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BENDING MOMENTS IN FLAT SLABS

A MODIFICATION OF GRASHOF'S GENERAL BENDING MOMENT THEORY, FOR CONSIDERATION OF UNIFORMLY DISTRIBUTED LOAD—THE LACK OF SUFFICIENT REINFORCEMENT A COMMON DEFECT IN MANY FLAT SLAB SYSTEMS

By V. J. ELMONT, B.Sc., A.M. Can. Soc. C.E.

WITH very few exceptions, the flat slab systems in use show lack of adequate reinforcement. The designs are very similar, as regards insufficient reinforcing, to those adopted during the period 1885 to 1895 in the making of ordinary slabs and beams. As long as the tension was at the bottom side of a structure the steel was placed correctly, and in general it was also correctly placed over columns, but for slightly more complicated structures and stress distributions but little understanding was shown. A great number of "systems" existed, formed, as a rule, by adding a few bars, here and there, to the usual reinforcing. As these "systems" were able to carry a test load of as much as twice the live load without failing and with a deflection of only a small fraction of an inch, their inventors considered these structures to be a complete success and assured architects and others interested in buildings of strength, rigidity, economy, etc., of the inventions, by means of neat printed matter and pictorially illustrated advertisements, showing a pile of well filled bags resting on the structure. There was usually added a list giving the various jobs where the "system" had been employed. The excellence of the invention was thereby made clearly evident without question.

To-day theoretical and practical experience will veto most of these early "systems." The same veto should be placed on the majority of the flat designs now in use.

The thorough and scientific test loadings, made by the University of Illinois (Prof. Talbot) and others, of flat slab floors in actual structures have shown the insufficiency of their reinforcing in a practical way. Below it is shown theoretically.

In nearly all flat slab designs it is found that the positive bending moments and the negative moment over the columns are provided for, more or less successfully. The existence of these moments are, of course, easily recognizable, even by those whose knowledge of mechanics does not extend much beyond the stresses and strains in a simply supported girder or truss. But the negative moments perpendicular to the sides of the panels are, as a rule, entirely neglected, although they have about the same numerical value as the maximum positive moments.

The following calculations are based on Grashof's general theory* modified by the general assumptions on which all calculations for reinforced concrete depend. The method adopted follows one given in a recent issue of "Deutsche Bauzeitung."

*Theorie der Elastizität und Festigkeit, Berlin, 1878, page 358.

For an infinite slab, of uniform thickness, h, supported at a series of points, dividing it into square panels of side, 2a, and uniformly loaded with q per sq. unit, Grashof gives the following values for the deflections, z, at the various points x, y:

$$z = \frac{g}{4 \cdot A \cdot h^3} \cdot [(a^2 - x^2)^2 + (a^2 - y^2)^2]$$

where $A = \frac{m^2}{m^2 - 1} \cdot E$, m is Poisson's constant, and E the modulus of elasticity.

The origin of the system of co-ordinates lies at the middle point of the diagonal of the panel, the directions of the x and y axes being parallel to the sides.

The horizontal normal stresses c_x and c_y at the point x, y, v (that is, the point whose distance is v from the centerplane of the slab) are

$$c_x = -A \cdot v \cdot \left(\frac{\delta^2 z}{\delta x^2} + \frac{1}{m} \cdot \frac{\delta^2 z}{\delta y^2}\right)$$

and

$$c_y = -A \cdot v \cdot \left(\frac{1}{m} \cdot \frac{\delta^2 z}{\delta x^2} + \frac{\delta^2 z}{\delta y^2}\right)$$

From the equation for z it follows that

$$\frac{\delta^2 z}{\delta x^2} = \frac{g}{A \cdot h^3} \cdot (3x^2 - a^2)$$

and

$$\frac{\delta^2 z}{\delta y^2} = \frac{g}{A \cdot h^3} \cdot (3y^2 - a^2)$$

$$\therefore \quad c_x = -\frac{g}{h^3} \cdot v \cdot \left[3x^2 - a^2 + \frac{1}{m} \cdot (3y^2 - a^2)\right]$$

and

$$c_y^2 - \frac{g}{h^3} \cdot v \cdot \left[\frac{1}{m} \cdot (3x^2 - a^2) + 3y^2 - a^2\right].$$

The corresponding bending moments per unit width are

$$M_x = -\frac{g}{h^3} \cdot \frac{h}{2} \cdot \left[3x^2 - a^2 + \frac{1}{m} \cdot (3y^2 - a^2)\right] \cdot \frac{h^2}{6}$$

$$M_y = -\frac{g}{h^2} \cdot \frac{h}{2} \cdot \left[\frac{1}{m}(3x^2 - a^2) + (3y^2 - a^2)\right] \cdot \frac{h^2}{6}$$

or

$$M_x = \frac{g}{12} . [3x^2 - a^2 + \frac{1}{m} . (3y^2 - a^2)]$$

$$M_y = \frac{g}{12} [\frac{1}{m} . (3x^2 - a^2) + 3y^2 - a^2].$$

Taking $m = 3$,

$$M_x = \frac{g}{12} . (3x^2 + y^2 - \frac{4}{3} a^2)$$

$$M_y = \frac{g}{12} . (x^2 + 3y^2 - \frac{4}{3} a^2).$$

These moments, parallel to the axes, can be shown to be the maximum moments, and the stresses c_x and c_y to be the maximum stresses in points x, y, $\frac{h}{2}$. The bending moments vary only with the value c of the normal stress in the upper and lower side of the slab

$$M = \frac{h^2}{6} . c,$$

the question of the direction of the maximum bending moments is accordingly reduced to that of the direction of the principal stresses. To find these advantage is taken of the fact that the stress distribution is a "plane" one for all points in the plane $z = \pm \frac{h}{2}$; the normal stress c_z (parallel to the z-axis) can with sufficient accuracy be assumed O and furthermore the shear stresses $s_x = s_y =$ O for the same reasons as for an ordinary beam. The necessary and sufficient requirements for a plane stress distribution are thus fulfilled.

To fully determine the stresses in the points x, y, $\pm \frac{h}{2}$ it is now only necessary to know the values of the shear stresses s_z. Grashof gives

$$s_z = -\frac{m-1}{m} . A . \frac{h}{2} . \frac{\delta^2 z}{\delta_x . \delta_y}$$

As the equation for z does not contain any product of x and y, $\frac{\delta^2 z}{\delta_x \delta_y} = 0$ and therefore $s_z = O$; consequently c_x and c_y derived above are the principal stresses at the point, and then again M_x and M_y the maximum bending moments.

The distribution of the bending moments over the entire slab is given by the equations for the bending moments; by substituting $\frac{l}{2}$ for a (l the span) the equations will take the form

$$M_x = \frac{gl^2}{12} . [3 . (\frac{x}{l})^2 + (\frac{y}{l})^2 - \frac{1}{3}]$$

$$M_y = \frac{gl^2}{12} . [(\frac{x}{l})^2 + 3 (\frac{y}{l})^2 - \frac{1}{3}]$$

In the following table is given the bending moments for different values of $\frac{x}{l}$ and $\frac{y}{l}$

$\frac{x}{l} =$	0.x centre of slab	0.1	0.2	0.3	0.4	0.5
0.x	$+\frac{gl^2}{36}$	$+\frac{gl^2}{39.6}$	$+\frac{gl^2}{56.3}$	$+\frac{gl^2}{189}$	$-\frac{gl^2}{81.9}$	$-\frac{gl^2}{28.8}$
0.1	$+\frac{gl^2}{37.1}$	$+\frac{gl^2}{40.9}$	$+\frac{gl^2}{59}$	$+\frac{gl^2}{225}$	$-\frac{gl^2}{76.7}$	$-\frac{gl^2}{28.1}$
0.2	$+\frac{gl^2}{40.9}$	$+\frac{gl^2}{45.6}$	$+\frac{gl^2}{69.3}$	$+\frac{gl^2}{514}$	$-\frac{gl^2}{64.3}$	$-\frac{gl^2}{26.3}$
0.3	$+\frac{gl^2}{49.3}$	$+\frac{gl^2}{56.3}$	$+\frac{gl^2}{97.3}$	$-\frac{gl^2}{450}$	$-\frac{gl^2}{50.7}$	$-\frac{gl^2}{23.7}$
0.4	$+\frac{gl^2}{69.3}$	$+\frac{gl^2}{83.8}$	$+\frac{gl^2}{225}$	$-\frac{gl^2}{124}$	$-\frac{gl^2}{39.1}$	$-\frac{gl^2}{20.8}$
0.5	$+\frac{gl^2}{133}$	$+\frac{gl^2}{225}$	$-\frac{gl^2}{327}$	$-\frac{gl^2}{64.3}$	$-\frac{gl^2}{33}$	$-\frac{gl^2}{18}$

(Over column)

The bending moments parallel to, and along the sides of the panel are thus positive at the middle point and equal to $+\frac{gl^2}{133}$ (see last line of table), decreasing to $-\frac{gl^2}{18}$ over the support; perpendicular to the sides the bending moments are negative (last column) over the entire length, $-\frac{gl^2}{28.8}$ at the middle point and $-\frac{gl^2}{18}$ over the support.

As the above calculations are based on a uniformly distributed loading, the negative moments derived therefrom can be considered as the maximum values for which the slab has to be dimensioned. The positive moments attain their maximum by partial loading. Judging from similar cases (continuous slabs and beams) it seems reasonable to assume that the maximum positive moment from a live load p per square unit will be

$$2 . \frac{pl^2}{36} = \frac{pl^2}{18},$$

$\frac{pl^2}{36}$ being the maximum moment at the centre of the slab for a uniformly distributed load. The resulting moment from a dead load g per square unit and live load p per square unit would therefore be

$$M = \frac{gl^2}{36} + \frac{pl^2}{18}$$

or for values of g varying from $\frac{2}{3}$p to $\frac{1}{3}$p, which covers nearly all practical cases, the maximum positive bending moment can be taken as

$$M = \frac{gl^2}{22},$$

where g is the total load per square unit (g = g + p).

Above Poisson's constant, m, has been taken equal to 3 which, according to the not very numerous experiments made so far on this continent and on the other side of the ocean, seems a fair figure. That the value of m is not of great significance will be seen by the table below, which gives the maximum negative moment over the columns, the maximum negative moment between the columns and the maximum positive moment at the centre of the slab for m, 2, 3 and 4:

	Maximum negative moment over col.	Maximum negative moment between col.	Maximum positive moment at centre.
m = 2	$\frac{gl^2}{16}$	$\frac{gl^2}{32}$	$\frac{gl^2}{19}$
m = 3	$\frac{gl^2}{18}$	$\frac{gl^2}{28.8}$	$\frac{gl^2}{22}$
m = 4	$\frac{gl^2}{19.2}$	$\frac{gl^2}{27.4}$	$\frac{gl^2}{23}$

RAIL FAILURE STATISTICS.

In a report recently submitted by the Rail Committee of the American Railway Engineering Association, statistics concerning rail failures in the United States for the year ended October 31st, 1912, are published. The data shows wide variation in results, which the committee claims must be due, to a large extent, to the lack of uniformity in the performance of different mills, and also to a lack of uniformity in the product of any individual mill.

The report shows also that the average performance of the heavy sections (85-lb. to 100-lb.) is not quite so good as that of the lighter sections (72-lb. to 80-lb.). The average rate of failure in the open-hearth rail is lower than that of the Bessemer, although both are higher than last year. The rate of failure of the open-hearth rail in 1912 was 22% higher than in 1911, and 40% higher than in 1910. The rate of failure of the Bessemer rail was 68% higher in 1912 than in 1911, and 56% higher than in 1910.

The rate of failure of the Bessemer rail was, in 1912, 116% higher than that of the open-hearth in 1911, was 58% higher, and in 1910, 94% higher.

A higher percentage of failures has occurred in rails from the upper part of the ingot than in those from the lower positions.

For the past four years, head failures have predominated except in 1912, in which year there was a slightly higher percentage of broken rails. It will be remembered that the early part of 1912 was marked by exceptionally severe weather which was accompanied by an epidemic of broken rails. The committee regards this as an abnormal condition, however, and maintains that the majority of failures are head failures, such as split or crushed heads, and are due not to imperfect track conditions, but to defective material in the rail.

The appropriations for the Panama Canal for the year ending June 30th, 1914, amount to $16,265,393, and include the cost of drydocks, wharves, warehouses, a quarantine station, as well as two colliers of 12,000 tons capacity each, to be built in the United States. In addition to the above, $4,870,000 are appropriated for fortifications of the Canal, including $2,635,000 for sea-coast batteries, $173,000 for electric light and power plants, $285,000 for searchlights, $180,000 for filling in the swamp behind the military works on Margarita Island, and $1,000,000 for cannon and equipment and one 16-in. gun and carriage, etc.

WINNIPEG RAINFALL.

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RAINFALL and the precipitation of snow forms an interesting and essential part of a municipal engineer's study, and it is only by the careful comparison of precipitations extending over years that an appreciative knowledge can be obtained.

The Dominion Government has established meteorological stations in many centres, and from these information is carefully and accurately conveyed by code daily, and by monthly and annual reports.

The attempt to set the following tables before those interested is a plea in the first instance for the further provision of these stations; in the second for the annual distribution of tabulated data, and in the third for the recognized establishment of stations in every municipality. For general information it would be difficult to find a more concise and better form than that in use known as "British Rainfall," edited and published by Dr. H. Mill, of London, England.

Table of Rainfalls, Municipality of Kildonan, 1906-1912, Inclusive. Rainfall up to and Including 0.19 Inch.—Table I.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Totals
1906	...	.12	.29	.30	.22	.22	.23	.07	.17	1.62
1907	...	.50	.42	.43	.39	.82	.20	.40	.17	3.33
1908	...	.17	.49	.88	.17	.29	.45	.17	.06	2.68
1909	...	.13	.41	.51	.13	.16	.15	.38	.05	1.92
1910	.29	.34	.63	.53	.28	.24	.15	.18	.10	2.74
1911	...	...	.40	.87	.41	.66	.33	.27	...	2.94
1912	.01	.23	.71	.47	.83	.36	.52	.18	.01	3.32
T't'l in.	.30	1.49	3.35	3.99	2.43	2.75	2.03	1.65	0.56	18.55
No. of prec ns	7	18	43	55	51	51	38	31	12	306
No. of traces	6	9	15	17	17	21	9	11	...	...
Average per month	.04	.21	.48	.57	.34	.39	.29	.23	.08	2.67

Average 0.06 per rainfall.

Humboldt assigned rainfall as varying with the latitude, the greatest being at the equator and diminishing towards the poles, in the following ratio: equatorial zones, 96 inches; at the 20th latitude, 80 inches; at latitude 45°, 29 inches; and 17 inches at latitude 60°. Again, this may vary throughout districts in the latitudes, owing to their positions in relation to the sea, large areas of water and the general configuration of the land surfaces.

Rainfalls From 0.20 to 0.30 Inch, Inclusive.—Table II.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Totals
	...	...	.28	.26	.24	...	...	...	...	...
1906	...	.25	.25	.28	.28	.27	...	...	.21	2.32
	...	...	...	...	...	.22	.27	...	...	...
1907	...	...	.23	...	.27	.26	.22	...	...	1.47
	...	...	...	.22	...	...	...	...	...	...
1908	...	...	...	.26	.20	...	.30	.29	...	1.27
	...	...	.21	...	...	...	...	...	...	...
1909	...	...	.22	.25	...	...	...	...	...	.68
	...	...	.23	...	.24	...	.30	...	...	...
1910	...	.21	.20	.25	.28	...	.21	24	...	2.16
	...	...	...	...	.20	.26	.20	...	...	...
1911	...	.20	.20	.28	.28	.24	.24	.20	...	2.77
	...	...	...	...	.24	...	.23	...	...	...
	...	...	.30	...	...	.30	.25	...	...	...
1912	...	.28	.26	...	...	.23	.26	...	...	1.88
T't'l in.	...	.94	2.38	1.80	2.23	1.78	2.48	.73	.21	12.55
Average per month per year		.13	.34	.25	.32	.25	.35	.10	.03	1.36
No. of Falls		4	10	7	9	7	10	3	1	51

Average 0.246 inch per rainfall.

As to the cause of rainfall, this does not call for any explanation here and as to evaporation and percolation, also falls without the province of this article; but again, conditions vary under each head to such a degree that for reliable figures for this continent the subjects should be diligently studied.

Rainfalls From 0.31 to 0.40 Inch, Inclusive.—Table III.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	...	.35	...	.34	...	...	...	0.69
1907........	...	...	.36	.35	.33	.40	...	...	1.44
1908........	...	...	...	...	...	...	...	.34	.34
	...	...	...	.40	...	...	...	...	...
1909........	...	...	...	.39	...	...	...	...	.79
1910........	.38	...	...	.39	...	...	.	...	.77
	...	...	...	.36	...	...	...	...	...
1911........	...	.31	.35	.34	...	.34	.36	...	2.06
	...	.38	.39	...	.31	...	...	...	...
1912........	...	.36	.34	...	.33	...	...	.40	2.51
Totals	.38	1.05	1.79	2.23	1.31	.74	.36	.74	8.60
Average per month per year	.05	.17	.25	.32	.19	.10	.05	.10	1.23
No. of Rainfalls ..	1	3	5	6	4	2	1	2	24

Average 0.33 inch per rainfall.

Rainfalls From 0.41 to 0.50 Inch, Inclusive.—Table IV.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........		...	...	.44	...	...	...	...	0.44
1907........	...	...	...	...	.48	...	...	...	0.48
1908........	...	.46	.43	.44	.48	...	...	.43	2.68
	...	...	...	...	.44	...	...	...	...
1909	...	...	.41	...	.50	...	.45	...	1.36
1910........	...	...	...	.46	...	.46	.42	.42	1.76
1911........	...	...	...	.42	.45	...	.50	...	1.37
1912........	...	.42	...	.44	.48	...	...	...	1.34
Totals	...	.88	.84	2.20	2.83	.46	1.37	.85	9.43
Average per month per year	...	.12	.12	.31	.42	.06	.19	.12	1.34
No. of Rainfalls ..	...	2	2	5	6	1	3	2	21

Average 0.449 inch per rainfall.

Two seasons form the meteorological year, viz., summer from the 1st of May to the 30th of September, and winter from the 1st of October to the 31st of April, but this cannot be applied as a hard and fast rule to the actual seasons of rain and snowfall.

Rainfalls From 0.51 to 0.60 Inch, Inclusive.—Table V.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	...	.60	...	...	...	.54	...	...
	...	...	.56	...	...	...	...	...	1.70
1907........	...	...	...	...	...	...	...	...	...
1908........	...	.51	.60	...	...	.60	...	...	1.71
1909........	...	...	...	...	...	...	...	...	...
1910........	...	...	.59	...	...	...	...	...	0.59
1911........	...	...	...	...	...	...	.57	...	.57
1912........	...	...	...	...	...	...	.58	...	.58
Totals	...	.51	2.35	...	...	.60	1.69	...	5.15
No. of Rainfalls ..	...	1	4	...	...	1	3	...	9

Average 0.57 inch per rainfall.

Rainfalls From 0.61 to 0.70 Inch, Inclusive.—Table VI.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	...	.66	...	.63	...	...	...	1.29
1907........	...	...	...	...	...	.64	...	...	0.64
1908........	...	..	...	.61	...	...	...	...	...
	...	...	...	.70	...	...	...	...	1.31
1909........	...	...	...	...	.61	...	...	...	0.61
1910........	.64	...	...	...	...	.70	...	...	1.34
1911........	...	...	...	...	...	...	...	...	...
1912........	...	...	...	...	.63	...	...	...	.63
Totals	.64	...	.66	1.31	1.87	1.34	...	...	5.82
No. of Rainfalls ..	1	...	1	2	3	2	...	...	9

Average 0.647 inch per rainfall.

In some instances in the tables certain subdivisions of rain and snowfall are given, and these occur only after the determination of one of the seasons, and with them has occurred a lowering or raising of temperature.

The precipitation of snow by seasons forms a not uninteresting table, and would be of greater value, were it possible to record the actual period of thaw each spring.

Rainfalls From 0.71 to 0.80 Inch, Inclusive.—Table VII

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	...	...	.73	...	...	.75	...	1.48
1907........	...	...	...	.77	...	...	...	...	0.77
1908........	...	...	...	.75	...	...	...	...	...
	...	...	...	.74	...	...	...	...	1.49
1909	...	...	...	...	...	...	...	...	...
1910........	...	.80	...	.75	...	.74	...	...	2.29
1911........	...	...	.76	...	...	...	...	...	.76
1912........	...	...	...	...	...	.72	...	...	.72
Totals	...	.80	.76	3.74	...	1.46	.75	...	7.51
No. of Rainfalls ..	...	1	1	5	...	2	1	...	10

Average 0.75 inch per rainfall.

Rainfalls From 0.81 to 0.90 Inch, Inclusive.—Table VIII.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	...	...	...	.85	.86	...	...	1.71
1907........	...	...	...	...	.87	...	...	...	0.87
1908	...	...	...	...	...	...	...	...	...
1909........	...	...	...	...	...	...	...	...	...
1910........	...	...	...	...	...	...	...	...	...
1911........	...	...	...	...	...	.83	...	...	0.83
1912...	...	.86	...	...	.87	...	...	...	1.73
Totals	...	*.86	...	...	2.59	1.69	...	...	5.14
No. of Rainfalls ..	...	1	...	...	3	2	...	...	6

Average 0.84 inch per rainfall.

*6th April—Rain .42
Snow .44
.86

Rainfalls From 0.91 to 0.99 Inch, Inclusive.—Table IX.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	...	...	.96	...	...	...	...	0.96
1907........	...	...	...	...	...	...	...	...	...
1808..	...	...	...	...	...	.94	.91	.98	2.83
1909........	...	...	...	...	...	...	...	...	...
1910........	...	...	...	...	...	...	...	...	...
1911........	...	...	.99	...	...	...	...	...	0.99
1912........	...	...	...	...	...	...	...	...	...
Totals	...	...	.99	.96	...	.94	.91	.98	4.78
No. of Rainfalls ..	...	...	1	1	...	1	1	1	5

Average 0.95 inch per rainfall.

The tables have been prepared with a view to establishing data for the calculation of the run-off from snow and rain. With regard to the latter, it is certainly regretable that automatic rainfall recorders are not more generally in use in the Prairie Provinces. The expense of establishment is possibly the reason of this, but surely municipalities that are contemplating the installation of sewerage

Rainfalls of 1 Inch and Upwards.—Table X.

Year	March	April	May	June	July	Aug.	Sept.	Oct.	Totals
1906........	...	1.07	...	1.63	...	...	...	...	...
	...	...	...	1.71	...	...	...	...	4.41
1907........	...	...	...	...	1.61	1.59	...	...	3.20
1908........	...	...	...	...	1.28	...	...	...	1.28
1909........	...	...	...	...	1 60	1.66	...	...	...
	...	...	...	...	...	1.26	...	...	...
	...	...	...	...	...	1.67	...	...	6.19
1910........	...	...	...	...	...	...	1.67	...	1.67
1911........	...	*1.72	2.80	...	1.38	...	...	1.15	8.09
	...	...	1.04	...	...	...	...	...	...
1912........	...	...	1.59	...	1.05	...	1.25	...	...
	...	...	...	...	1.57	...	1.30	...	...
	...	...	...	...	...	...	1.34	...	8.10
Totals	...	2.79	5.43	3.34	8.49	6.18	5.56	1.15	32.94
No. of Rainfalls ..	...	2	3	2	6	4	4	1	22

Average 1.49 inches per rainfall.

*1.72 Rain 1.42
Snow .30
1.72

Monthly Precipitation for 7 Years, 1906-1912, Inclusive.—Table XI.

Year	Jan.	Feb.	Mar.	Apr.	Mav	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1906	1.29	.20	.53	1.64	2.99	6.31	2.56	1.35	1.52	.21	1.78	1.25	21.63
1907	2.07	.27	1.11	.99	.87	1.55	3.95	3.93	.69	.40	.72	.18	16.73
1908	.44	1.80	1.84	1.64	3.01	3.11	1.65	2.75	1.89	2.21	.55	.61	21.50
1909	.73	.67	2.49	1.26	1.25	1.55	3.84	4.75	.60	.52	.92	3.99	22.57
1910	.25	1.58	1.61	1.84	1.65	2.38	.80	2.14	2.75	.84	1.27	1.87	18.98
1911	.45	.81	.28	2.57	6.38	2.27	2.96	2.33	2.43	1.84	.59	.59	23.50
1012	.30	.18	.30	2.25	3.59	.90	6.09	1.63	5.50	1.15	.11	.78	22.78
T't'ls	5.53	5.51	8.16	12.19	19.74	18.07	21.85	18.88	15.38	7.17	5.94	9.27	147.69
Av'ge	.79	.78	1.16	1.74	2.82	2.58	3.12	2.69	2.19	1.02	.85	1.32	21.09
H'g't	2.07	1.80	2.49	2.57	6.38	6.31	6.09	4.75	5.50	2.21	1.78	3.99	23.50
L'w't	.25	.18	.28	.99	.87	.90	.80	1.35	.60	.21	.11	.18	16.73
No. of days	70	63	83	66	89	99	97	96	71	60	79	100	973
Average No. of days per annum	10	9	11.8	9.4	12.7	14.1	13.8	13.7	10.1	8.5	11.2	14.2	139

Number of Days of Precipitation, Including 10% of Snow and Excluding Traces.—Table XII.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1906	10	5	5	5	9	13	10	6	8	3	12	11	97
1907	12	7	8	8	9	11	14	16	9	6	6	3	109
1908	4	8	9	5	10	16	6	12	8	6	9	12	105
1909	9	10	16	14	10	9	12	7	4	8	10	19	128
1910	7	8	10	7	11	10	7	9	8	5	9	13	104
1911	11	7	7	6	9	15	13	12	11	9	7	12	119
1912	9	3	7	9	15	7	18	13	14	9	5	14	123
Total	62	48	62	54	73	81	80	75	62	46	58	84	785
Av'ge	8.85	6.99	8.85	7.71	10.42	11.57	11.42	10.71	8.85	6.57	8.28	12.00	112.14
High't	12	10	16	14	15	16	18	16	14	9	12	19	123
Lowest	4	3	5	5	9	7	6	6	4	3	5	3	104

Precipitation of Snowfalls Not Reduced in Inches.— Table XIII.

Year	Jan.	Feb.	Mar.	Apr.	May	Sept.	Oct.	Nov.	Dec.	Totals
1906......	12.9	2.0	5.3	...	...	...	1.4	14.0	12.5	48.1
1907......	20.7	2.7	11.1	9.9	1.4	...	4.0	5.5	1.8	57.1
1908......	4.4	18.0	18.4	5.0	...	2.3	...	4.9	6.1	59.1
1909......	6.3	6.7	24.9	11.3	...	...	1.4	8.7	39.9	99.2
1910......	2.5	15.8	3.0	7.0	0.4	...	...	12.7	18.7	60.1
1911	4.5	8.1	2.8	6.4	1.6	...	0.10	4.9	5.9	34.3
1912......	3.0	1.8	2.9	5.8	...	...	5.7	1.1	7.8	28.0
Totals ..	54.3	55.1	68.4	45.4	3.4	2.3	12.6	51.8	92.7	385.9
Average .	7.75	7.87	9.77	6.5	0.5	0.32	1.8	7.4	13.2	55.12

Snow Precipitation by Seasons.

1906-7	73.7—rain at 1/10th	7.37 at 1/8th	9.21
1907-8	57.1	5.71	7.13
1908-9	62.5	6.25	7.81
1909-10	78.7	7.87	9.83
1910-11	54.8	5.48	6.85
1911-12	24-4	2.44	3.05
	351.2 ins.	35.21 ins	43.88 ins.
Five seasons 1906-7 to 1910-11	326.8	32.68	40.85

Average 65.36

Table XIV.

Rainfall Table	No. of Rainfalls Percentage	Intensity of falls Percentage
I.	0.66	0.167
II.	0.11	0.114
III.	0.052	0.078
IV.	0.046	0.085
V.	0.019	0.046
VI.	0.019	0.053
VII.	0.022	0.068
VIII.	0.013	0.046
IX.	0.011	0.044
X.	0.048	0.298
	1.000	1.000

and water systems should not fail to provide the necessary means of obtaining such important information.

In conclusion, the writer wishes to express indebtedness to Mr. H. C. Cox, of St. John's College, Winnipeg, who supplied the records of the rainfalls, etc., from which the tables have been compiled.

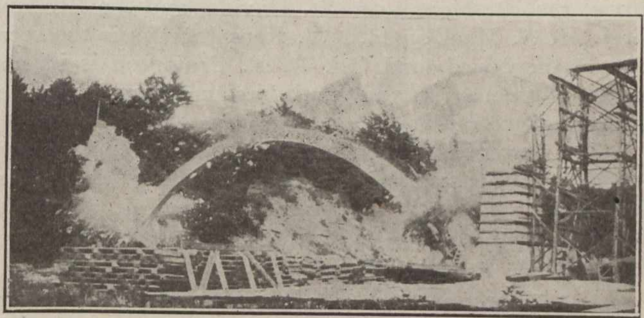
WINNIPEG'S MUNICIPAL POWER PLANT.

The waterfalls and works of the Winnipeg civic hydro-electric power and light plant are located at Point du Bois, on the Winnipeg River, seventy-seven miles north-east of the city of Winnipeg. The water fall (naturally 32 feet) is increased by the power development dam to 47 feet. The total available power without storage is 60,000 horse-power, which can be increased to 100,000 horse-power. The present installation is 28,000 horse-power, the full capacity of the present building being 45,000 horse-power. The average flow of water is 25,000 cubic feet per second. The transmission line (owned by the city) is 77 miles long and 100 feet wide, upon which is constructed one line of double towers, with transformer station and distributing stations in Winnipeg. The cost of the plant, including power house, dams, wires, forebay, tailrace, intake, rack piers, for full installation, machinery, transmission line, transformer station and distribution stations is $5,400,000.00. The work of the first year's operation of the plant was entirely satisfactory. The cost of domestic lighting has been reduced seventy per cent., and that of power proportionately, and the plant is already paying its way, the revenue monthly covering the cost of interest, operating expenses, depreciation, advertising and other expenses.

The city of Hamilton is contemplating the purchase of a large gravel pit near Guelph. The gravel contained therein has been found to be well suited for use in civic construction, and if the city acquires it, the understanding is that a stone crusher will be installed and a railway switch run into it for immediate use.

AN UNUSUAL ENGINEERING OPERATION.

The accompanying illustration has been sent in by Mr. E. Bennett, a Toronto contractor, and relates to an incident described in *The Canadian Engineer* September 5th, 1912, in which issue an article appeared relating to the destruction of an arch span at Oakville, Ontario.



Readers are referred to the article. The illustration herewith is descriptive of the method of dynamiting and shows the position and simultaneous explosion by electric spark of the shots placed in the crown and near the haunches of the arch.

AMERICAN ROAD CONGRESS.

Systematizing the purchase of all road materials and equipment through the establishment of purchasing departments, somewhat along the lines followed by great railroad corporations, is strongly advocated by Maj. Henry G. Shirley, Chief Engineer of the Maryland State Roads Commission, in a paper which he will present at the third American Road Congress, which will be in session at Detroit, Mich., during the week of September 29. An intelligent selection of material and equipment, exact knowledge of values and prices and utilization of discounts and credits are among the advantages claimed for a centralized system for the purchase of road materials and equipment.

The construction and maintenance of concrete roads, a type which is attracting attention among road builders, will be explained in a paper by Mr. F. F. Rogers, State Highway Commissioner of Michigan, and the discussion on his paper will be opened by Mr. A. N. Johnson, State Highway Engineer of Illinois. A similar treatment will be given the subject of brick roads by Mr. J. M. McCleary, County Engineer of Cuyahoga County, of which Cleveland is the county seat and which has a large mileage of excellent brick roads, the discussion to be opened by Mr. R. Keith Compton, chairman of the Paving Commission of Baltimore.

Tars, oils and asphalts in connection with the construction and maintenance of roads have been so generally used in the eastern states as to bring out much valuable data. The basic paper on this subject will be presented by Mr. S. D. Foster, Chief Engineer of the Pennsylvania State Highway Department. The discussion will be opened by W. A. McLean, Chief Engineer of the Province of Ontario, Canada.

The lessons learned at the International Road Congress recently held in London will be presented at the big meeting in Detroit by Col. Wm. D. Sohier, chairman of the Massachusetts State Highway Commission.

There will be a host of other papers and addresses which will deal searchingly with every phase of the road subject from the standpoint of the engineer, the financier, the legislator and the road user.

THE BRITISH ROAD BOARD.

THE British Road Board was formed in 1910 for the purpose of aiding the county councils and other local authorities of Great Britain in the construction and maintenance of new roads and the improvement of existing roads. The board consists of four members: Sir Geo. S. Gibb, chairman; the Rt. Hon. Lord Pirrie, the Rt. Hon. Lord St. Davids, and the Rt. Hon. Sir J. H. A. MacDonald. W. Rees Jeffreys is the secretary of the board, and Col. R. E. Crompton is its consulting engineer. In addition it has an advisory engineering committee of six.

The board has published its third annual report, covering its operations for the year ending March 31st, 1913, and including, in nineteen appendices, a mass of statistical data relative to its work, and an explanation of the methods of administering its affairs.

While the report covers the year ending March 31st, 1913, in some cases figures are given up to June 30 of this year. Up to this latter date, the total of the grants and loans made amounted to £1,474,793. This was divided among the different kinds of work undertaken, as shown in the following table:

Improvement of road crusts	£1,210,012
Road widenings and improvement of curves, gradients and corners	120,466
Road diversions	29,395
Reconstruction and improvement of bridges	53,842
New roads and bridges	61,078
Total	£1,474,793

The grants and loans indicated up to June 30, 1913, amounted to £3,435,233, or £1,960,440 more than the grants and loans made. This difference is due to the fact that grants and loans may not be actually paid until some time after they are indicated or allotted, since the arrangements under which grants and loans are made may provide for the payment of half the sum indicated in any particular case at the beginning of the work and the remainder at its completion or in instalments payable at the time the grantees are ready to commence work, when the work is half completed and when the work is finished. In this connection, the method followed by the Road Board in making grants is of interest. As set forth in the report, this is essentially as follows:

Any local highway authority may apply for a grant or loan at any time, and all these applications are considered by the board so far as possible when they are received. In deciding upon the making of a grant or a loan, the Road Board investigates its advisability, taking into account the conditions in the district in question, as revealed by information obtained by conferring with the county councils from time to time in regard to the requirements in each county, and from other sources. According to the usual procedure, a county council when making up its estimate for the ensuing year submits to the Road Board a general statement including a list of the contemplated improvements for which assistance is desired. This statement is not usually treated as a formal application, but is followed by a conference of the Road Board and representatives of the county council. At this, and, if necessary, at subsequent conferences, the question is discussed and the decision arrived at by the Road Board after a consideration of the various requests from all of the counties applying for aid. After the Road Board has selected the improvements upon which it is willing to grant aid and has suggested the amounts to be devoted to the work, the local authorities bring in detailed plans and specifications of the work. The Road Board then submits each case to the treasury for its approval, which is usually prompt. The grants are then indicated by the Road Board.

The annual income of the Road Improvement Fund (calculated without regard to the date of the actual receipt of the sums involved) has steadily increased since the establishment of the board, and during the year 1912-13 amounted to £1,252,970 4s. 10d. The details of the income are shown in one of the accompanying tables.

In regard to the policy of the board in making grants and loans, the following statement is included in the report:

In settling the total amount up to which advances may safely be made at any date the board do not confine themselves to dealing with the balance in hand, representing cash received less commitments. They are prepared to anticipate their income to a certain extent, but in view of the limited experience available in regard to the rate at which commitments will mature, and the probability that as the procedure and operations of the board become better known to highway authorities there will be a constantly increasing acceleration in the maturity of commitments and the expenditure of money on assisted works, they have not thought it advisable to anticipate more than a year's income. They are confirmed in this view by the consideration that in their opinion the amount of road improvement work which is being undertaken by highway authorities (apart from urban street widenings to which, for reasons given in their previous annual reports, the board are not generally disposed to make contributions at the present time, except in special cases) is, generally speaking, as much as can practically be carried out by the staff and with the moneys at the disposal of highway authorities aided by advances from the Road Improvement Fund.

At the present time the board are making grants on the assumption that they can safely indicate a sum of about £1,700,000 in addition to the indications made up to June 30, 1913.

Yearly Income of British Road Board.

Item.	Apr. 30, 1909, to Mar. 31, 1910. £ s. d.	Apr. 1, 1910, to Mar. 31, 1911. £ s. d.	Apr. 1, 1911, to Mar. 31, 1912. £ s. d.	Apr. 1, 1912, to Mar. 31, 1913. £ s. d.	Total. £ s. d.
Motor spirit duties	290,702 15 9	410,376 5 7	591,781 18 7	702,381 10 3	1,995,242 10 2
Carriage license duties	....	460,265 17 6*	403,270 19 11	493,790 6 9	1,357,327 4 2
Interests on investments and loans	....	4,851 16 0*	23,064 13 7	56,798 7 10	84,714 17 5
Total annual income	290,702 15 9	875,493 19 1	1,018,117 12 1	1,252,970 4 10	3,437,284 11 9

*From Jan. 1, 1910, to March 31, 1911.

USE OF CEMENT AT COLLIERIES.*

By John Gregory.

CONCRETE by itself is much more capable of withstanding compressive than tensile stresses, the ratio being approximately 10 to 1, and in reinforced concrete the object of the designer is to increase the strength of those parts subject to tension by adding steel of suitable section. The size and disposition of the reinforcement are matters of calculation equiring considerable technical skill, as the various stresses have to be worked out and the several members of a structure proportioned accordingly. For important surface works this is somewhat out of the province of mining engineering, and it will be found an advantage to get designs from engineers or architects who have specialized in concrete work.

Underground Roadways.—With regard to the support of underground roadways, however, other conditions prevail. The crushing effect of the strata in deep mines is an unknown quantity, and as the stresses are chiefly in compression the writer has preferred to put in a thick concrete lining combined with heavy steel girders, rather than a correctly designed thinner lining dependent for its success upon an elaborate system of reinforcement. He is not prepared to justify this from a purely scientific standpoint, but it has the merit of being more easily put in by the ordinary colliery labor, and if the necessity should arise, it lends itself more readily to repair or renewal.

The first application at Sneyd Collieries was in 1908 when, owing to the failure of a brickwork barrel arch, 4 ft. in thickness, it was necessary to reconstruct the insets in a pit 1,860 ft. deep. Steel girders, 12 in. by 6 in. by 56 lbs. per ft., were obtained, bent to a circle having an internal diameter of 14 ft., each ring being composed of three segments, secured at the joints by fishplates and bolts. On the eastern side of the pit, the ground was very bad owing to the roadway intersecting a large fault having a downthrow of 100 yards, and here the girder rings were spaced 18 in., centre to centre. Where the ground was more settled, this distance was increased to 3-ft. centres. Sufficient ground was taken out to allow of at least 18 in. of concrete being put in, measuring from the inside face of the finished arch, and the concrete was well rammed in between and at the back of the girders, making a smooth finished barrel arch of 14 ft. diameter.

The girder rings were taken down the pit in sections and erected in position, a special portable standard being designed for raising the top segments. Temporary laggings laid on the top of the girder rings served to support the roof whilst the concrete was being put in, being removed as the work progressed, and although three parallel lines of rails were in use during the time the work was in progress, no interruption of coal-drawing was occasioned.

When cross-cuts joined the main road, the spacing of the girder rings was increased to allow of smaller rings having an internal diameter of 7 ft. 6 in. or 6 ft., to be inserted, their axis being at right-angles to the main tunnel. In these instances old rails were used to bridge the space between the large girders, resting on the inner flanges. The concrete lining at the junction was properly groined, and when finished had an exceedingly neat appearance.

The results achieved were so satisfactory that it was decided to adopt a similar method of securing a crut, 200 yards long, at a depth of 2,610 ft. This was also driven through the large fault already mentioned, and with the original timber supports the cost of upkeep of the road was very heavy. Girder rings of the same section but 10 ft. internal diameter were put in, the spacing again being dependent on the nature of the ground. Where it was necessary to provide manholes, two rings of 12 ft. diameter were placed eccentrically to the axis of the main tunnel. This work was also commenced in 1908, and so far as appearances go, it will be unnecessary to spend a single penny in maintenance during the life of the colliery.

Since the completion of the above, many of the main roads, airways, and water lodges have been lined in a similar manner. In very few instances have signs of crushing been observed, and in no case has it been necessary to renew the concrete, though this would be a much less expensive operation than renewing brickwork arches. The slight crushing which has taken place has invariably occurred where the roof had fallen to a considerable height, and the space intervening between the top of the concrete arch and the solid ground had been made good with chocks and loose débris, making the crush on the arch unequal. Now this is filled up solid with concrete or brickwork, or if this is not practicable, the concrete lining at the weak spot is considerably strengthened.

Other Colliery Purposes.—Stables and motor houses have been constructed in concrete, and although their initial cost is somewhat high, the saving in upkeep will soon repay for the first charge. In good ground a modified cross-section has been adopted, and the steel formers made from old pit rails bent to a shape resembling a square with rounded corners. The sides are smooth and dust is easily removed, and the entire absence of combustible material commends itself where electrical apparatus is installed.

In one or two instances, girder rings, 12 in. by 6 in. section, embedded in concrete in a similar manner to that described for the roadways, have been used with conspicuous success for pit-shaft repairs. Where the shafts cut the 100 yards fault already mentioned, brickwork lining, 4 ft. 6 in. thick, has been crushed, but where this has been replaced by concrete, no sign of weakness has yet been observed. Many other instances in which the use of concrete is a distinct advantage suggest themselves, and there seems no limit to its useful application. Straight steel girders, with concrete rammed in between, have been used in air-crossings, floors for double landings, foundations for machinery, etc. In several instances, main airways have been lined with concrete without the use of girders, the smooth surface of the finished work reducing the friction of the air and presenting no ledges for the deposit of dust.

On the surface the most important use to which concrete has been applied up to the present is in the construction of a bunker to hold 300 tons of pit dirt, and a gantry carrying a creeper and tram rails for conveying the loaded tubs to a tippler on the top. This work was designed and executed by reinforced-concrete specialists. The cost was approximately equal to that of a steel structure, and the advantages gained are an increased life and the saving of the expense of painting every few years.

Engine-room floors, stillages for oil stores, etc., on the surface have been put in by the colliery staff. For

*Paper read before the North Staffordshire Mining Institute.

work of this class expanded metal makes an excellent reinforcement, and data for the construction of floors suitable for safe working loads of from ½ cwt. to 6 cwts. per superficial foot can be readily obtained.

A further application of concrete, of special value where old shallow mines have been worked, is in the formation of rafts for the foundations of heavy or valuable buildings. For important work these should be properly designed to avoid unnecessary waste of material, but for small jobs the writer has found old rails interlaced with steel guide rods, or even wire ropes, quite successful. The examples given might be multiplied indefinitely.

Selection and Mixing of Materials.—For the benefit of those who might be inclined to adopt reinforced concrete, Mr. Gregory offered some practical hints on the selection and the mixing of the materials:—

Cement.—For all reinforced work, and particularly for underground application, when some considerable time generally elapses between the mixing of the concrete and its being placed in position, a slow-setting cement should be selected. Considerable variation exists in this respect with different makes, and before adopting any particular brand tests should be carefully made. The selected cement should, in addition, comply with the British standard specification as to fineness, specific gravity and tensile strength.

Sand.—This requires equally careful selection. When examined under the microscope the grains should appear sharp and angular. Many sands are mixed with clay or loam, and this is fatal to the making of sound concrete. Washing is sometimes resorted to with a view to eliminating these impurities, but in this district no difficulty is experienced in obtaining suitable qualities locally.

Aggregate.—For underground work the writer strongly advocates broken granite. In the work described two sizes have been used, namely, ½-in. chippings and 1½-in. screened stone. For many purposes on the surface broken bricks or saggars may be advantageously used, but it must be remembered that the sand and cement simply form a matrix or mortar binding the aggregate together, and the greater the strength of the individual fragments of aggregate, the greater the ultimate strength of the concrete as a whole. The aggregate forms the bulk of the finished concrete, and it is useless to get good cement and sand to bind together material which cannot in itself offer considerable resistance to a crushing load.

Gauging.—The correct proportions of the various classes of aggregate sand and cement vary according to the size and shape of the individual fragments. Theoretically, the intersticies or voids in the large stone should just be filled by the smaller stones, and the voids still remaining should be completely filled up by the mortar of sand and cement. In practice a considerably larger proportion of the smaller material must be used, in order to insure a compact concrete, owing to inequalities in mixing and stowing. The voids in the various grades of aggregate are easily determined by filling a box of known capacity level full with the stone to be tested, and adding a measured quantity of water until it is on the point of overflowing. With the aggregate adopted at Sneyd the following proportions by measure of the material give good results:—

1½ in. broken granite	36%	or 9 parts
½ in. granite chippings	32%	or 8 parts
Sand	20%	or 5 parts
Cement	12%	or 3 parts

The proportion of the neat cement to aggregate, including sand, is thus 1 to 7⅓. The aggregate, sand and cement are measured out accurately in the proportions stated above and then mixed well dry, after which a measured quantity of water is added and the whole thoroughly mixed wet.

Owing to the finished concrete forming a homogeneous whole without intersticies, the bulk is considerably reduced in mixing, and forms only 60 per cent. of that of the dry material. For making 1 cubic yard of concrete, therefore, the following table gives the quantity of each ingredient based on the proportions already stated:—

	Cu. ft.
1½ in. broken granite	16.2
½ in. granite chippings	14.4
Sand	9.0
Cement	5.4
	45.0

The mixing can be done by turning the material over with spades, but careful supervision is necessary, and it is difficult to ensure that the whole of the ingredients are thoroughly incorporated first in the dry state, and afterwards when the water is added. When much work is likely to be carried out, the writer strongly advises a machine, the cost of which is speedily recouped by the saving in labor, and absolute uniformity in the quality of the cement is secured.

Cost.—The cost of the application of concrete underground is dependent to a great extent on local conditions. The nature of the ground to be excavated and the facalities for the transport of the materials to the site are factors which it is necessary to take into consideration for each individual job. The following table gives the cost of the raw materials for 1 cubic yard of concrete as used at Sneyd Collieries, and will be some guide in working out an estimate:—

Material	Cubic feet	Weight in lbs. per cubic foot	Total weight in lbs.	Price per ton s. d.	Total s. d.
1½ ins. granite	16.2	84	1,360.8	9 6	5 9
½ in. chippings	14.4	84	12,906	7 6	4 0
Sand	9.0	80	720	6 6	2 1
Cement	5.4	95	513	36 0	8 3
Water	—	—	202.6	—	—
Total per cu. yard	—	—	—	—	20 1

The cost of stowing the concrete in position, including fixing the centering, is approximately 3s. per cubic yard, and mixing with the machine about 2d. per cubic yard. If girder rings are used, their cost has to be added, and as an example the cost per lineal yard of a barrel arch, 11 ft. in diameter, with rings spaced 3-ft. centres, is given:—

	£	s.	d.
1 girder ring 19 cwts. at £10......	9	19	0
6.55 cubic yards concrete at £1....	6	10	10
Stowing cement 6.55 cu. yds. at 3s		19	8
Fixing girder rings		7	6
	£17	8	0

This, of course, excludes the cost of excavation or of mixing the concrete and conveying it underground to the position required. Where the girder rings can be dispensed with, it will be seen that the cost can be enormously reduced, the steel representing more than half of the total expenditure.

It is important that running water does not come in contact with the concrete until it has set, as the cement is liable to be washed out. When this has to be contended with, the general method adopted has been to put in temporary dams and pipe the water across the green concrete.

FUEL IN THE UNITED KINGDOM.

The industrial development of Great Britain is mainly due to the cheapness of fuel, raw material, labor and transport. The coal produced is anthracite and bituminous, and as the deposits to be found in Great Britain are being gradually exhausted, attention is being paid to the use of coal wastes, etc., which were formerly dumped over the tip as worthless. The cost of coal is low at the pit mouth, despite the enormous expenditure involved in the machinery, deep shafts and an increasing labor bill, yet the most inferior of slack and washery-refuse are now being consumed in considerable quantities for the development of cheap power. As one instance of the influence of cheap fuel and power the North-East Coast (England) Power system is referred to by R. O. Wynne-Roberts, M. Inst. C.E., in his report on the Coal and Power Resources of the Province of Saskatchewan. There are seventeen generating stations belonging to this company, of which six are coal-fired stations and the remainder waste heat stations, where steam for generating the electricity is obtained either from exhaust steam that has already done work in blowing, or other engines, or by steam raised by blast furnace gas, or from the waste heat and gas from coke-ovens; the total horse-power connected amounts to nearly 200,000. The engineer in his description of the work pointed out that cheap fuel is of paramount importance, and expressed his opinion that the future of electricity supply lies in the very large stations employing very big units of plants and established at the coal-fields. The above electrical installations have afforded facilities which have attracted several new industries to be located within the area of supply. The same remarks are applicable to the manufacture and distribution of gas, which is being adopted more generally each year.

The next International Geological Congress will be held in Belgium in 1917. "The Agricultural Resources of the World" will then be presented. Many geologists consider that the study of agricultural deposits of the world is the most important branch of geology, and by far the most important branch yet to be investigated. Owing to the fact that large territories of agricultural land have been discovered within the last ten years in Canada, South Africa and Australia, there is as yet no accurate compilation of the agricultural resources of the world. Another reason for the decision to investigate the world's agricultural resources is the attention at present being directed by political economists all over the world to the high cost of living. The geologists believe that if they can collect full details on the grain-growing land resources of the world, the march from the cities to the land will be strengthened and the price of food commodities will be moderated. Another topic that will be discussed in 1917 will be the nitrate, phosphate and soda deposits of the world. As these three chemical compounds form the basis of all fertilizers, the research to be conducted by the scientists will be of great importance to the subject of agriculture. Besides these topics the Belgium Council will be at liberty to consider two others which were suggested by the council. These are the world's copper deposits and petroleum resources.

BITUMINOUS CONCRETE PAVEMENTS.*

By Wm. B. Spencer,

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Up to the time of the advent of the automobile the question of modern highways was pretty well solved, except in the more highly trafficked streets of our great cities, by the discoveries of John Macadam, and the more recent improvements of the French engineers and the pioneers of this country. But in their system of road building the pioneers did not contemplate heavy vehicles carrying loads of from one thousand to twenty thousand pounds and passing over their prepared roadbed at the rate of from five to fifty miles an hour, sucking up the carefully placed filler or binder, and depositing it over our lawns, our farms and in our houses, permeating the entire atmosphere with a dust which was both objectionable and unhealthy. In response to the immediate cry of protest, engineers at once attempted to solve the puzzling problem. In the West temporary relief was found by taking the crude natural asphaltic or semi-asphaltic oils of California, Texas and Kansas and sprinkling them over the macadam roadways. This generally gave temporary relief from the dust nuisance, but it was found that these oils, which had not gone through the process of refining, contained many substances which were detrimental to the automobile tire. It was also found that they had a decidedly bad effect on the binding materials of the macadam roadways. A well-bound macadam roadway secures its cohesiveness by the hydration of its granular constituents, but when the surface coat is more or less thoroughly sealed by the application of a heavy oil, then the body of the mass is denied the water which prolongs its life, and shortly thereafter the road will commence to ravel.

Some time during the year 1903 an observer in the oil regions of California noted that a flock of sheep, which had been driven back and forth to pasture, over an oil-saturated piece of ground, gradually consolidated this soil to such a degree of hardness that it was not affected by vehicular traffic, and also produced a highway which was cheap and did not require the use of stone, which had always been deemed necessary for the construction of highways. A tamping roller, made as nearly as was mechanically possible to imitate the sheep's foot action on the soil, was designed, and the "Petrolithic" or tamped road was launched. In some sections of California it met with fair success, and is still in limited use in that section of the country.

In the summer of 1907 a road of the same type of construction was laid near New York City, and during the summer and fall season of that year it withstood traffic conditions remarkably well, but during the early winter frost penetrated the road and immediately thereafter a warm rainy period ensued, with the result that the road rapidly disintegrated and became a quagmire. The following spring it was found necessary to entirely remove the prepared roadway and substitute another form of road construction.

The Petrolithic specifications were substantially as follows:—

*Part of a paper read to the American Society of Engineering Contractors, and appearing in the Journal for June.

The earth roadway to be improved shall first be cleared of all vegetable and other foreign materials and shall then be crowned with a road grader, or by hand, to the proper line and grade, filling in all low places with suitable material. It shall then be plowed to a depth of not less than eight inches, after which a disc-harrow shall be run over the surface of the plowed roadway in order that all lumpy material shall be disintegrated. The road shall then be carefully graded to the required cross section, after which there shall be distributed one gallon of hot asphaltic oil to the square yard of pavement. The sheep's foot or tamping roller shall then be used until its teeth refuse to penetrate into the soil for a distance of more than one inch. The material shall then again be lightly harrowed and an application of hot asphaltic oil, at the rate of not more than one-half gallon to the square yard, shall be applied, and the surface shall then be lightly harrowed, after which the tamping roller shall be again used until the teeth refuse to penetrate. The surface shall then be covered with a coating of stone chips or sand and rolled with light circular roller.

Other experiments with the same or allied processes were made in the east during the ensuing year with no better results, and in so far as this type of construction is concerned, it has been virtually abandoned outside of California.

Various states and municipalities then attempted to improve on the water-bound macadam and its filler of stone chips by substituting heavy asphaltic or semi-asphaltic oil, by means of what is termed the penetration or grouting method. The initial process relating to the preparation of the base and first course of stone was substantially the same as in the preparation of the water-bound type of macadam. The second course, generally composed of what is known as inch and a half stone, was then spread upon the base course and rolled with a 10-ton roller to an average thickness of about four inches. An application of asphaltic oil, heated to a temperature of approximately 300° F., was applied, at the rate of one and one-half gallons per square yard, by means of pouring pots or sprinkling wagons and immediately thereafter a coating of stone chips was applied and the surface was then again carefully rolled with a steam roller. Immediately after this rolling another application of hot oil was made at the rate of approximately one-half gallon to the square yard, and another course of stone chips applied, after which the surface was again rolled, and after a short period of time, ranging from 3 to 24 hours, the road was opened to traffic.

The success of this type of pavement is somewhat problematical, and has been abandoned in many places. The States of New York and New Jersey spent many millions of dollars in this type of road construction during the seasons of 1910-1911, but during the season of 1912 the use of this type of construction was almost entirely abandoned. In order to make a success of this type of construction it has been found necessary to have almost ideal climatic conditions. A working temperature of over 55° F. has been found necessary because in a lower temperature the stone becomes so cold that it immediately chills the asphaltum when applied and prevents it from thoroughly penetrating the voids in the mass; an unstaple top surface coat is thus formed with an under strata which is poorly consolidated Traffic soon finds the weak spots in this pavement, with the result that ravelling soon begins and the complete disintegration of the pavement is only a matter of a short time. In order to secure even fair results from penetration work the following conditions are absolutely necessary: An asphaltic oil of approximately 18 Beaume gravity at 77° F. A flash point of not less than 400° F. A fixed carbon total of not more than 6%. A bitumen content of not less than 99%, and a paraffin scale residue of not more than 3%. This material should be heated and applied at a temperature of not less than 300, or more than 350° F. The temperature of the air should not be less than 60° F. The mineral aggregate should be bone dry and the asphaltic oil should be applied to the surface by means of sprinkling appliances containing an exact quantity of the material; templates, or other means of determining the exact quantity of oil to be applied per square yard of roadway should be laid on the prepared road surface, in order that an even distribution of the oil may be secured.

Power sprinkling devices employing compressed air as an atomizer have been used with fair results, but the continued decrease of this method of construction in favor of some method of the mechanical mixing of the cementing medium and the mineral aggregate, is proof evident that at its best the penetration system is only a step in the right direction from the water-bound macadam era to the present era of mixed bituminous surfaces.

Bituminous Macadam.—This type of pavement has been largely adopted for use on main highways and also on the principal streets of some smaller towns. A specification of this type of pavement as prepared by the State Highway Department of Pennsylvania is submitted herewith.

"After completion of the bottom course, telford or macadam, the bituminous macadam course is to be placed thereon. It shall consist of a mixture of bituminous material and good hard stone acceptable to the State Highway Department, trap rock preferred. When trap rock is used the stone shall be of such size as will pass through a two-inch ring and be rejected by a half-inch ring, and shall be entirely free from dust. When limestone is used it shall be of such size as shall pass through a three-inch ring and be rejected by a one-inch ring. When asphalt is used it shall contain not less than 90% bitumen and shall be heated to a temperature of 350 to 400° F. When tar is used it shall be heated to a temperature of 270 to 325° F. The bituminous material shall be mixed with the stone in a mechanical mixer and then spread on the telford foundation to a depth of five inches in the centre for a width of six feet, and to a depth of four inches on the sides, loose measurements, and thoroughly rolled and compacted. One and five-tenths gallons to two gallons of bituminous material per square yard of road surface will be required to make the mixture. The contractor shall, upon the direction of the engineer in charge, heat the stone to a temperature of 250 to 300° F. before mixing the compound. After the above-mentioned course has been thoroughly rolled in place and compacted with a ten-ton roller, to the satisfaction of the engineer or inspector in charge, and the surface swept clean, the surface shall be painted with the neat bituminous material, using five-tenths of a gallon per square yard of road surface, unless otherwise directed by the engineer. Immediately following the flush coat or painting there shall be applied a coating of clean rock screenings, ¼ to ¾ inch in diameter, of the same material as has been used in the four-inch course, to a depth of ½ inch and rolled into the voids in the surface. Should the bituminous binder appear on the surface after rolling, enough additional rock screenings must be applied to take up the surplus material."

This type of construction is one which leaves considerable to be wished for. Personal experience has led me to believe that the grading of the mineral aggregate is not done with sufficient care to give a minimum of voids in the mass, with the result that depressions and ravelling are apt to occur in a period of not more than three years after the pavement is laid.

Bituminous Concrete.—The specifications covering this type of construction are no doubt familiar. In a general way, however, a grading of mineral particles ranging from material which passed a 200-mesh sieve to a maximum amount of from 5% to 11%, to particles which passed in a 2-mesh sieve to a maximum amount of 10%, is used. Where this pavement has been laid with care and by experienced contractors it has met with extreme success, and is being specified in ever-increasing quantities in all parts of the country. During the season of 1912 the City of New York awarded contracts for the construction of over one million five hundred thousand square yards of this type of pavement in the Borough of Queens. The highways on which this pavement is laid are the main arteries of travel leading to and from Greater New York points on Long Island. Over eighty per cent. of this travel consists of pleasure automobiles and heavy auto trucks, and a majority of the remainder being heavy horse-drawn farm wagons. A traffic census taken on the Merrick Road this summer showed an average of over six thousand vehicles a day, with a daily total of approximately ten thousand vehicles passing over it on Saturdays, Sundays and holidays.

The pavements have been down for too short a time yet to be able to judge of their future wearing qualities, but what they have gone through the past season with excellent results is evidence of the fact that they will bear the heavy traffic imposed upon them for many years to come without the necessity of any large amount of repairs. The old roadbed consisted, in the majority of cases, of old macadam, which had been worn down to the base course of stones. This course was lightly scarified and sufficient 1½-inch stone was added to bring the road to the proper cross section and crown, and two inches below the finished grade. A layer of screenings or sand was then applied and worked into the voids by means of hand brooms and puddling with water, and the whole foundation was then thoroughly rolled with a 10-ton macadam roller. The bituminous concrete was then laid and raked by expert rakers and then thoroughly rolled with a 6-ton tandem roller until it had an ultimate thickness of two inches. The pavement was then dusted with a coat of Portland cement to fill any surface pores and was opened to traffic after a period of not less than 12 hours.

In order that the shoulders of the roadway should be protected, a layer of 3 rows of vitrified block were butted in against each side of the roadway and the joints were then poured with an asphaltic filler. In the outlying sections the wings of the roadway were carefully graded and suitable gutters were constructed leading to masonry seeping basins. In sections where storm water sewer systems prevailed the gutters were paved with either cobble or brick and the construction extended from curb to curb.

Among the other forms of modern bituminous pavements may be mentioned those which come either under the patents or control of the Warren Bros. Co., and consist of the well-known Bithulithic pavement, Warrenite and Amesite.

There is also another type of pavement which has recently come into vogue in the Middle West, and is also being used in some parts of the East. It bears the trade name of "Dolarway" pavement. This process consists of first laying a concrete base of suitable thickness of rather a rich mixture and providing suitable expansion joints. Immediately after the laying of the concrete and before the initial set has taken place, the top of the concrete is carefully trowelled, in order to have a uniform finish, and to bring the finer particles to the surface, after which the surface is broomed. Upon this foundation there is spread a layer of hot bitumen at the rate of about ⅓ gallon to the square yard, immediately after which a uniform layer of clean dry sand or stone screenings is spread in a sufficient quantity to cover the asphalt coat and leave a wearing coat not less than ¼ inch in thickness. This pavement is at the present time in its infancy and it is therefore impossible to form an opinion as to its permanent quality. One good feature of this type of pavement, however, is the fact that irrespective of the wear of the surface course there always remains the concrete foundation which can be used either for a new application of this same type of surface treatment, or it can be used for another type of pavement.

Sheet Asphalt.—This type of pavement has probably received more praise and at the same time more criticism than any other form of bituminous pavement, but in the writer's opinion there is no more substantial bituminous pavement laid than modern sheet asphalt pavement. In the early days, and even in more recent times, paving engineers have given too little attention to the details which go to make up a good modern pavement of this type. This lack of attention to details is slowly being eliminated, due greatly to the fact that intelligent bodies of engineers and contractors have been working together to standardize the specifications covering this type of pavement. A set of standard specifications covering the making and laying of sheet asphalt, which is the result of many years' study and labor, has recently been published by the American Society of Municipal Improvement. A digest of these specifications may be of interest:

Refined Asphalts.—The tests provide that all penetrations shall be made at 77° F., and are to be expressed in hundredths of a centimeter with a No. 2 needle acting for five seconds under a total weight of 100 grams. There is no distinction made between the so-called natural or lake asphalts and the oil asphalts; i.e., those derived by distillation from asphaltic oils, it being stated that all asphalts shall be prepared from a natural mineral bitumen, either solid or liquid, or a combination thereof, by suitable and approved methods of refining.

All shipments of refined asphalt shall be uniform in consistency, and shall not vary more than 15 points in penetration at 77° F. Ninety-eight and one-half per cent. of the total bitumen shall be soluble in carbon tetrachloride.

Flux.—The specifications covering the fluxes state in part that they shall be the residue obtained by the distillation of paraffin, asphaltic or semi-asphaltic petroleum, and shall be of such character that they will combine with the asphalt to be used to form an acceptable and approved asphalt cement.

Binder Stone.—The requirements are that the stone shall be clean, hard and free from any particles that have been weathered and are soft. It shall all pass a 1¼-inch screen, and from fifteen to thirty per cent. shall pass a ten-mesh screen. Particular attention is called to the latter requirement. Strict conformation with this phase of the specifications will produce a dense binder which will have much to do with the ultimate life of the pavement.

Sand.—The careful grading of the sand particles has received more study in recent years, with the result that the modern specifications are as follows:

200 mesh, 0 to 5%				
100 mesh and retained on 200 mesh,				10-25%
80	"	"	100 "	6-20%
50	"	"	80 "	15-40%
40	"	"	50 "	10-30%
30	"	"	40 "	8-25%
20	"	"	30 "	5-15%
10	"	"	20 "	2-10%
8	"	"	10 "	0- 5%

Particular attention is called to the large percentage of particles which must pass the 80-mesh sieve and the small amount which pass a 20, 10 and 8-mesh sieve.

It is unusual to find a sand which can comply with both the fine and the coarse requirements of these specifications. The writer is at present engaged in the laying of a considerable amount of sheet asphalt pavement under these specifications in the city of Norfolk, Va., and it has been found necessary to secure two sands in order to produce a blend which meets the requirements of the specifications. The fine grain sand is secured in North Carolina, and the coarse sand is secured by dredging in the Chesapeake Bay. A blend of three parts of the former to one part of the latter produces a mixture which complies in every respect to the requirements of the standard specifications.

The exact quantities of materials used in making a nine-cubic-foot box of our Norfolk paving mixture are as follows:

Sand	880 lbs.
Carbonate of lime	170 lbs.
Asphalt cement	127 lbs.
	1,177 lbs.

A nine-foot box of this mixture lays approximately 5.28 square yards of finished pavement two inches thick after compression with a steam roller weighing not less than two hundred pounds per inch width of tread.

Asphalt Cement.—The requirements of asphalt cement are that it shall be composed of refined asphalt or asphalt and flux prepared in the proper proportions and melted in such a manner that they shall be blended into a homogeneous mixture complying with the following requirements:

(*a*) It shall be thoroughly homogeneous and shall not be oily to the touch.

(*b*) It shall have a penetration between 40 and 75 at 77° F., depending upon the sand and asphalt used and traffic upon the street on which the pavement is to be laid.

(*c*) It shall not flash below 300° F. when tested in a New York State closed oil tester.

(*d*) When heated in an open tin at a temperature of 325° F. for five hours in a hot air oven, it must not show a loss by volatilization of over 5% and the penetration at 77° F of the residue left after such heating must not be less than one-half of the penetration at 77° F. of the original sample before heating.

(*e*) When the pure bitumen of the asphalt cement is brought to a penetration of 77° F. of 50 and made into a briquette having a cross section of 1 sq. cm. it shall have a ductility of not less than 20 cm. at 77° F., the two ends of the briquette to be pulled apart at the uniform rate of 5 cm. per minute.

When the asphalt cement as used has a penetration greater than 50 at 77° F., an increased ductility of 2 cm. shall be required for every 5 points in penetration above 50 penetration.

Binder and Laying.—The binder mixture shall be heated to a temperature of between 200 and 325° and shall be mixed with from five to eight per cent. bitumen. On reaching the street it shall immediately be dumped on the concrete and at once spread with hot shovels and rakes to the required thickness, after which it shall be thoroughly rolled. No more binder shall be laid at any one time than can be covered by two days' run of the paving plant on surface mixture.

Wearing Surface.—The sand and the asphalt cement shall be heated separately to such a temperature as will give, after mixing, a surface mixture of the proper temperature for the materials employed. The sand when used must be at a temperature of between 250° F. and 375° F. The asphalt cement when used must be at a temperature between 250° F. and 350° F. The filler shall be added to the hot sand in the required proportions, and the two thoroughly mixed. The asphalt cement in the proper portion shall then be added and the mixing continued for at least one minute.

Laying.—The surface mixture shall be brought to the street in wagons at a temperature between 230° F. and 350° F., and shall be covered with canvas covers while in transit. It shall then be dumped on a spot outside of the space on which it is to be spread. It shall then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes in such a manner that after having received its final compression by rolling, the finished pavement shall conform to the established grade and have a thickness generally of not less than two inches.

The modern sheet asphalt specifications generally require a binder course from one to one and one-half inches in thickness, and a surface course from one to one and one-half inches to two inches in thickness. I have never been able to discover to my satisfaction why it has been found necessary to have such a thick wearing course, as of 2 inches. It is a well-known fact that generally after a surface course has worn much over one-half to three-quarters of an inch that the remainder of the course disintegrates very rapidly. Would it therefore not be better to reduce the thickness of the surface course to one inch, and increase the quality and thickness of the binder course by having a very dense mixture of sand and stone mixed with the proper percentage of asphalt cement, and of a thickness approximately two inches? A pavement of this type laid under my direction more than three years ago has given very good results, and especially in view of the fact that it was laid on a macadam foundation.

The St. Thomas-Windsor extension of the Hydro-Electric power line has been decided upon to pass through St. Thomas, Ridgetown, Rodney, Dutton, and a number of other points. The route selected will allow easy construction, and will be in proximity to the Michigan Central right-of-way. It will serve the largest area and the most thickly-populated district of any route under consideration. The entire line is 112 miles in length, and the construction of it is being commenced.

SOME PRACTICAL EXAMPLES OF PROVINCIAL LAND SURVEYING

TYPICAL INSTANCES IN THE RE-SURVEY OF OLD LINES, WHERE THE SURVEYOR MUST ARBITRATE — REMARKABLE ACCURACY OF OLD COMPASS LINES, THOUGH LITTLE USED FOR THAT PURPOSE IN PRESENT PRACTICE

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NEARLY all of the lands in the older provinces of Canada have been surveyed by the magnetic needle or surveyor's compass; so that all lines, division and otherwise, roads, township lines, etc., are based on the magnetic meridian and not the astronomical or due north and south, east or west. These old lines, said to run north, are not due north, but ten to twenty degrees west of north, and the same proportion of error east and west. This does not matter much, but it would matter a good deal if all those compass-run lines were re-run by the astronomical meridian. It is only a few years ago that the land lines began to be run astronomically. The Dominion Government was the first to begin this innovation in dividing up the lands of the North-West Territories, where all lines are now run astronomically and where lines run with the surveyor's compass are not allowed. In the maritime provinces of Nova Scotia, New Brunswick and Prince Edward Island; in Quebec and old Ontario; all land lines were run by the magnetic meridian and any correction, retracement or resurrey work, in these provinces must be done with the compass. As all transits are provided with a compass the lines may of course be run with the transit. But the transit-compass is usually small, usually sluggish, and therefore not usually reliable; so that the regular surveyor's compass with 4½-inch needle is the proper instrument to use in this work.

Old Compass Surveys Wonderfully Accurate.—It is a matter of wonderment to engineers and surveyors, whose only experience is with the transit, how fairly accurate those old compass lines really are. These veteran surveyors are deserving of the greatest credit for the wonderful accuracy of their lines. No modern surveyor could duplicate such work with the magnetic needle. In fact, the modern surveyor has little respect for the compass as an instrument for running lines and courses. The minute accuracy of the modern transit, and the refinement of the courses, down to 30 seconds, causes men to marvel how correct bearings could possibly be run with the compass, when such refinement as seconds or even minutes are out of the question.

The compass, at best, especially in the hands of inexperienced instrument men, is not considered accurate up to 10 or 15 minutes. In fact, the old traverse tables used for calculating compass bearings, were only given to 15 minutes, that being considered the limit of compass accuracy. With the old compass surveyors, however, the limit of accuracy was by no means confined to 15 minutes or the quarter of a degree. With the sensitive needles and perfect order in which the compass was usually kept, and frequent tests made with a standard meridian, the accuracy was refined to 5 minutes and seldom more than 10 minutes. Old surveyors have told the writer—men who were familiar with the use of the modern transit—that they could, and usually did, run their lines within 5 minutes of the accurate direction given of the course. The state lines of the older states of the Union, and of the older provinces of Canada were run with the compass. The line between Pennsylvania and Maryland, run with the compass, is the marvel of modern surveyors for its wonderful accuracy.

Very Little New Work Now for the Compass.—There is practically no new work done now with the compass. By this I mean new work undertaken by the governments of the several provinces. For instance, in New Ontario all lands are now surveyed astronomically with the transit and the direction of the needle ignored, though the isogenic line is noted for reference. In railway surveys the compass is used throughout unless the country is full of mineral, as a check on the transit bearings. Were it not for the possibility of being able to run lines independent of the compass a good deal of territory could not be surveyed at all. In a large portion of northwestern Ontario the compass is of no use on account of the large amount of mineral in the ground beneath. The writer found, while railway surveying in Northern Ontario, between Winnipeg and Lake Abbitibi, that the compass was of no use as a check on the transit bearings on account of the prevalence of various minerals. The present prevalence of wire fences bounding farm and lot lines is a great stumbling block to using the compass on those lines. The proximity of railway tracks is another. In fact, wire of any form in close proximity to the compass makes its readings negligible.

The professional surveyor in the older provinces of Canada must, therefore, use great discretion in the pursuit of his work.

The Professional Land Surveyor Must be a Diplomat.—Of all professions, not excepting that of the doctor, the land surveyor must be a diplomat. In doing correction work, as resurveys and retracements, for the public, the greatest delicacy must sometimes, if not generally, be used in dealing with the interested parties. For instance, in re-surveying a division line between two owners on either side of the line, the task is a most difficult one to adjust fairly and satisfactory to both parties. All traces probably of the old line have been obliterated by time, fires, etc., the existing lines are far from being in correct position, and this incorrect position of the division line may be long-standing, through one and two generations, it may be. The father recognized these old lines during his life time, possibly aware that the division line was not in the right place. But the son who inherits the property will not stand for the crooked, sidling division line, and gets a surveyor to run the line correctly. Then trouble commences, as the man on the other side of the line, when he sees himself losing slices of his land, attempts to stop the survey.

Here is where the diplomatic ability of the surveyor comes in. If he is not diplomatic at this point, and knows the proper initiative, if he is brusque, obstinate and lacking in the great art of reconciliation and diplomacy, a law suit probably ensues.

It is said that it is the province of a doctor to prevent people from getting sick—at least very sick, and that of a lawyer to prevent law suits, so it is the province of a professional land surveyor, dealing with the public, to prevent litigation.

A Case in Point.—The writer was called on to re-survey a division line. The line had been run many years before, but fires and the clearing of the land from woods obliterated the original monuments. The line in places was very zig-zag, and apparently far out.

in 1776, when the magnetic declination was 15½ degrees. This, then, is the standard magnetic meridian for that province, and all lands transferred and deeded from the government are based or referred to this meridian. Property surveyed, say, 90 years later, in 1866, when the magnetic needle varied since some 8 degrees, would be shown by the surveyor to be this number of degrees west of the meridian, and lands surveyed fifty years before would be 3 to 4½ degrees west, as the case might be, at the particular date of the survey. This simplifies the work of the present-day surveyor, and he knows what he is at, once he determines the magnetic bearing of the original survey which can in most cases be readily obtained, if not of that particular lot, then of a neighboring bound surveyed approximately at the same time.

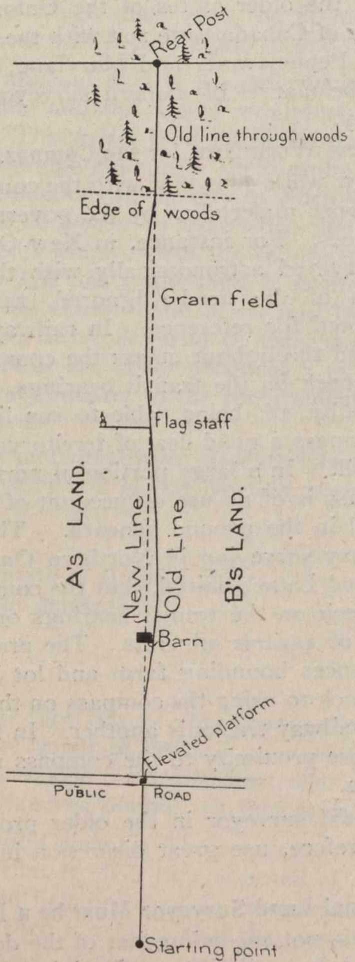

Fig. 1.

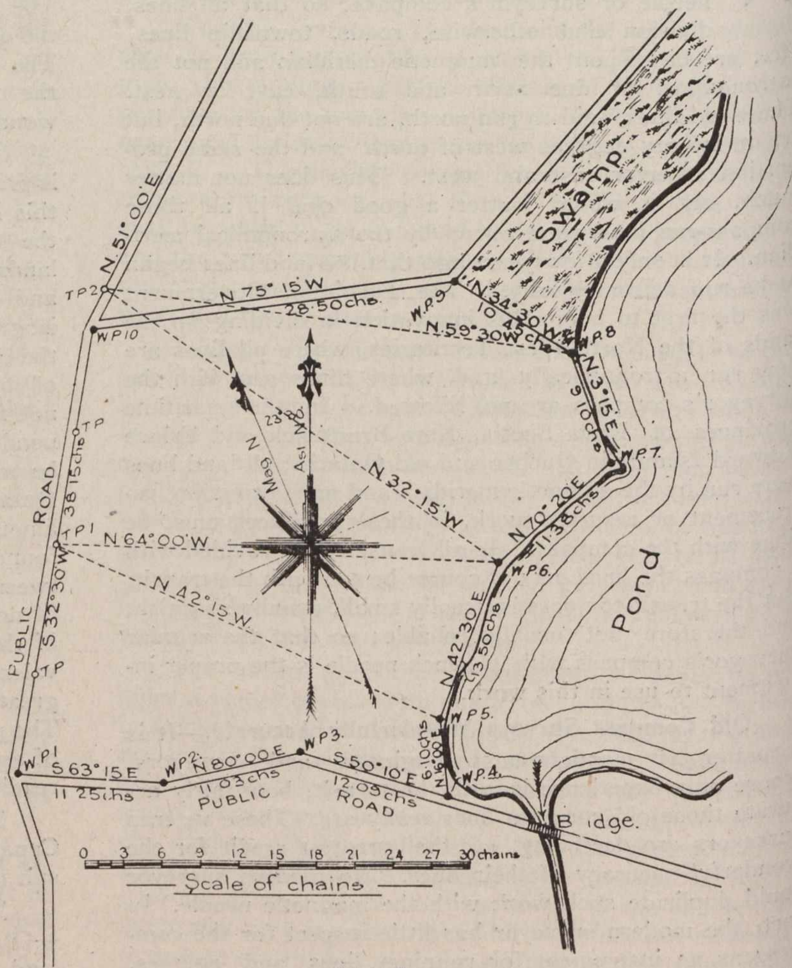

Fig. 2.

Fig. 1 gives a fairly good outline plan of the property. The full lines show the zig-zag position of the division fence line.

In making those correction surveys it is necessary for the surveyor to have a copy of the original deed showing the magnetic direction of the line in the year the land was surveyed. As the magnetic declination changes with years, it becomes a difficult matter to get the correct magnetic course's bearing. In some of the provinces, probably in all of them, there is a standard magnetic meridian laid out by the government under the direction of the Surveyor-General or the Minister of Public Lands, and of this meridian, usually the year the township outlines of the province were surveyed, all compass of magnetic bearings are referred. For example, in one Canadian province the survey of the township outlines was begun

In Fig. 1 the magnetic bearing of the division line was, in this way, readily obtained, a reliable starting point is also obtainable, and this starting point is of the greatest importance in all surveys, as without a permanent monument to start from it will be almost impossible to make a correct survey.

In the survey in question the old post or starting point was admitted to be in correct position. Here the compass was set with the proper declination of the needle made to reconcile with the original survey, and it was found that the line on the ground, north to the public road, was approximately as it should be. At the road the compass was again set up to get a view of the existing line. The road was on high ground and a good view back and front could be taken. From the back sight and from the reading of the needle, the line for a portion north of the road was also fairly accurately in correct line, but a few chains farther north the line zig-zagged most outrageously, and looking through the compass sights it was found that the barn of one of the property owners was directly in the line. Here was a "contretemps." The line to the rear from starting point might not be right, and, again, it very possibly was. The barn prevented seeing how the line fared farther on, and without having to offset the line at the barn, and the fact that the line at the road was on the highest ground, it was decided to erect a scaffolding or elevated view-point. This was constructed and the transit (not the compass here) was set up after. Back-sights being taken, it was an easy matter to see how the old line proceeded towards the north. It was found, after zig-zagging on B's property it deflected into A's. At about three-fourths of the distance the line went into thick woods. It was thought, and rightly so, that here the old line would be found; a flag-staff was therefore set at the edge of the wood, and the reading of the needle determined it was found that the original line came out as expected. Where the line of sight crossed the old line, as shown in Fig. 1, a fence pole, about 15 feet long with a small flag fastened to its top, was set up in exact range with the correct line of sight entering the wood. Pickets were set, and the line run straight, sometimes on one side of the old line fence and sometimes on the other, until the wood was reached, when it was found approximately directly in continuation, and followed to the front where old bearings were easily discernible.

The owner who found he was losing a big slice of his land and one-half of his barn was finally consoled by his gain of ground farther ahead and permitted the line to proceed. By the plan it will be seen that the true line went into the other man's grain field, taking off quite a slice of ground. He developed the idea that he would lose in this way all along the line farther on, but when the woods were reached, approximately striking the old line, and were proceeding along it, he was satisfied the new line was correct. Had it not been made plain to the man who lost part of his barn that he would gain farther on, he certainly would not allow the line to be run, and, as he had been 21 years in peaceable possession of the property under fence, he could hold the land in any law court, and have the old line remain as the true line. This is an example of a case where the surveyor must use great delicacy and discretion.

Another Case in Point.—Here an enclosed lot was to be surveyed by compass bearings, as done originally, the various bearings and distances obtained and a correct area of the property determined.

As will be seen in Fig. 2, this land has many sides, and affords some difficulties in the conducting of the survey. There were no division lines, however, which made the survey a less delicate matter, starting at the southwest corner of the lot, marked (1) along the public highway; the course by the compass is S. 63° 15′ E., and a distance of 11.25 chains to station (2). From station (2) the course is N. 80° 00′ E., distance to (3) 11.03 chains. From (3) to (4) the course is S. 50° 10′ E., distance 12.09 chains, at (4) a pond is reached. Here some offsets have to be taken to the banks of the pond, to arrive at the area of the land to the east of station (4). From station (4), the course is N. 16° 00′ E., distance 6.10 chains, and so on. From (4) to (9) the lines skirt the banks of the pond or lake. Offsets are taken to its banks, where necessary, in order to be able to plot the ground correctly, a row of telegraph posts are shown along the public road and marked on the plan T.P. Two of these posts are used for intersecting, in order to determine the degree of correctness of the courses and chainages of distances between monuments. These are a necessary check to the survey where the bounds are deeply angled. At station (5) the compass was sighted to T.P. (1), the course being N. 42° 15′ W.; at station (6) the course sighted to the same T.P. was N. 64° 00′ W. At this station an intersection was further taken to another telegraph post, marked T.P. (2) on the plan. Here the course was N. 32° 15′ W. Proceeding to (8) another intersection was taken to T.P. (2), the course being N. 59° 30′ W.

At station (8) we come to the edge of a marsh and to the delimitation of the pond. At (9) we strike a public highway, one of the bounds of the lot, the course from here to (10) being N. 75° 15′ W., and distance, 28.50 chains. At (10) is the main public roadway or street leading out of the city. This road runs N. 57° 00′ E., but turns at station (10) and runs S. 32° 30′ W. to station (1).

In calculating the area of this lot, resort is best made to Double Meridonal Distances, where there are so many courses and angles, as in this lot, this is the only proper method of calculation, and ensures the accuracy of the survey. As to the manner of computing by this method, the reader can refer to any book on surveying.

A lot of this kind and shape, plotted on a fairly large scale, say, 5 or 10 chains to an inch, can easily be calculated for area by means of triangles, the area of each being obtained by multiplying the length of the base by half the altitude.

Points About Plans to Remember.—All the bearings of a plan must be referred to a single meridian. It matters not whether the meridian is astronomical or magnetic. In nearly all of the land divisions of the older provinces the meridian is magnetic. The angle of any two lines may be given by the difference in their bearings.

The date of a survey is the date on which measurement was completed on the ground. The dates of commencement and ending of the survey which are entered on the title page of the field notes should include all traverse or other surveys within the field book.

The surveyor must not lose sight of the fact that the main object of his plan is to identify the boundaries of the parcels laid out; the plan must not be obscured by irrelevant details. Only the main topographical features are to be represented, and in so far only as they may assist in locating the boundaries. Traverse lines of rivers or lakes, generally are of doubtful utility; they are not boundaries, and as the feature which they define is liable to change, any measurements required may, if the transverse has been accurately plotted, be scaled off the plan with sufficient accuracy. Plans must be plotted carefully and accurately, and must be fair specimens of draughtsmanship.

The title of the plan of a group lot must state the number of the lot, the number of the group, a concise designation of the locality, the district, province or territory, the name of the surveyor, the date of survey and the scale. The designation of the locality must be that one which is in general use among the public in referring to the place.

The plan of a town site must show the whole of the section or lot in which the site is situated, the connections with the corners, and every section, quarter section or lot line passing through or bounding the site. It must exhibit the bearings and lengths of all boundary lines, the posts, the numbers of the blocks, town lots, avenues and streets, the width and depth of the town lots, the width of the streets and avenues, and the houses and improvements. Only the essential topographical features are indicated.

The title of the plan of a town site must state the name of the town site, the number of the section, or lot in which the town site is situated, the province, district, or territory, the name of the surveyor, the date of survey and the scale.

Plans of highways must show the bearings and lengths of the courses, the monuments, their description, and the bearings and lengths thereto, the main topographical features and the area of the highway, computed to the nearest hundredth of an acre, in every separate parcel crossed by it.

Monuments.—In private or custom surveying wooden posts are used. In Dominion land surveys no wooden posts are now used, excepting in deep swamps. The corner posts of a survey are usually bigger and deeper in the ground than posts used elsewhere.

A wooden post for a corner of farm or settlement lot is 36 inches in length, to be one-half in the ground. It is squared 12 inches from the top, and the faces are about 3 inches wide. The top is bevelled to shed rain. Such a post, when perpetuated by a mound in the northwest, is not placed in the centre of the mound, but in the same position that an iron post would occupy. Mounds and pits are seldom used in provincial work of a correction or jobbing nature. In new government work I believe they are used by some of the provinces.

In the Dominion lands surveys pits and mounds are used throughout, as corner monuments, and also witness monuments, and a square-topped post is only used for settlement lots, group lots, etc. Stone mounds are also employed, whenever stones can be readily procured, and make good monuments for any kind of survey work. These two classes represent the style of boundary monuments largely used by Dominion land surveyors, in work in the western provinces.

MANITOBA'S FOREST WEALTH.

Manitoba has not been looked on as a forest country, but it has always had a considerable area of forest, and, since the boundaries have recently been extended, a large territory has been added which is almost entirely forest land. The forest flora of this province is varied. At the south-eastern corner the red pine of Ontario intrudes, intermingled with spruce, jackpine, tamarack, birch and poplar. Along the valley of the Red and Assiniboine Rivers was a mixed forest of elm, ash, oak, basswood, and ash-leaved maple, where trees were found ranging to 24 inches in diameter. Rising like islands from the agricultural plains, tracts like the Turtle, Riding, Duck and Porcupine Mountains, bore forests of oak, ash and poplar in the Turtle Mountains, and of spruce, jackpine, oak, elm, ash, poplar and ash-leaved maple in the others. The character of the virgin forest may be seen from the following extract from a report of explorations made by Professor Hind on the 8th November, 1858: "I beg to subjoin the circumference, five feet from the ground, of a few trees within 50 yards of our camp on the Riding Mountain: Aspen, 4 ft. 6 ins.; 4 ft. 6 ins.; 4 ft. 1 in.; 5 ft.; white spruce, 7 ft. 3 ins.; 5 ft. 6 ins.; 6 ft. 6 ins.; 6 ft.; birch, 3 ft. 6 ins.; 3 ft.; poplar, 4 ft. 9 ins.; 4 ft. 6 ins. These trees represent, as far as observations permitted, the general character of the forest on the summit plateau of the Riding Mountain."

OXY-ACETYLENE TORCH.

Some tests have been undertaken recently to determine the mechanism of cutting the practical consumption of oxygen and the effect of variations in the different heating flames produced by the oxy-acetylene blowpipe when cutting metal. The metal on which the researches were carried out was a sheet of Martin boiler-plate of a thickness of 10 mm. and a sheet of Martin extra hard steel from 28 to 30 mm. thick. This latter was similar to that used for locomotive girders. It was found that, contrary to the general impression, the act of cutting did not consist of a simple combustion of the iron. In fact, with small or medium thicknesses only a small percentage of the metal removed by the influence of the jet of oxygen was actually burned. It was also found that a heating flame could be too powerful, and so retard the cutting and give an irregular surface. With equal cutting surfaces it was also found that less oxygen was consumed by those blowpipes with a central jet than by those which had separate burners.

It is interesting to note that particular attention is being given in Germany to cutting and welding metals by the oxy-acetylene flame, and, according to an authority, an advanced course in the subject is being given to the students in one largest technical industrial schools in the country. Writing in "Indian Engineering," he points out that the method of application to the various trades is taught, including boilermaking, the work of the blacksmiths, coppersmiths, machinists, shipbuilders, pipe-workers, electricians, aluminium-workers, etc. The method is also taught in twenty-one other technical schools, and at Nuremberg a special school is being built to be devoted exclusively to practical and theoretical teaching in this branch. Already oxy-acetylene cutting has begun to displace cutting by tools to a large extent. One direction in which a revolution is being effected is in piping. Instead of having short lengths with screwed joints, which necessitated a certain minimum thickness of metal to allow for the screw threads, the method now being commonly adopted is to use thin plates of steel or iron run through rolling machines to the required diameter and then butt-welded by the oxy-acetylene flame in an automatic machine. Jointless pipes of any length are thus obtained at less cost than formerly, the work proceeding on the spot where the pipes are being used, exactly according to requirements. There is a successful example of a repair to a large cast-iron cylinder which cracked and would have taken a month to re-cast. To prevent the chances of the cylinder developing cracks near the joint, owing to unequal contraction when cooling, it was covered with asbestos on the outside, while a wood fire was kindled inside, which maintained it at a dull red heat while the oxy-acetylene flame was being applied. After completion of the weld the cylinder was covered with insulation and allowed to cool very slowly. The insulation was removed after two days, when the joint was found to be perfect, without the trace of a shrinkage crack. The convenience of repairing by this method the machinery and boilers of ships at sea has only to be mentioned to be appreciated. It can also be realized how great is the saving in time in repairing and putting on the road again locomotives which otherwise might lie for weeks in the shops.

LARGEST DRYDOCK.

The drydock which is to be built at Quebec for the Dominion Government by a Montreal firm will, when completed, be the largest structure of its kind in the world. It is to be 1,150 ft. long and 137 ft. wide, or 100 ft. longer and 17 ft. wider than the Gladstone Dock, which was opened by King George at Liverpool.

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CONTENTS OF THIS ISSUE.

POINTS IN CHOOSING A PAVEMENT.

The information which *The Canadian Engineer* has accumulated, respecting the various types of pavements that have been laid in Canadian cities, forms the basis of an article appearing in another part of this issue. The data show a marked tendency toward greater uniformity in the use of pavements for special grades of traffic, and they also show that the question of traffic has been receiving more attention and scientific investigation during the past several years than had hitherto been given it, in the selection of pavements.

The opinions which our city engineers have expressed are of great value in that they are based upon constant personal observation. Where these opinions differ materially from the general conclusions at which highway officials in other countries, and even in other cities of our own country, have arrived are instances which are sources for information of particular value, and which bear out well the old-established belief in experience as the best teacher, though in many cases the most expensive.

That these general conclusions respecting paving practice at home and abroad are subject to modification for any city's particular requirements, does not entirely explain the wide diversity of opinion which still exists throughout the country concerning the pavements that are being used. Although Canada's expansive territory is subject to a considerable range of climatic conditions; to a varying quality in materials, and to a changing and varied collection of vehicular traffic, these factors are not sufficient in themselves to prevent the crystallation and adoption of a more uniform and a more scientific pavement selection than the actual results indicate from practice in the past.

Not that absolute uniformity is desired. *The Canadian Engineer* is not an advocate of hard-and-fast rules in the matter of street paving. Newer methods and materials are being continually introduced, and the trying-out process is slow. But there are many pavements that are well-established and do not belong to the novice class, and the evidence that among them there are pavements that have not been properly chosen in some cases points to towns and smaller cities the wisdom of careful selection. The durability of a pavement has one unredeeming feature, in that it does not furnish an early opportunity for the laying of a more appropriate pavement if a desire for such may develop.

Other characteristics besides durability enter most paving projects. Quietness is desired in residence sections, and on streets lined with office buildings. Sanitariness is desirable on all streets, and the street cleaning department of a city should be shown consideration where possible in the selection of pavements. The quality of unslipperiness is often at variance with the nature of the surface which assures other desired characteristics. Especially in cases of intersections busy with light and speedy traffic, and on ungraded streets, slipperiness is a most undesirable feature. Qualities such as the radiation of heat, reflection of light, emission of unpleasant odors and other factors which concern the pedestrian and the adjoining residents, are also worthy of some consideration.

Further, some pavements, though quite satisfactory when new, may be subject to a wear of such a nature as to render them wholly undesirable, long before they are in such an advanced state of wear as to warrant their being torn up and replaced.

These and other factors influence the choice of a pavement, some lightly, some considerably, depending on local conditions; and, while one good quality may be obtained at times only at the expense of another, the search for the ideal pavement requires a judicious consideration of them all. The proper time to think of these items is before the pavement has been laid. There will be fewer discrepancies to overlook afterwards, as a result.

STEEL FOR CANADIAN SHIPBUILDING.

The old saw about the ill wind is given another chance in the case of the new Government regulation respecting materials that go into the making of Canadian vessels. The shipbuilding industry receives its share of the good in the clause which states that all vessels built for the Dominion Government must be built in Canada. The steel industry of Canada also should receive a healthful incentive from the fact that all material for the construction of these vessels must henceforth be British product, thus putting an end to the use of steel from the United States for this purpose. Whatever material Canada is not at present able to supply, for a yearly output, may be of such magnitude as to act as a last straw in the breaking down of indecision toward the establishment or the extension of other industries.

But the shipbuilding industry is not jubilant over the necessity of having to look in another direction, than has been the custom, for steel plate. There are items of cost and speed in getting actual construction under way, that are somewhat handicapped by the new rule. The length of time necessary for the delivery from England, of steel and other materials which Canada may not yet be in a position to supply, is going to hold up the fulfilling of contracts. Concerning cost, Canada has been purchasing United States steel for her shipbuilding at a better rate than it is claimed she can get it from Great Britain, the quality being practically the same. Or, she might buy from Belgium at a lower figure than that obtainable in either of the other sources of supply.

So that the Canadian shipbuilding industry is affected by the new regulation to the extent of an increased cost in the materials of construction, and of a longer period necessary for the completion of a vessel.

A CENTRALIZED ROAD BOARD ADVOCATED FOR CANADA.

Returning to Canada, after a study of the evidences of road engineering, as displayed in Great Britain and on the Continent, Mr. A. T. Laing, lecturer in highway engineering, University of Toronto, pronounces as the vital point in Canada's road situation to-day, the lack of organization.

"It is hopeless to expect a satisfactory treatment of the question so long as each municipality continues an independent policy of experimentation with one pet scheme or another at the caprice of a council. What is needed more than anything else at the present time is centralized authority, which, of course, must be accomplished by legislation. The establishment of a board modeled after the British Road Board and modified to meet the conditions here would greatly aid the movement and place it on a substantial basis."

The suggestion is not new to readers of *The Canadian Engineer*, and it is regrettable that engineers, who have a better knowledge than anyone else of the necessity of a comprehensive Dominion-wide road policy on a sound financial basis, do not bring the idea into more prominent publicity, now that the road problem is being so widely discussed in some of the provinces.

Of course, conditions in the two countries are vastly different, and Great Britain with her densely inhabited areas and her comparatively short roads is not a model for Canada to copy. But the principle is the same, and should work out as well in Canada as it has done in England.

BIG PAVING FIRM TO BE WOUND UP?

Application was made last week at Osgoode Hall, Toronto, to wind up the Canadian Mineral Rubber Company, Limited. J. S. Lovell, who was the petitioner, is a creditor for $2,500. It was suggested that this year's business will increase the company's liability by $200,000.

The company was incorporated in 1909, under Canadian laws. It owns a Gilsonite property near Price, Utah; a bituminous limestone property near Tucker, Utah, and also the entire $500,000 capital stock and $500,000 bonds of the American Asphaltum and Rubber Company, of Chicago.

The company manufactures "Pioneer" mineral rubber asphalt, insulating and waterproofing compounds, pipe coatings, paints, etc. The registered office in Canada is in Toronto, but the Toronto office is very small compared with the large staff at the Chicago headquarters of the American Asphaltum and Rubber Company, which handles a large volume of business throughout the United States.

The officers are: D. B. Hanna, Toronto, president; A. J. Mitchell, Toronto, secretary. The directors are the foregoing and Sir H. M. Pellatt and A. D. Davidson, Toronto; H. Sutherland, Winnipeg; J. M. Greata, J. J. Hill and D. Northall-Laurie, Chicago.

The outstanding capital stock of the company is $200,000 preferred and $800,000 common. The bonded debt is $825,000, most of which, it is understood, was issued in England, with the British Empire Trust Company, Limited, of London, as trustee.

It is generally thought that the application for winding up the company is probably the direct result of the suit against the American Asphaltum and Rubber Company, which was won recently in the Illinois courts by a competing company, the Standard Asphalt and Rubber Company, of Chicago. The latter company, which makes practically the same products as are made by the American Asphaltum and Rubber Company, claims to own the basic patents covering the methods of manufacture of many of the American Asphaltum and Rubber Company's products, and their contention was apparently upheld by the courts.

This suit and the subsequent application for the winding up of the Canadian Mineral Rubber Company are of immense importance to paving interests, both in Canada and the United States, because the Standard Asphalt and Rubber Company claim that their patents are basic patents covering every commercial method now known for producing asphalt products.

Toronto has 42.76 miles of macadam roads; Winnipeg follows with 33.75 miles.

The Canadian Pacific Railway Company's tunnel under the Selkirk Mountains is regarded as one of the most important enterprises which has ever been undertaken in the Canadian west. It will be five miles long, and will be built for a double track. The time prescribed for the execution of the works is forty-two months

THE EXTENT AND WEAR OF PAVEMENTS IN CANADIAN CITIES.

CLASSIFICATION OF DATA AND OPINIONS FROM CITY ENGINEERS ON THE VARIOUS TYPES IN EXTENSIVE USE AND THEIR GENERAL SUITABILITY FOR DIFFERENT KINDS OF TRAFFIC — STATISTICS COMPILED BY *THE CANADIAN ENGINEER*

It is very difficult to fix, with any degree of accuracy, a definite period for the life of a pavement or a definite conclusion as to its serviceability, especially as conditions vary so greatly in different cities and on different streets of a city. No two highway engineers may be expected to agree in their estimates concerning the value of different pavements for this reason. Considering, for instance, the question of durability, although there are many streets on which an ordinary pavement might be considered to be efficient for fifteen or twenty years, or even longer, there are many instances where the same pavement has been carefully laid and has not exceeded ten years in life-time. Again, a stone pavement may withstand heavy traffic for fifteen years, while, under a lighter traffic, and provided it is not opened too frequently, it should last thirty or forty years, if well laid. Such a great deal depends upon the nature of the traffic to which a pavement is to be subjected, that the problem of pavement selection is mainly one of acquiring a composite knowledge of the many present and future conditions to influence its wear. An investigation of traffic is manifestly an important preliminary upon which the success of a proposed pavement depends.

The Canadian Engineer has set about to ascertain an analysis of the pavement situation in Canada—the service which the more extensively laid pavements have given, and the opinions of the engineers as to their suitability for the traffic over them.

The information contained in this article shows conclusively that while the paving of city streets has not entirely passed the experimental stage, there is a marked tendency toward uniformity of opinion among city engineers in the matter of selection. (The pavements that have been laid during the past several seasons, especially, bear this out.) And, where their opinions are shown to differ from the generally adopted conclusions respecting certain pavements, it is to be remembered that many of these types in Canada have served but a short portion of their lifetime, and also that every city has its own peculiar conditions of traffic.

The observations contained herein tend to show that the most suitable pavement has not always been the one selected; and that in many cases, the selection rather than the pavement, is within the range of criticism. Thus, while it is necessary for those who have paving to do to acquaint themselves with the characteristics of the different materials, as they may do by observation, and from the volumes that have been written about them, it is also necessary to study carefully the trend of local civic expansion and traffic.

It is not to be expected, therefore, that the city or town engineer who is in a quandry as to the best pavement to lay on his next street will find solution in the opinions expressed herein; but, the choices which other engineers have made, and the manner in which their pavements are answering, will go a long way toward a satisfactory selection, after he has equipped himself with a well-defined knowledge of his requirements.

From Table I. an idea may be obtained of the extent of Canadian pavements. A grand total is not indicated as a few cities are not represented, while some have included the present season's development and others have not. Mileages of macadam and gravel roads, and of some of the lightly used pavements have also been omitted from this analysis, in order that the more largely used pavements might be more simply described.

Table II. comprises the deductions from present opinions of city engineers in the matter of comparative suitability for different traffic conditions. Here, again, one must bear in mind that these opinions are derived from experience with whatever pavements were first laid, and may not, therefore, conform entirely to what the engineer might advise had he the laying of the pavements to do again.

Opinions as to the nature of wear of pavements and its effect upon the general condition of streets are summarized in Table III. As each type has been used in various grades of traffic in different cities, as indicated in Table II., the conclusions respecting wear are also varied. Where, in one city, a pavement wears evenly, and in another develops holes, the assumption that the nature of the traffic is different is borne out by the data submitted, and in every instance the table expresses the nature of deterioration under the traffic to which it has been more widely subjected, rather than under the traffic for which it might be termed the ideal pavement.

The question of durability of any individual type is far from being satisfactorily answered in the approximate comparison given in Table IV. Traffic does not lend itself to strict classification, nor does it confine itself to the streets best suited for it. As the life of a pavement advances residential streets may become business streets or may develop into channels of dense traffic between business sections. Again, "small" repairs may be occasioned from foreign causes, while the stage where "complete reconstruction" is necessary frequently depends upon the number of times the pavement has been torn up for the laying of mains, etc. At any rate, engineers are not of one mind in the matter of durability of the various pavements in use, nor are the methods and materials of construction so uniform throughout the Dominion that all pavements enter the test for longevity on an equal basis.

Opinions Respecting Pavements in Use.

Asphalt Block.—The earliest report of this pavement being laid in Canada dates 1904. It is generally conceded to be a good pavement for residence streets, and for light traffic streets without car tracks, although several western cities report its favored use for heavy traffic, it is not so recommended by eastern city engineers. It is a too recently accepted material for authoritative opinions as to durability. It has not always worn well wherever laid, having developed a tendency toward holes and cobbling, and there are instances where disintegration of the lower part of the block has caused trouble. It is likely to endure ten years of service without extensive repair, a few engineers making a more conservative estimate. Many cities mention cost as a prohibitive feature against more general use. When the block commences to wear at the edges, and the surface becomes roughened, it is hard to keep clean.

Asphaltic Concrete.—This is one of the youngest of the pavement family and engineers do not commit themselves as to its wearing qualities. We find no record of asphaltic concrete having been laid in Canada prior to 1909. It is suitable for light to heavy traffic with a tendency to wear into holes. Mr. A. F. Macallum, city engineer of Hamilton, reports its use on grades of from 3% to 7%—too steep for the use of sheet asphalt. On the steepest grades transverse grooves were cut across the pavement every nine inches to eliminate undue slipping in unfavorable weather.

Bitulithic.—This pavement dates from 1902 in Canada, in which year it was laid in London, where it has proved satisfactory, although Mr. W. N. Asphlant, the city engineer, recommends a concrete base for the best results with it. Chatham has had it in use for ten years and reports an even wear with a tendency to holes. Bitulithic is not so liable to markings in hot weather, as asphaltic concrete. Mr. W. A. Adams, assistant city engineer, Lethbridge, endorses the advantages of using a stretcher on streets with car tracks, both inside and outside the rails. Concrete with wire mesh reinforcement has been satisfactorily used for this purpose. Bitulithic appears to answer for all ordinary traffic. It has the advantage of being comparatively noiseless and easily cleaned, although a squeegee coat, frequently applied, makes cleaning a little difficult, and requires the pavement to have a slightly higher crown.

Fifteen years is claimed to be its approximate lifetime before extensive repairs are necessary, although several place this limit at ten years, and in each of these latter cases the pavement has already been down for nine years.

Brick.—Toronto laid brick pavement in 1895, and Chatham in 1896. "Good under all conditions," including steep grades, heaviest traffic and streets with car lines, expresses its efficiency in so far as durability is concerned. Its tendency to edge-wear produces cobbles and holes. On streets with car tracks it will last eight years or more before any repairs are necessary, if carefully laid. On streets with heavy traffic and without car lines this period is extended to fifteen years, while twenty-five years is a conservative estimate for light residential traffic. But no engineer recommends its use for quiet streets.

Mr. L. W. Rundlett, of Moose Jaw, reports laying this summer a vitrified brick pavement in a subway under a railway track. The brick is laid on five inches of concrete, with a sand cushion and grouted with a 1 to 1 Portland cement grout. He regards it as an exceedingly satisfactory pavement for this location.

Table I.—Mileages of Pavements in Some Canadian Cities and Towns.

CITY OR TOWN	Asphalt Block	Asphaltic Concrete	Bitulithic	Brick	Scoria Block and Stone	Sheet Asphalt	Untreated Wood Block	Treated Wood Block	Concrete
Berlin, Ont.	....	....	2.00	Car track allowance	....	....	....	....	....
Brantford, Ont.	0.05	....	2.98	2.08	....	....	....	....	0.20
Calgary, Alta.	....	....	12.30	....	....	29.90	....	4.50	4.10
Chatham, Ont.	2.00	....	4.60	3.80	....	....	Replaced	....	0.70
Edmonton, Alta.	....	being laid	12.50	....	....	5.50	1.50	....	....
Fort William, Ont.	1.76	....	....	....	....	0.54	....	0.30	....
Guelph, Ont.	2.27	....	....	0.81	....	....	....	....	....
Halifax, N.S.	....	....	3.00	....	1.50	2.00	....	....	....
Hamilton, Ont.	....	3.00	....	4.00	Street intersections	20.00	....	3.00	....
Kingston, Ont.	0.73	....	....	....	....	....	....	....	....
Lethbridge, Alta.	....	1.08	0.50	....	....	....	....	....	....
London, Ont.	0.38	0.24	2.17	1.02	....	4.97	....	....	....
Maisonneuve, Que.	....	....	....	....	....	....	....	....	2.50
Moncton, N.B.	....	....	....	....	....	....	0.75	....	....
Montreal, Que.	....	....	....	....	....	....	....	....	....
Moose Jaw, Sask.	....	....	....	0.57	....	0.67	....	11.80	....
New Westminster, B.C.	....	....	5.40	0.28	0.47	....	....	0.29	3.10
Ottawa, Ont.	....	....	0.65	....	0.57	23.90	....	0.41	....
Port Arthur, Ont.	2.16	1.18	2.12	....	....	2.76	....	....	0.12
Quebec, Que.	....	....	....	....	....	....	....	....	....
Regina, Sask.	0.72	....	9.31	....	....	6.20	2.10	....	1.45
St. Boniface, Man.	0.81	....	11.7	....	....	....	1.90	1.57	0.31
St. Catharines, Ont.	2.50	2.00	5.00	1.00	....	....	....	....	....
St. John, N.B.	2 bridge floors	0.50	....	0.16	....	0.15	3.00	....	....
Steelton, Ont.	....	....	....	....	....	....	....	....	0.66
Stratford, Ont.	1.10	....	1.0	1.40	....	....	....	....	....
Toronto, Ont.	6.30	being laid	37.72	29.07	2.16	157.03	....	8.77	....
Vancouver, B.C.	....	8.80	5.30	1.40	2.80	5.30	4.20	22.30	3.20
Victoria, B.C.	....	....	....	0.50	....	44.00	....	3.50	....
Walkerville, Ont.	2.31	....	0.38	....	....	....	1.25	....	1.50
Winnipeg, Man.	....	12.00	....	....	....	81.00	26.50	....	....

Brick worn to any extent is not easy to keep clean when revolving brooms are used, but cleans thoroughly if flushing is resorted to.

Sheet Asphalt.—In 1887 Toronto laid its first sheet asphalt and its 157.03 miles now in use indicate that it has been found generally satisfactory. Approximately 350 miles of it are now in use in Canadian cities. It appears to withstand all kinds of traffic well, wearing fairly evenly, with a tendency toward ruts and holes under heavy traffic. It is generally conceded to be a slippery pavement in wet and frosty weather, and requires frequent cleaning for best service. Mr. Arch. Currie, city engineer, Ottawa, states that for his city's requirements this pavement, properly constructed, is the best that can be used. Several cities report a little cracking, not serious, in their asphalt pavements.

No repairs are necessary during the first four or five years. If good sand is used in its construction sheet asphalt will last from ten years under fairly heavy traffic, to 16 or 20 years on residential streets, before reconstruction is necessary.

There is such a tendency to tear up streets for the installation of sewer mains, water and gas services, etc., with an uneven and unsightly patching as a result that quite a number make mention of it in commenting upon the durability of this pavement.

Wood Block.—This type of pavement is considered satisfactory on both residential and business streets. It it well adapted for the heaviest kind of traffic, and has the advantage of being comparatively noiseless. Its tendency, however, toward slipperiness in wet and frosty weather is quite marked.

Untreated wood blocks were laid in Toronto as early as the seventies. St. John, N.B., reports their use since 1880, and Winnipeg had wood block pavements in 1885. Untreated blocks decay rapidly and require replacement after four or six years of wear. Some cities have run traffic of all kinds over them for a slightly longer period, but on the other hand, several report the necessity of repairs after three years of use. Walkerville, Ont., used cedar block very extensively some years ago, but found them to last only five or six years before extensive repairs were necessary, in spite of careful attention to little defects, and of the fact that they were laid on concrete base.

Creosoted wood block pavement goes back about ten years only, in America, with native woods. Some pavements have thrived in New York and Boston for that length of time, and upon them there have been no repairs to date. Treated wood block has not been in use sufficiently long in Canada, however, for engineers to acquire an opinion of its durability. Several hazard a suggestion of fifteen years under heavy traffic, and twenty years under ordinary wear before any extensive repairs are necessary.

Most of Moose Jaw's pavement is creosoted wood block, three inches in depth and laid on a sand cushion. They receive a 16-pound per cubic foot treatment. They have answered well up to the present, except where water and frost has got beneath them. This occurs particularly along the street car tracks, but Mr. Rundlett advises laying the blocks in a cement grout to obviate this difficulty.

The more scientific methods of laying wood block pavement is bringing it into favor for Canadian city streets. Vancouver, Saskatoon, and other western cities appear to be giving this type of pavement a good deal of attention and preference. The Forestry Branch of the Department of the Interior recently issued a bulletin containing the following:—

"Best results are obtained from rectangular-shaped blocks cut from Southern or Norway pine which are thoroughly seasoned and creosoted. This latter process not only lengthens the life of the wood but reduces its absorptive capacity for water, thus preventing the weakening of the wood-fibres and reducing its tendency to buckle. The most approved method of laying this pavement used in London, New York and other large cities, is to first make a concrete foundation four or six inches thick on which is laid a thin layer of sand, or, better still, of moist Portland cement, into which the blocks are closely set.

"The blocks are from five to nine inches in depth and must be free from defects. Care must be taken to place them with the grain perpendicular to the road-bed. If laid with the long edges at right angles to the curb the joints are apt to become worn by the calks on the horses' shoes, so, to prevent this and to best provide for possible expansion, the paving is laid at an angle of about sixty-seven degrees with the curb. The joints are usually filled with ground cement and the surface of the paving is then covered with a thin dressing of coarse sand, which beds into the pores of the blocks and roughens them.

"Such a pavement has the smoothness of asphalt and will last almost without repair for fifteen years under

Comparative Value of Different Pavements.

Pavement.	Percentage.	Granite.	Sandstone.	Asphalt (sheet).	Asphalt (block).	Brick.	Macadam.	Creosoted wood.
Cheapness (first cost)	14	4.0	4.0	6.5	6.5	7.0	14.0	4.5
Durability	20	20.0	17.5	10.0	14.0	12.5	6.0	14.0
Ease of maintenance	10	9.5	10.0	7.5	8.0	8.5	4.5	9.5
Ease of cleaning	14	10.0	11.0	14.0	14.0	12.5	6.0	14.0
Low traction resistance	14	8.5	9.5	14.0	13.5	12.5	8.0	14.0
Freedom from slipperiness (average of conditions)	7	5.5	7.0	3.5	4.5	5.5	6.5	4.0
(A) Favorableness to travel	4	2.5	3.5	4.0	3.5	3.0	3.0	3.5
(B) Acceptability	4	2.0	2.5	3.5	3.5	2.5	2.5	4.0
Sanitary quality	13	9.0	8.5	13.0	12.0	10.5	4.5	12.5
Total No. points	100	71.0	73.5	76.0	79.5	74.5	55.0	80.0

A.—Favorableness to travel is dependent chiefly upon smoothness and freedom from dust and mud; secondarily upon the qualities composing "Acceptability."

B.—Acceptability includes noise, reflection of light, radiation of heat, emission of unpleasant odors, etc. It chiefly concerns the pedestrian and the adjoining resident.

ordinary conditions. It is sanitary, noiseless, easily kept clean and has a certain springiness lacking in asphalt, and is much easier on horses' feet. Expert labor is not required in its laying and the cost of maintenance is practically nil, so that from the standpoint of cost as well, it compares favorably with the asphalt, macadam and brick now being used in Canadian towns and cities."

It is interesting to note that Minneapolis is laying approximately 215,000 sq. yds. of pavement this summer, over 82% of which is creosoted wood block.

Scoria Block.—This type of pavement is wearing lightly and evenly in Toronto, and is satisfactory for most kinds of traffic. Hamilton paved some street intersections in 1899 with this block, but replaced them later with wood block. Ottawa's scoria block pavements is wearing into holes, but Mr. Currie attributes this to a possible use of poor concrete on soft sub-grade, when the pavement was put in place. Scoria block appears to possess disadvantages due to slipperiness in unseasonable weather, and noise at all times.

Toronto has stone pavements in use since 1881. They are cobbling but are indicative of indefinite wear.

Concrete.—Concrete pavement is of comparatively recent date, no report indicating its use in Canada prior to about five years ago. One feature of the opinions concerning it is its durability. Many cities have begun its use but no repairs have been necessary, especially if carefully laid. The general expression of engineers upon this pavement is one of favor and satisfaction for residential streets and moderately heavy traffic. Mr. Owen McKay, town engineer, Walkerville, Ont., advises the use of reinforcing at the expansion joints, and several suggest continuous reinforcing throughout with steel plates at the joints. The pavement is very easily cleaned with broom or flusher. Chatham reports that a pavement put down in 1908 has cracked longitudinally with the street, and is wearing at the juncture of the crack with the expansion joints. No repairs have yet been made, but it is the intention to fill these cracks with asphalt at an early date.

The durability of concrete pavements is illustrated by a recent press reference to a road from Detroit to Dearborn, ten miles in length, constructed of macadam, asphalt macadam, and concrete. Here it was found that the concrete pavement which had been in use for about four years was greatly superior in surface to the others, which had not been in service for more than half that period. In another instant a piece of macadam laid less than a year ago at a cost considerably exceeding that of concrete, was in a much inferior condition to a strip over the same territory constructed of small stone and concrete some four years ago, and it is claimed that no road in Michigan excels this particular piece of concrete pavement. Concrete roads have proved so successful in Wayne county, Michigan, that hardly any other kind is now being laid.

Some Opinions From United States.

We quote the following from a number of letters which have furnished us with information concerning the use of various pavements in cities of the United States.

Capt. Mark Brooke, U.S. Corps of Engineers, and assistant to the Engineer Commissioner of the District of Columbia, expresses his belief that sheet asphalt should be expected, under ordinary conditions, to attain a life of approximately twenty to twenty-two years, although in some instances in Washington it runs over thirty years. He believes that asphalt block, if well laid, should approximate the same life. They have more sheet asphalt in that city than any other type, and on the whole it is as satisfactory as any.

Mr. Wm. H. Connell, chief of the Bureau of Highways and Street Cleaning, of Philadelphia, considers asphalt as a very desirable pavement on ordinary medium traffic streets where grades are not too heavy. He is putting in wood block pavements on streets with very heavy traffic, especially where it is desirable to have a quiet pavement and where a finely dressed granite block pavement would be too noisy, and is finding it very satisfactory under such conditions. Sheet asphalt is being used very largely in Philadelphia, as is shown by the following statement of mileage and yardage of the various types in use:—

Character.	Miles.	Sq. yds.
Granite block	352.99	6,653,532
Asphalt (sheet)	472.35	6,959,656
Asphalt (block)	7.49	72,532
Vitrified brick	163.63	2,376,224
Cobble	14.02	162,775
Rubble	6.69	93,182
Slag block	8.13	78,071
Cement and granolithic	11.03	54,242
Wood block	4.06	121,505
Totals of improved pavements	1,040.39	16,571,719

Mr. John B. Hittell, chief engineer of streets, Chicago, estimates the life of the various pavements principally used there to be as follows:—

Asphalt	12 to 15 years
Brick	12 to 15 years
Creosoted block	15 to 18 years
Granite blocks	30 to 40 years

Chicago has laid, up to the present time, more asphalt pavement than any other type. Under normal conditions granite block is considered the most durable for heavy traffic and asphalt for light traffic.

Mr. Nelson P. Lewis, chief engineer to the Board of Estimate and Apportionment, of New York City, states that the average life of an ordinary sheet asphalt pavement in the borough of Manhattan may be considered to be fifteen years, and about eighteen years in other boroughs. Asphalt is very extensively used, probably more than all other types of pavements combined. It is found most suitable for resident streets and where it is difficult to maintain good sanitary conditions.

Next to this comes stone block which, if well laid, should withstand very heavy traffic for at least twenty years, and under lighter traffic, unless frequently torn up for the laying of mains, etc., it should last thirty years or more. If laid on a concrete foundation it is found to be most suitable for very heavy traffic, although wood block has been found to be the satisfactory pavement on light grades. Of this type he does not express an estimate of its life as it has not been in use sufficiently long. There is every indication, however, that if well laid and not disturbed it will be as durable as stone block.

The United States Bureau of Agriculture issued a bulletin this summer containing, as a result of an enquiry as to the opinions of a number of city engineers in the United States, the following table, in which under the percentage column the various qualities desired in a pavement are assigned proportionate values, the total being 100 points. The pavement ranking first under any given quality is given the full quality percentage, the rest grading down from this value in proper proportion.

Returning to our Canadian cities, Mr. A. F. Macallum, city engineer of Hamilton, Ont., states that the standard pavements used there are wood block, asphalt, and a form of asphalt-macadam. Brick is used only in alley-ways. Sheet asphalt exceeds other types in quantity and is considered the best under normal conditions. It is used on light traffic streets, except on grades exceeding two per cent., where asphalt-macadam is laid instead. For very heavy traffic wood block is used.

Concerning the life of the asphalt pavement, Mr. Macallum states that it is very difficult to arrive at an estimate unless the conditions specified in its construction are very carefully followed. Some pavements of this type have been down for fifteen years and are in excellent condition, while others, down for only three years, are not in good condition, due principally to a poor mixture of sand used. The principal difficulty experienced there has been in securing a good, clean combination sand that will give a sufficiently dense pavement. Mr. Macallum holds this to be a most important thing in asphalt pavement work, as at present the asphalt itself is made to such a standard that, if the proper penetration is used, there is no danger in that proportion of the pavement.

He cites an experiment on one pavement of using no binder, but described it as unsuccessful, as the pavement moved and formed an undulating surface under traffic.

Judging from the manner in which treated wood block pavement, which has such a comparatively recent history, has stood the test of the heaviest traffic in that city for the past four years, Mr. Macallum places its life at what he considers to be a very conservative estimate, 10 years.

He adds that asphalt-macadam and other pavements of that nature depend for their lives altogether upon the hardness and toughness of the stone, which will vary a great deal according to the vicinity from which the stone is secured, the limestone from their own quarries being too soft for such a purpose.

Table II.

Opinions of Canadian city engineers concerning the suitability of various pavements as they have been used for different conditions of traffic. (Arranged in descending order of present popularity):—

Light Residential to Semi-Business:
Sheet asphalt, bitulithic, asphalt concrete, asphalt block, wood block, concrete.

Semi-Business to Medium Heavy Traffic:
Bitulithic, sheet asphalt, asphaltic concrete, wood block, asphalt block, concrete.

Heavy Traffic:
Brick, wood block, stone, and scoria block.

Along Street Railway Tracks:
Wood block, brick.

Quiet Streets:
Wood block, bitulithic, sheet asphalt, asphaltic concrete.

Graded Streets:
Brick.

The city of Winnipeg has more sheet asphalt pavements than all others combined, and it is considered the best pavement for the city's use from all points of view. The first asphalt pavements were laid in 1897, one upon a residential strees, and one in the heart of the wholesale district. Both are still in perfect condition. In 1911, pavements consisting of two inches of asphaltic concrete on a 4½-inch cement concrete base were laid. Mr. H. N. Ruttan, city engineer, states that no pavement will withstand heavy traffic in Winnipeg without concrete foundations. Cedar block has been used principally in lanes, where it is standing seven to ten years' wear.

Table III.—Opinions as to Nature of Deterioration.

Asphalt Block:
Edge-wear forming holes and cobbles; worn pavement noisy and hard to keep clean; disintegration of bottom of blocks.

Asphaltic Concrete:
Wears into holes; susceptible to marking in hot, sunny weather.

Bitulithic:
Wears evenly, with a tendency to holes under heavier traffic; susceptible to surface marks in hot weather.

Brick:
Edge-wear and cobbling under heavy traffic; increased noise and unsanitariness as wear increases; when worn badly it slows down traffic.

Sheet Asphalt:
Wears slowly into large holes or patches; heavy traffic causes ruts; cracks hasten deterioration.

Wood Block:
Rots rapidly if untreated, retarding traffic; treated block wears slowly and evenly; frost intrusion causes buckling.

Stone and Scoria Block:
Wears gradually into holes and cobbles; unsanitary when roughened.

Concrete:
Wear is slow and even if well placed; cracking and chipping develop otherwise.

The Bonding of Pavements.

There is a wide diversity among Canadian municipal authorities as to the number of years that each type of pavement should be bonded, asphalt block, for instance, being subject to bond requirements extending from five to twenty years although, generally speaking, its lifetime is not expected to exceed more than twelve or fifteen years. In the majority of instances a five-year bond is the policy followed for all types of pavement; some of the larger cities, however, requiring a ten-year bond on most of them. Regina, previously ten years, has reduced its requirement to five; St. Boniface, Man., on the other hand, requires a bond extending twenty years. In the case of London the majority of bonds has been for ten years, but as the Guarantee Companies now decline to bond contractors beyond five years one is taken for that length of time for sixty per cent. of the amount of the contract, the contractor still requiring to guarantee his pavement for ten years, the city retaining six per cent. of the contract price for that period and paying annually the contractors' interest on the guarantee, providing the terms thereof are complied with.

In Ottawa ten per cent. of the contract price is held as guarantee for ten years, the average lifetime of asphalt and wood block pavements being considered fifteen years and Nepean stone and Scoria block pavements twenty years. In Toronto, fifteen per cent. is withheld for ten years.

Table IV.—Consensus of Opinion as to Durability.

Pavement.	Small repair. Years.	Extensive repair. Years.	Complete recon-struction. Years
Asphalt block	5 to 10	10 to 12	12 to 15
Asphalt concrete	4 to 6	6 to 8*	8 to 10*
Bitulithic	5 to 8	10 to 15	15 to 20
Brick	8 to 10	10 to 15	15 to 18
Concrete	5 to 8	10 to 12	15 to 18*
Scoria block and stone ..	10 to 15	15 to 20	20 to 30
Sheet asphalt	4 to 8	10 to 15	15 to 18
Untreated wood block ...	3 to 5	6 to 10	10 to 12
Treated wood block	8 to 10	12 to 15	15 to 18*

*These pavements have not attained an age in Canada sufficient to place the figures beyond conjecture.

Financing of Pavements.

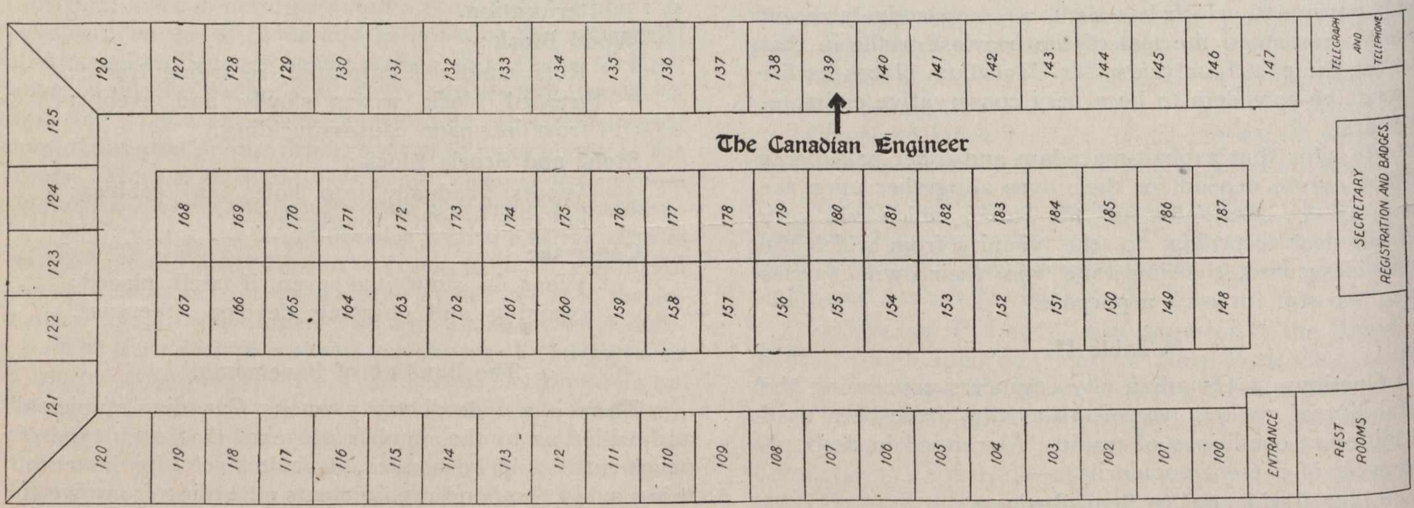
Hamilton does all its paving by day labor and, estimating the life of a pavement at ten years, bonds are issued against them for that length of time. In Toronto ten years is also considered as a fair estimate, and ten-year debentures are issued to finance them. In Winnipeg practically all paving is done by day labor. The money for paving is secured in all cases by the sale of thirty to fifty-year stock, i.e., the city may redeem any time after thirty years to fifty years. The term of assessment on sheet asphalt pavements is fifteen years, on asphaltic concrete, ten years; on cedar block pavement, seven years.

It is interesting to note that the city of New York has assessed the entire cost of the first pavement upon the abutting property and has paid from city funds the cost of all subsequent renewals, raising money for this purpose by the issue of fifty-year bonds. This policy is discussed at considerable length in the report of the Board of Estimate and Apportionment for 1912. Since then, however, the city has decided to limit to ten years the bonds issued to meet the costs of re-paving.

Washington's pavements are paid for in cash under appropriations made by Congress, the funds being derived from revenues of the District of Columbia, and a contribution on the part of the General Government on the basis of its ownership of property.

Philadelphia and Chicago issue five-year bonds against their pavements of various types.

THE CANADIAN ENGINEER AT THE DETROIT ROAD CONGRESS.



Plan of Exhibition Building.

The Canadian Engineer will exhibit at the Third American Road Congress at Detroit. Canadian visitors to the Congress are invited to make Booth No. 139, *The Canadian Engineer* headquarters, their headquarters also, during the week. Mail, telegrams, packages, etc., may be addressed care of *The Canadian Engineer*, Booth 139, American Road Congress, Wayne Gardens, Detroit.

NEW YORK'S PROBLEM OF SEWAGE DISPOSAL.

The pollution of New York harbor by the sewage from the metropolitan district has been gradually increasing, and it is recognized that steps must soon be taken to correct the conditions. In 1906 the New York State Legislature passed a bill requiring the city of New York to appoint the Metropolitan Sewerage Commission to study the pollution of the harbor and devise a proper method of correcting the conditions. The magnitude of the work of this commission mav be realized when it is understood that the area studied is some 700 square miles, with a present population of about 6,000,000, and a future population of about twice this figure. Within the metropolitan district there are over 100 cities and towns, and the sewage produced is about 765,000,000 gallons per twenty-four hours. It is assumed that within thirty years the daily volume of sewage flow will be increased to 1,500,000,000 gallons. Of course, the volume of water in the harbor will not increase to furnish available dilution, and unless proper provisions is made for treatment of the sewage, a general intense pollution of the harbor is inevitable. The scope of the work of the Metropolitan Sewerage Commission includes a study of the facts and the formulation of a remedy for the existing and future conditions. As the work has progressed it has been found that the problem is of much greater magnitude than was at first anticipated, and several years' further study may be required before a final decision is reached.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

The Elements of Specification Writing.—By Richard Shelton Kirby, C.E., Professor of Civil Engineering, Pennsylvania College. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. Publishers' agents for Canada, Renouf Publishing Company, Montreal. Cloth, 6 x 9 ins.; pp. vii. + 125. Price, $1.25 net.

Reviewed by C. R. Young, B.A.Sc.

Although a number of excellent works on the subject of engineering contracts and specifications have been issued within the past few years, Professor Kirby's book easily surpasses any of them as a text for students or beginners in the art of specification writing. The ground covered in it is only such as should receive attention in an engineering college, and the manner of presentation leaves little to be desired. This excellence of treatment is no doubt largely due to the fact that the work is the outcome of a series of lectures delivered by the author annually for the past six years.

An outline of the matters treated will indicate the comprehensive character of this compact little treatise. As an introduction to the subject, construction work is classified according to the character of the financial arrangement between the Owner and the Contractor, and the documents incident to a contract are enumerated and described in brief. The author then proceeds to discuss the legal essentials and the composition of a contract, the surety bond, the notice to contractors, information for bidders, and the proposal. Since the specifications are, to the engineer, the most important part of the contract, the author very properly devotes the major portion of his book to the consideration of their composition and subject-matter. General clauses are treated fully, a proceeding rendered possible by the fact that their character has been the cause of a strong movement towards uniformity during recent years. Specific clauses covering all manner of construction, materials and apparatus cannot be treated in anything but a general manner in a short text, and for this reason the author has contented himself with a few pages of general directions and the outlines of specific clauses required in specifications for sewers, roads and pavements, pipe lines, bridges and similar typical undertakings. The work is concluded by a useful list of references in periodical literature to the subject of contracts and specifications.

The value of Professor Kirby's book lies chiefly in its being a concise, well-ordered presentation of the principles underlying the preparation of specifications. It is not a collection of specifications, nor a legal treatise, but such a book as might be placed in the hands of an engineering student to give him an idea of what is really meant by specification writing. Sufficient examples are given to illustrate the principles and to serve as models, except in the case of the specific clauses, where, for considerations of space, this is not done. Reference to the pages of high-class technical journals, for these in reality introduce another educative factor commensurate with the knowledge of the particular subject obtained. The manifest fitness of this little book as a text for engineering colleges will no doubt result in its extensive adoption for that purpose.

Simplified Formulas and Tables for Floors, Joists and Beams; Roofs, Rafters and Purlins.—By N. Clifford Ricker, Professor of Architecture, University of Illinois. Publishers—New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. Publishers' agents for Canada, Renouf Publishing Company, Montreal. Cloth; 6 x 9 ins.; pp. vi. + 77. Price, $1.50 net.

Reviewed by C. R. Young, B.A.Sc.

Like his larger work on roofs, this book of formulas and tables was evidently intended by the author for the use of architectural students and beginners in structural design. The structural engineer will find in it little which he has not already in one form or another. In some instances the methods of computation are much less expeditious than those in common use by structural designers.

The work which the author undertakes is to present simplified formulas for the computation of the section moduli, moments of inertia, total safe loads and limiting spans of beams in various materials and subject to various end conditions. Simplification is brought about by expressing lengths and distances in feet, loads in tons, constants for the material in tons per square foot and bending moments in foot-tons. The numerical coefficients are thus reduced to comparatively small quantities, rendering slide-rule computations easy and short. The resulting formulas are then arranged in tables extending across both pages, and covering the use of steel, cast-iron, Washington fir, hemlock, white oak, long-leaf pine, short-leaf pine, white pine and spruce. Preceding these tables are thirty pages of explanatory matter, and following them are tables or properties of cast-iron lintels and a table of four-place logarithms for those who do not use the slide rule. The application of the formulas to the design of floor joists, flooring, sheathing, rafters, purlins and lintels is made plain by examples.

Although the subject-matter is well presented in the main, certain indications of lack of care in preparation exist. On page 1, l is defined as the *clear* span in inches of the beam, while on page 4, L, which is obviously $l \div 12$, becomes the "length of beam in feet, or distance between *centres* of beams." In the example on page 3, the required moment of inertia on the basis of limiting deflection is computed without stating for the guidance of the student what the maximum permissible deflection is in this case. The following beginning to a sentence is not particularly auspicious: "Also, that if these formulas can be materially simplified, much time and labor can be saved, and it may become . . ."

Apart from the cases which can be solved much more simply by reference to tables in existing handbooks, the matter presented in Professor Ricker's book will be found useful for the architectural draughtsman and junior structural designer, provided no building regulations prevent the adoption of the working stresses on which the simplified formulas are based. Where this does occur, some assistance may be obtained by deriving new simplified formulas from the general formulas which the author gives.

The Improvement of Rivers: A Treatise on the Methods Employed for Improving Streams for Open Navigation, and for Navigation by Means of Locks and Dams.—By B. F. Thomas and D. A. Watt, United States Assistant Engineers. Published by John Wiley & Sons, Inc., New York. Publishers' agents for Canada, Renouf Publishing Company, Montreal. Second edition, two volumes; 713 pages of text, 346 illustrations and 84 appended plates; cloth; 9 x 12 ins. Price, $7.50 net.

There are eighteen chapters in all having the following titles:—

Part I.—Characteristics of Rivers—Regulation—Dredging and Snagging—Dikes—Protection of Banks—Levees—Storage Reservoirs—Improvement of the Outlets of Rivers.

Part II.—General Design and Construction of Locks and Dams—Locks—Lock-gates and Valves—Fixed Dams— Movable Dams—Chanoine Wicket Dams—Gate and Curtain Dams; Bridge and Shutter Dams—Drum Wickets, Bear Traps, Rolling Dams—Accidents to Structures.

Both volumes are models of typographical excellence, and the editing and arrangement of subject-matter is admirable. One pleasing feature is an unusually complete system of cross-referencing, which enables the reader to find expeditiously all that the work contains with reference to any particular subject.

This book is remarkable in that it epitomizes world-wide engineering practice in river regulation and improvement. The method of treatment is distinctly practical throughout, and the chief merit of the books lies in the multitude of practical ideas which the encyclopedic scope of the work makes accessible to the reader. While there is much in both volumes of interest to hydraulic engineers generally, the nature of the subject dealt with makes them particularly valuable and interesting to engineers engaged on governmental and other public works. To them the book is confidently recommended.

The first volume consists of eight chapters, devoted principally to the discussion of river improvement for open navigation, "Improvement by Regulation" being the subtitle of this portion of the work. Chapters I. and II. are of an introductory nature, containing a more or less academic discussion of river characteristics, and a brief description of various schemes of regulation in use on the larger rivers of Europe and America. The remaining chapters, as their titles indicate, are devoted to the discussion of the various methods now in use for providing and maintaining open navigation on navigable streams. In Chapter X. the principles which govern the economic use of storage as an aid to navigation are covered in a general way.

As related to navigation alone, there is nothing in the first volume of vital interest to Canadian engineers, as it deals almost exclusively with navigation on silt-bearing streams, notably the Mississippi, and problems of this nature are rare north of the international boundary. The value of the first volume lies rather in the fact that the various metrods outlined for the improvement of open navigation can be effectively and economically applied to the prevention of flood damage on non-navigable rivers.

Volume II. consists of ten chapters covering river improvement by means of locks and dams, "Improvement by Canalization" being the sub-title. Chapter I. is devoted to general discussion of the principles of design. The succeeding chapters, entitled as above, cover the subjects dealt with more or less in detail. Most of the chapters furnish cost data, and also a considerable amount of mathematical discussion.

The chapter on fixed dams is too brief to be of much value, the intention of the authors being doubtless to indicate, in a general way only, the functions of fixed dams in connection with canalization, rather than enter into the details of a wide subject already well covered by Wegmann Schuyler et al.

The chapters on movable dams constitute the most interesting and important feature of the second volume, the various types now in use in Europe and America being described at length and amply illustrated.

The possibility of using this type of dam in Canada for the development of mill powers on torrential rivers is worthy of very serious consideration, and it is safe to say that no single publication extant contains more information bearing on this question than the work under consideration.

Engineering as a Profession: Scope, Training, and Opportunities for Advancement.— A. P. M. Fleming, M.I.E.E., and R. W. Bailey, Wh. Sc., Principal of the Technical Institute, Crewe, England. Published by John Long, Limited, London. 288 pp.; 4½ x 7½ ins.; cloth. Price, 75 cents, post paid.

"While much has been written as to the manner in which the technical and practical portions of an engineer's training should be co-related so as to ensure the best results, very little has previously been written setting forth the facilities that actually exist for obtaining the most satisfactory training and employment."

The book sets about to supply this deficiency by giving a broad, general outline of the fields of engineering activity, by discussing modern methods and facilities for obtaining a thorough training, and by enumerating suitable apprenticeship courses and scholarships for those who are and those who are not in possession of sufficient means for a university training.

It must be admitted that the major portion of the book deals exclusively with conditions and facilities for training in the British Isles, thus rendering its value to young men elsewhere as that for general information only. But its clear-cut classification of the various channels which a young engineer may follow up makes it a most acceptable addition to his library. The chapters concern: The Engineering Profession; The Training of the Engineer; Facilities for Obtaining Education and Training for a Minimum Financial Outlay; Engineering Appointments; Foreign Methods of Training Engineers; and Modern Developments in Engineering Training and Employment.

The curriculums of English technical institutions, the enumeration of Government and professional appointments, and the summary of apprenticeship courses for various branches of the profession, contained in this book, make it a useful one for university and professional men in any country.

CATALOGUES RECEIVED.

The Valve World.—Illustrated bulletin for the month of August. Issued by the Crane Company, Chicago.

Duntley Electric Grinders.—Illustrated bulletin. Issued by the Chicago Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill.

Foos Junior.—Illustrated catalogue dealing with gas and gasoline engines. Issued by the Foos Gas Engine Company, Springfield, Ohio.

Q. E. F. Runway.—Illustrated catalogue describing runway. Issued by the Herbert Morris Crane and Hoist Company, Limited, Toronto.

American Vanadium Facts.—Illustrated bulletin describing different uses of vanadium. Issued by the American Vanadium Company, Pittsburg, Pa.

Abram Cement Tools.—25-page catalogue describing the company's sidewalk finishing tools. Issued by the Abram Cement Tool Company, Windsor, Ont.

Universal Bulletin.—Describing pouring of concrete for the Ford Motor Service Building, Chicago. Issued by the Universal Portland Cement Company, Chicago, Ill.

Adjustable Speed Direct Current Motors.—Technical bulletin describing company's adjustable speed direct current motors. Issued by the General Electric Company, Schenectady, N.Y.

Chicago Pneumatic Power-driven Compressors.—Illustrated bulletin describing the different kinds of compressors. Issued by the Chicago Pneumatic Tool Company, 50 Church Street, New York.

Curtis Steam Turbines.—15-page illustrated catalogue describing the Curtis steam turbines, from 100 k.w. to 2,500 k.w. capacity for driving 60-cycle generators at 3,600 revolutions per minute, special features of construction and steam extraction. Issued by the General Electric Company, Schenectady, N.Y.

Continuous Current Dynamos and Motors.—A pamphlet, No. 18 B, of Bruce, Peebles & Company, Limited, Edinburgh, dealing exclusively with machines of the open type, including a full detailed specification and supplemented by tables of weights and dimensions for different frame sizes, list of ratings, etc. The publication is well illustrated and contains interesting technical data. Bruce, Peebles & Company, Limited, engineers, Edinburgh, Scotland.

The Heenan Refuse Destructor.—A 32-page catalogue dealing with the disposal of garbage, rubbish, etc., by the H. & F. Destructor. The catalogue is well illustrated with photographs of many installations in Canada, United States and Great Britain, some of them having the capacity of several hundred tons. Reading matter is instructive respecting modern methods of refuse collection and disposal, and illustrated uses to which clinkers produced by the H. & F. destructor may be put in building operations, etc. Published by Heenan & Froude, of Canada, Limited. Laurie & Lamb, managers, Board of Trade Building, Montreal.

PUBLICATIONS RECEIVED.

Fur Farming in Canada.—By J. Walter Jones, B.S.A. Published by the Commission of Conservation, Canada. Committee on Fisheries.

Ontario Railway and Municipal Board.—Seventh annual report to December 31st, 1912. Issued by the Ontario Railway and Municipal Board, Toronto, Ont.

Employers' Welfare Work.—Bulletin No. 123. Issued by the United States Department of Labor Bureau of Labor Statistics, Washington, D.C.

Fourscore Years.—Illustrated publication, containing a record of the company's contribution to industrial engineering. Issued by Lockwood, Greene & Company, 60 Federal Street, Boston, Mass.

Fifth Census of Canada, 1911.—Volume III., pertaining to manufacturers for all the industrial establishments having five employees or over. 432 pages, 6 x 9 ins.

Ontario Land Surveyors.—Annual report of the Association and proceedings of the twenty-first annual meeting, held in Toronto, February last. Published by the Association of Ontario Land Surveyors.

Tar and Wood Journal.—Special by-product number, which may be obtained by any reader interested in the wood, tar and allied trades on application to the Swedish Chamber of Commerce, 5 Lloyd's Avenue, London, E.C.

Union Scale of Wages and Hours of Labor.—120-page bulletin on scale of wages and hours of labor from 1907 to 1912. Issued by the United States Department of Labor Bureau of Labor Statistics, Washington, D.C.

Electricity on the New York Central.—Descriptive booklet, which illustrates and describes the important features of electricity as used by the New York Central system. Issued by the General Electric Company, Schenectady, N.Y.

Mining Operations in Quebec Province.—Report for 1912 of the Mines Branch, Department of Colonization, Mines and Fisheries, Province of Quebec, reviewing the entire industry for the past year. Supplemented with illustrations, maps and appendix.

Mines and Mining.—Bulletin No. 61, containing abstracts of current decisions on mines and mining from October, 1912, to March, 1913, by J. W. Thompson. Issued by the Department of the Interior, Bureau of Mines, Washington, D.C.

Game and Fur-bearing Animals.—A 166-page book, 6 x 9 ins. in size, and fully illustrated with photographs and maps, descriptive of fur-farming in Canada, and containing sections devoted to preparation of skins for manufacture, commerce in raw furs, Canadian legislation, and statistics of fur production.

Mining Operations in Quebec.—Report for the year ending December 31st, 1912, by Theo. C. Denis, Superintendent of Mines. Contains statistical tables and a review of the mining industry in the Province of Quebec. Issued by the Mines Branch, Department of Colonization, Mines and Fisheries, Ottawa.

Waterworks of Canada.—Compiled by L. G. Dennis, B.Sc., Hydro-Electric engineer of the Commission of Conservation. Published by the Commission, Committee on Waters and Water Powers. Presenting in suitable form for reference principal physical data respecting all waterworks systems in existence in the Dominion, and classified according to Provinces. The report is illustrated, and occupies 108 pages, 6 x 9 ins.

CANADIAN FIRM BUYS AMERICAN FACTORY

By adding to their factory, at one stroke, the entire equipment of another telephone cable-making factory, the Eugene Phillips Electrical Works, of Montreal, have greatly increased their capacity. The Phillips company completed recently the building of a quarter of a million dollar extension to their Montreal plant, and then equipped it by installing all of the machinery that had been previously used by the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, New York, in their telephone cable-making branch. This branch of the Stromberg-Carlson business was purchased outright by the Montreal firm.

The Eugene Phillips Electrical Works have been making telephone cable for about twenty-five years, but the addition of the Stromberg-Carlson machinery gives them sufficient output to handle very large contracts.

COAST TO COAST.

Winnipeg, Man.—A resolution introduced by H. D. Picket, Moose Jaw, at the recent convention of the Associated Boards of Trade of Western Canada, asking that the Dominion Governments of Ontario, Manitoba, Saskatchewan and Alberta provide for the construction and maintenance of a good vehicular highway between the Great Lakes and the Pacific Coast was passed unanimously, it being considered that such a road was needed, and would help the commercial and general interests of the country.

Kenora, Ont.—The engineers of the International Joint Commission, Arthur V. Arthur, Toronto, and A. F. Myers, Minneapolis, accompanied by Douglas N. McLean, of the Manitoba Hydrographic Survey, have examined the evidences relating to water levels here, and have inspected the new gauges which have been established. Arrangements were also made to start some survey parties from Kenora to examine places bordering on the shore of the lake, which might be affected by holding the water of the lake at various stages. Survey parties will begin operations at once.

Ottawa, Ont.—The whole question of the pollution of lakes, rivers and all navigable streams will be considered by an interprovincial conference, to be held in Ottawa in October. The Bradbury committee on the pollution of streams, which heard considerable evidence from experts and others on the matter last session, recommended a conference to discuss all phases of the question, at which all the provinces would be represented, and Hon. J. D. Hazen, Minister of Marine and Fisheries, has sent out an invitation to the various provincial governments asking that this be done. It is expected that the conference can be got together in October.

Vancouver, B.C.—That the Canadian Northern Railway engineers had puzzled over every possible entrance to False Creek, and that all plans were being forwarded to headquarters in Montreal were the statements made by Mr. T. G. Holt, executive agent of the company, to the civic bridges and railways committee. Whatever plan was thought most feasible would be submitted to the Railway Commission, and, with other obstacles out of the way, work could be started in a few weeks. Mr. Holt explained that getting over the Great Northern tracks was the problem they had been up against. To use an overhead crossing or a subway raised difficulties of grade, and the Railway Commission would hardly likely consent to a level crossing, although, Mr. Holt said, that would facilitate matters considerably. As to the filling in of the bed of the creek, Mr. Holt said it would be necessary to know the plans of the Sewerage Commission for the route of the China Creek extension. Ald. Crowe, Vancouver's member of the Sewerage Commission, however, informed him that the Commission was taking up that question now and would have details worked out at an early date. It is the Commission's intention to run the sewer down Clark Drive instead of through the creek. Mr. Holt wished to have a coffer dam built across the creek to keep the silt in, and this will be looked into. A report of Mr. C. A. P. Turner, engineer for the Georgia-Harris bridge, stated that hard footings had been found five feet higher than expected, and that a saving of $1,200 could be effected. Plans of the ground are being got out, however, before the committee agrees to change.

Toronto, Ont.—The Provincial Highways Commission will begin its peregrinations at once in the interest of good roadways in Ontario. New York State will form the basis of study, although the first observations will be made in Quebec. Mr. W. A. Maclean will meet Commissioners McGrath and Rankin in Montreal, and the party will go over the King Edward Highway, which runs south of Montreal to the international boundary at Rouse's Point. This road is some forty miles in length. It is being constructed by the Quebec Government and will be completed this fall. Quebec has a Provincial highway system, under which the Government supplies the township organizations with machinery, equipment and instruction, but with slight financial assistance. When the Commission arrives at Albany an extended conference will be held with Mr. John N. Carlisle, Chief Superintendent of State Highways. The New York system follows the French method of maintaining a central highway department, which extends assistance to the municipalities. The main arteries of traffic are built by the State with small contributions from the counties.

Edmonton, Alta.—Most important of the legislation to be taken up at the coming session of the Alberta Legislature probably will be the building by the Provincial Government of the Alberta and Great Waterways Railroad from Edmonton to Fort McMurray, 230 miles, from which point the Athabasca, the Great Slave and the Mackenzie Rivers are navigable to Fort McPherson, 2,100 miles. The primary purpose of the railway is to afford adequate transportation facilities to settlers, prospectors and trappers in the north country and provide an easy outlet for their products, including grain, minerals and fur. The estimated value of the raw fur trade of the north alone is a matter of between $6,000,000 and $6,500,000, of which about 50 per cent. has come out by way of Edmonton this year, the rest going to the United States through traders from Seattle and San Francisco, who send ships into the Behring Sea and to Herschell Island. "There are many reasons why the railroad should be built to Fort McMurray at once," said a prominent supporter of the Government recently. "From what I can gather I should say that work may be started this fall and rushed to completion. The chief survey has been made, and it is only a matter of assembling men and materials. Every man who has ever been in the north country must be in favor of the plan, as it will ultimately mean a railroad from Edmonton to Dawson, connecting the Yukon country with the outside world."

Quebec, Que.—In view of the increasing attention which is being directed to the adoption of oil as fuel in the British Navy, it is interesting to know that oil lands in different parts of the Empire are being sedulously developed. The decision of the Government to secure supplies as far as possible within the Empire has given a new impetus to the search for large oil deposits in different parts of the dominions, and it would be fitting that the premier dominion, Canada, should be reckoned among the fuel-oil sources of supply. In this connection Viscount Selby, who is chairman of the Eastern Canada Company, and who has just returned from the Canadian fields, supplies interesting details. In the course of a conversation Lord Selby remarked that he was greatly impressed with what he saw and heard during the visit. The most favorably situated oil fields in Canada, from a geographical and strategical point of view, he states, are those of Gaspe, which extend from the seacoast on the Bay of Gaspe, on the Gulf of St. Lawrence, for several miles in a north-westerly direction. It was in the Larocque district, in the North-West, that a considerable number of wells were put down, and good supplies of oil of a high quality obtained. What is known as an anticlinal formation extends from this district in a south and easterly direction down to the coast. The opinions of experienced drilling men and geologists in that country are to the effect that oil will be found there in large quantities. Should this be the case, the importance of the field from the points of view of supply for the British Navy and for marine and industrial purposes cannot be overestimated.

Winnipeg, Man.—The condition of the road to Selkirk at the present time is not conducive to the best feeling on the part of the users of this particular stretch of highway.

The work of putting the road in first-class shape was well commenced by the Government engineers, and just when the road-users were congratulating themselves that at last a piece of road work was to be done in a sensible manner, they were disappointed to find that a number of cross culverts were put in all at one time and the trail almost rendered impassable for want of a little trouble on the part of those in charge of the construction. There is one portion of the road where a deep gully has to be traversed in order to get by the new bridgework, and in the event of rain it simply means that a vehicle is stuck on whichever side of the gully it happens to be, and it is necessary to secure the aid of three or four teams to get through. Another cause for dissatisfaction is the method of laying gravel. It is piled on the centre of the road to a depth of about four inches, and has some stone mixed with it big enough to make it dangerous for a car when the wheels strike them and they roll on the hard surface of the road underneath. This sort of work is not what might be expected of engineers who are in the service of the Government, and unless some radical steps are taken to alter the method of procedure, the work might just as well have been done by the old system of jobbing. It is a waste of the taxpayers' money to put up a road in such a shape that the expense of after maintenance is almost as heavy as the original cost of construction.

The Pas, Man.—The plans for the Hudson Bay Railway terminals at this point have been approved. P. Gordon, resident engineer, is understood to be on his way back from Winnipeg, and is bringing with him the plans of the terminals, showing the layout of yards, freight-handling plant, roundhouse, shops and other details. It is stated that the Government has acquired half a section of the Finger mill property and a considerable area to the north and east of The Pas annex. The shops, freight sheds and depot will be immediately adjoining the original townsite, and the receiving and sorting yards at the other end of the new property. It was originally proposed to acquire a portion of the Indian reserve property, a part of which was purchased for the townsite, to be used for terminal purposes. The Indians, however, asked such an inordinate price for their land that the Government went to the other side of the annex for a site. It is expected that connection will be made with the terminal site and the present terminal of the line through the original townsite.

Nelson, B.C.—Rich in minerals, timber and agricultural resources, Duncan River and Howser Lake districts, the development of which has been retarded for many years by lack of cheap and expeditious means of transportation, may in the not distant future be opened up by improvements to Duncan River which would make that stream navigable. R. F. Green, M.P. for Kootenay, is interesting himself in the project, and J. P. Forde, resident federal works public engineer for Kootenay, will visit the district for the purpose of reporting upon the advisability of making the waterway navigable from main Kootenay Lake to Howser Lake.

Vancouver, B.C.—Work on the boring of the "pioneer" Rogers Pass tunnel through Mount Donald, at Glacier, on the main line of the Canadian Pacific Railway, is being actively prosecuted, stated Mr. J. G. Sullivan, chief engineer of western lines for the company, who arrived in Vancouver recently. He remarked that 125 feet of the drift has already been scooped out. The Canadian Pacific Railway is piercing the mountain with a 22 feet by 30 feet tunnel, five miles long. The contractors are adopting a new method, which is being eagerly watched by engineering experts. The "pioneer" tunnel will run parallel to the main bore, and work will be pressed by means of cross-cut borings. A large force of men are engaged at the scene of the operations, and camps have been established on each side of the mountain. Steam shovels are being used to grade the approach to the western portal below Glacier Station. Mr. Sullivan will conduct a general inspection of the work being carried on in connection with the Vancouver terminal improvement schemes at Port Coquitlam, and also on the lines of the British Columbia division.

South Vancouver, B.C.—"That in the opinion of this council the establishment of a municipal electric plant is a pressing necessity, and would prove of great advantage to the interests of the municipality." This resolution was unanimously passed by the South Vancouver Municipal Council on the motion of Councillor Campbell, seconded by Councillor Third, after thoroughly dicussing a report brought in by Municipal Electrician Rawden to the effect that at an initial cost of $600,000 an electric light and power plant could be established in the municipality capable of providing for the needs of the district for the next five years, and stating that electric light could be supplied at seven cents per kilowatt hour, and at two cents per kilowatt on the day load for power purposes. Mr. Rawden recommends a two-unit steam generating plant of the turbo-generator units type, with a nominal rating of 2,000 kilowatts, and a maximum rating of 2,500 kilowatts, which, he estimates, would meet the needs of the municipality for the next five years. The cost of the plant, Mr. Rawden estimates, would be approximately $400,000 for the first unit, and $200,000 for the second unit. This would not include the cost of a building, which, Mr. Rawden suggests, could be either temporary or permanent, and should be situated near the Fraser River. Provision was made in the estimates for an adequate system of street lighting, including 300 arc lamps and standard lamps for Main Street, Cedar Cottage, Fraser Avenue and Collingwood. Mr. Rawden points out that there are over 8,000 connections using electric light and power in South Vancouver, and a large number of dwelling houses not at present using electric light.

Ottawa, Ont.—The report on the water supply will be ready for either the first or the second meeting of the city council in October. The British engineers, Messrs. Binnie and Tickell, are still here, but they are making such progress in their work that there is a good possibility of the report being ready early in October. The mayor has stated that the reports which will be presented to the city council will be most comprehensive, taking in Lake Deschenes and other proposals which have been made from time to time. There will also be a report as to what the Government is prepared to do, though it is understood that as yet the Cabinet has not discussed figures. When special legislation was secured for raising five million dollars for the work, the stipulation was that a two-thirds vote of the city council or endorsation by the people would be necessary. It is generally understood that the five million will not be sufficient, but it is also believed that there would be no difficulty in getting special legislation to expend a couple of millions more on the same condition. If the estimated cost is not too far over the five million mark, there seems quite a probability of the council by a two-thirds vote settling the matter for good. It is believed that most people would be glad of the water question not figuring as an issue in the coming municipal elections.

Sault Ste. Marie, Ont.—Continuing his official tour of inspection, Hon. Frank Cochrane, accompanied by Hon. W. H. Hearst, met the members of the Sault Ste. Marie City Council and the Board of Trade recently and discussed matters of importance regarding the future development of the Soo. The subject of an ice-breaker for the Soo for the purpose of assisting in keeping navigation open for a longer period in the early part of the winter, to facilitate the handling of the grain shipments from the West, was brought up, and the hearty support of the Minister of Railways and Canals was promised in the prolongation of the navigation season. In answer to an enquiry as to the proposed new ship canal here, the Minister replied that the matter was as yet only in its initial stages, but there would be no use of the Government deepening the Welland Canal without also taking care of the shipping interests at the Soo. To a question as to the location of the proposed new lock, Mr. Cochrane thought it would be to the south of the present one, as the Government has expropriated all the land in anticipation of this. The influence of the Minister of Railways and Canals was solicited in preventing the narrowing of St. Mary's River by means of docks being built out past the deep-water line, as it is contended that all the space available is needed at present for the handling of the large vessels plying up and down the river.

PERSONAL

T. AIRD MURRAY, consulting engineer, Toronto, has been engaged by the town of Whitby, Ont., as engineer in connection with the proposed establishment of a sewer system.

STEPHEN MORRISON, mining engineer, Scotland, has opened an office in Victoria, B.C. Mr. Morrison is interested in British Columbia development, and believes in the development of Pacific commerce to relieve the congestion of shipping in the Atlantic.

J. KEELE, of the Department of Mines, Geological Survey, has returned from the West, where, in company with Dr. Heinrich Ries, professor of geology at Cornell University, investigation into the clay resources of Canada has been continued this summer.

ARTHUR H. BLANCHARD, M. Can. Soc. C.E., consulting highway engineer and professor in charge of the graduate course in highway engineering at Columbia University, and PREVOST HUBBARD, Assoc. Am. Soc. C.E., consulting chemist, in charge of the division of roads and pavements, the Institute of Industrial Research of Washington, and lecturer in highway engineering chemistry in Columbia University, have formed a partnership under the firm name of Blanchard & Hubbard, highway efficiency experts, with offices at Broadway and 117th Street, New York City. At present Messrs. Blanchard & Hubbard are retained by Commissioner John H. Delaney as the advisory board on highways for the New York State Department of Efficiency and Economy, and a few days ago the announcement was also made that they had been delegated to serve as members of the United States Committee on "Standardization of Nomenclature of Road Materials," which committee is to co-operate with the Engineering Standards Committee of Great Britain.

OBITUARY.

D. A. McCAW, of Welland, Ont., a third year student in civil engineering at the University of Toronto, died on September 15th after an illness of only several days' duration.

DONALD MATHESON, a young engineering student connected with a survey party in Northern Ontario for the Canadian Pacific Railway Company, died on September 20th as a result of blood poisoning from the bites of black flies.

JAMES ROSS, well known in engineering and financial circles, died at his home in Montreal on September 20th, 1913, after a short illness. Death was due to acute heart trouble.

Mr. Ross was born in Scotland in 1848, and, after completing his education there, spent a few years in railway, harbor and waterworks in England. He came to America in 1870, and became resident engineer of the Ulster and Delaware Railway, and subsequently was chief engineer. Mr. Ross was in turn connected with the Wisconsin Central Railway and the Lake Ontario Railway. He moved to Canada, and was appointed chief engineer and then elected general manager of the Victoria Railway. In 1878-1879 he built the Credit Valley Railway, and was its general manager. He was consulting engineer for the Ontario and Quebec Railway. Mr. Ross took control of the construction of the Canadian Pacific Railway west of Winnipeg in 1883, and in 1885 completed that line over the Rocky Mountains. He took up his residence in Montreal in 1888. Mr. Ross assisted in building many of the leading railways in Canada and in electrifying her street railways, such as those of Toronto, Montreal, Winnipeg, St. John, etc. He carried out work of a similar character in England and Jamaica, and was the first president of the Mexican Power Company, which developed an immense water power at Necaxa and controls the electric business of the city of Mexico. Subsequently he became president and active head of the Dominion Coal Company.

From among his numerous business connections it might be mentioned here that he was vice-president and managing director of the Montreal Street Railway; vice-president of the Toronto Street Railway, president of the Winnipeg and St. John Street Railways, president of the Dominion Bridge Company, vice-president of the Montreal Light, Heat and Power Company.

Although Mr. Ross had withdrawn from most of his business activities, he retained the presidency of the Dominion Bridge Company and St. John Railway until his death.

Mr. Ross was a member of the Canadian Society of Civil Engineers and also of the American Society of Civil Engineers.

ROYAL ARCHITECTURAL INSTITUTE

The Royal Architectural Institute of Canada closed its Sixth Annual Convention, held in Calgary, September 15th and 16th, with the following election of executive officers: J. H. G. Russell, Winnipeg, Manitoba, retains his office as president, and Alchide Chausse, of Montreal, is honorary secretary. The vice-presidents are Roland W. Lines, Edmonton, Alta., and J. P. Ouellette, Quebec. J. W. H. Watts, of Ottawa, is honorary treasurer.

Quebec was chosen as the next place of meeting, the date to be September, 1914.

COMING MEETINGS.

AMERICAN ROAD CONGRESS.—Annual Session will be held in Detroit, Michigan, from September 29th to October 4th. Secretary, J. E. Pennybacker, Colorado Building, Washington.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Twentieth Annual Meeting to be held in Wilmington, Del., October 7th to 10th. Secretary, A. Prescott Folwell, 15 Union Square, New York.

UNITED STATES GOOD ROADS ASSOCIATION.—Convention will be held at St. Louis, Mo., November 10th to 15th. Secretary, J. A. Rountree, L021 Brown-Marx Building, Birmingham, Ala.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.