PAGES

MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

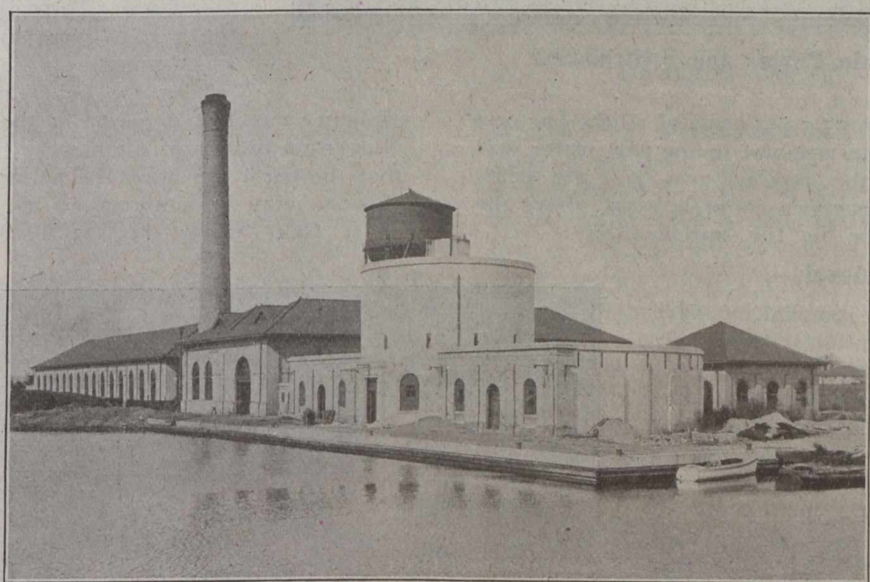
Drifting Sand Filter, Toronto Island

Report As To Its Efficiency—First Municipal Drifting Sand Filter On This Continent—Normal Rate of Filtration Sixty Million Imperial Gallons Per Twenty-Four Hours—Number of Filters, Ten—Thirty Units in Each Filter

By Col. Geo. G. NASMITH,* F.C.M.G., D.Sc., and N. J. HOWARD†

A BACTERIOLOGICAL and physical test of a section comprising five filter units of the new mechanical filtration plant on Toronto Island, as provided in sections 4 and 200 respectively of specifications and condition forming part of the contract therein, was completed in January, 1918.

The test extended over a continuous period of thirty-eight days, from December 5th, 1917, to January 11th, 1918, exclusive of Sundays and holidays. The actual number of days upon which the plant was tested was thirty-two, covering the period specified in paragraph No. 4, section a, of said contract.



View of Building Taken From South-West

A total of 108 bacteriological samples of the filtered water, and 108 examinations of the raw unfiltered lake water were made during this thirty-two day test, the results of which are herewith attached.

The lake water during this period was frequently disturbed and polluted by storms, and therefore represents at least the average, if not worse than the average, condition.

During the period of testing, the average amount of alum applied to the raw water was 1.02 grains per gallon, the specification calling for the use of an average of 1 grain per gallon during such test.

The average amount of water filtered daily was thirty-one and one-third million Imperial gallons.

The turbidity of the raw water varied from one to 115 parts per million with an average turbidity of 6.6 parts per million. The turbidity never exceeded one in the effluent, which was at all times clear and bright.

During the test the amount of alum was controlled to some extent by the chemical condition of the raw lake water. Whenever this showed evidence of pollution the amount of alum was increased. On four occasions, however, it was not possible to make this chemical determination, with the result that less alum than necessary was applied. On several occasions also, there was failure in the Hydro-Electric supply, with the result that the operation of the filters was seriously disturbed.

For these reasons we considered it to be just to exclude the results obtained on four days on which we believe that the efficiency of the filter was probably interfered with.

The bacteriological results, therefore, are being given under two groupings, one in which all results obtained during the whole of the thirty-two day period have been summarized, and the other from which, for reasons just stated, the results of eight samples have been excluded.

Bacteria Removal (Agar 37°C.)

A.—The total bacteria reduction during the thirty-two day period was 93.9 per cent.

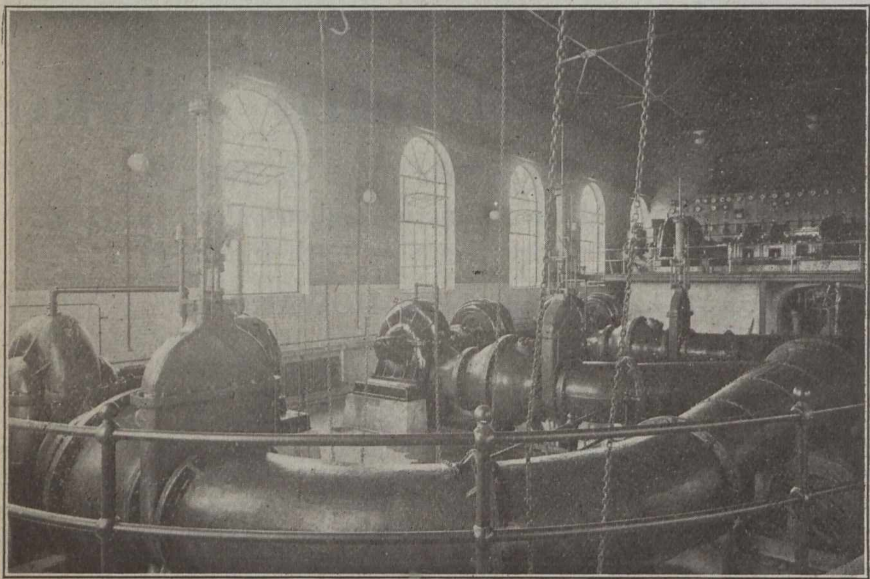
[NOTE.—For other articles dealing with this plant readers are referred to *The Canadian Engineer* of April 8th, 1915, containing a report of a 30-day test of a drifting sand filter of the Ransome type. Articles relating more particularly to the constructional features of the plant will be found in *The Canadian Engineer* for November 25th, 1915, and September 14th, 1916.—EDITOR.]

*Director of Laboratories, City Hall, Toronto.
†Bacteriologist in charge of Filtration Plant Laboratories.

On the days on which the bacteria count in the raw water was from 50 to 500 per cc., the removal by the filter was 97 per cent., where the specifications call for a removal of 90 per cent.

Only one occasion occurred where there was a bacteria count of over 500 per cc., in which case the removal was 99.4 per cent.

B.—(Excluding results for reasons specified).



Main Pumps and Switchboard

The total removal was 93.5 per cent. of all the bacteria present. When the bacteria count in the raw water was from 50 to 500 per cc. the removal was 97.2 per cent.

In both groups the bacteria count is away above the 90 per cent. called for in the specifications.

B. Coli Removal

A.—The total B. Coli removal inclusive of all results during the thirty-two day period was 95.8 per cent

B.—Exclusive of results on days previously mentioned the removal was 98 per cent. This is the removal called for in the specifications.

The difference of 2.2 per cent. in efficiency is probably due to the failures cited above, is of no practical significance, and may well be discarded. That this is true may be seen in the results of the B. Coli efficiency of the individual filters. These samples from the individual filters were collected at times when there was no disturbance due to Hydro failure or to insufficient amounts of alum.

In the case of the five filters tested separately, the B. Coli removal in all cases exceeded 99 per cent.

From these results it will be seen that the efficiencies and requirements demanded in the specifications have been attained. The difference of 1/50 grain of alum per gallon over the one grain per gallon specified may be considered a negligible quantity.

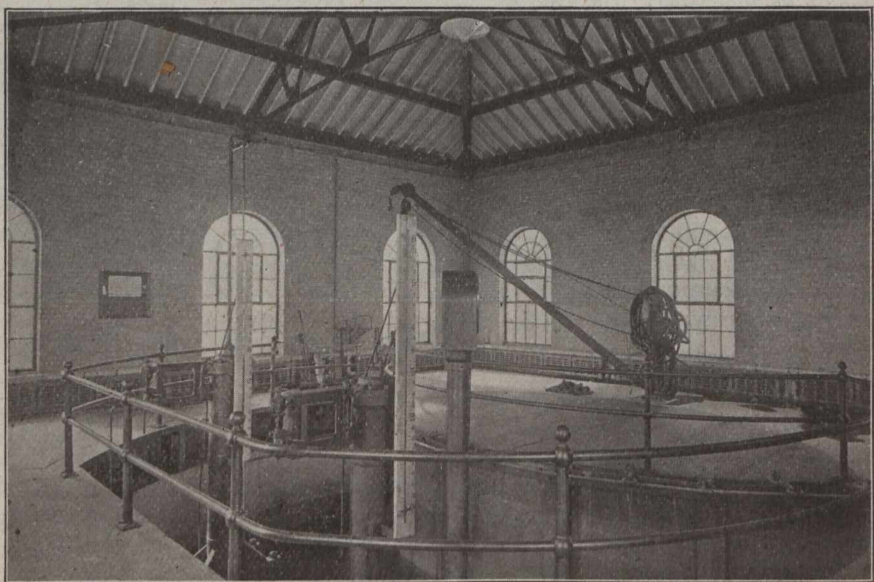
Addendum

Since the foregoing report was made and the new plant has been completed a considerable amount of time has been devoted to research work on the treatment of Lake Ontario water with aluminium sulphate.

It has been frequently noted that whilst the raw Lake Ontario water at Toronto seemingly did not vary to any great extent chemically, yet considerable physical and bacteriological variations followed the addition of aluminium sulphate. This was particularly noticeable at times when variations in the temperature of the water, as a result of wind currents, occurred. The flock formed slower in a cold water (35°-45° F.) than was the case in a warmer water (46°-70° F.), but the water in which the best flock formation occurred did not, as is generally supposed, give the best bacteriological purification after filtration. The colder waters generally gave the best results and were easier to treat.

Further tests were made to determine the differences between alum-treated waters after 30 minutes contact and three hours sedimentation periods. With this object in view, two small, rapid sand filters were set up, filtering at the rate of 120 million imperial gallons per acre per day. All tests were run in parallel. The raw water was treated with varying quantities of alum, ranging from .5 to 3.5 grains per gallon, and the above-mentioned tests were made on the effluents therefrom. Throughout the whole series the results were uniform, showing relatively small differences, and also establishing the important point that the time element was not a factor in the purification process. Numerous brands of alum were tried, and it was found that the purer the alum the better the results. Our conclusions may be summarized as follows:—

1. Cold water (35°-45° F.) treated with alum always gave better results than waters of a higher temperature.



Suction Well and Screen Chamber

2. Cold water required less alum, but flocked slower.

3. Water which was moderately polluted and had a low turbidity (1-10 p.p.m.), with a temperature over 46° F., required at least two grains per gallon to get

good bacterial purification in spite of the fact that the flock usually appeared to form quirker than was the case with a colder water.

4. Turbid waters generally flocked quicker.

5. In waters containing large numbers of microscopic organisms the flocking was invariably retarded.

6. The final flocking and clarification at the end of 18 hours of waters that in the earlier stages had shown considerable physical differences was substantially the same.

7. The employment of cheaper brands of alum containing an insoluble matter content, exceeding .5 per cent., was uneconomical and gave correspondingly poor results.

Conclusions

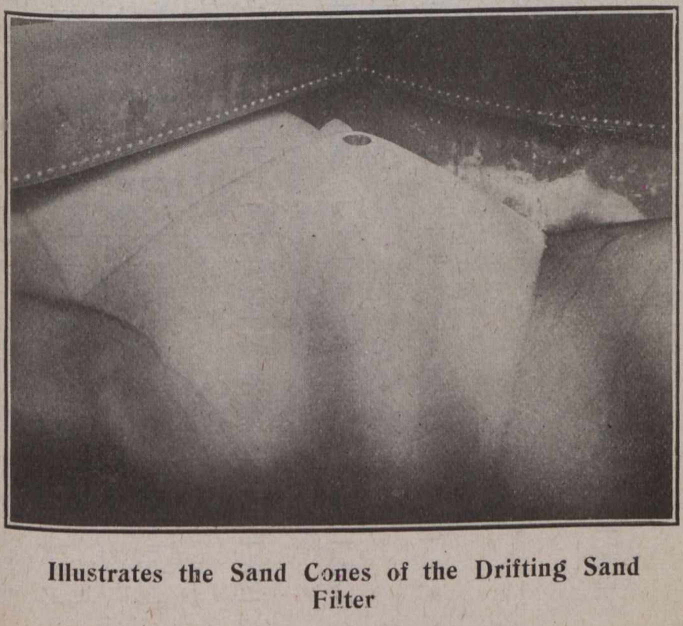
In a large number of cases we were unable to definitely ascertain the cause, judging by chemical, physical or bacteriological tests, as to the differences in action of the coagulant upon the resultant purification. As we have previously stated, there was a considerable effect due to changes of temperature, but this did not appear to account for all the differences noted. Obviously, the nature of the colloidal content in some waters prevented flocculation, this being particularly demonstrated by a laboratory test in which gelatine (.01 p.p.m.) was added to the water, and the bacterial efficiency was seriously affected thereby. We are also of opinion that fine suspended matter and the organic microscopic content play an important part in interfering with this process.

Observations on the purification effected by the new plant, covering a period of 18 months, has shown that the quality of the effluent does vary when conditions cited above occur. A high purification takes place when favorable conditions occur, whilst on occasions when the conditions are unfavorable, it has been necessary to increase the dosage of alum to obtain the required results.

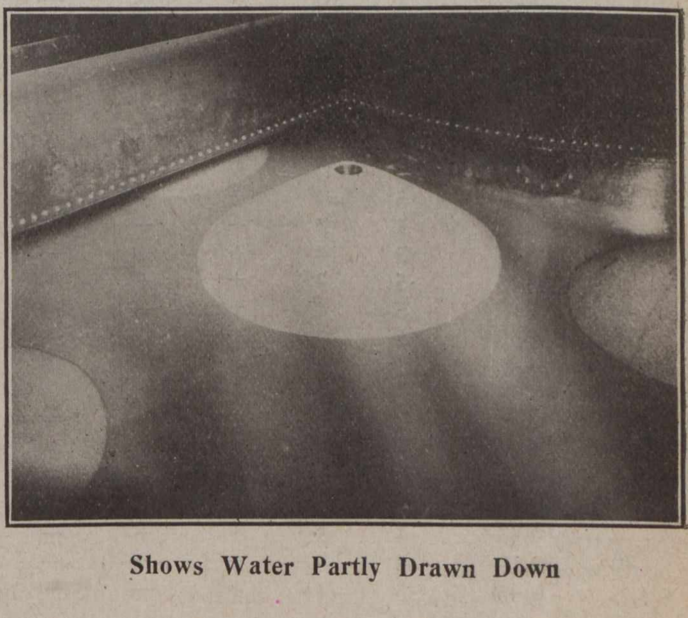
In a great many cases mechanical water plants operated in American cities have chlorine applied with the coagulant, thereby considerably reducing the cost of operation and at the same time maintaining a high bacterial efficiency. In the near future this practice will be adopted in Toronto, and a considerable economy effected by the procedure.

The decision we arrived at when the tender for the mechanical plant was first let, "That our former conception of a filtration plant was undergoing a material change; that sterilization of the water was the vital thing, from the public health standpoint, but that a filter was essential to clean the water, keep sand and dirt out of the water supply, and thereby prevent the wear and tear of machinery valves, taps, etc., as well as prepare the water for efficient sterilization; and that for a great portion of the year only a fraction of a grain of alum in conjunction with a slight amount of chlorine would be essential for filtration, thereby resulting in a great saving in the cost of operating," has been generally confirmed as a sound one, not only by ourselves, but by sanitarians in civilian and army work the world over.

Operating Gallery



Illustrates the Sand Cones of the Drifting Sand Filter



Shows Water Partly Drawn Down

TORONTO FILTRATION PLANT LABORATORY MECHANICAL FILTRATION PLANT

Bacteriological Results of Raw and Filtered Water with an Average of One Grain Alum Per Gallon.

		Raw Water.							Filtered Water.					
		Alum, grains per gal.	Bact. per cc. Agar. 37°C.	B. Coli.					Bact. per cc. Agar. 37°C.	B. Coli.				
Date.	Time.			100 cc.	10 cc.	1 cc.	.1 cc.	.01 cc.		100 cc.	10 cc.	1 cc.	.1 cc.	.01 cc.
1917, Dec.	a.m.													
5	9.25	·5	5	+	—	—	—	—	0	+	—	—	—	—
	11.00	·5	9	+	+	+	—	—	1	+	—	—	—	—
6	9.00	·5	4	+	+	—	—	—	4	+	+	—	—	—
	9.45	3·	8	+	+	—	—	—	1	+	—	—	—	—
	10.45	3·	10	+	+	+	—	—	0	+	—	—	—	—
	11.45	3·	11	+	+	—	—	—	1	+	—	—	—	—
7	8.45	3·	4	+	+	—	—	—	0	+	—	—	—	—
	10.45	·3	3	+	+	—	—	—	0	+	+	—	—	—
	11.45	·3	6	+	+	—	—	—	2	+	+	—	—	—
8	10.30	3·	295	+	+	+	+	+	6	+	+	—	—	—
	6 p.m.	3·	380	+	+	+	+	—	1	+	—	—	—	—
10	9.10	1.	34	+	+	+	—	—	3	+	+	—	—	—
	10.45	·3	3	+	+	—	—	—	1	+	+	—	—	—
11	9.00	·3	3	+	+	—	—	—	1	+	—	—	—	—
	10.45	·3	4	+	+	—	—	—	1	+	+	—	—	—
	11.45	·3	4	+	+	—	—	—	1	+	—	—	—	—
12	9.45	·3	45	+	+	+	—	—	2	+	+	—	—	—
	10.45	·3	11	+	+	+	—	—	1	+	+	—	—	—
	11.45	·3	21	+	+	+	—	—	2	+	—	—	—	—
13	9.00	·3	2	+	—	—	—	—	3	+	+	—	—	—
	10.45	·3	4	+	+	—	—	—	2	+	—	—	—	—
	11.45	·3	6	+	+	—	—	—	2	+	+	—	—	—
14	9.00	·5	16	+	+	—	—	—	4	+	—	—	—	—
	10.20	·5	11	+	+	—	—	—	4	+	—	—	—	—
	10.45	·5	42	+	+	—	—	—	3	+	—	—	—	—
	11.45	·5	14	+	+	—	—	—	2	+	—	—	—	—
15	9.00	·3	9	+	—	—	—	—	2	+	—	—	—	—
	10.00	·3	6	+	+	—	—	—	0	+	—	—	—	—
17	9.00	1.	170	+	+	+	—	—	2	+	—	—	—	—
	10.00	1.	135	+	+	+	—	—	3	+	—	—	—	—
	11.00	2.5	110	+	+	+	+	—	2	+	—	—	—	—
	11.45	2.5	110	+	+	+	—	—	2	+	—	—	—	—
	12.45	2.5	160	+	+	+	+	—	0	+	—	—	—	—
18	9.00	·5	12	+	+	+	+	—	0	+	+	+	—	—
	9.45	·5	10	+	+	—	—	—	0	+	—	—	—	—
	10.45	·5	9	+	+	—	—	—	0	+	+	—	—	—
	11.45	·5	2	+	+	+	—	—	1	+	+	—	—	—
19	9.00	·5	8	+	+	—	—	—	0	+	+	—	—	—
	9.45	·5	6	+	+	—	—	—	2	+	+	—	—	—
	10.45	·5	7	+	+	—	—	—	3	+	+	—	—	—
	11.45	·5	6	+	+	—	—	—	4	+	+	+	—	—
20	9.00	·5	6	+	—	—	—	—	1	+	+	—	—	—
	9.50	·5	7	+	+	—	—	—	0	+	+	—	—	—
	10.45	·5	8	+	+	—	—	—	2	+	—	—	—	—
	11.45	·5	2	+	+	+	—	—	1	+	+	—	—	—
21	9.00	·5	4	+	—	—	—	—	1	+	—	—	—	—
	9.55	·5	2	+	+	—	—	—	0	+	—	—	—	—
	10.45	·5	7	+	+	—	—	—	2	+	—	—	—	—
	11.45	·5	0	+	+	—	—	—	1	+	—	—	—	—
22	9.00	·5	10	+	—	—	—	—	2	+	+	—	—	—
	10.00	·5	6	+	+	—	—	—	6	+	—	—	—	—
24	9.00	·5	240	+	—	—	—	—	31	+	—	—	—	—
	10.00	·5	2	+	—	—	—	—	1	—	—	—	—	—
	10.45	·5	5	+	+	—	—	—	3	—	—	—	—	—
26	9.10	·5	2	+	—	—	—	—	0	+	—	—	—	—
	9.45	·5	4	+	—	—	—	—	1	+	—	—	—	—

TORONTO FILTRATION PLANT LABORATORY MECHANICAL FILTRATION PLANT

Bacteriological Results of Raw and Filtered Water with an Average of One Grain Alum Per Gallon.

		Raw Water.							Filtered Water.					
		Alum, grains per gal.	Bact. per cc. Agar. 37°C.	B. Coli.					Bact. per cc. Agar. 37°C.	B. Coli.				
Date.	Time.			100 cc.	10 cc.	1 cc.	.1 cc.	.01 cc.		100 cc.	10 cc.	1 cc.	.1 cc.	.01 cc.
1917, Dec.	a.m.													
26	10.45	·5	0	+	—	—	—	—	2	—	—	—	—	—
	11.45	·5	4	+	+	—	—	—	2	+	—	—	—	—
27	9.00	2.	4	+	—	—	—	—	1	—	—	—	—	—
	9.45	2.	3	+	—	—	—	—	2	—	—	-	—	—
	10.45	1.	3	+	—	—	—	—	1	—	—	—	—	—
	11.45	1.	5	+	—	—	—	—	1	+	—	—	—	—
28	9.00	1.	1	+	—	—	—	—	0	—	—	—	—	—
	9.45	1.	5	+	+	—	—	—	1	—	—	—	—	—
	10.45	·5	6	—	—	—	—	—	1	—	—	—	—	—
	11.45	·5	16	+	+	+	—	—	4	+	—	—	—	—
29	9.00	·5	7	+	+	—	—	—	0	+	—	—	—	—
	9.45	·5	6	+	+	—	—	—	2	+	—	—	—	—
	10.45	·5	16	+	+	—	—	—	2	+	—	—	—	—
31	9.00	·5	28	+	+	—	—	—	10	+	+	—	—	—
	9.45	·5	47	+	+	+	—	—	17	+	—	—	—	—
	10.45	·5	86	+	+	+	—	—	17	+	+	—	—	—
	11.45	1.5	152	+	+	—	—	—	7	+	—	—	—	—
1918, Jan.														
1	Noon	1.	520	+	+	+	—	—	3	+	—	—	—	—
2	9.00	2.	11	+	+	—	—	—	6	—	—	—	—	—
	9.45	2.	15	+	—	—	—	—	0	—	—	—	—	—
	10.45	2.	5	+	+	—	—	—	0	+	—	—	—	—
	11.45	2.	34	+	+	+	—	—	2	+	—	—	—	—
3	9.10	2.	170	+	+	+	—	—	1	+	+	—	—	—
	9.45	2.	4	+	—	—	—	—	0	+	—	—	—	—
	10.45	2.	7	+	+	—	—	—	1	+	—	—	—	—
	11.45	2.	5	+	+	—	—	—	0	+	—	—	—	—
4	9.00	1.5	116	+	+	+	—	—	2	+	+	—	—	—
	9.45	1.5	346	+	+	+	—	—	2	+	+	+	—	—
	10.45	2.5	107	+	+	+	+	—	1	+	+	—	—	—
	11.45	2.5	144	+	+	+	—	—	2	+	—	—	—	—
5	9.10	2.5	30	+	+	+	—	—	3	+	—	—	—	—
	9.45	2.5	20	+	+	+	—	—	2	+	—	—	—	—
7	9.45	2.5	130	+	+	+	—	—	16	+	+	—	—	—
	10.45	2.5	53	+	+	+	—	—	1	+	—	—	—	—
	11.45	2.5	61	+	+	+	—	—	5	+	+	—	—	—
	12.45	2.5	35	+	+	+	—	—	3	+	+	+	—	—
8	9.00	1.0	6	+	—	—	—	—	0	—	—	—	—	—
	9.45	1.	1	+	—	—	—	—	1	—	—	—	—	—
	10.45	·75	2	+	+	—	—	—	5	+	—	—	—	—
	11.45	·5	4	+	+	—	—	—	0	+	—	—	—	—
9	9.00	·5	1	+	—	—	—	—	0	+	—	—	—	—
	9.45	·5	2	—	—	—	—	—	1	+	—	—	—	—
	10.45	·5	1	+	—	—	—	—	1	+	—	—	—	—
	11.45	·5	1	+	—	—	—	—	0	+	+	—	—	—
10	9.00	·5	1	+	—	—	—	—	1	—	—	—	—	—
	9.45	·5	1	+	—	—	—	—	1	+	—	—	—	—
	10.45	·5	5	+	+	—	—	—	1	+	—	—	—	—
	11.45	·4	2	+	—	—	—	—	1	+	—	—	—	—
11	9.45	·3	4	+	—	—	—	—	0	+	+	—	—	—
	10.45	·3	2	+	—	—	—	—	0	+	+	—	—	—
	11.45	·3	1	+	+	—	—	—	1	—	—	—	—	—
	12.45	·3	2	+	—	—	—	—	2	+	—	—	—	—

Water Filtered, and Alum Figures, December 5th, 1917, to January 11th, 1918

Date. 1917,		Water filtered M.I.G. daily.	Alum used in lbs.	Alum, average grains per gal. daily.	Total M.I.G.	Total alum.	Total average.
Dec.	5	31.35	2203.2	0.492	31.35	2203.2	0.492
"	6	31.05	9015.3	2.032	62.40	11218.5	1.258
"	7	31.25	7587.6	1.699	93.65	18806.1	1.406
"	8	26.50	9174.6	2.423	120.15	27980.7	1.632
"	9	22.10	4636.6	1.468	142.25	32617.3	1.605
"	10	31.45	2522.4	0.561	173.70	35139.7	1.416
"	11	31.18	1453.3	0.326	204.88	36593.0	1.250
"	12	33.67	1605.6	0.334	238.55	38198.6	1.121
"	13	33.70	2122.7	0.449	272.25	40321.3	1.037
"	14	37.00	3364.8	0.636	309.25	43686.1	0.988
"	15	36.35	1782.6	0.343	345.60	45468.7	0.921
"	16	30.85	4537.5	1.029	376.45	50006.2	0.930
"	17	30.50	8899.8	2.042	406.95	58906.0	1.013
"	18	30.95	4550.3	1.029	437.90	63456.3	1.014
"	19	32.47	2191.0	0.472	470.37	65647.3	0.977
"	20	31.93	2174.0	0.477	502.30	67821.3	0.945
"	21	32.20	2191.6	0.476	534.50	70012.9	0.917
"	22	31.45	2123.7	0.473	565.95	72136.6	0.892
"	23	31.20	2174.0	0.488	597.15	74310.6	0.871
"	24	31.28	2174.0	0.487	628.43	76484.6	0.852
"	25	31.37	2174.0	0.485	659.80	78658.6	0.834
"	26	31.03	3128.0	0.706	690.83	81786.6	0.829
"	27	30.47	6926.4	1.591	721.30	88713.0	0.861
"	28	31.51	3982.7	0.882	752.81	92695.7	0.862
"	29	29.19	1803.1	0.432	782.00	94498.8	0.846
"	30	30.00	3333.4	0.778	812.00	97832.2	0.843
"	31	30.95	6582.2	1.488	842.95	104414.4	0.867
Date. 1918,		Water filtered.	Alum, in lbs.	Alum average.	Total M.I.G.	Total alum.	Total averages.
Jan.	1	30.60	7581.6	1.734	873.55	111996.0	0.897
"	2	30.00	7985.6	1.863	903.55	119981.6	0.929
"	3	30.95	8143.2	1.841	934.50	128124.8	0.959
"	4	29.05	8736.0	2.105	963.55	136860.8	0.994
"	5	30.55	7359.4	1.663	994.10	144120.2	1.015
"	6	30.35	7027.8	1.621	1024.45	151148.0	1.032
"	7	29.80	10647.0	2.501	1054.25	161795.0	1.074
"	8	31.75	4129.6	0.914	1086.00	165924.6	1.069
"	9	34.05	2522.2	0.519	1120.05	168446.8	1.053
"	10	34.95	2593.0	0.519	1155.00	171039.8	1.037
"	11	35.90	2928.0	0.579	1190.90	173967.8	1.023

THE WORLD'S PRESENT POWER DEMAND

While it is impossible to estimate with any pretensions to accuracy, the power now being used in various countries of the world, independent estimates tend to show that it approximates 120 million horse-power, including all steam, gas and water-power, made up as follows:—

	Millions of horse-power.
World's factories, including electric lighting and street railways	75
World's railways	21
World's shipping	24
Total	120

Of the 75 million horse-power used for factories and general industrial and municipal activities, a rough approximation of the most probable distribution would appear to be:—

	Millions of horse-power.
United Kingdom	13
Continental Europe	24
United States	29
British Dominions and Dependencies	6
Asia and South America	3

It is stated that a company in Quebec is considering the building of thirty wooden vessels of five thousand tons each.

INCREASE OF WATERWORKS OPERATING EXPENSES AND READJUSTMENT OF RATES

INFORMATION on operating expenses and rate increases of some of the leading water plants of this country was collected last spring by Mr. F. C. Jordan, secretary of the Indianapolis Water Co. Replies to his letter of inquiry received up to June 10th last showed an average increase of 29 per cent. in operating expenses during the previous six months over the normal pre-war operating expenses. This was the average for 32 plants. The highest increase (50 per cent.) reported was that of Jamestown, N.Y. The lowest (15 per cent.) was at Peoria, Ill.

Action during the past year or so regarding water rates was reported as follows:—

Atlanta, Ga., reduced its discount for prompt payment from 25 to 10 per cent.

Cincinnati, O., increased its rates 25 per cent., this increase affecting all water consumers.

Dayton, O., increased its annual minimum on ⅝-in. meters from $4.40 to $6.60. This amount covers a quarterly consumption of 1,000 ft. in addition to the meter rental.

Flint, Mich., increased the rate to its large consumers from 5 cents per thousand gallons to 8 cents.

Brockton, Mass., increased its rates to all consumers.

Philadelphia, Pa., increased its metered water rates 30 per cent.

Richmond, Va., increased its rates to large consumers from 3¾ cents per 1,000 gallons to 5 cents.

Detroit, Mich., put into effect an increase covering all consumers, and is now considering an additional increase.

Toledo, O., increased its water rates on October 12th, 1916, and is now figuring on another increase.

Savannah, Ga., increased its rates to all water consumers.

Toronto, Canada, increased its rates 10 per cent. in 1917, and an additional increase of 25 per cent. became effective in the early part of this year.

Town planning schemes are being proposed for the four principal cities of Alberta: Edmonton, Calgary, Medicine Hat and Lethbridge. The first steps have been taken and the engineers of the four cities are preparing maps, in consultation with the town planning adviser of the Commission of Conservation, showing the existing physical features and character of development in the city areas. These maps will be used as a basis for assessment and town planning purposes, and it is hoped, by means of the proposed schemes, to effect a change in the basis of taxation of real estate which will solve some difficult financial problems with which these new western cities are confronted.

PROPORTION OF RATES TO BE BORNE BY CITIES AND TOWNS AS COMPARED TO DOMESTIC CONSUMERS*

By J. J. Moore, Boston, Mass.

HON. SKELTON WILLIAMS, Comptroller of the Currency, in his report to Congress for 1917, goes into detail about the decline in earning capacity of public utility corporations. He speaks of the danger as a national one, in the loss in efficiency of such utilities due to lack of funds to operate plants efficiently on account of the increased cost of material and wages. Mr. Williams urges upon public utility companies and on commissioners in the States the necessity of some action to lessen the danger to war work and industries, many of which are dependent in one way or another upon the service rendered by public utilities.

Great Increase in General Expenses.

In a general way the cost of materials used in operating water plants has, as most of you know, advanced all the way from 150 to 250 per cent. Fuel and wages have advanced 100 per cent. Figures which I quote are taken from the records of companies in which I am interested, and in all of which we have either increased or asked for an increase in the water rates. First, I would call your attention to an item which can hardly be considered under either materials or wages, and yet which has added greatly to the operating expense of many companies. I refer to taxes. In one Massachusetts company eight or nine years ago we were paying to the town in taxes 50 per cent. less than we were receiving from them in hydrant rental. Last year we paid them $1,300 more in taxes than we received from them in hydrant rental, that is, the amount paid to them was 30 per cent. more than the amount received from them. In another Massachusetts company the taxes have advanced 43 per cent. in the last five years.

Operating costs in both of the above-mentioned companies have advanced during the last year in percentage varying from 50 to 80 per cent.

Where oil is used as fuel the increase is between 50 and 60 per cent. Where coal is used the increase is about 80 per cent.

Wages of pumping station have advanced from 30 to 45 per cent.

Wages of engineers have advanced 50 per cent. Day laborers have advanced 60 per cent. over 1917, which showed at least 30 or 40 per cent. advance over previous years.

Companies which two or three, or even one year ago, were earning an average of 8.8 per cent. on the capital stock are to-day earning 6.3 per cent. Companies which were earning a year ago an average or 4½ per cent. on the capital stock are to-day earning a little less than 2 per cent. on the capital stock.

Certain Maine water companies in which I am interested, and in which we have asked for an increase of rates, were built very shortly before the European war, and were unable to more than pay their operating costs. With the steadily mounting cost of labor and material these companies are now unable to meet even the operating costs.

One of these Maine towns is a very good example of one of the reasons why a town or municipality should pay more for hydrant rental than has been customary in the past. The town is small and not compact, and many pipe lines are in streets where there are numbers of vacant lots. Now these lots have increased in value

*Abstracted from address delivered before the meeting of the New England Water Works' Association.

since a water system was established in the town. The water company is obliged to pay for maintaining lines in the streets, yet the company received not one cent of revenue from these lots.

Problem the Water Companies Face

This, in brief, is the problem many water companies are to-day facing. The question is how to meet it. There seems to be only one way, and that is to raise the rates. Water companies are a necessity. The public must have water, and the companies cannot be expected to furnish it at a loss. Therefore, there seems to be no question as to the necessity and wisdom of raising the rates to meet the increased cost. There is no other possible way to meet such cost unless it is to cut the dividends, and it is very rare to find a water company earning enough to pay any dividends which could be cut and give any adequate return to stockholders. In such companies as are able to meet the increased costs and pay their dividends there would, of course, be no excuse for increased rates. In towns where the system is a gravity one, or where the town is so compact as to have made the original cost of construction small and where in past years the company has been able to create a surplus it may be possible for them to meet increased costs and still pay a reasonable return on their investment during lean years.

Practically all water systems were built in good faith, and people who invested money in them to construct them felt that such investment was a conservative one, probably knowing that the return would never be large but would at least always be sure. We cannot, therefore, expect such investors to sit by and allow the old rates to stand in companies where doing so would mean under present increased costs that dividends on the invested capital would not be paid.

Probably the greatest question is how and where to get the increased rates. I have mentioned before that there is a question now as to what proportion of rates the towns should bear as compared to that paid by domestic users. The old idea was that the town should get all it possibly could for the lowest rental. In the west it has been held by public utility commissions that the cost of building and maintaining a system of water works giving fire protection to a town or city is about 66⅔ per cent. more than the cost of a system supplying water for domestic uses only, and therefore the proportion of the burden of supporting a public utility in such a way as to render efficient service to the town or city should be greater for the town or city rather than for the domestic users.

In a recent decision given by the Maine Public Utility Commission it was stated that 25 per cent. of the total revenue necessary to operate a company and pay a fair return on the investment was not too large for the town to pay.

Towns Should Bear Larger Portion

It is a much fairer adjustment of rates for towns and municipalities to bear the larger portion of the revenue required by water companies, but it becomes a matter of educating townspeople to this idea.

In a recent decision in Pennsylvania the commission decided that a water company should be entitled to earn in addition to the expense of operation and annual depreciation a seven per cent. return on the value of its plant.

In another decision the same commission decided that a water company in a town where they ordered certain improvements should receive an 8 per cent. return on the valuation fixed by the commission. This valuation, by the way, was fixed by the commission as only fifteen thousand dollars less than the book value of the company.

The California Commissioner also considers a net return of 8 per cent. on the valuation as a fair return. Taking an example a little nearer home—the Maine Utilities Commissioners have in a decision rendered in 1917 stated that they consider 6 per cent. net income on the fair valuation of the properties of a water company a fair return on the investment.

COMPRESSED AIR TERMS

THE following definition of certain compressed air terms have been adopted by the Compressed Air Society, with headquarters at 30 Church St., New York City:—

The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder, as shown by indicator cards, and may be expressed as the product of the volumetric efficiency (the incompression), all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horsepower in the case of a power-driven machine.

Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

During the week ended October 18, six Cobalt companies shipped an aggregate of 14 cars, containing approximately 1,084,710 pounds of ore. This is the first time in a good many weeks that shipments have exceeded one million pounds in a single week. The indications are that these heavy shipments will be continued throughout the fall. The Nipissing this week sent out six cars containing over half a million pounds. A summary follows: Nipissing, six cars, 508,935 pounds; Buffalo, three cars, 241,900 pounds; McKinley-Darragh, two cars, 147,524 pounds; Mining Corporation, one car, 65,136 pounds; Hudson Bay, one car, 63,195 pounds; O'Brien, one car, 58,020 pounds. During the corresponding period the Kerr Lake Mine shipped 84 bars, containing 112,581.51 fine ounces of silver bullion.

The operation of the Miller Lake O'Brien Mine, at Gowganda, is going forward unremittingly. Production for the current year will probably be about $1,000,000, possibly more. Its operators being a closed corporation, the details of production, reserves, or cost of operation are not always available, at least not more than the approximate figures. Unofficial figures place ore reserves as containing around 6,000,000 ounces of silver. Such an estimate, if correct, would constitute the second largest ore reserves of any mine in the Dominion, being second only to the Nipissing. The latter company, according to the company's last report, had around 8,000,000 ounces in ore reserves. Allowing for a good deal of over-enthusiasm in the un-official estimates of the reserves of the Miller Lake O'Brien, it is still evident they are large. This one great mine has been the sheets-anchor of the whole Gowganda district. Success here on a large scale has spurred to renewed and greater effort the owners of the property in its vicinity. Work in the district is being done on the theory that the best place to prospect is near the proven mines. Judging from the results of operations at nearby properties the chances of the proven area becoming considerably broadened appear bright.

REINFORCED CONCRETE VESSELS*

By Walter Pollock

DEVELOPMENT of reinforced concrete vessels is in a very embryonic stage and seagoing experience is practically nil. The war situation brings the question before shipowners and shipbuilders as one not to be lightly dismissed, and has resulted in close co-operation of naval architects with experts in concrete structures, to produce the best designs that present knowledge permits.

Three principal causes have been at work to direct attention to this subject, viz. (1) the imperative need of economy in steel and timber owing to vast calls on these materials for numerous war munitions and equipment, (2) the urgent necessity to use a minimum amount of skilled labor in home industries, and (3) the insufficient number of small mercantile vessels such as coasters, tugs, and lighters that have been built owing to the prior claim of naval vessels.

It is only fair to say that the present programme of construction of reinforced concrete vessels would not have been possible had it not been for the pioneer work which established its possibilities before the autumn of 1917.

Limitations

For river craft, pontoons, floating dry docks, floating piers, etc., reinforced concrete construction will probably develop and become a permanent industry.

For river and harbor lighters, tugs and coasting vessels, this form of construction will, if all the present experimental vessels are successful, probably remain a recognized form of construction for some years to come. Steel vessels may come back to their own as soon as freights are low and the competition keen. For larger vessels, up to, say, 2,000 tons deadweight capacity, reinforced concrete will no doubt prove a practical and commercial proposition for a few years.

Ideal Points Aimed At

Designers and builders are striving to produce a reinforced concrete vessel:—

(a) That will as nearly as possible reduce the weight of the hull to that of a steel ship of the same deadweight capacity.

(b) That will contain not more than one-quarter or one-fifth of the steel that is required in a steel ship.

(c) That will be sufficiently strong and safe with a thin concrete hull to stand stresses and ordinary knocks and at the same time have the necessary density to ensure watertightness.

(d) With a concrete that will not fracture by expansion and contraction, and that can be protected from disintegration in contact with acids, etc.

(e) That can be launched quickly after completion, without danger to the concrete work.

(f) That after bottom and side damage has been repaired, can be put to work again quickly without waiting several weeks for the repair work to set and harden.

Co-operation of Experts

It is necessary to combine the knowledge and experience of the designers of reinforced concrete work on land with that of a naval architect who has had experience in the design and construction of vessels of the type to be adopted. Neither party can at present hope to attain the best results without the other.

Consideration of Design

The underlying principles are to use only the amount of steel necessary to take up the tensile stresses and for the concrete to do the rest and stiffen the structure.

The ideal design would appear to be a vessel with longitudinal construction (dispensing with two-thirds of the usual floors and frames), fitting only a few web-frames and as many bulkheads as possible, and in addition to the usual longitudinal rods, a series of diagonal ones. In larger size vessels it would no doubt be advisable to fit a centre bulkhead for the full length of the ship, but in any case it is advisable for cargo vessels to have the hatch coamings continuous all fore and aft. In smaller vessels a continuous carling, even if it projects 6 inches above the deck, is desirable.

It is not difficult to design a reinforced concrete vessel with graceful form, nice curved lines and a handsome sheer, though difficulty and expense are involved in building and in keeping the steel reinforcement in place during moulding and casting. To overcome these difficulties, the writer designed the "straight-lined" vessels in July, 1917, and published a number of designs wherein all the transverse sections are straight lines throughout the ship, the sheer being also in straight lines.

If the steel reinforcement is not kept in its proper position both vertically and horizontally in the thin slab walls of the shell, bulkheads, hatch coamings, bulwarks, casings, etc., a considerable amount of the strength of the reinforced concrete structure will be sacrificed. Take for an example a 3-inch slab curved vertically, horizontally, and diagonally, as is the case on the bow of an ordinary ship-shaped vessel. It is almost impossible to keep all the steelwork in its proper position, and a deviation of only ¼ inch of the bars one side will bring them so close to the surface as probably to throw off the concrete, or if set inwards will considerably reduce the strength of the slab locally. Furthermore, if the steel rods be not true to line, they tend to straighten out when subject to a tensile pull and cause the concrete to burst off, besides reducing their effectiveness by introducing secondary stresses.

The unit or sectional method of construction is being tried, but the advantages for ship work have yet to be proved, while the disadvantages are serious; so that the monolithic system, which makes it easy to obtain continuity of strength, is almost universally used.

For small vessels, barges, etc., a slab form of construction should be much more economical, as it dispenses entirely with floors and frames, side keelsons, stringers, beams, etc. The shuttering, being reduced to a minimum, is quickly placed in position and more rapid construction attained.

There are the following methods of reinforcement:—

(a) Wire netting, expanded metal, and similar meshwork with or without bars.

(b) Flat bars, special bars, steel joists, etc.

(c) Round bars of varying diameters.

All of these are suitable for either the unit method or the monolithic method of construction, and may be used either singly or in combination.

There are four methods of jointing the steel rods: (1) by a long overlap, (2) by a short overlap with hooked ends, (3) by welding, and (4) by turnbuckles or other mechanical attachment. The long overlap, which is usually forty diameters of the rod, although some go as low as twenty diameters, relies entirely upon the adhesion or grip of the concrete to the bar. The short overlap, of

*Read at the Spring Meeting of the British Institution of Naval Architects.

say twelve diameters in the small rods and eighteen diameters in the rods over 1 inch diameter, relies mostly upon the hooked ends and appears to be a satisfactory solution, as it reduces weight without sacrificing strength. Welding is certainly the most economical as regards weight, but if done in the shop makes the rods difficult to handle and keep in shape, and if in place may result in a local weakening of the rod at the weld. A mechanical connection such as a turnbuckle, to unite screwed ends of the rods, is sometimes adopted for special purposes. The cost of welding and mechanical connection is usually considered prohibitive. In each of the above cases the loss due to the weakness of all rivetted seams or butts in a steel ship is avoided.

In order to resist the diagonal tensile stresses induced in a beam by the action of the shearing force, stirrups are frequently introduced extending between the tension and compression members. They may be considered as the web members of a truss system, the triangulation of which will vary as they are placed vertically or diagonally.

In ordinary building work, considerable dependence is placed upon the "adhesion" of concrete to steel, as it is called, but perhaps it would be better to speak rather of the "grip," as indicating that the bond between the steel and the concrete is derived chiefly from the contraction of the concrete in hardening in air. Therefore precaution is taken to give a mechanical bond by hooking or bending the ends of all reinforcement. It will be found advantageous to employ concrete richer in cement than that ordinarily used for buildings, and made with ballast or other coarse material (sometimes called aggregate) restricted in size. There is also another element in question, as to what reduction in stress, if any, should be allowed in concrete which is always kept in water and that which is alternately wet and dry, while it is necessary in addition to ascertain what effect salt water has on the strength of concrete as used in a vessel, although data go to show that salt water has no effect on a dense concrete: this is a subject that can well be experimented with in regard to concrete shipbuilding.

In a steel ship, say, up to 1,000 tons, it is usual to allow a stress of 8 tons per square inch on the steel, but in view of the uncertainty of the behavior of the concrete work at sea, it will no doubt be found advisable to allow only one-fifth of the ultimate tensile resistance for the reinforcement.

Weight of Hull

The weight of reinforced concrete hulls is the most serious problem in the adoption of this type of vessel, the concrete being 143 lbs. per cubic foot, plus the reinforcement.

The bare hull with fittings of a coasting vessel of, say, 300 tons deadweight, will weigh 130 per cent. more than that of a steel vessel, while the increase in total displacement is about 40 per cent. (see table below). Put in another way, if a concrete coaster was built of the dimensions and coefficient of fineness of a 420-ton deadweight steel vessel, it would only carry 300 tons deadweight on the same draught.

The linear increase (length, breadth, and depth) would be 12 per cent. to 14 per cent. greater for a concrete vessel than for a steel vessel.

The table below gives a comparison of a 300-ton deadweight auxiliary coaster in concrete, wood, and steel.

The practice of stating that a concrete hull is from 50 per cent. to 70 per cent. heavier than a steel vessel of the same dimensions does not give a fair comparison, because the concrete hull would carry much less cargo. The method of comparing the weights of vessels of similar deadweight has therefore been adopted.

It will be seen that the total steel is only 27 per cent., the reinforcement alone accounting for 25 per cent. of that of a steel vessel of the same deadweight capacity.

Comparison of a 300-ton D.W. Vessel in Concrete, Wood and Steel.

	Reinforced Concrete.	Wood.	Steel.
Length	125 ft. 0 in.	108 ft. 0 in.	105 ft. 0 in.
Breadth	25 ft. 0 in.	23 ft. 9 in.	21 ft. 0 in.
Depth	11 ft. 9 in.	10 ft. 7 in.	11 ft. 4 in.
Draught, bottom of keel aft	10 ft. 3 in. (no keel)	10 ft. 3 in. (keel)	10 ft. 3 in. (no keel)
Deadweight cargo, tons	300	300	300
Cubic capacity of holds and hatchways, $ft.^3$	17,320	12,350	12,500
Displacement, tons	640	495	455
Time to construct, months	4	8	6
Weight of steel, tons	28½	15	110
Weight of bare hull, tons	290	140	120

Disadvantages

The principal disadvantages are: —

(a) Greater weight and consequently greater displacement for the same deadweight.

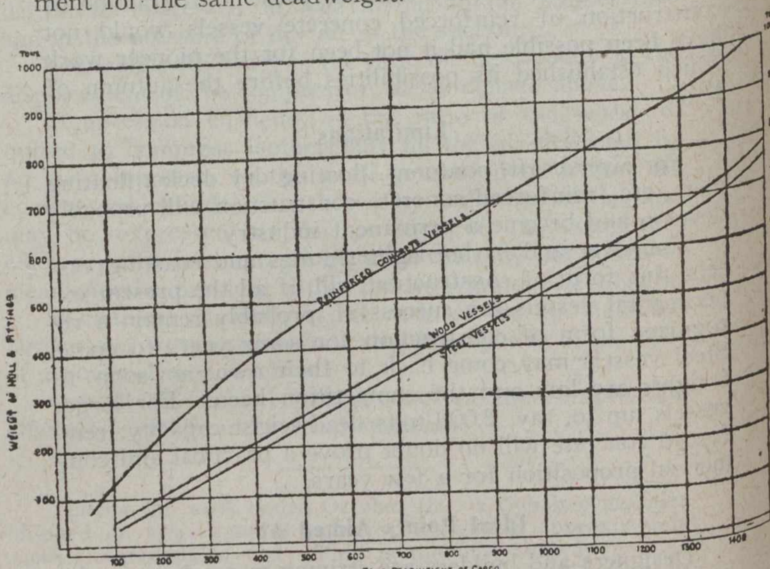


Fig. 1—Curve of Comparison of Dead Weights

(b) Increase of net tonnage and consequent increase in port and harbor dues.

(c) Increased cost of building and launching ways.

(d) Longer time to repair if bottom repairs are necessary.

Advantages

(1) Much less steel than is necessary for a steel vessel, and no waste due to scrap.

(2) No loss of strength due to rivet-holes and jointing as in a steel vessel.

(3) Cheaper and quicker construction.

(4) Very little skilled labor, no platers, anglesmiths, or riveters required.

(5) Longer life and reduced depreciation.

(6) Reduced upkeep and repair bill.

(7) Freedom from dry rot as in wooden vessels and freedom from corrosion as in steel vessels.

(8) Smoother surface and less skin friction.

With regard to depreciation: so far as can be at present ascertained, the concrete should last for several hundred years. Depreciation, however, may take place in the steel bars due to corrosion and fatigue of the metal. The former will only occur if the concrete is permeable to water and air; this can be avoided by a careful selection of the materials used and by strict overseeing of the mixing and casting operations. The question of fatigue of the metal would depend upon the stresses set up on the steel due to the "working" of the

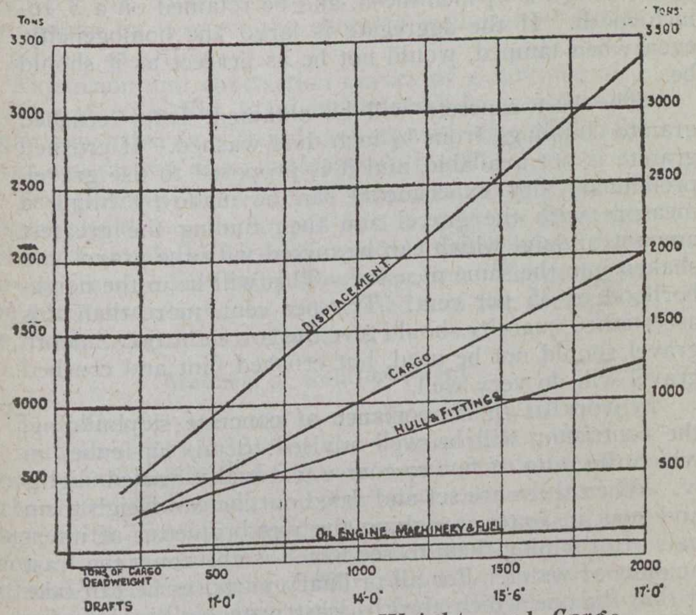


Fig. 2—Displacements, Weights and Cargo

ship, but this is not likely to affect the vessel up to, say, the first fifty years of its life.

Local Strength

Damage as a result of a collision should not be so serious as some critics appear to imagine. As an instance of the strain reinforced concrete is capable of withstanding, there is in Flanders to-day the tank of a water tower that was brought to the ground with a crash by the legs having been shot away, and yet that tank is still capable of holding water. It is 66 ft. by 33 ft. by 8 ft. 6 in. deep. The forces set up by collision are practically incalculable, and depend on the speed of collision, the angle of impact, the point at which impact occurs, and other factors. However, the local strength of the structure can be arranged to withstand a momentum or blow which compares quite well with ordinary steel construction.

Repairs can be made quickly, but bottom repairs may require three weeks to harden before the vessel can be loaded and put to sea.

Classification Rules

At present there are no recognized rules for the construction, although all the Classification Societies are studying the subject.

The Norwegian Veritas have formulated some rules which include the following:—

The stress on the steel is not to exceed 6.35 tons per square inch when in compression and 5.08 tons per square inch when in tension.

The modulus of elasticity of the concrete is to be taken as one-fifteenth of steel. The stress when in compression not to exceed 570 lbs. per square inch, or one-sixth the strength of the concrete. The stress when in tension not to exceed 57 lbs. per square inch.

The outer bottom, between the floors, has to resist a water pressure equal to 50 per cent. more than the maximum draught, and in foreign-going vessels for 20 per cent. amidships (25 per cent. of motors fitted aft), to resist a pressure of twice the vessel's maximum draught. The inner bottom, where fitted, to resist a pressure equal to 25 per cent. more than the maximum draught. The sides of the vessel between the frames to resist a pressure of 75 per cent. of the maximum draught, the forecastle 60 per cent., and the bridge or deck-house 50 per cent. The deck between the beams to resist a pressure equal to 35 per cent. of the maximum draught.

Stanchions to beams and hatch ends are supposed to bear a weight of water of 4.35 ft. on the main deck, and 2.85 ft. on the upper deck.

A watertight bulkhead to resist a head of water equal to its height, plus 3.35 ft.

The deck and bulkhead steel rods to be covered with at least ⅜ inch of concrete, and those in the bilges with at least ¾ inch of concrete.

Where rods have to resist pressure, they are to be spaced not more than 15 diameters apart.

The overlap of rods to be 60 times the diameter.

Welding is only allowed by special permission.

A solid fender of wood to be fitted for the whole length of the vessel above the load line.

Ceilings and cargo battens must be fitted in all cases.

When the hatch coamings are made of concrete, they must be boarded with wood or protected in some other way against knocks.

The stern frame is to be of the size required for a steel vessel of similar size.

Lloyd's Register of Shipping are prepared to give an "A" Experimental Class to vessels approved by them, and will no doubt in due time prepare rules, as also the British Corporation Registry, Bureau Veritas, etc.

Types of Vessels Suitable

Reinforced concrete is particularly suitable for coasting vessels, tugs of all types, sailing vessels, harbor and dock vessels, lighters and barges of all types, lightships,

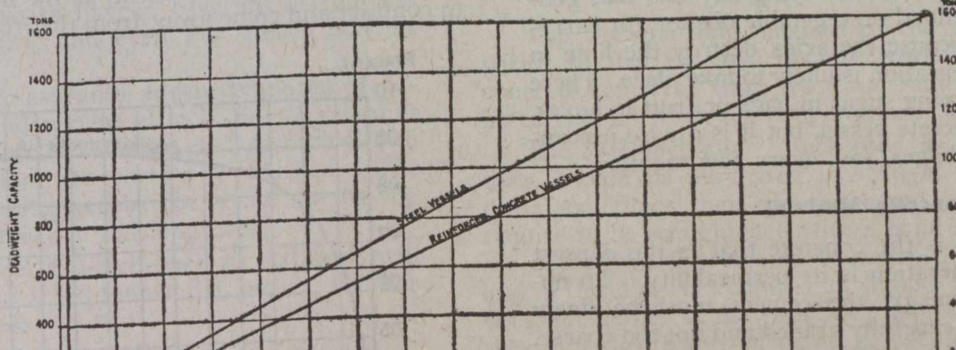


Fig. 3—Curve of Capacity

mooring and lifting lighters, floating piers, caissons, pontoons, floating docks, and buoys.

With tugs, weight is a distinct advantage, as all designers well know, for it enables them to hang on to the "tow" under adverse conditions, and, when docking, reduces the heeling over of the tug when the tow-rope is girted.

Oil tankers can be constructed of reinforced concrete for carrying any hydro-carbon oils in the concrete tanks,

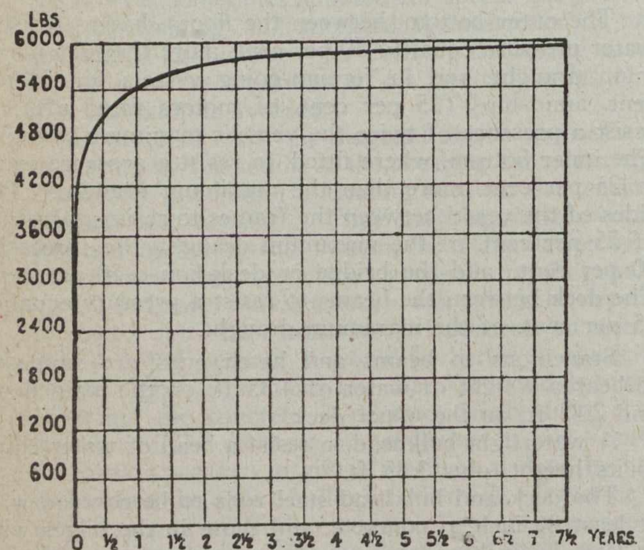


Fig. 4—Crushing Tests. Concrete 1 : 3

and there is no reason why vertical side tanks should not be built of reinforced concrete for carrying oil fuel. Double bottom and side tanks have the advantage of increasing the number of watertight compartments and consequently the safety of the vessel.

Concrete tanks, unless specially made for such exigency, should not be used for carrying any oils that generate free acid, i.e., animal or vegetable oils, or for carrying sugar or fruit, because the acids destroy the lime in the cement and disintegration is likely to take place. There is no objection to carrying sugar in bags or fruit in boxes, etc., as cargo in a concrete vessel, but it is a wise precaution to wash out the bilges, say, every few months.

Concrete Material

The best concrete is the concrete that is the densest —the principal consideration is its permeability. To obtain the necessary density, the cement must be finely ground, the aggregate carefully graded and not too coarse, and the mixing thorough. If the concrete is too rich it is subject to greater contraction and cracks. It is made of cement, sand, and aggregate, and for shipwork the proportions are usually of 1 to 1½ to 1½ by weight, although the writer prefers to specify a mixture of 1 to 3 graded ¼ inch downwards.

The cement usually obtainable is to the British Standard Specification which provides for a residue on a sieve $180 \times 180 = 32,400$ meshes per square inch, not exceeding 14 per cent. The finer the grinding the better, and as manufacturers now often produce cement with up-to-date machinery, a residue of 6 to 8 per cent. might be insisted upon with advantage. The great point is to get a concrete that is not only strong, but impervious to water, for otherwise the reinforcement may rust and throw off the concrete.

The sand should be clean and sharp, and pass through a sieve having square meshes 3/16 inch in the clear; the grains should vary regularly between coarse and fine without a large proportion of either extreme.

The aggregate must be clean and sharp and able to pass through a ¼-inch mesh, and be retained on a 3/16-inch mesh. If the aggregate is large, the homogeneity, even when tamped, would not be as perfect as it should be.

The best concrete will be obtained from crushed granite chippings from ¼-inch dust washed. If crushed granite is not available, and it is proposed to use gravel, preliminary dry experiments can be made by filling a measure with the gravel and then finding the greatest amount of sand which can be mixed with the gravel and shaken into the same measure. This will be in the neighborhood of 35 per cent. Ten per cent. more than this ascertained quantity should give the correct ratio. Smooth gravel should not be used, but crushed flint and crushed gravel will do very well.

In work of the importance of concrete shipbuilding, the contractor will be well advised to mix up cubes in which the ratio of fine to coarse material is varied slightly. When these are set and dried out, he can weigh them and soak in water, weighing the wet briquettes at intervals after wiping them to see which is absorbing the least amount of water. For all ordinary purposes he can take it that the one which absorbs least water will be best for his purpose all round, both in strength and permeability.

Special care will be required to make sure that the aggregates tested are fair samples, and warning is necessary against taking the stone from the edge of a heap on account of its not being a fair sample of the whole. Similarly, when the concrete is being mixed for placing in the ship, the stone should not be entirely shovelled from the bottom of the heap, where it is always coarser than the average.

For grouting purposes and for fitting various iron parts in position after the concrete structure has been cast, it is better to use an equal mixture of cement and sand rather than pure cement, as the latter is more liable to contract and come away from the ironwork.

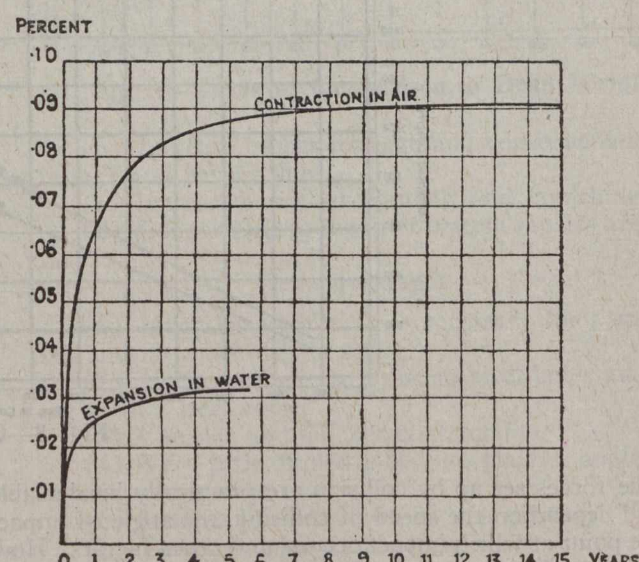


Fig. 5—Expansion and Contraction of Concrete.

There are two kinds of cracks that appear in concrete: hair or surface cracks, and setting or hardening cracks. The former are caused by a film of richer concrete getting to the surface, or through the concrete being faced with neat cement, and thus constituting a different mixture from the bulk of the concrete with a different coefficient of expansion and contraction. The latter cracks are caused by the difference in contraction of the concrete in air, as compared with the contraction when in water.

Surface cracking may be avoided by keeping the aggregate in the concrete well to the surface and contraction cracks by keeping the concrete well wetted during its process of setting.

Expansion and contraction curves of a mixture of 1 to 3 are given in Fig. E by which it will be seen that the linear expansion in water decreases with age, whilst the linear contraction in air increases with age.

Test pieces of the concrete should be made from the mixture decided upon, tamped as described for the work, and say four blocks of each tested at twenty-eight days, the compression load being slowly applied. The compressive resistance should be ascertained and the average of the results adopted as a standard.

Material of Reinforcement

The steel for the rods is usually of shipyard quality of mild steel 28 to 32 tons per square inch tensile, although some reinforced concrete experts prefer medium carbon steel (to which category shell discard steel belongs) with 35 to 45 tons per square inch tensile, a contraction of area at fracture not less than 45 per cent., to withstand bending cold to 180° around a diameter equal to twice that of the bar without fracturing the skin of the bent portion. All bars used to be bent cold, and any showing signs of brittleness in the process of bending to be rejected.

Structural Details, Concrete Work

A minimum covering of the reinforced steelwork with concrete is desirable so as to reduce the weight of the structure, while, at the same time, it must be sufficiently strong to prevent the concrete from breaking away under the torsional and other stresses that a vessel is subject to. For the slab work it will be found necessary to have at least a covering of 1½ inches of concrete over all the bars, floors, frames, and keelsons, and where heavy bars are used it is advisable to have a covering of not less than 1 inch of concrete, and even 1¼ inches may be necessary.

The deck may have a granite finish composed of ¼-inch washed granite and cement gauged 2½ to 1, laid at the same time as the under concrete, and sprinkled with fine carborundum before the casting is finished. The latest vessels being constructed by the writer are having a chequer pattern cast in the finishing coat.

For a 300-ton vessel a 3-inch shell or slabwork will be found sufficient, for a 500-tonner 3½ inches, and for a 1,000-tonner 4 inches.

Structural Details of Hull, Steelwork, and Fittings

The stern frame requires special consideration and design to ensure proper attachment to the reinforced concrete work, especially where a stern tube is fitted.

At present it is hardly worth while to make the rudders of concrete, although this is quite possible for large ships; the same remarks apply to masts.

A method that may be adopted for attaching fenders or fender angles, bollards, and holding-down bolts, is to cast in the concrete a tube with a flattened end that is screwed internally to take an ordinary or a cheese-headed bolt, although many fittings, such as stanchion sockets, small bollards, mooring pipes, hatch cleats can be constructed with bulb or splayed ends, so that they can be cast in position, and consequently bolts or other attachments dispensed with. If this method is adopted, it would be as well to use malleable cast or wrought iron fittings, to avoid breakage, if possible.

Bulkhead connections, hawse and mooring pipes, wash port doors, scuppers and deck pumps are placed in position before the casting of the concrete takes place, and therefore costs practically nothing to fit.

Shroud plates can be held down by bolts, although plates immersed in concrete and attached to the reinforced bars would no doubt be better.

Deck-houses of wood will no doubt be more satisfactory in the early stages, although later these might be made of concrete.

Shipbuilding

The best situation for building concrete vessels is the part of the country where the climate is warm and damp, and the ideal site is where the ground and foreshore are very hard and firm, in order that construction can be made without piling or expensive preparation, and where launching can take place with simple slipways. It is well to remember that there are very few shipbuilding sites that are suitable for building reinforced concrete vessels that do not require piling or other expensive methods of constructing the building berths to ensure freedom from damage during construction and launching, or require concrete slipways or reinforced concrete "rafts."

To prevent concrete vessels getting out of shape when being built, and to launch without fracture, exceptional care is required. Side launching would appear to be preferable to the more usual "end-on" launching. The cost of constructing the water end or wharf for side launching will be almost as great as the cost of the "building ways." It is therefore advisable to provide for three or four building ways for each launching way, the declivity of the latter being 1½ inches per foot, but of the former somewhat less.

It is very advisable to have the building slipways properly covered over to keep off the rain, and a complete building with sides would be an advantage, especially in an exposed position, as it would keep away the frost and cold.

Construction

The workmanship must be of the very best and superior to that of any concrete work on land, and the concrete kept free from frost and rain; work should not be carried on when the temperature is below 35° F.

The 3/16-inch and ¼-inch rods, as well as the larger ones, should be purchased in straight lengths and bundles; sometimes they are purchased in rolls, and then require to be straightened with a hand machine. If they are badly bent they should be warmed and straightened, and if bending is required it should be done cold. It does not matter if the rods are rusty in appearance, but they must be free from paint, grease, loose rust, dirt, or other foreign matter.

The shuttering and rods being in position, small distance blocks of concrete should be placed as required. For frames, beams, pillars, etc., it is advisable to have a block with one long channel instead of a small groove for each bar, so that any diameter of round bar can be used. All the blocks should have holes cast, so that wires can be used to hold them in position.

It is necessary to mix the concrete thoroughly by machinery in quantities that can be immediately used, and to use it as quickly as possible after being mixed, as cement commences to set immediately it is mixed with water; under no circumstances should a concrete which has once been allowed to set be mixed again for use. Each section, if possible, should be completed in one operation. In mixing, clear fresh water should be used.

Some claim that the correct consistency of the concrete is that it should be in a "mushy" state, i.e., when tipped out of a bucket it should not flow or run, but can be easily "tamped" with a tamping tool; others, that if the double shuttering is finished for a height of 5 feet at a time, the concrete should be in a very liquid state and not tamped, the shuttering being vibrated or agitated instead. This latter method of casting 5 feet at a time is not desirable for ship construction.

The thickness of loose concrete that is to be tamped should not exceed 4 to 5 inches.

If contraction cracks or defects appear, the concrete should be cut out and the remaining surface thoroughly wetted and made good with cement mortar, i.e., sand and cement gauged 1 to 1.

When a section is stopped either for a meal-hour or for the day, the surface should be made rough by the tamping tool or other means, some preferring a longitudinal groove as well. Before continuing, the surface should be damped well and coated with half an inch of cement mortar to ensure good jointing. The efficiency of the work depends largely upon the careful casting, and if at all possible continuous work is to be preferred, to ensure homogeneity.

In tamping the concrete, which must be done thoroughly to increase the impermeability to water, care must be taken not to displace the steel reinforcement. The tamping is also necessary to get good adhesion to the bars.

To get a smooth surface, besides agitating the shuttering during casting, the surface of the concrete should be rubbed over with cement 1 to 1 to fill all the interstices and when dry smoothed down and polished with a carborundum block.

Electric rotary concrete surfacers are also used; these machines will surface from 50 to 70 sq. feet per hour, after all voids have been filled in.

The American "cement-gun" is sometimes used to apply the concrete. The mortar is placed in an upper chamber, the valve at the bottom of same being closed; when the chamber is full the top valve is closed and the bottom one opened, so that the concrete falls into the lower chamber. When the upper chamber is empty it is immediately refilled, so that the supply to the nozzle is continuous. Air is supplied from a compressor at 50 lbs. per square inch for first coating or rough work, and 40 lbs. for the finishing coat, the water to the lower chamber being supplied at 20 lbs. higher than the air pressure. It is claimed that by this system shuttering is dispensed with and the construction of the vessel is much more rapid; the claims have not yet been proved for ship construction, and so far as can be seen the system is not likely to be adopted in this country, except for small boats.

Launching

Designers and constructors may well feel nervous of the risk of launching vessels within a short time of completion.

There are the three usual methods of launching: (a) building in a dry dock and floating out, (b) launching end-on in the ordinary way, and (c) side launching.

The ideal condition is to build a reinforced concrete vessel in a dry dock and float the vessel by filling the dock in the ordinary way: the interior of the hull can also be flooded with water to harden the concrete, and both operations carried out without putting an undue strain on the concrete structure. The objection to the general adoption of this method is that dry docks are rarely available for this purpose, as they can be more profitably used for repairing ships and because, if they were available even for a few months, the cost would be practically prohibitive.

The second method is to launch end-on and stern first, as is usual in 97 per cent. of the vessels built. The stresses due to the vessel entering the water at a declivity and at a considerable speed are probably in excess of any ordinary stress that will be brought upon the vessel in a heavy sea, and to minimize risk of fracture a period of a month or two would be useful to allow hardening between the final casting and the launching. Nevertheless, it may be found more economical and convenient to adopt this method of launching if the building berth and foreshore is suitable and if numbers of vessels can be built at one time, so that the vessels after completion can be left standing for a month or two

If the building berth and foreshore for launching require considerable piling, it will probably be advantageous to adopt side launching, which may present slightly greater difficulties in the design and construction of the fixed launching ways, but will have the advantage of enabling the vessel to enter the water several weeks earlier.

In the case of a Thames "swim" barge now being constructed by the writer, which has a length of 77 ft. x 21 ft. 6 in., and a depth of 7 ft. 3 in., with a deadweight capacity of 130 tons, it has been calculated that (a) it can be supported light by one transverse support across the centre of the bottom, and (b) that when loaded it can rest on a "camp-shed" high and dry, with one-third the length overhung, or (c) still under loaded condition be left across a small river or canal, with each end resting on a bank and one-third of the length in the centre entirely unsupported.

The seagoing tests, even in a heavy sea, should not be difficult to carry out, but the launching, bumping into other vessels, quay walls, etc., will no doubt be more severe, though it has been stated above that good local strength is provided for.

After launching, careful observation should be made to see whether the hull is watertight, and if it is found to make a little water, flooding internally will help to fill up the pores and interstices and also harden the concrete.

Cost of Construction

The prime cost of the finished reinforced concrete work for an ordinary vessel with ship-shaped lines at the present time should average £8 15s. per ton, made up with the double shuttering at 18s. per square yard for timber and 6s. 6d. for labor—the concrete at 1s. 8d. per cubic foot, and the round steel bars from £16 10s. per ton for the large diameter to £22 10s. per ton for the small diameters. Vessels with straight lines will cost less, and probably a saving of £1 to £1 5s. per ton will be made, the usual establishment charges and profit being added. These figures are based on a 300-ton deadweight coaster, and for the first vessel only. Larger vessels would, of course, show a reduction.

Assuming that the shuttering will last for five vessels of the same design, the cost of the wood could be divided over that number, but would require an addition of 10 per cent. of wood in each case to cover depreciation and damage. If the wood were coated, as mentioned on page 13, the straight shuttering might last for eight vessels and the curved for six vessels. The cost of removal and re-erection for the second and subsequent vessels might be taken at, say, 9s. per square yard for double shuttering on each occasion.

The cost of fenders, woodwork generally, fittings and equipment will be the same as for a steel or wooden vessel of the same size, but owing to the larger dimensions, will be about 8 per cent. greater for a vessel of the same deadweight.

A considerable reduction is obtainable in the labor because anglesmiths, platers, and rivetters are practically dispensed with.

Taking the hull complete and comparing with steel and wood construction, even if the steel is obtainable at £11 15s. per ton, concrete vessels of the same deadweight should, if standardized, be constructed at 20 per cent. less cost than a steel vessel, and 10 per cent. less cost than a wooden vessel.

The machinery for propulsion will, of course, cost more because of the extra displacement.

With regard to the time for construction after, say, three building berths have been prepared: with ample labor available, and after the first vessel has been cast, the one set of shuttering, so long as it lasts, should enable a barge of 130 tons deadweight to be completed and launched every ten weeks, a 300-ton deadweight coaster every sixteen weeks, and a 1,000-ton deadweight coaster every twenty weeks.

Insurance

Insurance may be a little expensive until these vessels prove their reliability, and until the classification societies are able to give them a full class.

Reinforced concrete ships will no doubt in time prove their reliability and safety, their capability of making ocean voyages, and of withstanding shocks due to seagoing conditions, and show that damage by collision will not be more serious than in steel vessels.

If so, they have a future for at least some years to come, and for river and harbor work for a much longer period in spite of the great disadvantage of the extra weight that will always be with them.

Generally, the immediate future for vessels in reinforced concrete seems substantial and most hopeful, and as a result of the many experiments and constructions now being made throughout the world, particularly in the British Isles, great improvements will be made as experience is gained; the excessive weight will be reduced, and the utility and earning power of the vessels increased.

The limitations imposed on this paper prevent a description of the features of special types of reinforced concrete vessels that are urgently wanted in this country, such as seagoing and river tugs, swim and river barges, channel and coastwise vessels, etc., and the problems that have to be dealt with in their design and construction.

Perhaps an opportunity will be given to discuss these vessels and the various specialized problems which they present in a later paper.

York Township Water Supply

Description of the Work Involved and Particulars of Contracts Let—Brief Outline of Scheme to Supply Municipality With Water

ACTIVE operations for the supply of water in districts situated to the north and west of the city limits of Toronto have been in progress since the month of May, 1917, and water was officially turned on over a limited area by Thomas Griffith, Reeve of York township, on July 13th, 1918. York township, situated north and west of the city of Toronto, occupies an area of about 54,725 acres, and has an estimated population of about 34,000. The portions contiguous to the north and west city limits, covering an area of approximately 5,500 acres, and constituting the water supply sections, have a population of about 25,000, and this is rapidly increasing. The total taxable assessment of the township in 1917 amounted to $24,204,934, of which about $11,000,000 was on property included in the water supply areas, extending from the vicinity of Avenue Road on the west to the River Humber, and from Weston to the lake front. York township has the greatest assessable value of any township in Ontario, and a very small debt for works of public utility.

As there was no municipal water supply available in the urban parts of the township, excepting for a short distance on a few streets adjoining the city of Toronto, house owners had to sink wells. The large number of such wells, more or less shallow in depth, and the location of cesspools in a populous district, caused the sanitary conditions to be unsatisfactory and a menace to the inhabitants of the township. Furthermore, there is an intimate intercommunication between the township and the city by virtue of the fact that a large number of work-people who dwell in the township are employed in the city, and, moreover, many are engaged in munition works, or in different vocations allied to munitions.

As there was a danger of contamination due to the proximity of cesspools to the water wells, and, owing to the serious handicap and expense of having to dig wells which often proved to be inadequate and had to be abandoned, the inhabitants during the last three or four years became most insistent that a comprehensive scheme of waterworks should be installed by the township. The council gave this matter every consideration, and endeavored to find a satisfactory and economic solution. They succeeded, by negotiations with the Toronto city corporation, in obtaining the necessary supply from the city system. Terms were agreed upon, and special legislative powers from the Provincial Parliament were applied for and obtained in 1916 and 1917.

After receiving the necessary authority, plans and specifications were prepared by the engineer, Mr. Frank Barber, 40 Jarvis Street, Toronto, for the more essential trunk mains, which were approved by the Provincial Board of Health, the Ontario Railway and Municipal Board, and the Commissioner of Works, Toronto. The city authorities have the right to inspect the works as they progress, as it is anticipated that some day the limits of the city of Toronto may be extended to include parts of these areas.

Contracts were let, and the following mains were laid in 1917 and 1918:—

	Diameter, Inches.	Feet.
Eglinton Avenue (part)	24	13,800
Oakwood Avenue	12	6,510
Vaughan Road	12	4,524
Wychwood Avenue	12	2,115
Weston Road	12	8,735
St. Clair Avenue	12	4,400
Jane Street and Baby Point	12	2,345
Windermere Avenue	12	2,066
Rogers Road	12	1,114
St. John's Road	12	2,750
Lambton Avenue	12	3,815
Dufferin Street	12	4,155
(About 10½ miles)		56,329

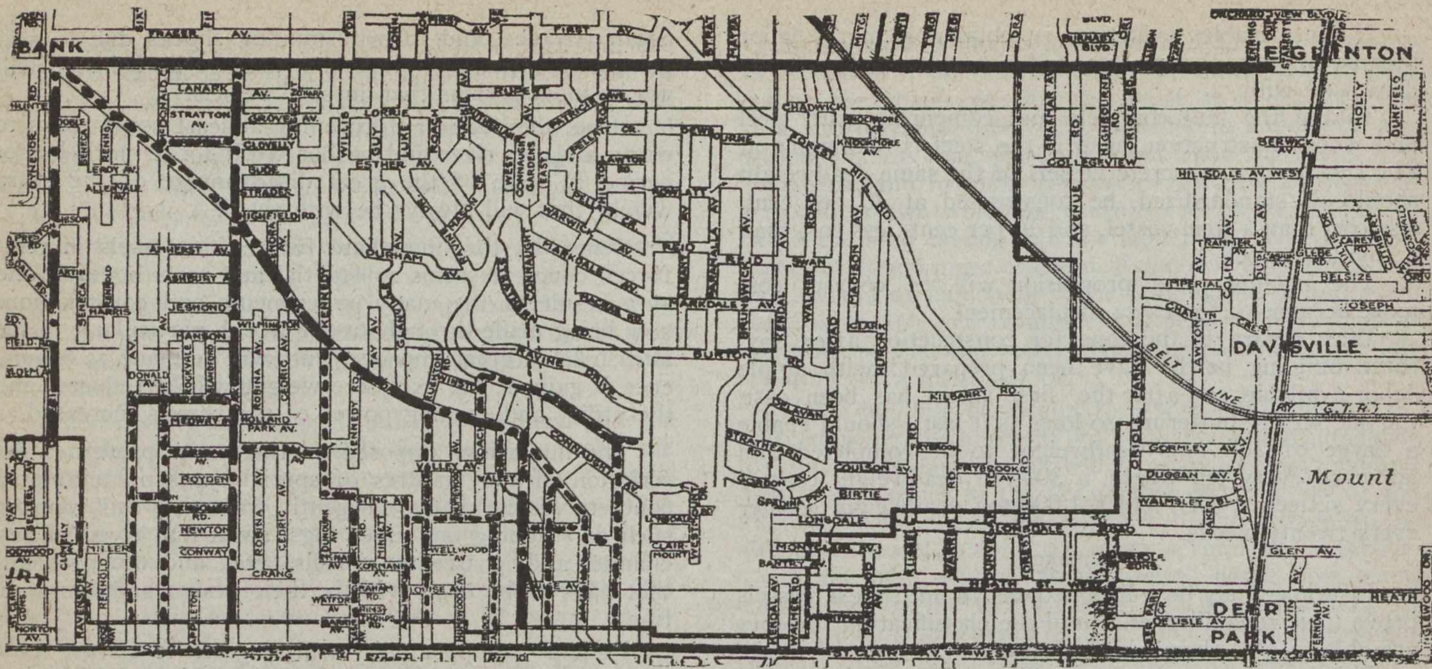


Fig. 1.

24-inch mains
12-inch mains
6-inch mains

The contractors were: For Eglinton Avenue, Jane Street, St. Clair Avenue, Baby Point Road and Windermere Avenue, Messrs. R. C. Huffman & Co.

For Oakwood Avenue, Vaughan Road, Wychwood Avenue and Weston Road, Messrs. Mitchell & Mohan.

For Rogers Road, St. John's Road, Lambton Avenue and Dufferin Street, Messrs. Orsiny Construction Co.

Work Divided Up into Sections

The scheme, as it exists at the present time, has been divided up into two main sections, that to the north of St. Clair Avenue being known as Section A, and that to

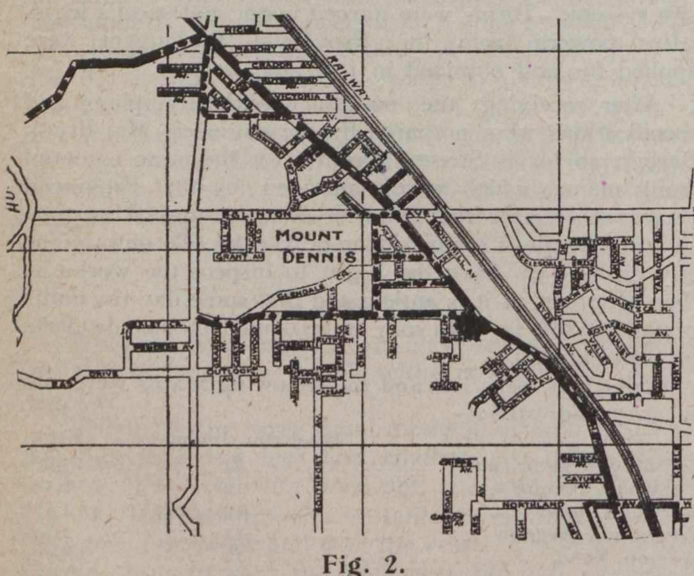


Fig. 2.

the south as Section B. These two main sections are again divided, for the present at any rate, into five sub-sections, each of which is being carried out independently of the other. Each derives, or will derive, its own independent supply of water, which is measured throughout, a meter being fixed at the various points of contact with the city mains.

Sub-section No. 1.—This consists of a 24-inch main along Eglinton Avenue, and extends from Duplex Avenue to Dufferin Street, the meter being located at a point on the city limits, about half way between Mitchell Avenue and Latimer Avenue. From the corner of Eglinton Avenue a 12-inch main follows the direction of Dufferin Street southwards as far as the city limits; another 12-inch main runs from Eglinton Avenue along Oakwood Avenue southwards to the city limits, with a short branch westwards on Rogers Road; another along Vaughan Road, in a south-easterly direction, from Oakwood Avenue to Wychwood Avenue; and another from Vaughan Road southwards along Wychwood Avenue to the city limits. Six-inch lateral mains then take care of the surrounding roads and streets, as shown in Fig. 1.

Sub-section No. 2.—This section consists of a 12-inch main running along Weston Road, in a south-easterly direction, from Jane Street to the city limits on Northland Avenue, where the meter is located. Another 12-inch main branches off along Lambton Avenue, while sundry 6-inch lateral mains take care of the area in question, as shown in Fig. 2.

Sub-section No. 3.—On this section there is a 12-inch main running along Jane Street, north of Annette, as far as St. Clair Avenue; along Baby Point Road as far as Langmuir Avenue; thence along St. John's Road, between Langmuir Avenue and the city limits, the meter being located at the junction of Jane and Annette Streets; 6-inch laterals are provided, as shown in Fig. 3.

Sub-section No. 4.—This section consists of a 12-inch main on St. Clair Avenue, between Jane Street and Runnymede Road, on the city limits, where the meter is located. (See Fig. 3.)

Sub-section No. 5.—On this section Windermere Avenue is provided with a 12-inch main between Morningside Avenue and Bloor Street West, on the city limits, where the meter is located, and 6-inch laterals take care of the neighborhood, as shown in Fig. 4.

The 24-inch trunk main in Eglinton Avenue constitutes the principal artery of the system, so far as it applies to Section A, and had to be constructed before it was possible to obtain a permanent supply in that section. The 12-inch mains are necessary to afford the foundation of a satisfactory distribution and circulation of the water supply. Consequently, it was expedient to construct these in the first part of the programme of construction. The cost of the 24-inch trunk main is to be raised by a special rate on all the rateable property in Section A. The cost of the 12-inch mains is to be divided; 55 per cent. of the entire cost of the mains, together with the entire cost of the measuring equipments on the same, is to be raised by a special rate on all rateable property in the two sections, whilst the balance of 45 per cent. is to be raised on local improvement basis, and specially assessed on lots fronting and abutting directly on the works.

The council undertakes to lay water mains only where it considers that they are urgently required, and where they can be of immediate use to the residents, so as to improve the conditions already referred to. The 6-inch mains are laid as local improvements, that is, the council finances the work and will be refunded the cost by the property owners in annual instalments during a period of ten years. Building operations for about four years have been reduced to very small dimensions, compared with the needs of the district, because of the war and the difficulty of obtaining materials and labor at a reasonable price. There is a demand for houses, and when peace is declared, the demand will be much intensified. It is, therefore, deemed expedient, as far as possible, to prepare facilities to home builders, and to organize for future employment of the returned soldiers. During the season of 1918 about forty 6-inch reticulation or distributing mains were laid, extending over a total length of about ten and a half miles. The contractors were Messrs. Peter Mohan, J. H. McKnight, Orsiny Construction Co., Angelo Cavotti, Godson Contracting Co., Grant Contracting Co., Constructing and Paving Co. and Routley Road Co. The whole of the cast-iron pipes and specials were supplied by the National Iron Works Co., valves and hydrants by Messrs. Drummond, McCall Co. and Bawden Machine Co., lead by Canada Metal Co., Venturi meter by Messrs. Allen General Supply Co., Helx meter by Messrs. Francis Hankin & Co., valve covers by Messrs. Tomlinson & Co.

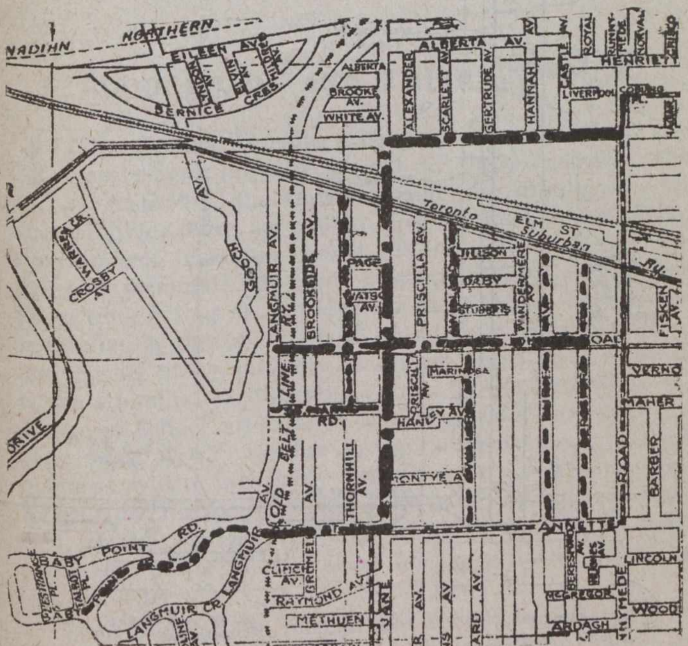


Fig. 3.

It is necessary to point out, however, that there are a large number of streets which call for attention next season. The localities known as Fairbank, Silverthorne, Cedarvale, South Swansea, Bathurst Street, Northland and Spadina Road are yet to be dealt with. The areas which require water are suburban in character, and the magnitude of the undertaking is comparable to that

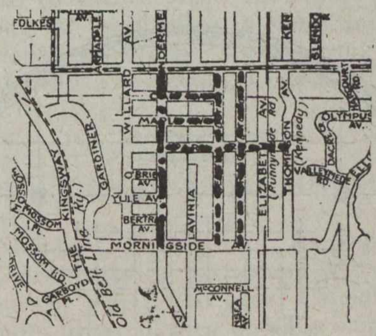


Fig. 4.

needed for a city of over 40,000 inhabitants.

The supply of water will be by meter, and the system is in charge of Mr. Hugh Hughes, superintendent of waterworks. The council consists of the reeve, Thomas Griffith; first deputy reeve, F. H. Miller; second deputy reeve, Robt. Barker; third deputy reeve, Wm. Graham; councillor, Charles McKay; clerk, Mr. W. A. Clarke. The entire work is being carried out under the direction of Mr. R. O. Wynne-Roberts, who is associated with Mr. Frank Barber.

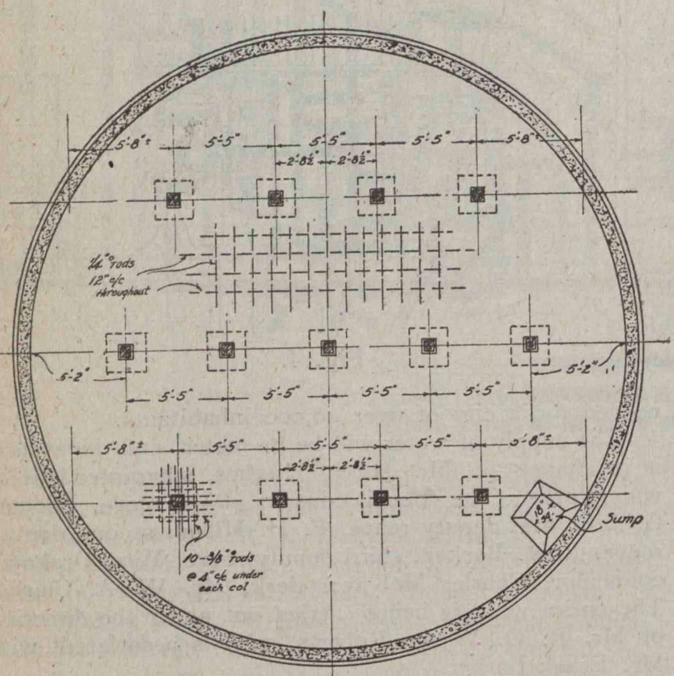
DEVELOP NEW LEAD AT RENO

Development of a new lead on the Reno Mine at Sheep Creek has been carried out during the summer by W. B. Pool, the chief owner of the property. Mr. Pool says that the new lead parallels the main vein of the property, but that it is much larger and apparently carries higher values. It averages about 3 feet in width and has been proved by stripping and crosscuts for a distance of 1,700 feet. It is within 60 feet of the original Reno vein.

The final barrier in the tunnel connecting the east and west sides of the Red River has been broken. The tunnel is to bring the Shoal Lake water to Winnipeg, and all that now remains to be done is to place the cast iron lining and fill the space between pipe and rock with concrete.

REINFORCED CONCRETE FUEL-OIL TANKS

THAT reinforced concrete, as a substitute for steel plates, readily accommodates itself to engineering design, is exemplified in the following description of a 40,000-gallon fuel-oil tank recently completed at St. Catharines, Ont. Underwriters' regulations, as they exist, compel the building of such tanks underground, and their design, therefore, includes certain features peculiar to themselves. The cylinder becomes a circular retaining wall, which, when empty, is subject to an external circular thrust only, and the roof is required to carry a permanent, distributed dead load of earth, besides a possible live load, such as a heavily-laden wagon or motor lorry. The tank in question has an earth covering of two and one-half feet, or two and one-half cubic feet per foot of area, which, at 100 pounds per cubic foot of material, say, makes a permanent dead load of 250 pounds per square foot, irrespective of any intermittent live load.



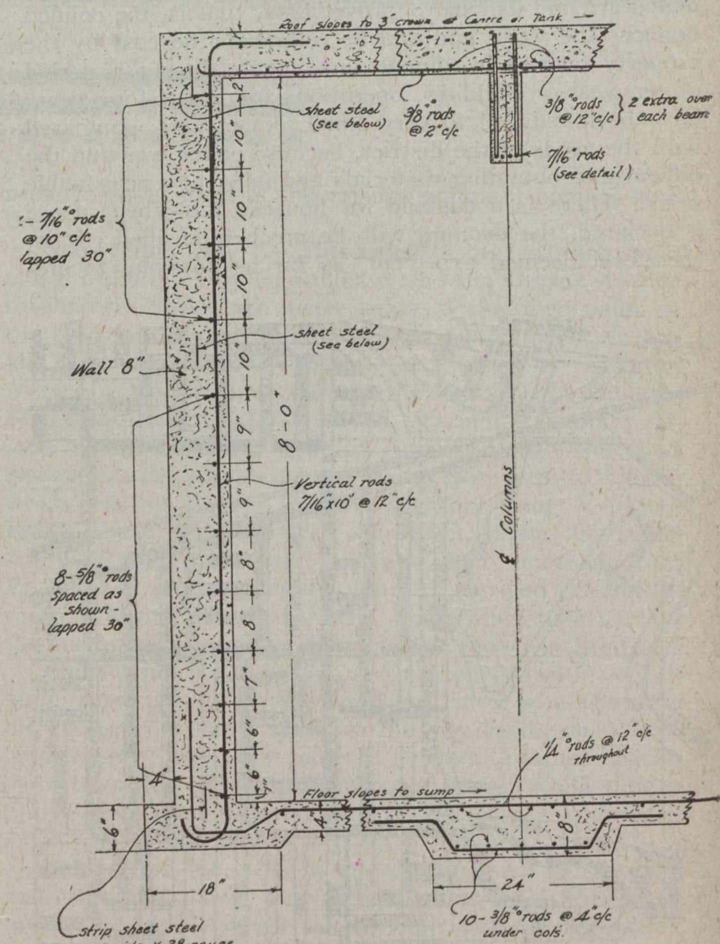
Floor Plan

Dimensions

The principal dimensions of the tank here illustrated are, internal diameter 32 feet and internal dep h 8 feet. The roof slab is provided with three ribs, or beams, 4 inches by 12 inches, which rest on columns, 6 inches by 6 inches. The floor is 4 inches thick, increased to 6 inches under the wall, and 8 inches under the columns; the wall is 8 inches and the roof slab 6 inches. The reinforcing was adapted to the material on hand, and, as there happened to be an adequate supply of ⅜-inch diameter rods on the premises, that size was largely adopted, otherwise a heavier rod might have been used, with spacing modified to suit.

Execution of Work

In order to reduce the cost of excavation to a minimum, the intention was to excavate a solid shaft of earth, the cross sectional area of which was covered only by the external circumference of the tank. By this method the face of the cut acts as the back form, and, as soon as complete, the tank would be already back-filled. If the material could have been relied upon to stand vertically upright (for a distance down of about twelve feet), long enough not only for the concrete to be poured, but also for it to set up, all well and good, but it is a method which does not readily accommodate itself either to rainy weather or to every kind of material. Some trouble was experienced in respect of both those points, though it was overcome by judicious handling. For the inside face of the tank steel forms were used, consisting of plates two and one-half feet wide, bent to the required radius, and stiffened by means of a bent rail. The wall was built up in rings, two and one-half feet wide, and a careful watch had to be kept to see that pieces of earth did not slip into the newly-poured concrete. Sheet steel strips, four inches wide, were inserted at intervals, or on completing a pour, the half of which was left projecting to help form a bond with the next batch. They served also to prevent any loose earth, which might have slipped into the concrete unobserved, from getting near the inner face of the wall. For the successful application of concrete to this class of work two conditions are essential. The concrete itself must be rich, and the whole worked up into a good, homogeneous conglomerate. Failure to observe either of these conditions results in leakage, as poor concrete is not oil-tight.



Section of Tank Wall

The design and execution of the tank herein described, together with a similar one now in course of construction, is the work of Mr. J. L. Weller, of St. Catharines, late engineer-in-charge of the Welland Ship Canal.

The annual meeting of the Engineering Institute of Canada for 1919 will be held in Ottawa.

The Canadian Engineer

Established 1893

A Weekly Paper for Canadian Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

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

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

Principal Contents of this Issue

	PAGE
Drifting Sand Filter, Toronto Island, by Col. Geo. G. Nasmith, and N. J. Howard	359
The World's Present Power Demand	364
Increase of Waterworks Operating Expenses and Re-adjustment of Rates	364
Proportion of Rates to be Borne by Cities and Towns as Compared to Domestic Consumers, by J. J. Moore	365
Compressed Air Terms	366
Reinforced Concrete Vessels, by Walter Pollock	367
York Township Water Supply	373
Reinforced Concrete Fuel-Oil Tanks	376
Personals	378
Obituary	378
Construction News	48
Where to Buy, An Engineering Trades Directory	60

GOOD ROADS AND THEIR INCOMES

THE economic benefits arising from country road improvement may be placed in three classes: the measurable, the tangible, and the intangible. Of the tangible, there are many. For instance, there is the development of motor traffic, linking more closely the railroad terminal city and country village, and at the same time acting as a feeder for the railroad itself. The reduction in the upkeep cost of automobiles must alone amount to many millions of dollars annually. Another is the stimulus to education, shown by the immediate increase in school attendance accompanying any road improvement. Still another is the improvement in local business which invariably follows in the sections contiguous to the betterment. Less tangible, but no less real, is the increase in direct distribution which must come with better roads. These are but a few of the more obvious effects.

Then there is the measurable benefit, which must be regarded as the direct return to the community upon its investment in road betterment. It lies in the difference between the hauling cost over a road before and after it has been improved. Of course, this is subject to considerable variation, depending as it does upon the condition of the road before improvement, as well as upon other factors. Nevertheless, it cannot be disputed that the reduction in all cases is very large.

This measurable benefit should be given the important consideration it demands when a community is thinking of borrowing money for road improvement. An investment therein returns an annual income to the community, arising from the reduction in cost of haulage. This reduction may be termed, as the railroads are disposed to call it, an operating income. While many factors influence it, it may be estimated with conservatism, for, while basing an estimate on existing tonnage over the road, there is always a decided increase in annual tonnage as a result of the improvement and a corresponding increase in operating income.

As we all know, the railways spend millions of dollars in the effort to reduce the ton-mile cost of hauling freight only two or three miles. It is, they find, money well invested, and it is illustrative of what may happen in the development of better roads when the people of this country come to realize that such improvement may mean a saving on the hauling of many millions of tons not of a fraction of a cent, but a saving which may amount to as much as 10 cents, 5 cents, or even 2 cents, per ton-mile.

VICTORY BONDS AS AN INVESTMENT

NEXT Monday, October 28th, the selling campaign in connection with the second Victory Loan will commence, and it behoves Canadian engineers and contractors to do all they possibly can to ensure the campaign proving a complete success.

Apart altogether from other reasons, the opportunity to invest money safely and at a good interest rate should be a sufficient argument to buy Victory Bonds to the limit.

The investment is as safe as an investment can possibly be, for, unless Germany should win, there is not the most remote possibility of loss. If the unthinkable should happen and Germany win, everything would be lost anyway.

The cry, "Its millions for defense or millions for indemnity," is not mere playing with words.

The rate of interest is attractive—is much higher than that paid by the banks—and practically as high as the average man can get without taking risks.

SHIPBUILDING IN CANADA

HEALTHY competition is the essence of business, and enemy ruthlessness afloat, whatever else it may have done, has aroused a spirit of competition in regard to shipbuilding throughout the British Empire, and beyond, which the termination of the war will only serve to accentuate. The British Empire, of which Canada is a part, views with satisfaction the prospect of the moment, which tells of ship after ship being built, launched and placed in commission by one or other of the allied powers in allied effort to complete the overthrow of the common enemy. For as long as the war lasts Canada can look with equanimity upon the efforts of her neighbors as being a means to an end, but the time has come when it might be worth while to reflect on their probable post-war effort. America, for example, is not likely to throw away a trade which she has long sought to possess, and which the fortunes of war have placed within her grasp. It is not likely that she has built great shipyards, like the one at Hog Island, near Philadelphia, with a frontage of two miles on the Delaware River, "for the duration of the war" only. Nor is it likely that either of the other new Government yards, let alone the numerous private concerns, will be closed down when the end of the war comes. On the other hand, it is more than likely—it is an absolute certainty

—that they have come to stay, and that America will prove to be a formidable competitor in the shipbuilding industry.

The competition that Canada will meet with will not be overwhelming, but it will be accentuated by a not unnatural desire on the part of her neighbors across the border to hold what they have. It behoves Canada, therefore, to gird herself for still greater effort if she wishes to retain a reasonable share of the shipbuilding trade which, at the end of the war, might otherwise slip through her fingers.

The recent statement of Lloyd George that you cannot build an A1 empire on C. B. citizens has been taken by nearly all the British newspapers as foreshadowing the early constitution of a health department, with a minister of public health at the head, under whom there should be a co-ordination of all the existing agencies dedicated to public health. In November, 1917, *The Canadian Engineer* suggested the establishment of a federal department of health for Canada.

PERSONALS

W. A. Pitt has been appointed assistant master car builder at the Montreal shops, G.T.R. system.

J. Brooks, of the G.T.R. system, has recently been appointed assistant master car builder, London shops.

C. H. Towle, of the C.P. Ry. Co., has been appointed assistant superintendent of the Smith's Falls Division.

C. Gribbon has recently been appointed division master mechanic of the London Division, C.P. Ry. Company.

J. N. Clark has been appointed master car builder for Ontario lines, G.T.R. system, with headquarters at London, Ont.

R. W. Scott, of the C.P. Ry. Company, has recently been appointed successor of W. J. Uren as superintendent of the Trenton Division.

J. E. Johnson, division engineer of the Michigan Central R.R. at St. Thomas, Ontario, has resigned in order to enter private business.

R. A. Sewell has been appointed to succeed P. W. Scott as assistant superintendent of the Montreal Terminals Division, C.P. Ry. Company.

W. S. Shaw, Jr., has been appointed division engineer of the Michigan Central R.R., in charge of the lines in Canada, with office at St. Thomas, Ontario.

T. A. Wilson, of the C.P. Ry. Co., has been appointed superintendent of the Smith's Falls Division in place of J. K. Savage, who has recently been promoted.

C. V. Johnson, chief engineer of Jas. Gosselin, Ltd., engineers and contractors, Quebec, has resigned. He has become associated with the Foundation Co., Ltd., Montreal.

Mr. Walton, of the C.P. Ry. Company, has been appointed division master mechanic of the Farnham Division. He is successor to Mr. Wells, who has recently been transferred.

M. H. MacLeod, who for a number of years has been general manager of lines west of Port Arthur, has been appointed vice-president of the entire Canadian Northern Railway system. His headquarters will be in Toronto.

Lieut.-Col. R. W. Leonard is to be the president of the Engineering Institute of Canada for the coming year. Col. Leonard was born in 1860, and graduated from the Royal Military College, Kingston, in 1883. He has had very wide and important experience, particularly along railroad engineering lines. He is now president and manager of the Coniagas mines. During the North-West Rebellion he served as staff officer of transport.

OBITUARY

Lieut.-Col. W. Mahlon Davis, formerly city engineer in Woodstock, Ont., died at Ottawa. He recruited a battalion in the Kootenay, but upon arriving in England received an injury which prevented him going into active service.

Hugh Leonard Phillips, B.Sc., died at his home in Cornwall on October 13th of Spanish influenza. He was 28 years of age, graduated from Queen's University in 1912, and has since been connected with various engineering schemes in eastern Ontario. At the time of his death the late Mr. Phillips was assistant to J. G. Cameron, county engineer.

There appears to be further indications of need for adjustment of boundaries between the O'Brien Mine and the Violet property of the La Rose Company. Apparently through lack of definite determination of boundaries, there is a possibility of a portion of the La Rose working being outside the Violet boundaries. Surveyors are said to have been employed in making a survey or re-survey of the ground. The Violet property adjoins the Violet Mine on the east. Development during the past few months has opened up considerable low grade ore as well as a small tonnage of high grade.

At the Saskatoon meeting of the Engineering Institute of Canada held August 8th to 10th, a resolution was passed asking the council of the institute to appoint a committee to investigate the action of alkaline salt on concrete. This question was brought up at the last meeting of the council and authorization was given for the establishment of such a committee. The various branches have since been asked to send in nominations and it is expected that at the next meeting of the council the personnel of the committee will be ratified and the committee authorized to proceed with this work under the direction of the council.

Though, states a contemporary, Switzerland led the world in the early electrolytic production of aluminum. France has been the chief producing nation since 1896, and supplied as much as 39.2 per cent. of the world's annual total at the time of the outbreak of the war. The ten plants for electrolytic aluminum had in 1914 an aggregate of 140,000 horse-power, with a capacity of 19,000 tons a year. The three plants of the United States supplied 25.8 per cent. of the world's production; the two plants of Switzerland, 12.4; the two English plants, 7.8; the one Canadian plant, 5.2; and the two plants of Norway, 4.3. French supremacy is due to the superior quality of the bauxite mined.