was necessary to make concrete, and more did not hurt any. The men handling the mixed concrete, especially from a mixer employing a chute, encourage the use of excess water, because it makes handling easier for them, and the operators of the template, or strike board, are usually fond of a sloppy mix. In this regard, the investigations of Prof. D. A. Abrams, of the Structural Materials Research Laboratory, Lewis Institute, Chicago, have shown conclusively that the strength of concrete depends absolutely upon the ratio of the amount of water to the amount of cement, and that the use of more water than is necessary to produce a workable consistency is not only wasting cement, but is producing a concrete from one-third to one-half the normal strength. It is also established that compressive strength of concrete is a direct measure of its wearing quality, so that the possibility of reducing the wearing qualities of a road by too liberal a supply of water in the mixing may assume tremendous proportions.

Slump Test

A test for consistency which may readily be made on the work has been devised by the Illinois State Highway Department, and is known as the slump test, using a truncated cone. The method of making the test consists in filling a thin metal mould in the form of a truncated cone, having an 8-in base, 4-in. top and 12 in. high, with the freshly-mixed concrete, which is lightly tamped by a rod as the concrete is placed in the mould. As soon as the mould is filled and struck with a trowel it is removed by means of handles, and the height of the concrete after removal of the mould is measured. The difference between this height and the height of the mould is taken as the measure of the slump. For concrete pavement the slump for a workable consistency lies between ½ in. and 1½ in., depending, respectively, on whether mechanical tamping and finishing is used, or whether the template is worked by hand. When the proper consistency of the batch has been determined by this means, the appearance of the concrete is noted and used as a guide for future batches, with only occasional slump tests being necessary. When it is proven that 10 to 15% excess water has cut down the strength of the concrete nearly 50%, it must be realized that too much importance cannot be attached to the question of consistency.

Specification for Consistency

The amount of water to be used for mixing concrete shall be that which will give a consistency to be determined as follows:—

Newly-mixed concrete shall be placed in a metal mould of the form of a truncated cone having an 8-in. base, 4-in. top and 12 in. high. The concrete shall be lightly tamped with a rod as it is placed in the mould, which, when filled, is to be immediately removed by means of handles on either side of the mould, and the slump or settlement of the concrete noted. For concrete to be finished by a mechanical tamping machine, the slump shall not be less than ½ in. nor exceed 1 in. If the concrete is to be finished by hand methods, the slump may be as much as 1½ in.

Our specifications for proportions are fairly fixed at 1: 2: 3, or thereabouts, and the grading of the fine aggregate

*Read before Seventh Canadian Good Roads Convention at Winnipeg, June 1st to 3rd, 1920.

from fine to ¼-in. is defined and the grading of the coarse aggregate from ¼-in to 1½-in. is specified. But assuming that the road is being built in a locality where materials up to these standards are possible, yet it is common experience that the sands from the pits and the stone from the crusher vary from day to day, and many of us have attempted by methods of screening samples and by personal observation to change the proportion of sand and to allow for an excess of fine material in the coarse aggregate, or to increase the proportion of cement when materials come too fine for specifications. Usually these changed proportions are met by objections from the contractor, although the same contractor is most anxious to keep his plant going by using the materials as they come to hand, without regard often to the suitability of the grading of the aggregates. Here, again, the investigations of Prof. Abrams are proving themselves valuable. From a very large range of tests and experiments Prof. Abrams has established that a wide range of proportions of fine and coarse aggregates of various gradings may be combined with the proper ratio of cement and water to give a concrete of the same strength as the model or specification mixture. Thus it is possible and practicable to make concrete of equal strength of quite dissimilarly graded aggregates. For example, one aggregate may range from 3-in. pieces to the finer sand particles, while the second may contain no pieces over 1-in. in size. Yet by varying the proportions of cement, each of these aggregates may be used and the strength of the resulting concrete be the same in each instance. This result is of far-reaching importance, as it enables the use of a wide variation of materials without sacrificing the quality desired. It results in standardizing the product instead of the specification.

From sieve analyses Prof. Abrams has evolved a property of aggregates which he calls the fineness modulus, which he defines as being such a property of the aggregates that two aggregates within reasonable limits of grading with the same fineness modulus will, if mixed with the same amount of cement and water, produce a concrete of similar plasticity and of a similar strength in a given time.

ABRAMS' TABLE OF PROPORTIONS AND QUANTITIES FOR ONE CUBIC YARD OF CONCRETE

SIZES: Coarse Aggregates, Inches	Cement in Barrels, Aggregates in Cubic Yards	0-28 Cement	0-28 Fine	0-28 Coarse	0-14 Cement	0-14 Fine	0-14 Coarse	0-8 Cement	0-8 Fine	0-8 Coarse	0-4 Cement	0-4 Fine	0-4 Coarse	0-⅜ in. Cement	0-⅜ in. Fine	0-⅜ in. Coarse
No. 4 Screen to ¾	Proportions	1	1.3	2.4	1	1.6	2.4	1	1.8	2.3	1	2.0	2.3	1	2.7	1.5
	Quantities	1.96	.37	.69	1.85	.44	.66	1.82	.48	.62	1.75	.52	.59	1.79	.72	.40
No. 4 Screen to 1	Proportions	1	1.3	2.7	1	1.6	2.6	1	1.8	2.6	1	2.0	2.5	1	2.6	1.8
	Quantities	1.90	.36	.76	1.77	.42	.68	1.72	.46	.66	1.67	.50	.62	1.72	.66	.46
No. 4 Screen to 1½	Proportions	1	1.2	3.1	1	1.6	3.2	1	1.7	3.1	1	2	3	1	2.4	2.4
	Quantities	1.82	.32	.84	1.68	.40	.79	1.63	.41	.75	1.61	.47	.72	1.62	.57	.57
No. 4 Screen to 2	Proportions	1	1.2	3.5	1	1.5	3.5	1	1.6	3.7	1	1.9	3.6	1	2.2	3.1
	Quantities	1.75	.31	.90	1.63	.36	.85	1.55	.36	.85	1.52	.43	.81	1.53	.50	.70
No. 4 Screen to 2½	Proportions	1	1.1	3.8	1	1.4	3.9	1	1.6	4.0	1	1.8	4.0	1	2.1	3.5
	Quantities	1.72	.28	.97	1.58	.33	.91	1.51	.35	.89	1.49	.40	.88	1.50	.46	.78
No. 4 Screen to 3	Proportions	1	1.1	3.9	1	1.4	4.1	1	1.5	4.1	1	1.7	4.1	1	2.0	3.7
	Quantities	1.69	.28	.97	1.58	.33	.97	1.49	.33	.90	1.49	.37	.90	1.49	.44	.81
⅜ to ¾	Proportions	1	1.3	2.3	1	1.7	2.3	1	1.9	2.3	1	2.2	2.2	1	2.8	1.4
	Quantities	1.96	.37	.67	1.85	.46	.63	1.82	.51	.62	1.75	.57	.57	1.79	.75	.37
⅜ to 1	Proportions	1	1.3	2.6	1	1.7	2.6	1	1.9	2.5	1	2.2	2.4	1	2.7	1.7
	Quantities	1.90	.36	.74	1.77	.44	.68	1.72	.48	.64	1.67	.54	.59	1.72	.68	.43
⅜ to 1½	Proportions	1	1.3	3.0	1	1.7	3.0	1	1.9	3.0	1	2.1	2.9	1	2.6	2.2
	Quantities	1.82	.35	.80	1.68	.43	.75	1.63	.46	.73	1.61	.50	.68	1.62	.63	.53
⅜ to 2	Proportions	1	1.3	3.3	1	1.7	3.4	1	1.8	3.5	1	2.0	3.4	1	2.4	2.9
	Quantities	1.75	.34	.86	1.63	.41	.83	1.55	.42	.80	1.52	.45	.77	1.53	.62	.66
⅜ to 2½	Proportions	1	1.3	3.7	1	1.6	3.7	1	1.7	3.9	1	2.0	3.8	1	2.3	3.3
	Quantities	1.72	.33	.95	1.58	.37	.87	1.51	.37	.87	1.49	.44	.84	1.50	.51	.74
⅜ to 3	Proportions	1	1.2	3.8	1	1.6	3.9	1	1.7	4.0	1	1.9	4.0	1	2.2	3.5
	Quantities	1.66	.30	.95	1.58	.37	.91	1.49	.37	.88	1.49	.42	.88	1.49	.48	.77
½ to ¾	Proportions	1	1.5	2.3	1	1.9	2.2	1	2.1	2.2	1	2.3	2.1	1	2.8	1.3
	Quantities	1.96	.44	.67	1.85	.52	.61	1.82	.56	.59	1.75	.59	.54	1.79	.75	.34
½ to 1	Proportions	1	1.5	2.5	1	1.9	2.5	1	2.1	2.4	1	2.3	2.4	1	2.8	1.6
	Quantities	1.90	.42	.70	1.77	.50	.66	1.72	.53	.61	1.67	.57	.59	1.72	.72	.41

SIZES: Coarse Aggregates, Inches	Cement in Barrels, Aggregates in Cubic Yards	0-28 Cement	0-28 Fine	0-28 Coarse	0-14 Cement	0-14 Fine	0-14 Coarse	0-8 Cement	0-8 Fine	0-8 Coarse	0-4 Cement	0-4 Fine	0-4 Coarse	0-⅜ in. Cement	0-⅜ in. Fine	0-⅜ in. Coarse
½ to 1½	Proportions	1	1.4	2.8	1	1.9	2.9	1	2.1	2.9	1	2.2	2.8	1	2.7	2.1
	Quantities	1.82	.37	.75	1.68	.47	.73	1.63	.51	.69	1.61	.52	.66	1.62	.65	.51
½ to 2	Proportions	1	1.4	3.3	1	1.9	3.3	1	2.0	3.4	1	2.2	3.3	1	2.7	2.7
	Quantities	1.75	.36	.86	1.63	.46	.79	1.55	.46	.78	1.52	.50	.74	1.53	.62	.62
½ to 2½	Proportions	1	1.4	3.6	1	1.8	3.6	1	1.9	3.7	1	2.1	3.7	1	2.6	3.1
	Quantities	1.72	.35	.91	1.58	.43	.85	1.51	.42	.83	1.49	.46	.81	1.50	.57	.69
½ to 3	Proportions	1	1.3	3.7	1	1.8	3.8	1	1.8	3.9	1	2.1	4.0	1	2.4	3.3
	Quantities	1.68	.33	.92	1.58	.42	.89	1.49	.40	.86	1.49	.46	.88	1.49	.53	.63
¾ to 1	Proportions	1	1.7	2.4	1	2.1	2.4	1	2.4	2.1	1	2.6	2.2	1	3.1	1.5
	Quantities	1.90	.48	.68	1.77	.55	.63	1.72	.61	.53	1.67	.64	.55	1.72	.79	.39
¾ to 1½	Proportions	1	1.7	2.7	1	2.0	2.8	1	2.3	2.7	1	2.5	2.7	1	3.0	2.0
	Quantities	1.82	.46	.73	1.79	.50	.70	1.63	.55	.65	1.61	.59	.64	1.62	.73	.48
¾ to 2	Proportions	1	1.7	3.1	1	2.0	3.1	1	2.3	3.1	1	2.5	3.0	1	3.0	2.4
	Quantities	1.75	.44	.80	1.63	.48	.75	1.55	.53	.72	1.52	.56	.67	1.53	.68	.55
¾ to 2½	Proportions	1	1.7	3.3	1	2.0	3.5	1	2.3	3.4	1	2.4	3.4	1	2.9	2.8
	Quantities	1.72	.43	.84	1.63	.47	.83	1.51	.52	.76	1.49	.53	.75	1.50	.64	.62
¾ to 3	Proportions	1	1.7	3.5	1	2.0	3.7	1	2.3	3.7	1	2.4	3.6	1	2.8	3.1
	Quantities	1.68	.43	.88	1.58	.47	.87	1.49	.51	.81	1.49	.53	.79	1.49	.62	.68
1 to 1½	Proportions	1	1.7	2.8	1	2.0	2.9	1	2.3	2.7	1	2.6	2.6	1	3.1	2.0
	Quantities	1.82	.46	.75	1.68	.50	.73	1.63	.55	.65	1.61	.62	.62	1.62	.75	.48
1 to 2	Proportions	1	1.5	3.2	1	1.9	3.5	1	2.2	3.3	1	2.4	3.3	1	3.0	2.6
	Quantities	1.75	.39	.83	1.63	.46	.85	1.58	.51	.76	1.52	.54	.74	1.53	.68	.59
1 to 2½	Proportions	1	1.4	3.4	1	1.9	3.8	1	2.0	3.7	1	2.3	3.7	1	2.7	3.1
	Quantities	1.72	.35	.86	1.58	.45	.89	1.51	.44	.83	1.49	.51	.81	1.50	.59	.69
1 to 3	Proportions	1	1.3	3.6	1	1.8	4.0	1	2.0	3.9	1	2.2	3.9	1	2.7	3.3
	Quantities	1.67	.33	.90	1.58	.42	.94	1.49	.44	.86	1.49	.48	.86	1.49	.59	.73

This table is based on the U.S. barrel of cement. For use in Canada, increase the number of barrels of cement by 7%.

Abrams' Tables of Proportions

Now, instead of making a rough screen analysis in the field or judging the visible proportions of the mixed concrete to decide on changes in proportions to take care of the variations in aggregates received, we have tables prepared by Prof. Abrams, showing a wide range of proportions of fine and coarse aggregates, which, mixed with the proper proportion of cement and mixed to the correct plasticity, will result in the model strength. The model has been taken as the usual 1:2:3 mixture, with the fine aggregate varying from ¼-in. in size to the finer particles and the coarse aggregate varying from ¼-in. to 1½-in. pieces. Such a concrete, tested in the laboratory, after being mixed to correct plasticity, gives a 28-day test of 3,000 lb. per sq. in. This is the basis of the table prepared. A copy of this table forms part of this paper, as it forms a reference for the suggested specification revision, and also a valuable reference for everyday use.

Size and Quality of Aggregates

Five different fine aggregates were used, with the upper limit of size from 1/28-in. to ⅜-in. A large variety of coarse aggregates were used, with the smaller limit varying from ¼-in. up to 1-in., and the larger limit from ¾-in. to 3-in. There are 27 variously-sized coarse aggregates, which, in combination with the five varieties of fine aggregates, give 135 combinations.

In every case the aggregates to be used are to be of material sound, clean and free from organic impurities. Then the resulting concrete, mixed to ideal consistency, will give a concrete equal in strength to the model mixture, namely, 3,000 lb. per sq. in. Then, when it is remembered that the wearing quality or resistance to abrasion of concretes vary as the compressive strengths, it is seen that each of the mixtures in the table will result in a concrete of standard wearing quality, and this is the feature applicable to cement concrete roads.

Certain rules are necessary in order to determine the limits of the sizes of the aggregates for a proper use of the information in the tables. Prof. Abrams defines, for instance, that a fine aggregate must contain 15% or more of sand from ⅛-in. to ¼-in. to be classed as having an upper limit of ¼-in. If less than 15% by volume of the material passes the sieve with four openings per inch and is retained on the sieve with eight openings per inch, then the sand should be classed as ⅛-in. sand.

For coarse aggregates, the rule laid down is that there shall be not less than 10% of material between the largest size and the next smaller size shown in the table. Thus, a coarse aggregate, to be classed as 2½-in. size, shall have not less than 10% of the material between the 2½-in. size and the 2-in. size. If there is less than 10% between these two sizes, then it would be classed as a 2-in., providing there should be at least 10% retained on the 1½-in. screen. The lower limit of size of a coarse aggregate shall be the largest size shown in the table for coarse aggregate, below which there is not to exceed 10% by volume of the material. Thus a coarse aggregate in which the lower limit of size is to be ½-in. should be an aggregate in which there is not to exceed 10% by volume of the material passing a ½-in. screen. In all coarse aggregates, if there is to exceed 5% of the volume passing a ¼-in. sieve, then such excess shall be considered as fine aggregate, and the amount of fine aggregate to be used is modified accordingly.

Quantities from the Tables

The table gives the proportions of fine and coarse aggregate and unit quanity of cement, and also gives the quantities of each required for 1 cu. yd of mixed concrete. These quanitities do not make any allowance for waste, so that, for practical estimates, they should be increased according to experience and construction methods employed.

It is interesting to note in connection with the information given in the tables for quantities of cement required per cubic yard of mixed concrete that for the finer coarse aggregates the amount of cement per cubic yard of concrete increases. For instance, for a coarse aggregate from ½-in. to ¾-in. particles 1.96 bbl. of cement is required in a cubic yard of concrete, while with a coarse aggregate, varying from 1-in. to 3-in. and a fine aggregate up to ¼-in., only 1.49 bbl. of cement are required to give a cubic yard of mixed concrete that will reach the standard test of 3,000 lb. per sq. in. in 28 days. This shows that materials that previous specifications did not admit will give a model concrete, and actually save cement.

Organic Impurities

In the aggregates considered in the table they must be free from organic impurities. In the sands, especially, tests should be made to make sure that no organic impurities are present, and the following is a test simply and readily performed in the field:—

Shake a few ounces of the sand in a 3% solution of sodium hydroxide, and, upon settlement over night, observe the color of the clear liquid. If colorless, or, at the most, light yellow color, freedom of organic impurities is indicated, whereas, if the liquid is a decided amber or brown color, it is an indication of an amount of organic impurity which should not be allowed in concrete for road purposes. A small amount of organic impurity is sufficient to reduce the strength of the concrete a third or a quarter, and only a comparatively small amount is necessary to cause complete disintegration of the concrete.

The proportions of cement, fine and coarse aggregate for the concrete shall vary according to the sizes of the fine and coarse aggregates to be used as indicated in Abrams' table of proportions and quantities as printed herewith. One sack of cement is to be considered as 1 cu. ft., and proportions are to be by volume. The quantity of cement in 1 cu. yd. of concrete in place shall be not less than the amount as shown in the table for a given proportion of coarse and fine aggregates.

Before work is started the contractor shall advise the engineer of the particular sizes of fine and coarse aggregates he expects to use, and no change shall be made by the contractor from such sizes except upon due notice in writing to the engineer.

Classification of Aggregate

To determine in what classification a given aggregate shall fall, the following method shall prevail:—

For fine aggregate there shall be not less than 15% of the total volume between the coarsest size and the next smaller size shown in the table. Thus, if fine aggregate is to be classed as ¼-in., there shall be not less than 15% of the material between the No. 4 screen and the No. 8 screen.

In coarse aggregate there shall be not less than 10% of material between the largest size and the next smaller size shown in the table. Thus a coarse aggregate, to be classed as 2½-in. size, shall have not less than 10% of the material between the 2½-in. size and the 2-in. size.

In each instance, whether fine or coarse aggregate, if there is not of the coarser sizes the amounts as here described, the upper limit of size of the material is to be that of the next smaller size. That is, an aggregate that contains some 2½-in. material, but less than 10% between 2½-in. and 2-in., is to be classed as 2-in. size for the upper limit.

The lower limit of size of a coarse aggregate shall be the size shown in the table for coarse aggregate, below which there is not to exceed 10% by volume of the material.

If there is to exceed 5% of the volume of coarse aggregate passing the No. 4 screen, then such excess shall be considered as fine aggregate, and the amount of fine aggregate to be used shall be modified accordingly.

Aggregate falling between limits of sizes other than shown by the table may be used only upon special written permission of the engineer, and in such proportions as he may indicate.

In all cases, aggregates, both fine and coarse, are presumed to be reasonably well graded between the limits specified.

Finishing and Curing

Finishing methods have benefited greatly by improvements during the last year or two, and these improved methods permit of a nearer approach to the ideal concrete mixture, and so are productive of a concrete surface of much higher wearing qualities than were originally produced. Floating has been replaced by rolling and belting, either by hand devices or by machines of more or less elaborate types. The previous floating method was a temptation to produce a concrete too high in mortar and of too wet a consistency. The new method includes the strike-board, or template, to bring the placed concrete to its correct contour, and then, after standing a short time, a light roller is pulled backwards and forwards transversely. This roller serves to slightly consolidate the concrete, bringing the mortar to the surface, and also removes any excess water. The finishing is then completed by belting, which consists in dragging a canvas belt with a zig-zag motion transversely over the surface of the rolled concrete. This gives a more perfect finish than any floating methods could possibly produce, and it is easier to operate and gives quicker results.

A mechanical tamping strike-board and belting device has been devised, and produces a more efficient concrete than the hand-rolling and belting method in that it permits of using a concrete of a more perfect consistency, as has been mentioned previously in this paper, in connection with the slump test.

Lastly comes the curing process, and it forms another important step in the production of a successful concrete road. The whole object should be to secure a slow and uniform hardening process for the finished concrete, and the methods should vary with the seasons. In hot, dry weather, for instance, the freshly-finished concrete should be protected from the sun by canvas covering until sufficient set has taken place to permit of the placing of the earth covering or the water ponds. The period for retaining such moist covering will depend on the temperatures, but a general tendency is to leave the road closed for curing for a longer period than heretofore. Instead of a fourteen-day minimum, some specifications wisely provide for a twenty-one day minimum period for curing. There is a temptation to be impatient, and to permit of rapid curing and drying and the opening to traffic after a shorter period than mentioned above, but this is most certain to be followed by ill effects to the wearing of the road as time, perhaps years, go on.

Expansion Joints and Cracking

There is an increasing practice of omitting entirely expansion joints in the construction of concrete roads. The chief advantage gained is the avoidance of an uneven surface at the joints, which is only avoided by extreme care in finishing in the vicinity of the joint when used. Expansion joints in usual practice are placed from 25 ft. to 50 ft. apart, depending on the width of the pavement, and also having regard to the season of the year at which the concrete is placed.

Then there is the subject of cracking, longitudinal and otherwise, and a whole paper might be written on the probable causes and possible cures of such cracking. I would only say that, if proper drainage facilities are afforded for the subsoil foundation, and if the concrete is properly constructed according to best methods, the percentage of cracks occurring will be so small and the remedy and annual maintenance so simple and cheap, that the cracking in cement concrete roads will not assume any great importance.

The writer wishes to thank A. N. Johnson, consulting highway engineer, Portland Cement Association, for copies of suggested specifications and of Prof. Abrams' tables.

CONTRACTORS TO PAY ONE PER CENT.

THE Inland Revenue Office, Ottawa, has issued the following rulings respecting the tax of 1% imposed on sales by manufacturers, wholesalers and importers as it will affect contractors.

"Contractors and sub-contractors will have to pay 1% tax on materials used by them.

"Products of the soil, such as sand, gravel and unprocessed stone, are not taxed. Lime, cement and stone which is quarried, crushed or which passes through any process, come under the tax.

"Building contractors and sub-contractors, though technically manufacturers are regarded for the purposes of the tax as retailers, selling to consumer. The tax is not chargeable on the amount of the contract, either between the sub-contractor and contractor or between the contractor and the owner.

"If a contractor or sub-contractor manufactures material for his work, such as metal cornices, sash and door frames, iron railing, etc., he is required to pay the tax on the cost of manufacture, including labor. He is not required to pay the tax on installation.

"The tax is primarily one upon materials, and is not intended to be a tax upon labor. Labor used in the installation of materials is not taxed, but the tax does apply to labor used in the manufacture of materials."

The twenty-third annual meeting of the American Society for Testing Materials will take place at Asbury Park, N.J., June 22-25, 1920, with headquarters at the Monterey Hotel. A full technical program with an ample admixture of social features is being provided. Amongst the papers to be read is one on "The Volume—Moisture Relation in Sand and a Method of Determining Surface Area Based Thereon," by R. B. Young and W. D. Walcott of the staff of the Hydro-Electric Power Commission of Ontario.

FINAL PROGRAM FOR THE CONVENTION OF THE AMERICAN WATER WORKS ASSOCIATION AT MONTREAL

PROMPTLY at 8 a.m., Monday, June 21st, registration will begin for the big convention of the American Water Works Association at Montreal, and from then till the break-up on Friday evening, there will be no dull moment. As announced in our issue of April 29th, headquarters of the convention will be at the Windsor Hotel, the meeting room, exhibits, secretary's office and committee rooms all being on the second floor.

A full and varied program has been provided, and in order that it may be carried out, meetings will be called strictly ON TIME, and the program proceeded with in accordance with the adopted schedule.

The final program follows:—

Monday, June 21st

Forenoon

Registration begins at 8 o'clock. Members are urged to register early, so that the secretary may be in possession of all necessary information concerning the attendance.

Afternoon

Meeting of executive committee. Meeting of standing and special committee.

Evening

8 p.m.—Gathering of members and ladies in exhibition hall, Windsor Hotel. Addresses of welcome by His Worship, Mederic Martin, Mayor of Montreal, and R. A. Ross, President of the Engineering Institute of Canada.

8.30 p.m. to 12.00 midnight.—Concert and dancing.

Tuesday, June 22nd

Forenoon

9 a.m.—Opening of convention. Announcement of officers elected for 1920-1921. New business.

Reading of papers as follows:—

"The Municipal Water Supply of Montreal," by Thomas W. Lesage.

"The Works of the Montreal Water and Power Company," by F. H. Pitcher.

"The Experience in Montreal in the Manufacture of Alum," by James O. Meadows.

Afternoon

2 p.m.—"The Water Works of the City of Quebec," by Arthur Surveyer.

"Water Supply Problems in the Province of Quebec," by T. J. Lafreniere.

"The Water Works of St. Johns, New Brunswick," by Frank A. Barbour.

Evening

8 p.m.—"Water Works Experiences," by Beekman C. Little.

"Economic Features of Pumping Station Operation," by Leonard A. Day. Illustrated with lantern slides.

"Difficulties in Building the Louisville Pumping Station," by James B. Wilson. Illustrated with lantern slides.

Wednesday, June 23rd.

Forenoon

8.15 a.m.—Trip through Lachine Rapids for members and ladies as guests of the Water Works Manufacturers' Association.

Afternoon

2 p.m.—"The New Water Supply of Winnipeg," by James H. Fuertes and William G. Chace.

President's address, by Carleton E. Davis.

Reports from sections.

Report of the Association's representatives on the American Electrolysis Committee, by Alfred D. Flinn, chairman.

Reports of Committees.—Private Fire Protection Services, by Nicholas S. Hill, Jr., chairman. Official Standards for Water Analysis, by Jack J. Hinman, Jr., chairman. Cold

Weather Troubles, by Charles R. Bettes, chairman. Reports of officers and standing committees. Nomination of members of the Nominating Committee. Selection of place for holding the 1921 convention.

Evening

8.30 p.m.—The Water Works Manufacturers' Association invite the men to a smoking concert and cabaret, Rose Room, Windsor Hotel.

Thursday, June 24th, Superintendents' Day

Forenoon

9 a.m.—Report of committee on Standard Specifications for Water Meters, by Caleb M. Saville, chairman.

Topics for general discussion:—

"What is the Proper Size of Meter for Multiple Family Houses?" Introduced by short papers by H. P. Bohmann, G. A. Elliott, D. W. French, W. R. Edwards.

"Testing Meters in Series." Introduced by short papers by J. A. Murray, C. M. Saville, Fred. B. Nelson.

"Experience with Compound Meters." Introduced by short papers by C. M. Saville, Seth M. Van Loan.

Afternoon

2 p.m.—"The Prevention of Water Waste on Railroads," by C. R. Knowles. Illustrated with lantern slides.

Topics for General Discussion:—

"What is the Legitimate Use of Water?" Introduced by short papers by E. W. Cuddeback, C. M. Saville, W. W. Brush.

"Some Aspects of Electrolysis," by Dr. Gellert Alleman. Illustrated by lantern slides. "The Revenue Chargeable to Public Uses of Water in the City of Rochester," by Stephen B. Story.

Evening

8 p.m.—"Damage to Deep Wells by Sea Water," by Dr. William P. Mason.

"Cost-Plus Contracts in Water Works Construction," by G. W. Fuller.

"The War Burden of Water Works in the United States Continues," by Leonard Metcalf.

Thursday, June 24th, Chemical and Bacteriological Section

Forenoon

9 a.m.—Special Session on Quality of Water.

"Quality of Water," by George A. Johnson.

"Standards of Quality of Water," by Jack J. Hinman, Jr.

"Index Numbers and the Scoring of Water Supplies," by Abel Wolman.

"Recent Progress in the Fight Against Typhoid Fever," by W. J. Orchard.

"Controlling Water Purification Plants in the Province of Quebec," by MacH. McCrady.

"The Operation of Small Water Works Plants from the Viewpoint of the Quality of the Water," by Paul Hansen.

"Co-operative Research in Water Purification," by Abel Wolman.

Friday, June 25th

Forenoon

9 a.m.—Entertainment Committee in attendance to take party to inspect the filtration plants of the city of Montreal and the Montreal Water and Power Company. Returning to the Windsor Hotel at 1.00 p.m.

Afternoon

Visiting and getting better acquainted.

Evening

7 p.m.—Entertainment Committee in attendance to give full information and instructions for members leaving for Saguenay River trip.

Arrangements have been made with the Canada Steamship Lines, Limited, to set aside space on the S.S. "Saguenay," leaving Montreal, Friday, June 25th, at 7.15 p.m. (Standard time), returning to Montreal Monday morning at 9.00 o'clock, for trip to the Saguenay River and return.

WATER SUPPLY MADE SAFE FOR A TROPICAL TOWN*

Town of Seccondee, Gold Coast Colony, Provided With Complete Water Works System—Excess Lime Process Destroys Bacteria and Algal Growths—Sand and Broken Stone Filters

ADEQUATE and reliable water supply for the towns has long been recognized as an especially important factor in conserving the health of the people in tropical and subtropical regions. Through the provision of such, and through improvements in drainage and other sanitary measures, the British authorities have made of the Gold Coast Colony, on the Gulf of Guinea, a region habitable for Europeans for the greater portion of the time.

One of the important works carried out in this process of making the Gold Coast a fit place to live in, was the provision of a water supply for the town of Seccondee, next in importance to Accra, the capital. There is in this work much that may be of assistance to those who have to deal with situations involving unusual difficulties of purification.

Preliminary Studies

The pioneer work of collecting data upon which water supply projects could be based was done some fifteen years ago by British engineers. It was found on a careful examination of rainfalls and the gaugings of streams, that, in years of low rainfall (such, however, as would be called a large rainfall for the east coast of England), the run off was so small that a catchment area which in England would afford a large supply with ordinary storage might fail altogether in the Gold Coast, even though storage to meet the demands of several years were provided. It was, therefore, necessary, in order to obtain even so small a quantity of water—about half a million gallons per day—as would satisfy each of the towns of Accra and Seccondee to utilize streams which, though in occasional years altogether empty in the dry season, assumed the character of considerable rivers in the wet season. Such a stream was found in the River Densu for the supply to the town of Accra, and the works were finished in 1914-15.

For the town of Seccondee, with the introduction of a water supply to which this article deals, the Anankwan River was selected, a reservoir being formed in the river bed near the village of Inchaban, at a distance of about 3½ miles, in a straight line from Seccondee. The needs of the town were considered up to the year 1924, when it was estimated that the quantity of water required would be 658,500 (Imperial) gallons per day, and the works were designed in the first place to afford a supply of 500,000 gallons per day. From the available data, the estimated average rainfall worked out at about 43 in. per annum, and the available supply from the river w calculated to be 1,040,000 gallons per day, so that the required supply was only 66 per cent. of that available. The water is of low mineral content, but is highly charged with organic matter, chiefly of vegetable origin; it was, therefore, necessary that it should be filtered before being used.

The works consist of a concrete dam with outlet works and sluices for passing floods, filters, clear water tank, pumping station, service reservoir and the necessary mains and contingent works. A glance at the general plan, Fig. 1, will show that the site of the reservoir is almost at the sea coast; unfortunately there was no suitable site farther upstream, consequently the reservoir had to be made at this low elevation, and pumping machinery introduced to lift the water to a service reservoir high enough to supply the town.

Mass Concrete Dam Faced With Concrete Blocks

The dam is 360 ft. long, with a maximum height above the original surface of the rock in the river bed of about 40 ft., and two large sluices are provided in the centre for passing flood water. Flood water can also be passed over

*From "Concrete and Constructional Engineering," May, 1920.

the top of the dam, but the intention is to use the sluices as much as possible, so that the less pure water which settles to the bottom may be scoured out from time to time. The structure is faced with concrete blocks in courses 2 ft. deep, the upstream blocks being smooth-faced and the downstream blocks rock-faced. The main body of the dam between the blockwork is of 1: 6 mass concrete containing displacers, which were specified not to exceed 1,700 lbs. in weight. As a matter of fact, however, owing to the nature of the schistose rock forming the foundation of the dam from which the stone for the dam was taken, it was not possible to get displacers of material size. The blocks have a face 3 in. thick of 1: 3 concrete, the remainder of the block being 1: 5 concrete. The

It was specified that the blockwork should be kept a course in advance of the mass concrete so as to serve as forms and render the use of timber forms unnecessary in the construction of the dam. The mass concrete was to be worked well up against the back of the blockwork to ensure thorough bonding. In actual construction, however, this method was not adhered to, a novel one, consisting in building a series of longitudinal walls, being adopted upon the advice and responsibility of the engineers in the colony who were in charge of the work.

Access is given to the sluices by means of a roadway carried on eight arches supported on concrete piers built up from the top of the dam from the north end. The faces of

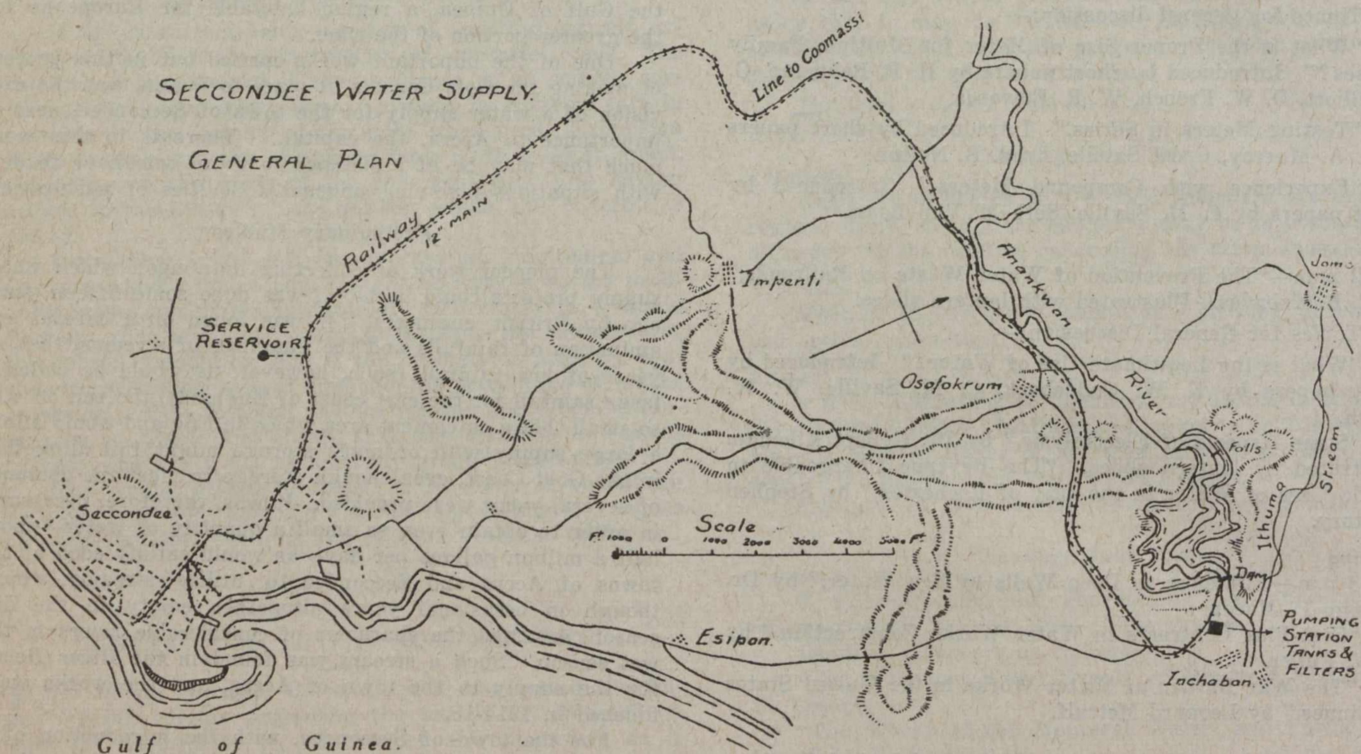

FIG. 1—GENERAL MAP SHOWING SCHEME OF WATER SUPPLY FOR SECCONDEE, GOLD COAST COLONY

concrete work round the sluices is 1: 6 faced with 1: 3 fine concrete. The cement and aggregates were so proportioned that the 1: 3, 1: 5, etc., concretes practically mean that in the finished work the bulk of the cement is a third, a fifth, etc., of the whole volume.

The sluices are on the Stoney principle, each having an opening 26 ft. deep by 18 ft. wide; they are built up of wrought steel plates and sections with the necessary roller paths and rollers; an adjustable bar is provided along the top so as to close down on the lintel and make a practically watertight joint; adjustable bars are also fitted to the sides of the sluice so as to reduce the leakage. The sluices are designed to withstand a head of 45 ft. above sill level, and each sluice is counterbalanced and provided with lifting gear so proportioned that two men can raise the sluice with the full head against it.

The concrete blocks were made in moulds on the works, and while the blocks were being cast the moulds were placed on a shaking machine, so that they were kept in a constant state of agitation during the process of casting the concrete, thus ensuring a dense and watertight mass. Recesses were formed in all vertical joint faces of the blocks, these recesses being filled with cement grout after the blocks had been set in the dam, thus dowelling all the blocks together. The blocks were left in the moulds for seven days after casting, and were then taken out and set in the air for a further minimum of 28 days before being used in the work. 1: 3 Portland cement mortar was used for setting the blocks in the dam.

the sluice piers and of the parapets of the roadway were brushed in panels, leaving the aggregate in relief, to improve the appearance of the work.

The ends of the dam are recessed to form keys for puddle walls, which are carried upstream for a considerable distance parallel to the water edge of the reservoir in order to prevent leakage, as the rock does not rise to the full height of the water in the reservoir, and it was found that the ground above the rock was not sufficiently impervious. It was thought possible that a puddle wall would have to be carried round the whole periphery of the reservoir, but a comparatively short length at each end has proved to be sufficient.

Outlet Works

The outlet works are situated at the north end of the dam, which is made 14 ft. thicker at this point, and a well 10 by 8 ft., and a screen chamber 12 by 3 ft., are formed in this thickened portion. The banks of the reservoir are cut away to allow easy access of the water, and the slopes so formed are covered with grouted pitching. The water passes from the reservoir through the screens which are of two kinds, the outer being of iron bars spaced to give 1 in. clear between them, and the inner ones of copper wire gauze having 400 meshes to the square inch. The passage from the screen chamber to the well is by four 12-in. bell-mouthed pipes each leading through two sluice valves, in series, to a 15-in. upstand pipe. These 12-in. pipes are at different levels to admit of the water always being drawn off near the surface. The supply pipe is taken through the dam from the lower end of the upstand and is 15 in. diameter through the dam, below which it is reduced to 12 in. diameter.

In order to facilitate construction, a timber gantry 30 ft. wide was built on the downstream side of the dam, the rail level on the gantry being 15 ft. below the crest level of the dam. On the side of the gantry near the dam a 7-ft. crane road was placed and on the farther side two lines of rails of 2-ft. gauge, one for conveying the concrete from the mixer and the other for returning the empty trucks.

Cistern and Double Row of Cascades

The raw water from the reservoir passes through the draw-off main to a concrete cistern 10 by 9 by 6 ft., the flow into which is regulated by means of a ball valve fitted on the end of the pipe and capable of passing 750,000 gals. in 24 hours when fully open. There are two 6-in. outlets from this cistern, feeding a double row of cascades, 10 in number, introduced for the purpose of aerating the water, which are used to regulate the flow to the filters in accordance with the varying seasonable demands. A 6-in. overflow pipe is provided in the lowest basin of the cascades and is fitted with a valve, this pipe being used for washing out when required. From this basin the water passes along a channel running across the top of all the filters and supplying them through feeding chambers in the form of cascades.

There are five filters each 80 by 35 ft. by 8 ft. 6 in. deep (see Fig 2), which for the greater part of their area are founded direct on rock, but, where the rock falls away, concrete walls are built up from the rock and the spaces between them filled with rubble stone to form the foundation. These supporting walls are 1:7.4 concrete, while the main

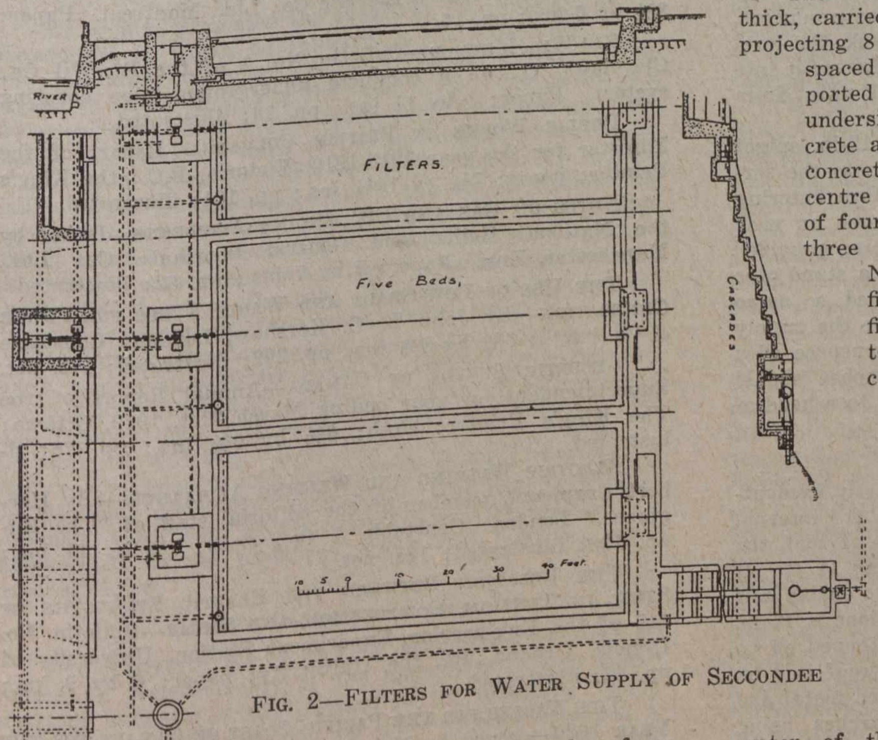

FIG. 2—FILTERS FOR WATER SUPPLY OF SECCONDEE

body of the filters is of 1:6 concrete. The internal surfaces of the filters and filtered water wells are rendered with 1:2 cement mortar.

The filtering material is supported on two layers of concrete bars 3 ft. by 4½ in. by 3 in. The bars in the lower of the two layers are laid on the flat, in rows 4½ in. apart. The bars in the upper layer are laid at right angles to those below, but closer together, only a small open joint being left, by which the filtered water drains to the ducts in the lower layer and is led to the outlet wells. In order to keep the bars in place notches are made in the under side of the upper ones into which the lower bars fit. The filtering material consists of 6 in. thickness of broken stone ⅞ in. to 1¼ in., laid on the concrete bars, then 6 in. of stone ⅜-in. to ¾-in., then 2 ft. of sand in two 1-ft. layers of different grades. There is a dis-

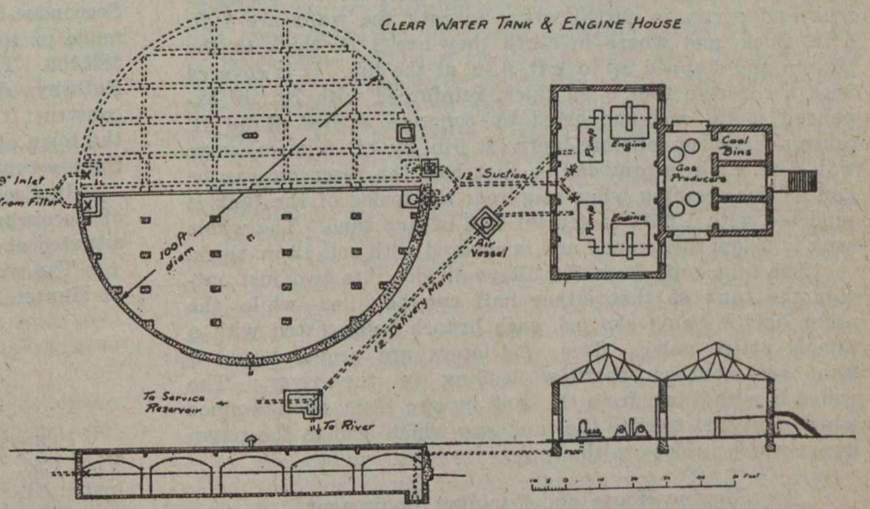

FIG. 3—CLEAR WATER TANK AND ENGINE HOUSE, SECCONDEE WATER SUPPLY

charge well 8 ft. square at the bottom end of each filter, the water entering through a 6-in. inlet valve. Each of these wells also contains a Glenfield-Jones regulating valve to ensure uniform delivery within the limits of head allowed in the filter. These valves discharge the water through 6-in. pipes into a 9-in. filtered water main leading to the clear water tank.

The filters are roofed with reinforced concrete 4 in. thick, carried on reinforced concrete beams 6 in. wide and projecting 8 in. below the underside of the roof slab, and spaced at 8-ft. centres, the ends of these being supported by beams 12 in. wide and 1 ft. 8 in. deep below underside of roof. These are, in turn, carried on concrete arched walls situated between the filters and by concrete columns 1 ft. 6 in. by 1 ft. situated on the centre lines of the filters. The reinforcement consists of four 1-in. square indented bars in the main beams, three ⅝-in. round bars in the cross beams and No. 8 expanded metal in the roof slab. Each filter is provided with five pairs of doors. The filters being situated on the river bank are protected on three sides by a training wall of 1:6 concrete founded on the rock.

Excess Lime Treatment for Bacteria and Algal Growths

As already indicated, the water of these tropical countries is organically highly impure, chiefly through decaying vegetable matter. The problem of filtration was, therefore, a difficult one. At the Accra works it was hoped that by the adoption of multiple filtration a pure filtrate would be obtained without the use of chemicals. While the system succeeded in materially reducing the impurities, it did not afford a water of the standard desired. It was at one time intended to add the iron process, but there were objections to it. Ultimately, on the advice of Sir Alexander Houston, it was decided to adopt the excess lime process, the character of the water being suitable. It was stated by Sir Alexander Houston that the lime would destroy practically all bacteria, and also algal growths which were very troublesome in the reservoirs. It has been reported from the Colony that the process has met with complete success, and it has been adopted also at Seccondee. The water is, of course, filtered through the sand filters after treatment with the lime.

Divided Clear Water Tank

The clear water tank (Fig. 3), to receive the water from the filters, is circular in form, 10 ft. internal diameter and 11 ft. 6 in. deep, of 1: 6 concrete, and is excavated partly in rock and partly in earth; where in rock the walls are 1 ft. 6 in. thick, and where in earth they are 3 ft. thick at the bottom and stepped up to 1 ft. 6 in. at the top. It is covered with a concrete roof 6 in. thick, reinforced with No. 10 expanded metal and supported by concrete arches at 10 ft. centres carried on concrete piers 2 ft. 6 in. by 1 ft. 6 in.; a centre wall 6 ft. high is provided so that half the reservoir can be laid off for cleaning when required; the inside of the tank is rendered with 1 part of cement to 2 of fine sand. The whole tank is below the ground and is covered with soil 12 in. thick.

The 9-in. pipe from the filters divides into two just outside the tank so that either half can be filled while the other half is being cleaned, each branch being fitted with a 9-inch. sluice valve. Two ventilators are provided and a 9-in. bell-mouthed overflow leading to the river. The water is withdrawn from the tank by two 12-in. suction pipes which join just outside the tank and which lead to the pump house which is close to the tank.

Engine House and Pumping Equipment

The engine and pump house is 54 ft. long by 30 ft. wide internally, and is constructed of concrete blocks 16-in. thick made in a Winget block-making machine; the roof is supported by steel trusses. At the back of the engine house is a gas producer house 30 by 30 ft.

The pumping machinery was supplied by Messrs. Tangye, Ltd., and consists of two sets of horizontal treble ram pumps, with rams 13-in. diameter by 15-in. stroke, running at 33½ r.p.m., and driven through gearing by two sets of horizontal suction gas engines of 108 maximum b.h.p. running at 200 r.p.m., these being supplied from two suction gas producers. The pumps draw water from the clear water tank, the level in which varies from 10 ft. to 20 ft. O.D., and deliver it into a stand pipe at the service reservoir about 1 mile from Seccondee, the overflow of which is 225 ft. O.D.

The delivery main from the pumps is of 12-in. spigot and socket cast iron pipe and conveys the water to the service reservoir; the main is bifurcated just before entering the service reservoir, the branches delivering one on each side of the reservoir division wall, and each being provided with a sluice valve. Just before the bifurcation a stand pipe 30 ft. high, above the centre of the pipe, is fixed, so as to enable a higher head to be put on the main for the supply of villages along the route, it also serves the purpose of a safety device in case the valves on both branches should have been left closed. The pipes were all tested to a head of 600 ft.

Service Reservoir

The service reservoir is circular in form, partly excavated and partly built above ground. It is 175 ft. internal diameter and 12 ft. deep from floor to underside of roof, the maximum depth of water to overflow level being 11 ft. It has a centre wall 7 ft. 6 in. high above the floor to enable half the reservoir to be emptied for cleaning. The floor is 12 in. thick and the walls 2 ft. 6 in. at the bottom, stepped off to 1 ft. 6 in. at the top, all of 1: 6 concrete. The roof is 6 in. thick of concrete reinforced with No. 10 expanded metal and is carried on concrete piers and arches, the arches being 20 ft. span and 10 ft. apart. The roof is covered with soil 12 in. thick sloped off at 3 to 1 all round to meet the original ground. The water leaves the service reservoir by two 12-in. pipes, one from either side of the division wall. These join at about 30 ft. from the reservoir, and about 22 ft. beyond this junction a Venturi meter is fixed for the purpose of recording the delivery to the town. The Venturi meter is situated in a house made of concrete Winget blocks. The 12-in. main is continued to a point in the town where it divides into the general distribution system. Two 9-in. Deacon meters are fitted on the distribution system for detecting waste.

The completion of the works was much delayed owing to the war, and the cost, consequently, considerably increased.

In order to facilitate the construction of the work a branch railway, about 3½ miles long, was laid from the Seccondee-Coomassie line to the site of the dam. It was made of the same gauge as the main line and cost about $83,000. The cost was subsequently paid by the Gold Coast Railways department, as it was arranged at the outset to construct the railway so as to carry passengers and serve the town of Chama and other villages in the neighborhood of the reservoir.

In Seccondee the water is introduced to the bungalows of Europeans, and the natives are supplied by street fountains situated at frequent intervals.

The work was carried out in accordance with the plans of Hunter, Duff & Middleton, consulting engineers.

PUBLICATIONS RECEIVED

PRENTISS VISES—Catalogue No. 52. New York: Prentiss Vise Co.; 106-110 Lafayette St.; paper; 6 by 9 ins.; illustrated.

CANADIAN FAIRBANKS-MORSE, CO., LTD., MONTREAL—General catalogue No. 20; cloth; 6 by 9 ins.; pp. 960; illustrated.

CENTRIFUGAL PUMPS—Catalogue B of the De Laval Steam Turbine Co., Trenton, N.J. Paper; 8½ by 11 ins.; pp. 44; illustrated.

ASPHALT PAVING MIXTURES—Brochure No. 11 of the Asphalt Association, 95-97 King St. East, Toronto. Paper; 6½ by 9½ ins.; pp. 7.

SUMMARY OF EMPLOYEES' PENSION AND BENEFIT PLAN—Issued by the Northern Electric Co., Ltd., Montreal. Paper; 3½ by 6 ins.; pp. 16.

RIC-WIL METHOD—Bulletin No. 1 of the Ric-Wil Co., Cleveland, O., on a complete underground pipe covering system. Paper; 8 by 11 ins.; pp. 16; illustrated.

PUBLIC WORKS OF BRITISH COLUMBIA—Report of the Minister for the year 1918-1919, Victoria, B.C.: the King's Printer; paper; 7¼ by 10¼ ins.; pp. 161; illustrated.

NOTES ON GAS AND OIL ENGINE ACCIDENTS—Issued by the National Boiler and General Insurance Co., Ltd., Manchester, Eng. Paper; 5 by 7 ins.; pp. 32; illustrated.

THE USE OF LOW-GRADE AND WASTE FUELS FOR POWER GENERATION—By John B. C. Kershaw, London: Constable & Co., cloth; 5½ by 8½ ins., pp. 202; illustrated; 17s. net.

GEODETIC SURVEY OF CANADA—Annual Report of the Superintendent for year ending March 31st, 1919, Ottawa: The King's Printer; cloth; 6½ by 9¾ ins.; pp. 76; illustrated.

ELECTRIC WELDING AND WELDING APPLIANCES—By Herbert Carpmael, member of the editorial staff of "The Engineer," London: Constable & Co.; cloth; 7½ by 11 ins.; pp. 128; illustrated; 18s. net.

THE RELATION BETWEEN THE ELASTIC STRENGTHS OF STEEL IN TENSION, COMPRESSION AND SHEAR—Bulletin No. 115 of the Engineering Experiment Station, University of Illinois, Urbana, Ill., the University; paper; 6 by 9 ins.; pp. 42; illustrated.

TIDE TABLES FOR THE PACIFIC COAST OF CANADA FOR THE YEAR 1920—Issued by the Tidal and Current Survey, Department of the Naval Service of Canada, W. Bell Dawson, F.R.S.C., superintendent, Ottawa: the King's Printer; paper; 6½ by 10 ins.; pp. 63.

ELECTRO-METALLURGICAL AND ELECTRO-CHEMICAL INDUSTRY IN THE STATE OF WASHINGTON—Bulletin No. 5 of the Engineering Experiment Station, University of Washington. By Charles, Denham Grier, Seattle, Wash., the University of Washington; paper; 6 by 9 ins.; pp. 43.

CANADIAN GOOD ROADS ASSOCIATION

Annual Business Meeting—Report of the Directors—Service Depends on Funds—Report of Committee on Resolutions—"Canadian Highway" Debated

FOLLOWING the seventh Canadian Good Roads Congress at Winnipeg, the annual meeting of the Canadian Good Roads Association was held Thursday evening, June 3rd. S. L. Squire, retiring president of the association, called the meeting to order at 8 o'clock and requested G. A. McNamee, secretary of the association, to read the minutes of the last annual meeting.

After the minutes had been read and approved, Mr. McNamee presented the financial report, which showed assets of $631 cash on hand and no bills receivable or payable. The statement of income showed that 153 active members had paid dues at $2 per annum and that 17 active members were in arrears; 32 associate members had paid dues at $10 per annum, and three contributing members at $100 per annum. The provincial governments had contributed $1,300 to the association and had advanced $500 toward the coming year's expenses.

The statement of expenditure set forth the following principal items: Winnipeg convention, $444; Quebec convention, $617; directors' travelling expenses, $491; honorariums, $725; Federal aid, $27; printing, $253; general expenses, $156. Income for the past year showed a surplus of $39 over expenditures, and this, added to the amount on hand at the end of the previous year, resulted in the present cash asset of $631.

The sums mentioned above do not represent the entire cost of either the Winnipeg or Quebec conventions. The province of Quebec paid practically the entire cost of the convention which was held in the city of Quebec in the spring of 1919.

Report of Directors

Mr. Squire presented the report of the directors of the association, in which he referred to the assistance which the association had given to the Dominion government in regard to the Federal Aid Bill, and to the Automotive Association in planning a good-roads publicity-campaign. Mr. Squire said that the work of the association, extending as it does from ocean to ocean and embracing every municipality in the Dominion, cannot be carried on without the expenditure of considerable money annually. He intimated that it would be the work of the incoming board of directors to place the association in a financial position which would enable it to function efficiently. The sources of revenue are limited, he declared; from membership little more than $1,000 annually can be expected, although he believed that many more municipalities could be induced to co-operate. The Federal government had been approached, both directly and through the Highways Advisory Commission, for financial aid, but Mr. Squire regretted to report that but little encouragement had been obtained from this source, the Dominion government maintaining that road building is provincial work. Mr. Squire acknowledged the association's indebtedness to the provinces, which had last year contributed $1,800.

Service Depends on Funds

The possibility for service by the association will be limited, he declared, only by the amount of money which is placed annually at the disposal of the directors. Thus far the association has had no office expenditure, but a stenographer has been engaged for the coming year, and arrangements have also been made in regard to remuneration for the secretary, who last year received merely an honorarium. The office space has been provided without charge by the Automobile Club of Canada, Montreal, to whom Mr. Squire tendered the thanks of the association.

At a meeting of the directors early in the year, it had been decided that in view of anticipated Federal assistance, the association should pay the expenses of the directors while attending board meetings. Although it must be admitted that any member of the board of directors who is willing to give his time to this work should be entitled at least to expenses, Mr. Squire declared that this policy cannot be pursued in the future on account of financial difficulties, because if all the directors were to attend a board meeting at the expense of the association, no less than $1,200 would be required for each meeting. Mr. Squire suggested that the directors should either rescind this resolution or find some means for providing sufficient money to carry on in accordance with the resolution. He also recommended that a central executive committee should be chosen and that the main work of the association should be accomplished by that committee. This suggestion was approved by the directors, and an executive committee was chosen with Mr. Squire as chairman. A report of all business transacted by this committee will be forwarded immediately to the directors, and will be considered as having been passed by the association and entered in the minutes only after a majority of the directors have given their consent.

Mr. Squire suggested that a bulletin should be prepared and issued monthly, containing road building information of value to municipalities. He urged that the attention of the various provincial governments be brought to the work of the association, and said that the work it performs is duplicated by no other organization in the Dominion and is in the public interest, and therefore, the governments should provide funds for its maintenance. Such contributions, he declared, should not be considered as a grant, but as an investment, because the educational work which the association is undertaking deserves governmental assistance and co-operation.

Report of Committee on Resolutions

C. R. Wheelock, chairman of the committee on resolutions, read the following report:—

"1. This association is of the opinion that the effectiveness of the 'Canada Highways Act' under present abnormal conditions is much retarded by the necessity of preparing all work for tender and contract in order to qualify for the Dominion subsidy, and strongly recommends the amendment of the act so as to remove all discrimination against work carried out by day labor.

"2. Whereas the construction of bridges is an essential part of the work of highway development, in which large expenditures are necessarily incurred; and whereas the Canada Highways Act specifically witholds aid from bridge construction; this association would recommend that the act be so amended as to extend aid to all bridges which are part of an approved system of provincial highways, in order that the aid to road-building may be applied where the need of assistance is greatest.

"3. The Canadian Good Roads Association, in annual congress at Winnipeg, acknowledges with pleasure the message of the council of the Engineering Institute of Canada, and desires to endorse the view expressed by the council, that the supervision and inspection of highway work of all descriptions should, as far as practicable, be entrusted by municipal and provincial authorities to qualified engineers and young men with technical qualifications, in order that the experience thereby obtained may be usefully conserved and expanded to the future national advantage in this important public undertaking.

"4. Whereas, with the increasing progress and development of Canada, it is desirable that the highway systems of the various provinces shall be linked together by means of a road extending from Glace Bay, N.S., to Cape Scott, Vancouver Island, the said road to be known throughout its length as the 'Canadian Highway'; and whereas the utilitarian value of the Canadian Highway would be great throughout every section, and it would serve as the main market-road into many market centre communities across Canada; and whereas the Canadian Highway would attract large numbers of tourists to Canada, besides keeping in Canada many Canadian tourists who now take vacations in other countries; be it resolved that the Canadian Good Roads Association urge upon the Dominion government and the provincial governments co-operative action to bring about the early planning of the Canadian Highway.

"5. Resolved that this Canadian Good Roads Association, in convention assembled, hereby records its endorsation of the granting of aid to good roads by the Federal government, and its belief that the impetus given to highway building and the consequent betterment of living conditions will amply warrant the course which the government and parliament of Canada have taken in this respect.

"6. Resolved that this association tenders its hearty thanks to the various provinces for their contributions to assist in carrying on the work of the Canadian Good Roads Association, and further, that this association now in convention requests that the incoming executive be instructed to continue its efforts for the securing of an adequate grant from the Federal government through the Dominion Highway Commission, this contribution being absolutely essential if the association is to continue its educational work for good roads."

Discussion of Resolutions

A lengthy discussion followed the presentation of this report. Resolution No. 1 received feeble support and was severely criticized by many of the members present, who were of the opinion that the Canada Highways Act is now sufficiently elastic, as orders-in-council can be secured to authorize construction by day labor, when it appears that such policy is in the public interest.

Hon. S. J. Latta, of Saskatchewan, explained that the resolution was meant to cover small work on which it would not pay to draw plans and specifications and call for tenders. It was pointed out, however, that while this might be the object of the resolution, if the amendment requested by the resolution were to be adopted by the government, it would open the door to the performance of all highway work by day labor. Mr. Latta disclaimed responsibility for the resolution and said that it had been introduced to the committee by the Hon. F. C. Biggs, minister of highways of Ontario. Mr. Latta declared that after hearing the discussion on the resolution, he was no longer in favor of it. The resolution was tabled.

There was no opposition to the second resolution, advocating that bridges be considered as part of the highway to be aided by the Federal government, and it was unanimously adopted.

Some of the delegates from rural municipalities opposed the third resolution, stating that it would create a monopoly for the engineering profession. Although the engineers who were present refrained from taking part in the discussion, it was conceded by most of the members that it is as wise to engage a qualified engineer to do engineering work, as it is to summon a physician when one is ill, or for a lawyer when in court.

"Canadian Highway" Debated

There was a marked division of opinion in regard to the fourth resolution, President Squire and Wm. Findlay, of Toronto, leading a strong opposition to the resolution. Some of the members urged that a national highway be planned at once, whether it is built right away or not, but it was decided that the Canadian Good Roads Association cannot support the idea of a national highway. It was declared that the association's work consists entirely of the promotion of roads that will increase production and improve living conditions, and that it is impracticable for the association to support the idea of a motor road from Victoria to Glace Bay. Many of the speakers declared that it was not the aim of the association to make it possible for a man to get into his automobile at Sydney and motor at high speed by the shortest possible route to Victoria. The aim is to spend the financial resources that are available in this country for road-building purposes on highways that will build up the community life of the nation, and that will gradually link together to form not one but numerous routes both from east to west and from north to south. The resolution was referred to the incoming executive for further consideration, but this did not satisfy many of its opponents and the matter was again opened, and upon further vote being taken the resolution was killed without any reference to the executive committee.

The fifth and sixth resolutions were carried unanimously.

Wm. Findlay, of Toronto, presented the report of the nominating committee. It was unanimously adopted by the meeting, resulting in the election of the following officers for the ensuing year:—

President, A. E. Foreman, chief engineer, department of public works, British Columbia; first vice-president, Dr. E. M. Desaulniers, M.L.A., Montreal; second vice-president, Hon. S. J. Latta, minister of highways, Saskatchewan.

Advisory Committee.—U. H. Dandurand, Montreal; W. A. McLean, Toronto; B. Michaud, Quebec; J. A. Duchastel de Montrouge, Outremont, Que.; S. L. Squire, Toronto; A. F. Macallum, Ottawa.

Directors.—J. R. Douglas, president Montreal Automobile Club of Canada; L. J. Tarte, Montreal; Hon. F. C. Carrel, Quebec; Mayor Gale, Vancouver; S. R. Henderson, president of the Good Roads Association, Manitoba; Captain Lucius Allen, president Good Roads Association, Ontario; G. Fred Pearson, president Good Roads Association, Nova Scotia; W. Findlay, Toronto; C. R. Wheelock, honorary president Ontario Good Roads Association; Russell T. Kelly, Hamilton; H. S. Carpenter, deputy minister, department of highways, Saskatchewan; A. M. Rankin, M.L.A., Ontario; T. P. Regan, president New Brunswick Automobile Association; H. H. Shaw, president Prince Edward Island Good Roads Association; L. C. Charlesworth, deputy minister of public works, Alberta; and the presidents of the provincial motor leagues and automobile associations.

Mr. Squire requested the newly-elected president, A. E. Foreman, of Victoria, to take the chair. Mr. Foreman briefly thanked the members for the honor which they had bestowed upon him and his province in electing him to the presidency. He was followed by Dr. Desaulniers and the Hon. Mr. Latta, who both declared that the new president would have their heartiest co-operation throughout the coming year.

Invitations were presented from St. John, N.B., and Vancouver, B.C., for the eighth annual convention. It was decided to refer these invitations to the incoming executive, although it was generally believed that it would be advisable to hold the next convention in the Maritime Provinces on account of this year's convention having been in the mid-west, with the likelihood that in 1922 the association will meet on the Pacific Coast.

City Treasurer Bell, of London, Ont., strongly advocates a scale of fees in connection with the issue of building permits. At present this service is free.

The Ontario Cement Co., recently organized, has taken over the assets of the Ontario Portland Cement Co., of Brantford. Prospects for cement companies are reported to be splendid.

At a session of the International Deep Waterways Commission held in Hamilton, Ont., recently, the claims of that city for recognition as a future ocean port were forcefully presented. Attention was called by the local harbor board to plans which provide for a twenty million dollar expenditure on the bay front. Hamilton at present handles 125,000 tons annually of steel, pig iron and agricultural implements over its docks and also 7,000,000 ft. of lumber. With the completion of the Welland Canal, shipments of coal and ore will increase and the added tonnage is expected to reach a million and a half tons. Exports shipments from this city overseas in 1919 amounted to $20,000,000. It was emphasized that the construction of a deep waterway to the sea and the development of electric power in the St. Lawrence would enormously increase the city's development. Natural products of Hamilton and contributary territory are in quantity 1,395,593 tons and in value $54,476,300 while manufactured products show a total of 584,494 tons and a total value of $191,302.

The Engineer's Library

RELATION OF FORESTS TO HYGIENE

REVIEWED BY R. O. WYNNE-ROBERTS
Consulting Engineer, Toronto

FORESTS, WOODS AND TREES IN RELATION TO HYGIENE—By Prof. Augustine Henry, Dublin. London: Constable & Co. Cloth; 6 by 8½ in.; pp. 305; 18s.

This volume is an addition to the Chadwick Library, named after Edwin Chadwick, a distinguished sanitarian. As the author states in the preface, the book was written in an effort to interest the statesman, the student of economics, the engineer, the physician and the layman, as well as the forester. The author sets out to describe the influences of forests and trees on climate, flow of water, erosion of soil, shelter from wind, purity of air and water, etc. Such influences affect directly the health and comfort of man.

Afforestation should be a most vital problem of the hour in Canada, because the country is destined to be one of the principal suppliers of lumber for different purposes to other parts of the world. The report of evidence submitted before a special committee at Washington indicates the importance of our lumber resources, and pulpwood supply from Canada may some day constitute a political issue of importance.

Apart from the questions of supply of lumber, which should warrant careful consideration on the part of our statesmen, there is the matter of conserving the health of the people, the afforestation for the shelter of stock and the preservation of the amenities, which are valuable assets of the nation. Prof. Henry points out that Bosnia, with its forests, has a summer temperature four degrees F. cooler than Herzegovina, which is denuded of trees.

When we consider forests in relation to water supply, we are confronted by theories and arguments advanced by different authorities which are difficult to reconcile. The author points out that forests retain snow and prevent it melting quickly, thus retarding the stream flows, minimizing floods and equalizing the passage of underground water. M. O. Leighton, of the United States Geological Survey, is quoted as contending that, during the last twenty to thirty years, there has been increased flooding in the tributaries of the Ohio River, due to constant and rapid deforestation. Similar views are held by Messrs. Hall and Maxwell, of the United States Forest Service.

On the other hand, Prof. Daniel W. Mead, in Bulletin 423 of the University of Wisconsin, expresses the view that, so far as Wisconsin is concerned, deforestation had no material effect, either favorable or adverse, on the flow of streams.

The author contends that the effect of forests is to depress the underground water level. For example, in the forest of Mondon, near Nancy, in France, the underground water stands relatively 12 in. lower than in the neighboring cultivated lands.

The afforestation of water catchment areas is becoming more and more recognized as a means of preserving the purity of the water, and also as an investment. The United States Department of Agriculture reports that a forest furnishes the best possible cover for watersheds. For this reason, fully as much as for the financial one, several water companies and authorities are planting extensively in the eastern States.

The relation between the British government and the municipal corporation appears to be one worthy of consideration in Canada. The treasury provides the money necessary for planting trees, while the corporations give the land and pay the expenses of management. In this partnership the produce of the forests will be ultimately divided between the two parties in proportion to the capital invested by each. One advantage of the arrangement is that the work of reforestation proceeds uninterruptedly, whereas, if the work was solely in the hands of the municipalities, it would be more sporadic.

The volume under review largely deals with conditions as they obtain in the British Isles, but the same information is illuminating as to what could be done in Canada and elsewhere. A large amount of work has been devoted by the author to collecting and assimilating the data.

DETAILS OF HIGHWAY CONSTRUCTION AND MAINTENANCE IN CONVENIENT FORM

REVIEWED BY GEO. HOGARTH
Chief Engineer, Department of Public Highways, Ontario

HIGHWAY INSPECTORS' HANDBOOK—By Prevost Hubbard, U.S. Bureau of Public Roads. New York; Wiley & Sons; Flexible "Fabrikoid"; 4¼ by 7 in.; pp. 372; 55 figures; $2.50.

Efficient inspection of highway construction by properly-instructed and capable men is necessary in order that the specifications may be properly interpreted and so applied that sound satisfactory and faithful work may be secured.

Mr. Hubbard has, in this handbook, presented the duties of the inspector and the essential details governing the inspection of sand, stone, cement and bituminous materials, together with the requirements of proper construction and maintenance for sand-clay, gravel, broken stone, brick and block, concrete, bituminous concrete and sheet asphalt roadways. The main details of inspecting miscellaneous work and materials are also given and include bituminous expansion joints, paving adjacent to car tracks, cold patching, pipe culverts, concrete structures, metal reinforcing, dust preventives, mensuration, field equipment for testing and sampling, records and reports and cost data.

Information as to sampling, tests, uses, quality and adaptability of the various kinds of stone used for highway purposes is concise. The classification and field tests of gravel sand and clay, will be found useful. The testing of Portland and natural cements is explained in detail. Full data are given on the use of bituminous materials, dust preventives, carpeting mediums, seal coating materials, bituminous cement, bituminous fillers, and bituminous aggregates and their manufacture, method of shipment and proper use explained. The various kinds of petroleum and asphalt products, and their adaptability to different works, are explained in detail with the proper methods of use. Tar products, liquid and semi-solid, pitch fillers and creosoting oils with methods of sampling, testing and payment, are given in detail, and an exhaustive description of laboratory tests with data on interpretation and value of results, will be found useful.

The inspection instructions covering the actual construction and maintenance of sand-clay roads, gravel roads with the use of sandy gravel, or clay gravel and macadam roads, emphasize the essential methods which must be followed to secure results. Bituminous surface treatments are explained and the use of dust preventives and maintenance of the surface of such roads clearly defined. Bituminous macadam, both as to methods of construction and materials used, is fully covered.

Extensive data on concrete foundations, concrete pavements, bituminous concrete and sheet asphalt pavements with a complete chapter on bituminous paving plants, will be found of value by those engaged in paving.

Brick and block pavements with points needing inspection, and the requirements of wood block paving, completes the chapters dealing essentially with paving. Miscellaneous inspection of details connected with paving and highway work, such as bituminous expansion joints, paving near car tracks, culverts, concrete structures, mensuration and useful typical specification requirements, complete the book.

As a concise, practical and complete handbook of present practice this work will be found of interest to the contractor, inspector, designer and engineer engaged in constructing or maintaining modern highways.

HIGHWAY BRIDGES AND CULVERTS*

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

WHEN should a bridge be built, and if it should be built at all, how large should the opening be? These are the most difficult of the problems to be solved in connection with any bridge project.

It is evident that a bridge must effect some real saving to economically justify its construction. This saving may be one of distance over which loads must be hauled, or persons must travel, or it may be a saving effected by an increase in the size of the load which may be hauled, due to its construction. As it costs about 35 cents per team-mile to haul a load, it is seen that the money in cents which can be spent on a bridge in order to save distance is thirty-five times the team-mile saved. For example, if the construction of a bridge will save a haul of five miles to five persons who have forty loads to send to market each year, the total justifiable yearly expenditure would be $350. On a wooden bridge this would justify the expenditure of about $2,500, or on a permanent bridge of about $4,500. Likewise, when the cost of auto traffic is 15 cents per mile, a saving of two miles for an average traffic of four cars per day for 200 days per year would effect a yearly saving of $240, or, taking the two suppositions together, an annual saving of $570, which would justify the expenditure of $8,000 on a bridge lasting thirty years. The amount of justifiable expenditure due to a saving effected by an increase in the weight of the load which can be hauled by the construction of the bridge will also vary as the traffic, and, when the amount of the traffic is known, the economical expenditure can be ascertained.

This, however, is only the economic side, and is, perhaps, not so important as the social or sentimental side, which cannot be estimated in concrete units, but must remain a matter of judgment or sentiment. The economic consideration is, however, generally the one on which the engineer must base his decision. Sometimes, however, neither economy nor sentiment is the deciding factor, but vested rights or orders of courts may compel the construction of a bridge.

Determination of Clear Opening

The determination of the area of waterway required is quite often a difficult matter. Various methods may be employed for finding this approximately. It may be found, (1) by a consideration of the manner in which the present structure (if one already exists) has fulfilled its duty; (2) by the evidence of men who are acquainted with water conditions at the proposed bridge site; (3) by an examination of water levels as shown on the surrounding objects; (4) by an examination of run-off data supplied by the Hydrometric Survey; (5) by an examination of rainfall data supplied by the Meteorological Service; (6) by means of a formula; (7), and best of all, by means of one or several of these methods and common sense.

Where there are existing structures the problem is somewhat simplified, but not solved. On small creeks there is a tendency to under-estimate rather than over-estimate the size of waterway required, especially if some years have elapsed since a season of heavy run-off. Where only temporary structures are being placed, this is, perhaps, not so important, but where the structure is to be a permanent one, care must be taken that the area is sufficient to provide for the greatest run-off which may take place. Too much dependence cannot, then, be placed on the size of the existing structure, but information must be obtained as to the area required under greatest flood conditions. If a structure has successfully passed all water for a considerable number of years, including years of excessive run-off, we know that it is at least large enough, and information must be obtained as to actual flood conditions in order to determine whether or not the waterway area can be reduced, should this reduction prove economical. On the other hand, on large streams the high-water mark has a tendency to move up a little beyond where the other man saw it. If definite marks of flood-water elevation recorded by men living in the vicinity at the time of flood can be obtained, these are generally to be depended upon. From cross-section measurements of the valley and known flood elevations the area of the required waterway can be estimated.

Ascertaining Maximum Run-Off

The use of water marks on surrounding objects is not a very accurate method of determining flood-water elevations. If a few years have elapsed since the season of heavy run-off, these marks may have been entirely obliterated, and any marks found be quite misleading. They are really only one indication to assist in determining the area required. The most valuable and dependable records of all are those supplied by the Hydrographic Survey, where these go back a sufficient number of years. Unfortunately, these records cover comparatively few streams, and on most streams cover only recent years. They do, however, form a valuable guide in determining the run-off on streams other than the ones which are covered by their records. While not numerous, the Hydrometric stations are fairly well distributed and the run-off of typical streams in various parts of the country has been recorded. Knowing the maximum run-off, the drainage area and the type of country constituting the drainage basin, it is a simple matter to arrive at an estimate of the discharge of a stream of similar drainage basin. This estimate will be of assistance in determining the proper waterway. As an example, from the discharge record of the Valley River for 1913 (a year of heavy run-off in this portion of the country), the maximum discharge is found to be 3,500 cu. ft. per sec. The discharge, divided by the mean velocity of 4 ft. per sec., gives the area of the required waterway, and this, divided by the drainage area of 1,028 sq. mi., gives as the waterway required an area of .85 sq. ft. per sq. mile of drainage basin for this particular stream. Knowing the drainage area of a similar stream, and multiplying this area in square miles by .85, would give some idea of the area of waterway required for this stream. The Valley River rises in the southerly slopes of the Duck Mountains, and runs fairly rapidly to Lake Dauphin, the discharge fluctuating rapidly. From a similar record of the Rat River, which flows through a comparatively level country, the discharge is found to be 1,030 cu. ft. per sec., mean velocity 1.63 cu. ft. per sec. and drainage area 650 sq. mi., requiring a waterway of .98 sq. ft. per sq. mi. of drainage area.

It is important to know that the records cover greatest flood periods, and an accurate knowledge of the drainage basins is necessary. The drainage area of the larger streams can be ascertained from present maps with sufficient accuracy, but sufficient topographic information is not always available to apply this to smaller streams. The Topographical Surveys' Branch is, however, undertaking to secure information which will be very valuable for future studies along this line. A study of the records of the Meteorological Service will also guide the judgment in selecting a proper area of waterway. Reasoning from one drainage basin, where total maximum precipitation and maximum percentage of run-off are known, to a similar drainage basin for which meteorological records can be obtained, a comparative estimate of the maximum run-off of this basin can be made. There are also a number of formulas which can be applied under certain conditions to drainage areas that are useful also as a guide to the judgment. With the exception of the testimony of dependable observances of flood conditions and the actual record of the Hydrometric Surveys, the various methods mentioned serve only as guides for the judgment in selecting a proper waterway, and all must be applied with common sense.

Selection of Type of Structure

In selecting the type of structure three factors will influence this choice, viz, economy, service and appearance, and of these the first two will generally, but not always rightly, be the deciding factors. It is impossible to estimate the value of the æsthetic in design, and, as this value cannot be expressed in concrete symbols, it is frequently not understood,

*Read before Seventh Canadian Good Roads Convention, Winnipeg, June 1st-3rd, 1920.

and, consequently, beauty of appearance is not given full value in deciding on the type of structure. It is a question as to how much additional money should be spent in order to achieve a pleasing appearance. The cost of a bridge is, however, soon forgotten, but an unsightly bridge cannot be forgotten, for it remains as a constant unpleasant jar on the senses.

Determining True Economical Type

In selecting the most economical type of bridge, first-cost, upkeep and value of non-interruption of traffic must be considered. The timber structure is in about every case the cheapest in first cost, but in the long run it does not generally prove to be as cheap as steel or concrete. A wooden pile bridge, if suitable for the site, is no doubt the cheapest bridge in direct cost. For example, a 50-ft. pile bridge will cost to-day about $1,500. Allowing 6% interest, a yearly payment of $270 would be required to keep this bridge in condition, made up as follows: Flooring to be renewed every three years, first cost $270, yearly payment for three years $101; stringers to be renewed every six years, first cost $270, yearly payment $55; remainder of bridge to last twelve years, first cost $960, yearly payment $114; total yearly cost $270. Indirect costs, such as delay to traffic during repairs, loss of traffic through neglect of repairs, liability to accident or fire may run the total cost far beyond the direct costs. At best, the pile bridge is very unsightly and only to be considered where first costs are of prime importance, as they sometimes are.

Comparison of Timber, Steel and Concrete

In many cases stream conditions are such that it is not permissible to have piles in the stream bed and a clear opening of long span is required. The type of structure may then be a choice between a wooden span, a steel span or a concrete span. Unless the wooden span is to be placed on piles, which, in many cases, is not feasible, the cost of the substructure for the three types will be about the same, so that it will only be necessary to compare the relative costs of the superstructure. Again selecting a 50-ft. span for comparison, and assuming wooden flooring to be renewed every three years, wooden stringers to be renewed every six years, painting wood and steel to be carried out every four years, the life of concrete and steel to be over 30 years and the life of a wooden truss to be 15 years, we have the following relative costs:—

First Costs

Wooden Truss—	$1,240
12,400 ft. b.m. timber at $100 per M.	450
3,000 lb. steel at 15c. per lb.	250
Painting	
	$1,940
Steel Bridge—	$2,772
17.6 tons steel at $220	368
4,600 ft. b.m. timber at $80	
	$3,140
Concrete Bowstring—	$2,380
68 cu. yd. concrete at 35c. per cu. yd.	1,160
11,600 lb. steel at 10c. per lb.	370
1,850 sq. ft. mesh at 20c. per sq. ft.	
1,000 lb. structural steel (bearings, etc.), 20c. per lb.	200
Crosby clips and handrail	200
	$4,310

Yearly Costs

Wooden Truss—	
Flooring, 2,800 ft. b.m. at $80, cost $224, yearly payment based on three-year life	$ 84
Stringers, 3,200 ft. b.m. at $80, cost $256, yearly payment based on six-year life	54
Remainder of bridge $1,210, yearly payment based on fifteen-year life	125
Yearly cost of painting every four years	72
Total yearly cost	$ 335
Steel Truss—	
Timber, 4,670 ft. b.m. at $80, cost $374, yearly payment based on three-year life	$ 140
Yearly payment on steel truss for 30 years (cost $2,772)	201
Yearly cost of painting every four years	36
Total	$ 377
Concrete Bridge—	
Yearly payment on concrete bridge for 30 years (cost $4,310)	$ 311

It thus appears that the concrete superstructure, for spans of this length at least, is cheaper than either wood or steel. It must also be noted, in the case of steel and concrete bridges, that at the end of thirty years the bridge is paid for and the yearly payments cease (except for the repairs on the steel bridge), while in the case of the wooden bridge the yearly payments still go on.

Each Bridge a Special Problem

For bridges of any size it is impossible to make any general statement that one class of bridge is cheaper than another, as every bridge is a problem in itself, and the foregoing is given as an example of a method of obtaining relative costs. The question of the nature of the foundations, cross-section of the stream-bed, condition of stream flow, waterway required, availability of materials, relative cost of materials, relative costs and availability of labor, relative cost of substructure to the superstructure, ice conditions and economical and suitable length of span must be taken into account when deciding which is the economical bridge. Wooden bridges are confined chiefly to two types, the pile trestle and the Howe truss. For steel bridges of clear span of 30 ft. or under, simple stringer spans are cheapest; from 30 ft. to about 45 or 50 ft., plate girders; from 50 ft. to 80 or 90 ft., low or pony trusses; 400 or 500 ft., trusses with subdivided panels; beyond this, cantilever or suspension bridges, with steel arches, coming in any place in the list.

Every concrete bridge is a study in itself. In Manitoba there have been constructed, or are under way, slab and girder bridges up to 30-ft. span, through griders up to 50-ft. span, barrel arches up to 100-ft. span, open-spandrel arches up to 60-ft. span, through arch or rainbow type up to 90-ft. span and bowstrings up to 90-ft. span. These are, however, only given as an example of different types of concrete bridges.

In appearance the concrete bridge can be made to surpass any other kind of bridge. It can be poured into any form, and beauty must lie in its lines and not in any ornamentation. It offers an opportunity for its designer to give to his country a structure that will be a constant pleasure to beholders, and which will be in mind long after the cost is forgotten. There is still another strong argument for the use of concrete, and it is that the materials used in the making of concrete are almost without limit. The time when our timber will be exhausted can be foreseen. Iron ore is limited and can never be replaced.

Types and Relative Costs of Culverts

Coming to the small but important culverts, there are, in general, four types in common use: First, wooden culverts; second, steel or iron culverts; third, concrete pipes; and fourth, concrete culverts cast in place. The wooden culvert is undoubtedly the cheapest, but the objection to this is that it is out of commission or unsafe about 101% of the time. In point of cost, concrete pipe culverts come next. These, however, must be placed where no water will freeze in or around them, and they must have a good, solid bed. Considerable saving has been effected in Manitoba by the use of concrete pipe, and the results have been quite satisfactory. The cost of manufacture last year ran about as follows:—

10-in. diameter	36 cents per lin. ft.
12-in. "	45 " " "
15-in. "	50 " " "
18-in. "	83 " " "
24-in. "	$1.22 per lin. ft.
30-in. "	1.75 per lin. ft.

The breakage in handling ran about 1%.

Corrugated steel or iron pipes have been used extensively where lack of suitable materials or labor prevent the making of concrete pipes. These can be laid in places where it would not be suitable to lay concrete pipes. We have also used semi-circular reinforced concrete culverts cast in place with success. These cost about the same as the corrugated iron pipes. We seldom use pipe culverts of over 30-in. or 36-in. diameter. Above that we advocate reinforced concrete box culverts.

Careful Designing Necessary

All bridges should be designed by competent engineers. The design of ordinary steel bridges is so well standardized that there is very little difficulty in getting a suitable bridge after the loads that it may be called upon to carry have been decided upon. The fixing of the proper loading will require careful study, but in the end it must remain largely a matter of judgment. The tendency up to the present has been to increase the weight of loads carried on highways. Many bridges have been discarded recently owing to the fact that they were not heavy enough for present traffic. In western Canada, the heaviest likely load appears to be a large tractor. In Manitoba, we design our floor system for a tractor load of 18 tons, plus 30% impact, and our trusses for this tractor, or a load of 100 lb. per sq. ft., whichever produces the greater stress. The tendency appears towards lighter tractors, rather than towards heavy ones. Before these bridges are worn out, however, some of them may be called upon to support heavy truck loads, but it is doubtful if these will ever exceed 18 tons.

The design of the foundation is most important. The bearing power of different soils varies so greatly, and similar soils vary so greatly under different conditions, that careful examination must be made of the soil in order to properly design a foundation. It is a strange fact that there are probably less data on the variable factors in the behavior of soils than on most other materials of construction, and, therefore, the assumptions made in the design of foundations is largely a matter of experience and judgment.

The design of reinforced concrete structures is not so well standardized as the design of steel bridges, and structures should not be considered which have not been designed by a competent and experienced engineer.

Importance of Close Inspection

Proper construction is just as essential as proper design. Great care must be taken in the selection of the material. For steel bridges the material rolled by steel mills is so nearly standard that for ordinary bridges there need be no hesitation in accepting structural shapes. But in order to eliminate poor field riveting, enlarged rivet holes made by drifting in erection, and other faults which may produce stresses for which no provision has been made, all shop work should be carefully inspected before the material is shipped to the job.

In reinforced concrete work the inspection must be more rigid. The cement should be subjected to standard tests before it is used. The making of cement is a delicate process, and any one of several factors entering into its manufacture may cause a variation in the product. Especial care should be given in the selection of the aggregates; these must be well graded and absolutely clean. It is probable that more failures occur through the use of improper aggregates than from any other cause. The water used must be clean and just the right proportion used. Prof. Abrams has shown that the proportion of water to cement is one of the big factors affecting the strength of concrete. The amount of water used should be just enough to make a workable mix, and any greater proportion of water rapidly decreases the strength of the concrete. There is only a certain amount of water required to cause the setting up of the cement, and it is quite evident that any amount beyond this, when it has dried out, leaves voids in the concrete.

The inspection of the steel is also very important, not only to discover quality, but to ensure that the bending is done according to plans. It is a common idea that any sort of steel will do for concrete reinforcing, but such is not the case. This steel is designed to take its share of the stress fully as much as the steel in a steel bridge. It must occupy the exact space it is designed for, otherwise it is of no use in the structure. For this reason the bends shown in the plans must be strictly observed.

Care in Construction

It is also important to have experienced contractors for concrete work, and inspection of construction is just as important as inspection of the material. This inspector must be a man who knows his business better than the contractor, and who has sufficient tact and judgment to get the work properly carried out without undue hardship to the contractor. It is a mistaken idea that any person will do for an inspector.

The form work is very important in concrete work, as it must be strongly built to withstand the pressure which will come upon it. It must also have a smooth surface, for every flaw in the forming shows up in the finished structure. Careful ramming of the concrete is necessary in order to make a dense concrete, to prevent voids forming next to the forms, and to ensure a close bond between the concrete and steel.

In these days of specializing, transportation is second in value only to production, and only within the last few years have most people realized the vital part that the road plays in our transportation system. At a time of shortage in the prime necessities of life, when the world teeters between enough and starvation, our market highway system is of greatest importance. The bridge is the important link in this system. Nominally, the bridge serves to carry water under a road or traffic over the stream. Actually, its possibilities are unlimited. Its existence may mean a supply of food to a starving being on another continent, or the difference between life and death to a sick one, or the difference between hope and despair to a toiler. Its appearance may be the cause of pleasant fancies, or it may be the cause of a feeling of repulsion. Let us, therefore, in our bridge work, do what we can to cause pleasant thoughts and create pleasant memories, and in this work, as in all our highway work, build well.

MONEY SPENT ON HARBORS SINCE CONFEDERATION

A RETURN recently tabled by Hon. A. L. Sifton in the House of Commons, sets forth the amount of money spent on the different harbors in Canada since Confederation, as follows:—

The Department of Marine and Fisheries, to December 31, 1919, had expended through harbor commissions the sums of $28,785,308 at Montreal and $10,809,807 at Quebec. Nothing was spent in this way at Vancouver.

The Department of Public Works spent the following amounts:—

Halifax, $75,569.64. Terminal facilities at Halifax were paid for by the Department of Railways and Canals.

St. John, $14,636,146.93.

Quebec, $12,060,263.92, including Louise Basin, two graving docks and St. Charles River works.

Montreal, $5,978,324.73.

Toronto, $6,014,259.76.

Port Arthur, $4,078,457.15.

Hamilton, $587,336.98.

Fort William, $8,790,408.65.

Victoria, $6,928,919.10.

Vancouver, $4,410,450.49.

The Intercolonial Railway expended the following sums at Halifax and St. John:—

Dredging at St. John, $28,584.05.

Wharves at St. John, $457,807.02.

Wharves at Halifax, $1,453,948.59.

Dredging and blasting rock at Halifax, $128,896.99.

Removing boulders, Halifax, $11,453.21.

Ocean terminal docks, Halifax, $6,799,235.71.

Total I.C.R. expenditures for both harbors since confederation, $8,879,927.57.

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PRINCIPAL CONTENTS

ADMINISTRATIVE AND COMMERCIAL EMPLOYMENT FOR ENGINEERS

MANY a young engineering graduate has felt that the acceptance of a position involving other than purely technical work amounted to an admission of defeat, an acknowledgment that he had made a grievous error in spending years acquiring a training that would be entirely worthless for administrative or commercial pursuits.

No greater mistake in attitude could possibly be made. Fortunately, as time passes, fewer and fewer technically-trained men hold the view that in forsaking the technical they are casting loose from their moorings to voyage an unknown and perilous sea. Increasing numbers are frankly entering upon employment that has a large commercial, and but small technical, content. The percentage of graduates of engineering colleges occupying administrative and commercial positions is rapidly increasing. It is an indication of the changing attitude of the technical graduate to business, and no less of the changing attitude of business to the technical graduate.

There is every reason that the technically-educated young man should consider executive and managerial work within his scope as much as the design of a turbine runner or the spacing of the rivets in a girder flange. He is trained to precision, to the getting of things done when and as scheduled without friction or fuss. That is the great essential in management, and the training that fits a man to successfully carry out engineering enterprises fits him quite as well to direct undertakings of a non-technical character. Often, besides, there are many technical aspects to a business, as in manufacturing, where machinery and processes play a fundamental part. In such a business, a broadly-trained and adaptable engineer finds himself very soon at home.

The direction of many non-revenue producing organizations is also peculiarly within the sphere of the engineer. An instance of this is the management of civic affairs into which the construction and operation of engineering works largely enters. Of the one hundred and twenty-five city managers in the United States, the greater number by far are engineers. It is fitting that this should be so. The engineer is by training and outlook especially qualified to undertake such work.

The engineering colleges and faculties of applied science are aware of the broadening prospects for the technical graduate and are fashioning courses accordingly. Nearly every institution of the kind now carries in its curriculum several subjects of instruction primarily intended to fit the young engineer to grapple effectively with administrative and commercial problems. Executive and managerial employment is now considered as quite as legitimate for the engineer as the location of a transcontinental railway or raising the efficiency of the internal-combustion engine.

RARE OPPORTUNITY FOR WATER WORKS ENGINEERS AND OFFICIALS

NOT for thirteen years have the water works engineers and officials of Canada had such an opportunity for conference and discussion as that which offers in Montreal next week when the American Water Works Association gathers for its fortieth convention. From the final program, which appears on another page of this issue, it is evident that no effort has been spared to make the meeting one of instruction and pleasantness for all. Attention will be given not only to the broad aspects of water works planning, but to many technical details and features of operation on which enlightenment is being constantly sought by those who have to grapple with the problems of water supply. The opportunity to hear matters of this kind discussed by many of the leading water works experts of the continent is one that should not be missed. The exhibits and the visits to plants in operation promise to supplement discussion and conference effectively, so that there is no side of water problems overlooked. Next week, June 21st to 25th, should be set aside for a trip to Montreal by all those who have to do with water works, even at the cost of some temporary inconvenience. It will be ultimately profitable to do so.

TWO MEN WHOM ENGINEERS HONOR

DOWN in Terre Haute, Ind., a water-works employee named Shepherd entered a gas-charged vault to make a reading. In five minutes he was lying unconscious with his face against the side of the vault. Frank Johnson, the foreman, fully aware of the danger, leaped into the vault and, with the aid of three men who had come up, succeeded in getting Shepherd through the narrow manhole to fresh air and life.

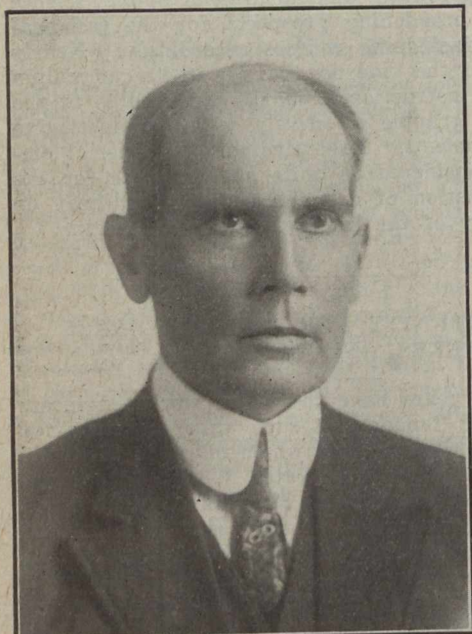
But now, Johnson, in turn had been overcome and lay senseless at the bottom of the vault. A few minutes there meant certain death for him. Then, Daniel Boyer, a switchman, sixty years of age, clambered into the vault, fastened a chain about Johnson's chest and climbed out. The chain became unhooked when tension was put upon it. Again Boyer descended into the vault and this time fastened a rope securely under Johnson's arms, all but losing consiciousness in the act. Johnson was hurried to a hospital in an unconscious condition and ultimately recovered.

These are men such as engineering relies upon, and not in vain, for the actual physical carrying out of great and hazardous undertakings.

Engineers in Ontario should set aside September 16th, 17th and 18th and let no circumstance encroach upon these dates. The Ontario Professional meeting of the Engineering Institute of Canada is to be held at "The Clifton," Niagara Falls, Ont., on these days.

PERSONALS

J. ANTONISEN, who was recently appointed city engineer of Port Arthur, Ont., after having been in private practice for the past six years, was born in 1869 in Christiana, Norway, and received his preliminary education at the Latin High School in Bergen, Norway, graduating in 1887. After working for a year in a shipbuilding plant in Bergen, he emigrated to the United States, where, during the following six years, he acquired some practical experience in civil engineering projects, particularly in water power developments. In 1894 he returned to Norway and studied mathematics for a year and then entered the University of Dresden, where he graduated four years later in civil engineering. After graduation Mr. Antonisen was employed for two years as an assistant engineer on the Saxon government railways, and was then transferred to the department for improvement and regulation of rivers, where he was employed for four years. In 1904 he came to Canada and entered the employ of the Canadian Pacific Railway Co. in Winnipeg as terminal engineer. The following year he was appointed city engineer of Port Arthur, and subsequently was also appointed general manager of the public utilities of that city. In 1911 Mr. Antonisen resigned his positions at Port Arthur, and the following year he was appointed city engineer of Moose Jaw, Sask. After a year at Moose Jaw he accepted a position as superintendent of the municipal railway at Brandon, Man., but in 1914 resigned from that position and returned to Port Arthur, where he has since been in private practice. He was recently re-appointed city engineer of Port Arthur, succeeding L. M. Jones, who resigned in order to accept an appointment as resident engineer at Toronto for the Warren Bituminous Paving Co. of Ontario, Ltd.



CHARLES CAMSELL, of Vancouver, B.C., has been appointed to succeed R. C. McConnell, retiring deputy minister of mines for Canada.

PROF. J. S. DE LURY, of the University of Manitoba, will represent the mining industry on the bureau of industrial research to be set up by the government of Manitoba.

F. M. SYLVESTER has resigned his position as general manager of the Granby Consolidated Mining, Smelting and Power Co. It is understood that he will enter private practice as a consulting civil and mining engineer in British Columbia.

COLBORNE P. MEREDITH has resigned from the Ottawa Housing Commission to enter private practice with Franklin E. Belfry, under the firm name of Meredith & Belfry. Mr. Meredith has been architect member of the commission for two years.

J. J. MCARTHUR, of Ottawa, has been appointed as a commissioner to "define and mark the boundary line between the United States of America, and the Dominion of Canada, with the exception of that portion of it extending from the 45th parallel of north latitude through the St. Lawrence River, the Great Lakes and connecting waterways to the mouth of the Pigeon River."

S. J. CHAPLEAU, resident engineer, Public Works Department, Ottawa, has been appointed to act as representative for Canada on the board of control recommended by the International Joint Commission, for the construction of compensating works in St. Mary's River by the Michigan Northern Power Corporation and the Algoma Steel Corporation. Mr. Chapleau will act on the board of control during the absence in Europe of W. J. Stewart, who was formally appointed, in June, 1914, as Canadian representative.

JAMES GOVAN, architect for the provincial secretary's department of Ontario, has been granted a month's leave of absence to proceed to New Mexico and assist the authorities of that state in devising plans for the building of reformatories similar to the one at Burwash, utilizing prison labor for the purpose. Mr. Govan has been eight years in the service of the provincial government. During that time he was associated in an important capacity with the work of the Guelph reformatory, of which John M. Lyle was architect, and had entire charge of the design and construction of the fine group of buildings constituting the asylum for the insane at Whitby. The state of New Mexico had heard of Mr. Govan's excellent work and made a request for the loan of his services. Mr. Govan is a member of the advisory committee of architects of the United States.

OBITUARIES.

GEORGE BAKER, a railway contractor of St. Thomas, Ont., died on June 13th, aged 77 years.

JAMES FRANCIS WHITSON, commissioner of the Northern Development branch department of Lands and Forests, Ontario, died suddenly at Sudbury on June 12th. Mr. Whitson, who previously had been assistant director of surveys for some twenty years, was appointed eight years ago to the position which he held at the time of his death. During his tenure of office as commissioner he was responsible for the expenditure of several million dollars on northern development, chiefly on colonization roads. The territory covered by him extended from Manitoba to Quebec and from the Ottawa River to James Bay. Mr. Whitson was a past-president of the Ontario Land Surveyors' Association.

RICHARD MARPOLE, general executive assistant for the C.P.R. in British Columbia died at Vancouver on June 8th, aged 70 years. In 1881 Mr. Marpole was appointed to the position of assistant manager of construction of the Algoma branch, Nipissing division of the main line, C.P.R. Later he became superintendent of construction and operation of the Lake Superior division, and in March, 1886, he was transferred to the Pacific division in the same capacity. The recognition of his ability gradually won for him the position of general superintendent of the Pacific division, which office he held with great success until 1907, when he was appointed to the position which he held at death.

KENNETH WILLIAM BLACKWELL, vice-president of the Canadian Steel Foundries, Ltd., and past-president of the Engineering Institute of Canada, died at his residence in Montreal on June 11th. Mr. Blackwell was born in England nearly seventy years ago, and was one of the founders of the steel-casting industry in this country. He was vice-president of the Merchants Bank of Canada and a director of several prominent business concerns. Mr. Blackwell's first position of responsibility came in the Grand Trunk Railway service in 1870, from which he rose through the grades of draughtsman, foreman and assistant superintendent to that of mechanical superintendent for the division between Toronto and Montreal. Subsequently, he became mechanical superintendent of the C.P.R. He was a charter member of the Canadian Society of Civil Engineers, and was elected president in 1902.