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PUBLISHED WEEKLY

ESTABLISHED 1893

Canadian Engineer

SUBSCRIPTION RATE—$3 a year; $1.75 six months; $1 three months; postpaid anywhere.

Issued in the interests of Canadian Civil Engineers & Contractors

This field includes chiefly the men who are engaged in municipal, railroad, hydraulic, structural, highway and consulting engineering surveying; mine-management; contracting; and waterworks superintendence.

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Published every Thursday by THE MONETARY TIMES PRINTING CO. OF CANADA, LIMITED

JAMES J. SALMOND, President and Gen. Mgr. *ALBERT E. JENNINGS, Asst. Gen. Mgr.*

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A weekly paper for Canadian civil engineers and contractors

Completion of Toronto-Hamilton Highway

Last Five Miles Now Being Laid—Concrete Base for Old Dolarway Road Torn Up With Steam Shovel—Thicker and Stiffer Pre-Moulded Joints Have Proven Advisable

By HARRY STEWART VAN SCOYOC, C.E.

Chief Engineer, Toronto-Hamilton Highway Commission

STEAM shovels have been used in a few cities in tearing up concrete sub-base of track allowance, owing to change in grade or location, but so far as is known a steam shovel is now being used for the first time in tearing up the concrete sub-base of a roadway. About four years ago a Dolarway road was laid from the Humber River to Church Street, Mimico, a distance of a little more than two miles. The concrete was laid in one course, 1 : 2 : 4 mix, 14 to 15 feet wide. The surface was treated with tar. The traffic over this road is extremely heavy, and as it is not in suitable repair, nor wide enough, nor of the right mix, nor proper section to form a part of the Toronto-Hamilton Highway, the commission decided to tear it up, as it was desired to lay a 24-foot roadway for four and a half miles at the Toronto end of the highway.

The contract was let to Franceschini & Co., excavating and grading contractors of Toronto, for 68c. a foot. This price includes 3,000 feet free haul. Part of the broken concrete is being deposited as fill for the approaches to the new Mimico bridge, the remainder being used to repair some of the streets in Mimico.

The Steam Shovel Broke Up 600 Lineal Feet of 15-ft. x 6-in. Concrete in One Day

A Type-o Thew shovel, with bucket of ⅓ yard capacity, is being used. The shovel gang consists of six men, with ten teams to haul the material away. The concrete breaks up readily in pieces varying from one-quarter square foot to a square yard. The shovel makes rapid progress, averaging 400 to 425 feet per day, and one day doing as much as 600 feet.

The Toronto-Hamilton Highway was finished last summer at the Hamilton end as far as the Hamilton city limits, with the exception of about 3,000 ft. which is being

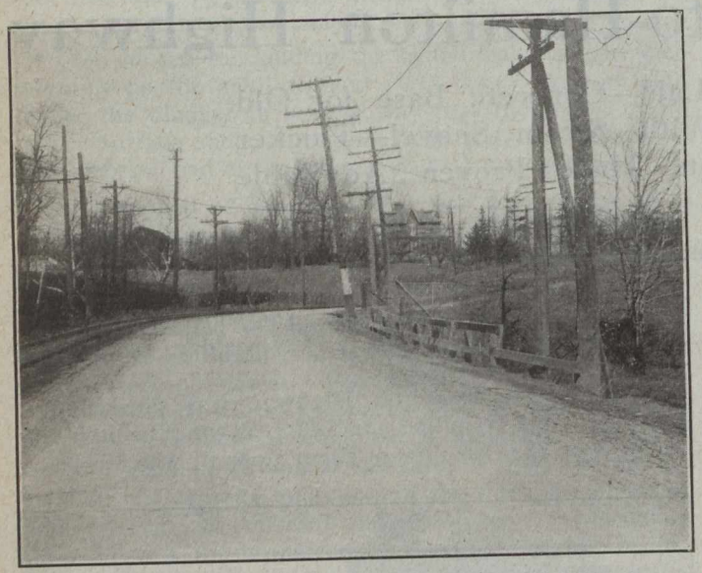
Tearing Up the Old Dolarway Road

maintained as a waterbound macadam roadway until the city of Hamilton decides whether to carry the highway into the city by means of a fill, or over a bridge or along the present Grand Trunk Railway right-of-way.

The commission had not considered the last-mentioned proposition, thinking that the Grand Trunk Railway would not be likely to give up their right-of-way at any time in the near future, and intimated to the city that the scheme known as the Armstrong fill would be quite satisfactory to the commission, and would probably cost only about half the amount that the bridges would likely cost.

The report on the railway situation at Hamilton, made a few weeks ago by Messrs. Tye and Cauchon, also dealt with the Toronto-Hamilton Highway entrance by request of the city officials, and the consulting engineers advised the city that the Armstrong fill would be "quite intolerable" when taken in connection with their new railway plan for Hamilton, as "all highway traffic would emerge from a subway directly onto the railway crossing without a clear view in either direction." Should the Grand Trunk join in with the new roads seeking entrance to Hamilton

in building the improved grade from Burlington Junction to the Stuart Street station, as recommended by the consulting engineers, it would have no further use for its old roadbed from some point near Waterdown station to a point on the large fill of the old entrance to the canal, and the engineers recommend that the old roadbed be secured, the highway diverted to it, the old entrance widened and

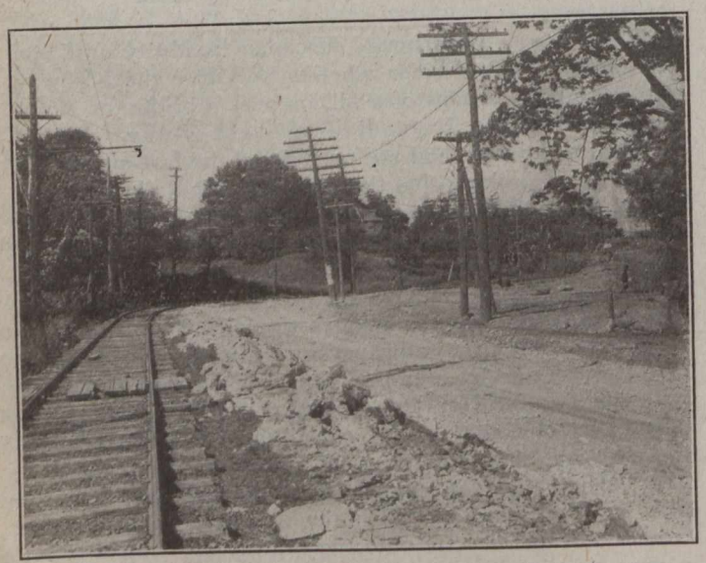


Near Mimico—A Sharp Curve on the Old Road

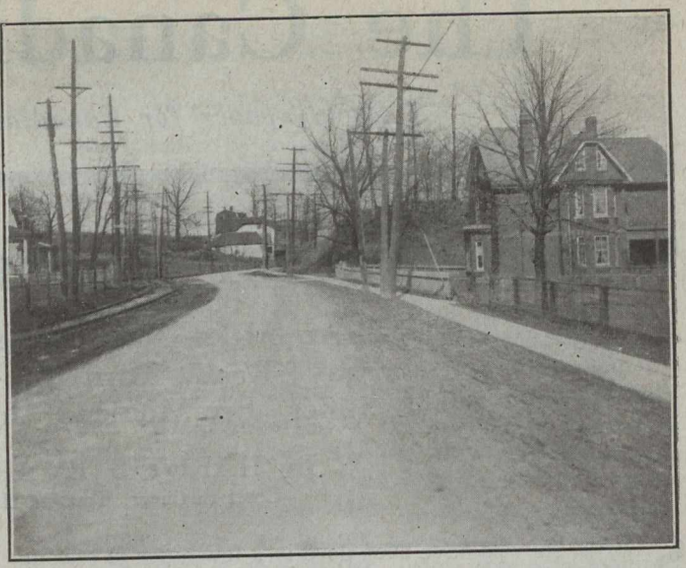
raised at the southern end and the construction of expensive bridges thus be obviated.

On the other hand, it is a question whether the commission will agree to wait until some indefinite time when the Grand Trunk may be prepared to surrender its roadbed, or whether it may force the city of Hamilton to take some action in providing a suitable entrance either by fill or bridges. The commission has authority to force action in the matter through an amendment to the Toronto-Hamilton Highway act passed at the last session of the provincial legislature.

The highway is complete from the point mentioned above, near the Hamilton city line, easterly to the Etobicoke River, five miles from the Toronto city limits, which are near the Humber River.



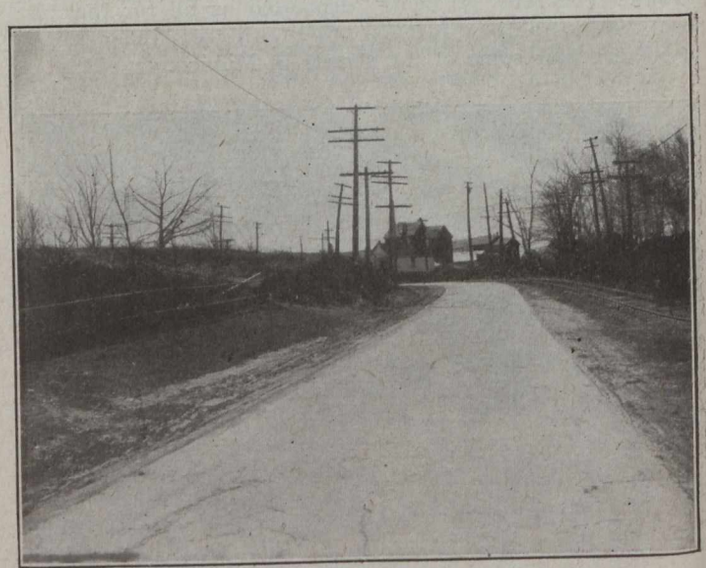
At the Same Curve Near Mimico, Showing Old Road Torn Up and Fill Completed to Carry a Better Curve



An "S" Curve That Has Been Eliminated

The westerly half mile of this section will be eighteen feet wide, like all the remainder of the highway excepting where it passes through the town of Oakville, where it is fifty feet wide, but the four and a half miles nearest the city of Toronto will be twenty-four feet wide.

The total width of the present highway from fence line to fence line from Church Street, Mimico, to the Humber River, is as narrow as 38 feet in parts and the whole highway is being widened to 66 feet, of which 24 feet will be paved as above mentioned. There will be room at each side for a sidewalk. The radial railway tracks will be moved so that they are at least 4½ feet north of the northern edge of the pavement. A broken-stone shoulder will occupy the 4½ feet between the track and the concrete. A few years from now the growth of traffic may



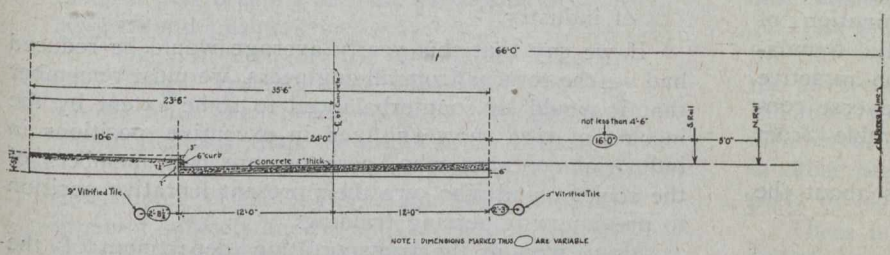
The Old Pavement that is Being Torn Up—Showing One of the Sharp Curves that are Being Eliminated

necessitate three feet of macadam shoulder on each side of the highway, for much of its length.

The tracks will be moved without disturbance of traffic so far as possible. The track is now located for the most part on the public highway, but where necessary the commission will expropriate any land belonging to the radial railway or other private owners.

The accompanying illustration shows the section adopted for the 24-foot highway. This includes a curb and is quite different from the design of the remainder of the highway.

Four bridges are required on the highway, namely, at Mimico, Etobicoke, Port Credit and Bronte, and these will cost a total of about $100,000, but tenders will not be called for them until fall, owing to an application before the Ontario Railway and Municipal Board to determine just how the cost of these bridges is to be divided



Proposed Cross-section of 24-ft. Road

between the commission, the interested municipalities and the province. Meanwhile, the old bridges will be used, but they are too narrow and are also unsafe, and should be rebuilt before another summer.

The concrete work has been divided into four sections and while it is hoped that two mixing plants will be sufficient to finish the work by the second week in September, the commission has divided the work into four sections and will, if necessary, put four separate plants at work. The commission owns five mixing plants and has one under lease from the provincial government. One mixing plant is now working east from the Etobicoke River and will finish at the yard near Mimico about the third week in August. A second mixing plant will work

On the Route of the Toronto-Hamilton Highway Near New Toronto. Photo in May, 1917. The farmers along this road will be glad to see the concrete mixers

west from Church Street, Mimico, beginning next week, and will finish at the yard about the same time. These two mixing plants will then be transferred to the easterly portion of the road, but if weather interferes, additional plants will be utilized.

The commission's whole plant, both mixing and transportation, cost about $80,000, and it is expected that if the war continues, the commission will be able to realize on the plant the full purchase price, as much of the equipment has increased greatly in value. Four miles of 20-lb. track was recently sold by the commission for more than was paid for it, and it has been offered higher prices for its locomotives and cars than were paid for the equipment when new.

A number of dangerous sharp curves and one "S" curve, as shown in the accompanying illustrations, are being eliminated on the five-mile stretch being laid this year. No curve of this stretch will have a radius of less than 500 feet. At Etobicoke it will be necessary to excavate 20,000 cubic yards of material, and about 10,000 yards have been taken out on the other curves.

A number of slabs which were laid in 1915 were found to be cracked in the spring of 1916. It was thought that this was due chiefly to the very unusual weather conditions during the previous winter. Also some of the joints had raised; this was thought to be due in part to the fact that all the joints were not truly vertical, some of them having ridden up one upon the other. The expansion joint used for the 1915 work was a layer of felt about 3/16 inch thick, and in the light of the experience gained in that season's work, it was thought advisable, particularly in work done late in the season, to allow a much wider expansion joint, and in the work done since then a 3/8 inch premoulded expansion joint has been used with greater satisfaction. Very few of the slabs laid in 1916 have cracked and hardly any of them have heaved. In the 1916 work every effort was made to obtain truly vertical joints. Elastite, Pittsburgh and Sarco joints were used on the work last year. The thicker and heavier joint stands up better, and while it costs a little more both in point of initial cost and maintenance, it is an added safeguard to the pavement, and it has been found to be desirable.

The maintenance on the highway last year, not including patrol and some other items which the commission classes as maintenance, but including merely the material used in repairing the road surface and the labor, amounted to $315.71, or about $20 per mile. This did not include the special item of chipping raised joints, which cost $326.78.

Very little reinforcing was used in the highway during 1915 and 1916, only a light mesh over the fills and in cuts. This year's work will be reinforced with Kahn road mesh, size No. 20, .053 sq. in. sectional area, 6-in. width x 12-in. length diamond. The reinforcing sheet will be placed about 2 ins. below the surface. In Mimico and New Toronto, where water and sewer lines have been recently installed, both top and bottom of the road will be reinforced. The reinforcement is being added on account of the increased width of the slabs.

The failure of the Mammoth dam of the Price River Irrigation Co., Utah, on June 24-25, was due to the following causes, according to a report by George F. McGonagle, state engineer: "This dam failed (1) because the flume portion of the spillway was improperly and inadequately constructed; (2) because the horizontal reinforcement of the corewall had been stopped 12 ft. above the base instead of being carried to the top of the core; (3) the first section of the corewall to fall sheared off at a point 5 ft. below the top, indicating that the bond between the older section of the wall and the 5-ft. raise made last year was not what it should have been; (4) because the management deliberately permitted the level of the water in the reservoir to rise to within 10 in. of the top of the core, contrary to all precedent.

SOME SUGGESTIONS FOR IMPROVEMENTS IN THE ENGINEERING PROFESSION*

By F. G. Jonah

WE know that the strenuous and ever-changing conditions of modern life have produced a feeling of unrest which manifests itself in every walk of life, but a careful review of the situation hardly justifies the widely-spread pessimistic views of our status, and much harm may be done by the dissemination of erroneous impressions which have only a partial foundation in fact. The young man just entering upon an active career may be greatly discouraged by the adverse conditions which he is led to believe are inseparable from the practice of his profession.

The most frequently expressed complaints about the profession, by the engineer himself, are:—

(*a*) That it is underpaid.
(*b*) That it is not sufficiently recognized in the appointments to public office.
(*c*) That its influence is not fully appreciated in the community.
(*d*) That it is, therefore, on a less desirable plane than the other learned professions.

The complaints which the general public make about the engineer are:—

(*a*) That he is narrow in his views.
(*b*) That he tries to solve all social problems by mathematical rigidity.
(*c*) That he is generally unfitted for business.
(*d*) That he is generally a poor executive.

And that by reason of these shortcomings he is unfitted for positions in the public service.

It is well worth our while to carefully consider these complaints, to ascertain how much truth there is in them, and to see where unfavorable conditions may be improved.

First: As to the profession being underpaid.

A committee of the American Society of Civil Engineers has been studying this question and collecting data for several years, and recently rendered a final report, which is based on replies to inquiries from 5,059 members of the American Society of Civil Engineers and 1,319 non-members, or a total of 6,378 engineers, who gave details as to their personal compensation. The American Society of Civil Engineers has 8,149 members in all grades, so that replies were received from 62 per cent. of the membership, but the replies from the non-members is probably a much smaller proportion of the men in the engineering profession not connected with the Society. The report shows:—

The average yearly compensation of the member is $4,142
The average yearly compensation of the non-member is 3,387
That the non-technical man earns more than the technical man in the first 2½ years of experience.
That the maximum compensation is reached when 30 years of experience is gained, after which there is a gradual decline in the earning power.

While these figures show the engineer to be making a fairly comfortable living wage, it is objected to that they correctly represent the true conditions, first, because in all probability those replying to the committee's circular are the most prosperous members of the profession; and, secondly, those who are failures are scarcely expected to herald forth that fact, and on this point the committee says:—

> "That in considering the replies of those considered cynical or pessimistic, that they have been made by men who would probably have been failures in any other occupation—men who fail by lack of adaptability, or even a fair degree of industry."

If we say that this yearly average would be reduced had we the returns from all engineers, we must remember that it would be counterbalanced to some extent by the income of men now engaged in executive positions in industrial concerns who, perhaps, are not members of the society, and who owe their present lucrative position to previous engineering training.

Many men in the transportation department of the large railroad systems came up through the engineering department. Many of these men are not members of our society, and their salaries are above the reported average. So the young engineer on small salary should be encouraged to know that his daily work may be fitting him for positions of greater remuneration outside of the profession in his more mature years.

Second: That we are not sufficiently recognized in the appointments to public office.

There has been considerable improvement in this respect in recent years. We now find engineers on public service commissions and on many important commissions appointed by the government, but much more might be done by concerted action. We should be as zealous for the welfare of our organizations as the labor unions are of theirs. We should realize that political activity is not necessarily partisan politics, and we could take a much greater part in public affairs than we have hitherto done to the ultimate good of the profession. We should demand recognition for the engineer in those appointments to public offices for which his qualifications pre-eminently fit him, and we should vigorously denounce the appointing powers when such recognition is not accorded.

Third: That our influence is not fully appreciated in the community.

Our profession seems to feel that we are without sufficient influence in the community. I believe this is a mistaken idea. Men possess and exert different kinds of influence, for example, political, financial and social. We are deficient in political influence, due to our own inactivity. We do not aspire to financial influence, but socially we are influential. We belong to a profession pre-eminently respectable. A scandal of any kind affecting our members is a rare occurrence. We are, perhaps, inclined to confuse influence and notoriety, and our influence is quietly exerted. No man is without influence who is industrious and does his duty, and the engineer's actions are always governed by his sense of duty.

Fourth: That our profession is on a less desirable plane than other learned professions.

We are very apt to say that we are not recompensed for our services as are lawyers and doctors, but a little reflection will show us that there are many lawyers and doctors making but a meagre living, and doubtless we all know personally men of those professions who never were in all their lives more than two jumps ahead of the collector.

Regarding the complains which the public has to make about the engineer, they are in a large measure

*Paper read before the Engineers' Club, St. Louis.

justified if we are to believe the statements made from time to time by eminent engineers, and I desire to call your attention to a notable address delivered before the American Institute of Electrical Engineers, 1915, by that very prominent educator and engineer, Prof. Geo. F. Swain, of Massachusetts Institute of Technology, from which I quote:—

> "Engineers are deficient in clarity of thought as compared with lawyers, and in both clarity of thought and breadth of view as compared with lawyers and business men.
>
> "The best men of the community take up law. Legal training and experience, on the whole, train men better to think straight and reason logically than the engineering training.
>
> "I question whether to-day, and in the past, the training of the engineer has given as much grasp of subjects and breadth of view as has the training of the lawyer and business man. I fear the engineer concerns himself in college and after college too much with the minor technical details of his profession and does not accustom himself to study, does not take interest enough in the broad questions affecting the community in general.
>
> "The fact that engineering is to so large an extent a mathematical subject is one of the main reasons why the engineer is not recognized.
>
> "There is scarcely anything that tends more to narrowness of view than dealing all the time with problems which can be solved only by rigid mathematical process, because the great questions that confront us are not mathematical—the data are shifting, variable, and the human element comes in. Therefore, the man who is accustomed to solve his problems by mathematics and who can only do the solving in that way finds himself at a loss in the practical affairs of life—mathematics do not apply."

I have quoted Prof. Swain at length, because he has given certain reasons for the opinion which the public to so great an extent shares about our profession, but I believe some of the views expressed by Prof. Swain may be seriously questioned.

It is a surprising thing, if true, that the legal training and experience, on the whole, train men better to think straight and reason logically than the engineering training.

The lawyer is dealing with the laws of man, which are constantly being amended, appealed and repealed. Can it be said that there is any particularly straight thinking and logical reasoning behind the laws which are constantly being ground out in the State Legislatures and the National Congress, three-quarters of whose members are lawyers? On the contrary, they are the result of the exigencies of party politics, a servile subserviency to the shifting views of public opinion, and that they are illogical is seen from the fact that so many of them are knocked out as soon as they reach the higher courts.

The engineer, on the other hand, is dealing with the unchanging laws of nature, which can never be faked, and I maintain that of the two men, the engineer should be the straight thinker and most logical reasoner. The lawyer appears to be, simply because he can better express his thought. His training accustoms him to public speaking and setting forth his reasons in argument. He is trained to think standing. The engineer's training affords very little opportunity for speaking. This and many other of the shortcomings mentioned by Prof. Swain are defects in the education of the engineer.

There seems to be some difference of opinion among the educators of the country as to the way in which engineering education may be improved. There are a large number of men who think a five-year course, and even more, is necessary. There are those who believe less education in engineering detail and more in general cultural studies, and a four-year course, would produce the best results.

I am inclined to the latter view. We are not looking for the colleges to turn out experts and specialists, as the advocates of the longer course think they should do. What we want is young men well grounded in the fundamentals of the profession, and with a liberal education in other branches. They will specialize and become experts in the course of their professional career.

There is no reason why a young graduate from an engineering school should not be able to make as fluent and as logical an address on any subject of general interest as a graduate from a law school. His education is deficient in literature and languages. He is often woefully lacking in the ability to write and spell English correctly, and the colleges are to blame for this. The engineer who will succeed in the profession is one who will regard his college education not as the end of his education, but merely the means to an end, the value of which will be in the forming of correct habits of study. An extensive acquaintance with the best literature in the language, and the ability to speak fluently and write correctly is within the reach of everyone. The "five-foot shelf of books" will furnish the basis of a liberal education, we are told by a great educator, and the young graduate should leisurely study along that line. Good literature and poetry will not only afford him great mental relaxation, but will unconsciously mould his habits of thought and speech.

We realize the inability to make a speech in a land governed by gab is a serious handicap, but with a broader general education on the part of the colleges and a general knowledge of literature acquired by reading after leaving college, the young engineer can train himself to at least hold his own with the lawyer, with whom he is so frequently contrasted to his disadvantage. Referring again to the matter of clear thinking on the part of lawyers: In every lawsuit tried to a conclusion, counsel on one side wins, which, we assume, indicates clear thinking and logical reasoning for that particular lawyer, but at the same time some other lawyer lost, so the lawyers' work breaks "fifty-fifty" all the time. He has the satisfaction, however, of knowing that he is being paid, even while losing, and can console his unfortunate client with the statement that the jury or judge surely erred, and that there may be a reversal for him if he continues the case through the long line of courts to the bitter and expensive end.

Now, what can we do to improve the conditions in the profession? We can look to the colleges for some improvement in the graduate, and we, the practising members of the profession, can undoubtedly improve the conditions of employment. The engineers have been misled by the fallacious doctrine that engineering consists in the art of investing a dollar so that it will earn the most interest, and with the equally fallacious idea that low costs means efficiency. The engineer should be concerned less about the cost than the character of his work. He has been often anxious to complete his work

(Concluded on page 101.)

A CRIB AND EMBANKMENT COFFERDAM COSTING $86,290

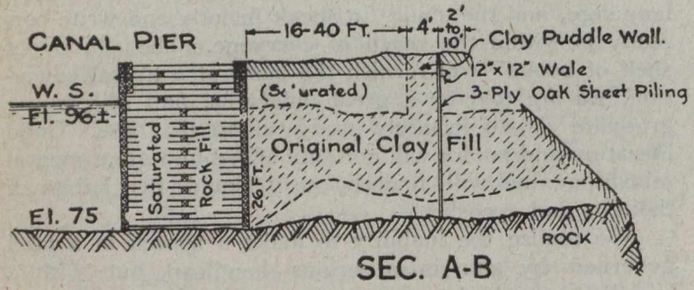
THE cofferdam for the $6,000,000 locks at Sault Ste. Marie, Mich., built by the United States Government, encloses an area of 22½ acres and has a total length of exactly one mile made up of 3,153 ft. of new dam subject to a maximum head of 23 ft. water pressure and over 2,000 ft. of old dam and wall utilized for the new cofferdam. The original estimate of cost for 6,000 ft. of dam enclosing the sides of the lock and part of the canal was $217,000, but the 3,153 ft. here described was built at a cost of $86,290.

The dam was built partly on a fill of loose rock and principally on a stratum of boulders underlaid with gravel and then silt extending down to rock, thus requiring excavation to be made the full length of the dam so as to carry all the foundations to rock bearing.

The dam was built in nine different sections constructed at different stages and with varying details and dimensions described in a paper by W. J. Graves, assistant engineer, in the May-June issue of "Professional Memoirs" of the Corps of Engineers, U.S.A.

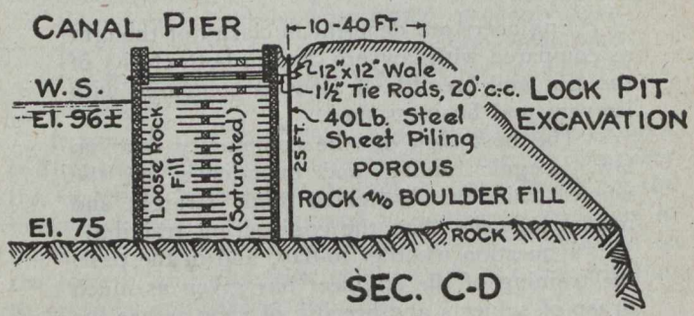
General Conditions

The preliminary subterranean survey by soundings over the entire area of the dam was made up to a depth of 10 ft. by a 1-in. steel rod and at greater depths by a 3-in. steel rod having a detachable blunt point and driven by a pile driver. Test holes were spaced from 10 to 20 ft. apart and were made to an average depth of 14½ ft. at a cost of 45c. per foot. The indications were fairly reliable except that the hand holes did not always pierce the hardpan and the machine holes sometimes penetrated the soft upper part of the rock.



Clay and Crib Dam with Sheet Pile Diaphragm

The construction was chiefly a combination of rock filled sheeted timber cribs and earth or rock embankment modified sometimes by the use of steel or wooden sheet piles for the higher pressure heads, with puddled clay walls built in trenches or in low earth embankment for small heads and to cut off seepage. In all sections a considerable economy was effected by using spoil from the lock excavation for backfill provided for by contracts awarded as material was needed.

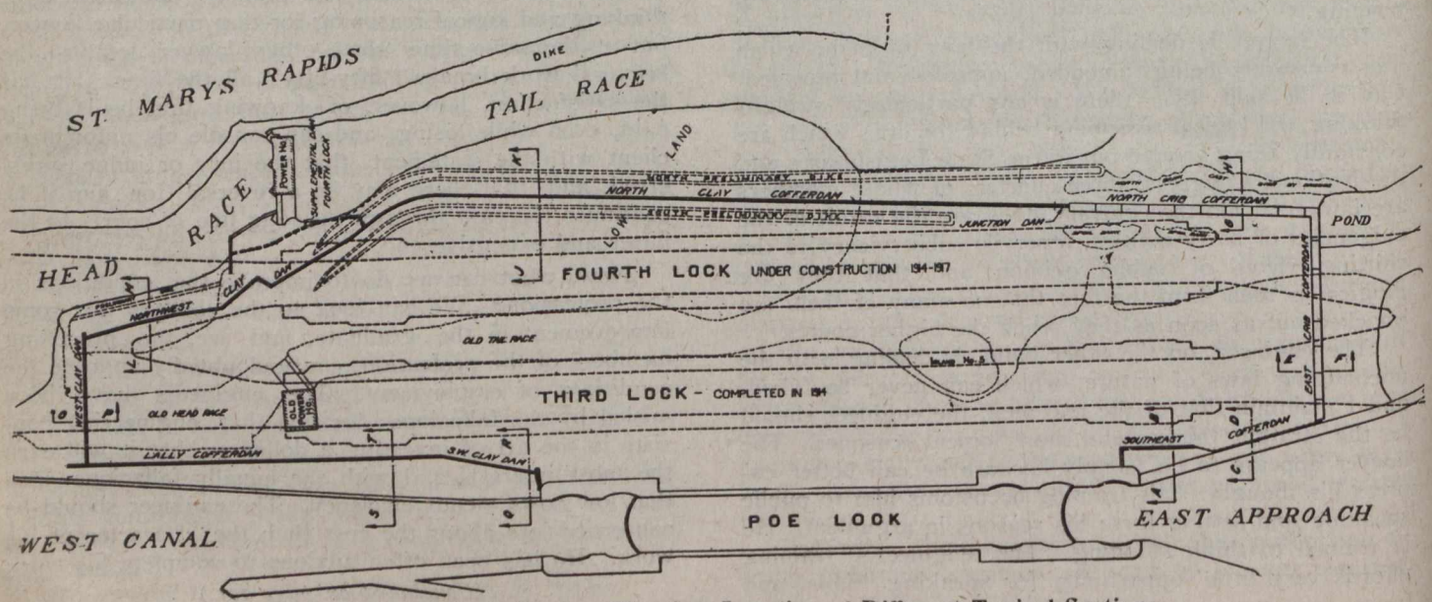


Crib and Embankment with Sheet Pile Diaphragm

Sheet Pile Dams

The southeast cofferdam, although really a crib and embankment structure, for the purpose of this article is virtually a sheet pile structure because the rock-filled crib and embankment already existed as part of the canal structure but not being adequate to exclude the water from the lock excavation was reinforced by sheet piles driven through the embankment, thus involving no other construction or expense chargeable to the present operations.

At the west end the existing canal embankment consisted of clay of unknown quality in which there was driven an oak sheet pile cut-off diaphragm 41 ft. deep and 144 ft. long tied back to the crib with 1½-in. anchor rods 16 ft. apart. As the upper part of the clay bank was saturated a trench 4 ft. wide was excavated in it and filled with clay puddled against the face of the sheet piles. The work was done at a cost of $2,676 for labor and supplies, and $2,224 for plank, clay and anchor rods, making a total cost of $1.62 per square foot of wall, shown in section A-B.



Plan of Complete Cofferdam Showing Location of Different Typical Sections

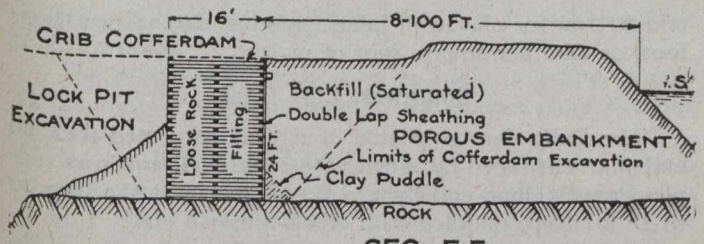
At the eastern end of this section of the cofferdam, section C-D, the embankment was of rock and boulder fill through which leakage was cut off by a 265-ft. line of 25-ft. 40-lb. Lackawanna steel sheet piles tied to the crib with horizontal anchor rods 20 ft. apart and sealed by extending 4 ft. into the clay puddle at each end. The labor and supplies cost $1,007, and the steel ties and rods $5,358, making a cost of 96c. per square foot of wall, shown in section C-D. About 50 ft. of the sheet piles was cut off at a cost of $1.20 per foot by an oxy-acetylene torch outfit costing $5 per hour.

East Crib Cofferdam

The east crib cofferdam, 402 ft. long, was a rock-filled crib shown in section E-F constructed in one of the existing embankments through which it was impossible to excavate a dry trench and make a puddled clay core wall. The site was excavated to bed rock by a dipper dredge of 9½ ft. draft. The 15,597 yds. of dredging cost $10,154, lumber, iron, and clay cost $4,311, and the labor and supplies cost $6,200, a total of $51.40 per linear foot, or $2.39 per square foot of cofferdam.

North Crib Dam

This section was adjacent to an earth embankment which was not watertight, and was supplemented by a



SEC. E-F

Porous Embankment with Sheeted Crib

structure like the east crib dam consisting of a filled crib sheeted and supplemented by backfill and toe puddles, as shown in section G-H.

A small amount of dredging was necessary to excavate to rock in a trench 27 ft. wide at the bottom. In it there was encountered a 9 x 10 x 12-ft. boulder which was drilled and blasted at a cost of $97 and the pieces removed by chaining to the dipper teeth.

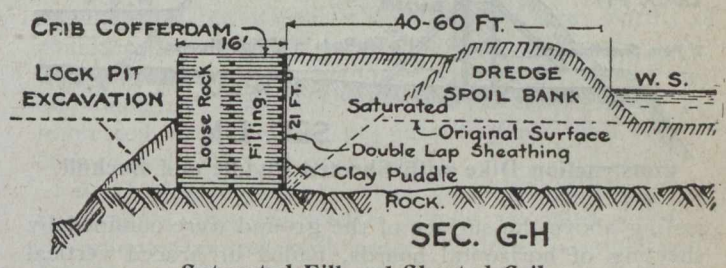
This section of the cofferdam was 432 ft. long, and the cost for the 10,538 yds. of dredging $5,286, for timber, iron, and clay $5,198, for labor and supplies $6,213, making a total of $38.65 per linear foot or $1.85 per square foot of cofferdam.

Construction of Cribs

The 16 x 40-ft. cribs 21 ft. high were built cob house style with 8 x 8-in. hemlock timbering, having ½-in. drift bolts at intersections. They were built on shore up to a height of 6 ft., sheathed on the water side with 1-in. vertical matched boards, launched, and afterwards completed to a height of 16 ft. while floating with the aid of buoyancy pontoons made of barrels. The bottoms of the cribs were fitted to conform to the profile of the rock bottom as indicated by soundings 3 ft. apart on the lines of the crib walls.

As the bottom was not properly cleaned by the dredge and as a considerable amount of material was deposited and hardened there during several months between the completion of the dredging and the sinking of the cribs, it was necessary to clean the bottom by a diver and derrick boat before the cribs were sunk. A dragline scraper was unsuccessfully employed to clean the bottom and was replaced by a ⅜-in. water jet of 60 to 100 lbs. pressure that loosened material requiring an 8-in. centrifugal sand pump running 450 r.p.m. to remove it.

The scraper, jet, and pump were manipulated by divers who worked during the winter months with their air



SEC. G-H

Saturated Fill and Sheeted Crib

pumps housed in a heated shed to warm the air for their comfort.

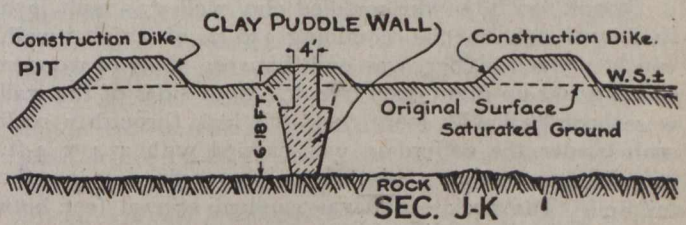
The ends of the front and back wall timbers in the cribs projected 6 ins. beyond the transverse walls so that when the cribs were sunk in contact a chamber was provided between adjacent ends in which there was driven a locking bent of framed 12 x 12-in. timber that forced the crib into good alignment and made a continuous anchored structure.

After the cribs were placed, about 1 yd. of clay to the linear foot was deposited along the outside toe of the cribs and 2-in. hemlock sheeting was driven into it, breaking joints with the 1-in. sheeting on the face of the cribs. The cribs were filled and backfilled with a mixture of earth and small rocks.

North Clay Cofferdam

This dam, shown in section J-K, is located in the former bed of the rapids, which in highwater is overflowed. It was, therefore, protected by low embankments on each side, built of material excavated from the lock and dumped on frozen ground or ice which eventually did not exclude the water but were useful to furnish material for backfilling the clay dam.

The site was covered with boulders which were removed by hand by a force of nine men who pried or blasted them loose and moved them only an average distance of 20 ft. to clear a space of 40 ft. wide. The larger ones were handled by a light tripod derrick and hand truck on plank runways. Seven hundred and twenty-one yards



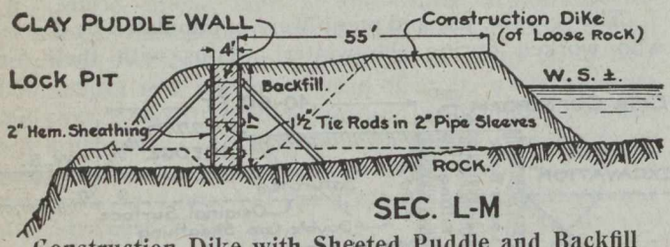
SEC. J-K

Wet Ground with Puddled Cut-off

of boulders was removed from 1.15 acres ground at a cost of 76c. per yard. Fifty-four of the largest boulders, averaging 2¾ yds., were drilled by hand and cracked with dynamite.

The trench, from 3 to 15 ft. deep, was excavated in frozen gravel in sections 300 or 400 ft. long partitioned off with blank bulkheads and filled with clay deposited in 6 to 24-in. layers dumped from sleighs driven alongside. It was puddled with hot water and when necessary was

covered with tarpaulins under which exhaust steam was discharged at night. The puddlers wore rubber boots and used wooden rammers. The puddling shrunk 33⅓ per cent. from box measurement. Portions of the wall pro-

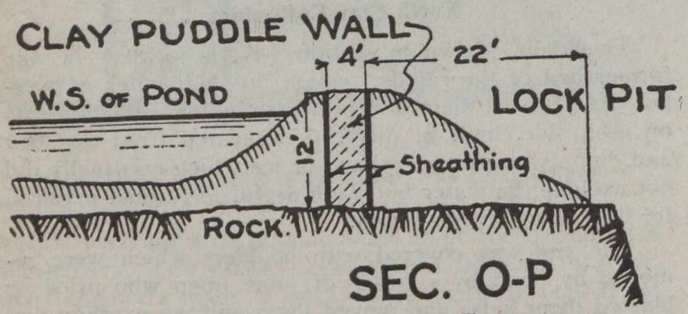


Construction Dike with Sheeted Puddle and Backfill

jecting above the surface of the ground were confined by sheeting of horizontal boards, nailed or braced vertical posts. This trench was dug and puddled in 4 months by an average force of 50 men. The cost was $545 for stripping boulders, $8,433 for 2,845 yds. excavation, $2,227 for labor and supplies required for 3,000 yds. clay puddled, $2,099 for 4,790 yds. of clay box measure, and $1,092 for labor on 550 yds. of backfill, making a total cost of $10.96 per linear foot or $0.934 per square foot of wall. In the construction of this dam the extra cost of drilling and blasting frozen materials was more than compensated by the reduced amount of pumping and the cheaper hauling in sleighs that was secured by doing the work in winter instead of summer.

Northwest Cofferdam

The northwest cofferdam, 540 ft. long, consists of a dike made of rock fill 20 to 30 ft. wide on top made in 16 ft. of water with spoil dumped in position at no extra cost



Sheeted Puddle Cut-off in Loose Embankment

and provided with a puddled clay core wall, as shown in section L-M.

About 190 ft. of the puddled clay wall was built in a shallow trench and the remaining 350 ft. of puddled wall, which is much higher, was built between walls of wooden sheeting set up in an open trench. Both sides of the wall were backfilled with loose rock. A leak through a rock seam under the cofferdam was capped with a 4 x 4-ft. concrete box having a 4-in. vent pipe overflowing into the tailrace. The rock seam was caulked several feet both sides of the box.

The cost of this section of the dam was $605 for development and incidental labor, $3,744 for excavation, $919 for sheeting lumber and labor, $2,552 for wall clay and labor, $1,149 for backfill, and $1,711 for ramming leaks, etc., making a total of $10,680.

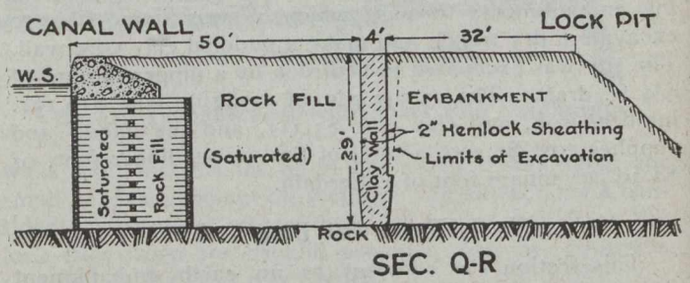
West Clay Cofferdam

The west clay dam, 258 ft. long, shown in section O-P, is a puddled clay wall with earth embankment on both sides, part of it being built without excavation and part being built in an excavation through an embankment which furnished material for the side slopes. The cost for excavation was $711, clay wall labor and materials, $1,632, sheeting, lumber and labor, $292, backfill and labor, $572, total, $12.43 per linear foot, or 97c. per square foot.

Southwest Clay Dam

The dam, 179 ft. long, is shown in section Q-R and consists of a puddled clay wall built in an existing rock fill.

The trench was excavated through frozen embankment, the sides sheeted with 2-in. vertical hemlock plank. The maximum width of the puddle was 5 ft., and the maximum depth of the trench 35 ft. The cost was $1,934 for 603 yds. of excavation, $420 for sheeting, labor and timber,



Crib and Rock Fill with Sheeted Puddle Cut-off

and $1,102 for clay wall labor, making $19.31 per linear foot, or 64c. per square foot of wall.

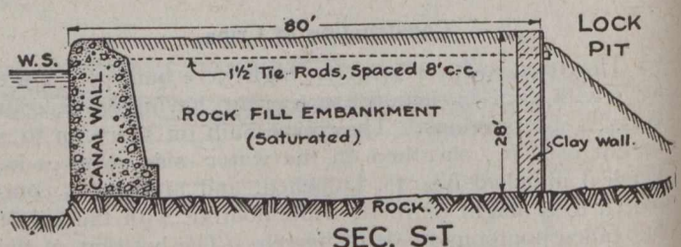
Southwest Clay Dam

The Lally dam consisted of a wide saturated rock fill embankment faced by a concrete canal wall and was supplemented at one end by 240 ft. of anchored sheeting 22 to 28 ft. deep, puddled with stock-rammed clay.

Six-inch by 12-inch hemlock sheeting was driven to rock in an old puddled clay wall and anchored with 1½-in. horizontal tie rods 8 ft. apart. It was built at a cost of $2,550 for timber and iron, $1,747 for labor, and $375 for stock ramming clay and labor, making a total of $12.24 per linear foot of wall.

Unwatering the Cofferdam

The amount of pumping to keep the cofferdam dry varied from a minimum daily average of 850,000 gallons in winter to a maximum daily average of about 3,000,000 in summer, the maximum of any single day being about 4,000,000 gallons. The water was handled by an 8-in. pump with 85-h.p. motor, one 6-in. with 50-h.p. motor, one 5-in. with 20-h.p. motor, and one 4-in. with 15-h.p. motor, besides which there was kept in reserve a 10-in.



Concrete Wall and Rock Fill with Anchored Clay Cut-off

with 100-h.p. motor, all the pumps being of the centrifugal type.

Between September 26th, 1909, and October 23rd, 1911, 1,242,628,000 gallons was pumped at a total cost of $21,816, including $11,428 for labor and $6,975 for electric power at 1c. per kw.-hr.

GOOD ROADS ORGANIZATION*

By Jas. J. MacKay, O.L.S.

STATESMEN, diplomats, historians and scientists agree that the most important element which lies at the root and beginning of a nation's progress is a system of good roads. Without this, the national resources and energies remain to a degree unawakened and useless. Roads are the veins and arteries by means of which the circulation of the social body is carried on. When they are clogged, the march of civilization is retarded, the people have little in common, and limited opportunity for intercourse of any kind hurts their commercial prospects.

The question of good roads is a very ancient one, dating from the time of the Romans, who constructed the Appian Way, the "Queen of Roads," having a length of three hundred and fifty miles, about the year 312 B.C. This road is in use to-day. The Romans regarded good roads as of vital importance for conquest and the maintenance of their empire.

It was the boast of Great Britain over one hundred years ago that beyond all national dispute it stood at the head of the world's civilization, because no country on the face of the earth was so well provided with good roads. The length of pike roads and highways in Great Britain, as long ago as 1820, exceeded a total length of 114,829 miles.

The progress of civilization in India is owing largely to the military highway built by the British from Bombay to Calcutta.

To-day France probably leads the world in a system of good roads, or did before the war. Although her area is only about four times as great as that of the State of New York, France has spent about six hundred million dollars in the construction of her common roads, and she annually spends about eighteen million dollars in keeping them in repair.

In the United States, our neighbor to the south, the construction of extensive public highways was begun so long ago as 1776, when the first artificial road was built from Philadelphia to New York and another from New York to Boston. To-day many States in the Union are spending millions annually in the construction of good roads, our bordering State of New York leading in this respect.

Cannot Canada, therefore, profit by the lessons taught by these older countries? Cannot we take a leaf from their book and avoid the pitfalls into which they slipped? Does not the future of our great country depend to a great extent upon the roads built and to be built, and surely the prospects of a heritage which is ours would recommend a continued and thorough study by our Federal and Provincial Governments into the building and maintaining of the road systems of this country?

It is only within the last fifteen years that any attempt has been made to develop an up-to-date policy to deal with this question. We have not yet completely cleared our highways of that old bone of contention, "the toll-gate." The introduction of our provincial county good roads system went a long way towards removing them from our midst and a great deal towards giving us better arterial roadways.

The county road system, as adopted by our provincial government, has been improved upon from time to time, and is a long step in the right direction; yet the question presenting itself is, Can we not improve upon it? Would it not be well to give this subject a more extensive study so as to bring into proper relation the interests involved? the provincial government? the county? the town and the village? These all have vital interest in the question of good roads.

There are many points to be settled, and I will enumerate a few which, it seems to me, are worthy of consideration and may provide food for discussion:—

1. What methods should be adopted for raising and administering funds for road construction? As all are interested, should not all pay in accordance with benefits derived and ability to contribute?

2. Having raised or provided means for raising funds, how should they be spent? Should we have a central government control, with proper business organization? Should we have a federal highway department, co-operating with the township, county, city or town departments? Some system whereby it could be assured that the money raised be spent to the best advantage and not wasted as it has been done in many cases in the past?

3. Should our roads not be classified? For instance, we might have a classification as follows:—

(*a*) National highways. (*b*) Provincial highways. (*c*) County highways. (*d*) Township highways. (*e*) Inter-urban highways. (*f*) Suburban highways, etc.

These again might be classified into first class, second class and other classes, depending on the nature of the roadways, the use to which they are put and the amount of traffic they have to provide for.

The question of highway administration is in urgent need of attention in Canada. There are at present highway commissioners in most of the provinces, but they deal with rural highways and are not concerned with the local improvements in cities and towns. It is desirable that every city, town and municipality in each province should have the assistance of a central department on all highly technical engineering questions, including that of road planning and construction. The work of the road board in Great Britain and of the highway commission of the state of New York are worthy of careful study in this connection, but to be really efficient each provincial highway commission or board should be linked up with a department of local government, dealing with municipal affairs in general and not solely with highways.

The roads in Canada are more important for distribution of produce than in Great Britain, where distances are so short and light railways are so plentiful. In Canada we have had to start off without any of the advantages possessed by older countries in the matter of old foundations and the accumulated work of centuries of road construction. We have had to develop motor transportation by road as a means of feeding the great trunk railways and securing the economical distribution of food. The respective obligations of the provincial and the local governing bodies in regard to road construction and maintenance have to be considered. Local authorities need to be advised regarding the proper use and value of the different kinds of road material, after adequate trial and investigation by an expert department, in order to save hundreds of thousands of dollars spent in unsuitable road material used in local improvements.

When we consider the enormous amount of money spent in roads and road maintenance and the great waste arising from the haphazard methods of carrying out local improvements, it is surprising to find so little effort being

*Paper read before the Association of Ontario Land Surveyors.

made to deal with the matter on more practical and scientific lines. Much is being done in Quebec and Ontario to carry out isolated road schemes, but a more concerted and comprehensive effort is needed—and that urgently—in the interests of national prosperity.

SURVEYORS' CHARGES

AT the last annual meeting of the Association of Ontario Land Surveyors, T. D. LeMay raised the question of surveyors' charges, saying that it does not seem possible or advisable to standardize charges, but that a committee through its members in different districts might exchange views with real benefit.

"In the year 1850," said Mr. LeMay, "the usual rate appears to have been about $4 a day for field work and even that at times had to be taken out in merchandise.

"Charles Unwin tells me that at one time his firm made a survey for a syndicate composed of a butcher and a grocer, and his share took the form of three 56-gal. barrels of whiskey, some of which he eventually disposed of to the county judge. In 1865, Mr. Unwin copied the following advertisement which was posted on a barn in a village west of Toronto, and which speaks for itself:—

CHEAP LAND SURVEYING.

P. L. Surveyor, Conveyancer and Issuer of Marriage Licenses.

In returning thanks to his numerous friends begs leave to remind all in Kent and Essex that he is always on hand in the above line of business, all orders either verbal or written promptly attended to; for surveying and conveyancing he has a deputy to issue marriage licenses at Rond Eeau, please address Rond Eau, Chatham, Thamesville, Ridgetown, Romney, Morpeth, Florence, Kingsville and Leamington Post Office.—Can boast over all for cheapness and can adjust all difficult lines with the aid of the old field notes of Samuel Smith, Esq., and drawing meridian lines. Take notice—No extra charge for travelling, as he keeps a conveyance of his own. Charge, $4 a day.

Silver at par for issuing marriage licenses.

"In 1889 a tariff was adopted by the association fixing the rate at $6 a day. In 1906 this rate was raised to $8 a day, and in 1913 it had raised, by easy stages, to $15 a day as far as the Toronto district was concerned.

"Under the pressure of the high cost of living it was deemed advisable to make a further increase this year, and a committee of Toronto surveyors was appointed to draw up a revised schedule of charges for the Toronto district. The principal difficulty encountered was to evolve a system of charges that would be elastic enough to compensate a surveyor for everything he did, bearing in mind the fact that this could only really be obtained by a fixed rate per day to be multiplied by a factor representing the value per foot frontage of the property to be surveyed. It appeared, however, that with such a system as this it would be impossible to secure the uniformity of charges so essential amongst the surveyors in any particular district owing to the impossibility of uniformity in fixing the value of the land except by reference to the assessment roll, which method was felt to be too cumbersome.

"The committee decided to recommend a schedule of fixed minimum rate for the different classes of work, somewhat higher than those hitherto in force, with an innovation in the form of explanatory notes defining the various forms of surveys included therein."

Mr. LeMay then read the proposed schedule. The minimum charge for a location or boundary survey is $12 and for each additional adjoining parcel, $2. The minimum charge for title survey is $10, and for each additional adjoining parcel, $2. Architect's survey costs the same as location or boundary survey, with an additional charge of $5 per hour for time spent in taking elevations and reading angles. Excavation surveys, $3 per hour for field or office work, calculation or plans for the purpose of ascertaining the elevation of the ground at different stages of an excavation and showing results, including quantities, on a plan or certificate. Minimum charge for topographical survey, $20 for day of eight hours, besides expenses. Subdivision and miscellaneous surveys, same as topographical survey.

"With regard to the standardization of charges throughout the province," continued Mr. LeMay, "it seems to me that something might be done in this matter. We have to realize that it is absolutely impossible to get any form of legislation which would enable us to adopt a tariff which would be obligatory for surveyors of the association. We might form a committee of the associations to look into the question of tariffs, to divide the province into districts and let the surveyors in each particular district see what minimum rate per day they would work for, all these minimum rates per day to be collected by this tariff committee and circulated amongst the members of the association, so that if a surveyor were asked to make a survey in some other district he would know what he would be expected to charge. Any alterations in this district minimum tariff could be made by the tariff committee at the instance of the surveyors in a district. I understand in some districts there is a rate war on and that the surveyors are working for $2 or $3 a day or anything they can get in order to get the work and it does not seem to be at all in the best interests of the profession. Take a man working at $20 a day. How many days a year can he work I don't suppose he can charge for much more than 200 days, and out of that he has to pay his assistant, his office, overhead expenses, and so on, and it does not leave him an income which is a very satisfactory goal to the ambition of a young surveyor, and anything which may be done to increase the prices, I think, must necessarily be for the benefit of the association, and anything which will possibly do away with rate wars and competition in prices amongst surveyors in adjoining districts would also be very desirable."

Mr. LeMay's remarks were discussed by Messrs. Speight, Ward, Chipman and Dobie. A motion was carried that a special committee be named to make a further report to the association at the next annual meeting, Mr. LeMay being appointed as chairman of the committee.

The French Government is about to introduce a bill creating a new office of Under-Secretary of State charged with the task of developing and extending the use of the country's water power resources.

The Board of Public Works of San Francisco, Cal., has just called for bids for constructing 18 miles of tunnel aqueduct in the Mountain Division of the Hetch Hetchy Water Supply Project. The tunnel is to be of horseshoe section, lined with concrete. The estimated cost is about $2,000,000.

A FEW THOUGHTS ON GEODESY

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

(Concluded from last week's issue.)

IT is a matter of great satisfaction to state that the level lines were this year completed from the Atlantic to the Pacific Ocean. The work has been based on five different reference points, as follows:—

Halifax to Moncton, on the Halifax sea level datum.

Moncton to Riviere du Loup, on a St. Stephen, N.B., sea level datum.

Riviere du Loup to Port Arthur, on a U.S. bench mark at Rouse's Point, New York.

Port Arthur to Kamloops, B.C., on a U.S. bench mark at Stephen, Minn.

Kamloops to Vancouver, on a Vancouver sea level datum.

The number of miles of levelling since the beginning of the work in 1907 is distributed among the provinces, as follows:—

Ontario	3,282	miles
Quebec	1,249	"
Alberta	1,185	"
British Columbia	1,046	"
Saskatchewan	928	"
New Brunswick	864	"
Nova Scotia	705	"
Manitoba	431	"
Minnesota, U.S.A.	89	"
Total	9,779	miles

This is exclusive of 491 miles of precise levelling in the Yukon in connection with the International Boundary Surveys.

The total number of standard bench marks established since the beginning of the survey is 2,813, which number does not include those bench marks of other organizations whose elevations have been found by our levelling.

At the 1914 meeting of the D.L.S. Association, in a talk entitled "Geodetic Results and Their Practical Meaning," Mr. W. M. Tobey, D.T.S., gave us a fitting motto for geodesists, "Be fair to D," in which D represented a very distant position. The argument was that the greatest care must be taken and the most rigid methods used in the prosecution of a geodetic survey in order that errors, minute in themselves, would not produce large discrepancies when carried hundreds of miles across the country through a triangulation to the position D. After the field data are secured a full investigation of the errors must be made and these errors and discrepancies must be carefully placed in their most probable position in the triangulation. Then, and only then, can the final computations of geographical locations be started.

Now, without taking much thought to the principles involved, one would readily undertake to throw a bridge across a narrow ditch, but when the erection of a stupendous structure such at the Quebec Bridge is undertaken it has been brought home to us in the most terrible manner that the effect of the most varied forces must be fully known and must be correctly allowed for in the successful prosecution of such a huge scheme. The awful disasters which have attended the erection of our Quebec Bridge bring home to us with shocking directness the necessity of giving attention to the small and apparently insignificant forces, the neglect to properly apply some of which has led to such formidable loss of life and money.

Although the writer does not propose to enter into the details of the forces which tend to cause trouble in the successful prosecution of a geodetic survey, he wishes to point out the analogy between the cases of the large bridge and a geodetic survey as showing the need of the greatest care and the fullest knowledge of the underlying principles of mathematics and geodesy, that comparative disaster may not crown the geodesist's efforts and in order that we may "Be fair to D."

Let us refer to the subject of the datum on which a geodetic survey will rest. A definition of what is meant by a datum in this sense must be given. After the errors of observation have been adjusted and in making computations through a triangulation system for the latitude and longitude of stations and the azimuth of lines we must commence with a station whose co-ordinates are known and base our computations on certain dimensions for our spheroidal shaped earth. Then the datum for the co-ordinates throughout that system of triangulation is the geographical position of that system on the particular earth which we assume as being the correct one, and is defined by the co-ordinates of the station from which the computations started.

Now, you will say that this problem is quite simple, that all we need is to make observations at our starting point for latitude, longitude and azimuth. Let us just take the case of the big bridge and see if we cannot find an analogy to the present case. Suppose we had no levelling instruments for obtaining the levels at the different piers. We would then probably make an assumption that bed rock was level and that, by starting to build our piers all from bed rock, the tops of the piers would all be at the required levels, and the bridge would all fit together point to point. It is unnecessary to state that the bridge would evidently be very uneven, to say the least.

Now, similar but much more complicated results would ensue if we started our geodetic survey on the datum defined by astronomical observation at one station. These astronomical results are subject to errors which may be many times the errors of observation, due to the deviation of the plumb line at the points of observation caused by the attraction of unequally distributed densities, as typified by mountains and lakes or valleys. Hence the co-ordinates of triangulation systems based on these erroneous observations would seriously clash at their points of junction and it would be impossible to follow our motto of "being fair to D."

Perhaps one of the most familiar examples of the analogy between our suppositious uneven bridge and a survey based on astronomical observations alone is given by the well-known crookedness of the 49th parallel boundary between Canada and the United States or the 45th parallel boundary on the south side of Quebec Province. These boundaries were both located by astronomical observations and are both badly bent at certain points due to the attraction of mountain masses in the vicinity of the lines—at certain points the located line is a quarter of a mile or more from the desired position.

You may ask why a certain datum cannot be selected and used for the co-ordination of points all over the country. What does an error of a few feet matter when we cannot plot distances smaller than miles on our maps? The answer is quite simple, "Be fair to D." Just as well ask a surveyor to begin work with a chain of an erroneous length, or tell him his survey may start at a point anywhere close to a monument or start him on his survey with an erroneous azimuth.

Do you ask how a reliable datum is to be obtained, how a mean level of bed rock is to be fixed for the building of our bridge so that it may be made even? In the case of our bridge it is only to be obtained by taking very careful levels between our different piers and taking a mean of the different rock levels; the more piers we have, the more accurate will be the mean level of bed rock obtained. With our geodetic survey we must connect our many astronomical stations by triangulation, the most accurate method known for obtaining the relative positions of points. The greater the number of astronomical points connected by triangulation the nearer perfect is our resulting datum. Do you realize why perhaps twenty-five years may elapse before a final datum can be selected and why published positions may have to be changed?

Very luckily for us in Canada we have a number of points at which we may start the construction of our huge bridge. Very kind was the United States Coast and Geodetic Survey when it said: "We also have a huge bridge already built right alongside of the site of your bridge. Our bridge may be somewhat imperfect in places and our mean bed rock datum may be slightly in error, but it is based on astronomical observations at some 600 points scattered over our country, and is better than you can get for a long, long time. There are also a number of places at which our bridge almost touches the site of your bridge. Why not make use of our work? Why not save the money and delay required to get your own bed rock datum? We are sure that finally it will be found that your bridge will almost exactly meet ours where they touch, when you have finished twisting it around and jacking it to and fro. Why go to the expense of jacking it up here and there for thirty or forty years to come? Let's make a great big bridge together over the whole continent, making use of outlying points of our work from which to start building yours and to which you can make yours fit. Mexico is also building a bridge and is using our bridge datum. Let's all use it and call it the North American datum."

The late Dr. W. F. King, then superintendent of the Geodetic Survey of Canada, examined the United States bridge, considered its weaknesses and strength, saw that certain points where it would touch our Canadian bridge were soundly built and on the firm foundation of the United States datum and very wisely and sensibly, we feel, in 1913 accepted the North American datum as the basis for our Canadian triangulation, thus saving much time and money to this country in having the question of the datum settled once and for all and avoiding clashes between the results of the work of the two countries.

There is one source of error in triangulation systems, to which a few words may be devoted. That is the error due to "twist." This error, as its name implies, is a gradual deflection of a scheme of triangulation from its true position due to certain unknown causes. In the case of our huge bridge it is as if certain members on one side were too long, with the result that, at our piers, the bridge would be to one side or the other of its true position. In a triangulation system this twist is noticed, for example, where the triangulation schemes along two meridians are joined by a cross line of triangulation along a parallel of latitude. In such a case it is often found that the systems along the meridians have approached or receded from one another by an amount which cannot be accounted for by the known errors of the triangulation. Now, you will easily see that the measuring of a base line will not remove this error, as the measurement of a base merely controls the scale of our triangulation but not its lateral motion or "twist." Nor could astronomical observations control the positions of our end points, as they are subject to errors due to the deflection of the plumb line possibly many times the errors of either twist or scale.

To give an example of how much this "twist" may amount to, one case in the boundary survey secondary triangulation on the western 49th parallel may be cited. Here a twist of 43 seconds in azimuth was found when the triangulation had progressed some 200 miles. Errors as large as the above would not be found in primary triangulation, but when it is said that the mean discrepancy between geodetic and astronomical results in azimuth at 24 primary stations in California was over 11 seconds, it will be seen that azimuth observations may be used with circumspection in checking up a geodetic azimuth at a station.

This error of twist is, happily, removable from triangulation in the adjustment of errors by means of a simple relation called Laplace's equation, that exists between azimuths and longitudes.

$$\alpha_a - \alpha_g = -(\lambda_a - \lambda_g) \sin \phi$$

where α_a and α_g are the astronomic and geodetic azimuths at a station.

λ_a and λ_g are the astronomic and geodetic longitudes at a station.

ϕ is the latitude of the station.

The discrepancy between the two sides of the above equation gives the twist of the triangulation system.

In speaking of the errors in astronomical results due to the deflection of the plumb line a few words may not come amiss. The effect of this force is comparable in its sinister influence on astronomical observations to the effect of horizontal refraction on the refined measurement of horizontal angles. We may give cases of its appearance and its causes, and we may to some extent predict its sign if we know the character of the surrounding topography, but it is very apt to steal on us like a thief in the night when we least expect it. Because this thief has not visited the house next door we may not argue that our house will be immune from his depredations, nor can we assume that our house will be left untouched because the surroundings seem to be such as not to tempt the thief.

The cause of this deflection of the plumb line is due to the attraction of unsymmetrically distributed masses of matter. Thus on the north side of a mountain range the plumb line will be deflected towards the south, our northern horizon will be depressed and the altitude of our pole or the latitude of our station is increased. By analogous reasoning longitude and azimuth results are affected by the same cause. We cannot, however, assume that, because our astronomical station lies on a level plain, our results will be free from errors due to this influence. Such an assumption was made in India, and a great deal of geodetic computation was based on the astronomic observations made at a certain station. It was later found that all these positions were greatly in error and it was concluded that some sub-surface mass of great density existed which deflected the plumb line in the whole region. Nor can we assume that because no deviation of the plumb line exists at one point, no errors will be encountered a short distance away—say, 100 miles. A case is on record on the south side of Lake Ontario where differences in the deflection of the plumb line of 12 seconds in latitude (1,200 feet) and 9 seconds of arc in longitude (600 feet) were found between stations only 80 miles apart.

TESTS OF CONCRETE SLABS TO DETERMINE THE EFFECT OF REMOVING EXCESS WATER USED IN MIXING.*

By A. N. Johnson.

THE importance of proper water content for concrete is generally recognized. The amount of water producing a maximum strength makes such a stiff mixture that it is impracticable in most concrete road work. It is necessary, therefore, to use a certain excess of water above that which will give the greatest strength.

In concrete road work, owing to the method of handling, it is of considerable convenience to use a fairly wet mixture. It has been found, however, that much of the excess water can be removed by proper manipulation of the concrete after it is placed. As a consequence, some methods of finishing concrete roads have been productive of exceptionally good results. A study of the methods employed shows that while they differ as to detail, in each case the concrete surface has been so treated as to remove a considerable amount of the excess water, thereby making the surface more compact and dense.

Of the different methods which have been observed, that devised by Captain Gaillard, city engineer of Macon, Georgia, seems to be the most efficient and least expensive. This method consists in rolling the surface of the concrete with a light roller about 8 ins. in diameter and 5 to 6 ft. in length, attached to the end of a long pole. The roller is made of light sheet metal; the total weight of a 6-ft. roller being in the neighborhood of 70 lbs. The operator stands at one side of the roadway and rolls the newly laid concrete transversely to the direction of the road.

This method was originally developed to remove any unevenness in the surface, but it really accomplishes a very much more important result as it squeezes out of the concrete much of the excess water.

In order to determine the effect on the strength of a concrete produced by the finishing method described above, a number of slabs were made for testing purposes, mixed and molded in much the same manner as in concrete road work, the exact proportions of water and other materials being recorded. The principal variation was in the consistency of the concrete and the method of finishing the surface.

The tests were made in co-operation with Prof. D. A. Abrams, in charge of the Structural Materials Research Laboratory, Lewis Institute. Professor Abrams gave his personal supervision to all of the details of the tests.

Twelve slabs, 2½ ft. wide, 5½ ft. long and 5 ins. in thickness, were made and tested. Pebbles were used as coarse aggregate for six of these and crushed limestone was used for the others.

The concrete was mixed in the proportion of 1 part cement to 4 parts total mixed aggregate by volume—a proportion approximately equivalent to the ordinary 1:2:3 mix. Three sets of slabs, two slabs in each set, were made from both crushed limestone and pebbles as a coarse aggregate.

The following consistencies of concrete were used in the test:—

1. Dry consistency, finished with a wood float in the ordinary way;

2. Wet consistency, finished with a wood float in the ordinary way;

3. Wet consistency, finished by means of a roller, as previously described.

The slabs were made on the concrete floor of the laboratory, the form being placed on a sheet of building paper.

The concrete for the slabs of dry consistency was mixed as stiff as could be easily handled—stiffer than is ordinarily found in concrete road work. The mixtures for the remaining slabs contained a somewhat larger amount of water, making a consistency that would ordinarily be classed as "good" in practical work. (See Table I.)

All slabs of the stiffer consistency, as well as one of the slabs of each other set, were finished by being first struck off with a straight edge and then floated by hand with a wooden float. The remaining slabs of each of the wet consistency sets were finished by the use of a roller. The concrete was left a little more than flush with the sides of the mold, and instead of being struck at once with a straight edge, it was first rolled; the straight edge was then used to strike off what surplus concrete remained. To bring the full weight of the roller—which was just long

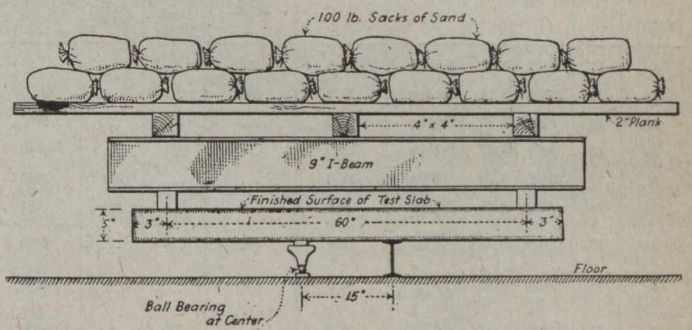


Fig. 1.—Method of Testing Slab.

enough to rest upon the side forms—on the concrete the slab was rolled transversely at intervals of about 15 minutes for 1½ hours, five rollings being made. The roller was moved back and forth over the width of the slab, moving sidewise a few inches with each stroke. As each rolling was made, considerable water was squeezed out of the concrete and forced over the sides of the mold. The rolling continued until the amount of free water became very small. No particular difference in the amount of rolling to effect this was noticeable for the limestone concrete and the gravel concrete. It was noticed, however, that the roller sank into the gravel concrete considerably more than into the rock concrete during the first one or two rollings.

The roller used was 2½ ft. long, 6 ins. in diameter and weighed about 50 lbs. In practical road work, an 8-in. roller about 6 ft. long, weighing about 70 lbs., is recommended.

The forms were removed the following day, when the slab was covered with a layer of damp sand which was kept moist until the slabs were one week old. The sand was then removed and the slabs lifted from the floor and permitted to dry out during the remaining eight days before the load was applied.

The arrangement for applying the load to the slabs is shown in Fig. 1. The slabs were placed on two supports spaced 15 ins. on centres, resting on the floor. A ball bearing on the lower side of one support compensated for what warp there might be in the lower surface of the slab. The load, which consisted of 100-lb. sacks of sand, was supported by two 9-in. I-beams, and was transmitted to the slab through two bearings spaced 5 ft. apart. The upper surface of the slab was thus put in tension. Each

*Paper read before the American Society for the Testing of Materials, June 26-29, 1917.

test was made in the same manner, and as far as practicable the loads were applied at the same rate until rupture.

The appearance of the broken slab disclosed a marked difference between those finished with the roller and those finished with the wooden float. The roller-finished slabs showed a distinctly denser appearance, extending for at least one-half the depth of the slab. It is to be noticed (see Table I.) that the slabs tested when they were 16 days old show a consistent increase in strength over those 15 days old.

With the small number of test specimens, there are not sufficient data to determine definitely any special difference between the strength developed by the slabs made of pebbles and those with the crushed limestone. It

Table I.—Results of Transverse Tests of Concrete Slabs Finished by Wood Float and by Roller Method.

Specimen No.	Age at Test, days.	Total Applied Load, lb.	Thickness,[1] in.	Kind of Coarse Aggregate.	Water Used, Percentage of Volume of Aggregate.	Modulus of Rupture of Concrete, lb. per sq. in.			Compressive Strength of Concrete (6 by 12-in. cylinders), lb. per sq. in.
						Medium Consistency, Wood-Float Finish.	Wet Consistency.		
							Wood-Float-Finish.	Roller Finish.	
1	15	3300	5.20	Pebbles	15.9	301	...	...	....
1a	15	3200	5.14	Pebbles	15.9	302	...	...	2370
2	15	3200	5.18	Pebbles	18.6	...	294	...	1760
2a	15	3500	5.27	Pebbles	18.6	...	311	...	1730
3	15	3850	5.32	Pebbles	18.6	...	...	331	1680
3a	15	3400	5.07	Pebbles	18.6	...	...	325	1680
4	15	4000	5.25	Crushed Limestone	15.9	353	...	....	2130
4a	16	4500	5.18	Crushed Limestone	15.9	405	...	...	2290
6	15	3000	5.11	Crushed Limestone	18.6	...	288	...	1600
6a	16	3750	5.20	Crushed Limestone	18.6	...	340	...	1680
5	15	3650	4.87	Crushed Limestone	18.6	...	...	378	1330
5a	16	4950	5.17	Crushed Limestone	18.6	...	...	443	180.
Average						340	308	369	

[1] Thickness of the slabs at the broken sections.

NOTE.—Concrete was machine-mixed in the proportion of 1 part cement to 4 parts aggregate, by volume. Size of slabs, 30 by 66 by 5 in. Loaded with dead weights at points 15 in. apart on 5-ft. span. Duplicate slabs were made on different days.

is to be noted, however, that the pebbles used were somewhat irregular in shape, some pieces being broken.

The broken sections of all slabs, particularly those that were rolled, showed that many pieces of the coarse aggregate had been broken apart, the number of broken pieces being considerably greater in the rolled slabs than in those not rolled. There was no difference especially noticeable in this particular, between the slabs made of the limestone and those made of the pebbles.

The results of the tests are shown in Table I. The noticeable fact is that those slabs finished with the roller developed a very considerable increase in strength over the slabs merely hand-finished. The four slabs of wet consistency that were finished by hand, have an average modulus of rupture of 308 lbs. per square inch, while the four slabs finished with the roller have an average modulus of rupture of 369 lbs. per square inch, or an increase of almost 20 per cent. As would be expected, the slabs that were made of a stiffer mixture, indicated in Table I. as medium consistensy, giving an average modulus of 340 lbs. per square inch, are stronger than those of the wet consistency, finished in the same manner; but the wet-consistency slabs finished with the roller are stronger than those of the medium consistency, showing an increase of nearly 10 per cent.

The results seem to indicate clearly the value to be gained by the use of the roller to finish a concrete road; that it is possible by proper manipulation of concrete to secure increased strength and density of a character most desirable for a concrete road surface; and that such surplus water as may be required to facilitate placing concrete in road work can be effectively removed by this simple expedient.

THE TREASURY DEPARTMENT STANDARD FOR DRINKING WATER—ITS VALUE AND ENFORCEMENT*

By H. P. Letton,
Sanitary Engineer, U.S. Public Health Service, St. Louis, Mo.

SHORTLY after the promulgation of the interstate quarantine regulations requiring interstate common carriers to furnish pure drinking water for passengers, it became necessary to establish a standard as a basis upon which to formulate an opinion as to the safety of any given water. The secretary of the United States treasury in January, 1913, appointed a committee of fifteen eminent bacteriologists and sanitarians to recommend such a standard.

After somewhat over a year's study the committee made recommendations which were adopted by the secretary and promulgated as part of the quarantine regulations on October 31, 1914. The committee was very explicit in pointing out that the recommended standard was not a "standard of purity," but was, on the contrary, a "standard of permissible impurities."

Briefly, the standard requires that there shall be not more than 100 colonies per cubic centimeter develop on agar incubated 24 hours at 37 degrees C., and that there shall not be more than 2 B. coli per 100 c.c. when the water is tested in accordance with the recommended procedure.

This was the first attempt made in this country to establish a general standard for the bacterial content of drinking water, although such standards have been in use in other countries for many years. Because of our peculiar governmental system, each State has been a law unto itself, and a water which would be considered of satisfactory quality in one State might fail to pass the requirements of an adjoining one.

There is absolutely no question but that the establishment of the treasury department standard has been an impelling force in improving the quality of public water supplies throughout the country. As far as the writer knows, there is only one State (Minnesota) which before the promulgation of this standard required that a public water supply should be free of B. coli in as large a quantity as 50 cubic centimeters. Minnesota has, and does now, require that B. coli be absent in 100 cubic centimeters.

The fact that the federal government requires railroads and other carriers to furnish passengers with a purer water than required by most State boards of health has stimulated many localities to better the quality of their water supplies until they conform to the standard under discussion. It is now a common experience when visiting a city where periodic analyses are made of water from the public supply, to find the tests being performed strictly in accordance with the technic recommended by

*Paper read before the American Water Works Association, May 4-10, 1917.

the commission, and it is pertinent to note that such cities take pride in stating that their water conforms to the treasury department standard.

The commission formulating the standard had in mind that it was to be applied primarily to water taken directly from cars or vessels. Realizing that in such cases the water might have been stored for some time, and that such storage would undoubtedly cause marked changes in the bacterial flora, they set the maximum permissible number of bacteria which would develop on agar at 37 degrees at 100 per cubic centimeter. The commission stated that they would have considerably reduced this number if the standard was to be applied to water at its source.

As regards bacteria of the bacillus coli group, however, they considered that inasmuch as these bacteria do not multiply in water, but, on the other hand, die out rather rapidly, the permissible number could be set within very definite limits. It has been this part of the standard which requires that there shall be not more than 2 B. coli. per 100 c.c., that has received the most criticism. It is not believed, however, that this criticism has been well taken for reasons which will be enumerated.

While the standard under discussion applies to lake and river carriers, as well as railroads, it is in the latter connection that it has a direct bearing on public water supplies since, in the majority of cases these carriers obtain their drinking water from such sources. The question of drinking water on lake vessels has been previously discussed before this association and will not be dwelt upon at this time.

In order to ascertain whether it was feasible to utilize this standard in the manner presupposed by the commission, several hundred samples were collected from railroad cars within the sanitary district of the Great Lakes. At the time the samples were collected information was gathered regarding the point or points where the water was originally obtained, as well as the length of time that had elapsed since the coolers were filled. In few cases could information of any reliability be obtained. The analyses of the water also gave little of value, inasmuch as certain samples, supposedly from the same source of supply, taken on different days, gave widely divergent results. Moreover, in case a sample failed to meet the requirement of the standard, there was no way of knowing whether the impurities were present in the source of supply or were introduced in the process of filling the coolers. As a result of these analyses, it was plainly evident that, in order to bring about any permanent and beneficial results from the enforcement of the standard, reliable and accurate data regarding the source of supply must be obtained.

Inasmuch as this would require a sanitary survey of each source, and since analyses of shipped samples are not as reliable as those examined immediately after collection, it was deemed advisable to carry a laboratory into the field. A portable laboratory was therefore devised and used for about two months. The results of the field work indicated that it was the proper method of handling the situation, but because of certain difficulties with the portable laboratory, its use was discontinued and a laboratory car designed. This car, which was built by the Pullman Company, has now been on the road for about two months, and has demonstrated its usefulness in handling the problem.

After having made some thirty sanitary surveys of water supplies used by railroads, it became more and more evident that such surveys were absolutely necessary to correlate the analyses, in order that an opinion could be formed as to the safety of any given water. In order to make the surveys mandatory, the interstate Quarantine regulations were amended on February 12, 1917, so that they now require that the water shall not only conform to the bacteriological standard, but shall not be from a supply that is exposed to contamination.

Formerly, if a sample of water taken from a source which was obviously contaminated, happened to contain not more than 2 B. coli per 100 cubic centimeters, the source of supply would have been approved. Under the present regulation, however, no matter what the bacteriological analysis indicates, the use of water from such a supply would not be permitted.

The matter of enforcing these regulations in the sanitary district of the Great Lakes has been from the start carried on with the idea of not only benefitting directly the passengers on railroad trains, but benefitting, indirectly, the much greater number of people using the same supplies in towns.

When the sanitary survey and analysis show that a supply is contaminated or is exposed to contamination, a letter is prepared to the municipality or private water company, as the case may be, in which the conditions are outlined and suggestions made for betterments. In many cases these recommendations have been adopted, usually because the municipalities are aware that unless corrective measures are adopted, the railroads will not be permitted to use the supply.

To return to the question of the B. coli requirements of the standard; over 100 investigations have been made of water supplies used by railroads in Illinois and Michigan. These supplies have been of all types, shallow wells, deep wells, and surface water, treated and untreated. The filtration plants, ranging in size from 15,000,000 gallons per day to 1,000,000 gallons per day, all produced a water well within the bacteriological requirements. All the disinfection plants, most of which used liquid chlorine, produced a satisfactory water. The only supplies failing to meet the standard were untreated supplies and a few ground water supplies. In every one of the latter cases, however, the sanitary survey had shown some point of possible contamination.

Only two supplies failed to meet the total count requirement, and in each of these instances the water had been stored in large reservoirs which had not been cleaned for a considerable period. The agar count, as a general rule, was less than 10 per c.c. The fact that most of these analyses were made during the winter months undoubtedly had some influence on the low counts. These data are sufficient to convince the writer that it is possible for any public water supply to meet the requirements of the treasury department standard without undue expense.

Several investigators have recently brought out data affecting the significance of the B. coli test, by differentiating the organisms into fecal and non-fecal strains. Their observations, however, have not yet been generally accepted and until they are and the technique is standardized, the presence of any of the B. coli group in a water must be considered as evidence of contamination. If sufficiently intensive investigations are made of water supplies containing B. coli, in practically every instance a possible entrance for the organisms will be discovered.

From the foregoing statements the following conclusions can be derived:—

(1) The requirement of the standard regarding total count is very lenient. It could be reduced more than half without eliminating any but an extremely small percentage of supplies that would otherwise pass the requirements.

(2) The limit of permissible B. coli content is not too low. A properly operated filtration plant will produce a better water than the standard requires. A disinfection plant which will not produce a water within the limits should be considered as only a temporary protection and filtration should be adopted. An untreated ground supply containing more B. coli than the standard permits is being contaminated by outside sources which should be discovered and eliminated.

(3) Sanitary surveys of the sources of supply are absolutely essential to correlate the bacteriological analyses.

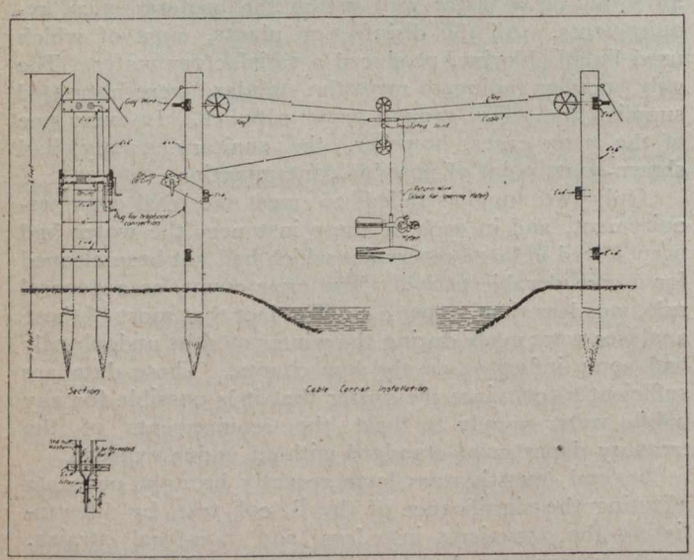
(4) The treasury department standard has been of immeasurable value, not only by causing carriers to furnish a safe drinking water for passengers, but more so by the establishment of a high criterion for judging the quality of public water supplies.

METERING ACCESSORIES OF MANITOBA'S HYDROMETRIC SURVEY

In connection with its investigations in the province of Manitoba, the Manitoba Hydrometric Survey has developed several devices for use in gathering stream-flow data.

Cable for Suspending Meter.

A number of the stations operated are on large streams, where depths up to seventy-five feet are encountered. Piano wire has been used for suspending the meter, a small, insulated wire forming the second side of the circuit. Lately a special steel cable of small diameter, with an insulated copper core, has been experimented with and has given good results, the advantage

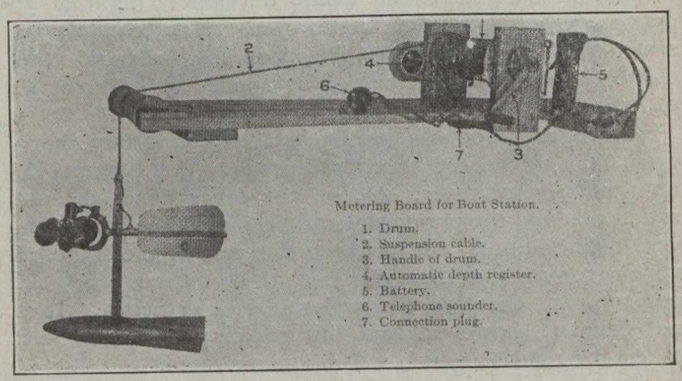


Details of Support and Tightener for Cable.

over piano wire being less liability to break through kinking and the elimination of the second wire. Where either method of suspension is adopted, a reel is necessary, so that all the stations where considerable depths are encountered are equipped with reels, a special equipment being used for metering at boat stations.

Counting Device for Use with Reels.

Mr. W. J. Ireland, assistant engineer, during the year designed a counting device for use with the reels, and a number of them are now in use. The counting part of the device is similar to that used in gas meters. It is connected to the spindle of the reel by a train of gears, the counter and gears being enclosed in a metal case. Through the connection, each revolution or part of a revolution of the reel or drum is recorded on the dial of the counter. By turning in one direction the revolutions are added, and by reversing the direction they are subtracted. The counter may readily be thrown out of gear and the dial reading brought to zero. By using a reel exactly



Metering Board for Boat Station

one foot in circumference and setting the dial to read zero when the meter is at the surface of the water any position with reference to the surface of the water is automatically registered on the dial. The counting device may be detached from the reel by loosening three thumbscrews; they are interchangeable, so that one may be carried by each field engineer and used with any reel.

The Nelson and the Saskatchewan are two of the largest rivers metered; on each of these there are boat stations. The velocities being high, it has been found that a canoe does not afford a steady enough working platform. The method now employed is to secure two canoes together parallel to one another by means of three pieces of oak laid across the gunwales and bolted to the thwarts at each end, thus forming a kind of catamaran. A bridle is then fastened to the bows of the canoes and a line led from the centre of this bridle to the tag line stretched across the river. The meter may be suspended between the canoes or over either side by means of the metering board used on boat sections. This modified form of the metering board is fully illustrated herewith.

A. F. Macallum, Commissioner of Works of Ottawa, Ont., has issued an eight-page booklet for foremen, containing the department's regulations for their conduct in regard to requisitions, etc. The booklet is bound in stiff cardboard, and is of very handy pocket size, 3" x 5", and leaves no excuse for the foremen to handle paysheets, requisitions, etc., in any irregular manner.

On July 1 the last unit of the jetty work authorized at the mouth of the Fraser River, B.C., was completed by the contractors, Messrs. Marsh, Hutton, Powers Co., Ltd., of New Westminster. The completion of this jetty represents the final investment by the Dominion Government for this year of $500,000 sunk in the waters at the mouth of the Fraser River for the purpose of aiding the currents of the river in carrying out to sea the vast deposits of silt that would otherwise spread over the flats below Steveston and divide the outlet of the river into so many mouths that no definite channel could be relied on. Now the rushing currents of the river strike this wall of rock and are confined so that they rush on out to sea, carrying along the silt that would otherwise block the channel. This channel wall rests on mattresses of brush, sunk to the bottom by weights, and is about 90 feet wide at the base, tapering to a width of 3 ft. at the top, and is built entirely without cement.

SIDE FORMS FOR CONCRETE ROADS

By J. H. Anderson

The placing of side forms for a concrete road is too often done in a haphazard fashion. Many forms are not properly constructed in the first place, with the result that they soon bend and warp or wear out of shape. In the second place, side forms are very seldom properly staked to line and grade.

The form setter, as a rule, when he desires to bring a form to grade, does so by inserting beneath it a small stick or stone, which is entirely insufficient to maintain the form to proper elevation under the saw-like pounding

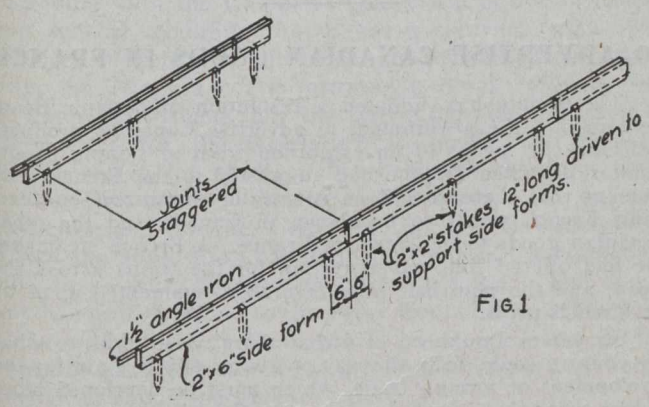


FIG. 1

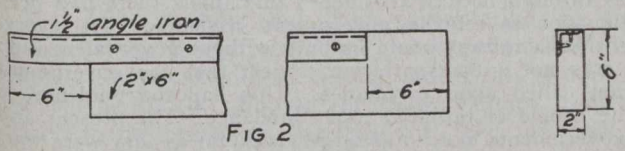


FIG 2

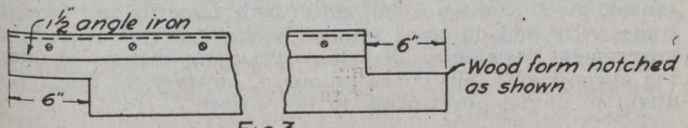


FIG. 3

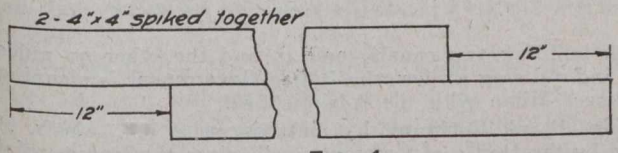


FIG. 4

action of the strike-board. Frequently, too, the joints in forms on opposite sides of the road are placed directly opposite each other instead of being "staggered," as are the joints on a railroad.

In Fig. 1 is shown a method of supporting side forms to grade which is easily applied. Note that 2 x 2-inch wooden stakes about 12 inches long are driven along the line of the side forms to the elevation of the bottom of the form. These stakes, of course, are intended merely to support the side form to the proper elevation, other stakes being driven in the regular way for the purpose of holding the forms in line. Note, also, that the joints in the side forms are staggered to prevent an undulation forming across the road in case the joints should be low. Fig. 1 shows the use of wooden side forms with an angle iron at the top edge. This method of staggering the joints and supporting the joints to grade can be applied also to steel forms.

Figs. 2 and 3 show details of wooden side form construction. In Fig. 2 the angle iron extends 6 inches beyond the end of the form to insure that adjacent forms will be maintained at the same elevation. Fig. 3 shows a slightly different design, intended for the same purpose as the form shown in Fig. 2 will be bent when the forms are handled roughly, and in order to obviate this and still retain the benefits of this design a form can be built as shown in Fig. 3. Fig. 4 shows a side form used by a contractor who happened to have a considerable quantity of old 4 x 4-inch timbers on hand. This side form was used for a road 18 feet wide, and a strike-board was mounted on wheels. Due to its width, this form was very satisfactory for a strike-board mounted on wheels, while due to its rigidity and the method of forming the joints a very smooth surface was obtained.

Proper placing of side forms costs but little more than does the careless placing all too frequently practised, and the improved riding quality of the road and the increased satisfaction derived therefrom will compensate manyfold for the slight extra expense.—Concrete Highway Magazine.

SOME SUGGESTIONS FOR IMPROVEMENTS IN THE ENGINEERING PROFESSION

(Continued from page 89.)

within his estimate and has paid his assistants the smallest wages for which he could hire them. The heads of engineering departments are responsible for the low wages paid the rank and file.

Recently, the engineering employes of the city of Chicago petitioned for an increase in wages, and among other things said:—

> "We submit that when engineers who are in charge of work and responsible for its proper execution are paid less than the foreman and some of the mechanics working under their direction and supervision, neither will attain the highest efficiency—the engineer because he is discouraged by the comparison, and the workman because he feels that the man over him is not recognized by the authorities."

Similar action should be taken by the city engineers wherever such conditions exist.

Engineers in private practice should pay their assistants good wages. These men usually work for corporations, and they don't ask for cheap engineering service. They always expect to pay well for legal services, and should be educated to regard engineering services as equally valuable.

The consulting engineer can undoubtedly improve the conditions of the men working under him.

The engineers in the railroad service can do much for their assistants. We should insist on an adequate force with good salaries at all times.

Those of us with railroad experience remember that on construction it was thought engineers were no longer needed after the first train passed over a division, whereas had an adequate force of engineers been maintained to work up complete records of cost and complete maps and plans, it would have been worth many times the cost, in their dealings with the government now in the Federal valuation work, and would oftentimes have saved the companies more than their costs in lawsuits.

The profession must be improved from within—not without. The public will appraise us at no higher value than we set upon ourselves. It is up to us to improve the profession by improving the conditions of service of those in our employ.

CONSERVATIVE CAUCUS DISCUSSES RAILWAYS

The "Mail and Empire," of Toronto, a recognized Conservative party paper, which is usually correct in most prophesies regarding government legislation, published an article last Saturday announcing that a government board would be placed in charge of the Canadian Northern and Grand Trunk railroad systems. The article, which had been telegraphed by the paper's correspondent at Ottawa, was as follows:—

"Further discussion of the serious railway situation which confronts the country and the difficulty of which has been accentuated by the war, took place at the caucus of government members of Parliament to-day. Sir Robert Borden and Sir Thomas White are understood to have reviewed the condition of the affairs of the Grand Trunk Pacific and Canadian Northern Railway companies and to have outlined the plans the government has under consideration for preventing financial disaster to those roads, and a consequent impairment of the efficiency of the transportation system of Canada. The government's plans, which members assert will, when announced, meet with the approval of the public, are believed to involve the complete control of the operations of the railways involved, as predicted, and to be wider in scope than has hitherto been suggested. In addition to providing for complete government control, it is stated, they will bring about a mobilization of railway effort which will permit of a saving in operation expenses, and it is hoped, ultimately avoid deficits in the accounts of the Grand Trunk Pacific and Canadian Northern.

"It is reported that the plans involve the operation of the Canadian Northern, Grand Trunk Pacific and Grand Trunk Railway companies by an 'operating board' to be appointed by the government. The corporate identity of the companies would be retained and the question of complete nationalization would be left for consideration at a more opportune time. Some changes might be made in the directorates of the roads, but the operating staffs of the three lines would be retained.

"Under the plans the operating board would consist of competent railway men and would supervise the running and financing of the three lines. Such a board, it is argued, would be able to co-ordinate the operations of the three roads and those of the Intercolonial and National Transcontinental Railway, now included in the Government railway system, stop unnecessary duplications of service and eliminate waste. It might also, it is said, work in harmony with the Canadian Pacific Railway.

"The identity of the three companies, as has been said, would be continued, and they would be enabled, with the aid of the Government, to renew the outstanding short-date loans which will be maturing from month to month in New York and Great Britain in the near future.

"The amount of this outstanding indebtedness is considerable, and it is felt, if immediate nationalization of the railways were resorted to, would hamper the Government in financing for war purposes, and to carry on the ordinary business of the country. Renewal of the notes under Government ownership, would probably involve a Government guarantee of the renewal notes which might then compete upon the market with Canadian Government issues.

"The scheme as outlined would meet the present difficulty, provide for the continued operation of the railways and leave the question of nationalization to be taken up in the light of the success of the co-ordinated roads and financial conditions after the war."

Mayor Martin, of Montreal, has issued a belated statement to the daily press in which he says that he has always been opposed to the aqueduct boulevards plan and that when he was an alderman he voted against the report of the Board of Control recommending an enlargement of the aqueduct and the establishment of boulevards on the banks.

There will be a meeting on August 28th and 29th (Toronto Exhibition week) of the Engineering Section, Ontario Municipal Electrical Association. Managers, superintendents, secretaries and all other officials of the Ontario municipal hydro-electric systems and commissions are invited to attend. The Tuesday session starts at 2.30 p.m.; Wednesday, at 10 a.m. and 2.30 p.m. The meetings will be held in Lecture Room C 22, Chemistry and Mining Building, University of Toronto.

COOK CO. WAIVES ANTICIPATED PROFITS

A. B. Cook, president of the Cook Construction Co., contractors for the Montreal Aqueduct, denies any desire to have the work cancelled, but wishes to have the Board of Control make up their minds definitely whether or not the work is to be abandoned. The company is willing to cancel the contract if the city so desires, and to waive anticipated profits on the work yet to be done, but will retain its profits on work completed and wants to arbitrate its claims for damages owing to the delays caused by the city. It also expects to be relieved of a portion of the cost of assembling and removing its plant from the work. Owing to delays, says Mr. Cook, only 46 per cent. of the excavation and 17 per cent. of the concrete work have been completed. The excavation work done represents only 25 per cent. of the capacity of the company's plant, and the concrete work, 10 per cent. of capacity.

TO ADVERTISE CANADIAN GOODS IN FRANCE

The Senate has adopted a resolution of Senator Beaubien, urging the government to advertise Canadian products in France by means of an exhibition train of sample goods. Senator Beaubien said he had suggested to the French government that there should be two trains organized, one carrying French goods to be shown in Canada and the other Canadian goods to be shown in France. A French steamship line had offered free transportation for the trains across the ocean, and the plan had been favorably commented upon by the French press.

Sir James Lougheed said that there were limits to what any country could do in the way of giving effective aid for the development of foreign trade, which must be developed more or less through natural channels. In Canada there had been a disposition to rely on government assistance for everything. Not a railway could be built without government aid; there was not a transportation project that the government was not called upon to finance. This had the tendency to rob the people of initiative and confidence. The present and past governments had, to as large an extent as they were warranted, given assistance and aid to both domestic and foreign trades. He had observed frequently that enterprises without government assistance did better than those that relied upon the government. Sir James promised, however, to direct the attention of the government to the matter.

By building two canals, one 45 and the other 30 miles long, and utilizing a river, the Italian Government is planning to connect Milan with the Adriatic Sea.

Hon. Frank Cochrane has introduced a bill, which, if passed by the House of Commons, will place the Intercolonial Railway under the jurisdiction of the Dominion Railway Board in matters of rates, traffic, etc.

In Japan's eleven shipbuilding yards there are 189 steamers, each exceeding 1,000 tons, now being build, or on which work will soon be begun. The government grants a subsidy for each steamer. The combined tonnage represented is 948,034.

The Thor Iron Works, Ltd., will launch Hull No. 4 Bulk Freighter at noon to-day. The carrying capacity of this boat is 4,300 tons, length overall 261 ft., breadth moulded 43 ft. 6 in., depth moulded 28 ft. 2 in. The boat was built for the Great Lakes Transportation Co., Ltd., of Midland, Ont.

The first floating dry-dock ever seen in Toronto was hauled into the city on July 28th, the huge structure having been brought in three sections from Sturgeon Bay, Wisconsin, a distance of about a thousand miles. The structure weighs several thousand tons. The dry-dock, the cost of which was between $50,000 and $60,000, was purchased by the Toronto Dry-dock Company, the principals in which are Messrs. John E. Lewis, a local contractor; Lawrence Solman, of the Toronto Ferry Company; C. S. Boone, Toronto; Capt. John J. Manley and H. Dickson, of St. Catharines. According to Mr. Russell, the dry-dock will be ready for business in a few days. If it proves a success the company will construct a modern, steel-floating dry-dock in keeping with those on the upper lakes, the idea being to accommodate canal-sized freighters and vessels of the larger types.

Editorials

PRIVY COUNCIL AND THE HYDRO

The Electrical Development Co., owners of one of the three Canadian hydro-electric plants now developing power at Niagara Falls, last year asked the attorney-general of the province of Ontario for a fiat permitting them to sue for an injunction enjoining the Hydro-Electric Power Commission of Ontario, as a Crown body, from proceeding with the Chippewa-Queenston power development scheme, claiming that it has a contract with the province whereby the province agrees not to develop power at Niagara. The attorney-general refused the fiat upon the ground that the operations of the Hydro are matters for the legislature to decide and cannot be reviewed in the courts. The company then appealed successively to the Master-in-Chambers, to Justice Middleton and to the Court of Appeal, but they all refused the application for injunction unless the company could first secure the attorney-general's fiat. The company has now appealed to the Privy Council for permission to sue without the fiat and the Privy Council has given it special leave to present its arguments as to why such permission should be given.

It is quite possible that after presentation of these arguments, the Privy Council will refuse permission to the company to appeal without the fiat and if this is done the case will be ended. Should the Privy Council give permission to the company, the case will then be brought back to Canada and will be heard on its merits before a trial court, probably before one of the judges of the Supreme Court of Ontario. If this is done, it is certain that whichever side is unsuccessful before the Supreme Court will appeal to the Privy Council, and the latter body may then decide to hear the arguments on the merits of the case.

Meanwhile the Hydro work at Queenston will continue, and as it will probably be very many months before the company, even if successful, could obtain against the work an injunction that would have any force, the work would be very well advanced by the time such injunction might be granted by the Privy Council.

The Privy Council serves a useful function in keeping uniform the legislation of the Empire, and in correlating and stabilizing legal precedents throughout the Empire. In its purely legal function of determining the correct interpretation of contracts and statutes, it is par excellence the greatest tribunal of its kind in the world. But if by any judicial slip or technical flaw in any contract or statute, judgment should be given by the Privy Council such as would render invalid the efforts of the Ontario Hydro-Electric Power Commission to make the most economical and efficient use of Canada's water rights at Niagara, the popularity of the Privy Council in Canada would, to say the least, be very seriously impaired.

The provincial government of Ontario is supreme in Ontario in regard to provincial affairs, and even should the contingency arise of the Privy Council's stopping the Chippewa-Queenston development, there would no doubt be some way for the Ontario Legislature to pass such provincial laws as to nullify the effect of the Privy Council's decision. As a tribunal in disputes between municipal or provincial governments, or between provincial and Dominion governments, the Privy Council serves a most useful function, and it would be a heavy blow to provincial rights if its functions in this regard were ever to be transferred to a politically appointed and government-dominated judiciary. But in regard to suits brought by private individuals or companies, the courts of Canada should be supreme in Canada, although it must be admitted that there should first be radical reform in the method of making judicial appointments.

THE CLAIM OF THE ENGINEER

In various fields and diverse ways it has been the privilege of the engineer to overcome the insurmountable and lay nature tributary to man, as has no other profession.

In manufacturing plant, mine, railway, dock, bridge, tunnel; on land, upon the sea, in the air, everywhere are triumphs of merit that cannot be contested.

Judging by results to date, it is safe to infer that, given a fair, unhampered field, there is nothing which, if resources are available, cannot be accomplished by the same type of mind.

Nothing of an engineering character is devoid of utility,—it either serves public need, public convenience, or effects enormous savings in the public pocket. It either effects economy in a direct sense, adds to the amenities of life, or renders the otherwise impossible or vain a commonplace thing.

One can pardon the attitude of the savage who worshipped a dynamo or offered oblation and sacrifice to a locomotive, for both are so far from any natural object, and their latent power so mysterious, that they are both worth reverence.

Past ages bear witness to large works of an engineering character; the difference in the modern sense is that such works must carry a profit upon outlay, they must pay dividends upon the capital employed. The engineer is the creator of modern wealth; the present viewpoint is not what is desirable, but what pays. If the work of the modern engineer did not give investment returns on outlay, in some form or another, there would be less of his handiwork visible. Seeing that engineering effort en masse is the largest industry extant when all its ramifications are duly considered, it makes clear to the meanest intelligence that of all men the engineer is an economist of front rank, if not the greatest of all. In reality, he is the economist of economists, and his training renders waste of any kind a thing to be avoided at all costs.

Every improvement he effects means greater economy of fuel, labor or time. He lives and moves and has his being by saving in the interests of the community as a whole. This claim cannot be made of any other industry. No other profession can show so enormous an achievement or look forward to the immediate future with so much confidence.

Besides the technical achievements made, there is the administrative side which co-ordinates large numbers of men into effective human machines. The engineer has tackled the problem of economy in a human sense no less than in the realm of material. To build and maintain a large organization of men, an economic human machine, running without waste of labor, smooth, efficient, is a

work for genius. Yet the engineer takes this in his stride on the road to his technical goal.

The present is a machine-made age, run by engineers who underpin everything, but guided, directed and controlled by lawyers and professional politicians. To gain efficiency in public affairs and reconstruct the national machine is work for the engineer in the broader field. Efficiency is the watchword of the engineer. Economy is taken for granted in his work. Discrimination in the selection of his material, both human and otherwise, is a daily exercise. Psychologist, administrator, executive, philanthropist, accountant, scientific investigator,—practical, shrewd, kindly, impatient of error, intolerant of the shirker,—his value needs no testimony.

PERSONALS

D. O. L'Esperance, president of the Quebec Harbor Commission, has been officially appointed as senator.

G. H. Clothier has been appointed district engineer of the Northwestern Mineral Survey District of British Columbia, with headquarters at Prince Rupert.

F. X. Couture was recently appointed superintendent of the Sherbrooke Railway and Power Company. He has been in the service of that company for twenty years.

Arthur Vincent, A.M.Can.Soc.C.E., formerly with the Road Department, Montreal, has been appointed town engineer of Longueuil, P.Q., in succession to the late F. Barbeau.

Harry A. McKnight has resigned as superintendent of the plant of the American Car & Foundry Co., Jeffersonville, Ind., to enter the operating department of the Canadian Car & Foundry Co., Montreal, Que.

Prof. E. E. Brydone-Jack, M.Can.Soc.C.E., formerly professor of civil engineering, Manitoba University, Winnipeg, has been appointed superintendent of engineering for the Dominion Public Works Department for Western Canada.

R. Bruce Wallace, operating manager of the Port Arthur Shipbuilding Co., has resigned to become general manager of a plant at Norfolk, Virginia. J. S. Fenn, late secretary-treasurer of the Port Arthur plant, goes to the same place as purchasing agent.

Lieut. C. S. DeGruchy, Jr.Mem.Can.Soc.C.E., formerly assistant engineer on the Halifax Ocean Terminals, is reported wounded. He is serving with a unit of the Canadian artillery, and was awarded the Military Cross for his work during the Somme offensive.

Hon. Robert Rogers, Minister of Public Works, Ottawa, received complete and absolute vindication, personally and officially, from the condemnatory findings of Mr. Justice Galt, of Winnipeg, in the report of the Appellate Commission appointed to review the case, and has resumed his duties.

R. C. Harris, Commissioner of Works, Toronto, has been appointed by Sir William Hearst to the position of associate fuel commissioner for Ontario, to act in association with the Dominion fuel commissioner, C. A. Magrath. Mr. Magrath stated that similar appointments will be made in all provinces.

R. B. Priestman, formerly connected with the Eagle & Globe Steel Co., Montreal, has enlisted for overseas service, having signed up with the Cobourg Heavy Battery. He has since been promoted to the position of corporal. H. C. Opie, for several years connected with the sales staff of Alexander Gibb, Montreal, will succeed him.

Arthur S. G. Richards, a Vancouver surveyor, was killed in France while in charge of a party of the 5th Battalion Railway Corps. He served his articles with W. H. Powell, Dominion Land Surveyor, Vancouver, and later was engaged on the C.N.R. survey under Mr. Gwyer, and subsequently on the P.G.E. Railway in the Cariboo country, leaving as sergeant in charge of a draft, but on reaching England he was transferred to the Railway Corps for service at the front.

OBITUARY

James Fulton Cummings, electrical engineer, who for many years was associated with the interests controlled by Thomas A. Edison, died on July 27th at Long Beach, N.Y. Mr. Cummings, who was born in London, Ont., 48 years ago, installed the first electric light stations in Philadelphia, Cincinnati and a number of other cities. He then went to Russia, where he worked out the plans by which electric wires in St. Petersburg (Petrograd) were placed in underground conduits. He did similar work in London and other English cities.

RESEARCH LEGISLATION

The legislation under which the new advisory council for scientific and industrial research will carry on its labors was put through the House of Commons at Ottawa last Monday. The bill provided by statute the authority conferred upon the council by the order-in-council under which it was appointed.

Sir George Foster, in explaining the bill, said that Great Britain and the United States had developed a movement whereby in the future they would be ensured from being cut off from supplies of basic materials and processes. The advisory council in Great Britain, he said, had been resolved into an Imperial trust with a capital of about $5,000,000, and this and other funds would be used towards general scientific trade advancement. It has been found desirable that this society work with branches overseas and thus the Dominion council had been organized to co-operate. A number of scientists and business men are giving their services to the council free, said Sir George, although some of them receive a salary. The chairman, Dr. McCallum, of Toronto, is paid $10,000 a year.

The bill provides for a series of studentships and fellowships to encourage young men to take up scientific research, the studentships amounting to $600 a year and the fellowships to $1,200.

After the adjustment of peace, said Sir George, this system of close relation between scientific research and business would be absolutely needed to meet the new conditions.

One result of the work of this commission, Sir George hoped, would be that means would be found to keep our best-trained men in Canada instead of having them called over to the United States at big salaries to advance industries there.

Sir Wilfrid Laurier said that the project seemed to be a very commendable one, especially in that it will co-operate with societies in the United Kingdom, Australia and other parts of the Empire.