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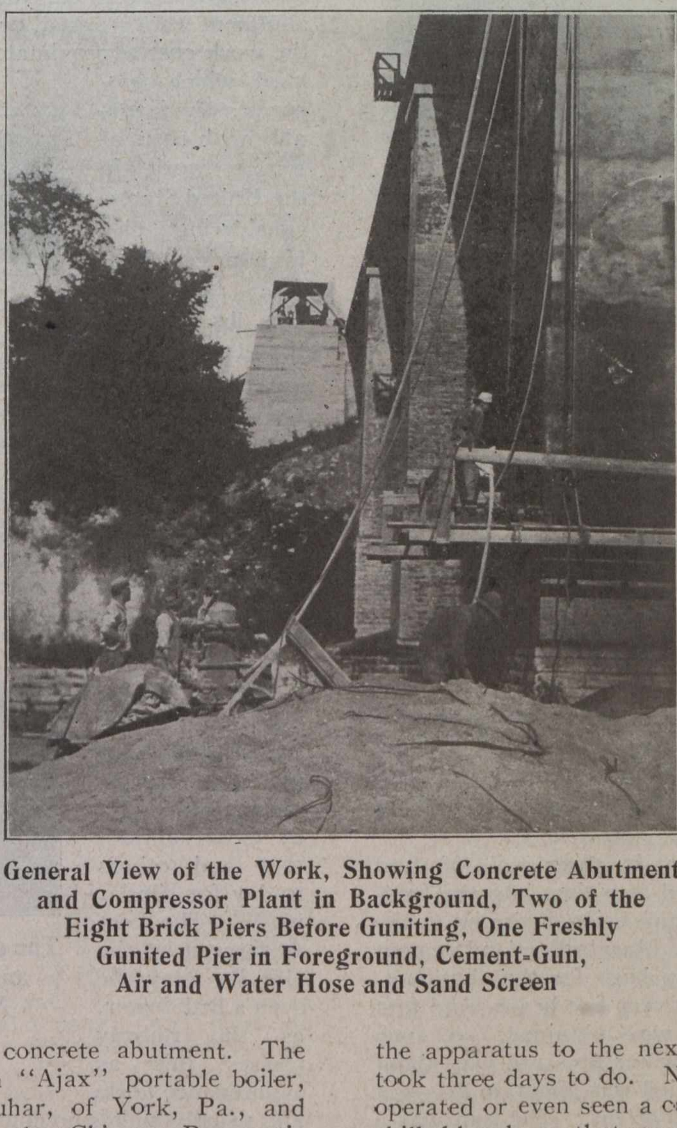
Saving a Railway Bridge Built 63 Years Ago

Half-Inch Coating of Gunite Applied to Brick Work of Abutment and Eight Piers of Grand Trunk Railway Bridge at Weston, Ont.—Three Thousand Square Yards Shot in Six Weeks by Inexperienced Gang at Cost of Forty-Seven Cents a Yard

AT Weston, Ont., on the Toronto-Guelph line of the Grand Trunk Railway, there is a single-track bridge across the Humber River. This bridge was built in 1854 and its brick piers and abutments recently began to show signs of serious disintegration. One of the abutments was torn down about a year ago and rebuilt of reinforced concrete. The masonry department of the railway, desiring to avoid all unnecessary reconstruction at this time, decided to try the cement-gun as a means of repairing and strengthening the brickwork of the other abutment and of the piers and of preventing further disintegration. The work has just been successfully completed, and from all indications the life of the bridge has been greatly extended and reconstruction indefinitely postponed by filling all the holes (some of them from 18 ins. to 24 ins. deep) with gunite, as the product of the cement-gun is called, and covering the entire surface of all the piers and the abutment with one-half inch of the material.

The bridge has eight brick piers, built on granite substructure. The brick portion of each pier is about 60 ft. high, rectangular in horizontal cross-section, 7 ft. x 15 ft. at the top, 11 ft. x 18 ft. at the base.

One of the railroad's car compressor plants was assigned to the job, but the boiler was found to be in need of repair, so the plant was taken off the car, overhauled and set up alongside of and at the top of the concrete abutment. The plant, as used, consisted of an "Ajax" portable boiler, manufactured by A. B. Farquhar, of York, Pa., and a small compressor, built by the Chicago Pneumatic Tool Co., furnishing air at 50 lbs. pressure through two small riveted boiler plate receiving tanks. A 2-inch iron pipe line was laid roughly across the bridge and connected to the tanks as the air line. Water connection was made with one of the town of Weston's services, and a 1-inch iron pipe was laid roughly across the bridge, with a cock at every pier.



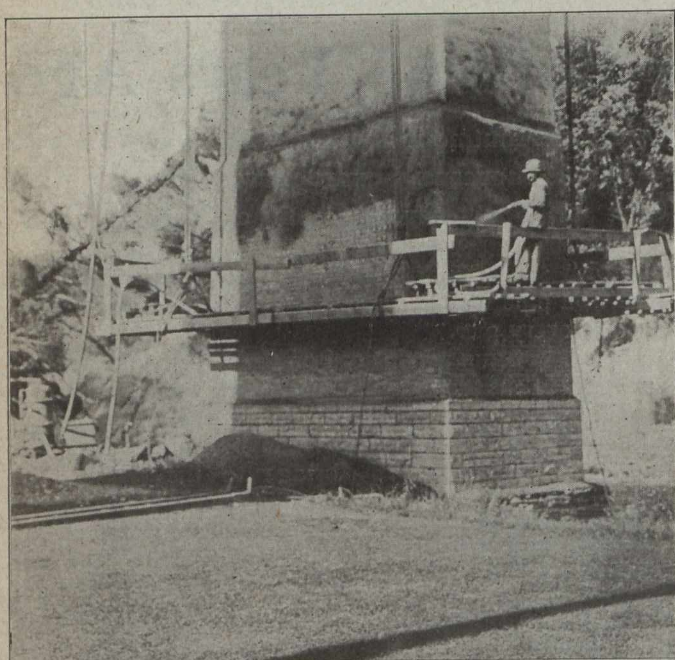
General View of the Work, Showing Concrete Abutment and Compressor Plant in Background, Two of the Eight Brick Piers Before Guniting, One Freshly Gunited Pier in Foreground, Cement-Gun, Air and Water Hose and Sand Screen

The cement-gun was placed on the river bank, as near as possible to the pier on which the work was started, and a 2-inch hose was dropped from the air line on the bridge to the gun, and a ½-inch hose from the water line on the bridge to the nozzle, the flow of water thus always being under control of the nozzleman, while the air pressure, governing the delivery of the mixed sand and cement, was under control of the gun operator, which is the usual arrangement in operating the cement-gun.

A mason's ordinary suspended platform was built around the pier, and raised and lowered by rope and tackle fastened to the girders and ties of the bridge. Only the nozzleman used this platform, starting at the top of the pier and covering all four sides from top to bottom, lowering the platform every five feet, thus covering each pier in twelve stages.

The gang consisted of five men, *viz.*, one nozzleman, one gun operator, one man in charge of compressor plant, and two men who alternated in their duties of screening sand and loading the gun with cement and sand. All sand was screened through ¼-inch mesh.

The work occupied six weeks, but toward the finish it took only two days to do a pier and one day to move the apparatus to the next pier, while the earlier piers took three days to do. None of the men had ever before operated or even seen a cement-gun, and were green, unskilled hands, so that much time was lost in the beginning (*a*) through rearrangement of the compressor plant; (*b*) through not thoroughly understanding the gun and using too low air pressure; (*c*) through using too fine a sand; (*d*) and through the nozzleman's holding the nozzle at an acute angle to the surface to be covered, instead of shooting the material directly onto the surface in a line perpendicular to the surface. The nozzleman soon noticed, however, that he was making but little headway, as the stream rebounded too much and also tended to cut off material already on, and he soon discovered, by his own observations, the proper way to handle the nozzle. A number of days and partial days were also lost through extraordinarily heavy rains which prevented the men from working and which at one time caused the river to overflow its banks to such an extent that they could not reach their work. These delays accounted for a considerable amount of time, and the men feel that, with the experience they have acquired, they could now do the same work, with continued fair weather, in a month; and if the air were to be pre-cooled, so that it would not reach the gun so damp as it did after travelling through the long stretch of pipe, considerably more time could be saved, as the gun and nozzle would then deliver as a faster rate. The rate of delivery of the gunite was only about half as fast as the writer has seen accomplished on other jobs with the same mixture.



A Closer View Showing the Nozzleman at Work

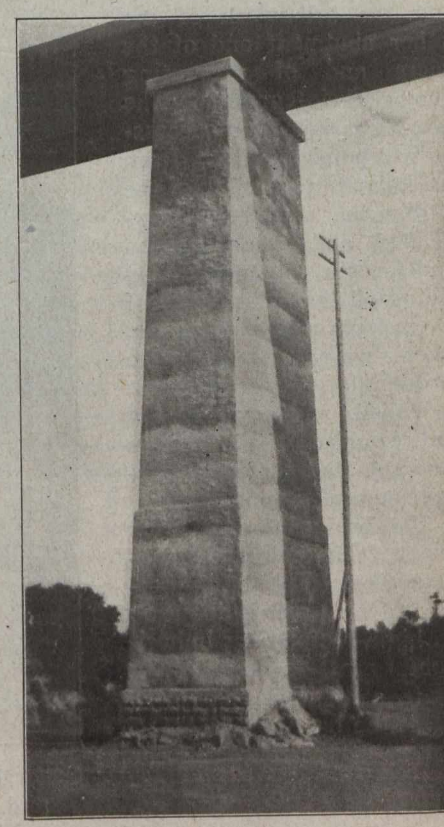
Besides the workmen mentioned above, it was deemed advisable, on account of the novelty of the work, to have a foreman devote most of his time to it, and several visits were also made by members of the railway's engineering staff.

The mixture was 3 to 1, that is, three pails of sand and one of cement being emptied at a time into the feeding hopper of the gun, the mixture being hydrated at the nozzle. About sixty bags of St. Mary's Portland cement were used for each pier and fifty bags for the abutment. The gun tended to clog with the very fine beach sand first used, but after a coarser sand was obtained, no such trouble was experienced. The water pressure was about 40 lbs. The air pressure first tried was about 30 lbs., but was changed to between 40 and 50 lbs. The gun was a type G.L.N., built in 1912, and had been frequently used before being acquired by the G.T.R. for this work.

No official figures regarding the cost of the work have been compiled, but from information furnished by the men on the job and by the bridge and building department of the railroad, the cost is estimated as follows:—

133 bbls. cement @ $1.85 net	$ 246.05
52 cu. yds. sand @ $1.55 delivered at base of piers	80.60
Rent of compressor plant and piping at G.T.R. fixed scale, coal and water	220.00
Interest and depreciation on gun, depreciation at the rate of 17% per annum and interest at 7% per annum, and the whole multiplied by three to allow liberally for time gun might stand idle (value of gun, new, $1,250)	112.50
Three men @ 27½c. per hour, 10-hour day	297.00
One man @ 27½c. per hour, 11-hour day	108.90
One man @ 32c., 10-hour day	115.20
Foreman's time	165.00
	$1,345.25
Engineering and overhead, 5% (G.T.R. percentage for maintenance work of this class)	67.26
Total	$1,412.51

As about 2,720 sq. yds. on piers and 280 sq. yds. on abutment were covered, or a total of about 3,000 sq. yds., the work cost approximately forty-seven cents per square yard, which compares very favorably with costs of gunite work in the United States, considering the high price of cement (and only 350 lbs. to the barrel instead of the American 380 lbs.), the unfavorable weather, the liberal allowance for all machinery rents and overhead, and the total inexperience of the foreman and workmen in this type of construction. On the other hand, it will be noticed that the wage scale is lower than paid by most contractors and others to-day for similar work. The cost as figured by the G.T.R. may be even a little lower, as the railway classes this as maintenance work, and usually makes no charge for the use of any machinery on maintenance work.



The Cement Stucco Effect is Pleasing and Makes the Bridge Look New, Besides Protecting and Strengthening the Brickwork

So far as is known, this is the first use of the cement-gun by the G.T.R., and the first application of gunite to brickwork in Canada. No reinforcement was used, the gunite being shot directly onto the brick and not trowelled. The surface is even and regular, presenting a pleasing stucco appearance.

After the gunite had set a week, the writer could not knock it off with the hardest blows of a heavy carpenter's hammer, the blows leaving hardly a mark when struck flat, and only a slight dent when struck with the sharp edge, the gunite being stronger than ordinary cement mortar on account of the cement receiving its initial set in place and on account of its density due to manner of application.

It will be noticed that there are only about 42 cu. yds. of gunite in the whole work (figuring an average depth of ½ inch and not allowing for filling of holes), whereas about 52 cu. yds. of sand were used. But little sand rebounded as waste—probably not more than three cubic yards on the whole job, including waste in handling. Deducting 3 yards from the 52 yards used, leaves 49 yards of sand making 42 yards of gunite. It is not at all likely that much of the 7 cu. yds. difference was required to fill the holes, so this supports the theory that the gunite is denser than hand mortar, of which 49 yards would have been made with 49 yards of sand and a 1 to 3 mix.

The work was under the supervision of G. A. Mitchell, of Toronto, engineer of bridges and buildings, G.T.R., and R. Armour, masonry engineer, G.T.R., Montreal, and in charge of Ed. Neville as foreman.

NOISELESS BLASTING

Although Maxim has not yet invented a "silencer" for use by those engaged in blasting rock, it is possible to split rocks noiselessly. This can be done in several ways, says "Engineering & Contracting," of Chicago. One method consists in drilling holes about 2½ or 3 ins. in diameter, and filling them with small lumps of freshly slaked lime. The drill hole is filled a foot at a time and water poured in to fill the voids, then another foot of lime and more water, and so on up to within the upper sixth of the hole. The top part of the hole is then filled with tamping, well rammed. In less than a quarter of an hour the rock begins to crack.

The holes must be speedily loaded and workmen must remain away from them, for the tamping is occasionally blown out with a great deal of force.

Building and machinery foundations may be removed in this manner without endangering nearby structures.

INDEX TO VOLUME 32

The index to Volume 32 of *The Canadian Engineer*, January 1st to June 30th, 1917, is being prepared, and will be published as an integral part of one of the August issues.

The increasing demands for steel for the manufacture of munitions place the private consumer in a difficult position, and to obtain his requirements he has to pay high prices, reports the Canadian Bank of Commerce. All steel mills continue to be very active, and the same is true of textile mills. In both cases the demands upon them are beyond their capacity. Stocks in the mill warehouses are low, but in the retail stores they are fairly complete. Labor troubles are common to all industries, and as a result production is not up to capacity. This is particularly the case in the mining industry. The production of all the Canadian coal fields is much less than normal, and some anxiety exists as to the winter supply at points distant from the mines where lack of transportation facilities adds to the difficulties of the situation.

METHODS OF LOCATING CURVES ON SUBDIVISIONS *

By R. Russell Grant, O.L.S.

THE irregularity of title of this article, I hope, will be sufficient apology for the rather haphazard arrangement of the following subject matter.

The introduction of streets, with curved boundaries, has been the natural development required to meet the desire of the land-owner to utilize the full possibilities of his property. Either from necessity, as is the case with many tracts, or for esthetic reasons and other practical demands, the design of each parcel is a law unto itself, and presents many intricate and important problems, each of which has to be considered with respect to its relation to the whole.

Unfortunately, the land surveyor has allowed the landscape architect to take practically full control of this field, with the result that where expense is not the first consideration, the design of very few large tracts of land comes to the surveyor.

Looking for the cause of this condition, it would seem that the land surveyor has been so thoroughly drilled with the rectangular systems, as exemplified by the township systems of the past one hundred and fifty years, that we have great difficulty in appreciating the possibilities of certain parcels to other than straight line designs, particularly as the average client demands a maximum frontage, irrespective of other considerations. The cost of subdivisions under the rectangular system is also so much less, that generally no other layout appeals to the owner. Personally, I know from experience that it is very difficult in placing a layout not to give undue weight to the probability of re-surveys.

We all appreciate the very great difficulty of making resurveys in subdivisions where the roadways are segments of circles. How the resurvey of any lot may be a problem of great difficulty not infrequently requiring the rear limit to be located by angular deflections from bearings on a registered plan, that we suspect were never calculated, and probably read with nothing more accurate than a protractor.

With the foregoing considerations in mind, it is hard to blame the surveyor for a certain hesitancy in designing curved layouts, and probably accounts for the reckless freedom with which the landscape architect has entered the field.

The design of a proposed plan of a subdivision, naturally, depends upon the topography of the proposed site requiring a general plan of the property in question, with more or less accurate contours, and the location of such important features as buildings, sometimes fences, trees, adjoining roadways, etc. Generally this work costs about $1 per acre on parcels exceeding 50 acres. Some form of general triangulation should be used, and from the triangulation points general topography can be readily located by stated readings. I have found a 5-foot rule of great service on this work, as no sight will be over 500, and the rule saves the transportation of a heavy and awkward rod. A great advantage in locating fences on your preliminary plan, is the very good check that it is upon the progress of the actual stake-out. It is impossible to have too many checks, and there is none so easily and cheaply secured as a few fence lines.

*Paper read before the Ontario Land Surveyors' Association.

The design of the plan depends upon so many features over which the surveyor has no control, that a very broad field is open to one's ingenuity. Generally, it can be recommended to design the difficult portions first. The level land is easily looked after and depends largely on the layout of the more difficult sections.

It is very desirable to leave sufficient land between the roadway and the crest of a hill for the site of a dwelling, and of course the higher the building restriction the more distant must be the street line. It might be said here, that it is on this very point that more annoyance and trouble has arisen than over any other. The general practice has been to let the plus or minus distance work to the crest of the hill, and should there be any error in the preliminary survey or the design, the most valuable lots on the subdivision are very seriously impaired.

Upon undertaking to stake out a subdivision with curved roadways, the very first act should be to replot, or at least check over, the submitted plan of the proposed subdivision. I am firmly convinced that the larger part of the difficulties that surveyors in Toronto had with curved layouts some years ago were almost entirely due to the faulty design of the proposed plan. A surveyor, or the designer's assistants, would make a preliminary survey of a certain parcel, and the designer laying out his curves paid no attention to the necessity of having them laid off from a tangent already located, but left the surveyor an impossible task, and in other cases inserting curves with a radius much less than required. It can readily be seen how hopeless the results of such plans must be. Unfortunately, there is no satisfactory way of making adjustments to suit plans. If the plan radius is used, the error is carried all through the subsequent work. Whereas it is sometimes possible to adopt a new radius, yet the solution rarely can fulfil the intention of the plan.

Cases have occurred in Toronto, where the only way to correct the plan was to have certain sections re-subdivided and new registered plans prepared. In another case, more lots were on the plan than could be located on the ground. With registered plans prepared, it is rather difficult to amend such conditions and as a matter of fact, the worst cases were the result of having registered plans filed, and then attempting to stake out the lots on the ground.

It is unfortunate that the designer of so many of the large subdivision plans around Toronto some years ago did not more fully appreciate the necessity of mathematical accuracy in his productions. It would have materially lessened our troubles of the past, and for many years to come. Otherwise his work had a lot to commend it.

The foregoing are a few of the serious results that have followed the attempt to stake out subdivisions from faulty designs.

Many methods have been attempted in the endeavor to find a satisfactory method of laying out curves, that they may be readily reproduced and will answer all the required conditions of a re-survey.

The following are a few of the methods tried, and have certain features to commend them:—

(*a*) Right-angled offsets from an established base line.

(*b*) Location of regular curves by means of deflection angles.

(*c*) Location of regular curves by offsets from chord.

(*d*) Random location of corners accompanied by traverse.

(*e*) Right-angled offsets from an established base line.

On small blocks of a few acres in extent over rough land, this method can hardly be improved upon. A plan is prepared on as large a scale as possible, and the distances from the offset line to the lot corners are scaled off. It would be most difficult to imagine a condition, on such a plan, where the base line could not be re-established. It has also the advantage that the intermediate points on the curve may be established with the same degree of accuracy as the corners of the lots.

Location of Regular Curves by Deflection Angles

This system is about the best for general purposes. It has many disadvantages, but for large areas seems to be the only practicable method that covers the many points involved.

The first essential is an absolutely definite tangent, and having this, it should be possible to reproduce the whole of any subdivision. The location of the side and rear lines has no greater obstacles than other methods, and where the side lines are laid out as radial lines, the conditions are ideal—but unfortunately this is rarely the case. I remember one subdivision I made, where street lines and rear lines were all concentric circles, and the side lines all radial lines. With a picket at the centre of the subdivision, it was possible to run the side lines to locate the rear lot corners into the most inaccessible places.

One great disadvantage of this method is, that it does not lend itself to the laying out of lots with a uniform perpendicular distance, say, 50 feet, between parallel side lines. The necessary calculations are quite prohibitive until some one can devise a table for us, giving the deflection angles for chords of various degree curves. For cases like the above, I have been using a graphical amendment that I will describe shortly. One great improvement that might be used with great advantage would be a rule to have stakes planted at intervals of not more than 25 feet. It is very difficult to determine the location of lot corners where the only stakes planted are at intervals of from 50 feet to 100 feet, and these subject to all the vicissitudes of corner stakes. Something that would add greatly to the usefulness of this method would be a traverse run over the subdivision connecting the E. C. and B. C. of curves in such a way as to confine the courses of the traverse, within the limits of the highway. A method of tying I have used is to take points on the curves as far apart as convenient, anywhere from 400 to 600 feet more or less, each end being a lot corner. The bearing of the tie line is taken and at intervals of 50 tie in each stake on either side of the street. This method has the advantage of being more rapid than the right-angled offset ties and is probably as satisfactory.

Graphic Method of Laying Out Curves

The formula I have used for laying out curves by this method is

$$r = \frac{c^2}{8m} + \frac{m}{2} = \frac{c^2}{8m} + \frac{m}{2}$$

which can be abbreviated where m is small to

$$m = \frac{c^2}{8r} \quad \frac{c^2}{8r}$$

m for any curve depending on $m = \frac{c}{2}$ and an $\frac{\Delta}{4}$

where r = radius of curve.
c = length of chord.
m = middle ordinate.
Δ = exterior angle.

The chord is divided into the required number of divisions. Usually a division of the half chord into eight parts is more than enough, and in that case the alternate points can be taken.

Starting from the B. C.

$$m_1 = \frac{15}{64}\ m \qquad m_5 = \frac{55}{64}\ m$$

$$m_2 = \frac{28}{64}\ m \qquad m_6 = \frac{60}{64}\ m$$

$$m_3 = \frac{39}{64}\ m \qquad m_7 = \frac{63}{64}\ m$$

$$m_4 = \frac{3}{4}\ m \qquad m_8 = m$$

Using the above formula, the curve is located on the ground by half-driven stakes or laths, after which the side lines are run to intersection with the curve. Where the stakes happen to fall between points located on the curve, the three nearest stakes are taken. The middle one giving m with reference to the other two, and by interpolation the required point is very quickly located. All the stakes are then driven down and the distances measured. There are always ample stakes to relocate the curve at any point and for curves in excess of 300 feet radius the abbreviated formula is quite good. The method is very fast in practice, and for long courses over rough, wooded land is of great assistance.

Another method, coming under the same classification, that is sometimes very useful, is that of external ordinates from a produced tangent—the disadvantage being that the external offset increases very rapidly, whereas in the former m is the maximum offset.

Random Location of Lot Corners

A method that is occasionally used is the random location of required lot corners, the principle being to plant stakes at the point flat, will give a desirable layout. Then by eye range in the other stakes at the most suitable places, as far as possible maintaining a street line with an attractive imaginary curve, the located points are then tied in by a series of traverses run from an astronomic base line, care being taken to check back to a base line occasionally. The advantage of the method is the little cutting required, also the definite location of side lines, which is not always the case in some of the other systems.

The disadvantages being the lack of connection between the two sides of a street; the use of imaginary curves leaving room for many interpretations as to the intended street line. The entire survey depends upon the accuracy of every measurement on the plan, a single error in field or clerical work making it impossible to retrace the survey unless other originals can be located by chance.

The greatest test of the methods of laying out curved subdivisions probably will not arise for some years. As yet originals can be found quite readily, but with their disappearance the future task of the surveyor is not a simple one. I am looking forward with considerable interest to the future development of Leaside, where hundreds of acres have been subdivided with curved layouts, and where the work as a whole was well done, the principal points being tied in and located by an extensive triangulation. The curves were laid out by deflection angles and the required closures were quite good.

With reference to the subdivision of larger tracts of land in unsurveyed territory by irregular lines, many of you have probably seen some of the proposed subdivisions drafted by Mr. Adams, of the Conservation Commission, the purpose of which is the endeavor to bring more closely together, for mutual benefit, the settlers in rural districts.

The present and past systems have done a great deal to open up Ontario, but we all appreciate the isolation of the average farmer under the systems of the past.

With the likelihood of a great influx to the rural sections of partially disabled men, and the unquestionably greater influx there will be if conditions can be made congenial, would it not be advisable for this association to consider amending the present system in certain localities in the endeavor to appeal to the returning soldier. In Ontario the considerations are such that very few men settling on virgin land require anything like 100 acres of land, while many would be satisfied with 10 acres, particularly if they are not rugged enough to stand the steady strain of keeping up a large tract of land.

The design of a tract of land containing a civic centre, playground, school library, church, post office, stores, etc., situated on a stream or railway, with radiating roads, the smaller parcels of land being situated near the centre of the proposed area, and the larger tracts at a distance, drawing on the communities for necessary labor, would be a fitting and worthy proposition for our association to take under consideration at the present time, when Canada as a whole is endeavoring to provide for and to find a way to show her gratitude to the men who have done so much for the Empire.

ACREAGES *

By E. R. Bingham, O.L.S.

SOMETIMES the sole purpose of a survey of a parcel of land or a body of water is to obtain its area; at other times it is an important feature of the survey. To obtain the area of regular surfaces there are various scientific methods which can be pursued, according to circumstances. In the case of irregular surfaces, however, different and less scientific methods have to be used.

If a chained traverse is made, the area of the rectilinear figure can be obtained by latitudes and departures, or by breaking it up into smaller figures and calculating the areas of these separately, while the area of the irregular portion is calculated from the offsets, the final area being obtained from the sum or difference, as the case may be.

In the case of a survey by stadia, micrometer or other method by which the points of the traverse are not directly connected, the area must be taken from the plot of the survey. The plot being made, the quickest and simplest method of taking out the area is by the use of the planimeter. If the plot is too large to be taken in at one setting of the instrument, it can be broke up by straight lines into figures of suitable size. Unfortunately, most planimeters seem to be made with but little thought for the requirements of the land surveyor, the scales being mostly fractional and intended for use on mechanical and architectural diagrams and plans. Consequently, one wastes so much time ascertaining what the various scales and settings are for, to find perhaps that the only scale that can be used is at the short end

*Paper read before the Ontario Land Surveyors' Association.

of the tracer arm, that impatience with this very useful instrument is apt to result. Is it not possible to get a standard design made for the use of land surveyors with the scales in most general use and giving the results direct in acres? With a comparatively small order these could be obtained made to such a design without extra cost.

In the absence of the planimeter, or as a check, tracing linen or other transparent substances divided into squares, each containing an acre or a tenth or a hundredth, according to scale and circumstances, and applied to the plan, will give good results. For instance, for taking out the areas of lakes plotted on a scale of ten chains to an inch, a sheet divided into squares of one chain gives results direct in tenths of acres by reading off the number of squares in each column, "giving and taking on" the fractional squares, and totalling the numbers. With a little practice a surprising quickness and accuracy are obtained. I believe the English supply houses make transparent celluloid sheets with squares to various scales.

No matter what is the method employed of calculating the area, with plans to a scale of feet, there is always the tiresome work of converting square feet to acres. I wish to make public some tables which I have had in use for some years and found exceedingly useful, as have others to whom I have given copies. In fact, it has saved many a weary hour of long division. I have now extended and elaborated them somewhat further, and my hope is that they will prove of use. Their purpose is to convert areas contained in square feet into acres and decimals. They are calculated to three places of decimals, so that where addition is necessary in taking areas from the tables, one is always sure of the result to the nearest point in the second place. They show the acreage for every thousand feet up to 500,000, and then for every 500,000 up to 10,000,000 square feet, so that up to the former figure they can be taken out direct, and up to the latter by the simple addition of two numbers. There are small side tables giving acreages for hundreds and tens of feet, which are of use for the smaller acreages where accuracy to the third or second decimal is required:—

Examples:

Convert 487,000 feet to acres: Table: 11.180 acres.

" 3,914,000 " "

3,500 80.349
414 9.504
———
89.853

" 439,650 " "

439 10.078
650 15
———
10.093 ac.

A quick and easy way to convert feet to acres when tables are not at hand is to multiply by 23 and point off six places from the right. This gives a close approximation for field work. To demonstrate, take 43,560 square feet and convert:

43,560
23
———
130 680
871 20
———
1.001 880

This shows an error of 19/10,000ths per acre. So that for fairly close work deduct .002 for each acre.

To take the same example as above, convert 439,650 square feet to acres:

439,650
23
———
1 318 950
8 793 00
———
10.111 950

For closeness deduct .002 × 10 .02
———
10.092 ac.

Which agrees within .001 with the table.

For another example:

4,378,000
23
———
13 134 000
87 560 00
———
100.694

Deduct .002 × 100 .2
———
100.494

which will be found to check within .01 acre. For many purposes that is close enough.

Acreage Table

Square Feet to Acres.

Thousands	0	1	2	3	4	5	6	7	8	9
0	....	.023	.046	.069	.092	.115	.138	.161	.184	.207
1	.229	.252	.275	.298	.321	.344	.367	.390	.413	.436
2	.459	.482	.505	.528	.551	.574	.597	.620	.643	.666
3	.689	.712	.735	.758	.781	.804	.827	.849	.872	.895
4	.918	.941	.964	.987	1.010	1.033	1.056	1.079	1.102	1.125
5	1.148	1.171	1.194	1.217	1.240	1.263	1.286	1.309	1.332	1.354
6	1.377	1.400	1.423	1.446	1.469	1.492	1.515	1.538	1.561	1.584
7	1.607	1.630	1.653	1.675	1.698	1.721	1.744	1.767	1.790	1.813
8	1.836	1.859	1.882	1.905	1.928	1.951	1.974	1.997	2.020	2.043
9	2.066	2.089	2.112	2.135	2.158	2.181	2.204	2.227	2.250	2.273
10	2.296	2.319	2.342	2.365	2.387	2.410	2.433	2.456	2.479	2.502
11	2.525	2.548	2.571	2.594	2.617	2.640	2.663	2.686	2.709	2.732
12	2.755	2.778	2.801	2.824	2.847	2.870	2.893	2.916	2.939	2.961
13	2.984	3.007	3.030	3.053	3.076	3.099	3.122	3.145	3.168	3.191
14	3.214	3.237	3.260	3.283	3.306	3.329	3.352	3.375	3.398	3.421
15	3.444	3.467	3.489	3.512	3.535	3.558	3.581	3.604	3.627	3.650
16	3.673	3.696	3.719	3.742	3.765	3.788	3.811	3.834	3.857	3.880
17	3.903	3.926	3.949	3.972	3.994	4.017	4.040	4.063	4.086	4.109
18	4.132	4.155	4.178	4.201	4.224	4.247	4.270	4.293	4.316	4.339
19	4.362	4.385	4.408	4.431	4.454	4.477	4.500	4.523	4.546	4.568
20	4.591	4.614	4.637	4.660	4.683	4.706	4.729	4.752	4.775	4.798
21	4.821	4.844	4.867	4.890	4.913	4.936	4.959	4.982	5.005	5.028
22	5.051	5.074	5.096	5.119	5.142	5.165	5.188	5.211	5.234	5.257
23	5.280	5.303	5.326	5.349	5.372	5.395	5.418	5.441	5.464	5.487
24	5.510	5.533	5.556	5.579	5.602	5.625	5.648	5.670	5.693	5.716
25	5.739	5.762	5.785	5.808	5.831	5.854	5.877	5.900	5.923	5.946
26	5.969	5.992	6.015	6.038	6.061	6.084	6.107	6.130	6.152	6.175
27	6.198	6.221	6.244	6.267	6.290	6.313	6.336	6.359	6.382	6.405
28	6.428	6.451	6.474	6.497	6.520	6.543	6.566	6.589	6.612	6.635
29	6.658	6.681	6.703	6.726	6.749	6.772	6.795	6.818	6.841	6.864
30	6.887	6.910	6.933	6.956	6.979	7.002	7.025	7.048	7.071	7.094
31	7.117	7.140	7.163	7.186	7.208	7.231	7.254	7.277	7.300	7.323
32	7.346	7.369	7.392	7.415	7.438	7.461	7.484	7.507	7.530	7.553
33	7.576	7.599	7.622	7.645	7.668	7.691	7.714	7.736	7.759	7.782
34	7.805	7.828	7.851	7.874	7.897	7.920	7.943	7.966	7.989	8.012
35	8.035	8.058	8.081	8.104	8.127	8.150	8.173	8.195	8.219	8.242
36	8.265	8.288	8.310	8.333	8.356	8.379	8.402	8.425	8.448	8.471
37	8.494	8.517	8.540	8.563	8.586	8.609	8.632	8.655	8.678	8.701
38	8.724	8.747	8.770	8.793	8.815	8.838	8.861	8.884	8.907	8.930
39	8.953	8.976	8.999	9.022	9.045	9.068	9.091	9.114	9.137	9.160
40	9.183	9.206	9.229	9.252	9.275	9.298	9.321	9.343	9.366	9.389
41	9.412	9.435	9.458	9.481	9.504	9.527	9.550	9.573	9.596	9.619
42	9.642	9.665	9.688	9.711	9.734	9.756	9.779	9.802	9.825	9.848
43	9.871	9.894	9.917	9.940	9.963	9.986	10.009	10.032	10.055	10.078
44	10.101	10.124	10.147	10.170	10.193	10.216	10.239	10.262	10.285	10.308
45	10.331	10.353	10.376	10.399	10.422	10.445	10.468	10.491	10.514	10.537
46	10.560	10.583	10.606	10.629	10.652	10.675	10.698	10.721	10.744	10.767
47	10.790	10.813	10.836	10.859	10.882	10.905	10.927	10.950	10.973	10.996
48	11.019	11.042	11.065	11.088	11.111	11.134	11.157	11.180	11.203	11.226
49	11.249	11.272	11.295	11.318	11.341	11.364	11.387	11.410	11.432	11.455
50	11.478	......	......	......	......	......	......	......	......	......

Thous'ds.	Acres.	Thousands.	Acres.	Hundreds.		Tens.	
1000....	22.957	5500....	126.262	1....	.002	01....	.000
1500....	34.435	6000....	137.741	2....	.005	02....	.000
2000....	45.914	6500....	149.219	3....	.007	03....	.001
2500....	57.392	7000....	160.698	4....	.009	04....	.001
3000....	68.870	7500....	172.176	5....	.011	05....	.001
3500....	80.349	8000....	183.655	6....	.014	06....	.001
4000....	91.827	8500....	195.133	7....	.016	07....	.002
4500....	103.306	9000....	206.612	8....	.018	08....	.002
5000....	114.784	9500....	218.090	9....	.021	09....	.002
		10000....	229.568				

A FEW THOUGHTS ON GEODESY*

By J. L. Rannie, D.T.S.

GEODESY is that branch of science which treats of making extended measurements of the earth's surface and of related problems.

Whatever one's viewpoint, no matter what aspect of the subject one considers, a large scope is presented.

From a historical outlook geodesy is one of the oldest of sciences, dating back to before the second century before Christ when Erastosthenes and the famous school of Alexandria produced a measure of the earth's circumference only about 15 per cent. in error. The modern era of geodesy is not quite so old, beginning as it did in the seventeenth century, when Newton discovered the existence of the law of universal gravitation with its corollary of the slight flattening of the earth at the poles.

From the point of view of development there is also presented a large field. At first we find the determination of the figure and dimensions of the earth to have been a fundamental object. Now we find that the object of geodetic work is to furnish precise locations for the controlling points of extensive surveys all over the world with allied problems, and its importance is recognized by all civilized nations, each of which maintains large organizations for this purpose.

Perhaps we may obtain the best idea of how broad a field of investigation is covered by this subject if we consider the scope of the topics covered and involved by modern geodesy.

These may be divided into three main classes with their subdivisions as follows:—

A.—Field determinations containing errors and discrepancies.

1. Triangulation.
2. Astronomical Observations for Latitude, Longitude and Azimuth.
3. Measurement of Base Lines.
4. Precise Levelling.
5. Soundings.
6. Tides and Tidal Phenomena.
7. Gravity.
8. Terrestrial Magnetism.

B.—Office Investigations.

1. Adjustment of Observations.
2. Computation of Geodetic Positions.
3. Correlation of Geodetic positions with Other Surveys.
4. Selection of a Datum Plane.
5. Figure and Dimensions of the Earth.
6. Deviation of the Plumb Line.
7. Anomalies of Distribution of Matter.
8. Refraction.
9. Map Projections.

C.—Publication of Maps and Results.

With such a wide range one would think it a comparatively easy task to select a subject for this paper. It seemed hard, however, to deal with the subject in a way which would be profitable and interesting without dealing with the phases of geodesy with which all are more or less familiar. The writer wishes, moreover, to avoid tiresome details of cumbersome operations, so the subject "A Few Thoughts on Geodesy" has been selected in the hope that a better conception may be imparted of a few of the broader principles which those in charge of a geodetic survey must constantly and strictly bear in mind.

*Paper read before the Ontario Land Surveyors' Association.

Let us just refresh our memories with some of the objects of a trigonometrical survey so we may have a number of arguments at hand in case we are asked the question, "Why do all the civilized nations maintain large organizations for the prosecution of these surveys?"

In answering this question the writer wishes to bring to your attention the stand taken by the Dominion Land Surveyors' Association on this subject, and feels that he cannot do better than quote from a memorandum prepared by a committee appointed at the fifth annual meeting of the Dominion Land Surveyors' Association held at Ottawa in March, 1888, to consider the question of a trigonometric survey of the Dominion. This committee was composed of Otto J. Klotz, W. F. King, W. S. Drewry, E. J. Rainboth, and J. S. Dennis.

To put the argument in a few words: Justify the building of a house and the same reasons hold for building a foundation for that house. A justification of a topographic survey along our coast lines, waterways and in the more densely settled parts of our country gives us the reasons why geodetic surveys should be prosecuted. It is just as reasonable to propose building a house without a foundation as it is to think of starting topographic surveys without having their accuracy controlled by a geodetic survey.

Excerpts from the memorandum insofar as they apply to the advantages of a geodetic survey are here given verbatim:—

"The question of the value and utility of a trigonometrical survey has been so settled by almost every civilized nation that it is hardly necessary to advance proof of the statement that it would be of immense practical value to the whole Dominion; but for illustration, and in support of the statement, the following facts are offered:—

"The surveys of this kind, which have been made by other countries, may be briefly referred to.

"First and foremost is the Ordnance Survey of Great Britain and Ireland, covering nearly 111,000 miles, which was begun in 1784 and is now (1888) nearing completion. Then comes the great Trigonometrical Survey of India, inaugurated at the beginning of the present century by Colonel Lambton, which is still in progress, and of which the beneficial results have been inestimable. Belgium is carrying on a survey which, when completed, will furnish 450 sheets of map on a scale of 1/20,000, with contour lines one metre apart.

"Prussia is carrying on an extensive survey, and since 1849 has introduced new and more perfect methods. Russia, with its enormous territory, about twice the size of the United States, including Alaska, has been for many years engaged in prosecuting trigonometrical surveys.

"Norway, although a comparatively poor country, has set itself on having a good topographical map, on a scale of 1/10,000, compiled from trigonometrical surveys.

"Austria has completed a new map of the empire, comprising 715 sheets, also compiled from data furnished by trigonometrical surveys.

"Denmark, Switzerland, Spain, Portugal and Italy are all carrying on trigonometrical surveys, to enable them to map their territories accurately.

"France has completed her survey, and the result is shown in 276 sheets of map.

"On this continent surveys of a high order of precision have been made by the United States government, and the work of the Coast and Geodetic Survey is going steadily on, having been extended along the sea coast and also along the Great Lakes, and many of the states and territories have been covered by its operations, including some in the far west, *viz.*, Nevada, Colorado, Utah, New Mexico, Montana, Idaho and part of Arizona.

"Several of the States have conducted independent trigonometrical surveys of their own territory, including Massachusetts, California, New Jersey and New Hampshire, and in other States they are in progress.

"All the foregoing surveys are based on triangulation.

"It may be asked what are the practical benefits to be derived from a trigonometrical survey, and what is there to justify the expenditure of the large sum of money which a survey of this kind would ultimately cost. To make the point of practical benefit clear, the following will be readily understood by all:—

"It is stated by an eminent American engineer that 'If the State of Massachusetts had had a good topographical map in 1838, some $20,000,000 would probably have been saved in its public railway expenditure.'

"Mr. Sandford Fleming, C.M.G., in his report to the minister of public works, dated April 5th, 1879, says: 'If the railways of Ontario has to be established *de novo*, a careful study of the requirements of that province would enable any intelligent engineer of ordinary experience to project a new system which at one-half the cost would far better serve the public, and would meet every demand of traffic, would more fully satisfy every expectation, and which would not result in disappointment and loss to those who have been induced to invest their means in that which has proved to many an unprofitable undertaking.'

"If to-day a railroad is projected in England, or any other country possessed of a good topographical map, preliminary surveys, such as we are obliged to make, are unnecessary, for from these plans the lengths and grades of any proposed line can be determined with sufficient accuracy to enable a final location to be made.

"In carrying on a survey of the character contemplated it is necessary to run lines of exact levels from station to station, and thus we would have the elevations of points all through the settled portions of the country, and in future operations, in which levelling is a feature, all levels could be referred to a common datum line (sea level, for instance), and when railway lines are pushed back into the wooded interior, the physical character of which is but little known, we would then have some definite idea of main watersheds and valleys, to guide future operations, instead of relying, as is at present done, on guesswork and hearsay evidence.

"Among other benefits to be derived from a survey of this kind are the following: Our extensive coast line, both in the Gulf of St. Lawrence, on the Atlantic and Pacific seaboards, and also in our inland waters, has been very roughly determined in many places, and in consequence many disasters happen to shipping, and many valuable lives are lost annually, which would in a great measure be avoided were we in possession of reliable charts of our waters; and one of the first requisites in making the hydrographic surveys necessary to provide the data for compilation of these charts is that certain points on the shore should be accurately fixed. It may be mentioned in connection with the Hydrographic Survey of Georgian Bay, at present (1888) being carried on under the direction of Staff Commander Boulton, R.N., that Commander Boulton stated before the D.L.S. Association, at its last annual meeting, that in making his survey he had not been able to connect his work with any point accurately determined by Canadian authority, but had to use points established by the United States Coast and Geodetic Survey.

"On our inland lakes and waters large sums are annually spent in harbor and other improvements, and yet the geographical positions of these harbors and waters are not accurately shown on any map or chart.

"A large sum has been spent in building the Murray Canal between Lake Ontario and the Bay of Quinte, but there is no correct chart of the Bay, and a stranger attempting to navigate a deeply laden vessel in its waters would probably meet with disaster. This has happened time and again, and will continue until we have an accurate chart of the Bay, and, as has already been said, the work of making these charts would be greatly expedited by having points along the shores established by a trigonometrical survey from which to begin the hydrographic survey.

"Numerous isolated surveys have been made under various departments of the government, at points on the Atlantic coast, the Gulf of St. Lawrence and in the Great Lakes; it is also proposed by the Militia Department to make a series of reconnaissance surveys at different points; all these surveys, made, or to be made, give valuable results, but they cannot be considered complete until they are connected. To this end a carefully executed triangulation is necessary.

"Again, with the increase in the value of real property, any work having in view the permanent marking of these points which would definitely fix the positions of boundaries of real estate, is for the public good. In many of the provinces the boundaries of valuable properties are in most cases dependent on the durability of wooden posts, a few marks on trees, or the testimony of the oldest inhabitants, and as a consequence expensive litigation often arises; in fact, it may safely be said that the amount annually expended in litigation regarding boundaries would go a long way towards paying for the cost of a trigonometrical survey.

"Were the boundaries, especially those of large areas, such as counties, townships and concessions, accurately defined by a trigonometrical survey, similar to that made by the countries herein referred to, all doubt as to their position would be forever set at rest.

"At the present time, throughout the Dominion, every city and many of the towns and villages are looking about for means of obtaining a good water supply or of improving the supply they have.

"Gravity being the best method of utilizing a water supply, is generally first sought after, but the information necessary to determine the availability of a supply by this means can now only be had by expenditure of large sums of money, as has been lately seen in Toronto.

"Had there been a good topographical map in existence, that expenditure would have been unnecessary.

"In drainage work the information derivable from a survey of this kind would be invaluable, and as our agricultural population is waking up to the benefits arising from proper drainage, no time should be lost in giving them this aid. The maps would enable any engineer to determine by a simple calculation the area of any basin to be drained and to know accurately the size of drain necessary and its proper location, and the survey would do away with all litigation arising from parties claiming that their lands do not lie in the basin to be drained, as a reference to the map would show at a glance the natural drainage outlet for any piece of land.

"These maps would also be exceedingly valuable in assisting an equitable assessment of real estate for taxes, and in providing the necessary information required in locating and building public highways, and would save large sums of money which are now expended in finding out where roads should be built, and the sum so saved might be expended in making the roads more solid and permanent.

"The information afforded by the maps provided from a survey of this kind, in reference to our inland waters and the possibility of their utilization for navigation, which is becoming every day of more importance, would be of vast benefit to the country.

"Many large public works are now being agitated and will no doubt in the near future be undertaken, as, for instance, the 'Ottawa Ship Canal,' the 'Trent Valley Canal,' etc. The possession of good topographical maps would very naturally assist in settling the question of the feasibility of these and many other schemes for the improvement of navigation, etc.

"Instances might be cited indefinitely to prove the value, not only to the government, but to the people at large of a trigonometrical and accompanying detail survey of the kind herein referred to, but it is thought that enough has been said to conclusively show the benefits which would accrue therefrom.

"The advantages accruing to the country by a geodetic survey would not be confined to the definite material advantages gained in topographical knowledge and the coast and sounding surveys based upon the triangulation.

"An additional and not inconsiderable advantage would be the stimulus given to scientific research. It has been the experience of other countries that men employed on geodetic surveys, having their attention drawn to the numerous branches of science involved, have, by their scientific and mechanical inventions, added greatly to the sum of knowledge in these branches and indirectly to the material wealth and progress of the countries."

It is interesting to note that the president of the Association in 1888 was Mr. Thomas Fawcett, D.T.S., who is at present attached to the International Boundary Surveys.

The Ontario Land Surveyors' Association also has for the last twenty years been most zealous in its requests for and support of triangulation surveys of our Dominion.

Quite an illuminating comment has just come to the notice of the writer from a most unexpected source—the Report of the Trigonometrical Survey of Fiji. Just an extract from its introduction:—

"With the greater development of the country, the difficulty of reconciling the location and acreage of some of the earlier and less accurately defined properties with the results of recent contiguous surveys began to be severely felt, the fitting of new plans into old maps being sometimes impossible. This difficulty is, of course, by no means new, being experienced by almost every civilized state at some period of its development. By all progressive governments, as soon as the resources of the State permit, it is met in the same way—by the initiation of a primary survey eventually embracing the whole area of the country."

The datum for the Fiji Islands surveys was based on the latitude and longitude of a pillar at Suva, determined in 1903 by Dr. Klotz and F. W. O. Werry, in connection with the determination of trans-Pacific longitudes, a fact in which we may take a pardonable pride.

In connection with our Geodetic Survey, which was started in 1906 and organized in 1909, the observing has been completed over an area of about 66,000 square miles of land and water, the distribution of this amount being about as follows:—

Maritime Provinces, largely in the vicinity of the Bay of Fundy, about	8,000 square miles.
Quebec, on both sides of the St. Lawrence and Ottawa Rivers, from Riviere du Loup to Ottawa, and covering the whole of the Eastern Townships, about	20 square miles.
Ontario, from Montreal to Collingwood and Windsor, and 2,700 square miles in the Port Arthur region, about	27,000 square miles.
British Columbia, from Victoria and Vancouver north, between Vancouver Island and the mainland, together with a scheme beginning at the Portland Canal, which is to be extended southward to meet the triangulation from the south, about	11,000 square miles.
Total, approximately	66,000 square miles.

One will note that the areas covered by our geodetic surveys have been such as to give control to topographic surveys along our waterways and in the more densely settled parts of the country. This, of course, is our direct function, the scientific problems which may be solved from the field data secured, although very important in themselves, being of relatively secondary consequence to the economic value of a geodetic survey. Indeed we may go further and say that unless the whole civilized world had realized the great economic importance of a geodetic control for detail surveys, but a fraction of the money and energy would have been expended that has been spent.

It should be realized that our results have already been of great assistance to other departments of the government for the control of their surveys and maps, and that, as no topographic work has been done directly by the Geodetic Survey of Canada, the importance of our light is apt to be hid under the bushel of the maps of other departments.

To show the importance of our Geodetic Survey results herewith is given a list of information which has been supplied to our Militia Department, Naval Department, Geological Survey and Geographer's Branch and others. It is pointed out that this information is only a fraction of what has been requested, but that owing to lack of data and perhaps owing to the lack of co-ordination of administration between the various surveys, we have been unable to supply nearly all the results which have been sought. In this connection mention might be made of the Public Works Department and the Departments mentioned above which have requested much data which could not be supplied.

Information Desired by Various Departments, etc., Supplied from the Geodesist's Office, Geodetic Survey

January 19th, 1911, information supplied Militia Department re Lat. and Long. of points in Eastern Townships and Western Ontario, for control of their military sheet maps, which they were most anxious to get.

September 16th, 1915, information supplied Militia Department re Azimuth of Standon—St. Paul's Church; Azimuth of Standon—St. Philomene Church, for control of military sheet maps.

February 5th, 1912, information supplied Geographer's Branch re Lat. and Long. of Bellevue, St Armand's, Owl's Head, Orford, Vankleek Hill, Plantagenet and Buckingham, for control of their maps.

March 9th, 1912, information supplied Geographer's Branch re Lat. and Long. of numerous places, for control of their maps.

January 5th, 1913, information supplied Geographer's Branch re Lat. and Long. of a large number of points in Ontario and Quebec, for control of their maps.

May 23rd, 1913, information supplied Geographer's Branch re Lat. and Long. of points between Vankleek Hill and Quebec, for control of their maps.

June 8th, 1915, information supplied Geographer's Branch re Lat. and Long. of a large number of points in Ontario and Quebec, for control of their maps.

June 15th, 1915, information supplied Geographer's Branch re Description re location of Royal, Covey Hill, St. Armand, Newton, Rigaud, East and West Base (Coteau), Huntingdon, Buckingham and Stratford, for control of their maps.

August 27th, 1912, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of Scarboro and points along the shore of Lake Ontario for control of Lake Ontario Survey.

October 23rd, 1912, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of Point Petre and West Point, for control of Lake Ontario Survey.

January 2nd, 1913, information supplied Hydrographic Survey, Naval Department, re Azimuth of Scarboro—Clarke; Azimuth of Scarboro—Uxbridge, for control of Lake Ontario Survey.

January 14th, 1913, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of Haldimand, Clarke N. and Uxbridge and Directions on North Shore of Lake Ontario, for control of Lake Ontario Survey.

March 3rd, 1913, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of points between Toronto and Niagara Falls, for control of Lake Ontario Survey.

December 3rd, 1913, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of Gibraltar Lighthouse, for control of Lake Ontario Survey.

December 9th, 1914, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of points around Scarboro, for control of Lake Ontario Survey.

May 14th, 1915, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of points near Coteau, for control of St. Lawrence Survey.

May 27th, 1915, information supplied Hydrographic Survey, Naval Department, re Lat. and Long. of Valleyfield, Coteau du Lac and St. Zotique, for control of St. Lawrence Survey.

June 10th, 1915, information supplied Hydrographic Survey, Naval Department, re inverse data of line, Lat. 50, Long. 60—Lat. 46, Long. 70.

May 9th, 1913, information supplied Geological Survey, re Elevation of Hefty and Canada, for control of topographical work.

November 3rd, 1913, information supplied Geological Survey re Lat. and Long. of points in Gatineau Region and descriptions of numerous points in Quebec and Ontario, for control of geological survey mapping.

January 20th, 1914, information supplied Geological Survey re Lat. and Long. of points in Quebec and Ontario.

November 13th, 1914, information supplied Geological Survey re Azimuth and Distance, Observatory—King; Azimuth and Distance, Observatory—Buckingham; Azimuth and Distance, Navan—King, for control of geological survey mapping.

April 25th, 1915, information supplied Geological Survey re Lat. and Long., Observatory, King Mountain, Hull, Wakefield, Buckingham, for control of geological survey mapping.

November 3rd, 1915, information supplied Geological Survey re Lat. and Long. of points beginning at Buckingham and Observatory and extending into the Gatineau Region, also descriptions of same, for control of geological survey mapping.

September 29th, 1914, information supplied U.S. Coast and Geodetic re Lat. and Long. of Hereford.

June 1st, 1915, information supplied U.S. Coast and Geodetic re descriptions of numerous stations in Quebec and Ontario and Lat. and Long. of same, for control of international boundary survey.

June 30th, 1914, information supplied Quebec Streams Commission re Lat. and Long. of points around Lake St. Francis, for control of their survey.

July 28th, 1914, information supplied Quebec Streams Commission re Lat. and Long. of Theford, Ham, Stratford, for control of their survey.

Janaury 15th, 1915, information supplied Toronto Harbor Commission re Lat. and Long. of Gibraltar Lighthouse, Upper Canada College or any prominent spire or tower, to adjust harbor triangulation.

February 15th, 1916, information supplied City Suveyor of Toronto re Lat. and Long. of points within or on the outskirts of the city, for control.

The writer would also mention the great amount of secondary and tertiary triangulation along the international boundary from the Arctic Ocean to the Atlantic which has been checked up at certain points by the results of our Geodetic Survey and the U.S. Coast and Geodetic Survey. This work has been done under the direction of the boundary commissioners of Canada and the United States, both of whom were until two years ago the superintendents of the geodetic surveys of their respective countries, so that it is not surprising that the importance of triangulation control was recognized by them and formed a vital part of these surveys.

Nor must we forget that important branch of the Geodetic Survey of Canada, the precise levelling branch, the work of which bears the same relation to ordinary levelling with respect to accuracy which a geodetic survey bears to ordinary surveying. This branch establishes the elevation above mean sea level of thousands of points scattered over our Dominion and gives the data whereby all elevations on subsequent surveys may be reduced to the same datum.

(Concluded in the next issue.)

REPORT OF THE ROAD MATERIALS COMMITTEE OF THE AMERICAN SOCIETY FOR TESTING MATERIALS

THE report of Committee D-4, on Road Materials, presented at the last annual meeting of the American Society for Testing Materials, included a number of proposed tentative tests and four new definitions.

The first tentative test proposed was one for the toughness of rock. According to the report, over nine years' experience in routine testing laboratories and a considerable amount of investigation resulted in the conclusion that it was desirable to revise the existing standard test for toughness of macadam rock as printed in the 1916 Book of A.S.T.M. Standards, "giving more complete and specific directions in connection therewith, and at the same time making the test more serviceable for ascertaining the relative toughness of different rocks. The following test was recommended by the committee for publication as tentative for one year before referring it to a letter ballot of the society for adoption as a standard:

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

2. Sampling.—Quarry samples of rock from which test specimens are to be prepared shall measure at least 6 ins. on a side and at least 4 ins. in thickness, and when possible shall have the plane of structural weakness of the rock plainly marked thereon. Samples should be taken from freshly quarried material, and only from pieces which show no evidences of incipient fracture due to blasting or other causes. The samples should preferably be split from large pieces by the use of plugs and feathers and not by sledging. Commercial stone block samples from which test specimens are to be prepared shall measure at least 3 ins. on each edge.

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

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

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

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

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

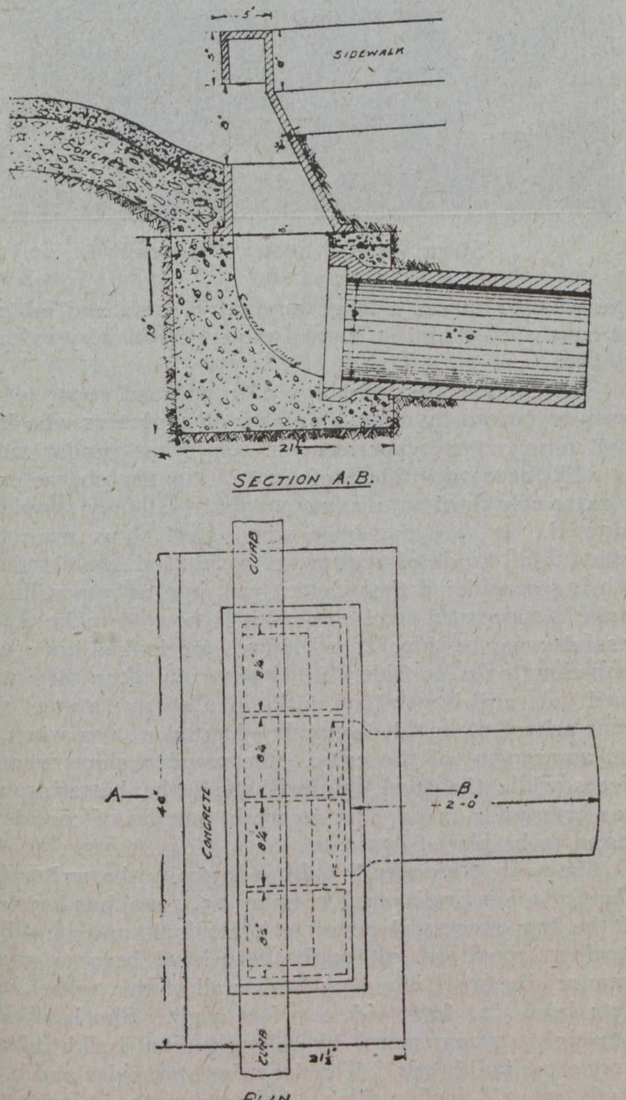
(*c*) A plunger made of hardened steel and weighing 1 kg., arranged to slide freely in a vertical direction in a

(Concluded on page 44, Construction News Section.)

SOME SEWERAGE DETAILS IN CALGARY.

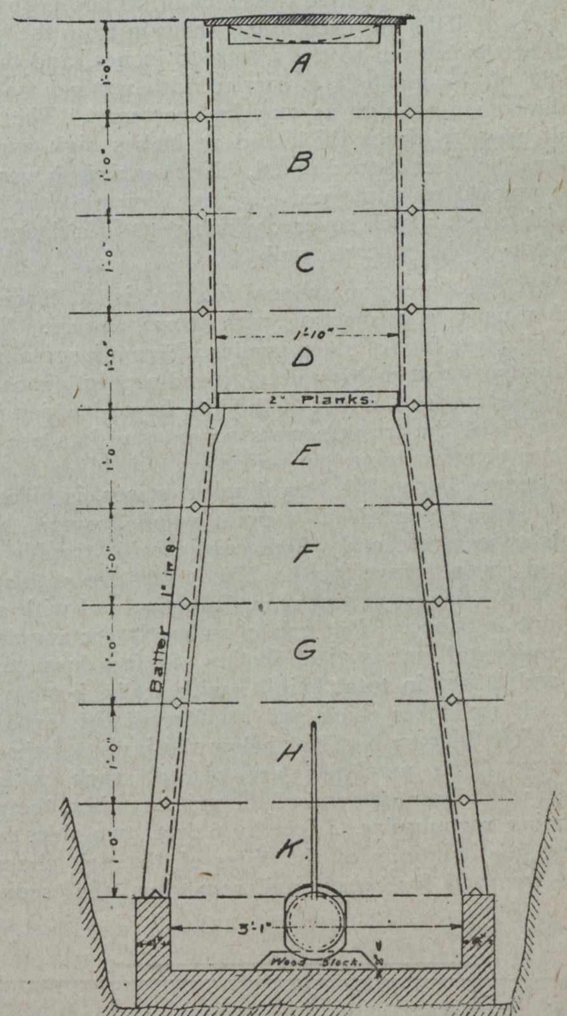
THE city of Calgary, Alta., has adopted several features in constructing its sewers that are more or less unusual. The following brief description, information for which was supplied by Geo. W. Craig, city engineer, is taken from the Municipal Journal:—

One is a special type of inlet used at points where storm water concentrates very quickly and it is desirable to get the water to the sewer without a moment's loss. The construction is a combination of iron casting, dropped pavement at the gutter line, and concrete and pipe underground construction. The iron casting is in the nature of a hollow curb with a top 5 inches wide, gutter face 13 inches high, and a total depth of 20 inches. In the face of this casting is an opening 8 inches high and 34 inches long, through which the water enters. The gutter at the opening is 13 inches below the top of the curb, the gutter being dropped quickly both longitudinally and crosswise of the street, the slope from the general street level occurring in about 18 inches in all three directions. This



Special Inlet for Steep Grades.

casting rests upon a mass of concrete, in which the bottom opening of the casting is continued by a curve which connects it to a 10-inch or 12-inch pipe through which the water is carried to the sewer. The hollow casting is strengthened by three ½-inch partitions extending across it both above and below the opening. The special features are the unusually deep drop in the gutter, which concentrates the water at the opening; the great length of the opening; and the curved form of the passage between the opening and the pipe, serving to concentrate the water into the sewer connection with a minimum amount of agitation. Mr. Craig says that even on steep slopes this



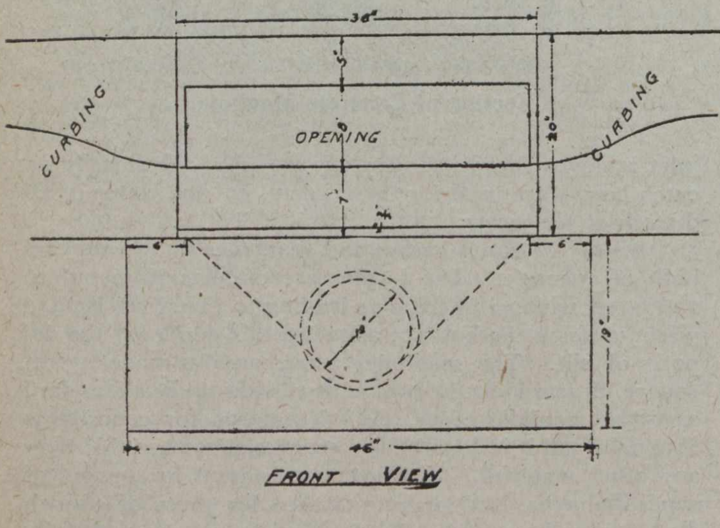
Section of Concrete Manhole.

inlet removes the water very successfully. Ordinarily no catch basins are used for these inlets, but the water is led directly to the sewer.

All of the catch basins and manholes in the city are built of concrete. The former are circular, 6 feet deep and 3 feet wide, with the pipe leading to the sewer located 3 feet up from the bottom, allowing this depth for the deposit of silt. The manholes are generally made 4 feet square, drawn in at the top on three sides to fit a standard cast-iron manhole cover. Good material for concrete is abundant and it is found more economical to use this than any other material. Vitrified pipe is used for sewers of small diameter, but concrete is used for those of 36-inch diameter and upward; also for curbs, gutters and sidewalks and foundations of all street pavements.

Catch basins have been made in sections, each section about 18 inches deep, using old iron for reinforcement; the sections being made at the city store where good gravel is near at hand. This construction is found to be slightly more economical than constructing the basins in situ. A few square manholes also have been built in sections after a standard plan. The walls are composed of a number of slabs pre-cast in moulds of such dimensions as to give a bottom width and length of 3 feet 1 inch, inside dimensions, tapering to 1 foot 10 inches at a height of five feet. These slabs are assembled on a concrete foundation, four slabs, one for each side, forming a course one foot high. Each slab carries on its upper and lower edges a triangular groove, the two grooves at each joint coming opposite each other and a filler or key being placed in the groove so as to hold the slabs in proper alignment. Five tiers of slabs are used in battering in from the 3 feet 1 inch at the bottom to the 1 foot 10 inches, and the remainder of the manhole is carried with vertical walls of this dimension as high as may be necessary. The slabs are all made 3 inches thick and 12 inches high and are reinforced with expanded metal. The manhole cover also is constructed of reinforced concrete, being in the form of a slab 2 feet 1 inch square, which rests in a depression in the top of the concrete walls.

Another somewhat unusual feature is a large grit chamber used in connection with storm sewers. These are used at the foot of steep grades where a large amount of heavy, silty matter from unimproved property is carried down the street to the foot of the hill, beyond which point the grades of the trunk sewers across the flats are very light and therefore give low velocity. One of these, on a sewer known as the Mt. Royal storm sewer, is placed at the foot of a steep hill at a point where several steep laterals concentrate and where considerable trouble with silt had been experienced. The outlet from this grit chamber is a sewer 30 inches in diameter, and with a fall of 1 foot in 1,000. The grit chamber is rectangular in both horizontal and vertical section, 62 feet long, 6 feet wide and 8 feet in total height, with walls, bottom and roof each 12 inches thick and reinforced with expanded metal. The bottom is 5 feet below the invert of the outlet sewer. Two manholes are placed, each with its centre 15 feet from one end of the grit chamber, the manhole being rectangular, 4 feet by 6 feet, two sides being vertical continuations of the sides of the grit chamber. These are used for access and removing the sediment

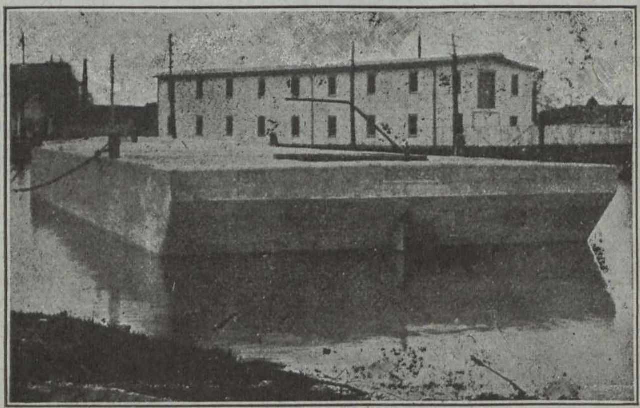


which collects in the chamber, the bottom of which is 18 feet below the street surface. As the area of the chamber below the level of the sewer is about six times that of the sewer itself, and the total area of the chamber is about ten times that of the sewer, the mean velocity of the storm water as it flows through the chamber is not more than one-tenth of that in the sewer itself; therefore only the lighter matters reach the outlet sewer, and the velocity resulting from the 0.1 per cent. grade of the sewer is sufficient to prevent these being deposited in it.

REINFORCED CONCRETE SHIPS

By J. L. Weller, M.Can.Soc.C.E.,
Consulting Engineer, St. Catharines, Ont.

THE great scarcity of ships, owing to such a large number having been destroyed by mines and submarines, and the lack of steel and labor with which to build others to take their places, has caused great activity in wooden ship building and a considerable number of these will soon be afloat, but the total result of both steel and wooden ship construction will be pitiably small compared with requirements, and it is well known that the wooden steamer is only a poor makeshift, yet



Stern View of Scow "Pioneer."

one which requires a large amount of time and labor in its construction and an immense quantity of very valuable timber.

The construction of ships of reinforced concrete has been advocated by quite a number of engineers who have had more or less experience in somewhat similar work, but, like most new ideas of a revolutionary character, it is extremely hard to convince capital that they should be adopted. It was the same when steel ships were first mooted; all kinds of arguments were used against them, it being considered then that it was just as impossible to make a successful steel ship as it is now to make a successful concrete ship. Steel ships were looked upon with suspicion for a considerable time, even after they were tried out, and it was not until, in a storm, a steel ship went ashore alongside a couple of wooden ones when, to the amazement of the critics, the wooden ships went to pieces while the steel ship withstood the battering and was eventually saved, that a certain amount of confidence began to be placed in them.

The scow "Pioneer," built in 1910 by the writer (see *The Canadian Engineer*, December 15, 1910) has been one of the few successful concrete boats built and is still in excellent condition, although there have been no maintenance charges. The length over all of this vessel is 80 feet; beam, 24 feet; sides, 7 feet high. She is divided into eight compartments by a longitudinal bulkhead and three cross bulkheads. The deck, bottom, sides and bulkheads are 2½ inches thick reinforced with ¼-inch steel wire running longitudinally and transversely. In addition to the bulkheads the steel is supported by beams and posts, generally six by eight inches.

The concrete was placed in the usual manner in reinforced concrete work. A platform was first laid on blocking about three feet above the level of the canal bank, upon which the bottom of the scow was constructed, the bottom beams were next built, the interior forms erected, and the posts, sides and bulk heads completed, after which, for convenience, the interior forms were removed and the forms for deck and deck beams erected, and both completed. The scow was then stripped, given a coat of grout, and launched on five ways in the usual manner.

The interior forms were built as far as possible in uniform sections, and can be used again in similar work.

On one occasion when a steamer carried away the gates of the lock below her, she was stranded and rested on diagonally opposite corners. This will give some idea of her great strength, as does also the photo showing her being loaded with ten-ton carload of rubble stone, dumped from a height of about fifteen feet directly onto her 2½-inch deck. This same photo also shows a method of loading by starting with full load at one end, which would make an old-time wooden scow captain shudder.

The writer maintains that this scow has established the fact that concrete is very suitable for vessels of small size and although it is small compared with a steamship, still it only remains to scientifically enlarge it to obtain an equally successful ship.

To-day much more is known about the properties of reinforced concrete than when the scow was built and engineers are now able to calculate with extreme accuracy the strength of reinforced concrete structures. Cement is more reliable than it used to be, and concrete of remarkable strength and homogeneity can now be made without any question as to its reliability.

The building of reinforced concrete ships thus becomes a matter of sound theory, good judgment in design, and practical knowledge of construction.

Concrete ships may not be quite as economical of operation as steel ships on account of their extra weight, but when capital and repair accounts are taken into consideration it is not so certain that they will be at any great disadvantage. They require no painting, no renewals of rivets, and repairs to the hull, when required, can be made at a fraction of the cost of the repairs to a steel hull. The first cost of a concrete hull will be considerably less than half the cost of a corresponding steel hull.

The writer has of late been engaged on reinforced concrete steamship design, and hopes to be able to build a 3,000-ton ship this summer, as it is extremely advisable that one ship at least should be tried out as soon as possible in order to be ready to cover the seas with them next summer, should it be necessary to do so.

The financial problem is, however, a severe one, as insurance companies are slow in taking up such a new and radical departure from established precedent.

There is also the unfortunate fact that some attempts to build concrete scows have not been entirely successful, owing to poor design or to poor workmanship. One very unfortunate thing about concrete is that it is so willing to do its share of everything it is put at and succeeds so well, where it gets any chance at all, that, like the willing horse, it is very much abused, and parties with a very perfunctory knowledge of its real merits and capabilities often try to make it do things without giving it the support of the technical knowledge and experience which are necessary to success.

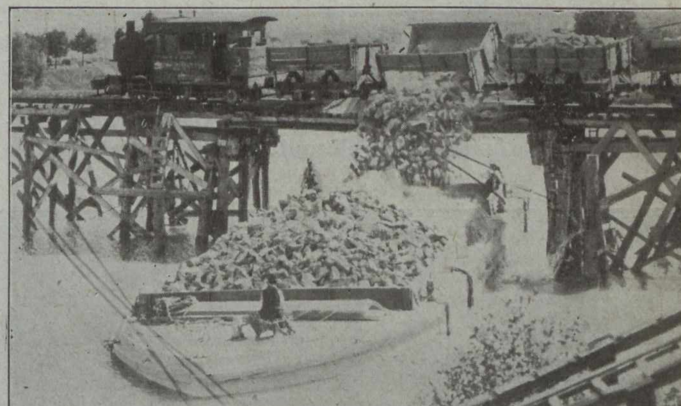
The writer would like to get in touch with a real patriot who has three or four hundred thousand dollars which he is prepared to put into a reinforced concrete ship enterprise with the purpose of trying out the scheme for the benefit of the Empire—if it is successful, he will be repaid manyfold, if not, he will have the satisfaction of feeling that he has "done his bit," and he will also know that he has had a "good run for his money."

The following will answer some of the many questions likely to be asked:—

Reinforced concrete is not rigid, as many suppose, but is quite elastic within a moderate range. A 40-foot pole will deflect two or three feet without cracking.

It is not brittle and is most difficult to break up. Dynamite has an extremely local effect upon it.

Local shocks may puncture it if heavy enough, and heavy shocks may cause cracks, but these do not at all destroy the efficiency of the concrete as a whole, and it is very probable that the same shocks would do more damage to the light walls of a steel ship.



Reinforced Concrete Scow "Pioneer" Being Loaded with Cobblestone in 10-Ton Lots.

Vibration has no effect on well-designed and well-constructed concrete, and in a ship the heavy monolithic mass will lessen the vibration very materially, as compared with a steel ship.

Good concrete is not affected by sea water, and barnacles do not cling to it with the same avidity they show for steel.

It is a very simple matter to patch good concrete, making it just as strong as it originally was.

It can readily be made watertight.

Concrete ships can be built in a fraction of the time required to build either steel or wooden ships, and the materials required are available almost everywhere.

ENGINEERS DINE ADVISORY COUNCIL.

A special meeting of the Saskatchewan Branch of the Canadian Society of Civil Engineers was held July 12th. It took the form of a dinner to the members of the Advisory Council on Industrial Research. The dinner was held in the Assiniboia Club, Regina.

Prof. A. B. MacCallum, chairman of the Council, briefly explained the lines upon which the Council had been formed and indicated the functions and aims of similar bodies in other countries.

Prof. Ruttan, McGill University, followed Prof. MacCallum. He cited some examples of research work which had been precipitated by the war, referring particularly to the strange effect of some of the industries which had really been stolen by Germany from England.

Dr. Adams, Dean of the Faculty of Applied Science, McGill University, followed and devoted some attention to the subject of the full production possibilities of Saskatchewan.

Professor Murray, of the University of Saskatchewan, also addressed the gathering.

THE DISTRIBUTION OF PRESSURES THROUGH EARTH FILLS.*

By A. T. Goldbeck.

[In *The Canadian Engineer* for August 3, 1916, an article on this subject by Messrs. A. T. Goldbeck and E. B. Smith appeared. That article dealt more particularly with a description of the apparatus for determining soil pressures, while the present article is devoted principally to the results obtained by the use of the apparatus in question. The solution of this problem is of utmost interest to the designers of highway structures.—Editor.]

THE present paper gives some results of soil-pressure measurements made with the aid of an apparatus which has already been described before this society. As the tests progressed certain structural defects developed in the diaphragm cell and changes were made to overcome these weaknesses and render the apparatus thoroughly practicable under working conditions. The principles involved in the manipulation and the general construction remain unchanged.

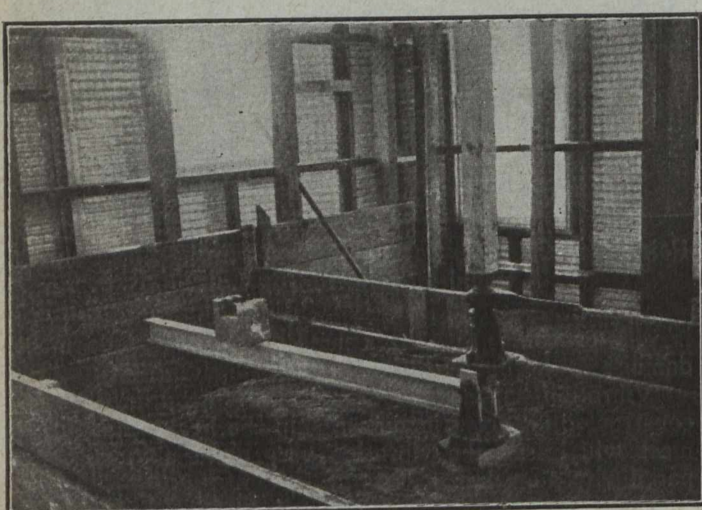


Fig. 1.—Device for Applying Load.

Soil-Pressure Measuring Apparatus.

The principles of pressure measurement with the use of this instrument, as already stated in the previous paper, depend upon (1) the equilibration of the soil pressure with air pressure within a small cell buried where the pressure is desired, (2) the detection of the instant of equilibration by the breaking of electrical contact within the cell, (3) the measurement of the air pressure within the cell at the instant of equilibration by the use of a sensitive gauge.

Application of Diaphragm Cells for Measurement of Pressures Through Earth Fills.

The measurement of the distribution and intensity of pressure under earth fills due to concentrated loads is only one of many phases of earth pressure measurements on which knowledge is desired by engineers. For carrying on this part of the investigation a special building, having a very heavy, reinforced-concrete floor was designed and constructed by the Office of Public Roads and Rural Engineering at the Arlington Experimental Farm, belonging to the Department of Agriculture. The soil pressure measuring cells were placed in this floor along a straight line with the following spacing: 5½, 5½, 7, 18, 18, 18 ins. One cell was also placed 10 ins. on each side of the middle on a line at right angles to the long line of cells. The top surfaces of the cells were set flush with the concrete slab and the air pipes led down to the floor below, where the indicating instrument was manipulated. Holes are provided in the floor for mounting other cells should this be necessary.

The bin for containing the material used in the investigation was 7½ ft. wide, 14 ft. long for all fills above 2 ft. Up to 2 ft. the bin was 7½ ft. square. Only in the case of the 5-ft. fill was the size of the bin insufficient to properly take care of the pressure distribution. In this case, the side walls interfered with the transmission of the vertical pressure.

In the present series of tests a coarse concrete sand dredged from the Potomac River was used. The sand was tested in its moist condition, as delivered, and was kept moist by daily sprinkling. There was from 3 to 5 per cent. of moisture in the sand, enough so that it would stick together when compressed with the hands.

Device for Applying Load.

When the proper depth of fill was obtained, the surface was smoothed off and the bearing block very carefully centered over the central measuring cells. Flat circular bearing blocks were used, one 8 ins. and the other 13½ ins. in diameter. A calibrated I-beam was used for applying the loads. It was provided with proper knife edges and was kept level by means of a screw jack. By placing a 100-lb. weight in various positions on this I-beam, the different loads could be obtained. Extreme care had to be exercised in placing the bearing block and in seeing that it remained level. The slightest disturbance from its position over the central cell or its lack of horizontality would show in the readings of the cells adjacent to the centre. Only those readings obtained with the block in as nearly a horizontal position as possible were considered in working up the results.

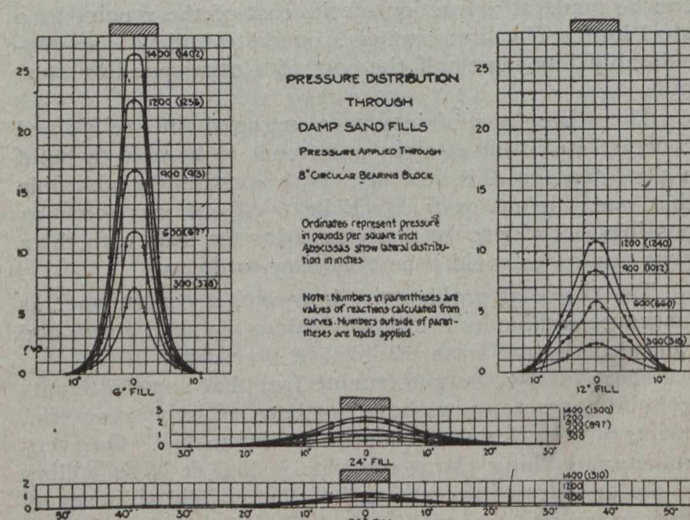


Fig. 2.—Results of Readings.

Results of Tests.

The results of the readings are shown in Figs. 2, 3 and 4. The readings due to the weight of sand alone were subtracted from the readings obtained when the fill was loaded. The differences were plotted as ordinates. The abscissas represent the lateral distribution of the pressures. Since a circular bearing block was used, it is to be assumed that the pressures in all lines passing

*Abstract of paper read before the American Society for Testing Materials.

through the centre are identical with those measured. The volume of the solid generated by rotating a curve of pressure about its vertical axis, when multiplied by the number of pounds represented by a cubic inch, will equal the reaction. These reactions have been calculated for a number of the applied loads, and are shown in parentheses on the curves. The loads applied are shown outside of the parentheses: theoretically they should be identical, and actually they are nearly equal. When it is remembered that any slight difference in the compaction of the sand in the different radial planes will change the intensity of the pressure exerted in those planes, and when it is remembered that the pressures were measured principally in a single plane and partly in a plane at right angles, the agreement of the calculated reactions with the applied loads is remarkably close. The reliability of the apparatus for measuring pressures through sand is thus established.

Application of Results.

The designing engineer is continually encountering the design of structures subjected to the pressure of earth fills or to pressures transmitted through fills. The present tests were made under conditions which resemble those in a road slab having an earth covering. In the design of such a slab, the engineer is primarily interested in the amount of distribution of a concentrated load furnished by the earth fill. He would like to know the lateral distribution in order that he might figure what width of slab carries the load. He would like to know the distribution forward or backward from the wheel load in order that he might determine the moment about the concentrated load of the distributed pressure load, and thence obtain the bending moment.

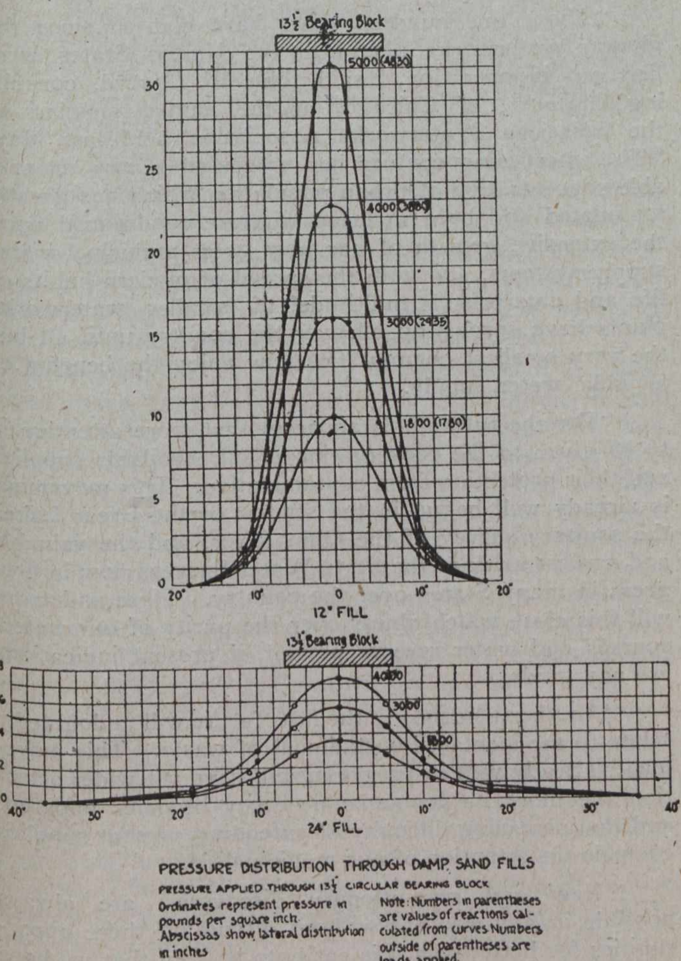


Fig. 3.—Results of Readings.

It is very common practice at the present time to assume that a wheel load acts over a definite area on top of the fill, that the pressure is transmitted with uniform intensity to the slab, and that it acts over an area determined by an assumed angle of spread from the top of the fill. This assumption of uniform intensity is, of course, wrong, as shown by these pressure measurements, but forms a convenient means of calculation provided the correct intensity and area of pressure are assumed. In order to make use of the curves of pressure for practical calculations of bending moment, it would be well to know the location of the centre of gravity of the half volume of the figure generated by revolving the curve about its central axis. The distance from the centre of gravity to the centre of the curve, multiplied by one-half the total load, is the moment about the wheel load of the distributed pressure to either side of that load. The centres of gravity of these half volumes for the maximum loads applied to the various depths of fill have been calculated, and are shown in Table I.

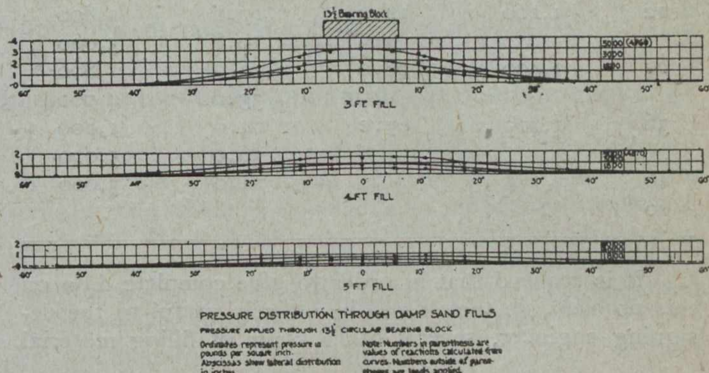


Fig. 4.—Results of Readings.

If, for the convenience of the designer, the pressure at the bottom of the fill is considered uniform and acts over a square of area, the sides of each of these areas will be equal to the values in the last column of the preceding table multiplied by four. The sides of the squares of areas thus obtained are somewhat different for the highest and lowest loads applied and may be tabulated as in Table II.

Table I.—Location of Centre of Gravity of Half of Pressure on Slab with Respect to Centre of Load.

Depth of Fill in.	8-in. Block Load, lb.	8-in. Block Center of Gravity to to Centre of Load, in.	13½-in. Block. Load, lb.	13½-in. Block. Center of Gravity to to Centre of Load, in.
6	1,400	2.6	....	....
12	1,200	3.6	1,800	4.4
			5,000	4.2
24	1,400	7.0	1,800	10.5
			4,000	8.4
36	1,400	16.8	1,800	16.0
			5,000	14.0
48	....	....	5,000	18.5

The results in Table II., for the high loads only, are shown graphically in Fig. 5. In calculating the bending moment in a slab, the designer, instead of using the varying intensity of the load, as it is shown to exist in the pressure measurements, may consider the same total pressure applied over a square of area whose side is given in Table II. or as shown in Fig. 5.

Table II.—Equivalent Squares of Area.

Depth of Fill, in.	Load on 8-in. Block, lb.	Length of Side of Square of Uniform Pressure Area, in. 8-in. Block	13½-in. Block.	Load on 13½-in. Block, lb.
6	1,400	10.4	....	....
12	1,200	14.4	17.6	1,800
			16.8	5,000
24	1,400	28.0	42.0	1,800
			33.6	4,000
36	1,400	67.2	64.0	1,800
			56.0	5,000
48	....	....	74.0	5,000
60	....	....	....	....

It is realized that in order to give complete data on this problem, so that it will be entirely useful to the designing engineer, several other kinds of filling material

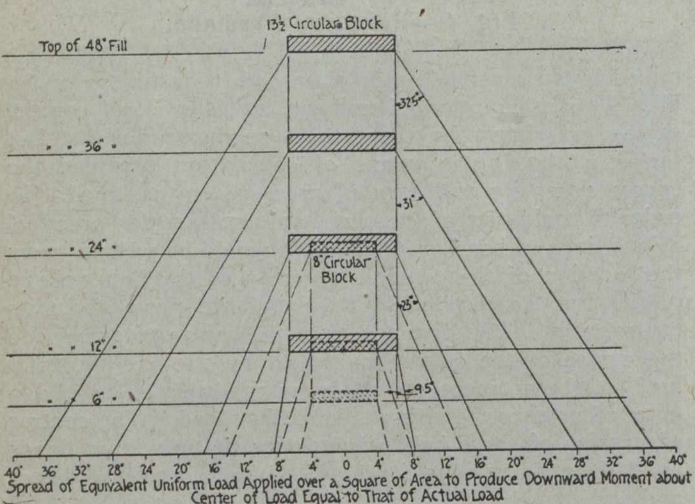


Fig. 5.—Equivalent Squares of Area.

should be investigated, and bearing blocks shaped and spaced like wheels and rollers should also be applied to the fill. This will all be undertaken in the investigation still under way, as well as the question of lateral pressures produced by vertical loads.

REPORT OF COMMISSION INVESTIGATING SASKATCHEWAN HIGHWAYS DEPARTMENT.

The Wetmore Royal Commission, which has been investigating the Highways Branch of the Provincial Government of Saskatchewan, has issued its final report and submitted it to the government. The report is signed by all three commissioners, ex-Chief Justice Wetmore (chairman), H. G. Smith and George D. Mackie. The report deals largely with the investigation into the Saskatoon bridge and answers the remaining questions categorically submitted to the commission regarding road matters.

Dealing with the Saskatoon bridge, the commissioners state that the government received full value for the money expended.

The commissioners censure Mr. McPherson for acting in a dual capacity as chairman of the Highways Board and shareholder in the contracting company, but state that neither the Minister, Mr. Carpenter, nor any other official of the government was aware at the time, or until some time after the claims had been adjusted, that Mr. McPherson was a shareholder of the company. From the commissioners' findings, however, it is clear that no evil consequences followed in the carrying out of the contract or the payment of money under it owing to Mr. McPherson having acted as stated.

The commissioners express the view that for such an important structure as the Saskatoon bridge, more time should have been allowed tenderers to submit prices.

The commissioners find that notwithstanding the facts contained in their criticisms, "the whole of the officials on whom devolved the duty of superintending and carrying out the details in connection with this contract performed their duties well."

Most of the questions categorically submitted to the commission were answered in the commissioners' interim report, already published.

The concluding pages of the report draw attention to the system prevailing in the Roads Branch of the Highways Department, and recommendations are made in connection with the departmental routine, looking to the future betterment of the system in certain directions.

WATER SUPPLY PROGRESS.

"About one hundred years have elapsed since the pioneer waterworks plants in the United States were first put in operation," said John W. Alvord, consulting engineer, of Chicago, at the annual meeting of the American Waterworks Association held last May. "The intervening century has witnessed a very remarkable concentration of urban population which has greatly stimulated and been in large measure conditioned upon the extensive growth of our now great municipal water supply systems, and with the spread of modern habits of life and enterprise a multitude of smaller waterworks plants have sprung up all over the country until all but the very smallest communities now enjoy the benefits of a public water supply.

"For the future it is apparent that more attention is to be given to the conservation of our available supplies and their protection from contamination. This movement is already well begun in the studies of the Great Lakes the sanitary survey of the Ohio River, and the valuable and earnest work of the State Water Surveys now in progress in many States over the country. More and more will this close watchfulness over the purity of our watercourses and water reserve prevail, if present indications are any guide.

"Another tendency in the near future will undoubtedly relate to the increased curtailment of waste. This movement, already well in progress, will have yet wider attention the more its economic necessity becomes apparent and the increasing difficulty of extending present supplies compels the attention of our municipalities.

"New and revolutionary discoveries are always possible in any art, but without discussing these opportunities for betterment it is easily to be seen that we have yet a great deal to do to organize, systematize and standardize the problem of public water supply in the next few years."

Mr. Alvord then re-read the paper on "Recent Progress and Tendencies in Municipal Water Supply," which he had presented to the International Engineering Congress, and which was published in full in *The Canadian Engineer*, issues of January 6th and 13th, 1916.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

CONTENTS.

BOOK REVIEWS.

Applied Methods of Scientific Management. By Frederic A. Parkhurst. Published by John Wiley & Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. 337 pages, 9 plates, 55 figures, 6 x 9 ins. Price, $2.00. (Reviewed by R. E. W. Hagarty, A.M.Can.Soc.C.E., Midland, Ontario.)

Mr. Parkhurst's new book, "Applied Methods of Scientific Management," adds one more to the growing list of publications on this new department of science.

For some years, engineers and others have been conducting investigations along this new line of industrial economics, but many of their activities have not met with complete response from the general public.

An explanation for this may be that many of the ideas which have been developed have revolutionized the systems commonly followed in standard commercial and industrial practice. There is probably no class more unwilling to admit the insufficiency of prevailing methods than "business men." This new department of science encroaches as never before upon big "captains of industry" and those responsible for promoting and maintaining our various industrial organizations. Such men are accustomed to issuing orders based almost entirely upon their individual sense of judgment. It is difficult for them to understand that science, in any form, tends to reduce the human équation of judgment to a minimum.

Further, it might be pointed out that many unqualified persons outside the engineering profession have undertaken to call themselves "efficiency engineers," resulting too frequently in public misunderstanding of the true aims of scientific management.

Also, it might be noted that any revolutionary movement passes through a stage of ridicule; but events which have transpired since the outbreak of the war have convinced the world of the necessity of applying scientific principles to industrial organization, and this branch of applied science has probably come to stay.

The field is large and still much unexplored. Scientific management has many phases, one of the most important of which Mr. Parkhurst has covered, namely, the industrial machine shop. His book is a highly practical and complete description of the application of scientific management to the works of the Ferracute Machine Co.

The author has followed largely the "Taylor System" with certain modifications adapted to the special case considered, which is applicable to businesses employing one hundred people or more. Particular attention is paid to the practical working out of details and many good examples are given of useful standard printed forms used in connection with this type of organization.

Another outstanding feature of the author's analysis of his case is the definite assigning of duties and responsibilities to all members of the organization down to the office boys.

As stated by Mr. Parkhurst, all applications of scientific management must be accompanied by an accurate study of human nature, and great diplomacy is necessary in making changes in organization methods. National and individual psychology must be taken fully into account in dealing with any large body of men. In this connection it would appear that some criticism might be offered in the wording of certain notification forms which are presented to workmen with their bonus money. Too much affluence is implied which is generally dangerous in dealing with men.

Mr. Parkhurst's book might be described, in a general way, as a practical answer to the question, "What does scientific management mean?"

Sanitation Practically Applied. By Harold Bacon Wood, M.D., Dr.P.H. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. 475 pages, 5 x 7 ins., illustrated, cloth. Price, $3 net. (Reviewed by R. O. Wynne-Roberts, consulting engineer, Toronto.)

As the author states in the preface, "this book is offered also as a corollary to the laboratory manuals, since the man in the field desires to know how sanitation of the home, of the school, of the factory and of the community can actually be obtained. It is primarily intended for the health officer and for the student of public health topics, but the employer, the employee, the teacher, the man in his own home or office or the municipal official may get some practical directions from it."

"Public health," the author states, "is an indispensable asset for the progress of any nation and its attainment an object of the first magnitude. The more protection a people is offered the more rapidly is it able to advance in civilization, in learning and culture, and the misery and ravages from catastrophe and pestilence will be correspondingly less."

This book is a valuable one for the health officer as it treats on the control of communicable diseases, child welfare, school lighting, pure foods, clean milk, water supplies, sewage disposal, hygiene of the home and factory, destruction of insects which transmit disease, etc.

For the municipal engineer it contains information on sewage disposal, but no reference is made to the activated sludge process. The chapter on water supplies has many points of interest, but the filters do not include the drift sand filter.

The book can be recommended to officials who require to understand the reasons for adopting different measures for the protection of the health of the people. It is well-printed and nicely arranged for reference.

It is interesting to note that Dr. Wood does not place much reliance on the presumptive test for colon bacilli, as it "gives little information of value and should be supplanted by plate isolation of the organisms. It does not prove sewage pollution or the presence of colon bacilli, but is simply suggestive." This is in line with Dr. Hugh S. Cummings' conclusion after making thousands of tests. The presumptive test and the erratic results obtained are subjects for lively discussion in many American conventions.

Irrigation Works Constructed by the United States Government. By Arthur Powell Davis, chief engineer, United States Reclamation Service. Published by John Wiley & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 413 pages, 128 illustrations, 6 x 9 ins., cloth. Price, $4.50 net. (Reviewed by A. S. Dawson, M.Can.Soc.C.E., chief engineer, Dept. of Natural Resources, C.P.R., Calgary.)

The author's preface states that in as much as all expenses in connection with these great works are charged to the water users, care is taken to incur no expenditure not absolutely necessary for the work; and that this rule applied to the publication of annual reports, excluding everything not absolutely required by law, and consequently the engineering descriptions of the work and illustrations which such would require.

It is the object of the present book to supply these needs for the information of the engineering profession.

The book as a whole is a valuable work of reference for all engaged in irrigation engineering, and has been prepared by an engineer whose connection with the United States Reclamation Service has enabled him to present much valuable data.

The book would be a valuable addition to any engineer's library, and particularly to those interested in irrigation engineering.

Its scope, which includes all the important projects throughout the United States, is clearly shown in its complete index, and it gives a very full description of the important features involved in the construction of the large irrigation works by the United States Federal Government—works which for boldness of design and unprecedented practice surpass anything in the world. This is particularly true when it is realized that these works included the designing and construction of the four highest existing dams constructed to date in any country, and for which no precedent exists. The book contains 400 pages (6 x 9), 128 figures.

The works described involved an expenditure of over one hundred million dollars, and in many cases were executed under extremely difficult and abnormal conditions.

The book contains twenty-three chapters. Chapter 1 is introductory, giving a short history of irrigation development in the United States, and leading up to the passage of the National Reclamation Act in 1902.

Chapters 2 to 22 inclusive are descriptions of the 21 different projects built, some of which are among the largest individual irrigation enterprises ever constructed. Each of these chapters include (1) a general history and description of the project in detail; (2) description of the various reservoirs, storage and diversion dams, constituting the headworks proper; (3) descriptions of the hydro-electric plants, pumping stations, or other special features existing; (4) a description of the distribution system in detail; (5) a description of the drainage problem involved; (6) a description of the system of water-delivery; (7) agricultural development resulting from the construction of the works.

Chapter 23 deals with the general questions of settlement and cultivation; and embodies such subjects as the difficulties of the settlers, values created by the works, soil conditions, etc.

The value of the book is greatly enhanced by a well-selected collection of 85 illustrations, about 43 detail drawings, and many valuable tables.

The book is a real addition to the literature of the special subject treated, and is an excellent description of these works, which will stand as monuments to their designers and builders.

It shows much care and thoroughness in preparation, and deserves a place in every engineer's library.

Applied Mechanics. By Professor A. P. Poorman, Purdue University. Published by McGraw-Hill Book Co., New York City. 244 pages, illustrated, 6 x 9 ins. Price, $2. (Reviewed by Prof. R. W. Angus, University of Toronto.

In looking over this book on applied mechanics one is struck very forcibly by the large collection of examples illustrating each part of the subject. These examples are, on the whole, carefully selected, and are of a practical nature which gives them an added value, and makes the book of much assistance to the reader.

The general treatment of the subject is much the same as is to be found in other similar text-books, although the author has made a special effort to use graphical methods where possible. Mathematical lines of deduction have been used quite freely, so that readers must understand the calculus to get the real value of the book. To this, however, no exception should be taken, as a good knowledge of mathematics must be assumed for readers of this subject.

The author has chosen two main divisions of his treatment, *viz.*, statics and kinetics, dealing with composition and resolution of forces, friction, centre of gravity, and moment of inertia under the first division and with motion of various kinds, work and energy and impulse, momentum and impact under the second.

The book is well arranged, the printing and illustrations are well made, and it is a very creditable work on the matters covered by it.

Shipyard Practice as Applied to Warship Construction. By Neil J. McDermaid. Published by Longmans, Green & Co. Second edition. 332 pages, illustrated, 6 x 9½ ins., cloth. Price, $4. (Reviewed by H. H. German, chief engineer, Canadian Vickers, Limited, Montreal.)

At a time when the attention of this continent is occupied so largely with warship construction, this volume will prove a valuable addition to the technical literature for anyone concerned with the building of warships. While the book was written to provide students and others with a knowledge of the actual operations performed in the shipyard during the construction of a warship, it is of great value to technical men and engineers, as it explains the inherent characteristics of ship construction.

The matter is arranged progressively so that the reader may work through the book in logical order. Starting as it does with a comprehensive study of the "Building Ship," and following with chapters on keels, framing, checking of form of ships, castings, rudders, launching, water testing, ventilating, draining, accommodation, etc., and finally giving a series of problems on "Laying-off." These chapters are particularly clear and are written in such a way as to be essentially practical; a style no doubt evolved from the author's experience when lecturing to naval construction cadets at the Royal Naval College, Devonport.

The book is clearly written, splendidly illustrated and is undoubtedly based on an accurate knowledge of the subject.

Water Purification. By Jos. Wilton Ellms, consulting engineer, Cincinnati, Ohio. Published by John Wiles & Sons, Inc., New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1917. 485 pages, 150 figures and numerous tables, 6 x 9 ins., cloth. Price, $5 net.

The author has attempted a broad account of the development of water purification. Considerable attention has been paid to the properties of various classes of water as regards physical, chemical and biological characteristics. The relation of polluted public water supplies to water-borne diseases has received special attention, and the various steps in the purification processes, such as plain sedimentation, coagulation, filtration and disinfection are described in detail. Special chapters are devoted to water softening and to the removal of iron and manganese from the ground water supplies.

The rapid progress made in the art of purifying and clarifying turbid waters during the past quarter of a century has been notable. The evolution of the rapid sand filter from its crude beginnings to its present well-developed state is distinctly the result of research work, and it was Mr. Ellms' good fortune to have been identified with many of the earlier investigations of this problem and to have been able to follow its solution closely in actual practice throughout the quarter century. He has not hesitated, however, to draw upon the experiences of other investigators, especially those of his partner, Mr. Clifford N. Miller, of the consulting firm of Ellms & Miller, of Cincinnati, who has contributed much material dealing with the hydraulics of the flow of water through filters and with the discharge of water from waste water troughs in the operation of rapid sand filters.

The contents of the book are well indicated by the chapter headings, which are: Classification of natural waters; transmission of disease through drinking water; the effect of improved water supplies upon health; objects and methods of water purification; sedimentation; types of settling reservoirs and coagulation basins; practical efficiencies of settling and coagulation basins; filtration of water; preliminary treatment of water for slow sand filters; system of slow sand filtration; efficiency and cost of operation of slow sand filters; rapid sand filtration; general arrangement of rapid sand filter plants; details of rapid sand filter plant construction; regulating, measuring and indicating devices for rapid sand filter plants; equipment for the handling and storing of chemicals and for the preparation of solutions; apparatus and methods for applying chemicals and the preparation of solutions; power plant, pumping machinery, air compressors, air tanks, wash water tank and miscellaneous equipment; the cost of constructing rapid sand filters; rates of filtration, loss of head and washing of rapid sand filters; the physical and chemical changes produced by the application of chemical coagulants, and by the subsequent filtration of the treated water; efficiency and cost of operation of rapid sand filters; disinfection of water supplies; the removal of dissolved mineral matter from water; the control of water purification processes; the flow of water through rapid sand filters; an approximate formula for calculating the discharging capacity of rapid sand filter wash water troughs.

At the end of each chapter is given a list of the references used in that chapter which, taken together, form a brief yet handy bibliography.

The book is eminently practical, showing actual equipment photographs, although not at all to the extent of giving the volume a catalogue appearance.

Text Book on Motor Car Engineering—Volume II., Design. By A. Graham Clark, M.I.A.E., A.M.I.M.E. Published by Constable & Co., London, 1917. 368 pages, 66 illustrations, 37 tables, 6x9 ins. Price, $2.50.

"Design is one of the most interesting branches of engineering." With this statement the author commences his second volume of the Text Book on Motor Car Engineering, that on "Design," the first volume dealing with "Construction."

Written from the British viewpoint, this book deals with the design of the petrol engine and chassis, and is intended for the use of engineers, designers, draughtsmen. students and others whose work entails a knowledge of design.

In the seventeen chapters, such subjects as general considerations in engine design, determination of engine dimensions, valve gears, lubricating and cooling arrangements, frames, axles and springs, and transmission gear are treated in full, together with allied topics.

Some 27 tables are incorporated into the text of this excellent volume which is well illustrated with diagrams, profiles and photographs.

PUBLICATIONS RECEIVED

Air Compressors.—Bulletin K-300-A of the Canadian Ingersoll-Rand Co., Sherbrooke, P.Q., illustrating power-driven, single-stage, straight line air compressors, designed for motor or belt drive, for use in industrial or mining plants where units of 950 cubic feet displacements per minute or less are required.

Holt Roof Connections.—An illustrated booklet published by the Barrett Company and distributed by the Paterson Manufacturing Co., of Montreal, Toronto, Winnipeg and Vancouver. Shows diagrammatic sketches and photographs of the connection for vents and leaders and illustrations. Twenty pages; two colors.

The F-M Book.—A very wide range of goods is shown in the Canadian Fairbanks-Morse Co.'s new general catalogue, which they have called the F.M Book. It is in convenient size for reference and contains 1,048 pages and nearly 5,000 illustrations. Twelve distinct departments are represented, namely, those handling scales, valves and steam goods, automobile accessories, engines, electrical apparatus, pumps, machine tools, wood-working machinery, transmission machinery, railway and contractors' supplies, factory supplies, safes and vaults. An interesting part of the book is a section of 64 pages, printed on yellow paper and well indexed, containing tabulated information of an engineering nature most commonly used and to which everyone has to make most frequent reference, and which is here given in very handy style. The book is being distributed gratuitously to engineers, manufacturers, contractors, etc., upon request.

"SEMI-CONFISCATION," SAYS SMITHERS

In a statement issued by Mr. A. W. Smithers, chairman of the board, Grand Trunk Railway system, he deals at length with the conclusions arrived at by the majority report of the Railway Commission. After pointing to the fact that the Grand Trunk Railway was commenced in 1853, and built by British labor, British engineers and British capital, at a time when, as the pioneer railroad of Canada, great obstacles had to be overcome, Mr. Smithers refers to the improvements carried out in the construction of bridges, double tracking, improvement in equipment, etc. In the 65 years of the company's existence, it has never defaulted on its fixed charges. Reference is made to the fact that in June, 1915, in the midst of war alarms, the Grand Trunk was able, with the consent of the British treasury, to raise $12,500,000 in five hours.

The increase in Grand Trunk capital raised in London since the present board came into office, amounts to nearly $150,000,000, which was all raised at a little over 4 per cent. The Grand Trunk capital at present amounts in round figures to $430,000,000.

Continuing, Mr. Smithers says: "Over this period of 65 years, during which the Grand Trunk Railway has been serving the ever-growing needs of Canada, the total assistance received from the government of Canada has been only $28,000,000, of which about $12,000,000 represents bonuses given by manufacturers to aid in the construction of lines subsequently acquired by the Grand Trunk, and of which this company really never got the benefit. This compares, according to the majority report of the commission, with $347,000,000 received by the Canadian Pacific Railway in 35 years, of which amount $119,000,000 represents the value estimated by the company of the lands still unsold, and $298,000,000 received by the Canadian Northern Railway in 15 years, and $114,000,000 received by the Grand Trunk Pacific Railway in 15 years."

Mr. Smithers details the history of the Grand Trunk Pacific and gives the causes which increased the cost of building the Grand Trunk Pacific far beyond the amount estimated when the acts of 1903 and 1906 were passed.

"The causes of the increase," Mr. Smithers says, "were obviously beyond the control of the company. This increased cost has brought both the Grand Trunk Pacific and Canadian Northern Railway into financial difficulties which have been aggravated by the effect on the money markets of the world of the terrible war now raging in Europe."

Continuing, Mr. Smithers says: "The majority report of the Royal Commission now proposes that the Canadian Northern should be taken over by the government and relieved of all its liabilities, but does not propose to apply the same method to the Grand Trunk Pacific, which has received far less assistance than any other road. The commission proposes that in consideration of the Grand Trunk Pacific being taken over by the government, the old Grand Trunk, as one of the parties to the construction of the Grand Trunk Pacific, should be surrendered to the government on terms amounting to the semi-confiscation of the rights of British stockholders. In other words, they suggest that the pioneer railway of Canada, which out of its own resources has rendered far more service to Canada than any other railway, should be the only railway to be treated in this unjust way, a way certainly unprecedented in the history of Canada. In addition to having carried the largest traffic in its history during the last year, the Grand Trunk, at the request of the government, has undertaken considerable orders for munitions, and the work has received high approval.

"Anyone reading the majority commission report will find, so far as the Grand Trunk is concerned, no reference to the fact that we are in the midst of the greatest war in history, that in consequence of the demands of that war, it has been impossible to obtain adequate supplies—coal, engines, rolling stock or rails, and that by common consent Canada has just passed through one of the severest winters in its history. The officials of the company are prepared to substantiate the fact that the congestion on the Grand Trunk Railway was less than on the American railways on the frontier, and on the other Canadian railways, and that notwithstanding the congestion, the company carried in that time the biggest traffic that it has ever carried.

"Locomotives have been ordered at prices varying from $45,000 to $50,000, or more than double the cost prevailing before the war, and freight and coal cars at even greater price," Mr. Smithers points out.

LACK OF COAL TRANSPORT PARALYZES TRADE

A sidelight on Canada's coal problem was furnished by the federal trade commission of the United States in a recent report to Congress. The following are excerpts from the report: "In the anthracite industry coal has been traced from point of production to point of consumption. Weekly reports are required from producers and jobbers wherever needful, with the result that as regards domestic sizes high premium coal has largely been eliminated from the market, and speculation and inordinate profits have been cut in the wholesale trade in these sizes.

"During the first two months of the coal year—April and May—there has been an increase in the production of anthracite of 2,433,000 tons as compared with same months of 1916. This is an increase of 24 per cent., and should have been translated into a distinctly favorable condition of the market."

The commission finds, however, that coal miners are crushing up domestic sizes in the breaker to supply steam sizes, the price of which the commission has been unable to curb. "If this practice continues it will constitute another evil for the future of the domestic user," the commission declares. "The stores of anthracite which now should be accumulating against next winter for domestic use are being used for steam-making in the place of bituminous coal, in place of coke, and in the production of water gas, because such anthracite is easier to obtain and at favorable prices as compared with bituminous and coke," the report continues. "The present production of bituminous coal the country over is about 40 per cent. short of the possible maximum, and this limitation is solely charged as a primary cause to faulty rail transportation. The present demand for coal is unprecedented, but the mines now open are capable of filling this demand if adequate car supply is furnished.

"It is a fact that in the bituminous industry the capacity of the mine for production and the capacity of labor is limited absolutely by the supply from day to day of coal cars for the moving of the product. Thus, we have found that with the market at unheard of prices, labor is often standing idle at the mines, and production is limited as compared with the possible producing capacity. The commission believes there are enough coal cars in the country, but that there are not enough coal cars delivered at the mines, and that an inadequate supply having been delivered to the mines and loaded, these cars are not moved to the point of consumption either with the greatest expedition, nor are they promptly discharged upon their arrival at their destination.

"The commission has much testimony of the widespread abuse in the use of cars by speculators for the storage of coal for speculative purposes, and the coal cars are being used for the transportation of many other sorts of products.

"The commission believes that the coal industry is paralyzing the industries of the country, and that the coal industry itself is paralyzed by the failure of transportation. The coal problem cannot be worked out as long as the railroads are allowed to divide and allot traffic; to lay embargoes without regard to their immediate effect upon industry or the systematic distribution of coal; to give priority to the movement of high freight rate commodities, and to use the device of the 'long haul.' Whatever remedy may be applied, should be applied as immediately as possible, for time is passing, and no human power can supply the factor of time lost. Time is necessary to build up the stores of fuel at distant points, and that storage should begin without unnecessary loss of an hour.

"The serious aspect to the country at large is the immediate and intolerable hardship laid upon industry and transferred in large part to the public in increased prices, and the future hardship which will fall upon the domestic consumer next winter. It would seem that steady employment, fair compensation to labor and capital, equitable distribution, and stable prices could be secured by pooling all coal and coke production in the hands of the government. This would still be ineffective, either as to distribution or as to the promotion of a maximum of production, unless similar control extended over all means of transportation, both rail and water, and to meet this, the pooling of railroads and boat lines is clearly indicated. The railroads of the country, if operated as a unit and on a government account, could be used to transport coal and other products by the most direct route to the point of destination, and the efficiency of the roads themselves and of existing rolling stock and motive power would be vastly increased."

Editorials

POLITICS AND THE ENGINEER

The means whereby electoral ascendancy is obtained, and after achievement maintained, are commonly termed politics. It is necessary to separate government from politics, although the two distinct activities are so intermixed that many confuse them. Politics is not government, but is the means whereby a particular policy is advertised or men of certain views are placed into power to govern.

Government and legislation must also be separated. The former is administrative, and carried on by individuals selected by the majority party in power. The latter is debated, discussed and passed upon by all the representatives chosen. It has been found necessary to provide safeguards and checks against panic and hysterical legislation to which democratic government is prone. The interaction between all the forces, together with the checks and safeguards, constitutes the ruling power in any State. No electoral system is perfect, judged by results. Under existing systems of majority rule it is the minority who suffer; hence the propagandist work done by sub-sections of the electorate, who may, although numerous, be scattered, and so penalized.

Systems of government and representation are at the moment under review, if not actually in the melting-pot. The outstanding virtue of popular control, expressed by the votes of the electorate at recurrent intervals, ensures that change shall be evolutionary. Where popular control is absent (and for that matter, sometimes where it is present) there is a tendency for the administration to sit upon the national safety valve. This overloading occasionally produces an explosion, the results of which are lamentable, since they cannot be expected to discriminate.

The interests of a country are far wider than its laws, which are mostly restraints of one sort or another. They are, therefore, wider than its parliament or the smooth working of a party machine.

Serving a country means developing its resources—mineral, manufacturing, agricultural and human. Thus it means fostering international trade, educating its people, organizing and exploiting its natural advantages, encouraging the finer things of life and thought. All these together present a limitless horizon, often, it is feared, beyond the vision of the party politician.

Government is becoming less and less superstitious belief in party, more and more a matter of economics; less a matter of speech-making, and more a matter of encouragement and action, fostered by wise administration.

The recruits to posts of executive authority in national affairs who would be the most desirable are men who, having proved personal capacity in other directions, can therefore be safely entrusted with the administration of the national property. Men of big vision and proven capacity, whose work is of communal character, done in the direction of service to the people at large, are the men wanted. The scope is limitless, the need is urgent, the moment is imperative, a new era of vital reconstruction is at hand.

If selection be not political, where should we look for the men who have accomplished the most difficult tasks, organized human material in the greatest numbers outside military scope, developed and increased natural resources more than anyone else? The answer is perfectly clear. The choice would fall upon the engineer.

Until now he is not represented save in exceptional cases, but times are changing. There is a new atmosphere; old shibboleths are being cast aside and the future looks for leaders. There is no question but that the men who have handled the biggest jobs since the world began have the mentality and experience to solve problems which have wrecked political parties in the past and may wreck them again next fall. It is national engineering that is wanted, state manufacture, the regrading of national prosperity; and the men ready and suitable are waiting their turn. The future government must include the engineer in some quantity.

ICE JAMS AT NIAGARA

Dr. T. Kennard Thomson, C.E., a well-known New York consulting engineer and a graduate of the University of Toronto, class of 1886, urges the development of power at Niagara by international agreement, and says that if too much water be taken from above the Falls and restored below the rapids, a ruinous ice jam will result. Dr. Thomson's views are of interest on account of the design of the Ontario Hydro-Electric Power Commission's proposed plant at Queenston, which will develop power from the 300-ft. head obtained by diverting water from the rapids.

The following letter, which Dr. Thomson recently addressed to the editor of The Engineering News-Record, of New York, makes the rather startling suggestion that all the new power plants might be carried away by the breaking of an enormous ice jam:—

"I see that the Hon. H. R. Flood, chairman of the Foreign Relations Committee of the House of Representatives, has introduced a resolution to permit taking 20,000 cu. ft. of water per second from above the Niagara Falls (as an experiment until July 1, 1918) for power development. There are also several concerns which desire to divert water from above the Falls and others from above the rapids below the Falls. In each case the concern would return the water to the Niagara River below the lower rapids, in order to take advantage of the 300-ft. head.

"This will not only destroy the beauty of the present Falls and the rapids below, but will create a very dangerous condition indeed, for to carry out these plans will be equivalent to committing suicide.

"The reason for this effect must be plain to anyone who knows the Niagara River well—for rapids always mean shallow water—and the Niagara rapids, as all others, are formed by rocks projecting above or near the surface, as can easily be seen from the shore. The rapidly flowing water striking these rocks is hurled up into the air, forming the magnificent spectacle we know so well. There are so many of these rocks that the flow of the river (220,000 cu. ft. per sec.) is only barely sufficient to carry away the ice, of which an enormous amount passes over the Falls every spring.

"The various projects want to divert 50 per cent. or more of the flow from the rapids through new channels (canals and tunnels); and if they are allowed to do this, then the remainder of the water flowing through the Gorge (in which the rapids are) will not be enough to carry off the ice, which will at once cause an ice jam.

"This ice bridge or jam is liable to be a hundred feet or more in height and will result in the destruction of all the existing power plants at the Falls; for when the jam breaks, all the new power plants below the ice jam will be carried away. All power development in the Niagara River would cease for a year or two. This can easily be understood by those who saw the jam, a few years ago, which lasted for eight hours and, in breaking, stripped the banks to a height of 20 to 40 ft. for miles down—destroying wharves, etc., at Queenston and Lewiston.

"The Niagara River should be developed to give the maximum amount of power at minimum cost and at the same time to preserve the beauty of the falls. This result can only be obtained by an international agreement in which the entire question should be treated as a unit—not as a 'crazy quilt' patchwork. Otherwise, the consumer pays the bill."

When considering Dr. Thomson's letter in connection with the proposed Hydro development, it should be borne in mind that the danger he refers to is based upon an assumption that 50 per cent. or more of the 220,000 sec.-ft. is to be diverted from the rapids.

The Hydro scheme, as at present constituted, calls for the diversion of only 17,790 sec.-ft. (even including the 11,180 sec.-ft. now developed at the Ontario Power Co.'s existing plant) and could include only 36,000 sec.-ft. even if the other two Canadian companies at the Falls were to be purchased and all their water rights diverted to the Queenston plant.

The United States has the right, of course, to divert from the rapids the same amount of water as is so diverted by Canada, but by the time proper allowance is made for the amount diverted through the Chicago and Erie Canals, the total diversion from the present rapids would not very greatly exceed 50,000 sec.-ft., or only about 25 per cent. of the present flow, instead of 50 per cent.

There is a wide variation of opinion concerning the amount of water necessary to keep the river clear of ice. Some engineers who are also closely in touch with the conditions, assert that 40,000 sec.-ft. would keep the river free from any dangerous jams.

Dr. Thomson's apparent anxiety regarding the "beauty of the present Falls and the rapids below," and his description of the "magnificent spectacle" which they afford, are strangely inconsistent with the attitude which he adopted only last summer when urging the Ontario government to adopt the Thomson-Porter scheme of development whereby a dam which he desired to build above Queenston would have completely drowned out the rapids and the whirlpool, leaving only a comparatively gentle and sluggish five-mile stretch from the Falls to Queenston.

However, inconsistency does not invalidate Dr. Thomson's remarks, to which the engineers in charge of Niagara's development will no doubt give proper heed and study. As Emerson says, "a foolish consistency is the hobgoblin of little minds, adored by little statesmen and philosophers and divines. With consistency a great soul has simply nothing to do. He may as well concern himself with his shadow on the wall. Out upon your guarded lips! Sew them up with pack thread, do. Else, if you would be a man, speak what you think to-day in words as hard as cannon balls, and to-morrow speak what to-morrow thinks in hard words again, though it contradict everything you said to-day. Why drag about this monstrous corpse of your memory, lest you contradict somewhat you have stated in this or that public place? Suppose you should contradict yourself; what then?"

PERSONALS

J. A. MacGillivray, assistant bridge engineer of the Manitoba Good Roads Department, has resigned.

E. W. M. James, A.M.Can.Soc.C.E., has been appointed bridge engineer with the Manitoba Good Roads Department.

Flight-Lieut. T. C. Hoidge has been awarded the Military Cross. He is a graduate of the School of Practical Science, Toronto University, Toronto.

C. W. Peeling, local manager of the Oshawa Electric Light and Power Co., has been appointed manager of the Cornwall (Ont.) Street Railway Light and Power Co.

Harry Clifford Rose, B.A.Sc., who was lieutenant in the 219th Field Company, Royal Engineers, and a 1916 graduate of the School of Practical Science, Toronto, has been wounded.

Melville P. White has been appointed manager of works of the Canadian Allis-Chalmers, Limited. In this column last week it was erroneously stated that Mr. White had been appointed general superintendent.

William J. Lynch has been appointed general manager of the Quebec Railway Light, Heat and Power Co., Limited, in succession to the late H. G. Matthews, and C. Piggot has been appointed chief engineer.

Allan O. Leach, of the engineering department of the Canadian Northern Railway, has been appointed by the United States War Department as supervising engineer in charge of the construction of Camp Dodge, Des Moines, Iowa.

Albert G. Langley, M.E., consulting mining engineer of Vancouver, has been appointed district engineer of the eastern mineral survey district. He will immediately assume his new duties at Revelstoke, B.C., his headquarters.

A. R. Roberts, B.Sc., of Toronto, is no longer representing the Cement-Gun Co., Inc., of Allentown, Pa., having decided to join the Burns Cement-Gun Construction Co., Limited, and take on contracts for gunite work instead of selling cement-guns. Mr. Roberts is also a partner in the firm of Burns & Roberts, manufacturers' agents, and is the representative for all Canada, excepting British Columbia, of the Chapman Valve Manufacturing Co.

OBITUARIES

Archibald Downie, of the firm of Watson & Downie, contractors, Calgary, died from injuries received by a fall at a building under construction by the firm.

Prof. Nathan F. Dupuis, for many years dean of practical science at Queen's University, Kingston, died on July 20th at Long Branch, California, where he went for the benefit of his health. He was 81 years of age and was connected with Queen's for fifty years.

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(Continued from page 72.)

sleeve, the lower end of the plunger being spherical in shape with a radius of 1 cm.;

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

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

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

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

A revision of the tentative test for the determination of the apparent specific gravity of coarse aggregates was also proposed by the committee. In its report last year the committee proposed a tentative test which was published among the tentative standards. While, according to the report, it is believed that this test is satisfactory for aggregates that are absolutely homogeneous, recent investigations have demonstrated that it is difficult to ascertain the homogeneity of an aggregate. The tentative test proposed by the committee to supersede the one presented in 1916 follows:

The apparent specific gravity shall be determined in the following manner:

1. The sample, weighing 1,000 g. and composed of pieces approximately cubical or spherical in shape and retained on a screen having 1.27-cm. (½-in.) circular openings, shall be dried to constant weight at a temperature between 100 and 110° C. (212 and 230° F.), cooled, and weighed to the nearest 0.5 g. Record this weight as weight A. In the case of homogeneous material, the smallest particles in the sample may be retained on a screen having 1¼-in. circular openings.

2. Immerse the sample in water for 24 hours, surface-dry individual pieces with aid of a towel or blotting paper, and weigh. Record this weight as weight B.

3. Place the sample in a wire basket of approximately ¼-in. mesh, and about 12.7 cm. (5 in.) square and 10.3 cm. (4 in.) deep, suspend in water* from centre of scale pan and weigh. Record the difference between this weight and the weight of the empty basket suspended in water as weight C. (Weight of saturated sample immersed in water.)

4. The apparent specific gravity shall be calculated by dividing the weight of the dry sample (A) by the difference between the weights of the saturated sample in the air (B) and in the water (C), as follows:

$$\text{Apparent Specific Gravity} = \frac{A}{B-C}$$

5. Attention is called to the distinction between apparent specific gravity and true specific gravity. Apparent specific gravity includes the voids in the specimen and is therefore always less than or equal to, but never greater than the true specific gravity of the material.

This test, according to the report, is suitable for both non-homogeneous and homogeneous coarse aggregate and, like the test for toughness of rock, was recommended by the committee for publication for one year as tentative before being put to letter ballot for adoption as standard.

The recommendations of the committee for the revision of the standard method for the distillation of bituminous materials for road treatment dealt only with the specifications for the thermometer used. It was explained in the report that the method adopted by the society in 1916 was entirely satisfactory from the standpoint of Committee D-4 alone, but that the paragraphs specifying the thermometer to be used should be revised to conform with similar portions of other specifications.

During the past year, according to the report, a joint conference committee, made up of members of Committees C-9, On Concrete and Concrete Aggregates, and D-4, has given further consideration to the terms "aggregate," "bank gravel," "screen," and "sieve." As a result of that study the committee recommended for publication as tentative the following definitions:

Aggregate.—The inert material, such as sand, gravel, shell, slag or broken stone or combinations thereof, with which the cementing material is mixed to form a mortar or concrete.

Screen.—In laboratory work an apparatus, in which the apertures are circular, for separating sizes of material.

Sieve.—In laboratory work an apparatus, in which the apertures are square, for separating sizes of material.

Bank Gravel.—Gravel found in natural deposits, usually more or less intermixed with fine material, such as sand or clay, or combinations thereof; gravelly clay, gravelly sand, clayey gravel and sandy gravel, indicate the varying proportions of the materials in the mixture.

The committee also reported that in addition to its recommendations regarding the adoption of the proposed method for the determination of the specific gravity of coarse aggregates and the definitions preceding, the joint conference previously referred to had under consideration methods proposed by Committee D-4 for the determination of the specific gravity of sand and other fine highway material, and of voids in mineral aggregates; and was also considering definitions for "filler," "grit," "loam," "screenings," and "silt."

The committee also submitted as a part of its report a discussion of British standard nomenclature as compared with the nomenclature adopted by the society. This was included because of the publication of a report on "British Standard Nomenclature of Tars, Pitches, Bitumens and Asphalts" by the Engineering Standards Committee of Great Britain.

Hon. F. G. Macdiarmid, Minister of Public Works for Ontario, announces that arrangements have been made for a short course in highway construction to be taken up at the fall term of the Ontario Agricultural College. Lectures will be given by members of the staff of the highway department. The course will cover road development, growth of traffic, economic value of roads, road drainage and grading, road foundations, maintenance, etc.

*The basket may be conveniently suspended by means of a fine wire hung from a hook shaped in the form of a question mark with the top end resting on the centre of the scale pan.