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SOUTH CANTILEVER ARM, QUEBEC BRIDGE

IN THIS ARTICLE THERE ARE GIVEN SOME INTERESTING DETAILS OF THE PROGRESS MADE DURING THE PRESENT SEASON.

By A. J. MEYERS, Assoc.Mem.Can.Soc.C.E.
Chief Draftsman, Board of Engineers, Quebec Bridge Commission.

THE material for the new Quebec Bridge, erected on the south shore of the St. Lawrence River during the season of 1915, amounted to approximately 17,000 tons of bridge material and 3,000 tons of falsework. This steel was placed by one traveller in about five months' working time, and consisted of inside falsework carrying the anchor arm floor and traveller tracks, the outside staging carrying the anchor arm truss material, sway and lateral bracing, and the complete erection of the south anchor arm, including the main post and the links at the top of the main post, connecting the top chords of the cantilever and anchor arms.

At the close of the working period of 1915, the traveller was standing over the south main pier, prepared to begin the erection of the south cantilever arm as soon as the working season of 1916 opened.

The erection of the 13,000 tons of steel in the south cantilever arm was properly started about the first of April, 1916, by which time the traveller machinery and tackle had been thoroughly overhauled and put in working condition.

As illustrated in Diagram I., the bottom chords of the cantilever arm were erected by means of an erection bridge which temporarily supported the different parts of the chords until they were properly aligned, the splices riveted up, and the pins connecting the chords to the web members of the truss were driven.

The bottom chords throughout the cantilever arm are made up of four vertical plate girder webs, laced together longitudinally in three horizontal planes. They are built entirely of nickel steel. The largest section in the first main panel adjacent to the main pier has a cross-sectional area of 1,630 square inches, with outside dimensions of cross-section 84 inches deep by 124 inches wide. Each main panel of the bottom chord was divided into two half panel sections, the members being fully spliced at this half-panel point in material and rivets, as well as being accurately faced to as nearly a perfect bearing as modern shop equipment and machinery could make possible. Each half section was again divided vertically along its longitudinal centre line. The members were shipped and handled in these sections, the heaviest section weighing 160,000 pounds.

Traveller placing, at the same time, sections of the bottom chord for both the east and west trusses on the erection bridge. Total weight lifted, 320,000 lbs.

Each section was handled by means of specially designed and tested hitches, bolted to the top flanges, two sets of hitches to each section. The sections were lifted from the cars in pairs at the same time, one section for the east truss and the corresponding section for the west truss, all four of the 55-ton hoists of the two traveller cranes

[For other articles on the Quebec Bridge readers are referred to the following issues of *The Canadian Engineer*:—April 9, 1914; July 9, 1914; November 12, 1914; December 31, 1914; September 23, 1915; June 1, 1916.—EDITOR.]

being used, one hoist of each crane to a section. The traveller, therefore, lifted and placed at one time approximately 320,000 pounds. The sections, after leaving the cranes, were fleeted apart until they hung vertically over their final positions in the bridge, when they were lowered into place on the erection bridge.

The erection bridge was a complete erection unit entirely and was handled as such. It was made up of four longitudinal plate girder webs of a length equal to the longest main panel of the cantilever arm. These webs were placed together in pairs under each cantilever arm chord. The pairs of webs were braced together by two transverse plate girder webs with a lateral system of their own. These transverse plate girders were used to support the bottom lateral members until they were connected up to the chords. The two girders of each pair were connected together by a bottom lateral system and cross girders which served as seats for the jacks which were used for aligning the chords to make the splices and jacking up the completely riveted chord to make the pin connections to the web members above.

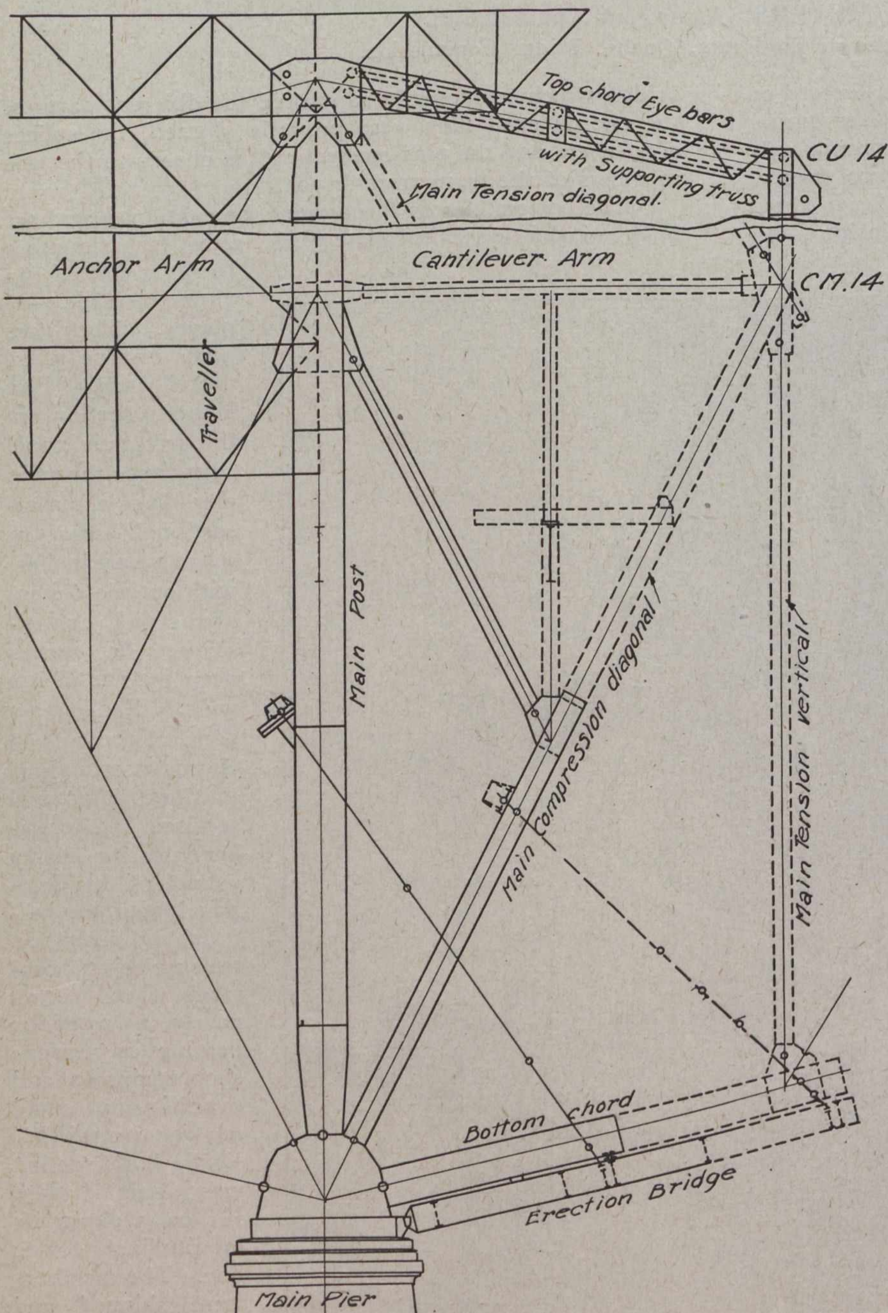


Diagram I.

The main compression diagonals are built members with an arrangement of cross-section similar to that of the bottom chord members but of much smaller area. They are spliced, shipped and handled in a similar manner to that of the bottom chord members. Those in the panels next to the main pier, where the weight of the member has very little influence on the stresses in the remainder of the bridge, are made of carbon steel. In all the other panels of the cantilever arm these diagonals are made of nickel steel. They were supported and adjusted, while their splices and end connections were being made, by means of tackle leading from the sub and main panel points of the diagonal to the bridge members in the panels already completed.

The main tension diagonals are built up of four plate girder webs; the webs are connected and riveted together in pairs by means of lattice bars and tie plates; the pairs are connected together by means of spacer tie plates. The largest of these tension diagonals, in the panel next to the main pier, is 150 feet 6⅛ inches centre to centre of end-connecting pins. For this member each pair of webs was shipped to the bridge site in three sections, making up the total length of the completed member. Before erection, these sections were assembled together on the floor of the bridge between the bridge trusses and the traveller. The splices were here completely riveted; each pair of webs was then hoisted in one piece into position separately by the traveller. These main tension diagonals were all of nickel steel except those in the panel next to the main pier.

The pin-holes at the lower end of the main tension diagonals and at the upper end of the main tension verticals, were slotted ¼ of an inch on the side remote from the bearing surface in order to facilitate the driving of the last connecting pins. The main tension verticals were all built of nickel steel and were designed similarly to the main tension diagonals. They were spliced, shipped and handled in a similar manner.

All the main compression verticals were similar in built-up construction to the main compression diagonals, and were handled in the same way. They were temporarily supported during erection by means of tension anchor bolts at the lower end of the members. These anchor bolts engaged brackets on the compression verticals and reaction brackets on the gusset plates of the main middle or "K" joints. The anchor bolts were thrown into tension by means of tackle which attached to the upper end of the members and by means of which the members were tied back to and supported by the truss material already erected.

The main panel top chords in the cantilever and anchor arms are composed of two lines of eyebars, spaced 3 feet 6 inches centre to centre vertically, the one above the other. Each panel of eyebars in all panels over 50 feet in length is made up of two lengths of eyebars per panel, pin-connected to each other at the middle point of each panel where the weight of the pins and one-half the weight of the eyebar is taken by a pair of supporting trusses. The eyebars were assembled with the supporting trusses in the storage yard and the middle pins put into place. They were then taken out on the bridge and hoisted into position, as shown in Diagram I., one-half the bars in each panel being placed at one time. As soon as the eyebars and supporting trusses were erected the adjusting links, illustrated in Diagram II., were placed in position.

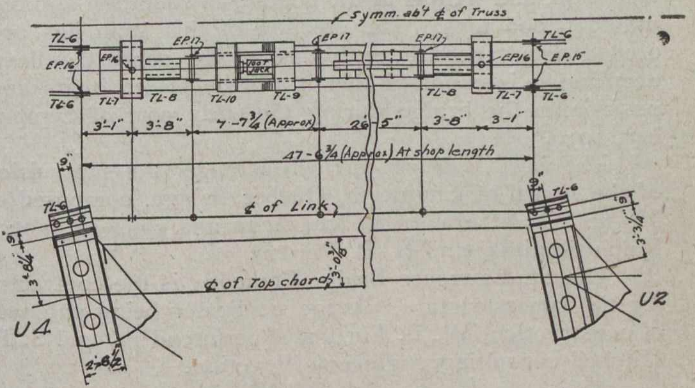
The top chord eyebars had the pin-holes at the end of each panel slotted ¼ of an inch on the side remote from the bearing surface, and these adjusting links were used to draw the top chord main panel points together so that the top chord pins could be easily driven in the elongated pin-holes of the eyebars. These top chord links also took care of any erection stress in the top chord panel until the eyebar pins at each end of the panel were driven.

The erection of the first main panel of the south cantilever arm was completed by April 28, 1916. The number of days, 10 hours to each day, actually worked was 22½, 2½ days only having been lost on account of high winds and rainy weather. The amount of steel erected during this time was approximately 3,100 tons, and included the placing of the largest, longest, and heaviest members of the cantilever arm. An average of 200 men for each working day were employed on the work, including from six to eight gangs of riveters.

The material in the second main panel weighed in the neighborhood of 2,650 tons, and was erected by May 26th—in 18 working days. The 1,960 tons in the third main panel was placed by June 12th—in 13 working days. As the traveller progressed towards the end of the cantilever arm, the members handled were lighter and the field splices fewer and smaller; the rate of progress was, therefore, greatly increased. By July 10, 1916, the traveller was standing at panel point 4, having completed the erection of six main panels. The fourth, fifth and sixth main panels were erected in 22 working days, the total weight of steel placed in this time amounting to approximately 3,600 tons.

The traveller was moved to its last position at the end of the seventh main panel on July 20th. The last two main panels were erected in 18 working days, the tonnage placed being about 1,280 tons.

The south cantilever arm, the erection of which was



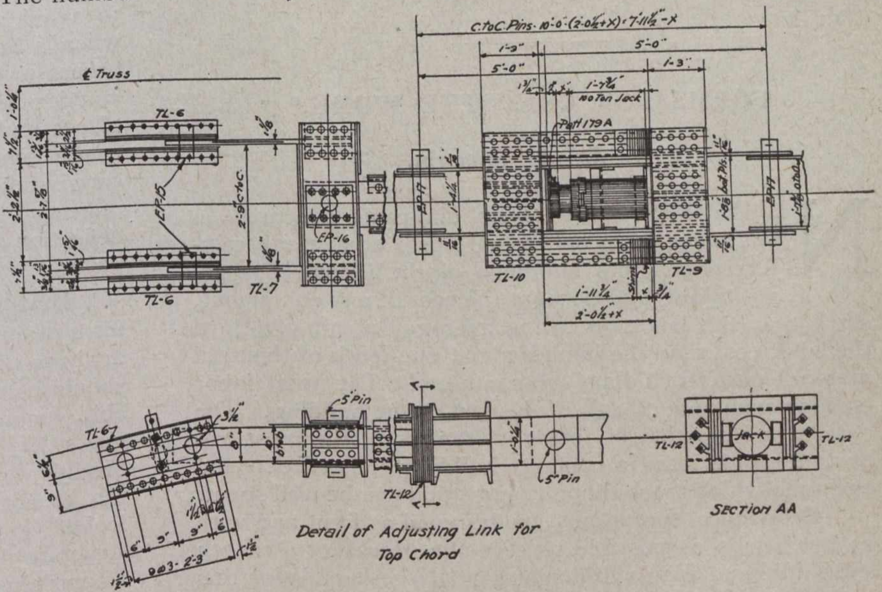
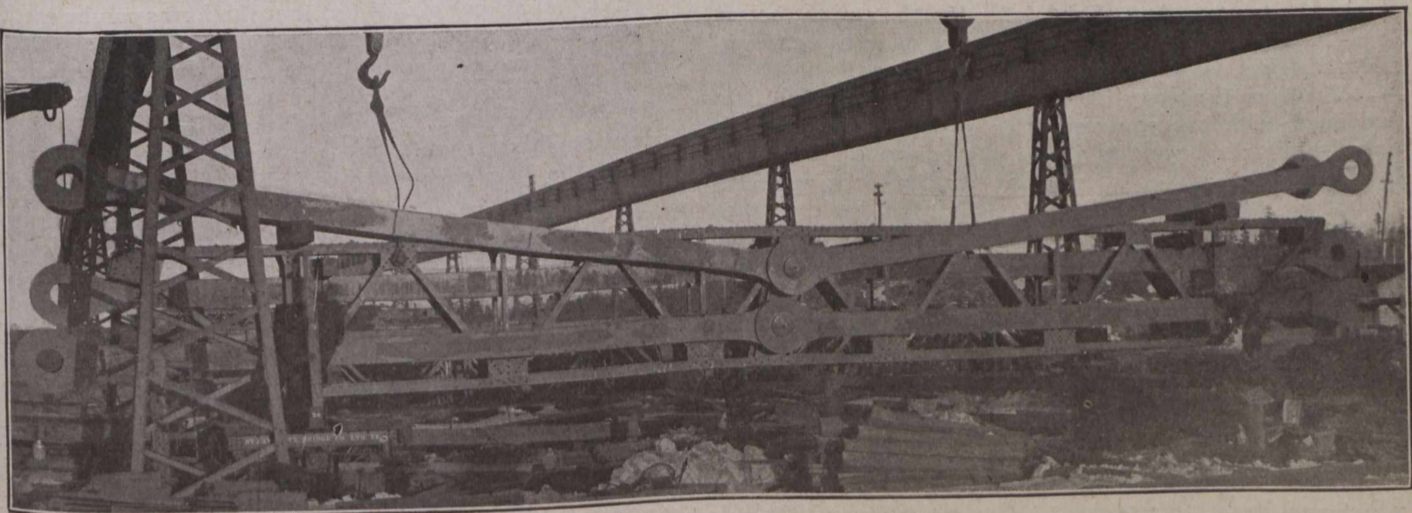


Diagram II.—Detail of Adjusting Link.

begun April 1, 1916, was completed by July 28, 1916. The total weight of steel placed was about 13,000 tons; the actual number of days worked was 92, about 27 days being lost from inclement weather, Sundays and legal



Top chord eyebars, assembled with the supporting trusses in the storage yard, before being taken out on the bridge for erection.

holidays. This cantilever arm was completed in over 25 per cent. less working time than was taken for the north cantilever arm, and over a month ahead of schedule time. With the completion of the south cantilever arm the bridge is in readiness for the floating in and hoisting into place of the suspended span. This span is 640 feet long, 88 feet wide, and weighs in the floating-in condition approximately 5,000 tons. The erection of this span has proceeded simultaneously with that of the south cantilever arm and it is expected that it will be placed in its final position in the bridge during the early part of September, 1916.

The work is being carried out under the supervision of the Board of Engineers, Quebec Bridge, composed of Messrs. C. N. Monsarrat (chairman and chief engineer), Ralph Modjeski and H. P. Borden.

The St. Lawrence Bridge Company is the contractor for the superstructure, George F. Porter being engineer of construction, W. B. Fortune superintendent, and S. P. Mitchell consulting engineer of erection.

FORMS FOR CONCRETE WORK.*

By R. A. Sherwin.

NUMEROUS cost-analysis diagrams prepared in our office from the actual costs of average reinforced concrete buildings of the industrial type, not taking into account the cost of any equipment, show that the labor on forms averages about one-third the labor cost, and the lumber about one-tenth of the total material cost, including sub-contracts. The total labor cost is usually about 35% of the cost of the building. The design and erection of forms is, therefore, the most important single item in concrete building construction and one upon which much thought and study can be well spent.

Economical forms must be designed as light and with as few sticks as possible to give the necessary strength and stiffness. You will note I say "Necessary," for this is the point to keep in mind. We must remember on the one hand that human lives and the cost of failure, both in money and reputation, are dependent upon the design, and, on the other, that forms are temporary structures loaded fully for a short time only. A low factor of safety is therefore allowable.

The main question, then, is one of strength with enough stiffness to prevent any appreciable sags in the finished concrete. Any slight deflection that might occur in the timbers themselves is taken care of in the camber always given horizontal members in erection.

The floor timbers should be designed for the full live and dead load, but any serious deflection will be caused only by the dead weight of the wet concrete. The full live and dead load can act together for only a short space of time. Therefore, I think that limiting the centering by small deflections and using full live and dead load is questionable practice. One place where deflection should be carefully guarded against is at the window-head. At this point a slight deflection will cause much trouble and expense in setting the sash.

The principal cause of settlement of form work is crushing of the soft spruce or pine lumber perpendicular to the grain in the girt over the post, and also in the adjustment of the wedges under the posts as the full load is applied. In this connection, Professor Johnson, on page 468 of his "Materials of Construction," says: "Since timber is very weak in crushing across the grain, as compared to crushing endwise, this is found to be one of the most common methods of failure in practice. It is common to rest a timber column on a sill of the same wood and to design the column for its maximum working load, paying no attention to the utter inability of the sill to carry this load without crushing. Many failures of timber structures are due to this cause alone." An average safe value to use in form design for this crushing stress, as determined by numerous tests, is 400 lb. per square inch for spruce. Considering this stress, a 4 by 4-in. spruce post under a 4-in. wide girt is good for 6,400 lb. The trouble due to wedges can be almost entirely eliminated by using large hardwood wedges. If the posts are cut square at the ends to give an even bearing and heavy wedges used to bring the posts to grade, no settlement will occur.

Posts are usually placed on a plank sill. When these sills are laid on the ground great care is needed in order to avoid settlement because of deflection in the plank when a hollow place comes under the post. This often occurs when sills are placed on frozen ground, and salamanders thaw out portions of the surface and cause soft places under the sills. When light sills are placed on a rough concrete floor, deflection is liable to occur unless care is taken to give the sills an even bearing. For these reasons I believe that limiting the floor timbers to small deflections and at the same time using high loads on the posts is not consistent, and surely not economical.

Design.—The first thing to be done in preparing a form design for a concrete structure is to make a careful analysis of the plans submitted by the engineer. This should be done as soon as the preliminary plans are available, for many details which seriously affect both the progress of the work and the cost of the forms may be brought to the engineer's attention and changes made for the benefit of the owner. These points are often overlooked by the engineer, who does not always look at the structure from the construction point of view. Chief among these points is that of story heights. It is desirable that these heights be kept uniform throughout the building so that the column forms can be re-used from story to story without either cutting off or splicing. Failing this, it is better to have the high stories at the bottom, as cutting off forms is much cheaper than splicing them.

Another important point is that of joints. I refer only to construction joints. These should be planned and the reinforcement detailed so that the forms can be erected in the simplest possible manner. These joints should, of course, come at a natural stop for a day's work and be located so that they will least affect the appearance of the finished structure. The position and detail of any expansion joints should be determined early, as they will affect the form design and probably require special study.

An example of a detail to be considered in connection with the question of joints is the important one of making the dowels for the column rods long enough so that the necessary lap will come above the point where the column forms will actually start. For example, it is not uncommon to find a wall beam, which comes above the slab, detailed so that it must be cast with the floor, but at the same time to find the lap for the column rods shown above the top of the slab instead of above the top of the wall beam, as it should be. It is economical to cast a curtain-wall beam, used sometimes in mushroom construction, as a later operation. The forms can be made and erected more cheaply. This can easily be arranged for by providing pipe sleeves through the column to take the

* Abstract from paper presented at the convention of the American Concrete Institute, Chicago, February, 1916.

negative-stress rods and a slot in the column as a seat for the beam.

The kind of windows must be decided upon at once so that the necessary groove strip can be scheduled and attached to the column sides and beam bottoms.

The floor finish will affect the form design. Questions as to the thickness of wood floor, or if granolithic, whether it is to be placed with the slab or as a separate operation, must be decided before the form design can proceed.

In calculating the sizes of form members, we do not use a standard set of loadings, formulae, etc., for all cases, but treat each one separately, according to conditions. In general, we use the following values:

Dead weight of concrete	150 lb. per cu. ft.
Construction live load on floor forms	75 lb. per sq. ft.
Pressure of concrete on columns and walls per foot of depth	140 lb. per sq. ft.
Coefficient of elasticity for spruce or equal	1,200,000
Extreme fibre stress in spruce or equal:	
For timbers	1,200 lb. per sq. in.
For column yokes	1,800 lb. per sq. in.
Horizontal shear for spruce or equal	200 lb. per sq. in.
Crushing perpendicular to grain in spruce or equal	400 lb. per sq. in.

The proper value for the equivalent hydraulic pressure of concrete to use in form design has been variously estimated all the way from 75 lb. per sq. ft. of depth to twice that amount. The value of 140 lb., noted above, will give safe results and is based on actual experiments under job conditions.

Timbers used as joists to support floor forms are figured for the full live load of 75 lb. per sq. ft. plus the dead load of the slab, on jobs where side-dump cars carrying a four-bag batch of concrete are used for distribution. Table I. has been prepared on this basis, using the simple beam formula. This will take care of the worst case and places the greatest factor of safety where it is most needed.

On jobs where buggies, barrows, or chutes are used for placing concrete, the spacings and spans given in the table can be increased because the live load will be a great deal less. It is doubtful if the full live and dead loads act at the same time in any case.

The span of the joist is usually fixed by the position of the girts. The position of the latter is determined by the column spacing in a mushroom floor and by the beam spacing in beam and girder construction. The spacing of the joists is kept as near 24 in. as possible in order to work the ⅞-in. panel decking to the limit. The spacing of joists once determined should be kept standard for the job, so that when the panels are re-used their cleats will not interfere with the joists previously placed.

Table II. gives the spacings of posts under the girts for various spans of joists and thicknesses of slabs. These tables were calculated for a 24-in. spacing of joists. The concentrated loads from the joists were used on a simple span in calculating the bending moment. The worst case, when one joist comes at mid-span, was used in this calculation.

It will be noticed that the full live load was also used in preparing this table. However, since the full live load will never get to the girt and the span of the girt is always continuous for at least two spans, the moment of resistance of the sticks has been multiplied by 1.2.

The load on the posts is next found. This load is usually far below its allowable load as a strut, but, as has been stated, the latter may cause an excessive crushing stress perpendicular to the grain in the girt at the top of the post. It is therefore well to play safe at this point, especially where granolithic finish is to be cast with the slab. A "dish" in the finished floor is often caused by settlement in the panel due to this cause. A drop of ⅜ in. is not uncommon if soft wedges are used.

Table I.—Spacings and Spans for Joists.

Slab Thickness, ins.		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Weight, lbs. per sq. ft.[1]		112.5	125.0	137.5	150.0	162.5	175.0	187.5	200.0	212.5	225.0
Size of Joists, ins.	Spacing of Joists, ins.	Span of Joists in Feet.									
2×6[2]	18	7.2*	6.9*	6.5*	6.3	6.0	5.8	5.6	5.4	5.3	5.1
"	20	6.9*	6.5*	6.2	5.9	5.7	5.5	5.3	5.1	5.0	4.8
"	22	6.5*	6.2	5.9	5.7	5.4	5.2	5.0	4.9	4.8	4.6
"	24	6.3	5.9	5.7	5.4	5.2	5.0	4.8	4.7	4.6	4.4
"	26	6.0	5.7	5.4	5.2	5.0	4.8	4.7	4.5	4.4	4.2
"	28	5.8	5.5	5.2	5.0	4.8	4.7	4.5	4.4	4.2	4.1
"	30	5.6	5.3	5.1	4.9	4.7	4.5	4.3	4.2	4.1	4.0
2×8[3]	18	9.7*	9.2*	8.8	8.4	8.1	7.8	7.6	7.3	7.1	6.9
"	20	9.2*	8.8*	8.3	8.0	7.7	7.4	7.2	6.9	6.7	6.5
"	22	8.9*	8.4	8.0	7.6	7.3	7.1	6.8	6.6	6.4	6.2
"	24	8.4	8.0	7.7	7.3	7.1	6.8	6.5	6.3	6.1	6.0
"	26	8.1	7.7	7.3	7.0	6.7	6.5	6.3	6.1	5.9	5.6
"	28	7.8	7.4	7.1	6.8	6.5	6.3	6.1	5.9	5.7	5.5
"	30	7.5	7.2	6.8	6.5	6.3	6.1	5.9	5.7	5.5	5.3
2×10[4]	18	12.2*	11.6*	11.0*	10.6	10.2	9.8	9.5	9.2	8.9	8.7
"	20	11.6*	11.0*	10.5	10.0	9.7	9.3	9.0	8.7	8.4	8.2
"	22	11.1*	10.5	10.0	9.6	9.2	8.9	8.6	8.3	8.0	7.8
"	24	10.6	10.0	9.6	9.2	8.8	8.5	8.2	8.0	7.7	7.5
"	26	10.5	9.6	9.2	8.8	8.5	8.2	7.9	7.6	7.4	7.2
"	28	9.8	9.3	8.9	8.5	8.2	7.9	7.6	7.4	7.1	6.9
"	30	9.5	9.0	8.6	8.2	7.9	7.6	7.3	7.1	6.9	6.7

[1]Weight includes dead load of slab plus 75 lb. per sq. ft. live load.

[2]Span which will develop 1,200 lb. per sq. in. fibre stress and deflection of

$$\frac{\text{Span (in.)}}{360} = \frac{5 \times 360 \times 1{,}200 \times 2}{48 \times 5.75 \times 1{,}200{,}000} = 77 \text{ in. or } 6.4 \text{ ft.}$$

$$Mr = 2 \times 5.75^2 \times 1{,}200/6 = 13{,}200 \text{ in.-lb.}$$

[3]Span which will develop 1,200 lb. per sq. in. fibre stress and deflection of

$$\frac{\text{Span (in.)}}{360} = \frac{48 \times 7.75 \times 1{,}200{,}000}{5 \times 360 \times 1{,}200 \times 2} = 103 \text{ in. or } 8.6 \text{ ft.}$$

$$Mr = 2 \times 7.75^2 \times 1{,}200/6 = 24{,}000 \text{ in.-lb.}$$

[4]Span which will develop 1,200 lb. per sq. in. fibre stress and deflection of

$$\frac{\text{Span (in.)}}{360} = \frac{48 \times 9.75 \times 1{,}200{,}000}{5 \times 360 \times 1{,}200 \times 2} = 130 \text{ in. or } 10.8 \text{ ft.}$$

$$Mr = 2 \times 9.75^2 \times 1{,}200/6 = 38{,}000 \text{ in.-lb.}$$

*Deflection in this case exceeds 1/360 span.

Table II.—Spacing of Girts in Feet.

Slab Thickness, ins.		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
Weight, lbs. per sq. ft.[1]		112.5	125.0	137.5	150.0	162.5	175.0	187.5	200.0	212.5	225.0
Size of Girt, ins.	[2]Span of Girt, Ft.										
3×6	3	12.3	11.1	10.1	9.3	8.6	7.9	7.4	6.9	6.5	6.2
"	3.5	10.6	9.5	8.7	7.9	7.3	6.8	6.4	6.0	5.6	5.3
"	4	9.3	8.4	7.6	7.0	6.5	6.0	5.6	5.2	4.9	4.7
"	4.5	6.8	6.1	5.5	5.1	4.7	4.3	4.0	3.8	3.6	3.4
"	5	5.3	4.8	4.3	4.0	3.7	3.4	3.2	3.0	2.8	2.6
"	5.5	4.3	3.9	3.5	3.3	3.0	2.8	2.6	2.4	2.3	2.2
"	6	3.7	3.3	3.0	2.8	2.6	2.4	2.2	2.1	2.0	1.9
4×6	3	16.3	14.7	13.3	12.2	11.3	10.5	9.8	9.2	8.6	8.2
"	3.5	14.0	12.5	11.4	10.5	9.7	9.0	8.4	7.9	7.4	7.0
"	4	12.2	11.0	10.0	9.2	8.5	7.9	7.3	6.9	6.5	6.1
"	4.5	8.9	8.0	7.2	6.6	6.1	5.7	5.3	5.0	4.7	4.4
"	5	7.0	6.3	5.7	5.2	4.8	4.5	4.2	3.9	3.7	3.5
"	5.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3	3.0	2.9
"	6	4.9	4.4	4.0	3.7	3.4	3.1	2.9	2.7	2.6	2.4

[1]Weight includes dead load of slab plus 75 lb. per sq. ft. live load.

[2]Span which will develop 1,200 lb. per sq. in. fibre stress.

For 3×6-in. girts, $Mr = 35{,}000$ in.-lb. $= Mo \times 1.2$.
For 4×6-in. girts, $Mr = 33{,}000$ in.-lb. $= Mo \times 1.2$.

Deflection in the floor timbers themselves need cause little worry. As seen by the tables, fibre stress usually governs. When it is desirable to increase the spans given in the tables in order to make a better arrangement of centering with only a slight increase in fibre stress, it is well to compute the deflection.

A cheap method for centering a wall 6 ft. high and over is to use full-height vertical panels, heavy horizontal studs, heavy vertical liners or standards and large rods threaded at both ends, with suitable plate washers to give proper bearing for the load on the rod. By this scheme the stock can be stressed nearer to its allowable load and fewer ties used through the wall. There are so many unknowns entering into calculations for wall centering that any tables are of doubtful value. It should be noted that as a rule the head of concrete in a wall is limited by the height that can be cast by the placing outfit in an hour. Ordinary concrete begins to set in this time enough to lose much of its hydraulic effect. Using this height and 140 lb. per sq. ft. pressure will give safe results. When high heads occur it is economical to limit the height to which the concrete can be cast in order to use lighter forms. A system which requires a large number of rod or wire ties is decidedly uneconomical.

More important to the success of the job than the values used in the calculations are the methods employed in the drafting room in turning out drawings of forms accurately and speedily. The person in charge should be experienced in the different types of concrete building construction and should have men under him who are not simply "picture" draftsmen, but men whose judgment of building work is reliable. With such an organization form details can be prepared in advance in the office, leaving the job superintendent free to work out the many other details attendant upon the beginning of the job. The carpenter foreman can also use his whole energy in directing the carpenter labor and the carpenters will need only to use their tools to assemble the panels made up in advance.

The first study and drawings to be made form a general assembly. Usually several different combinations of timbers and methods of assembling the panels are sketched up and compared as to cost.

A record of costs of the various units which go to make up the complete centering scheme is therefore necessary. Contractors who do not have such a record will find Taylor and Thompson's "Concrete Costs" a valuable guide in this work.

Points to be remembered in this study are:

1. Joists and girts should be in as few lengths as possible to save time in sorting on the job.

2. Use stock sizes and lengths of lumber.

3. Keep number of panels and pieces to a minimum.

4. Provide easy stripping.

5. Allow clearance enough for slight inaccuracies in making up and erecting, swelling of panels, etc.

6. Panels should be a whole number of boards in width, if possible, for ease in making up.

7. Units to be as big as can be handled and joists used as panel cleats where possible.

8. Provide for re-use of panels.

9. Beams to be handled as trough units when the job is regular and units can be re-used.

10. Consider use of floor domes or inverted boxes when beams are close together. In this way beam sides and slab are erected, stripped, and moved as a unit. When either of the last two systems is used the beam sides should be given a slope to prevent hard stripping.

11. Provide for re-shoring if necessary.

12. Have bracing above men's heads.

13. When four beam haunches occur at a column consider making haunches as a unit similar to a column head in flat-slab construction.

14. Consideration of steel forms.

When it is necessary to strip the floor centering for re-use before the concrete has been in place long enough to gain its full strength, provisions for proper support of the green slab must be made in the design of the floor forms. The safest and cheapest method of doing this, in my opinion, is to place boards between the floor panels and wedge posts up to a bearing under these boards before centering posts are knocked out. In this way the slab is never left unsupported as is the case when reposts are placed after all the centering is down. These boards should be placed according to a plan and so as to shorten the spans of the main reinforcing bands.

Materials.—The materials to be used for the form work should be scheduled from the form drawings and not ordered by guess, as is so generally the custom. If complete form drawings for the job are available in time, it is economical to order even the boards for columns and beam forms to exact widths and lengths to make up the panels. This saves ripping and cutting off the boards in the job mill, where the saws are often taxed beyond their capacity at the beginning of the job getting out miscellaneous stock. It is always desirable to get the lumber in car-load lots because of the lower price. For this reason, on many jobs, in order to get the stock in time from mill shipment, it is necessary to prepare the schedule from the general assembly and typical details.

The ft. B.M. of ⅞-in. "roofers" for slab and wall panels can be taken off directly from the square foot of floor and wall surface, adding at least 10% for waste and 25% for cleats. As these come in random lengths it is desirable to specify the length preferred, so as to get as big a percentage as possible of this length.

One and one-half inch boards for columns and beam sides and 2-in. plank for beam bottoms should be ordered S-4-S. Boards 7¾ in. and 5¾ in. wide after planing are the most useful widths for beam and column sides and can be ordered in random lengths, specifying again the lengths desired for as large a proportion as possible. The best length for the majority of columns and beam sides and the best width for beam bottoms can be easily taken from the plans by one familiar with form work. Stock for beam cleats and column yokes can be ordered rough and the quantity can be estimated closely from the assembly plan. Rough plank and timbers for staging and runways should always be included in the order.

From the assembly of the columns and walls a schedule of the number and lengths of rods and fittings needed for tying the forms together can be made and the order placed early. It is safer and more economical to use rods threaded at both ends. The thread at one end can be short for a hand nut while the other end can be threaded to give any desired adjustment. A nut and washer can be set by a laborer at the proper point on the long thread so that the carpenters need only use the hand nut on the short thread. If a long thread on each end is desired, a nut can be turned up and loosened by a special socket-wrench operated like a carpenter's bit-stock.

The use of check nuts on a rod to give adjustment in length, depending upon a set screw for its grip, while convenient in some ways is not economical in the long run. The grip of the check nut is the weak point of the outfit. This makes it impossible to stress the rods to their working strength. If, however, a set screw is overlooked and not tightened at all a failure is liable to result. The worst that can happen when threaded rods are used is a crushing of the wood under the washer if the bolt is over-stressed. The washers used, of course, should not be the standard cast-iron variety, but should be steel plates of sufficient area to develop the strength of the rod when the washer is bearing on wood.

The possibility of using metal forms must be considered when planning the form work for any concrete structure. Where it is possible to use the same units many times without remodeling, or by making adjustments easily provided for in the metal forms, the latter are usually an economy. On sewers, pipe-lines, subways, straight wall work, etc., they can usually be used to advantage. In building work the use of metal forms, except for round columns and column heads in flat-slab construction, is of doubtful economy. It is usually impossible to get enough uses out of the metal forms on one building to make the first cost, even on lease, compare favorably with wood. Then, again, the building must be designed for the standard form units or else there is the expense of buying special units which are of no use after the building is done.

Our company has recently used one well-known make of sheet-metal forms on the exterior walls of a group of five buildings having a total of 267,000 sq. ft. of contact surface. These wall surfaces were at first thought ideally adapted to metal forms, but when the elevations were laid out and the task of fitting standard units to them begun, many obstacles were encountered on account of irregularities. Many special panels had to be purchased and a great deal of wood used for the fitting. By this office study many problems were encountered and solutions found long in advance of erection, thus saving time and expense on the job. On this job the forms were used an average of 13½ times at a labor cost of 9.23c. per square foot for making, erecting, and stripping. The total cost, including material and plant, was 12.93c. per square foot. These figures include office expense of the job. This work was done by an organization enthusiastic over the use of steel forms. The costs are as low as can be expected on general work.

One bad feature we found with the particular form we used was the cost of purchasing extra wedges and keys. Of a total cost of 2.7c. for material, 0.5c. was for extra keys. These were loose parts easily lost. There are makes of steel forms which do not have this disadvantage and they might prove less expensive. The steel forms on these buildings produced a good exterior, true to line, and required less rubbing down after the forms were stripped than is usually the case with wooden forms.

Corrugated sheet-metal for slab forms can be used economically on some buildings, especially those of the flat-slab type. The sheets are laid over the wooden joists, lapping the metal at the ends and sides. These sheets can be re-used many times and re-corrugated on the job. When unfit for forms the sheets can still be used for concrete chutes and as siding for temporary buildings on the job. The corrugated ceiling, however, is objectionable to some owners. When a large number of inserts need to be placed, the use of metal sheets is of doubtful economy because it is more difficult to attach the inserts to the metal forms.

As much assembling as possible should be done at the bench. Rangers for wall beams can be attached and ledgers to support joists can be nailed to the interior-beam side-cleats at the proper depth. When inserts need to be placed in the sides of beams, the holes for the bolts to hold them can be located on the details and the holes bored at the mill. The groove strip for steel sash and also the corner fillet can be put on the column sides and beam bottoms. Bevel key-strips for walls should also be nailed lightly to the panels when necessary. Heavy cleats for big wall columns should be cut and bored, but not attached to the panels. The panel can be cleated with 1¼-in. boards, and is thus made much lighter and easier to handle in erecting. Clean-outs at the bottom on two opposite sides of all columns should be made at the mill. Reduction strips should be nailed at the edge of all panels which reduce in size when re-used. All small pieces liable to get lost or used for other purposes can be dipped in red paint so that their small size will be respected by the carpenters when looking for loose boards.

Much waste in making up ⅞-in. panels can be prevented if the floor is laid out so as to make the majority of the panels a whole number of boards wide. Roofers come 5⅜ in. to 5½ in. wide, and it is an easy matter to plan the panels to come, say, seven or eight boards wide, which means no waste in ripping one board to make the width. The length should be planned as near stock lengths as possible. Panels made of spliced boards are expensive to make and easily broken.

It is usually not economical in labor to make up panels from lumber which has already been in contact with concrete several times. If, however, panels are in good condition they can be cleaned and repaired at a considerable saving, both in labor and material. As an example, 13,562 sq. ft. of ⅞-in. floor panels was cleaned, repaired, cut to a new length, oiled, and piled; 6,560 sq. ft. of 1¼-in. column sides was cleaned, repaired, oiled, and piled; 1,250 sq. ft. of column heads was cleaned, repaired, oiled, and piled, at a total cost of $99.25, or a unit labor cost of $0.00466. The estimated labor cost of making the above forms from new stock, using unit costs obtained on the same work, was $178.20, or a saving of over 40% in labor, besides a big saving in material. Old 1¼-in. panels can be knocked to pieces, the boards cleaned and piled for about $3 per 1,000 ft. B.M. Large quantities of typical forms can be made from these boards at a slight increase in labor cost over using new stock. The lumber saving is considerable. The quantity made must be large to allow a thorough routing of the old stock through the mill.

The cleat spacing for the various kinds of panels should be kept uniform so that the strips on the benches, for spacing the cleats, will not need to be moved for every set of panels. For beam sides, 2 by 3-in. cleats, flat, can be used on panels up to 30 in. deep; 2 by 4-in., flat, up to 42 in.; and 3 by 4-in., on edge, above 42 in. deep. Nails should be specified about as follows:

No.	Size.	Width of board.
3	10d	6¾ and 7¾ in.
2	10d	2¾ to 5¾ in.
1	10d	Less than 2¾ in.
..	12d	In 3 × 4-in. cleats
..	8d coated and clinch ends	In ⅞-in. boards.

Wire nails should be used for form work because of ease in driving and drawing. The holding power is also sufficient. Double-headed nails should be used in securing all boards which have to be loosened before stripping.

Reorganization of the management of the Corrugated Bar Co., of Buffalo, N.Y., has taken place as follows:—A. C. Garrison, president; A. L. Johnson, vice-president and general manager; W. H. Kennedy, vice-president and treasurer; R. McCarty, secretary; A. E. Lindau, manager of sales.

PROCEDURE IN MAKING ELECTROLYSIS SURVEYS.*

By Burton McCollum and G. H. Ahlborn.

THIS paper deals with the methods of procedure to be followed in examining underground pipe and cable systems and the return system of electric railways for the purpose of determining the liability of the underground metallic structures to damage from stray electric currents from the electric railways. The paper describes the principal methods that have been successfully used by the engineers of the Bureau of Standards in work of this kind during the past five years.

The introduction sets forth the purpose of making electrolysis surveys, and outlines several classes of surveys that may be made according to the character of the information sought. The paper points out that by means of proper measurements it is possible to determine the extent and location of the areas in which the pipes and other structures are in danger, and the approximate degree of seriousness of the trouble. The cause of the damage in progress, whether due to stray currents or natural corrosion by soil, cinders, or organic matter, can generally be pointed out, and in case of electrolytic corrosion the source of the current can generally be definitely determined. The various factors tending to produce or aggravate electrolytic damage, such as local discontinuity or high resistance in the pipe systems, unusually low resistance soil; or, in the railway lines, poor rail-joints, infrequent cross-bonds, insufficient conductance in the negative return, improper use of such conductance, or too long feeding distances, may be determined, besides many questions of local importance. Attention is called to the fact that a large amount of preliminary data and information on the railway systems needs to be obtained prior to the making of electric measurements. These include:

1. The character of the service, whether city, suburban, or interurban. This will have a bearing on the schedule, momentary variation in load, and load factor.

2. Physical data on the railway systems, such as rail weights, types of bonds and joints used, and road-bed construction.

3. The practice of the railway company in regard to frequency of cross-bonding, bond maintenance, and bond testing.

4. Load curves are necessary for the interpretation of the data in order to reduce short-time readings to all-day or other average values. Where the load varies considerably in different sections of a power-house feeding area it may be necessary to get the load curves on different feeders as well as the total power-house load.

5. Where a survey is made with the ultimate purpose of correcting electrolysis conditions by applying some method of mitigation it will also be necessary to secure complete data on the magnitude and distribution of load, the generating and substation feeder systems, frequency of schedule, and probable future demands of traffic.

The electrical measurements required in electrolysis surveys are treated under three heads, namely: (1) Measurement of over-all potential drops between the points of lowest potential and outlying points on the railway system, potential gradient measurements in tracks and earth, and potential difference measurements between different systems of underground structures; (2) current measurements, including measurement of current in feeders and rails, measurement of current in pipes and lead cable sheaths, measurement of current leakage from buried metallic structures into the earth; (3) miscellaneous measurements, which include the location and testing of high-resistance joints in pipes, track testing, measurement of earth resistance, measurement of leakage resistance between railway tracks and earth, determination of the cause of corrosion, determination of the source of stray currents, location of concealed metallic connections, and examination of concrete structures.

There is also a section devoted to the discussion of the principles involved in the proper interpretation of the results of electrolysis test data, and the importance of having electrolysis surveys carried out under the supervision of an engineer thoroughly experienced in work of this nature is emphasized.

*Notes from the Bureau of Standards Journal of Franklin Institute for August, 1916.

QUEENSTON SEWAGE TREATMENT PLAN.*

Queenston, an undivided part of Niagara township of the province of Ontario, has a population of about 200, and is located on the Canadian side of the Niagara River immediately opposite to Lewiston, N.Y., U.S.A. It is the terminus of the passenger line of boats plying between the Niagara River and Toronto, but otherwise is a strictly rural residential community, with small chance for increase in population unless there should occur a serious development of power at the rapids in the lower Niagara River.

Water supply is derived entirely from local springs and wells. Drainage is non-existent, except perhaps in the case of two or three local residences which drain direct to the river. There appears no probability that this community will require the installation of sanitary drainage for some time to come, but should the need arise it would be quite simple to supplement any strictly drainage lines by the addition of some 1,000 feet of intercepting sewer which would serve to carry the dry-weather flow to any of several sites, the most convenient, perhaps, being in the vicinity of the lower reaches of the car loop of the electric line connecting to the Toronto boat landing, although this site has the disadvantage of being located somewhat upstream from the village itself, an objection which, considering the small amount of sewage which would have to be handled, and the large volume of the river, would not be of much force. The construction of interception of this character, together with supplementary tank treatment, would be covered by the following estimate of cost:

1,000 feet of interceptor, at $2.50	$2,500
Sewage treatment, 300 people, at $6	1,800
Total	$4,300

As in the case of Lewiston, to which the community is in many ways similar, the operation costs should not exceed $500 per annum, with annual charges at 6 per cent. of the construction cost.

*From report to the International Joint Commission made by Prof. Phelps, consulting sanitary engineer to the commission.

The building permit for the new Lake Erie and Northern station at Brantford, Ont., has been issued, subject to the carrying out of the award of the Dominion Railway Board in regard to the transfer of certain lands. Work on the foundation has started and the new station, which will be a handsome one, will cost $25,000. Schultz Bros., Limited, have the contract.

RESEARCH ORGANIZATION.

By W. R. Whitney,
Director, Research Laboratory, General Electric Company.

(Concluded from last issue.)

The Committee, therefore, recommends that:—

(a) The control of the present Commonwealth laboratories be not disturbed, but that they be co-ordinated, their staff increased, and their equipment improved.

(b) Any new national laboratories which may be created for special purposes of research and experimental inquiry, including a physical laboratory for testing and standardizing purposes, should be controlled by the institute.

(4) With regard to the constitution of the institute the Committee passed the following resolutions:—

(i.) "That an Advisory Council consisting of nine members representing science and the principal primary and secondary industries be appointed who shall advise and co-operate with the directors in framing the policy and in the administration of the institute."

(ii.) "That the members be appointed by the Governor-General in Council."

(iii.) "That for the purposes of controlling and administering the institute and of collecting and determining on the researches to be undertaken and directing their elucidation, three highly qualified salaried directors, of whom one should be chairman of the directors, shall be appointed by the Governor-General-in-Council. The directors shall seek the advice and co-operation of the Council and shal be ex-officio members thereof."

(iv.) "That of the three directors one should be an expert business and financial man with ability in organization; the other two should be chosen mainly on account of scientific attainments and wide experience."

(v.) "The tenure of the directors shall be fixed by the Act."

(vi.) "That the scientific staff should be appointed by the Governor-General-in-Council on the recommendation of the directors."

(5) The Committee further resolved as follows:—

(i.) "That all discoveries, inventions, improvements, processes, and machines made by workers directly employed by the institute should be vested in trustees appointed by it as its sole property, and should be made available, under proper conditions and on payment of gratuities or otherwise, for public advantage."

(ii.) "That the council of the institute should be empowered to recommend to the Government the payment of bonuses to successful discoverers or inventors working under the auspices of the institute."

(iii.) "That the institute should be empowered to charge fees for special investigations, subject to regulations approved by the Governor-General-in-Council."

(6) Though these matters are not directly connected with the proposed institute, the Committee passed two further resolutions

(i.) "That steps should be taken with a view to coordinating the work of our technical colleges and trade schools throughout Australia, sc that a supply of scientifically taught craftsmen will be available to support the expansion of industry that it is hoped will result from the operations of the Institute of Science and Industry."

(ii.) "That with a view to promoting our export trade in Australian products it is desirable that serious attention be given to the study of modern languages, including Oriental languages, for commercial purposes."

(7) The Committee realizes that the establishment of the institute will necessarily involve some delay, but being impressed with the urgent need for work of the character proposed the Committee resolved as follows:—

(i) "That until the institute is established an Advisory Council be appointed by the Governor-General-in-Council particularly to carry out the objects expressed in resolutions 2 (i.) and (ii.), viz.: To consider and initiate scientific researches in connection wth, or for, the promoton of primary or secondary industries in the Commonwealth, and (ii.) the collection of industrial scientific information and the formation of a bureau for its dissemination amongst those engaged in industry."

(ii.) "That the Federal and State Munitions Committees, heads of the Commonwealth and State scientific departments, and bodies representative of Commonwealth manufacture, commerce, agriculture, mining, and engineering, the universities and technical colleges, and private enterprises, be invited to suggest branches of industrial scientific research in which investigation would be of immediate practical use to producers and manufacturers."

(iii.) "That the Advisory Council be appointed forthwith, and that when appointed it immediately take steps to initiate research work into the most pressing matters needing investigation, and seek the co-operation of existing institutions and utilize the resources of staff and equipment at our disposal at the present time."

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. . . .

The Committee, however, suggests that . . . most valuable work could be done in collecting data, and, in effect, making a preliminary census both as to present discoveries, and the staff and apparatus available in Australia. Such work is an indispensable first step in all research.

"In addition to this there is ample scope for practical work during the interval in vigorously prosecuting the dissemination of known information as to processes, etc., amongst our producers and manufacturers."

. . . .

Canada also appears to be following the general trend. Recently the "Royal Canadian Institute has inaugurated a bureau of scientific and industrial research, based upon the system in operation at the Mellon Institute." [Science, 43, 455 (March 31st, 1916).] Details are not available, however.

Representatives of the movement for governmental organization of research in all three of these countries have already inspected the various research organizations of America within the past few months to see what is being done.

At a discussion on "University and Industry," held on April 7th at the Chemists' Club in New York, Dr. Takamine stated that the Japanese Government had just appropriated $1,000,000 for a laboratory for physical and chemical research, and that the Emperor has contributed an additional $500,000.

In the United States scattered efforts toward a general co-ordination of industry and science have not been lacking. Pre-eminent among these has been Mellon Institute of the University of Pittsburg.

"This Institute [Journal of Industrial and Engineering Chemistry, 7, 343-7 (April, 1915)] represents an alliance between industry and learning, the possibilities of which may be said to be without limit.

"The alliance takes the form of what is known as 'The Industrial Fellowship System.' According to this system, an individual or a company having a problem requiring solution may become the donor of a fellowship by contributing to the Institute a definite sum of money for a period of not less than one year. This money is used to pay the salary of the man or men selected to carry out the investigation desired, and the Institute furnishes such facilities as are necessary for the conduct of the work. The results obtained belong exclusively to the donor of the fellowship."

The idea of this system of practical co-operation between science and industry was formulated by Robert Kennedy Duncan, the late Director of the Mellon Institute, in 1906, while attending the Sixth International Congress of Applied Chemistry in Rome.

. . . .

"In 1911, Dr. Duncan was called to the University of Pittsburg to inaugurate the system in the Department of Industrial Research, and the working of the fellowships began in a temporary building erected at a cost of about $10,000. In March, 1913, Messrs. Andrew William Mellon and Richard Beatty Mellon, impressed by the practical value of the system, both to industry and to learning, established it on a permanent basis through the gift of over half a million dollars. While the Institute is an integral part of the University of Pittsburg and works in close sympathetic accord with it, it possesses an endowment of its own and is under its own management. The present annual expenditure for salaries and maintenance is over $150,000.

"The Company obtains from the Institute such research laboratory facilities as but few industrial concerns possess. Even more important, it obtains complete library facilities, which are so valuable for research work."

There is a scarcity of men gifted with the genius for research, and it requires much experience in selecting suitable men and in training them to the desirable degree of efficiency after having determined the special qualities required. Important qualifications in industrial researchers are keenness, creative power, and confidence; these are often unconsidered by manufacturers, who, in endeavoring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The men who are best trained for a particular problem are carefully chosen by the Institute, and these work under the supervision of a staff experienced in handling industrial research problems. The Company thus secures at a comparatively small cost ideal conditions for working out industrial problems which would cost any single company probably from $60,000 to $70,000 each year to duplicate in a laboratory which it might establish in connection with its own factory.

. . . .

"There is about university work, as differentiated from the factory, freedom from interference, correct judgments concerning progress, and an atmosphere sympathetic to research.

"All these advantages, laboratory, library, consultative and inspirational, together with the supervision and administration of these Fellowships, the Institute offers gratuitously to any company having important problems offering a reasonable chance of solution, and it undertakes, as well, to surround the researches with the necessary secrecy."

. . . .

The University, under the agreement, fulfils its function in increasing the sum of knowledge; the fact that it is useful knowledge does not make it any less valuable. Furthermore, the right, after a reasonable time, to publish such knowledge is assured to the University. The University also obtains a highly trained staff of specialists as a faculty for a School of Chemistry and Chemical Engineering. Then, too, the University undoubtedly feels the stimulating influence of having in its midst a large body of trained investigators engaged in research work.

"At the present time (March 1st, 1916) [Science 43, 453 (March 31st, 1916)] there are thirty-six fellowships and two additional ones have recently been arranged for, to begin later in the year. Sixty-three industrial fellows are engaged on the fellowships now in operation. The growth of the Institute has about reached the stage where we shall be obliged to decline further industrial investigations for the present, since our laboratories are almost filled up to capacity.

" . . . The experience of the industrial research institutions now in operation, which is certain to be drawn upon heavily in the movement to make the research work of the country national in both scope and effort, should be readily available for use by their prospective allies. Their entrance into this field should be warmly welcomed. No greater good fortune could come to the Mellon Institute, for example, than a division of labors with a number of similarly well-founded establishments." . . .

Still in the tentative stage is the progress of the Committee of One Hundred on Research. The Pacific Coast sub-committee has recently expressed its prospective policy in the following terms: [Science 43, 457 (March 31st, 1916).]

"1. The relation of advances in pure and applied knowledge to intellectual and economic progress and to good government should be made clear to individuals and to communities at every opportunity.

"2. The publication of timely and accurate popular articles making known to the people the results of research should be encouraged.

"3. The Committee should be informed concerning researches now in progress in the Pacific region. This information need not be carried to extreme detail.

"4. The Committee should lend assistance to investigators who are handicapped in any way. In special cases it may be possible to assist with grants of money from the American Association, or from other sources."

Among the subjects which have given this Committee concern is the responsibility of scientists in the United States for the progress of research during and immediately following the European war. Will the impoverishment of governments curtail the support of science in Europe, or will the demonstrated efficiency of scientific methods induce the governments to maintain scientific research at a sacrifice of something else? Whatever the outcome may be, the obligations of American men and women of science to push forward the boundaries of knowledge are certain to be increased.

Within the universities themselves there seems also to be a growing recognition of the responsibility and privilege of producing new knowledge, which has been well expressed by Professor Wilson [Science 42, 630 (November 5th, 1915)] of Columbia University:—

"We have heard of late an intimation that the universities have not been so much leaders of progress as 'depositories of stationary thought.' Well, depositories of stationary thought the universities indubitably have been, like the monasteries, that they succeeded as centres of learning; and they have thus served as the guardians of a treasure that is beyond all price. But this is only half the truth; for it has long been one of our most cherished ideals that universities should also be the natural homes of original discovery and productive scholarship. The real universities—and I believe that our own is one of them—have demonstrated by their example that the atmosphere which these things create make teaching live and move."

GRAVELLED ROADS.*

By Gabriel Henry,
Chief Engineer of Highways, Province Quebec.

THE nature of the top course to be adopted for a road depends, more than anything else, upon the traffic which it is destined to accommodate. It is useless to insist upon this fact, so well established by experience and now so generally admitted.

The cost of top courses varies according to their qualities and powers of resistance, and the more solid and durable they are made, the more expensive, as a general rule, they are. In cities, it is usual to employ a series of paving having the greatest powers of resistance and of duration, but which are too expensive for the country districts.

On the trunk roads connecting the different cities and forming the country's principal arteries of circulation, resort is had to pavings or top courses of concrete, brick, bituminous macadam, water-bound macadam with or without a bituminous carpet. The choice of these different top courses depends upon the nature and the importance of the existing and future traffic, as far as the latter can be foreseen. These top courses are also all of them relatively costly and require careful maintenance. They are only used where absolutely necessary. But outside of the cities and of the trunk roads there are a number of less important roads. The total length of these latter is generally much greater than that of the principal arteries above mentioned. They are really local roads, connecting different villages and giving communication with these villages and with railway stations, factories and trunk roads to the farmers scattered throughout the country districts. The traffic on these roads is much less important than on the trunk roads and in the cities, and from the economical point of view costly top courses are not to be recommended for them.

They are generally known under the name of earth roads, gravelled roads and—the most important of them—stone or macadamized roads, according to the nature of the top courses employed.

When the soil is of good quality and gravelly, they are maintained as earth roads. But when there is good gravel, as frequently happens, it is sometimes preferable to make use of it. And it is the utilization of this gravel for improving earth roads that we are now about to consider. Even when stone is abundant it may be advantageous in some cases to prefer gravel, provided, of course, that the volume of traffic does not exceed certain limits.

It is necessary to remark, however, that this refers only to good earth roads covered with a top course of bank's run gravel and not what is generally called gravel macadam roads. The gravel macadam is constructed like ordinary macadam, but with certain special precautions.

As this lecture treats only of ordinary gravelled roads, macadam will not be dealt with.

Surface Drainage and Underground Drains.—One of the advantages of well-constructed gravelled roads is that they can be made to serve later as foundations for a more costly top course and one of greater resistance, if traffic increases and if circumstances demand it. This fact is worthy of special attention.

Just as gravelled roads may serve as foundations for water-bound macadam or for a top course of still greater resistance, so earth roads serve as a base for gravelled roads. That is to say, that in order to construct a gravelled road it is first necessary to establish a good earth road; in other words, to prepare first of all a suitable substruction.

Before gravelling a road and when all the principal earthworks have been made and the road straightened, the curves improved and the bridges and culverts constructed it is necessary to be assured:—

(1) Of a perfect drainage of surface water.
(2) Of a suitable drainage of subterranean waters.

These two conditions are indispensable for any road, no matter what covering may be chosen for it. To attain this end it is necessary:—

(1) To create a complete system of ditches so as to rapidly drain the water from the heaviest rains and from the melting of the snow in the spring. The grade of the different ditches of this system, their dimensions and their form, should be such that no stagnant water remains a few hours after rain, and that this rapid drainage causes no erosion at any point.

(2) To inspect all places where subterranean waters soak into the sub-soil and remain there, and to drain them off by means of subterranean drains emptying into the ditches or by other means; to lower the highest level to which water rises and remains in the substructure of the road to at least twelve or eighteen inches below the surface of the road before it is gravelled.

There are many means of obtaining this result, but the study of these means does not enter into the programme of this lecture.

The large earthworks, the bridges and culverts, ditches and drains once completed, the levelling of the surface and slope of the road should be proceeded with. A large part of this work may be advantageously done with the road machine.

If a steam roller or horse roller can be obtained for this purpose it may be employed to consolidate the surface of the road and to ascertain that there remain no soft spots or places not properly drained.

It must be remarked here that it takes some time for the drains to give the expected result. In certain soils it is sometimes necessary to wait many months before the effect is felt.

If by means of the roller soft, damp spots are found, they must be drained and hardened before the gravel is laid.

It is as necessary to insist on this question of surface and subterranean drainage for gravelled roads as it is for earth roads, and even more so. Just as an earth road may be called upon to receive a covering of gravel or other top course, so a gravelled road may later be called upon to bear a covering of macadam. It is, there-

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*Paper read before the Third Canadian and International Good Roads Congress.

fore, necessary that this covering should be protected from accidents caused by the lack of resistance of the substructure without its being necessary to proceed before laying said covering with preliminary works of consolidation which should have been made at the time of the first improvement of the earth road or at the time of the placing of the gravel.

Yet a covering of gravel placed on a solid substructure costs very much less for maintenance than another covering on a damp and badly prepared ground.

Laying the Gravel Covering.—There are two principal ways of laying the gravel:—

(1) Covering the entire width of the road between the ditches with one layer. Then it is given a fixed thickness in the centre, which gradually diminishes towards the sides, where it is reduced to one or two inches.

(2) Spreading a layer of gravel over the centre of the road for a determined width (ten, twelve or sixteen feet, for example, according to the importance of the road), with earthern shoulders three to four feet wide at each side to keep the gravel in place. In this case the thickness of the layer is uniform over all its width, or only slightly deeper in the middle, and the roadbed may be crowned from a half to three-quarters of an inch per foot.

In this second method a slight layer of gravel may also extend over the shoulders, allowing it to spread as far as the ditches. This gives the road a better appearance, makes the shoulders more practicable for vehicles and prevents the growth of weeds, facilitating also the maintenance of the roads, and also the surface drainage of rains from the centre of the road towards the ditches. In the first method it is also a good thing to give a slight crown to the substructure before placing the gravel.

For heavy traffic the system with trenches is best.

The system without trenches, which is not quite so costly, is generally employed for light traffic.

The average thickness of the layer of gravel depends upon the resistance of the soil and upon the importance of the traffic.

A good gravel on good, solid ground may be reduced to an average thickness of four or five inches, measured after settlement. In the case of grounds with less power of resistance, the gravel may be as thick as twelve inches or more. The spreading of the gravel on the road may be done by first dumping it in heaps close together, which may then be spread with shovels, rakes or a horse-scraper.

Pebbles exceeding two inches in size are carefully raked ahead of the gravel, so that they will be spread on the bottom of the trench and be overlaid by the gravel in such a manner that when the road is completed none will be found within three inches of the surface. Roads so gravelled may be rolled with a steam or horse-roller if it can be easily procured. The rolling accelerates the settling of the road, and it consolidates more quickly under the influence of traffic.

An energetic harrowing of the layer of gravel before rolling acts in the same manner and is to be recommended.

When gravel is very sandy it may be laid in two layers by interlacing between the two a third layer of half an inch to an inch of clay, marl or earth. The whole is carefully harrowed and then rolled.

The dry rolling of a bed of gravel is generally difficult, especially if the roller is heavy. If water can be had it is preferable to sprinkle the layer of gravel before rolling.

When the road has been completely crowned it should have a crown of an inch to an inch and a half per foot. If the crowning is left to traffic it is necessary to give a little more crowning when laying the gravel, two inches per foot, for instance, because vehicles have the tendency to push gravel towards the sides. If a gravel road is not rolled at once it will take a season or two to completely settle and harden, and sometimes more, according to the quality of the gravel and of the soil and the nature of the traffic. During this time it is frequently necessary to employ the split-log drag to fill in the ruts, to level the surface and to re-establish the crown until the road is completely consolidated.

Gravelling on Stone Foundation.—When stone of good quality and of moderate size, say, 4-in. to 6-in., is plentiful in the fields, and when it is difficult to advantageously procure good gravel, a foundation of stone may be interlaced between the bed of gravel and the prepared surface of the road. When the traffic is light and moderate this system gives good results, and will prove a good foundation for future macadam. It is economical and permits municipalities to await the development of traffic before going to the expense of water-bound macadam or of other more costly top courses, while enjoying meanwhile the advantages of a good gravel road.

Qualities of Gravel.—The gravel to be employed should not contain too large a proportion of sand; 20 per cent. to 25 per cent. is sufficient. Sand is here understood to be that part of the gravel which will pass through a screen of a quarter-inch mesh. It should not be too earthy. The little pebbles of which it is composed should be hard and of good quality.

Certain gravels contain too large a proportion of sand or earth. In this case it is necessary to resort to screening, not leaving any more sand or earth than can be avoided, or else to employ a much heavier layer of the gravel than usual.

In this last case the rain transforms the sand and earth into mud, which may be got rid of by the frequent use of the split-log drag and through the drying up of the mud into dust, which is gradually scattered by the wind or scraped or swept from the road. At the end of one or two seasons there remains upon the surface of the road a layer of small, hard and well-cemented pebbles.

Some gravels contain a certain proportion of very soft pebbles, which crush under the wheels of vehicles. When the proportion of them is large the result is the same as in the two preceding cases. Between these extremes occur all the intermediaries. All gravel which contains soft pebbles should be completely rejected. It is not worth its transportation, even for short distances.

Certain gravels bind with difficulty; others easily. Quartz gravel from the beds of rivers belongs to the first category. However, some silicious gravels coming from banks outside of watercourses bind well with time, notwithstanding their freedom from earthy matter. The same thing naturally applies to those containing a certain proportion of such matter.

Some river gravel and some unwashed sandy gravel, which contain a proportion of soft pebbles, often bind very well. These soft pebbles, crushing under the wheels of vehicles, help to cement the union.

When a hard gravel does not bind well, a certain portion of clay or marl or limestone dust may be employed by incorporating it with the layer by the use of the harrow or by other economical means. This use of clay or earthy matters with the gravel has been severely criticized, but I believe that this criticism referred to gravel macadam only and not to bank's-run gravelled roads.

It is not the same thing in regard to economical roads in which we are interested here. The average distance that it pays to transport gravel depends upon its quality. First quality gravel, which makes a well-resisting wearing surface without too much loss, is worth hauling three miles. For poorer qualities this distance must be reduced. Sandy and earthy gravel, for example, requiring screening or an increasing thickness of covering, which adds to its cost, belongs to this category.

The cost of labor and of horses have also an influence on the minimum haul to be adopted. Each case should be studied separately, and it is impossible to give general rules.

The Employment of Oiled and Other Bituminous Products on Gravel Coverings.—To give more resistance to gravel coverings and to render them more suitable for soft tires, oils and other bituminous products have been tried, spread hot or cold, as the case may be, on "bank's-run" gravel coverings like those which we have been considering. In this province, at least, the results have not as yet been sufficiently satisfactory, and there is little probability that they will ever be for this category of gravel coverings.

It is not a question here, of course, of gravel macadam coverings for which this oiling may be recommended.

Maintenance of Gravel Roads.—The permanent part of gravel roads, that is to say, the ditches, the drains, the foundations when there are any, the slopes of the fills and excavations, the bridges and culverts are to be maintained in the same manner as in the case of all other roads. They should have the same care.

The covering is kept in repair by use of the split-log drag, which must often be used, especially during the first years, to fill in the ruts, to level the surface, and to re-establish the crown. The split-log drag is used as it is in the case of earth roads, and preferably after rain, when, for one reason or another, depressions occur; it is necessary to add some gravel where these depressions are only due to uneven settling or to irregular wear. In these two cases the road machine may also be employed to put the surface in good condition again. But if the depressions are caused by humidity of the soil it is necessary to resort to subterranean drainage.

When the covering becomes thin and commences to break up from long usage it is necessary to recover it with a sufficient layer of gravel to support traffic without injury.

Coverings constructed with hard gravel of good quality will last a long time without the addition of new material, but those which are constructed with sandy or earthy gravel wear more quickly and require more frequent additions.

Resume and Conclusions.—Coverings of unscreened gravel are a special type.

They must not be confounded with macadam or gravel coverings, that is to say, with those made of screened gravel. They may be utilized in a large measure, and very economically, to improve earth roads, at the same time diminishing the cost of their maintenance.

They are very suitable for local roads where the traffic is not very important.

Made with or without a stone foundation, when they are well built and well kept, they may themselves serve later as foundations for more costly coverings, thus permitting municipalities to await the increase of traffic on certain of their roads before resorting to macadam, which is more costly, and have the benefit in the meanwhile of a good rolling surface.

The gravels of which they are composed are unscreened gravel, generally of little value from the viewpoint of the composition of top courses of great resistance. It is, therefore, important to submit them to as little manipulation as possible.

All attempts to work these materials, or to complicate the employment of them for the purpose of adding to the resisting power of the surface which they are destined to form generally add to the cost of these top courses of unscreened gravel in such a proportion that it would be better to resort to water-bound macadam composed of screened gravel or of broken stone, with a bituminous carpet or bituminous macadam or concrete, but in doing so we depart from the type which we are considering, and of which the first characteristic is its economy.

The maintenance of these coverings is very easy and inexpensive. It does not call for the use of costly machines or special labor. The materials are close at hand. However, they support an active automobile traffic badly. They are generally dusty in dry weather, and if the scraping of them is neglected they become muddy in wet weather. Oils and other bituminous applications do not suit them unless the unscreened gravel of which they are composed is of the very best quality. They are suitable only for local roads. In the Province of Quebec they have so far given good results. The Government recommends their use everywhere where they may be successfully employed. In view of the results already obtained the Government has established a branch in the roads department which is specially occupied with these roads.

Some municipalities having first decided to employ water-bound macadam, and having with the aid of the inspectors of this branch discovered beds of gravel, have afterwards changed their mind and substituted, with great economy, gravelling to macadamizing.

In a general manner these roads may play an important part in the improvement of the roadways of the country.

CANADIAN SOCIETY OF CIVIL ENGINEERS, OTTAWA BRANCH.

In order to keep the membership list of the branch up to date the managing committee has decided to have the branch membership list revised periodically, say, twice a year. If the various members of the branch will co-operate with the secretary to this end, the matter can be satisfactorily arranged.

The first issue of the branch year book has been sent out, in which will be found as complete a list of the membership of the Ottawa branch as is obtainable from present records. The committee suggests that members take an early opportunity of going over this membership list and advising the secretary as promptly as possible on the blank form enclosed for the purpose (1) of any members who have enlisted for overseas service, if possible giving their regiment, whose names are not now indicated in the list as on overseas service; (2) the names of any engineers who are not included in the list, with their addresses; (3) the names of any engineers on the list who are not now resident within the jurisdiction of the Ottawa branch; that is to say, within twenty-five miles of Ottawa.

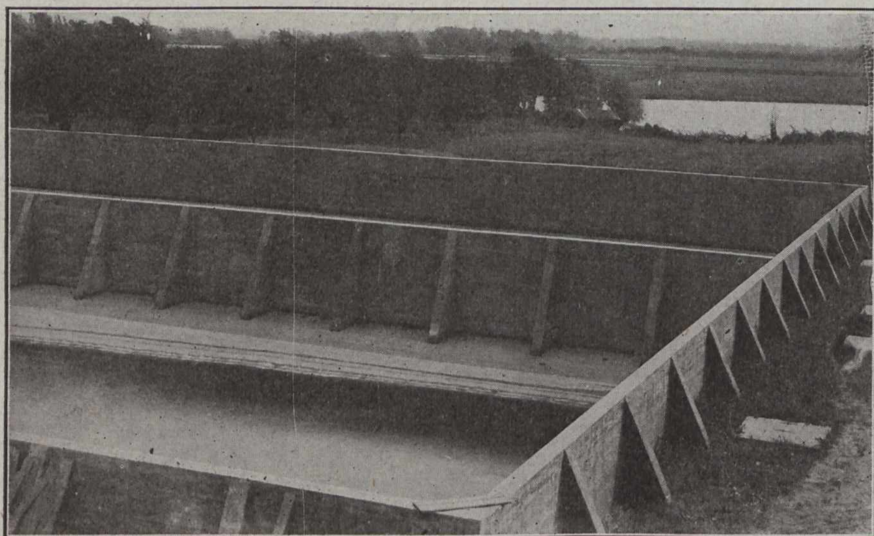
RECONSTRUCTION OF EAST END SEWAGE DISPOSAL PLANT, HAMILTON, ONT.

By E. R. Gray, City Engineer.

IN 1907 a by-law was passed whereby it was proposed to issue debentures amounting to the sum of $120,000 for purchase of land and the construction of sewers and sewage disposal works, in order to provide sewer accommodation for the eastern section of the city of Hamilton. At that time the city limits extended from the mountain brow along Sherman Avenue and Barton Street to a line passing northerly down Depuis Street along Burlington Street to Ottawa Street, down Ottawa Street to the bay.

These debentures were payable in annual instalments to be spread over a period of 30 years.

A very comprehensive sewage disposal scheme was designed by E. G. Barrow, Esq., then city engineer, which was at that time the last word in sewage disposal practice.



Showing Tanks with Buttress Walls.

The plan consisted of a pumping plant which raised the sewage from a well and forced it through a pressure main into two large settling basins 2,500 feet away on the shore of Hamilton Bay. These tanks were 219 feet long by 76 feet wide and 11 feet deep.

After passing through these settling basins, the sewage was filtered by an upward flow through a rough filter and then conveyed by a piping system to a sprinkling filter. This filter was composed of slag obtained from the steel plant nearby. The filter is 455 feet long and 220 feet wide, the sewage being delivered to the filter through 591 sprays.

This sewage was underdrained from the filter into open ditches on the side through which it ran to the bay.

For a number of years the plant was operated very successfully. Recently, however, because of the very great overloading, and the need of the renewal of the filter media, the results have not been as satisfactory as desired.

This overtaxing has resulted from the phenomenal growth of the city's eastern section, which drains to this point. It has not been deemed wise to extend the present system during the very rapid change of opinion as to just what is the proper installation to secure the most desirable results.

It has been necessary, however, to increase the pumping plant in order to handle the increased flow of sewage.

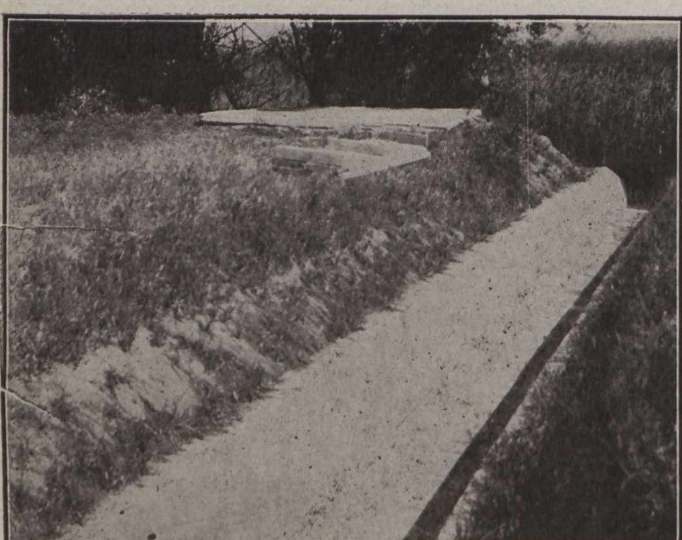
The eastern portion of the city is very flat, rising slowly from the bay level to the foot of the mountain. This has resulted in the grade of the sewers at the station being too low to allow treatment of the sewage by gravitation.

In July, 1914, a by-law was passed for the issue of debentures for $175,000 for the cost of a main trunk sewer and plant for additional drainage for the eastern part of the city.

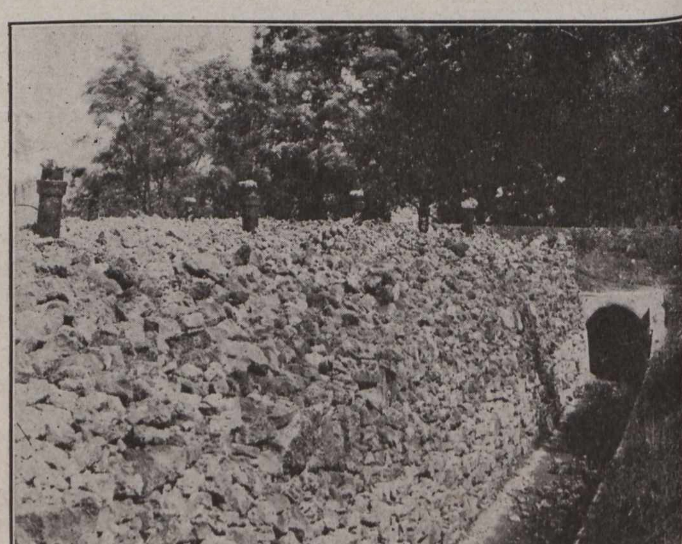
This by-law covered the cost of construction of new concrete trunk sewers, a new pumping station on the same site, including a motor-driven, direct-connected, 8,000,000-gallon centrifugal pump, the transfer and installation of two 3,000,000-gallon units from the old station and the construction of a new 36-inch rising main from the station to the tanks.

The plans and specifications were prepared in the office of the city engineer, Mr. A. F. Macallum, and the work was placed in charge of Mr. J. Stodart, engineer in charge of the sewer section, Mr. J. Wardrop designing the superstructure of the station building.

The accompanying illustrations show the tanks and filter beds.



Effluent Channel to Bay.



Take-off Drain and Slag Filter.

PROPOSED TENTATIVE RECOMMENDED PRACTICE FOR LAYING OF SEWER PIPE.*

From Report of Committee C-4 of the American Society for Testing Materials. Criticism of this recommended practice is solicited and should be directed, preferably, before January 1st, 1917, to Mr. Rudolph Hering, Chairman of Committee C-4, 170 Broadway, New York City.

I. Preparing Trenches and Foundations for Pipe Laying.

THE foundations in the trench should be formed to prevent any subsequent settlement and thereby possibly an excessive pressure and consequent rupture of the pipes. If the natural foundation is rock it is recommended that an equalizing sand bed be placed upon the rock and well compacted by watering or otherwise so as to obviate irregular settlement. If the natural foundation is good firm earth, the earth should be pared or molded to give a full support to the lower third of the pipe. Otherwise the bed should be made firm, either by sand well watered or rammed, or by a layer of cement mortar. The same means of securing a firm foundation should be adopted in case the excavation has been made slightly deeper than necessary.

If there is no good natural foundation, a firm and sufficiently broad bed should be artificially made either with sand, with gravel or broken stone, with concrete, reinforced concrete or other means to secure a solid and firm foundation.

If the soil is porous and ground water rises above the sewer pipe, a plank foundation with or without piles may be advisable.

When the sewer is to be laid in a concrete cradle, the concrete for the full width of the cradle should be continuously deposited to the height of the outside bottom of the pipe. Before the concrete has set the pipe should be evenly bedded therein and the remainder of the concrete immediately placed on each side of the pipe and carefully tamped in such a manner as to avoid disturbing its position. Or, the pipe may be supported and held in position by wedges or templates and the concrete mixed wet, and poured under and around it in such a manner as to complete the cradle in one operation.

When the sewer is to be laid in a gravel or broken-stone cradle, the material should consist of clean gravel or sound broken stone, all of which should preferably pass through a screen of 1-in. mesh and be retained on one of ⅛-in. mesh. The gravel or broken stone should be deposited and consolidated for the full width of the trench to the height of the outside bottom of the pipe. The pipe should then be bedded therein and the remainder of the gravel or broken stone deposited and carefully consolidated in such a manner as to avoid disturbing the position of the pipe. The cradles should in all cases be so constructed that an excessive proportion of the load shall not be borne by the hubs.

If the trench is situated in ground water, it is recommended to lay the pipe in a concrete cradle up to the springing line to maintain firm joints.

When a sewer is to be laid without a cradle the earth forming the bed should be carefully freed from stones and organic material. The pipe should then be evenly bedded therein, the joints properly made and the backfilling placed and firmly tamped in such a manner as to avoid disturbing the position of the pipe.

When pipe is laid in soil which is not sufficiently firm to carry it, the earth or soil should be removed, and sufficiently broad foundations and retaining supports substituted.

When pipe is to be laid in new embankment the fill up to a point over the springing line of the pipe should be deposited in layers not exceeding 6 in. and thoroughly consolidated by rolling, ramming, teaming, watering or a combination of these, depending upon the nature of the filling material, whether it is clay, sand, gravel or a mixture of these.

If a pipe line is situated on one side of an embankment where the soil is liable to lateral movements, and is thus subjected to a one-sided load or pressure, care must be taken to secure a stable foundation, so that the pipe line will not be moved on its bed and broken. A retaining support should be placed at the side having the less pressure. It should be made with suitable material of proper height, width and weight, to transfer to the foundation the excessive lateral earth pressure, without danger to the stability of the pipe line.

Trenches should be kept free from water until the material in the pipe joints has hardened sufficiently so that the pipe line will be continuous and strong.

The stresses produced in pipe by the backfilling will differ according to the conditions of the soil. In self-sustaining soil it is possible to lay pipe at a considerable depth without producing excessive stresses. In soil which permits of lateral movement or which is water-carrying, special precautions are necessary to prevent undue pressure upon the pipes.

To protect pipe lines from unusual stresses all work should be done in open trenches. Tunnelling should be prohibited except with the special consent of the engineer.

Pipe lines should be placed at such a depth below the surface of the street that dangerous pressure or impact cannot occur. If it is not possible to do this, special reinforcement is required.

Rock excavation should be made to a depth of at least 4 in. below the outside bottom of the pipe, or as shown on the plan.

Width of trenches in earth should be sufficient to provide a free working space of from 6 to 12 in., exclusive of spurs and hubs, according to the size of the pipe and the character of the ground.

The width of trenches in rock should be sufficient to provide a free working space of 12 in. on each side of the pipe, exclusive of spurs and hubs.

In every case there should be sufficient space between the pipe and the sides of the trench to make it possible to thoroughly ram the backfilling around the pipe and to secure tight joints.

If soil conditions and ground water require the use of sheeting, sheet piling and bracing, the trenches should be made correspondingly wider. The sheeting should be closely driven and to such depths as the soil conditions may indicate to be necessary for the stability of the pipes.

Steel sheeting may be used with advantage where the flow of ground water into the trenches is excessive and the stability of the foundation soil and of the sewer is affected thereby.

Where a trench for a proposed sewer or extension of a sewer terminates in rock, it should be excavated for a distance of not less than 5 ft. beyond the end of the sewer and in the direction of the proposed extension. The pipes

*These recommendations are limited to conditions which will affect the strength of pipes in their resistance to the external stresses, and are not intended to cover the art or practice in other respects. It is the intention of the committee that the acceptance of sewer pipes, to be furnished in compliance with the specifications for sewer pipes as finally presented to and adopted by the Society, shall be generally conditioned upon the substantial observance of the precautions formulated in the Recommended Practice for Laying of Sewer Pipe, as finally adopted by the Society.

and all other structures should be carefully protected from the effects of blasts.

II. Pipe Laying.

The laying of pipes in finished trenches should be commenced at the lowest point, so that the spigot end points in the direction of flow.

All pipes should be laid with ends abutting and true to line and grade. They should be fitted and matched so that when laid in the work they will form a sewer with a smooth and uniform invert.

It is necessary to use all possible care when shoving the pipes together, so that the joints will not be unnecessarily large.

Sockets should be carefully cleaned before pipes are lowered into trenches. The pipe should be so lowered as to avoid unnecessary handling in the trench. After the ends of the pipes have been sufficiently wetted, the hub end should receive upon its lower half a layer of mortar composed of one part of Portland cement to one or two parts of fine sand.

The pipe should be set firmly according to line and grade, and the joint carefully adjusted, filled with mortar and finished to a smooth bevel outside. The inside of the pipes should be then cleaned of dirt and mortar refuse. In small pipes the inside should be made smooth by a hand swab. Large pipes should be laid with block and tackle, and with bar and tongs.

Gasket and mortar joints should be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than ¾ in., and in one piece of sufficient length to pass around the pipe and lap at the top, should be solidly rammed into the annular space between the pipes with a suitable caulking tool. Before being placed, the gasket should be saturated with neat cement grout. The remainder of the space should then be completely filled with plastic mortar mixed 1 : 1, and the joint wiped inside and finished to a smooth bevel outside.

Where butt or bevel joint pipes are used, the following method of joining is recommended: After a layer of mortar about 8 in. wide has been prepared at the joints, a wire netting is spread upon the same and covered with a layer of mortar about an inch thick. Upon this wire netting, which is embedded in the mortar, forming a bandage, the pipes are laid and adjusted according to line and grade. The bandage is then raised on both sides of the pipe, bound at the top, and covered with a layer of strong cement mortar at least 2 in. thick. The inside of the joint is finished in the same manner as specified for hub-and-spigot pipes.

The ends of pipes which enter masonry should be neatly cut to fit the face of the masonry.

No pipe or the cradle thereof should be laid or placed until the sub-grade of the trench has been tested and found correct.

In deep cuts, in high embankments or in poor soil, it is recommended to use concrete reinforcement.

The smaller sizes of cement or concrete pipes should preferably have flat bases. If of sufficiently large diameter, they may be reinforced.

When mortar or concrete are to be mixed or placed in freezing weather the following precautions are advised: No concrete should be laid when the temperature of the air is below 24° F. When the temperature is between 24 and 32° F., and rising, the mixing water should be heated to a temperature determined by the engineer, or he may advise that one per cent. of salt, by weight, should be added for each degree of Fahrenheit of air temperature below 32° F. Under such conditions other materials for concrete and mortar should all be similarly heated.

III. Backfilling Trenches.

All trenches and excavations should be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The backfilling material should be selected and deposited with special reference to the future safety of the pipes. Clean earth, sand or rock dust should be used up to a level at least 2 ft. above the top of the pipe. This material should be carefully deposited in uniform layers about 6 in. in depth. Unless otherwise permitted, each layer should be carefully and solidly tamped or rammed with proper tools, so as not to injure or disturb the pipe line. The backfilling material for the remainder of the trenches should contain no stones over 10 in. in their largest dimensions. It should be spread in layers and thoroughly consolidated by tamping or otherwise as the engineer might direct. Stones which are used in backfilling should be so deposited through the mass that all interstices are filled with fine material.

Where the safety and stability of the pipe line and other structures render it necessary, sheeting should be left in place, particularly below the top of the pipe.

Where sheeting is withdrawn, all cavities remaining or adjoining the trench should be solidly filled. When the sheeting is left in place, all cavities behind such sheeting should be solidly filled.

For retaining backfilling temporarily, timber bulkheads may be used. They should be removed as the trenches are backfilled.

Puddling or water flooding for consolidating the backfilling is recommended only for sandy and gravelly materials. If this method is used, then the first flooding should be applied after the backfilling has been compacted by tamping up to the springing line of the pipe, and the second flooding during or after the subsequent filling of the trench. An excess of water should be avoided, in order to prevent disturbance of the earth under and around the pipe, and also to prevent an undue excess of pressure on the pipe.

Walking or working on the completed sewer, except as may be necessary in tamping or backfilling, should not be permitted until the trench has been backfilled to a height of at least 2 ft. over the top of the pipe.

Where a one-sided pressure exists, due to unbalanced loading, the filling of the trench should be carried on simultaneously on both sides and in such a manner that injurious side pressures do not occur.

In freezing weather backfilling should not contain any frozen lumps of earth below a level at least 2 ft. above the top of the pipe.

CIVIC IMPROVEMENT LEAGUE OF OTTAWA.

The Civic Improvement League of Ottawa, the objects of which are to promote the highest interests of the city of Ottawa; to stimulate the study of principles and methods of civic improvement and development, and also to secure a general and effective interest in affairs pertaining to the welfare of the citizens, is anxious to secure the co-operation and good-will of everybody in Ottawa, and particularly the support of the engineer. With this end in view the League, through the co-operation of the Ottawa branch of the Canadian Society of Civil Engineers, is making a special effort to secure new members from among the engineering profession. The president of the League is Hon. Sidney Fisher, while Ronald Hooper, 13 Second Avenue, Ottawa, is honorary secretary.

Editorial

NIAGARA POWER IN UNITED STATES.

New York users of power are working in co-operation with the power companies to secure more water from the Niagara River. At present there are 4,400 c.f.s. unallotted of the United States treaty portion, and it is held under the jurisdiction of the United States Secretary of War. A strong effort is being made to have this released immediately. The power companies on the United States side have machinery installed which is not working to capacity, and they could immediately place extra water in service.

This 4,400 c.f.s. would relieve present conditions only for a comparatively short time, so consequently those interested in power in the United States have made representations that much greater diversion than is provided for by the boundary waters treaty, should be made available by amendment to treaty or by supplementary treaty.

The Cline bill, which is before the United States committee on foreign affairs, makes a strong feature of the efficient use of the waters of Niagara,—that is, under full head. Possibly the Federal legislators may carry out such provisions, if enacted in law, by insisting that the 20,000 c.f.s. allotted to the United States be used under its full head. To do this would increase the power available in the United States by probably 40 per cent., but the question of amount of water that can be diverted from the rapids would have to be considered.

The recommendations respecting efficiency in the Cline bill are exemplified in the Chippawa Creek project of the Ontario Hydro-Electric Power Commission, where about 300 ft. head will be used. The committee on foreign affairs held final hearings in Washington August 1st, when representatives from Buffalo and vicinity who sought to obtain the unappropriated 4,400 c.f.s., made strong representations that this water should be allotted to New York State for the benefit of all the people, and as a nucleus for a state system of hydro-electric development similar to the Ontario Hydro-Electric Power Commission development.

Other parties reported to the committee that the water should be given to the State and that the State should be allowed its own discretion, and if thought desirable, the water should be leased by the State on rental to existing or other power companies.

The whole situation is a difficult one on account of the power shortage on both sides of the boundary. Congress will probably adjourn the end of August or early in September. It will be interesting to observe whether any relief can be obtained by those who are short of power in New York State in the brief time which remains before adjournment; also to observe what sort of reception the Cline bill will have when finally presented to Congress. There may not be sufficient time for a measure of this kind to go through all the steps which will have to taken before Congress adjourns.

During the week of July 24, a meeting was held of the committee on foreign affairs, and it was reported by one of the gentlemen present at this meeting, that he understood that arrangements were then made whereby 1,000 c.f.s. of the unappropriated 4,400 c.f.s. would be made available for use,—it may be only temporarily—by the United States power companies at Niagara Falls, in order to help out the power shortage at Buffalo.

Sooner or later this important subject of Niagara power will be prominently before the public both in Canada and in the United States.

DEPRECIATION OF MACHINERY.

We are afraid that engineers and engineering contractors do not, when purchasing equipment, give due attention to the matter of depreciation.

Depreciation is made up of two factors—age and actual deterioration—each important as the other.

Furthermore, these two elements cannot in the very nature of things be combined satisfactorily, as the latter bears a direct relation to the volume of work done by the machine, but no such relationship is borne by the former. For example, if a concrete mixer is driven to its utmost capacity day and night its liability to become out of date is not increased. On the other hand, its life is shortened.

It is not a difficult matter to keep an efficient tool in order. To do so, it is necessary that due attention be paid to defects as soon as they show themselves—the renewing of wearing parts just as soon as they show signs of wear—as well as careful handling whilst in use. Depreciation on such a machine will be very small, provided the tool is maintained at a high efficiency.

Another matter which calls for care in purchasing machinery is the question of a tool being bought to-day which may be superseded to-morrow. This should be taken into account when the subject of depreciation is under consideration. It may not have an effective life of many months, as another tool may at any moment be designed which will render it financially unsound to keep the original machine in use. It is of vital importance that liberal provision be made for this risk when purchase of equipment is being made.

BRITISH TRADE WITH CANADA.

The report of Mr. C. Hamilton Wickes, His Majesty's Trade Commissioner in the Dominion of Canada and Newfoundland, for the year 1915 contains a number of facts which ought to be of interest alike to both Canadian engineers and engineering contractors, as well as the British manufacturer of engineering equipment.

Under the heading of "Agencies," Mr. Wickes says: "A representative from a United Kingdom manufacturing firm, making a visit to Canada, with the object of securing orders, should keep clearly before him the conditions under which his firm intend to carry on their business connection after he has returned from his visit. If, as is generally the case, it is intended to leave the business in the hands of a local Canadian firm as agent, the travelling representative should make his prices to cover the agent's commission in the future, and the additional duty which will be payable on the commission when it appears on the invoice to the customers.

"Moreover, the manufacturer will need to protect his agent as far as possible, in cases where direct applications are received from buyers who may have seen the agents' samples without placing orders and have instructed their European buyer to call on the same agents' principals and buy the same articles at a price which, of course, will not include the agents' commission."

In dealing with enemy trade he cites the experience of two young Germans who came to Montreal in the fall of 1912 to introduce a line of goods and took a small office. Neither of them had been in Canada before, but they had received advice that there would be a market for certain classes of articles. After working for eighteen months they had built up a considerable and profitable connection. Asked one day as to the reason for their success they explained that they had come to Montreal equipped with information as to (1) likely buyers in Montreal and Toronto and other towns in the neighborhood, (2) the financial standing of each firm and the names of the men employed by these firms upon whom it was advisable to call, (3) the articles of Canadian or foreign manufacture that they would have to meet in competition, and the prices of such articles, and, (4) the customary terms of credit prevailing. All this information had been available to them before they left Germany. Furthermore, they were guaranteed sufficient living and office expenses, they knew that their principals would second their orders with prompt delivery and they were very well posted indeed as to the details of trade, such as the preparation of invoices, declarations, etc., in accordance with Canadian Customs requirements. The above facts teach their own moral.

While some British manufacturers of engineering equipment have established very desirable connections in Canada, others have not had such experiences, and it is fair to assume that in some cases, at least, much of their disappointment can only be attributed to the lack of first-hand information as to the market, knowledge of the rating of firms with whom they would do business, the competition and especially the matter of credit terms which prevail in the Dominion.

THE MUNICIPAL ENGINEER.

Perhaps there is no phase of municipal work where an engineer has the opportunity to develop greater versatility than in the city of from, say, 20,000 to 30,000 population.

In a peculiar way he is thrown upon his own resources, as a result of which his engineering instinct is quickened. The work he has to do, while not of the magnitude to be found in the larger municipalities, is still very important.

He has to deal with sewerage, road and street construction and maintenance, water supply—in fact, he virtually has under his care practically every kind of public work incidental to a city of the size referred to.

The fact that the city engineer of a medium-sized city is called upon to exercise control over so many different phases of engineering work (which in a larger city are cared for by specialized departments) makes it exceedingly urgent that those who determine to follow municipal engineering as a life work be given special training which will justify and enable them to give reliable guidance and advice. The expansion of municipal responsibility indicates the necessity of securing accomplished men for these important civic services.

It is doubtful if the skill, energy and adaptability of an engineer can be more highly developed than as the municipal engineer in a medium-sized city.

The position is one which offers unusual opportunities for the acquiring of a most useful engineering experience.

LETTERS TO THE EDITOR.

Proposal to Dam Niagara Rapids.

Sir,—Previous to receiving your clipping regarding the suggested dam across the lower Niagara River, the writer had seen several references in New York papers and elsewhere to this proposed scheme.

Your editorial covers the matter thoroughly.

A few years' residence in Niagara Falls and some studies in connection with the power developments at that point, leads the writer to believe that the problems in connection with the construction, to say nothing of the operation after the work is built, are such that for the time being the scheme is impracticable. There are several schemes for developing power at Niagara which are so much simpler and more economical from all points of view, that the necessity for damming the Lower Niagara River does not seem to exist.

While it may be that some time in the future, when the demand for power has exceeded more easily available schemes, and when the problems which are raised in your editorial have been solved very much better than they are now, such a project may be worth serious consideration.

The writer agrees with you that the problems presented can, no doubt, with sufficient time and sufficient money, and proper engineering skill, be met and overcome successfully. The same amount of skill, money and time, in the writer's opinion, can be devoted better to other problems in connection with the Niagara Falls development at present with the hope of greater accomplishment.

JULIAN C. SMITH,
Vice-president and Chief Engineer,
The Shawinigan Water & Power Co.

Montreal, July 29th, 1916.

Proposal to Dam Niagara Rapids.

Sir,—I note the editorial in your issue of July 6th, in regard to the proposal of damming the lower Niagara River at Queenston with a view to the development of some two million horse-power.

Mr. Johnson, in your issue of July 27th, points out clearly some of the main difficulties in the carrying out of such a stupendous scheme, and while it is conceivable that such a proposition might be worked out ultimately, there is no doubt that the cost of the undertaking would be out of all proportion to the benefits derived.

Personally, I believe that any feasible scheme leading to the development of the Niagara Falls and river, to the utmost limit of power available, should be encouraged by the engineering profession in both Canada and the United States. The industrial development on both sides of the line is rapidly approaching a point where the curtailment in the use of such natural resources as represented by Niagara is suicidal. As the time is approaching when the development of the power will become a vital feature in the economic growth of the country, it is high time that the problem be taken up by the governments of both Canada and United States, and solved on a broad scale, so that any work of development may be started in a manner such that extensions can be made from time to time on the basis of an ultimate maximum efficiency. Whether these future developments be made by private corporations under government control, or by the governments themselves, is immaterial to the broad question itself.

The question of scenic beauty is one which has been subjected to a great deal of false and hypocritical discussion ever since the power question at Niagara was mooted, and one has only to visit that district now and compare it to what it was before development started, to become thoroughly convinced that the present state far transcends that of the past; and no one can deny that the increased esthetic value is due in a great measure to the power development there to date.

It need not be feared that a project laid out to obtain the maximum amount of power practically available would destroy the beauty now existing, since it would be necessary in any scheme of development to permit a very large flow of water to take care of regulation and of ice discharged from Lake Erie and the Gorge.

M. V. SAUER, M.Can.Soc.C.E.,

Ass't. Chief Eng'r, Greater Winnipeg Water District.
Winnipeg, August 4th, 1916.

PERSONAL.

HERBERT J. S. DENNISON, well-known mechanical engineer and patent attorney of Toronto, has just returned from an extended visit to England and France.

A. C. TOWNE has resigned his position with the Johns-Manville Company, Montreal, to take charge of the engineering department of the Electrical Equipment Co., Montreal.

CONTROLLER KENT has been appointed controller of the waterworks department of the city of Ottawa, and ex-Controller G. H. WILSON has been appointed secretary of the civic works department.

J. A. KILPATRICK, president and manager of the Dominion Wheel & Foundry Co., of Toronto, and formerly of St. Thomas, has been appointed by the Imperial Munitions Board at Ottawa to take charge of the production of forgings.

C. W. KNIGHTON, general manager of the Canadian Hart Accumulator Company, Limited, of St. Johns, P.Q., has opened an office at 701 Merchants Bank Building, Winnipeg. He hopes to considerably develop the company's western business as manufacturers of electric storage batteries.

Sergt. W. STUART LAING, who has been a year at the front in France with the 6th Field Company of Canadian Engineers, was recently promoted to lieutenant, and recalled to the Canadian Engineers' Training Depot in England. He is a graduate in engineering of Queen's University, Kingston, and enlisted on August 20th, 1914.

C. J. WILSON, formerly with the Algoma Steel Corporation, has been appointed superintendent of the mechanical and engineering department of the Donner Steel Co., Buffalo. Mr. Wilson was with this corporation for fourteen years, having entered their service in 1901 as foreman electrician. Some time later he became superintendent of the electrical department, then assistant to the general superintendent, and finally assistant to the general manager.

OBITUARY.

ALEXANDER McCARTNEY, a building contractor of Kingston, Ont., died recently at the age of 66.

JOHN L. JOHNSON, general contractor, died recently at his home in Toronto at the age of 75 years.

SAMUEL GROVER VEARY, late chief mechanical engineer Montreal waterworks, died in Montreal on August 2, aged 75.

F. X. BERLINGUET, engineer and architect, of Quebec, died at Three Rivers, Que., recently at the age of 86. He was the Dean of the Province of Quebec Architects.

CLARK GORDON, of Sherbrooke, Que., died recently at North Hatley at the age of 80 years. Mr. Gordon was a contractor, and built a section of the International Railway.

Alderman ALEXANDER KELLY, chairman of the Hydro Commission of the city council of Sarnia, Ont., died on August 9th, after an illness of several weeks, at the age of 65 years.

ALEXANDER MURPHY, who for twenty years was clerk of Fitzroy township council, recently passed away after a long illness. In his younger days the deceased was a building contractor.

PETER SILAS GIBSON died at his home in Willowdale, York County, on August 7th at the age of 79. The late Mr. Gibson was a well-known civil engineer and surveyor, and head of Peter S. Gibson and Sons, engineers and land surveyors. Mr. Gibson was engineer for York Township for over 35 years, and was also on the board of examiners of the Ontario Land Survey.

THOMAS J. DRUMMOND, of Montreal, died on August 6th at his summer residence at Castine, Me. Mr. Drummond was born in Ireland in 1860, but educated in Montreal. Together with his brother, George Edward Drummond, and Mr. J. T. McCall, he founded the iron and steel firm of Drummond, McCall & Co. The "Drummond group" of iron industries were in 1908 consolidated under the name of the Canadian Iron Corporation, of which he was president. In 1909 he was elected president of the Lake Superior Corporation.

CANADIAN SOCIETY OF CIVIL ENGINEERS—ELECTIONS AND TRANSFERS.

At the meeting of the council of the Canadian Society of Civil Engineers held on August 1st, the following elections and transfers took place:—

Members.—Joel Horace Pillsbury, Prince Rupert, B.C.; James Ruddick, Beaupre, Que.; Lewis Stockett, Calgary, Alta.

Associate Members.—Walter J. Armstrong, St. Lambert, Que.; Alfred Hector Dion, Moose Jaw, Sask.; Wm. H. Eassie, Fort Steele, B.C.; A. V. Gale, Ottawa, Ont.; E. P. Gingras, Prince Rupert, B.C.; R. P. Graves, Edmonton, Alta.; Alan Mair Jackson, Brantford, Ont.; Manson Ainslie Lyons, Winnipeg, Man.; J. R. Mackenzie, Montreal, Que.; David Wm. Ritchie, Edmonton, Alta.; Alfred Trudel, Ottawa, Ont.

Juniors.—Ralph Hector Cooper, St. Vital, Man.; Henry Clifford Craig, St. Catharines, Ont.; Hermel Marie Perron, Edmonton, Alta.; Albert Fraser Wall, Montreal, Quebec.

Associate.—Francis C. C. Lynch, Ottawa, Ont.

Transferred from Associate Member to Member.—Arthur John Gayfer, Capreal, Ont.; Will Reid Wellington Parsons, Regina, Sask.

From Junior to Associate Member.—Maurice Weeks Black, Windsor, N.S.; Ainswell Gordon McIntyre, Bathurst, N.S.

From Student to Associate Member.—Leonard E. Hawkins, Chilliwack, B.C.; Adheinor Laframboise, Lachine, Que.; Clifford Austin Meadows, Toronto, Ont.; John C. Moyer, St. Catharines, Ont.; Arthur Hale Munson, Montreal, Que.; Norman E. D. Sheppard, Ottawa, Ontario.

From Student to Junior.—Fred. Bowman, Lachine, Que.; Frederick Theo. Gnaedinger, Lake George, N.B.; Walter Griesbach, Windsor, Ont.; Raphael Andrew McAllister, Port Arthur, Ont.; Henri Prieur, Montreal, Que.; Roderick Bearce Young, Toronto, Ont.

WESTERN CANADA IRRIGATION ASSOCIATION, ANNUAL CONVENTION.

At the recent annual convention of the Western Canada Irrigation Association, held in Kamloops, B.C., on July 25th, 26th and 27th, the following officers were elected for the ensuing year:—

Honorary president, Hon. Dr. Roche, Minister of the Interior; president, Hon. W. A. Motherwell, Minister of Agriculture, Saskatchewan; first honorary vice-president, Hon. Duncan Marshall, Minister of Agriculture, Alberta; second honorary vice-president, W. R. Ross, Minister of Lands, British Columbia; first vice-president, Senator H. Bostock, Ducks; second vice-president, G. R. Marnoch, president of the Board of Trade, Lethbridge; executive committee, east of the Rockies: F. H. Peters, Calgary; R. S. Williamson, Maple Creek; W. D. Trego, Gleichen; A. S. Davison, Calgary; west of the Rockies: J. L. Brown, Kamloops; James Johnstone, Nelson, B.C.; F. E. Wollaston, Vernon.

GREAT BRITAIN'S BLACKLIST.

In last week's issue of *The Monetary Times* was published a complete and official list of United States firms that were blacklisted by Great Britain. Following is the blacklist of firms and individuals in Argentina and Uruguay. All persons and firms in the United Kingdom are forbidden to trade or have any dealings with these firms:—

ARGENTINA AND URUGUAY.

Aders, Alberto, & Company, Buenos Aires.
Allgemeine Electricitats Gesellschaft Sud Americana, all branches.
Austro-American Steamship Company, all branches.
Balzer, Carlos, Calle Cangallo, 417, Buenos Aires.
Banco Aleman Transatlantico (Deutsche Ueberseeische Bank).
Banco Germanico de la America del Sud (Deutsche Sud-Amerikanische Bank).
Barth, Eugenio, & Company, Montevideo, Uruguay.
Bernitt, Rodolfo (partner of Dorner & Bernitt), Misiones, 1472, Montevideo, Uruguay.
Boker & Company, Argentina.
Bonino, E., & Schroeder, E. A., Misiones, 1467, Montevideo, Uruguay.
Bottini, Oscar, Calle Cerropany, Montevideo, Uruguay and Argentina.
Brauss, Mahn, & Company, Reconquista, 80 Buenos Aires, Argentina, and Montevideo, Uruguay.
Bromberg & Company, Calle Moreno, 401, Buenos Aires, Argentina.
Bunge, Ernesto A., & Born, J., B. Mirte, 226, Buenos Aires, Argentina.
Cadenas, Enrique, Montevideo.
Canto, Roberto, (c/o Staudt & Company).
Cassini & Company, Calle Cangallo, 840, Buenos Aires, and Rosario.
Clarfeld, Federico, & Company, all branches, Uruguay and Argentina.
Clausen & Co., Montevideo, Uruguay.
Curt, Berger & Company, Calle 25 de Mayo, 382-392; Calle Corrientes, 344, and Colo, 1384, Buenos Aires, Argentina.
Delfino, A. M., & Hermano, Calle Sarmiento, 442-448, Buenos Aires.
Dorner & Bernitt, Misiones, 1472, Montevideo, Uruguay.
Dorner, Arturo (partner of Dorner and Bernitt), Uruguay.
Dyckerhoff & Widmann Schmidt, Calle Reconquista, 37, Buenos Aires.
Ellerhorst, Fernando (of "La Germano Argentina.")
Franke, Otto & Company, Calle Bolivar, 161, Buenos Aires.
Funck, Ph., & Company, Calle Upsallata, 1056, Buenos Aires, Argentina.
Gasmotorenfabrik Deutz, Buenos Aires, Argentina.
German Coal Depot Company (Deutsches Kohlen Depot).
Hamburg-American Steamship Company.
Hamburg-South American Steamship Company.
Hansa Line.
Hardt, E. and W., & Company.
Hardt, Engelbert, & Company, Buenos Aires, Argentina.
Hasberg, P. (of "La Germano Argentina.")
Hasenclever & Company, Calle Belgrano, 673, Buenos Aires, Argentina.
Heinlein & Company, Av. de Mayo, 1402, Buenos Aires, Argentina.
Hirsch, (of Sociedad Financiera Industrial Sud Americana).
Hoffmann & Stocker, Calle Moreno, 443, Buenos Aires.
Kohelt, G. (of "La Germano Argentina.")
Koerting Brothers, Calle Bolivar, 292, Buenos Aires.
Koppelmeyer, Carl Christian (partner of Clausen & Company), Uruguay.
Kropp & Company, Buenos Aires, Argentina; Montevide , Uruguay.
Lagemann, F., & Company, Montevideo, Uruguay.
"La Germano Argentina."
Lahusen & Company, Buenos Aires, Argentina, and Montevideo, Uruguay.
Lasker & Company, Corrientes, Argentina and Uruguay.
Martinez de Hoz, Florencio, & Co., Buenos Aires, Argentina.
Marquez, Joaquin C. (partner of Dorner and Bernitt), Uruguay.
Massimino, Adolfo, Buenos Aires.
Metzen, Vicenti y Cia, Misione, 152, Montevideo.
Meyer, L. D., & Company, Calle Lima, 387, Buenos Aires.
Meyer, Martin (of "La Germano Argentina.")
Mitau & Grether, Calle Cangallo, 840, Buenos Aires.
Moller & Company, Calle Bartolome Mitre, 722, Buenos Aires.
Monje, Fernandez, Puerto Deseado, Patagonia.
North German Lloyd.
Orenstein & Koppel, Argentina.
Osten & Company, Rondeau, 303, Montevideo, Uruguay.
Oster, (of Sociedad Financiera Industrial Sud Americana).
Pintos, Domingo, Argentina.
Quincke, Ernesto, Montevideo, Uruguay.
Rabe, Margarita N. de (partner of Rabe Walder and Company).
Rabe, Otto (partner of Rabe Walder & Company).
Rabe, Walder & Company, Misiones, 1373, Montevideo, Uruguay.
Rhodius & Company, Castilla, 224, & Ribadavia, 842, Buenos Aires, Argentina.
Roehrs, E., & Company, 195, San Martin, Buenos Aires, Argentina.
Sassoli, A., Buenos Aires.
Schelp & Schelp, Calle Bartolome Mitre, 1123, Buenos Aires, Argentina.
Schweitzer, Felipe, Santa Fe 951, Rosario.
Siemens Schuckert Companies, Calle Bernardo Irigoyen, 330, Buenos Aires, Argentina.
Sociedad Anonima Argentina Hidraulica Agricola, Argentina.
Sociedad Financiera Industrial Sud Americana, Buenos Aires.
Sociedad Tubos Mannesmann Limitada, Calle Defensa, 383, Buenos Aires.
Societa Anonima Transporti de Mestre, Argentina.
Staudt & Company, Buenos Aires, Argentina.
Steffens & Nolle, A. G., Calle Cangallo, 499, Buenos Aires.
Sternberg, H., Junior, & Company, Calle Cangallo, 840, Buenos Aires.
Stofen, Schnack, Muller & Company, Buenos Aires.
Strothbaum, Felix (partner of Clausen & Company), Uruguay.
Strothbaum, Gmo. (partner of Clausen and Company), Uruguay.
Stubenrauch & Company, Puerto Deseado, Patagonia.
Vasquez, Pablo, Solsipuedes, 231, Montevideo.
Velasquez, Pedro, Uruguay.
Vilmar, Rimplar & Company, Defensa, 569-571, Buenos Aires, Argentina.
Vogel, F. W., & Company, Calle Defensa, 467, Buenos Aires.
Wagenknecht & Company, Cerro Largo, 791, Montevideo, Uruguay.
Walder, Enrique (partner of Rabe Walder & Company), Uruguay.
Warburg & Goldschmidt, Calle Bartolome Mitre, 1265, Buenos Aires.
Wayss & Freytag, Calle Moreno, 508, Buenos Aires.
Weil Hermanos & Company, Buenos Aires, Argentina.
Wentzky, R. Von, Calle Corrientes, 685, Buenos Aires.
Weygand & Zum Felde, Calle Peru, 1034, Buenos Aires.
Wirth & Schiebeck, Calle Sarmiento, 372, Buenos Aires.
Wolff, Buchholz & Company, Calle 25 de Mayo, 179, Buenos Aires, Argentina.

UNION OF CANADIAN MUNICIPALITIES, ANNUAL CONVENTION.

The Union of Canadian Municipalities will hold its annual convention in the City Hall, Montreal, August 21st, 22nd and 23rd. The convention will be opened by an address of welcome by His Worship the Mayor of Montreal, which will be replied to by the president of the Union, Mayor T. L. Church, of Toronto.

The following discussions and papers which are of special interest to readers of *The Canadian Engineer*, are to be presented: On Monday at 8 o'clock Mr. Thomas Adams, town planning adviser of the Commission of Conservation, Ottawa, will speak on "The Town Planning Outlook." On Tuesday at 10 a.m. Mr. J. Duchastel, city engineer of Outremont, Que., will speak on "The Good Roads Movement and Its Influence on Urban Municipalities." At the same session Mr. T. J. Hannigan, secretary of the Ontario Hydro-Electric Radial System, will deliver a paper entitled "Hydro-Electric Railway System in Ontario," in which paper Mr. Hannigan will review what is regarded as the largest municipally owned electric railway system in the world. Those of our readers who are interested can get a copy of the complete programme by addressing G. S. Wilson, assistant secretary of the Union, Coristine Building, Montreal.