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The Canadian Engineer

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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Meteorology and Stream Regulation

Direct Effect of Weather on Flow and Indirect Effect Through Protection of Forest Growth—Study of Wind, Temperature, Precipitation and Barometer Records Aids Both In Control for Power Purposes and In Fighting Forest Fires

By W. F. V. ATKINSON

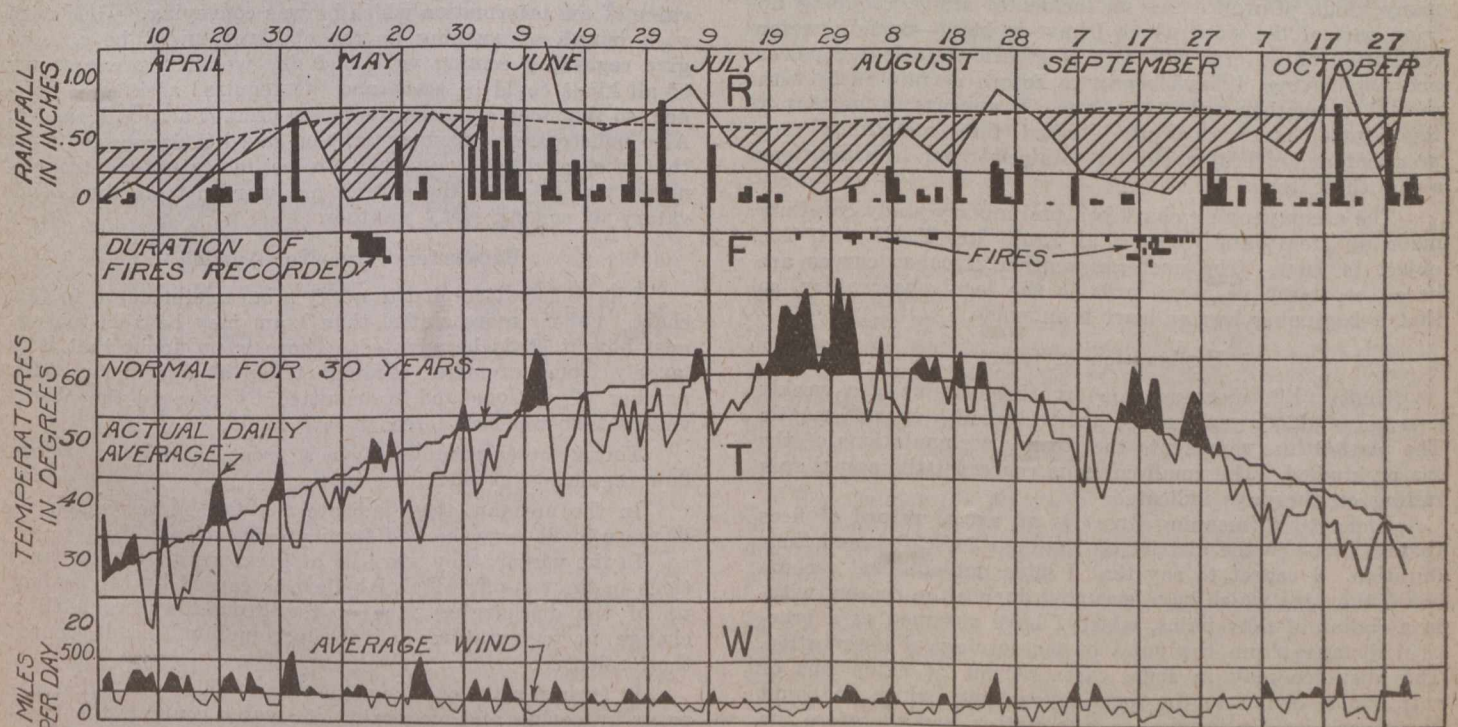
Superintendent of Water Regulation and Chief Forester, The Spanish River Pulp and Paper Mills, Ltd.

SINCE the days of Noah, people have been watching the weather and trying to obtain advance information in regard to it. Meteorological work has advanced until within the last fifty years it has become a science and is now used in many ways, while water storages have been constructed to offset unfavorable weather conditions.

Ever since logs have been floated on streams where the flow was not always sufficient, water storages have been built and used, generally without any reference to meteorological data. The modern intensive idea, however, seeks to get the greatest possible advantage from expenditure of any kind. So storage capacities are taxed to their utmost to supply the ever-increasing demand for power.

Engineers, when consulted as to the greatest possible efficiency of a plant run by water, require a continuous and steady water flow, and know that the uncontrolled flow of a river is one of the most variable things in the world and that no two rivers are alike. My own experience has shown a variation in flow as one is to thirty-five and even greater, depending upon the pitch of the watershed. Where man has cleared part of the land and drained it, and where fires have frequently occurred, so that the vegetable covering which nature provided has been destroyed, these varying conditions are very much increased and erosion begins.

When one has to attempt to control a river, the first question asked is, what has the weather man recorded in the district? The meteorologist is then consulted; for he, alone and unnoticed, may have been patiently recording the rain and snow fall, temperature and winds for years, possibly making evaporation tests also. The length and accuracy of this work, as well as the inter-proximity of the locations at which it is carried out, is one of the fundamental points on which success largely hangs. River flow gauging and correct area measurements are others. The botanist is needed in order to know how plant life affects the situation and how much of the water precipitated in the district is absorbed to sustain the growth therein. The geologist is also needed to advise what effect the mineral soils and rock strata have upon the surface waters in each locality, what percolation may occur, and also the action of the sub-surface waters. This latter condition depends largely, however, on the former. The information required from these varying sources, together with topographical maps, form a logical foundation for a practical report. The local topography and



METEOROLOGICAL CHART, SAULT STE. MARIE OBSERVATORY, SEASON 1917

growth cover, whether forest or otherwise, plays no little part in this problem.

Meteorological records show that precipitation varies very considerably from one year to the next in the same place, and that this may easily be 20 per cent. plus or minus to the average, should one be fortunate enough to have an average to figure from. Does this then mean that there may be a difference of one-third between one year and the next? While this may literally be the case with precipitation, it is a rare exception when absolute control of run-off can be expected, and therefore, while the annual precipitation may thus vary, the available per cent. of the run-off need not necessarily vary to this extent for practical purposes, depending partly on the season at which the shortage occurs. More than two-thirds of the average run-off cannot often be made effective for actual power by construction and organization. Thus the loss caused by the shortage in precipitation should, if conditions are such as to permit a considerable control of the water, be allowed to relate as far as possible to the surplus, or waste water, and not to the required effective percentage of the mean run-off.

Weather and Forest Fires

If meteorology has now got to the stage where it plays so important a part in works of this kind, can it not be used further? Speaking as a forester of many years' experience, I believe it can, but in all attempts at work in which experience, either personal or otherwise, is unavailable or lacking, this work is likely to be regarded by those without the necessary patience and powers of observation, as foolish experiments and a waste of time.

In beginning any study or occupation worth while, one is apt to find very soon that there is a lot to learn about it which they little realized. I well recall that I felt somewhat that way myself many years ago when in the "lab" I asked the late Prof. Mgr. Laflamme if he had ever come across a student so physically constituted that he could not learn to use a blow-pipe; and again later in the logging business before I learned to ride a saw log. Afterwards one feels ashamed of the feelings that almost led them to quit. Patience, persistence and observations properly recorded will get us a long way further than can be seen near the start.

I feel that if meteorological facts could be properly understood, that a reasonably correct forecasting of conditions for a shorter or longer period would be a real asset in many kinds of work. As an incidental study, cropping up from part of the work which I have in hand—namely, water regulation on several rivers in Northern Ontario for power and log driving, I have begun to record certain facts with regard to weather and forest fires. It appears to me that if this matter were carefully studied that something very practical and useful could be obtained from investigations along these lines.

The accompanying chart is a preliminary study carefully made up from data recorded at Sault Ste. Marie with this object in view. The average weather lines or curves are based on thirty years' records in the local observatory, so that a beginning has at least been made.

Explanation of Chart

Under "R" (meaning rain) the broken line is a weekly average of thirty years expressed to the 15th of each month. The plotted line represents the weekly accumulations of the season studied. The small columns represent the actual rain falling on the days indicated.

Under "F" (meaning fires) is an actual record of fires that occurred in the district on the days indicated, and their duration. I regret to say that I have not obtained records of *all* the fires which have occurred during the season, within a radius of fifty miles, which I have assumed as a practical distance from the point of meteorological observation. This distance may in some cases permit of extensions or retractions, owing to the local topography, which no doubt has a considerable bearing in this matter, and therefore the district, centering as it were on the particular observatory, may be of irregular form. Some other fires did occur in the district, but owing to the reticence of those in charge of this matter, the required information was partly withheld. This is not the only instance in my experience where secretiveness was falsely considered to be an advantage.

Under "T" (representing temperature), the curve which is almost a parabola shows the daily average temperature for thirty years, which we have called "normal"; and the plotted line shows the actual daily average temperature for the season under observation.

Normal Conditions Not Dangerous

Under "W" (representing wind), is a depressed or concave curve for the daily normal or general average, decreasing to the middle of July and increasing again as the season progresses. The irregular lines show the wind in accumulated miles per day as it actually occurred during the season. In speaking of wind, it may be of interest to note here one from amongst other important facts, which we learned from a series of curves made of the mean hourly wind velocity for every hour of the day during seventeen years at Sault Ste. Marie, and plotted separately for each month—namely, that while the hourly as well as the monthly averages are greater or less, as the case may be, for one month or another, the greatest winds in all cases occur at or near 4 o'clock in the afternoon and the least at or near 4 o'clock in the morning, and that the months which have the highest average at one hour have almost the lowest at another.

Cold and rain apparently go together and frequently wind, but not always. Fires apparently come after a dry, hot period; and when the wind is strong they last much longer. Normal conditions are not favorable fire conditions, or we would have no forest. Abnormally dry conditions, plus a spark, mean fire. Fire without sufficient control and warning leads to disaster.

Without wishing to take up any more space on this point, I believe that records showing average curves on which occurring weather conditions were superimposed, would show when these conditions were tending towards trouble or otherwise. Even if the full meaning is not understood, especially to begin with, sufficient indications would be apparent to warrant the party in charge applying by wire to the observatory for further information. From the observatory valuable advice as to future weather conditions no doubt could be obtained, more particularly if the observer there had a similar chart on hand and realized the use and value of the information which he was conveying. Thus with such length of warning as the observer might be able to give regarding coming wind and dry weather, preparations of all kinds could be made and the required assistance notified, so that men could be ready for prompt action if needed. Also unnecessary expense might be saved if during the time that the conditions appeared to be indicative of trouble notice was given to the district fire warden from the observatory of coming rainy weather.

Barometer Curve Not Applied

I have not attempted to apply a barometer curve to this chart. Others more skilled than I am may be able to suggest how it could be adapted. There is no doubt that it is largely from barometer readings taken at fixed hours at a number of stations and transmitted by wire to the observatory that weather forecasts are made.

Thermometer readings have a great bearing on stream flow regulation at certain seasons.

In the autumn, they indicate the time after which no increase of flow can be had from precipitation.

In the winter, they warn us of great temporary contractions in the run-off, which I believe is caused by the sealing up of the discharging face of the ground waters until a change in temperature and the accumulated head secures their release.

In spring, after our usual testing of the unmelted snow-cover by coring and measuring its water content, the thermometer readings give us warning if sudden flood conditions are about to occur.

In summer, the maximum and minimum temperature, when taken together with our hygrometer readings (dry and wet bulbs), are used to study evaporation losses.

The winds also have much to do with these losses. Everybody has noticed the way the snow will disappear in spring apparently without melting. We are trying to measure this loss and to see if some general rule can be found to make this knowledge of practical use.

Evaporation and absorption for plant life, use up together apparently 48 per cent. of the precipitation, as shown from long series of measurements on our rivers. Of course, this does not apply elsewhere unless the conditions are similar.

It is perhaps not generally realized that one can forecast power production and its commercial effect from properly kept meteorological and stream records. While I have passed thus casually over some of the present and possible uses of meteorology, to those interested in the forest and in streams there are other ways in which it can and must be used if a thorough knowledge of the possibilities and limitations is required. One point of interest that has still to be worked out, is to determine in a satisfactory manner how much of the precipitation is absorbed from actual water contact with the roots and leaves of the trees and plants, and how much in a secondary way from evaporated water by fog contact and the lesser degrees of atmospheric humidity.

Upper Air Currents

I have reason to hope that meteorologists will be able to give us valuable information from their study of the action of sun spots, and especially of the upper air currents, war being over. The means of obtaining reliable and sufficient data on the upper air did not formerly exist. Sooner or later we will have general long-range forecasts of the weather, which are now continually asked for and much needed in our work as also in other lines.

Our eminent meteorologists should be consulted more frequently, and a more practical use should be made of the valuable data accumulated during long years by these men, of which little notice is taken by the average citizen. My own experience has been that these gentlemen are willing, nay anxious, to give all the assistance possible when called upon for it, and I feel that I owe very much to the officers of the Meteorological Service of Canada and the United States.

Following is a partial list of Canadian patents recently issued through the agency of Ridout and Maybee, Toronto: Hugo Gronroos, moulds for casting building blocks; James W. Moffat, processes of treating metallic oxides; Bernhart Zwillinger, apparatus for converting beehive ovens into by-product coke ovens; Wm. R. Holliday, steam turbine; John G. A. Kitchen, means for reversing screw propelled boats; Minerals Separation North American Corporation, ore concentration; Alfred Darker brush and terminal contact mechanism of dynamo electric machines; Charles Gilliett, fuse controls for multiphase circuits.

A deputation of members of the Bruce County Council recently waited upon W. A. McLean, Deputy Minister of Highways of Ontario, asking that the government designate three roads in Bruce County as "county highways." It was pointed out that to have the roads designated and properly constructed and maintained, would not only link up the point farthest north with the western part of the Province, but it would also help to provide a lake shore route all around the Great Lakes. It was stated that lack of railway service in the county makes it imperative that the highway system should be improved. The roads urged for designation were one to Lion's Head, the Durham road and the Elora road. The deputy minister said that if anything were done, the Elora road would be the starting point, and the others would be given careful consideration.

LIGNITE UTILIZATION BOARD

Now Concluding Preliminary Investigation of Briquetting Plants—Type of Binder Not Yet Definitely Chosen

WITHIN a fortnight the preliminary investigations being conducted by the Lignite Utilization Board of Canada will be complete and a start will be made on the design of the plant to be built near Estevan, Sask., for which $400,000 has been voted by the Dominion government and the governments of Manitoba and Saskatchewan. R. DeL. French and Edgar Stansfield, both of Montreal, who were appointed as consulting engineers to the Board, are now finishing a six weeks' tour of all the principal briquetting plants in the United States. Upon their return home, they and Leslie R. Thomson, formerly of the engineering staff of the Dominion Bridge Co., who is secretary of the Board, will report on the proposed designs.

The members of the Board are: R. A. Ross, city commissioner, Montreal; J. M. Leamy, electrical engineer for the Province of Manitoba; and Hon. J. A. Shepard, Moose Jaw, Saskatchewan.

The order-in-council creating the Board gives the following reasons for the appropriation made:—

"That there are large deposits of lignite underlying various districts of the Provinces of Saskatchewan and Alberta, some of which, in the raw state can only be utilized when freshly mined, and are, moreover, unsuited in such state to household use;

"That by carbonizing this lignite, a coke or charcoal is obtained which briquettes readily and, without consideration of the by-products such as oil, pitch, ammonia sulphate, gas, etc., the result is to turn two tons of inferior fuel into one ton of briquettes approximating in heating value, anthracite coal with practically the same heating value in the domestic furnace as the two tons from which it was made."

The immediate objective of the Board is the carbonizing and briquetting of the lignites of southern Saskatchewan for domestic use. To reach this objective the following are the steps being undertaken:—

(a)—A thorough investigation of all machines and processes in use on this continent covering carbonization of coal, the use of binders and briquetting.

(b)—With full information at hand regarding machinery and processes, the Board will construct or contract for a plant of commercial size adjacent to the developed mines of southern Saskatchewan.

(c)—After operations are developed to a point where a commercial product may be obtained, the Board will distribute its output through the ordinary channels of trade.

(d)—While the production of domestic fuel is the immediate objective, the by-products derived therefrom will be studied, as will also the use of carbonized or powdered fuel for commercial power purposes.

Sulphite Liquor Otherwise Useful

An official bulletin issued by the Board makes the following statement:—

"Canada's coal resources are greater than those of any country in the world, with the exception of the United States. Much of Canada's coal, however, requires treatment before being available for satisfactory domestic use. It is expected that a successful outcome of the development undertaken by the Board will result in the establishment of an industry of national importance."

For the present the work of the Board will be carried on in Montreal at 80 St. Francois Xavier St., but headquarters will soon be established somewhere in the West, probably in Saskatchewan.

It is understood that no definite decision has been reached yet regarding the type of binder to be used in the briquettes. The Board planned at first to use sulphite liquor, but the Research Council has discovered other valuable economic uses for sulphite liquor, so the Board may use tar or the Hite process. Which of the three processes will be adopted depends upon the report that will be made by Messrs. French, Stansfield and Thomson.

NECESSITY FOR THE PROPER LOCATION OF ROADS

By A. Dennis Williams
Chairman, West Virginia State Roads Commission

So much has been written and spoken on this subject that little would remain as new if we had a perfect digest of all the literature. But no subject can be classed as finally elucidated so long as the fundamental principles remain a part of any great problem; therefore, it would seem that there is something more to be said and written.

The highway problem of America is not solved; it is the biggest question before the American people to-day. The cost of living, preparedness, and defence depend upon transportation and supplies, and these depend on the road, which, in truth, gets its constitution in its location. The construction and surface are but the by-laws of each passing whim, but the location is the pivot on which the success and failure are balanced. The dropping of a stone, a leaf, or even a drop of water upon one end will tip a beam to inspire, thrill and advance a community, or to stagnate, impede, and discourage a section. This beam is the road.

A road may be a canal of mud, a pile of stone, a streak of ruts, or it may be a surface sick unto death from neglect and false exploitation; but if properly located it can be restored without a surgical operation. A road surface is placed to meet a condition and can be for only a limited time. A road location should be made to fill a demand for all time. By efficiency we mean service and not always durability. A road may be durable and not serviceable; and, *vice versa*, it may be serviceable and not durable. To be of value to the community it must be serviceable and if of enduring service it will be more valuable. It is here that we determine the efficiency, the service and the value.

An Architect of Destiny

It has been said that the location, grade and drainage are the only permanent parts of a road, and it can be further said that the grade and drainage at an equitable cost can be had only through proper location, which, in turn, can be had only at the hands of skilled and trained men. The locating engineer is an architect of destiny. He can make a community; and he can, through ignorance or carelessness, bind it with a condition that will hamper its growth for all time.

The man who understands certain surfaces and surface materials is a factor and his service is an economic requirement. But the competent locating engineer, who is big enough to comprehend the entire scope of the task before him and to execute that vision into a road that will give maximum service to all parts of the community with a minimum maintenance cost, is a social and economic necessity.

Trails vs. Highway Engineering

In many instances our roads are not the products of engineering skill but the developments of a custom. Some wild animal or pioneer explorer made a trail which has been widened into a road. No attention has been given to the demands of the community, to the class of soil, the dip or slope of strata, the per cent. of grade or any other item that should be considered in the proper location of a road. In fact they are just happenings. It is often good economy to disregard the old road and make a new location. Here we sometimes find right of way troubles that seem to be great problems, and in some instances it is better to purchase a seemingly expensive right of way than to build a road with a bad grade on slippery soil where drainage will be difficult and maintenance expensive.

Things to note in locating a road are:—

(1) Ground that has a tendency to slip should be avoided if possible.

(2) The road should be placed on a slope where the dip of the strata leads the water from the road whenever conditions will permit.

(3) The road should be placed, when practicable, on slopes that are exposed to sun in winter, so as to reduce the number of days the road will be covered with ice.

(4) The curvature should be kept to the lowest degree possible so that the longest obtainable sight lines may be had.

(5) The road should be located above high water when conditions will warrant.

(6) The grade should be the best the funds and topography will permit.

(7) For horse-drawn vehicles, distance should yield to grade.

(8) For motor-driven vehicles, alignment and surface may take precedence over the grade, but grade must be considered.

(9) The direction of the traffic and the kind of freight produced in the community should be considered.

(10) The nature of the future development of the territory should also be noted.

(11) The general bearing the improvement will have on other sections of the state, or province, and nation should be studied and applied in the general plans.

(12) In short, everything to make the road of the greatest service at the least cost should be done so far as possible and practicable.

The Engineer's Library

MAP READING AND TOPOGRAPHICAL SKETCHING

Reviewed by H. L. Seymour
Town Planning Assistant, Commission of Conservation

By *Edwin R. Stuart*, Professor of Drawing, United States Military Academy; author also of "Topographical Drawing" and other works. Published by McGraw-Hill Book Co., Inc., New York City, Cloth, 5¼ x 7¾ ins., 139 pages, 46 illustrations and 1 plate.

In his preface the author states that he has attempted to record for the benefit of others something of the results of thirteen years of experience in the practice and teaching of topographical surveying and sketching. Judged from the character and the sometimes elementary treatment of the subject matter, the book should make an appeal to the student, especially the military student for whom the work has no doubt been more particularly prepared.

In the introductory chapter, the theme that "map reading and topographical sketching are essential tools of the military profession," is successfully though briefly elaborated. The next eight chapters deal with map reading and are followed by chapters on topographical mapping, the fourteenth and last chapter being devoted to panoramic sketching.

Written during the war, the author makes particular reference in his book to map reading and topographical sketching for military purposes, but most if not all of the information given contains suggestions for the topographer in peace times.

The reader is made familiar with map scales and with problems arising in the preparation and use of reading and working scales; with conventional signs, the more important of which, as adopted by the United States Geographic Board, are shown; with the representation of differences in elevation and the general nature of ground surfaces. It is clearly pointed out that the ability to interpret in a mechanical way information to be found on a map can be acquired from indoor studies, but that "to be able to weigh the topographical evidence given by a map, practical experience in the work of representing ground on a map is necessary."

It is reported unofficially that arrangements are being perfected for a conference early in February of all Dominion and Provincial organizations which have to do with the investigation and utilization of power resources in Canada.

RIDEAU RIVER INTERCEPTING SEWER, OTTAWA

By L. McLaren Hunter
City Engineer's Department, Ottawa

CONSTRUCTED to a drain a portion of Ottawa South and Ottawa East and to give a greater depth for house drainage in other portions of those districts, the Rideau River intercepting sewer extends from Somerset Street to Windsor Avenue, a distance of 17,900 feet.

The city some years ago engaged R. S. & W. S. Lea, consulting engineers, Montreal, to make a report on the necessity for and the design of the interceptor. In designing, it was important to adopt such a route and grade as would permit of a convenient incorporation of the interceptor in the main drainage scheme which eventually must be provided for the whole city of Ottawa and its suburbs.

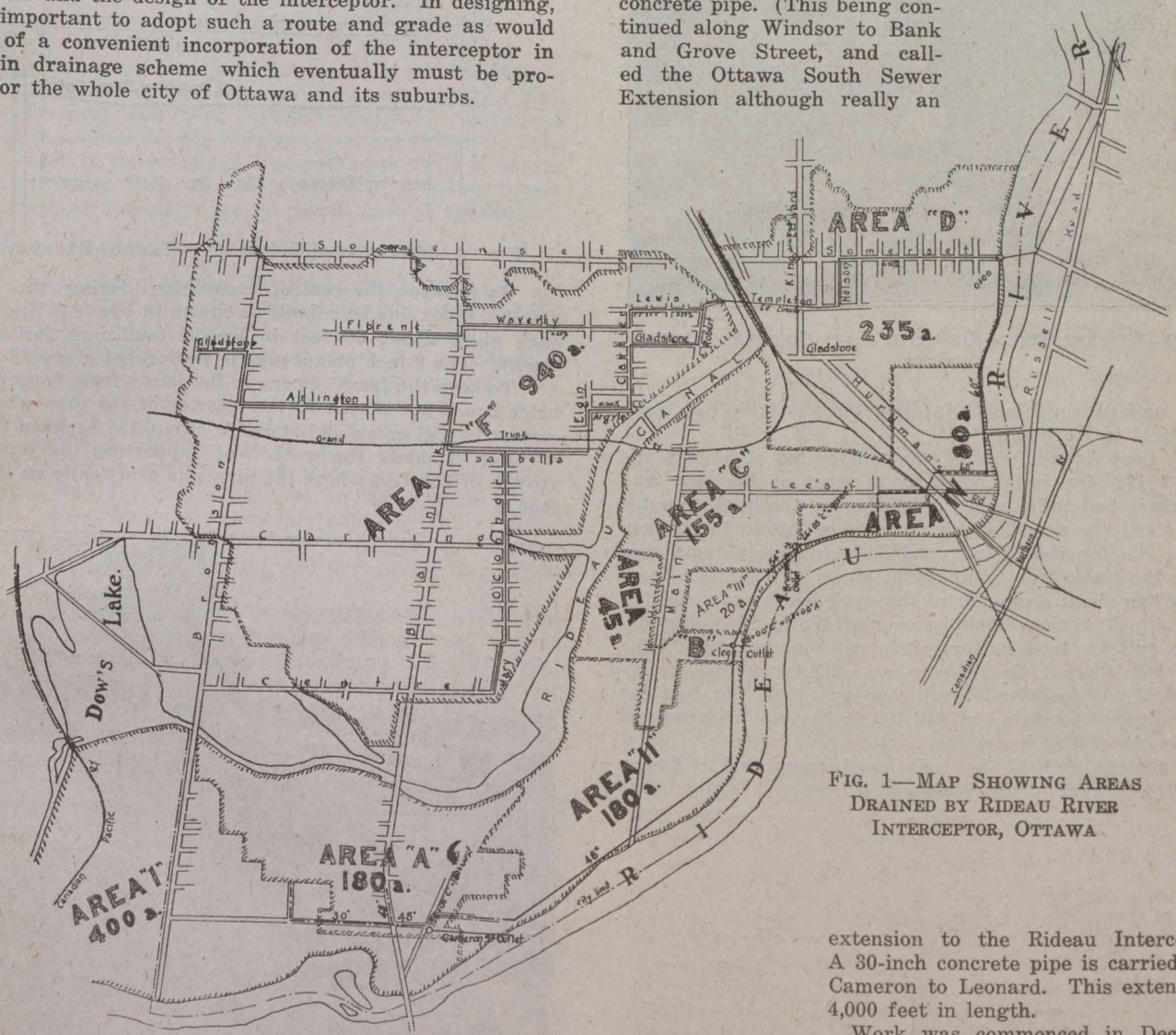


FIG. 1—MAP SHOWING AREAS DRAINED BY RIDEAU RIVER INTERCEPTOR, OTTAWA

The area of the section drained is 1,060 acres, 36 per cent. of which is already sewered on the combined system. Fig. 1 shows the sewered and unsewered area. The former is referred to by letters and the latter by Roman numerals.

It will be noted that area "A" includes 180 acres in Ottawa South, with an outlet at Cameron Street; Area "B" includes 45 acres in Ottawa East, with an outlet at Clegg Street; and Area "E" includes 155 acres in Ottawa East. with an outlet at Brunswick Street. The unsewered areas are as follows:—

Area "I"—Including 400 acres above the Cameron Street outlet.

Area "II"—Including 180 acres between Cameron Street and Clegg Street outlets.

Area "III"—Including 20 acres between Clegg Street and Brunswick Street outlets.

Area "IV"—Including 80 acres lying along the Rideau River between the Ottawa East district and the area tributary to the Somerset Street main sewer.

The present main sewer has its outlet in the Ottawa River at the foot of John Street, and crosses the canal at Somerset Street, where the Rideau River Interceptor commences.

The first section was constructed of segment tile 60 inches in diameter, running from Somerset Street to the gas company's property. The next section, 54 inch pipe, (part segment and part concrete) runs from the gas company's property to Clegg Street. The section from Clegg to Windsor was constructed of 48-inch concrete pipe. (This being continued along Windsor to Bank and Grove Street, and called the Ottawa South Sewer Extension although really an extension to the Rideau Interceptor). A 30-inch concrete pipe is carried along Cameron to Leonard. This extension is 4,000 feet in length.

Work was commenced in December, 1916, by day labor, a concrete bellmouth, 60-inch off 84-inch, at 40 feet radius, being built to connect with the main drain. A gang of seventy-two men were employed during the winter of 1916-17 and rapid progress was made.

The gradient for the whole length of the interceptor is 1 in 1,000, three crossheads being used every 100 feet for sighting purposes.

The most interesting part of the work was the tunnelling under the Canadian Pacific and Grand Trunk Railway tracks. This tunnel was commenced just north-east of Hurdman Road and was carried across the tracks for a distance of 400 feet. The average depth of the tunnel below ground level was 24 feet. A night and day gang were kept constantly at work on the tunnel, the progress made being six feet per shift. Four men laid the tile and two excavated, there being six men to each gang.

The tunnel drum was constructed of rivetted boiler plate, braced by angles. The peak end, 8 feet in diameter, allowed

room for mucking and for laying of tile. The drum was driven ahead by screw jacks. For most of the way, the drum was pushed through hardpan and river clay. In one part, however, quicksand was encountered and air had to be used.

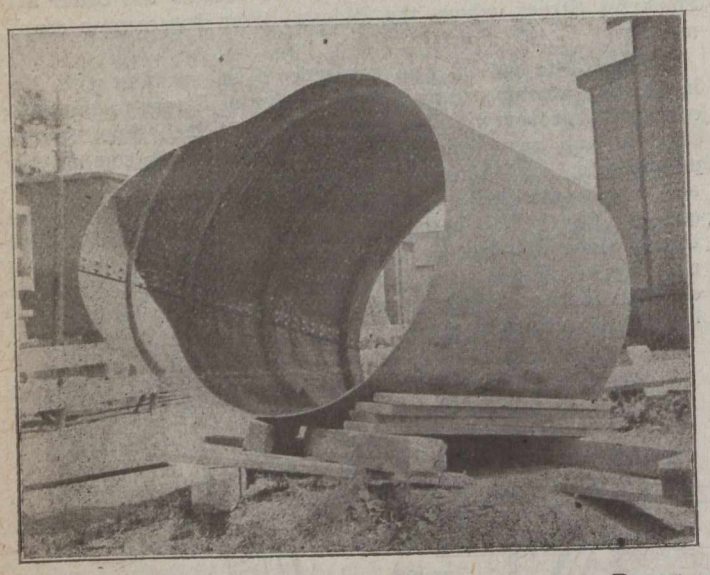


FIG. 2—TUNNEL DRUM USED FOR 5-FT. CIRCULAR BLOCK SEWER

An underdrain 9 inches in diameter was laid from Somerset Street to Hurdman Road.

The Lees Avenue section was constructed of 54-inch tile during 1917, Quicksand was found most of the way and truss braces had to be used for holding up the bank. Double sheeting and the wood haunches had to be left in the trench.

The tile for the 60-inch and 54-inch sections was supplied by the Natco Tile Company at a cost of $5.65 per lineal foot. When about a quarter of the work had been completed on the 54-inch section, Commissioner of Works Macallum decided to call for tenders for reinforced concrete pipe. The tender of B. Blair & Co., of Woodstock, Ontario, was accepted at $4.34 per foot for 54-inch pipe and $3.44 per foot for 48-inch pipe, or a saving of $16,400 in the cost of pipe and $3,600 in the cost of laying it.

By the end of 1917 the work had been carried as far as Main Street; next to the Williams' property. Further pro-

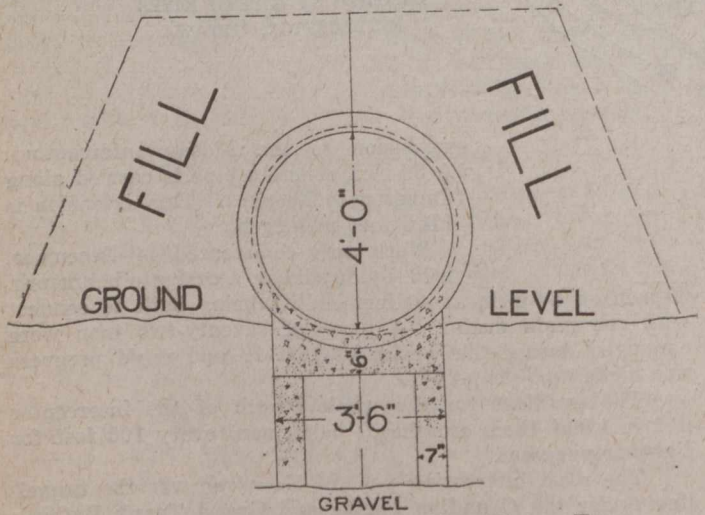


FIG. 3—METHOD OF SUPPORTING PIPE UNDER FILL

gress was delayed by a disagreement between the city and Mr. Williams over the price of a strip of land. This dispute was settled in July, 1918, and the work was recommenced in August.

The work of conveying the pipe from where the contractors had dumped it caused delays and entailed a great deal of expense. At first a track was built and a light horse-drawn carriage was made, but the lifting and laying of track always delayed pipe-laying for several days. This was overcome by providing a set of wheels, joined by a 2-inch steel spindle that protruded about 9 inches past the edge of the pipe on each end. A team was hitched to the spindle and each pipe was drawn to the job like a large roller, the spindle being tightened into the pipe by wooden wedges. With this device there are no delays in pipe laying. The highest record reached was 124 lineal feet, the average being 72 lineal feet per day of nine hours. It has been decided to push the work ahead this winter in an endeavor to finish it by next August.

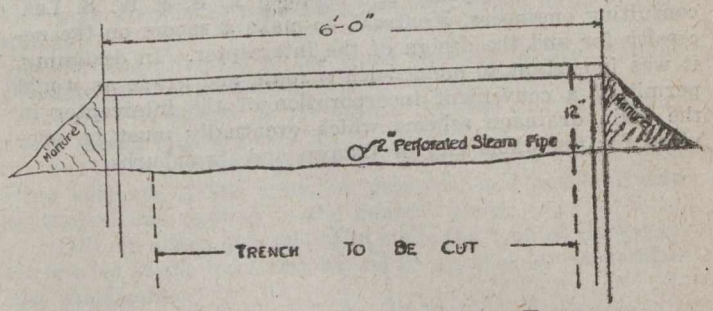


FIG. 4—THAWING GROUND CHEAPENED EXCAVATION

To cheapen the cost of excavation during the winter months, a box has been built as shown in Fig. 4. This is laid each night about 60 feet in length (sufficient for a day's work). The 2-inch steam pipe is perforated every 18 inches.

To keep the fresh cement in the joints from freezing, two brick heads are placed in the interior of the pipe where the cement is still green and steam is circulated between them.

Fig. 3 shows the method of supporting the pipe on a stretch of 250 feet where the pipe was practically on the surface.

FIG. 5—LAYING 48-IN. CONCRETE PIPE—NOTE CONVEYOR ON TRACK AT LEFT

The larger equipment used during construction included one 45 h.p. boiler, one 40 h.p. boiler, one derrick and traveller, three syphons, one 4-inch submerged pump (electric) and one 4-inch suction pump (electric).

The costs of various materials used were as follows:—

1917—54-inch	concrete pipe	.....	$4.34 per ft.
48 "	"	.....	3.44 "
1918—48 "	"	.....	4.30 "
30 "	"	.....	2.35 "
1917—60 "	Nacto Tile	.....	5.65 "
1916—Cement		.....	.43 per bag
1917— "		.....	.52 "
1918— "		.....	.73 "

(Concluded on page 111)

LEAD PIPE COUPLINGS*

By John A. Jensen
Supervisor, Minneapolis Water Works

THE object of this paper is to discuss the joints commonly used in service pipe connections and the development that has taken place from time to time under the guiding light of experience, for the purpose of improvement and prolonging the life of the service and its various appurtenances.

A service pipe, as discussed here, consists of a corporation cock at the water main, a run of lead pipe to the curb or walk, where a stop cock is placed and covered with a box extending to the surface of the ground, and galvanized iron pipe continued to the premises. Lead pipe is selected because of its durability and necessary physical properties for conditions generally met with in most localities. Galvanized iron pipe is suitable for the remaining portion of the run from the stop cock to the building. The cocks are made of bronze or non-corrodible metal for the purpose of resisting deterioration and, as a consequence, to permit ease of operation.

Improvements Based Upon Leakage

The principal object in the selection of materials and fittings is to make up a suitable and durable structure that will insure the owner minimum repairs and troubles from leakage. Aside from corrosion of materials, consideration should be given to the various kinds of joints used for connecting the several parts of the service pipe.

The use of lead pipe probably originated the so-called "wiped joint," or soldered connection to the cocks. There were originally in use the fixed soldering nipples. These later gave way, for obvious reasons, to the separate nipples and tail pieces, with their necessary couplings, all of which are now commonly used. For the iron pipe, the common threaded fittings are convenient and apparently suitable for all purposes.

Any improvement in the various parts of a service pipe is naturally based upon the troubles arising from leakage. The leak is the alarm that calls attention to the condition of the service. These leaks require considerable attention by water departments to locate the trouble, to serve notice upon the owner and to see that prompt repairs are made.

For some time the city of Minneapolis has given consideration to the matter of service leaks that occur between the water main and the meter. During 1917 there were 642 cases of such trouble, which were repaired by licensed plumbers under the supervision of the water department. These leaks not only give trouble and expense to the owner, but also cause a considerable loss of water to the municipality. This loss has been variously estimated at from 15,000,000 to 20,000,000 gallons per year. These services are owned by the consumers but the city supervises their maintenance to prevent loss of water.

The number of leaks referred to is an increase of 19 per cent. over the previous year. With an increasing number of services approaching the age of trouble and replacement, further increase in the number of leaks must be expected.

No Means for Reduction

There are no practicable means for the reduction of leaks occurring in existing services, but in order to prolong the life and lessen troubles on services that will be installed in the future, a study was made to discover the precise nature of existing troubles so that the proper remedy could be applied.

At present the service connections are made up of a corporation cock at the main, tail piece with wiped joint to lead pipe leading to the stop cock at the curb where it is again wiped to a soldering nipple. From this point to the meter, galvanized iron pipe is used. All of the wiped joints are made by licensed plumbers who install all services under city inspection.

A classification of service leaks was made and some interesting data have been obtained which indicate clearly the various kinds of trouble encountered. The classification was as follows:—

1. Defective curb cock	6	1.0 per cent.
2. Iron pipe, corroded	302	47.0 per cent.
3. Lead pipe, corroded or burst	96	15.0 per cent.
4. Wiped lead joints	238	37.0 per cent.
Total	642	100.0 per cent.

In considering only the serious leaks in this table, those that occur in iron pipe might be set aside, since such pipes are accessible for repairs without disturbing walks or pavements to any serious extent. The portion of the service that should be most secure and durable is the lead pipe and its connections which are located under the roadway and in the majority of cases under pavements.

The street leaks may then be separated and reclassified as follows:—

1. Defective curb cock	6	2.0 per cent.
2. Lead pipe, corroded or burst	96	28.0 per cent.
3. Wiped lead joints	238	70.0 per cent.
Total	340	100.0 per cent.

An examination of these street leaks shows the following facts to be apparent:—

Results of Examination

1. The curb cocks enumerated were found to be defective. They were all old-style cocks which have since been replaced by an improved type by the use of which a minimum amount of trouble will be experienced in the future.

2. The table shows 28 per cent. of street leaks to be in the lead pipe itself. About one-sixth of these were due to bursts by swelling of the pipe from repeated water hammer caused by defective faucets. Inspection of these showed all such pipe to be of lighter weight than that used at present. One-fourth of the lead pipe troubles were found under car tracks and the pitting and corrosion clearly indicate electrolysis. The remaining leaks were due to other causes, though many of them also appear to be from the effects of electrolytic action. Since heavy lead pipe is now used and means are employed to eliminate electrolysis, these troubles are already reduced to a minimum, so far as the future is concerned, and justification found for the continued use of lead pipe.

3. The wiped joint leaks made up 70 per cent. of the street leaks and troubles. These leaks are due chiefly to inferior workmanship. In most cases there has been failure to secure proper bonding in the joint. A number were "lop-sided;" others barely covered the end of the tail piece and in several cases the solder had run inside and partially closed the water opening. One joint had an opening left no larger than a pencil and after a remarkable record of patience covering a period of 24 years, the owner had the service dug up and the trouble was discovered and corrected. Many of these joints stood up for many years before giving way.

Several years ago lead pipe was used extensively in all plumbing work, but at the present day it has been replaced almost entirely by improved plumbing appliances and fittings made of other materials than lead, so that the art of wiping lead joints has passed into the hands of pipe fitters rather than the plumbers of former days. In many shops the wiped joints on service pipes form the only work of this nature that is encountered, and it must be undertaken as a special task. The work is attempted by unqualified and incompetent persons not familiar with nor skilled in the art. The result is that present-day wiped joints, under these conditions, do not measure up to the standard of former times, and more trouble may be expected in the future than in the past if such joints continue to be installed.

*Read before the St. Louis Convention of the American Water Works Association.

It appears from a consideration of this matter that these facts have been recognized in various cities. Efforts to secure protection against inferior joints have resulted in the development of a connection that is superior to the wiped joint.

This joint is a mechanical connection in the form of a coupling in which the lead pipe is shaped to form its own gasket. The lead flange should undergo slight reaming to make true parallel surfaces for close contact. The couplings should have plane faces, at least in part, to insure a good joint and must not be permitted to cut the lead flange. The coupling should have a sleeve to cover a short portion of the lead pipe close up to the flange to prevent any movement or deformation of the lead at the joint. The shaping of the lead flange may be conical or at right angles to the axis of the pipe.

There are several types of this joint on the market, all having desirable features of design, but the principle is similar in all cases. The coupling is made a part of the corporation or curb cock and is of composition metal. The joint develops the full strength of the lead pipe and is equally as strong as the best wiped joint and superior to it in results because it can eliminate defective workmanship.

Tests Were Successful

Tests made in the presence of waterworks men have demonstrated conclusively that rupturing stresses applied as internal pressures and tension on lead pipe secured at both ends by flanged curb cocks, have failed to break the joint or injure the coupling. In all cases the lead pipe burst or parted.

The initial cost of the material for this joint is slightly greater than for the wiped joint, but when the necessary labor is added, this cost is more than offset. The cost to the property owner ought at least to be practically the same. An intelligent man can make a flange coupling joint with simple tools and a pair of wrenches in a very short time, and on the ground where required. The need of a plumber with a blow-pot and other appliances is eliminated.

The comparative cost of the wiped joints and flange couplings in an ordinary service, at recent prices and labor costs, is as follows:—

Comparative Costs

⅝-inch wiped joint corporation cock	$1.05
¾-inch wiped joint curb cock	2.40
2 lbs. solder, two wiped joints	.80
Plumber's time, 1 hour	.90
Total cost wiped joints	$5.15
⅝-inch flange coupling corporation cock	1.30
¾-inch flange coupling curb cock	3.15
Time making joints, 1 hour	.40
Total cost flange joints	$4.85

This shows a balance of 30 cents on each service in favor of the flanged joints which can be considered as a margin for fluctuation in cost of materials and labor.

In considering the data given, the use of lead flange joints promises longer life to service connections as a whole, and a consequent reduction of leakage troubles and expense to both the city and property owner.

The street service department of Minneapolis has used lead flange couplings of different types for repair work for several years and they have been satisfactory and successful in every way. They have not only proved more convenient than the wiped joint for the department, but their use has also resulted in the saving of time and money in every case.

A recommendation was made at the December session of the Northumberland County Council (Ontario) that the Cobourg and Hastings road, known as the "Grand Trunk road," be taken over by the provincial government. W. A. McLean, deputy minister of highways, was interviewed by representatives of the council and, it is understood, he gave assurance that the road would be taken over.

RECONSTRUCTION AND THE BUILDING INDUSTRY*

By William A. Calder
United States Senator from the State of New York

In order to understand the problems of reconstruction which the building industry is facing, it is necessary not only to review the factors which brought about a curtailment of building during the war, but to go back of that and study the condition of the industry just before the war. Even during this pre-war period there had been a gradual decline in building activities due to increasing costs of labor and material.

Construction During the War

The history of the war orders of the past 13 months is well known to you. The first order issued by Judge Lovett, Oct. 27, 1917, restricted the use of open cars. Then came Secretary McAdoo's demand for the cessation of all building not essential to the prosecution of the war or immediately necessary for domestic welfare, followed by the increasingly stringent rulings of the Fuel Administration, the War Industries Board and the Capital Issues Committee, and the position taken by the Department of Labor in classing building labor as non-essential. The most far reaching orders of the War Industries Board were those affecting the building industry. The zero hour for building came when pledges were required of all material dealers and licenses of the non-war construction section of the War Industries Board for all buildings over $2,500.

The release of building work has been more rapid beginning with a more liberal attitude toward housing projects, followed by the release of building under $10,000, the general removal of restrictions, and culminating in Mr. McAdoo's statement of Nov. 17 urging civil construction and instructing the Supervising Architect of the Treasury Department to proceed with government work, and then Mr. Baruch's order of Nov. 21 releasing all restrictions.

Essential to Normal Development

The present conditions in the building industry are similar to conditions before the war, but more acute. Costs of labor and material are still higher. The most favorable aspect of the situation lies in the increasing shortage of buildings of all types—constituting a potential demand for construction. Deferred building is part of the war debt, that is, it must be met before we can return to normal conditions. Construction is an essential industry and therefore a prerequisite to all normal business development. The natural inactivity of building in the fall and winter should give opportunity, in view of the shortage in all types of construction, for the gradual restoration of confidence in such investments, unretarded by fear because it does not come faster. The winter may also give those who are planning to build the opportunity for laying plans and choosing their materials.

Unfavorable Factor in Outlook

The most unfavorable factor in the building outlook is the timidity of investment capital. This is a hang-over from pre-war conditions which still pervades finance. The effect of the war orders of the administration and the systematic discouragement of building by the Capital Issues Committee is still apparent. Another adverse factor in the restlessness of labor apart from the element of wages (since only 10 per cent. of labor disputes in the building lines are over wages, the other 90 per cent. being petty, jurisdictional or breach of contract), together with inefficiency due to government work and overtime standards. Transportation cannot be depended upon for efficient service and rates have increased to almost a prohibitive degree, although before the war 25 per cent. of the carrying capacity of the railroads was devoted to building material. Finally, fuel.

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*An address delivered last month at the convention of the National Federation of Construction Industries.

although released, is high and difficult to obtain, for the building industry consumes 30,000,000 tons out of the 425,000,000 produced by the country.

Government Construction Alone Insufficient

But builders who are far seeing and able to analyze the present situation realize that public construction alone will not bring the industry back to its normal position in the life of the nation. Government construction can only help as a transition measure, while private enterprise is slowly recovering its confidence and reabsorbing labor and materials. As an ultimate solution of the building prices, government construction alone will fail, because at most it can substitute but a small proportion of normal building; it will not relieve the present burden of taxation; and it will not supply buildings which bring reduction of rents and afford the necessary tools of industry.

On the whole, military and government housing construction has had an unfavorable influence on building. Government contracts have been let in large numbers. They have been let on a cost plus basis and they have been carried out without close supervision. Abnormal war requirements have set false precedents for the cost of materials and the cost and efficiency of labor. Continued government construction as a substitute for private enterprise will injure the industry, for the public work will absorb a fraction of our surplus labor and material and thus help to stabilize markets, it will maintain the present false standards which are now the greatest discouragement to private investment. Thus in the long run the total annual output of construction will not be caught up.

The remedy for these difficulties is the encouragement of private building which shall steadily and increasingly replace public construction and as rapidly as possible take over surplus labor and material and establish the industry on a sound economic basis.

Government Co-operation Needed

The immediate problem, therefore, which confronts the building industry is to find a means of encouraging private construction. Two methods suggest themselves. First, the co-operation of the government should be secured, not only for the development of large public works, but more fundamentally in the encouragement of private investment. During the past year, from the time of the first restrictions on building until the day when the armistice was signed and rapid releases were made, the government, through a series of rulings and non-binding orders, carried on a vigorous publicity campaign designed to discourage all non-war construction. Now that the objects of the war are achieved and the time has come to build up the industry again, the government should through similar methods of publicity counteract the depressing effect which its war measures have had on capital, and thus hasten the return of normal conditions.

Effect on Whole Country

Aside from the benefits which will accrue directly to the building industry through the government's adoption of such a policy, will be its far reaching effect on the country as a whole. As a source of national revenue alone, the government would do well to restore the building industry by every means at its command. Before the war the construction of the country, including increased land values, because of such construction, paid more than one-half of the taxes of the nation, if County, State and Federal budgets are included.

Before the war the industry employed over 2,000,000 men, all tax members of society. Since the war a greater portion of the total annual output of construction has been deferred on account of government restrictions, causing the loss of a sum equal to the entire estimated savings effected by price fixing.

The government should encourage private enterprise as the only solution of the serious social problems which spring from the high cost of living and the restlessness of labor.

But the restoration of the building industry cannot be brought about through government encouragement of private investment alone. A second measure which it seems imperative to take in this complex period of readjustment is the organization of the many diverse factors of the industry through a federation, flexible and yet strong and far-seeing enough to deal with the problems which are common to all branches of the industry. The very complexity of these problems to-day are evidence of the need of such unity and strength and co-operative effort as federation alone gives.

Should Total $250,000,000 Monthly

While there is an under-supply of building extending back over a period of years, there is insufficient demand to form a satisfactory basis in order to keep the industry in normal condition. For this purpose construction should total about $250,000,000 per month. It presumably will be a government policy to allow each industry to solve its own problems free from government regulations. Industries which have been enjoying war profits and the benefits of organization through war activity are better able to solve their own problems than is the building industry under present conditions. Unless the building industry takes on more than normal activity and produces in addition to current requirements, during the next two or three years, an additional amount of building construction, equal to that which has been deferred, the country will remain in a state of arrested development.

The Labor Situation

On a basis of an armed force of 4,000,000 men there are probably between 15,000,000 and 20,000,000 diverted from peace to war work. If the armed force is reduced to 1,000,000 men during the coming year there will be from 12,000,000 to 15,000,000 men free for the industries of peace. The maximum of labor shortage never exceeded between 1,000,000 and 2,000,000 men and at present there is little or no shortage.

While there is less than a normal supply of materials in the hands of manufacturers, there is an over-supply in the hands of the government which cannot be thrown on the market without breaking the market and throwing labor out of employment. Representatives of the War Industries Board estimated that the country was producing steel at the rate of 45,000,000 tons per year (on Nov. 1); that this was practically all used for war purposes. The first half of 1918 the steel industry produced 17,000,000 tons, or at the rate of 34,000,000 tons annually. It is estimated that France will not need over 8,000,000 tons during the coming year, if as much. The use and sale of the surplus output must be arranged for unless the steel industry is to go into a condition of depression with unfavorable effect on labor and with sympathetic effect toward general building depression. Building industry will never absorb steel at the former rate per cubic foot, because reinforced concrete construction has become popular and requires but one-third the steel of ordinary steel construction, with a consequent saving of labor in steel production, transportation and erection.

Intelligent Organization Required

On the wise solution of these intricate problems involving all branches of the building industry will depend the recovery which it makes in the period of reconstruction ahead. For their solution should be marshalled the best brains of the industry, through an organization which will give expression to all aspects of these problems and function adequately with the department of commerce of the government in working out a liberal and progressive policy for the development of the industry during the next few years.

At the annual meeting of the Saskatchewan Association of Architects, held last Friday at Regina, the following officers were elected: President, Capt. David Webster, Saskatoon; vice-presidents, Norman Thompson, Saskatoon, and W. G. Van Egmond, Regina; secretary-treasurer, F. B. Reilly, Regina.

INADEQUATE SALARIES

Being Paid to Municipal Engineers—Chicago Chapter of the American Association of Engineers Makes Strong Protest to Mayor and City Council

ENGINEERS employed by the city of Chicago are protesting against the entirely inadequate salaries which they receive, and have called to the attention of their mayor and city council the fact that no increases in salary have been received for the past twenty-one years, with just a few almost negligible exceptions. The following letter, which was passed by the executive committee and approved by the Chicago chapter of the American Association of Engineers, was addressed December 21st, 1918, to the mayor and aldermen by the secretary of the Chicago chapter of the American Association:—

"The American Association of Engineers, a nation-wide organization of technical engineers, desires to set before you through its Chicago chapter the unsatisfactory schedule of pay of technical engineers in the service of the city of Chicago, which it expects and hopes you to remedy in the 1919 appropriation bill.

"1.—With very few exceptions, almost negligible, the salaries of technical engineers have not been increased in 21 years, or since the civil service law went into effect.

"2.—Because increases have been allowed, mostly to union labor, it now is almost the general rule, and has been for the past four years, that the engineers are paid less than the journeymen working under their direction and for whose work they are responsible.

Excuse—No Funds!

"3.—The cost of living has increased abnormally in the last 21 years, and especially during the past three years, and workers in most all lines have received substantial increases to cover the increased cost of living. This has been denied the technical engineers in the city of Chicago's service on the ground, we are informed, that the city has not the funds. This answer begs the question.

"4.—The engineering service of this city is already beginning to suffer because of the above conditions, and as a result the value of service rendered to the taxpayers for taxes paid is growing less. The reason is plain. When a faithful and competent employee realizes that the longer he works for the city, becoming thereby more valuable to the city, and the more experience he acquires the less he earns, because his salary is stationary, while the value of a dollar grows less, he is forced to leave the service. This, in turn, keeps ambitious men from entering the service, with the result that mediocrity will be all that is left. You usually only get what you pay for. Further, it costs money to train a new man.

"5.—The study of the duties of the various grades of the engineering service of the city of Chicago leads this association to recommend the following salaries as being fair and reasonably proportional to those paid by fair employers for similar work:—

"Grade	1,	Group	C, ...	$150 per month
"	1,	"	B, ...	170 "
"	1,	"	A, ...	190 "
"	2,	"	C, ...	205 "
"	2,	"	B, ...	225 "
"	2,	"	A, ...	245 "
"	3,	"	C, ...	260 "
"	3,	"	B, ...	280 "
"	3,	"	A, ...	300 "

"Grade 4 and above; not less than $5,000 and up, annually, according to specific position. Specific recommendation will be made on request.

"6.—The association is of the opinion that this salary adjustment will increase the efficiency of the service to such a marked degree as to require little or no additional appropriations, because of the economies that will be brought about in the administration of the work done under engineering supervision.

"7.—We are aware that the engineering force of the city of Chicago has done some remarkable work by which it has attained an enviable position in the United States. We ask that you do not allow the city to lose this service by the refusal to provide them with adequate pay.

"8.—Please refer this request to the proper committee with instructions for action.

"The American Association of Engineers is carefully watching the record of elective officials throughout the United States on matters of public concern which are intimately affecting engineers. We trust that Chicago's city government will at this time measure up to its opportunity and perform its manifest duty in this matter."

TO EXTEND RESEARCH

Council Confers with Boards of Universities Regarding Increase in Number of Students and in Facilities

NEGOTIATIONS with Canadian universities with a view to greatly increasing the facilities and the number of students in the applied science faculties have been begun by the Advisory Council for Scientific and Industrial Research. A committee of the Council conferred on Friday and Saturday of last week with representatives of the governing bodies of Toronto and McGill Universities, outlining the urgent needs of the situation in Canada in regard to the supply of trained research workers and technologists, and asking that prompt steps be taken to provide for the pressing requirements of the allied forces of science and industry.

The proposals of the Research Council are now under consideration by the Toronto and McGill governing boards. Other universities will be similarly approached to see how far ways and means may be found for training research workers and turning out men capable of applying new scientific knowledge to industrial processes and development.

Supply Little of Demand

At present Canada produces from her own universities only a half dozen or so men each year with the necessary advanced scientific training and experience fitting them for research work. A recent inventory of the men available in Canada, equipped for adequately tackling the complex problems of industrial and scientific research work, disclosed to the Council that the supply is hardly equal to five per cent. of the demands of Canadian industry, if it is to keep pace with what the United States, Great Britain and other trade competitors are doing in this regard. In the United States ten big universities having great applied science faculties for post-graduate work are turning out every year scores of such men. In Canada there are, all told, considerably less than three hundred, including all those now in university or governmental positions, to whom the Research Council or big industrial firms can turn for assistance in solving scientific problems of industrial development. And even the limited output of the Canadian universities now goes for the most part across the border, where research facilities and scientific positions abound. Chemists, physicists, metallurgists, electrical and chemical engineers, etc., are needed, and at present in Canada only Toronto and McGill have graduate courses in which scientific research figures to any degree.

Extension of Facilities Needed

A close survey of the need and of the supply of trained men in both pure and applied science, and a study of what other countries are doing along this line, have convinced the Research Council that the carrying out of its plans along anything like adequate lines demands prompt extension of university facilities for research training and laboratory work. The council has already provided for twenty studentships and fellowships to be annually awarded to science grad-

uates in connection with some specified research. As yet the number of men available for such studentships and fellowships has limited awards to less than half the total number provided for. The council believes that there should be at least fifty men now engaged on research work in Canada. A hundred subjects could be readily assigned were men and university equipment available. But the extension of university facilities is a first necessity.

Federal Government May Help

At last week's conferences representations were made to Toronto and McGill universities, pointing out the need of provision for research students, especially in the departments of physics, chemistry and metallurgy. Attention was drawn to the fact that four years of war have greatly cut down the number of graduates who might be available for scientific research work, and that it will probably be five or six years yet before the supply of those graduates now gets back to normal. The whole situation was canvassed with the university boards, and, if ways can be found of raising the necessary funds, by either State or private aid, the proposals of the council will be met.

RIDEAU RIVER INTERCEPTING SEWER, OTTAWA

(Continued from page 106)

On the 60-inch Natco tile section, in 18 feet of excavation, the costs were as follows:—

Excavation and backfilling	$8.240	lin. ft.
Pipe laying	.375	"
Natco Tile, including underdrain ..	7.427	"
Pumping	.766	"
Shoring	.652	"
Grading, plant, sundries	1.744	"
Total cost per lin. ft	$19.204	
Tunnel section (excavation)	$19.37	per ft.
Manholes (concrete)	61.46	each

The cost of 48-inch concrete pipe section, in 4 ft. 6 ins. of excavation, this year was as follows:—

Labor

Excavation	$1.37	lin. ft.
Shoring	.68	"
Pumping	.20	"
Backfill	.60	"
Culvert Drains	.16	"
Rolling Pipe	.29	"
Running hoist	.33	"
Derrick and track	.44	"
Grouting	.12	"
Pipe laying	.34	"
Sundries (including Saturday afternoon holidays	.58	"
	$5.11	
Pipe (including hauling)	$3.60	lin. ft,
Coal	.24	"
Cement	.11	"
Sundries	.11	"
	$4.06	

Total cost of interceptor per ft.—$9.17.

The above costs on the 48-inch section were taken on 400 lineal feet of work which was done in August, 1918. On the Williams' property, laborers were being paid 35 cents per hour. On this section and on the Natco Tile section, laborers were being paid 27½ cents per hour.

The assistant engineer in charge to Main Street was W. F. M. Bryce, who is now overseas, the writer taking his place in carrying the work to completion. F. C. Askwith supervised the work at the beginning, and latterly A. F. Macallum, Commissioner of Works, has been in charge.

The interceptor will cost $300,000, and the extension to the interceptor, an additional $50,000.

When the work is finished another drainage scheme will be commenced for that part of Ottawa South west of Leonard and south of Cameron Streets. This will be built as a separate system, the surface water being drained into the river and the sewage pumped into the present interceptor at Leonard and Cameron Streets. Preliminary surveys are now being undertaken.

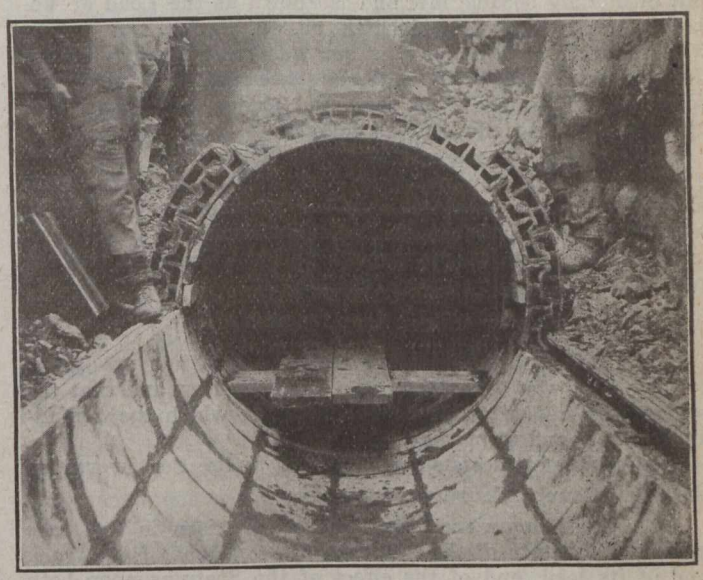


FIG. 6—BLOCK SEWER ON STRATHCONA PARK DRIVE

The city has expropriated a strip of land along the bank of the river where the interceptor is laid, this strip averaging 50 feet in width. It is intended to build, later on, a new driveway to connect with the Federal Government's boulevard system.

THE COST-PLUS CONTRACT

THE next great lesson to which I urgently direct your attention is that bearing upon the relationship between the contractor and the owner. Experience is now the law. No contractor should be called upon nor permitted to undertake the performance of any contract that within the four corners of the paper upon which it appears, is, or may be written, the financial bankruptcy of the contractor. It is unjust, it is inequitable, it is uneconomic. The great lesson of this war on the subject of relationship between the contractor and the owner is the cost-plus contract. This represents the only equitable basis under which a contractor may perform constructive and economic services for the owner. It is the only form of contract which affords protection to both parties. To me all of the energies, the thought, and the experience of the country within its own continental lines during the past year and one-half of this world shall have been in vain unless out of it all shall grow, as a permanent institution, solidifying the economic relationship between the contractor and the owner, the cost-plus contract.—Brig. Gen. R. C. Marshall, Chief Construction Division, U.S. War Department, in address at first annual convention of Associated General Contractors of America.

A daily newspaper despatch from Paris states that there has been a renewal of the talk about building a tunnel across the Strait of Gibraltar and making a direct all-land connection between Africa and France, which might be extended to England if the English Channel tunnel be built.

LOAD OF VEHICLES ACT

First Case in Ontario Under This Act Tried Before Judge Coatsworth and Decided Against the Municipality

AT the 1917 session of the Ontario Legislature, Hon. G. S. Henry introduced a bill regulating the loads which vehicles should be allowed to carry on public highways. This bill ultimately became law and is known as the Load of Vehicles Act, 1917, 6 George Fifth, ch. 49.

The first case under this act was tried recently before Judge Coatsworth at Toronto, and because of its wide application, will interest all road and bridge engineers. The circumstances, briefly, are as follows:—

The plaintiff was a cartage agent, and in November, 1917, one of his men was delivering furniture in the township of Vaughan (Ontario), in the plaintiff's motor truck, and on passing over the bridge in question, the bridge collapsed and the truck went through and was damaged, and the plaintiff claimed the cost of repairing it.

Too Fast, Says Defence

The defence was that the truck at the time was going too fast and was wider than is allowed by law, and that the bridge was sufficient for all purposes for which the defendants were bound to provide.

In giving his decision in this case, Judge Coatsworth, in the York County Court, says:—

"A great many nice questions have arisen in this case as to the strength of the bridge and the weight of the truck and of its load, and of the effect of the Statutes upon both the bridge and the load and where the responsibility lies, having in consideration the statutory liability of both parties and the allegation that the onus is upon the plaintiff to clear himself of any negligence under the Ontario Vehicles' Act.

"It may be convenient first to consider whether or not the bridge was sufficient for the purpose, and in doing so it is important to keep in mind the statutory duty of the defendants to keep the bridge in question in repair for lawful use of such vehicles as are allowed by law, that the bridge should be reasonably sufficient and safe for all such vehicles.

"The first question which arises is for what class of vehicles provision had to be made. It is unnecessary for the purpose of this action to consider the question of traction engines at all, but chap. 49 of 6 George the Fifth, sec. 5, allows for a motor vehicle, including loads, of 6 tons and 8 miles an hour, where it is equipped with rubber tires. And under sub-section 2 of section 3 of the same Act, the weight resting upon the surface of the highway is not to exceed 650 pounds per inch in width of the tire without a permit from the Council.

"And under sub-section 1 of the said section 3, there shall be no vehicle of a greater weight than 12 tons moved on the highway without such a permit.

Provision for Twelve Tons

"The defendants, therefore, had to make provision for a vehicle of 12 tons, apparently, including its load, and the question is whether they did so. Probably this can best be answered from the evidence of Mr. E. M. Proctor, C.E., (of James, Loudon & Hertzberg, Ltd., Toronto), who was called as a witness by the defendant.

"He says that he had removed to the city one of the bridge stringers that was broken by the plaintiff's car, or, to be exact, a piece of it between 5 and 6 feet in length, to test it and determine what strain or weight it would bear. This was a cedar timber 10 ins. square, and Mr. Proctor's evidence is that on a test of a span of 4 ft. 6 ins., the timber broke with a load of 26,120 pounds,—that is, a trifle over 13 tons. This was on a very short length, and when it is remembered that the length of the span of the bridge was 14 feet, the timber would require to be proportionately stronger.

"Unfortunately it did not occur to any of us at the moment to ask him if this broke with a weight of 13 tons, what tonnage could safely be driven over it? And, also, what was the difference between the carrying weight of 4 ft 6 ins. span and 14 ft. span?

"However, it is obvious to any person that where the Statute requires them to make provision for a weight of 12 tons, and the timber in question, one of the timbers of the bridge, broke on a 4 ft. 6 in. test with a weight of 13 tons, then it must mave been unsafe even for 12 tons, especially when the span was 14 feet, and also taking into consideration the increased weight caused by the impact with the speed of the motor vehicle when such impact is negligible only up to five miles an hour, and the Statute allows eight miles an hour, which would cause a considerable impact and consequent increase in weight.

"The only conclusion one is able to arrive at, therefore, is that the timber in question, which was one of the timbers of this bridge, was quite insufficient to bear the weight which by Statute people were entitled to put upon it, and therefore was inadequate, and the maintenance of such a bridge was not a sufficient fulfilment of the defendant's statutory duty. And the fact of the timbers breaking with a less weight than the plaintiff was entitled to put upon it, goes to show that it was quite inadequate.

"I find, therefore, that the defendant's bridge was insufficient for the purposes for which it was to be provided by Statute.

Not Guilty of Overloading

"The next question to consider is whether the plaintiff was guilty of any negligence or overloading which was a material factor in causing the accident. The weight of the truck itself was 5½ tons. Part of the load which was weighed afterwards was 7,360 pounds, or nearly four tons, and probably was four tons taking into consideration some portion of the load which was removed for the convenience of the consignee, consisting of bedding and provisions, after the truck went through the bridge. However, if it did amount to four tons, which I doubt, then the whole weight was practically 9½ tons, quite within the Statute.

"The defendants raise the question, however, under subsection 2 of section 3, that the weight of this motor truck resting on the surface of the highway exceeded 650 pounds upon any inch in width of the tire. The very highest calculation which could have been made or which was attempted to be made for the purpose of enabling Mr. Proctor, the witness above mentioned, to give testimony, was 8,860 pounds for the load, and this was on the supposition that the bedding and provisions removed that evening for the convenience of the consignee amounted to 1,500 pounds. At that it gave 655 pounds per inch of tire. I do not consider, however, that it was at all proved that the weight of the load was 8,860 pounds. I am personally, so far as I could judge, convinced that it was not more than 8,000 pounds, which will keep the plaintiff within the 650 pounds upon an inch in width of tire.

"So far as the weight of the car was concerned and the weight of the load, they were well within the Statute, and as to the weight upon any inch of tire, I find there is nothing to satisfy me that it was not within the 650 pounds.

Six Inches Too Wide

"A question was raised about the width of the car. Section 6 of the above Act, chap. 49, says that no vehicle shall have a greater width than 90 inches, except a traction engine. It was proved that this car was 96 inches in width. In my judgment, however, as this extra 6 ins. in width is not shown in any way to have contributed to the accident, it is a question for penalty under section 8 of the Act rather than for defence in this suit.

"Then as to speed, the evidence as to speed all goes to show that the speed was very moderate and well within eight miles per hour. The approach to the bridge was not at all a difficult one, although it is said that owing to a rise in the character of a hill on the other side, the chances were that the driver of the car speeded up to take the hill on the other side; yet there is no direct evidence to that effect. Another smaller truck of the plaintiff was following this one, and the

driver of that truck stated that the truck in question had been going six or seven miles an hour but slowed down to about five miles an hour when about to cross the bridge.

"Two of the defendant's witnesses had seen the car, one of them just before the accident and another a short time before, and neither of them intimated that the car was going at any objectionable rate of speed.

"So that, taking all the circumstances into consideration, I find that the plaintiff has cleared himself of any charges of negligence with regard to the operation of the car at the time of the accident.

"Returning again to the matter of the bridge, there was no engineer's inspection of the bridge at any time so far as I was able to ascertain. It has since been repaired with second-hand timbers and probably is still insufficient for the purpose. It has been repaired by cheap work and cheap material. The defendants have not taken any advice as to strain or stress upon the bridge, and there was no notice up of warning of any kind, and everything goes to show that the bridge was not maintained in the proper way.

"The claim for non-use of the car is in my judgment over-estimated at $150 and I will only allow one-half of this, or $75. Under all the circumstances, I feel no hesitation in giving judgment for the amount claimed, $333.82, with costs of action."

The township of Vaughan has entered an appeal.

AMERICAN METRIC ASSOCIATION

FOLLOWING is a summary of the proceedings of the second annual meeting of the American Metric Association, held in Baltimore, December 27th and in Washington, December 28th:—

David A. Molitor, consulting engineer, outlined his work for the C. E. Schmidt Co., of Detroit, tanners. He found that about 500 different commodities were being purchased for the use of this company and that they were received in many different units of weight and measure. It became clear that economy would be effected by entering the weight or measure of all material received in metric units. This step was taken with great success. The metric weights and measures were then used exclusively throughout the factory. The output of the factory was increased approximately 50 per cent. with the same working staff. The weighing in one department had previously been made by an expert in the old weights and measures. After the change to the metric system, this work was done by a laborer with fewer mistakes than formerly. Mr. Molitor estimated that a saving of approximately 20 per cent. could be effected in the bookkeeping and calculations of factories which introduced the metric weights and measures throughout.

Dr. C. O. Mailloux, consulting engineer, chairman of the United States Committee of the International Electro-Technical Commission, told of his practical experiences in the use of the metric system in the United States and foreign countries, describing his last interview with Sir John Wolfe Barry, who designed the London Bridge and other engineering enterprises in England. He expressed to Dr. Mailloux his firm conviction of the desirability and necessity for adopting the metric weights and measures in England and discussed the practical steps contemplated for their general use. Dr. Mailloux pointed out the fact that the electrical units throughout the world were based on metric weights and measures and that this in itself was indicative of their ultimate adoption for all purposes in America and England.

Will Establish Local Sections

Jesse M. Smith, past president of the American Society of Mechanical Engineers, stated that he had been in close touch with the metric movement for fifty years. He had frequently used the metric system in America and other countries and believed it to be only a question of time when that system would be adopted in all parts of the world.

Prof. Eugene C. Bingham, of Lafayette College, was appointed chairman of the Committee on Sections of the American Metric Association. The following resolution on this subject was adopted:—

"Resolved, that the American Metric Association hereby requests the formation of local sections throughout the country."

United States Senator John F. Shafroth read a bill which he has introduced in Congress, and asked for a discussion on the subject. This bill is a step toward the general use of metric weights and measures, making exceptions where such seem to be advisable for special work. The bill was endorsed by the American Metric Association.

Address by Secretary Redfield

Secretary of Commerce William C. Redfield was the principal speaker at the "Metric Dinner," held on the evening of the 27th. After outlining his practical experience as a manufacturer for thirty years and his travels in other countries in the interests of his export trade, he voiced the conviction that the metric weights and measures should and would be adopted for general use in the United States. The Secretary of Commerce said in part: "I believe that the metric system offers a return to simplicity, offers an effectiveness of thought, offers more to little children in our schools, if you please, which we are not justified in withholding from them."

The following were among the resolutions passed:—

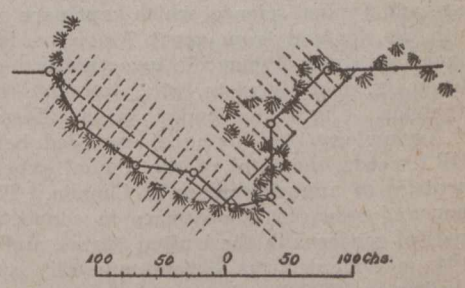
"Resolved that the American Metric Association hereby expresses its desire to co-operate more fully with those American industries and trades using and contemplating the use of metric weights and measures."

"Resolved that the American Metric Association send greetings to the universities, colleges and other educational institutions and respectfully invite their co-operation in bringing in the general use of meters, liters and grams for the welfare of America."

USE OF THE SURVEYOR'S COMPASS IN PRELIMINARY RAILWAY SURVEYING

By Jno. Alfred MacDonald
Provincial Land Surveyor, Hermanville, P.Q.

GILLESPIE says that the compass is seldom absolutely correct, but never very far wrong. The compass is not used enough in preliminary railway surveying. Hugh Lumsden, late chief engineer of the National Transcontinental Railway, in the building of that road, advised his engineers to use the surveyor's compass and not the transit in the work of getting a good line in the wild country, Winnipeg to Moncton.



Preliminary Location Around High Ground by Means of Compass

The writer worked for two years on that line under Mr. Lumsden, and we used the surveyor's compass considerably—in difficult places only, however. In one place we had very high ground to get over, and as the grades were very light, 0.6 going west, and 0.4 going east, we found the compass very useful in securing this grade.

In one case we had about two miles of very high ground to get around (see illustration). We first ran a compass line in a general straight direction on one side of the hill, or plateau, and took cross section every ten chains, in most cases on both sides of the compass line. Some of these cross lines we found necessary to run up or down the grade a distance of a half-mile. The leveler followed the compass, taking levels on all cross sections also. After reaching the terminus of one side of the plateau, we turned a right angle

on the other side and worked in the same way. The dotted lines every ten chains on the compass line show the cross-section lines. In camp we mapped and profiled the compass line, including the cross section. Then we had a complete plan and profile of the country and it was an easy matter to pick out on the plan a preliminary location. The preliminary is shown on the sketch. This involved a good deal of work, but it paid.

RESEARCH COUNCIL'S WORK

Review of Activities for the Year—Situation in Canada in Regard to the Application of Science to Industry

By Dr. A. B. Macallum
Administrative Chairman, Honorary Research Council

RECONSTRUCTION and development in Canada in the new era of international girding for supremacy in the arts of peace means to the Canadian Honorary Advisory Council for Scientific and Industrial Research much in so far as "development" is concerned, but little in regard to "reconstruction."

Reconstruction postulates the building up again of what existed before; and up to the outbreak of war there was constructed in Canada no national organization for research work. The glowing path of Canada's opportunity for industrial development runs wide and far, but the Council's research path has to be blazed through a comparatively unexplored forest. It is almost entirely new ground to be covered.

Germany Had Trained Technologists

Where Germany, and, though perhaps in lesser degree, the United States had builded before the war great organizations for industrial research founded on wide-visioned realization of the commercial value and necessity of applying science to industry, in Canada, as in Great Britain, state encouragement and individual enterprise had, until the war started, been content in the main with a *laissez-faire* policy. Germany had her trained technologists and research workers by the thousands in every field of industry, and, through the organized application of science to industry, was winning her trade victories in every foreign mart.

In the United States, which early took a leaf from Germany's book, the great universities like Harvard, Yale, Chicago, Columbia and Cornell had staffs and equipments in pure and applied science, which kept pace or almost kept pace with the demand from great American industrial establishments for trained scientific investigators, chemists, electrical engineers, metallurgists, etc., to solve industrial research problems. The annual budget of the Massachusetts Institute of Technology, for instance, exceeded before the war, and still exceeds, the total of the annual expenditures of all the faculties of applied science in Canada. There are some two thousand research laboratories in connection with large industrial concerns in the United States, and each of more than fifty individual firms expend annually sums ranging from $25,000 to $500,000 for research.

In Canada in a score of years less than twenty students have received the advanced (Ph.D.) degree in science from the University of Toronto and fewer still from McGill. Not two per cent. of Canadian firms have research laboratories and only about ten per cent. have routine laboratories, chiefly for the testing of materials. If Canadian industries were to seek for a supply of trained technical men capable of applying the most advanced scientific knowledge to industrial processes sufficient to meet even their most ordinary needs, the number of adequately trained men available would not be sufficient to satisfy five per cent. of the demand.

That, briefly put, is the situation with regard to the needs in Canada for equipment and men for research work. That is the situation which has confronted the Research Council since its creation in December, 1916. And that has been, and is, the crux of all the problems of scientific and industrial research in Canada, handicapping the carrying out of the large research programme planned for the past year and for the coming year, jeopardizing Canada's position in the international rivalry for export trade and demanding prompt remedy if the full measure of our opportunity is to be grasped.

In resources of capital and materials, in all the natural advantages for industrial supremacy we are in an enviable position as compared with our trade competitors. But in regard to the vital question of scientific organization of our industrial processes of finding new uses and, hence, new markets for the raw materials and the by-products of manufacture, and of keeping pace with the advances made in other countries through research, we have as yet hardly touched the fringe of opportunity.

Canadian Central Research Institute

Confronted with this situation and with a slowly awakening public and individual realization of its portent, the main task of the Council this past year has been, while carrying on the immediate needs of research work with the means at hand, to pave the way for meeting adequately the urgent needs of the future. The goal has been a supply of trained men for research work, adequate equipment and facilities for research and the enlistment of industrial organizations in co-operative effort to solve common problems, the solution of which lies in the application of science to industry. The great forward step taken has been to promote the establishment of a Central Research Institute at Ottawa, combining the functions of the Bureau of Standards at Washington and of the Mellon Institute at Pittsburgh.

The proposal for such an institute, submitted to the government in November last, was the result of many months' careful investigation by the Council. In view of the situation above outlined, the argument advanced in support of it is so obvious as to need no restatement here. There has been a prompt and appreciative response to the proposal by the government and by all the public interests concerned. There is good reason to believe that the institute will be established without any unnecessary delay.

It will involve an expenditure of $500,000 for a four-story building, having initial provision for fifty laboratory rooms and with plans so drawn as to provide for expansion as the needs develop. The cost of the scientific equipment is estimated at $100,000, and the cost of maintenance, salaries, etc., at about $100,000 per annum for the first few years.

Necessary to Keep Abreast

The establishment of the institute is the necessary first step towards placing industrial research work in Canada upon an adequate and permanent basis and towards enabling the Dominion to keep abreast of similar progressive methods in the United States, Great Britain, Japan, France, Australia and our other trade competitors. It will, doubtless, be followed by the organization of trade guilds or associations for research in each branch of industry, formed to pool resources in solving common problems and to take advantage of the laboratory equipment and opportunity offered, under the council's proposals, by the government-maintained institute.

A further necessary step will be the working out of the council's plans for more adequate provision by the universities for the training of qualified scientific workers. In the more generous investment of state funds for this purpose, starting, say, with Toronto, McGill and L'Ecole Polytechnique in Montreal, lies the hope of securing for the ensuing years of the world's strenuous and pitiless trade warfare, the nation's leaders in scientific and industrial research.

Apart from these crucial phases of the work and aims of the Research Council, space permits of only passing reference to some of the many research problems already undertaken.

As a result of the Council's initiative, governmental action was taken in June last to secure federal co-operation with the governments of Saskatchewan and Manitoba in establishing a demonstration plant in the Souris coal areas of Southern Saskatchewan, to prove the commercial feasibility of carbonizing and briquetting the Western lignites for heating in domestic furnaces.

This year will see a plant established with an outlay of $400,000 and an annual output of 30,000 tons of coal equal to the Pennsylvania anthracite and marketed in Regina or Moose Jaw at, at least, two dollars per ton less than the imported anthracite is now costing.

What Success Will Mean

The success of the initial plant, about which there can be little doubt, will lead eventually to the development of the immense and little realized latent lignite resources of Saskatchewan and Alberta, relieve for Ontario and Quebec the present coal famine through limited American supply and save to Canada the five or six millions of dollars now annually going to the United States for coal for the prairie provinces.

A systematic study of the rate of reproduction and growth of Canadian forest trees of the commercial species has been undertaken through scientific survey of some eighty square miles of an old cut-over lumber district on the Petawawa Military Reserve. The data being secured will in the course of a few years give, for the first time, the essential definite information enabling the Dominion and provincial governments to inaugurate on a scientific and practical basis a scheme of reforestration paralleling the best results obtained in the past in Europe. Our forest wealth, now in danger of exhaustion through reckless waste and disregard of adequate conservation systems, can only thus be preserved as a great and permanent national resource.

Alcohol from Sulphite Liquor

The tar fog research, initiated in 1917, has been continued with satisfactory practical results which will doubtless lead in the near future to the application to various plants in Canada of a new electrical process for the recovery of valuable by-products now lost in the destructive distillation of coal, wood, etc.

The research on sound measurements and fog signalling conducted in 1917 by Dr. Louis King, of McGill, has made further progress this year and forecasts a new type of sirens for use in the St. Lawrence River and Gulf.

Research work connected with the recovery of industrial alcohol from the enormous sulphite liquor waste of our Canadian pulp mills points to the installation of recovery plants and the production in Canada, at decreased cost to consumers of the alcohol increasingly needed for industrial purposes and as a substitute for motor fuel.

Five Millions for Research

There have been a score or more of other phases of industrial research initiated or continued during the year, each having a practical bearing on some branch of national production. More should and could be done, were trained men and money available. The Council's budget for the year has been under $100,000.

In Great Britain parliament has recognized the need and the opportunity by creating a separate Department of Scientific and Industrial Research and has voted one million dollars per annum for five years to be expended by the Research Council. In Canada, we, too, are learning the obvious lesson taught by Germany and already adopted by British industry. The path has been blazed for replacing rule of thumb methods in Canada by scientific investigation.

The Canadian Pacific Railway has bought the King lumber mills at Yahk, B.C., an initial payment of $100,000 having been made. The company is now engaged in building eight miles of railroad to develop its limits and to connect them with the mill at Yahk.

COMPRESSIVE STRENGTH AND MODULUS OF ELASTICITY OF GUNITE

DURING the past year the U.S. Shipping Board, in co-operation with the Bureau of Standards, has made extensive tests to determine the compressive strength and the modulus of rupture of gunite. Tests also were made this year by Prof. McKibben of Lehigh University, to determine the modulus of rupture and other characteristics. These tests are summarized in a paper: "The Cement Gun, It's Application and Uses," presented last month before the Society of Municipal Engineers of the city of New York, by B. C. Collier, general manager of the Cement Gun Co., Inc. The data following are taken from Mr. Collier's paper:—

Tests by Prof. McKibben

Tests have recently been made by Prof. McKibben, of Lehigh University, to determine the modulus of rupture of gunite, and his report shows results on slabs shot as follows:

A. Shot horizontally at one operation, 2 in. thick.
B. Shot horizontally at one operation, 4 in. thick.
C. Shot horizontally, four layers, 1 in. each, 1-hour intervals.
D. Shot horizontally, four layers, 1 in. each, 4-hour intervals.
E. Shot horizontally, four layers, 1 in. each, 24-hour intervals.
F. Shot vertically at one operation, 4 in. thick.
G. Shot vertically, four layers, 1 in. each, 1-hour intervals.
H. Shot vertically, four layers, 1 in. each, 4-hour intervals.
J. Shot vertically, four layers, 1 in. each, 24-hour intervals.
K. Shot vertically at one operation, 4 in. thick.
L. Shot vertically, four layers, 1 in. thick, 4-hour intervals.

It was the original intention in making these tests to get the modulus of rupture on samples A, B, C, D and E and, therefore, provision was made to eliminate the possibility of weak material along the corners of the forms. It was further intended to use the slabs that were shot against vertical forms to make compression tests. It was found, however, that the gunite was so hard that the ordinary cutting machines would not suffice to cut it into cubes, and so it was decided to use these slabs for additional rupture tests. It will be noted from the following tests that these slabs did not show as good results as did the horizontally shot samples, and as all other evidence warrants the belief that vertically-shot gunite is slightly stronger than that shot horizontally, the assumption has been drawn that the "weak" corners which were included in the area were responsible.

Modulus of Rupture

	28 days—	90 Days—
A.	617 average of 3 samples	643 average of 3 camples
B.	445 average of 2 samples	802 average of 2 samples
C.	384 average of 3 samples	766 average of 4 samples
D.	355 average of 3 samples	621 average of 3 samples
E.	210 average of 3 samples	308 average of 3 samples
F.		581
G.		494
H.		550
J.		598
K.		699
L.		590

The results were obtained by placing a knife-edge load on the centre of each slab which was supported on knife-edge supports, and the notation is made, "Every slab failed by breaking practically straight across the centre of the span."

Mechanical Analysis of Sand

All of these slabs were shot from bank sand having an average moisture content of 5.26 per cent. The mechanical analysis showed 73 per cent. passing a No. 10 sieve, 25 per cent passing a No. 40 sieve, and 2.3 per cent. passing a No. 100 sieve. The cement used was a standard brand of "Valley" cement. Tensile tests made on hand-made briquettes of this cement and sand mixed 1 to 3, gave an average tensile strength of 142 lb. per square inch. Other interesting data gathered from these tests show:—

1. That to 625 cubic ft. of dry mixed sand and cement fed to the gun was added 71 cubic ft. of water.

2. The percentage of dry material to completed gunite averaged about 50 per cent.

3. The percentage of sand rebound was about 15 to 20 per cent.

4. The voids in the sand averaged 40.7.

Tests were made on the total absorption of gunite 28 days old; samples taken from slab B showed 4.2 per cent.; slab C, 3.7 per cent., and slab D, 5.5 per cent.

Compression and Elasticity Tests

At about the same time that the tests were being made by Prof. McKibben, the United States Shipping Board, in co-operation with the Bureau of Standards, began a very exhaustive set of tests to show the compressive strength and modulus of elasticity of gunite. The engineers of the board experienced the same difficulty as did Prof. McKibben in cutting the samples into testing prisms, but as the facilities offered by the Bureau were so extensive, they were able to complete an extensive program of tests, although they were able to get 28-day tests on only a few samples. These few tests showed that there was a very much smaller proportion of increase between the 28-day tests and the 90-day tests than is usually the case with concrete. The figures herein quoted will apply to tests made on samples 90 days old or slightly older.

There were a total of 384 prisms tested and an analysis of the results produces some very interesting and instructive data. Two hundred and four of these prisms were shot against both vertical and horizontal surfaces with different proportions of mortar, and under other varying conditions. All samples were tested with the breaking load applied both perpendicularly to the plane of the applied layers, and also parallel with these planes. This was done in order to determine whether the samples shot in varying thicknesses of layers, and at varying intervals showed any difference in strength resulting from possible weakness of bond.

The average ultimate compressive strength of all of these 204 prisms was:—

Tested perpendicularly	4,470 lb. per sq. in.
Tested parallel	4,258 lb. per sq. in.

The other 180 prisms were shot through heavy screens of reinforcing, the object being to determine the strength of gunite behind the reinforcing bars. These samples, shot against both horizontal and vertical surfaces, showed a strength of:—

Tested perpendicularly	4,341 lb. per sq. in.
Tested parallel	4,531 lb. per sq. in.

Of the 180 prisms, 21 of these were shot against horizontal surfaces and showed:—

Tested perpendicularly	4,724 lb. per sq. in.
Tested parallel	4,521 lb. per sq. in.

159 were shot against vertical surfaces with results:—

Tested perpendicularly	4,291 lb. per sq. in.
Tested parallel	4,532 lb. per sq. in.

Of the 204 prisms above referred to, 168 were shot against vertical surfaces, and the average of the samples showed:—

Tested perpendicularly	4,500 lb. per sq. in.
Tested parallel	4,283 lb. per sq. in.

The other 36 prisms were shot against horizontal surfaces with the result of an average:—

Tested perpendicularly	4,345 lb. per sq. in.
Tested parallel	4,142 lb. per sq. in.

In this case it is noted that the samples tested perpendicularly showed more strength, which is what is to be expected, when it is recalled that the layer or film of dust that settled on a horizontal surface precluded a perfect adhesion between the various layers, but even this difference is so slight as not to be reckoned with.

A further analysis will show results that are of still greater interest and benefit in determining what can be done with the material in actual practice. Although it is not considered good practice ordinarily to place as heavy a layer as 6 in. of gunite at one operation, due to the tendency of gravity to break it down, still this was done in these tests, and the results of 18 prisms shot against a vertical surface showed:—

Tested perpendicularly	4,631 lb. per sq. in.
Tested parallel	4,490 lb. per sq. in.

Forty-eight prisms were shot against vertical surfaces in three layers of 2 in. each at varying intervals, and the results were:—

Tested perpendicularly	4,454 lb. per sq. in.
Tested parallel	4,073 lb. per sq. in.

One hundred and two prisms were shot against vertical surfaces in six layers of 1 in. each, at varying intervals, and the test showed:—

Tested perpendicularly	4,492 lb. per sq. in.
Tested parallel	4,336 lb. per sq. in.

It will be of interest to compare the two last referred to results. The results of the six layers showed that the strength of the sections were practically identical each way, while the results from the three layers showed a difference in favor of the samples tested perpendicularly. Of the samples tested, however, about half showed a greater strength under parallel testing, which offsets any pre-disposition to suppose that these results are an evidence of weakness.

Of the samples shot against horizontal surfaces 15 were shot in a single operation, or 6 in. thick. They resulted:—

Tested perpendicularly	4,470 lb. per sq. in.
Tested parallel	3,928 lb. per sq. in.

Eighteen prisms were shot in three layers of 2 in. each. and showed:—

Tested perpendicularly	4,090 lb. per sq. in.
Tested parallel	4,123 lb. per sq. in.

Only three prisms were shot in six layers of 1 in. each. with results:—

Tested perpendicularly	5,250 lb. per sq. in.
Tested parallel	5,320 lb. per sq. in.

In making a further analysis, it is interesting to develop the fact that the difference in intervals between layers of gunite, when properly applied, against surfaces that have been thoroughly wetted, produces very little variation in strength.

Six of the vertical prisms were shot with 1 to 3 mixture in three layers with 72 hours intervening. They showed a strength:—

Tested perpendicularly	3,755 lb. per sq. in.
Tested parallel	3,485 lb. per sq. in.

Inasmuch as most of the samples discussed above were shot at 24-hour intervals, the comparison is apparent.

It developed in this work that rich mixtures under normal treatment developed shrinkage cracks.

Forty-five prisms shot vertically with a mixture of one part cement and two parts sand (or aggregate) resulted:—

Tested perpendicularly	4,819 lb. per sq. in.
Tested parallel	4,652 lb. per sq. in.

while with a mixture of 1 to 2½ six samples showed:—

Tested perpendicularly	4,783 lb. per sq. in.
Tested parallel	4,500 lb. per sq. in.

On the other hand the 1 to 3 mortar showed in 105 prisms a test of:—

Tested perpendicularly	4,266 lb. per sq. in.
Tested parallel	4,006 lb. per sq. in.

(Concluded on page 118)

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PRINCIPAL CONTENTS

CENTRAL RESEARCH INSTITUTE

LOSSES due to preventable ignorance are incalculable. They transcend the cost of war. In fact, all the realized wealth of the world would not offset them. The resultant toll of human life is greater than that of war, famine and pestilence combined. Man, of course, is only groping in a dim twilight toward the secrets of the universe, but the knowledge he has already acquired has been more than sufficient to revolutionize most human activities and to add immensely to the health, wealth and convenience of mankind. But what is lacking is universal and extensive, to say nothing of intensive application of the known and proven.

Any extension of the present boundaries of knowledge adds to human resource, multiplies wealth, prevents untoward happenings, and helps the less able to better things. Yet it is a remarkable fact that scientific research is in bondage to ignorance, since it is denied legitimate extension and support by those to whom the results mean the most.

The usual attitude toward research is whether it is likely to pay, as if it were necessary to justify knowledge in terms of economic fact and trade profit. Surely it is conceded that past research has paid countless thousands per cent. What further need has it of any justification?

To attain the best results in the sense of fundamental discovery, the mind of the investigator must be untrammelled and his eyes without the blinkers of simple commercialism. Industrial research is perhaps another matter, for the immediate problem is stated and the scope of the investigation circumscribed.

It is ignorance that binds the feet of science, lack of knowledge that acts prejudicially against the novel. To win through to the emanicipation of mankind by making nature servant in place of master, demands freedom and means, together with trained intelligence. One-tenth the world's expenditure on armament would suffice in less than a century to unlock mysteries unnumerable. We must discard ignorance, unshackle research from the chariot of commerce, and endow science in order to set man free.

Throughout the British Empire, the importance of research appears now to be receiving somewhat adequate recognition, probably for the first time in modern history. In Great Britain, parliament has created a separate Department of Scientific and Industrial Research, and has voted for its maintenance the sum of five million dollars to be spent in five years. In Canada, there is good reason to believe that a Central Research Institute will be established at Ottawa, combining the functions of the Bureau of Standards at Washington and the Mellon Institute at Pittsburgh. According to an announcement by Dr. Macallum, administrative head of the Honorary Advisory Council for Scientific and Industrial Research, there will be an expenditure of $500,000 for a four-story building, of $100,000 for equipment, and at least $100,000 per annum for maintenance. Canada urgently needs such an institute. It should be established at once, even if it should cost many times the figures quoted by Dr. Macallum.

STATE AID FOR HYDRO-ELECTRIC PLANTS

TWO adverse factors have affected the development of water power in Canada, as in many other countries: First, public sentiment; second, initial cost. The public feels that there is a nobility in the country's rapids and waterfalls; that their grandeur is a heritage which must not be surrendered at the call of commercial interests. This sentiment is deep-rooted, and in many cases cannot be trifled with until fireless homes, foodstuff costs, freight congestion and other issues pertaining to personal welfare and the personal pocket-book, are seen to be dependent upon the water power for solution.

Once established, a hydro-electric station costs little to maintain and is largely automatic in operation. There are no expensive outlays for coal or oil. The pay-roll is comparatively small and the interruptions in service are few. But the initial cost is generally much greater than for a coal-power or oil-power plant. With money at over 10 per cent., allowing for present interest rates and all incidental expenses and discounts, the individual water-power plant is an expense not likely to be undertaken under present conditions by individual companies, which generally have need for most of their initial capital, unless:—

(a) They are compelled to make use of water power in the interests of the country, and

(b) The government aids them in so doing, which would be only fair if (a) be enforced.

The energy problem of the country as a whole should be given active consideration. The Dominion Power Board was appointed for this purpose some time ago, but as it has issued no report, nor has it made public any of its investigations or discussions, the public cannot determine whether anything has been done toward economic correlation of the energy resources of Canada.

Through the Victory Loan and other sources, the Dominion government is in possession of ample funds for investment in any enterprise which will be of economic benefit to Canada. While the funds are available, it would be well if the Dominion Power Board could suggest some method of assistance in financing water-power developments which would conserve coal or oil, yet which would be impossible from a business standpoint without State aid.

The utilization of water power deprives the country of no asset or resource. Every pound of oil, wood or coal of any kind that is used for power where hydro-electric energy could have been substituted, lessens our national wealth. True conservation would be effected by State aid in the financing of water-power developments, this aid not to take the form of bonuses or grants, but merely loans which would be fully repaid, with reasonable interest, upon the instalment basis.

PERSONALS

MAJOR WILLIAM GEORGE TIVAN, of New Westminster, B.C., has been awarded the Croix de Guerre. He is a graduate of the University of Toronto, Faculty of Applied Science, and has served as an engineer with the Light Railway Construction Corps.

ARTHUR EMIL DOUCET, who was recently appointed director of the Public Works Department of the city of Montreal, is a native of that city. Born June 9th, 1860, he was educated at the Royal Military College, Kingston, and started his professional career in 1881 as a rodman on the construction of the Algoma branch of the C. P.R. He was appointed resident engineer of the C.P.R. in 1882 and acted in that capacity during the construction of the Lake Superior-Jackfish Bay line from 1883 to 1885. He was appointed assistant engineer of the Lachine bridge construction in 1886, and the following year was division engineer of the C.P.R. at St. John's, P.Q. Joining the staff of R. G. Reid, contractor for the Algoma & Sault Ste. Marie Railway, Mr. Doucet became chief engineer of construction for that firm, and acted in that capacity from 1887 to 1890 during the construction of the Cape Breton Railway, and for the following eight years during the construction of the Newfoundland Railway. From 1898 to 1900, Mr. Doucet was chief engineer of the Arrowhead & Kootenay Railway, in British Columbia; 1900-4, chief engineer of the Quebec & Lake St. John, Great Northern and Trans-Canada Railways; 1904-8, chief engineer Quebec & Lake St. John Railway; 1904-15, district engineer at Quebec for the National Transcontinental Railway. In 1915 Mr. Doucet entered private practice and was so engaged until July, 1918, when he was appointed adviser to the City Commissioners of Montreal, this step being followed a few weeks ago by his appointment as head of the city's engineering department. Mr. Doucet was responsible for the location of the National Transcontinental from Quebec city to the western boundary of Quebec province, and obtained a maximum grade of 0.4 per cent. He is said to have declined at one time appointment as assistant chief engineer of the Transcontinental. He was a member of the Canadian Society of Civil Engineers since its inception, and is at present a member of the council of the Engineering Institute of Canada. He is a past president of the Quebec branch of that Institute, and of the Royal Military College Club. He was gazetted a Lieutenant of the Mounted Infantry School Corps after qualifying at Kingston. Serving as A.D.C. to his brother-in-law, the late Lt.-Gen. Sir F. D. Middleton during the northwest rebellion, he was seriously wounded, winning a decoration. He was appointed a captain of the Corps of Guides in June, 1906. Capt. Doucet is also president of the Garrison Club at Quebec, and a member of the American Railway Engineers' Association. He was the promoter of the Quebec Transport Co. and the Pacific Pass Coal Fields Ltd., and is vice-president of the Dobell Coal Mines and chairman of the St. Maurice Molybdenite Syndicate, Ltd.

MAJOR DOUGLAS H. C. MASON, D.S.O., B.A.Sc. (1908), University of Toronto, one of the original Third Battalion, has been awarded a bar to his D.S.O.

CAPT. R. Y. CORY, B.A.Sc. (1909), University of Toronto, was one of the heroic Third Battalion that held the line at Langemarck. He was captured by the Germans but has now been repatriated.

PUBLICATIONS RECEIVED

PHILLIPS' HANDBOOK.—New edition of the electrical handbook issued by the Eugene F. Phillips Electrical Works, Ltd., Montreal. 4½" x7", 270 pages and limp leather cover, clearly printed on good quality of coated paper. Complete information is given regarding the wide range of Phillips' products, together with valuable tables regarding the properties of electrical cables, wire, etc. Section 5, consisting of 67 pages, contains general mathematical reference data, well arranged and useful in character. There is also an index to contents. Section 1 covers electrical conductors; Section 2, bare and weatherproof wires and cables, magnet wires and cotton covered wires; Section 3, rubber insulated wires and cables and flexible cords; Section 4, paper insulated power and telephone cables and varnished cambric insulated cables. The handbook is illustrated with a large number of well made halftones.

COMPRESSIVE STRENGTH AND MODULUS OF ELASTICITY OF GUNITE

(Continued from page 116)

It would, therefore, seem that the most advantageous mixtures are 1 to 2½ for work demanding high water resisting qualities and 1 to 3 for ordinary conditions.

Some samples were developed with the use of aggregate ranging up to ½ in., on the assumption that the larger material would show greater strength, as is the case with concrete. As the work progressed, the results showed that here was no advantage and that a well-graded mixture, ¼ in. and under, best satisfied all conditions. As a matter of fact, some excellent results were obtained by using Potomac River sand directly, without any attempt at graduation. This sand was of about the same character as that analyzed above in the report of the Lehigh University, and is what is termed "a good concrete sand."

A study of these results will show that a safe assumption for 1 to 2½ gunite will be 4,500 lb. per square inch ultimate compressive strength, and for 1 to 3 gunite 4,000 lb. per square inch.

In developing the modulus of elasticity, it was not possible to test as many samples as for compression, but the results obtained were highly instructive and beneficial:—

Three prisms were made of 1 to 2 gunite and showed an average modulus at 90 days of 5,417,000 lb.

Two of 1 to 2½ gunite were tested at 90 days and showed an average of 4,670,000 lb.

Eight tests were made on prisms of 1 to 3 gunite with an average result of 4,705,000 lb.

The Winnipeg city council at a meeting last week endorsed the Federal government's proposition to loan money for housing and appointed a committee to draft a report regarding the best way to take advantage of this offer.

Work on the Welland Canal will be continued for the time being on a basis of cost plus eight per cent. No work exceeding $2,000,000 will be done upon this basis, however, as before that amount is spent this year, the Minister of Railways and Canals will call for public tenders for the completion of the work. The cost-plus contracts have been placed with the former contractors.