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Volume 25 Toronto, Oct. 9, 1913

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

POINTS IN BRICKS AND BRICK CONSTRUCTION

STANDARDIZATION OF BRICK IS TIMELY—LOSS OF STRENGTH IN BRICKWORK DUE TO FROGS—LACK OF UNIFORMITY IN SIZES—CLASSIFICATION OF BRICKS —BRICK MORTARS—SUGGESTED IMPROVEMENTS OVER PRESENT PRACTICE

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THE commonest building material used to-day in factory construction is the old-fashioned brick. The art of brick-making and brick-laying is a very ancient trade. One of the causes of trouble, according to Biblical record, between the Israelites and Egyptians had to do with the making of bricks, and from this we are at liberty to infer that brick-laying, as well as brick-making was a very ancient craft. Some of the oldest ruins of the Orient remain to-day as monuments of the skill of these men.

It follows, therefore, that when a student of present-day building materials discovers a desire to investigate all parts of his subject, he ought to be fully warned about the seriousness of tampering with history. The age of these ancient crafts and the history surrounding them, make the art of the brickmaker and bricklayer venerable and exempt from the invasion of recent learning. They seem to have been the barrier which has prevented the thorough examination such as all the newer materials have had to undergo in recent years.

Brick is the last of the commonest of the building materials to be standardized. The investigation and subsequent standardization of the brick crafts are being undertaken by the American Society for Testing Materials, and this society may be depended upon to carry on the work in the same thorough way that they have done in the case of steel and concrete.

The reasons for the present revision of the rules of brick-making and brick-laying is that present methods are uneconomical, inefficient and careless. The necessity of economical consideration is the result of the present tendency to build high buildings. The inefficiency is seen in the ineffective distribution of material; and the carelessness is everywhere evident in the business.

In recent years factory and office buildings have grown from the old three, four and five-story type to the present ten, fifteen and twenty-story buildings. If brick buildings were restricted to the old type there would be no pressing reason for a change. But office and factory buildings are so expensive to erect at present that prospective builders are compelled to give careful consideration to economy in their building material. A good brick building would suit a great many such builders if designed on an economical principle, allowing an adequate factor of safety.

Economical designs are not now possible under our very conservative building by-laws. But the by-laws are not properly to blame, for back of them there are good and sufficient reasons for the conservation; and those reasons are the direct result of carelessness all through the brick-making and building trades.

In the last thirty years, the rules governing the use of all our building materials have undergone, or are undergoing, revision. Technical and economical considerations have led to new, more accurate and appropriate uses. Processes of manufacture are yearly improving the uniformity of most building materials. The result of these improvements is a more reliable material. The more reliable it is, the closer may the safe working

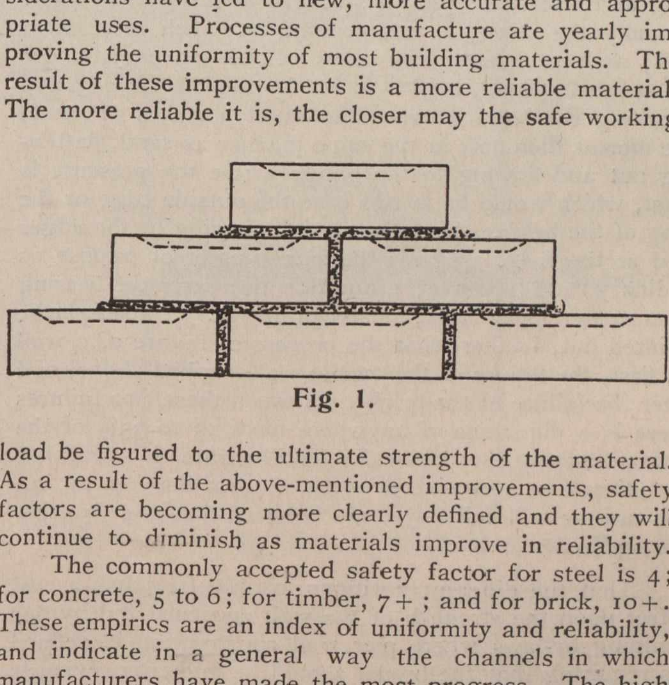


Fig. 1.

load be figured to the ultimate strength of the material. As a result of the above-mentioned improvements, safety factors are becoming more clearly defined and they will continue to diminish as materials improve in reliability.

The commonly accepted safety factor for steel is 4; for concrete, 5 to 6; for timber, 7+; and for brick, 10+. These empirics are an index of uniformity and reliability, and indicate in a general way the channels in which manufacturers have made the most progress. The high safety factor is very necessary in timber, owing to natural defects, such as knots, cross-graining, etc., but where a man commences with the raw material and makes a brick wall by his own process, it seems to be a misjudgment to lay the blame for all the defects of the resultant to natural causes.

The Effect of the Frog in Brickwork.—The first point at issue is the use of the frog in bricks. The commonly accepted theory, with regard to the frog in a brick, is that it is the bond which resists the possible horizontal shearing stresses. If Fig. 1 is examined, it will be seen that the mortar between the bricks is bonding the frogged surface of the lower brick to the flat surface of the upper course. Failure from such shearing stresses will take place across the weakest horizontal section, which would be in this case the sections at the flat surface. Therefore, the resistance to shear between the bricks depends upon the bond between the mortar and the flat surface, hence it is obvious that equal resistance to shear would be obtained if the surfaces were flat below and flat above. In practice the Canadian bricklayer spreads his mortar on the preceding course, which is laid frog downwards, as in Fig. 2a, then he takes the point of his trowel and runs a gutter in the mortar along about the centre of the course of bricks. The bricks are then laid frog downward, making the frog fit over the gutter in the mortar, as shown in Fig. 2b. That this is the case has been proven by a test, in which fifty bricks were selected on different jobs; so that the fault could not be claimed as local to any one contractor, and of the fifty selected but three frogs contained any mortar, and in those cases it seemed to have been more by accident than intention. The present practice clearly destroys the bonding and shearing theory supporting the use of a frog in bricks, and it also furnishes a very strong argument against its use at all.

The above is by no means the most serious defect of a wall so constructed. Consider the effect the loss in bearing area, caused by this practice, has on the compression value of a wall. The average brick laid flat gives a bearing area of 4″ × 8½″ = 34 sq. ins., the area of the frog is 2″ × 6″ = 12 sq. ins., so that the actual bearing area of a frogged brick is 22 sq. ins. Thus the frog decreases the effective strength of the wall by 35%. Actually the strength is decreased by much more than 35%, as experiments will show. Brick masonry, under an increasing load, begins to fail by the lime failing and breaking the bond between the small particles of sand; the mortar then acts in the same manner as sand, flattening out and flowing to the points where the pressure is least, which would be in this case the outside edge or the frog of the brick. Also, the sand in flowing at the edges and at the frog, assumes the same angle of repose as ordinary sand (about 45°), and thus decreases the bearing area of the upper brick, as shown in Fig. 3. It might be pointed out, further, that the process of failure of a wall is, first, the failure of the mortar as described above, and later the failure of the bricks. Between these two failures there is a difference of anywhere from 15 to 35% of the ultimate strength of the wall. To illustrate: if a wall has an ultimate compressive strength of 1,000 lbs. per sq. in., the mortar will fail anywhere between 650 and 850 lbs. per sq. in.

That the different positions of the frog has a real effect upon the strength of the wall is recognized by our building by-laws where pier wall construction is defined as requiring that the bricks should be laid frog upwards and the wall grouted, thus making certain that the frog is well filled. Additional bearing values must therefore be allowed for a wall so constructed. If a wall of a certain compressive strength per sq. in. is desired and the bricks may be laid either of these ways, it follows that to build the wall pier construction throughout, ought to mean a saving in bricks, and thus an economy in material would be effected.

Another argument which is sometimes advanced in favor of the frog is that bricks are easier and quicker laid when placed frog downward. As has been already stated, this is the Canadian practice. English and continental practice is to lay every brick frog upward, and fill the frog. The question of which way is easier and quicker seems to be only a matter of which way a bricklayer is taught and rapidity then is but a matter of practice.

Variation in Size of Bricks.—Bricks vary in height from 2 ins. to 3 ins., due to at least two causes: (1) a difference in the size of the forming mould; (2) the process by which they are solidified. It seems necessary to establish a minimum and a maximum dimension in height, allowing a variation of not more than one-eighth of an inch in the finished product. The difficulties of estimating air-shrinking and fire-shrinking in clay brick is well known, but they are not such that they cannot be overcome. That some precaution is necessary can be very well illustrated by considering the difference in the amount of mortar in the face and back of a wall, where the bricks differ by one-eighth inch in height. (The writer knows of cases where the face and filling bricks have differed by as much as one-half inch.) The difference of one-eighth of an inch in the height of the bricks would mean a difference of one-half to the vertical foot of wall, assuming four bricks to the vertical foot. In a fifty-foot wall there is a difference of twenty-five inches in

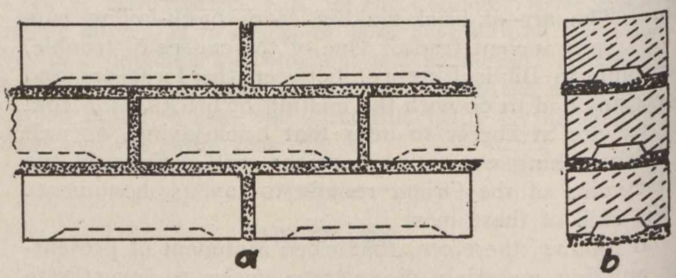


Fig. 2.

the amount of mortar. The mortar is the weaker material in the wall, and therefore the inside of the wall, which has to carry the floor loads and should be stronger, is weaker than the outside.

Classification According to Strength.—There should also be a minimum requirement of strength in a definite period after a brick is made. Bricks, as they are used now, vary in crushing strength from 400 lbs. per sq. in. to 7,000 lbs. per sq. in., and are classified according to appearance and not according to strength. The above-mentioned brick showing a strength of 400 lbs. per sq. in. would probably be used as a filler, and placed in the back of the wall where it would have to carry the greater portion of the load. It is because these poor bricks are used that building regulations are justified in allowing a compressive strength of from 50 to 75 lbs. per sq. in. This laxity in allowing the use of the poor bricks is the reason for discounting the strength shown in 85% of the bricks produced, for any of the modern kilns will show 85% of the bricks to be hard burnt. Therefore, if some rigid standard was enforced for factory and office building construction, such as a requirement of 2,000 lbs. per sq. in. in compression, one month after being made, it would only exclude about 15% of the bricks produced and many uses could be found for the rejected 15%. Building regulations would then be justified in raising the allowable unit stresses in brick wall construction.

Lime versus Cement Mortar.—In Table I. is given the results of compression tests on blocks of cement and lime mortar.

Table I.—Strength of Mortars.

Composition of mortar.	Age when tested.	Strength in lbs. per sq. in.
1 lime : 2 sand	1 month	94.
1 lime : 2 sand	3 months	136.
1 lime : 2 sand	6 months	245.
1 cement : 3 sand	2½ months	1352.
1 cement : 3 sand	8 days	655.
1 cement : 3 sand	13 days	1320.
1 cement : 3 sand	28 days	2155.
1 cement : 2 sand	8 days	895.
1 cement : 2 sand	13 days	2325.
1 cement : 2 sand	28 days	2690.

The table shows that cement mortar is much stronger and gains strength much more quickly than the lime mortar. In factory and tall building construction, both of these points of superiority of cement mortar are of importance. By the use of a mortar such as 1 part cement to 2 parts sand a much higher allowable strength could very safely be allowed than is allowed at the present time, which would mean an additional economy in material.

Another difficulty with mortar, and especially lime mortar, is the variation in quality due to carelessness in proportioning and mixing. The proportions are usually left to the experience and guessing ability of the mortar mixer, and seldom, if ever, is the material accurately measured. The only tests required of the fitness of the resulting mixtures are their spreading and working qualities, which are in many cases very different from strength qualities. More care in measuring and mixing the materials of a mortar would improve its strength and reliability.

The purpose of this article is to point out where improvements might be made. What has been termed carelessness is as much the fault of the architect and engineer as it is the fault of the brickmaker or bricklayer. If specifications were drawn up more carefully and precisely a great many of the inaccuracies in using building materials would be eliminated; for instance, if architects, by agreement, were to issue specifications for bricks without frogs it would be but a short time until the manufacturers would be making only that kind of brick. To the brickmaker the frog is more or less of a nuisance anyway, and its elimination would, in most cases, mean but slight changes in his moulding machinery. The writer knows of four firms of architects doing business in Toronto and Montreal whose specifications are of the type described. Most of the other difficulties pointed out could be gotten rid of by a similar process.

In Canada at present the ceramic industries are booming. The development has improved the quality as well as increased the quantity and ultimately the improvement in quality must be recognized by increasing the allowable safe loads and thus cutting down the waste in building operations.

The following points are suggested as improvements over the present practices:—

1. The elimination of the frog in bricks.
2. The use of cement mortars, not exceeding 1 part cement to 3 of sand, in all but residential buildings.
3. A definite minimum and maximum height for all bricks.
4. Better and more precise specifications for proportioning and mixing mortars.
5. Increased bearing values.
6. That the following be the specification for bricks, which is the specification proposed by the American Society for Testing Materials:—

Selection of Samples.—For the purpose of tests, brick should be selected by some disinterested and experienced person to represent the commercial products. All brick shall be carefully examined, and their condition noted before being subjected to any test.

Transverse Test.—At least five brick to be tested, laid flat-wise with a span of seven inches, and with the load applied at mid span. The knife edges shall be slightly curved in the direction of their length. Steel bearing plates, about ¼-inch thick and 1½-inches wide, may be placed between the knife edges and the brick. The use of a wooden base-block, slightly rounded transversely across its top, upon which to rest the lower knife edges, is recommended. The modulus of rupture shall be obtained by the following formula.

$$R = \frac{3\ W\ L}{2\ b\ d^2}$$

in which:—

L. is the distance between supports in inches.
b. is the breadth of the bricks in inches.
d. is the depth of the brick in inches.
W. is the load in pounds at which the brick failed.

The half brick resulting from the transverse test shall be used for the compression and absorption tests. One half to be crushed in its dry condition. The other half to be used for the absorption test and crushed while in this wet condition. No specimen shall be used if any part of the line of fracture is more than one inch from the centre line.

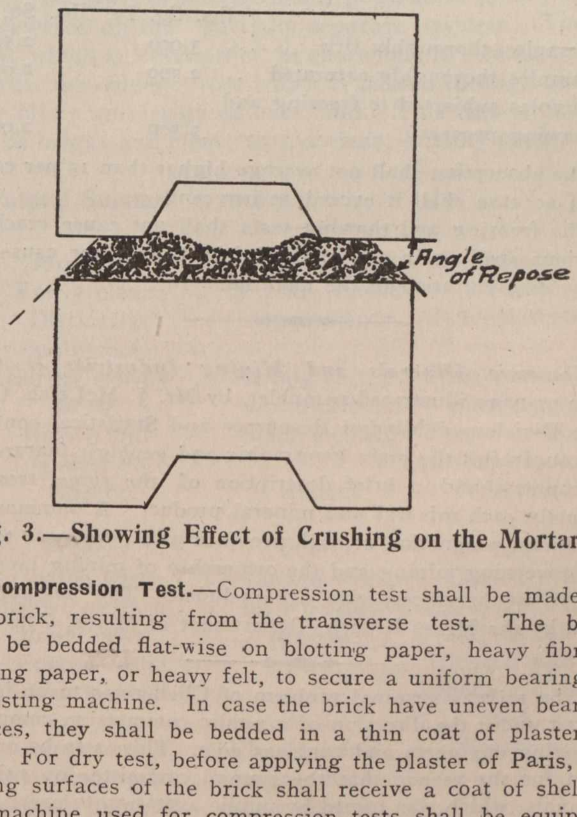


Fig. 3.—Showing Effect of Crushing on the Mortar.

Compression Test.—Compression test shall be made on half brick, resulting from the transverse test. The brick shall be bedded flat-wise on blotting paper, heavy fibrous building paper, or heavy felt, to secure a uniform bearing in the testing machine. In case the brick have uneven bearing surfaces, they shall be bedded in a thin coat of plaster of Paris. For dry test, before applying the plaster of Paris, the bearing surfaces of the brick shall receive a coat of shellac. The machine used for compression tests shall be equipped with spherical bearing block. The breaking load shall be divided by the area in compression, and the results reported in pounds per square inch.

Absorption Test.—At least five half brick shall be first thoroughly dried to constant weight, at a temperature of from 200 to 250 degrees F., weighed, then placed on their face in water to a depth of one inch, in a covered container. The brick shall be weighed at the following intervals: one-half hour, six hours, and forty-eight hours. Superfluous moisture to be removed before each weighing. The absorption shall be expressed in terms of the dry weight and the balance used must be accurate to five drams.

Freezing and Thawing Test.—In case the freezing and thawing test is desired, at least five bricks shall be thoroughly saturated by immersion in cold water, the temperature of the water to be raised to 200 degrees F. in thirty minutes, then allowed to cool. The specimen shall be immersed in ice water for not less than one hour, weighed, then transferred to the refrigerator and supported in such a manner that all faces will be exposed. The specimen shall be subjected to a temperature of less than 15 degrees F. for at least five hours; then removed and placed in water at a temperature of not less than 150 degrees F., nor more than 200 degrees F., for two hours. This operation shall be repeated twenty times, after which the bricks shall be again weighed, still saturated. The character of the bricks shall be noted before and during the test, and all visible changes noted. Immediately on completion of this test, samples are to be thoroughly dried and subjected to the transverse and compression tests.

Requirements.—The following requirements shall be met:—

Modulus of rupture shall be as follows:—

	Average.	Minimum
For samples thoroughly dry	400 lbs.	325 lbs
For samples thoroughly saturated .	275 lbs.	225 lbs
For samples subjected to freezing and thawing process	275 lbs.	225 lbs.

The ultimate compression strength shall be as follows:—

	Average. lbs. Sq. In.	Minimum lbs. Sq. In.
For samples thoroughly dry	3,000	2,500
For samples thoroughly saturated ..	2,500	2,000
For samples subjected to freezing and thawing process	2,500	2,000

The absorption shall not average higher than 15 per cent., and in no case shall it exceed 20 per cent.

The freezing and thawing tests shall not cause cracking or serious spalling in any of the bricks tested, nor cause the serious disintegration of the material.

Economic Minerals and Mining Industries of Canada, a 77-page illustrated pamphlet, by Mr. J. McLeish, Chief of the Division of Mineral Resources and Statistics, contains data concerning the main geographic and geologic features of the country, and a brief description of the same, treating separately each mineral and mineral product. A summary of the mineral production of each province and references to the laws governing mining and the ownership of mining lands in the various provinces, also are included. The pamphlet is issued by the Mines Branch, Department of Mines, Ottawa.

The railway-terminal problem of Chicago is to be investigated under the direction of a public commission composed of leading engineers and business men. This is to be undertaken for the reason that the council committee on railway terminals, which was forced by public agitation to order such an investigation made under its direction, is considered to be prejudiced in favor of the plans submitted by the Pennsylvania Railroad. The committee has openly advocated these plans, and has predicted that they will be approved by the city authorities, thus indicating that it will give slight consideration to other plans or to the general problem of improvement of the railway-terminal system of the city.

ROYAL COMMISSION'S SEWAGE DISPOSAL ENQUIRY.

THE Royal Commission on Sewage Disposal (Great Britain) has recently issued an appendix to its eighth report which was published last autumn. This report dealt with the establishment of some co-relation between the chemical character of the water of rivers and streams, and the relative purity and freedom of them from nuisance. It will be remembered that the Commission expressed its opinion that the liability of a stream to become objectionable under unfavorable conditions might fairly be estimated by the amount of dissolved oxygen absorbed in five days at a constant temperature of 65° F. This it regarded as the best indication of the liability of a stream to become offensive in warm weather and that is surpassed in value as an index to the stream's conditions, the percentage of ammoniacal nitrogen present.

The Commission's conclusions defined the limits of temperature variations as 37.2° F. lowest, and 64.4° F. highest, from observations taken on a number of streams.

In the appendix, now issued, the Commission sets forth in detail the experimental work which constituted the basis of its recommendations and a great deal is contained therein of value to engineers concerned in the prevention and abatement of river pollution. "Engineering" (London), outlines the work as follows:—

In commencing their operations the Commission addressed inquiries to all the county medical officers of England and Wales, as well as to the various river conservancy boards, and from the information thus acquired, a preliminary list of fifty streams was drawn up and personally inspected. As the result of this examination, which was carried out by Mr. G. B. Kershaw, the engineer to the Commission, twenty-five places were selected for further inspection and examination, but in the end attention was mainly concentrated on sixteen of the sites thus chosen. The object of the inquiry being to correlate the chemical characteristics of the waters of a stream with its state as estimated by the eye and nose, careful note was taken of the condition of its bed and banks. Stones from the shallows were examined for algæ growth, water insects, and the like, and special attention was paid to any deposits of mud in the pools and banks. Fish life was also carefully noted, and at the same time data were taken of the relative rapidity of the streams, which were classified as follows:—

Mean current velocity.	Character of stream.
From 20 ft. per minute downwards	Sluggish to very sluggish
From 20 ft. to 40 ft. per minute	Slow
" 40 ft. to 60 ft. "	Moderate
" 60 ft. to 80 ft. "	Rapid
Over 100 ft. per minute	Very rapid

Based on these observations the Commission have been able to tabulate the features given in the accompanying table as characteristic of the relative purity of natural waterways in normal summer conditions.

The cases of pollution inquired into by the Commission covered every condition, from insignificant to distinctly bad. The relative volume of effluent to the stream in which it was discharged was in some instances as low as 1 to 2, and in others less than 1 to 1,000, but in all cases a pretty close connection was established between the results of the oxygen-absorption test and the place which would be assigned to the stream in the table, as the result of an inspection by eye and nose. The grey growth mentioned in the last column of the table appears to be eminently characteristic of an undesirable degree of pollution.

The efficacy of the test recommended depends upon the fact that clean river water in normal condition, and at 60 deg. F., contains in solution 7 c.c. of oxygen, or 1 part by weight, in 100,000 of water. If polluted, this dissolved oxygen, as the result of bacterial action, enters into combination with the organic matter present, with a consequent reduction in the amount of that freely dissolved, and this loss of oxygen thus serves to indicate the degree of pollution of a stream. All river water contains some organic impurity, and hence, if kept in conditions in which the store of oxygen cannot readily be replaced from the air, there will, on keeping, be always some reduction in the quantity of oxygen contained in solution. With clean river water, however, this loss is small, whilst with badly contaminated streams the whole of the dissolved gas may disappear from the sample under test. The connection between the oxygen dissolved and the character of the stream is stated to be as follows:—

	Gramme of dissolved oxygen in 5 days.
Very clean	0.1
Clean	0.2
Fairly clean	0.3
Doubtful	0.5
Bad	1.0

The figures refer to the weight lost from 100,000 grammes of the water under test. It will be noted in the above table that the figure given for a badly polluted stream exceeds the total amount of oxygen which water is capable of holding in solution at a temperature of 65° F. This, in fact, was frequently the case in the tests, which were made by mixing the sample under observation with tap water in such proportion that some 50 to 60 per cent. of the total dissolved oxygen was taken up in the five days over which the test extended. This degree of dilution was found by experiment to yield the most concordant results.

A very fair correlation was, as already mentioned, also established between the condition of a stream and the ammoniacal nitrogen present, but the Commissioners came to the conclusion that this test was on the whole the less satisfactory of the two, since the ammonia figure in the case of a stream receiving sewage effluents was not always as good an index of the actual condition of the stream as the dissolved oxygen test was found to be.

A most interesting feature of the present series of researches has been the comparisons made between the condition of a stream above a sewage outlet and below it. Probably the most interesting observations made in the whole investigation are those on the River Avon, from Rugby to Stratford. This river rises in Northamptonshire, near Naseby, and flows across Warwickshire to the River Severn at Tewkesbury. It is a winding, sluggish stream, with a muddy bed, and there are many weirs on it. On it, or its tributaries, are situated the towns of Rugby, Coventry, Kenilworth, Leamington, Warwick, Stratford, and Evesham, the distance between successive centres of pollution being generally about 10 miles. For many years the stream received the untreated sewage effluents from all the centres above named; but as matters stand to-day, it would appear that the effluents sent into the stream are in the main fairly satisfactory, and that the river is maintained in a passable condition. Between Rugby and Stratford the proportion of sewage-derived water in the river never falls below 1 in 8 or 1 in 9, and in one reach amounts to as much as 1 in 2.5.

The town of Rugby has a population of 21,000, and is sewered on the "partially separate" system. The sewage, which is "domestic" in character, is treated in septic tanks, the effluent from which is passed through percolating filters and irrigated over land. This effluent is stated to be bright and clear, with a clean, healthy smell, and is

Features Characteristic of Streams in Normal Summer Weather.

Condition of water as regards	"Very Clean"	"Clean"	"Fairly Clean"	"Moderate"	"Doubtful"	"Bad"
Suspended matter	Clear	Clear	Fairly clear	Fairly clear	Slightly turbid	Turbid
Opalescence	Bright	Bright	Slightly opalescent	Distinctly opalescent	Opalescent	Opalescent
Smell on being shaken in bottle	Odorless	Faint earthy smell	Pronounced earthy smell	Earthy wormy smell	Strong earthy wormy smell	Soapy, fœcal, or putrid smell
Appearance in bulk	Limpid	—	Slightly brown and opalescent	Brown and opalescent	Black looking	Brown or black and soapy looking
Delicate fish	May be plentiful	Scarce	Probably absent	Absent	Absent	Absent
Coarse fish	—	Plentiful	Plentiful	Present	Scarce	Do
Stones in shallows	Clean and bare	Clean	Lightly coated with brown fluffy deposit	Coated with brown or dark green layer	Coated with brown fluffy deposit	Coated with grey growth and deposit
Stones in pools	Do	Covered with fine light brown deposit	Do	Coated with brown deposit	Do	Coated with brown or black mud
Water weeds	Scarce	Plentiful; fronds clean except in late autumn	Plentiful; fronds brown-colored in places	Abundant and covered with deposit in pools	Plentiful and covered with fluffy deposit	Scarce
Green algæ	Do	Moderate quantities in shallows	Plentiful in shallows	Plentiful	Abundant	Abundant in protected pools
Grey algæ	—	—	—	—	Present	Plentiful
Insects, larvæ, etc.	—	—	—	Plentiful in green algæ	Plentiful in green algæ	Abundant in green algæ

non-putrescible on incubation. It contained in 100,000 parts about 1.5 parts of matter in suspension, and when maintained at 65° F. for five days took up 1.97 parts of oxygen per 100,000.

The ratio of the sewage effluent to the dry-weather flow of the river is about 1 to 8; the river flow being 4,500,000 gallons per twenty-four hours. No smell was observed near the Rugby outfall, and there was very little of the grey growth, which, as already stated, seems to be characteristic of polluted waters. Small coarse fish were present in the water below the outfalls, although in dry weather the admixture of the effluent caused considerable deoxygenation of the water in the sluggish reaches. The Coventry sewage reaches the river 13 to 14 miles further down. At this point the river has practically completely recovered from the effects of the Rugby discharge, at least so far as its chemical constitution is concerned, the chlorine content of the water alone being permanently increased. Coventry has a population of 90,000, and the sewage discharged amounted to 4,000,000 gallons per day in 1911. It is of a domestic character, but with trade wastes. The treatment to which it is subjected before discharge is settlement followed by land irrigation and land filtration; the area assigned for this purpose was 378 acres at the time of the observations, but has since been largely augmented. The effluents are stated to be very variable in quality. The dry-weather flow of the river, which is said to be fairly clean on its arrival at Coventry, is put at 7,500,000 gallons per hour, and the ratio of dilution less than 3 to 1. Under these conditions of an inferior effluent and little dilution there was an abundant grey growth below both outfalls, and masses of putrifying mud have formed in parts of a very sluggish reach, where many dead fish are found in warm, dry weather, accompanied by an objectionable smell. Nevertheless, the river purifies itself further on, and though it receives also the sewage effluent from Leamington, Warwick, Kenilworth, Stratford, and Evesham, it is, as already stated, now maintained in a passably fair condition, so far as actual nuisance is concerned. Bacteriologically the results are much less satisfactory, although there is in all cases a well-marked progressive improvement of the river as the distance from each new outfall increases. It appears, however, that from the standpoint of bacteriology reversion to the original state of the unpolluted stream cannot in general be effected within the limits of distance which are probable in this country between independent sources of pollution.

The observations made at Berkhampstead have rather a special interest, since the sewage is discharged not into a natural stream, but into the Grand Junction Canal, where practically the whole of the flow is merely that due to lockage operations. The sewage is from a population of 8,000, and is "domestic" in character. It is treated in closed septic tanks, followed by double-contact beds, the average flow being 500,000 gallons per 24 hours. The effluent is slightly opalescent, with a brown tint, and generally, but not always, has a clean smell. Two out of seven samples putrified on incubation. This effluent is discharged into a pound, where the water is practically stagnant. This water has a stale wormy smell on shaking, but there was no smell on the tow-path. Much grey fungus was present below the outfall, and the only fish observed in the pound were minnows. Several cases in which sewage is discharged direct into the stream without treatment of any kind are discussed in the report. Apparently where the dilution is sufficient this practice does not give rise to any active nuisance, but even in these cases the discharge of paper, corks, and matches into the stream is objectionable, and could be avoided by straining the sewage before discharge.

"DUKE OF CONNAUGHT" TOLLS.

The Canadian Gazette publishes the tariff of tolls submitted by the Canadian Vickers, Limited, in connection with their floating dock, the "Duke of Connaught," at Montreal. The schedule has been recommended for approval, subject to amendment, by the Minister of Public Works. It is as follows:—

Montreal Floating Ship-Dock Canadian Vickers, Limited Tariff.

Gross Reg. Tons.	1st day	Commencing 24 hrs. after vessel is raised. Following days or fractions thereof each.
Up to 1,000	$ 300.00	$ 80.00
1,000— 1,199	340.00	95.00
1,200— 1,399	365.00	95.00
1,400— 1,599	390.00	95.00
1,600— 1,799	415.00	110.00
1,800— 1,999	450.00	110.00
2,000— 2,249	475.00	110.00
2,250— 2,499	500.00	125.00
2,500— 2,749	525.00	125.00
2,750— 2,999	550.00	125.00
3,000— 3,499	575.00	150.00
3,500— 3,999	600.00	150.00
4,000— 4,499	625.00	150.00
4,500— 4,999	650.00	175.00
5,000— 5,499	700.00	175.00
5,500— 5,999	750.00	200.00
6,000— 6,749	875.00	200.00
6,750— 7,499	950.00	225.00
7,500— 8,249	1,025.00	225.00
8,250— 8,999	1,100.00	250.00
9,000— 9,999	1,200.00	275.00
10,000—10,999	1,300.00	300.00
11,000—11,999	1,400.00	350.00
12,000—12,999	1,500.00	400.00
13,000—13,999	1,600.00	450.00
14,000—14,999	1,700.00	500.00
15,000—15,999	1,800.00	550.00
16,000—16,999	1,950.00	600.00
17,000—17,999	2,050.00	650.00
18,000—18,999	2,150.00	700.00
19,000—19,999	2,250.00	750.00
20,000—20,999	2,350.00	850.00
21,000—21,999	2,450.00	950.00
22,000—22,999	2,550.00	1,050.00
23,000—23,999	2,650.00	1,150.00
24,000—25,000	2,750.00	1,250.00

THE MONTANA IRRIGATION PROJECT.

The Sun River diversion dam, a part of an immense irrigation project in Montana, is at present under construction by the United States Government. A contract has just been awarded to MacArthur Bros. Company, of New York, consisting of the construction of about forty-five miles of main canal and several small tunnels, aggregating about three-quarters of a mile in length. The canal will have a capacity of 1,700 feet per acre per day. It will be twenty-seven feet wide at the bottom and sixty-nine feet in width at the top, the water having a depth of eleven feet. Its cost will amount to about $900,000.

THE SASKATOON TRAFFIC BRIDGE

THE new traffic bridge which will supplant the present steel bridge at Saskatoon, is in its early stages of construction, and will probably be ready for use by December of next year. The present bridge was built in 1906-07, but during the past six years the city has grown so rapidly that the structure is quite inadequate to accommodate the large traffic crossing the river. The old bridge is built on concrete piers. It is interesting to note that the petition of 1904, asking for a bridge at Saskatoon, estimated the population at 1,200, while the 1901 census had placed it at 113, a conservative estimation of the present population being 26,000.

Early in 1912 the need of a new and larger bridge was voiced, resulting in a thorough investigation on the part of the Board of Highway Commissioners, and in June of last year the site was selected. It was definitely decided that the bridge should span the river between Twenty-fifth Street on the west and Saskatchewan Street, which bounds the University grounds, on the east. It was agreed that only a very wide bridge would meet the requirements.

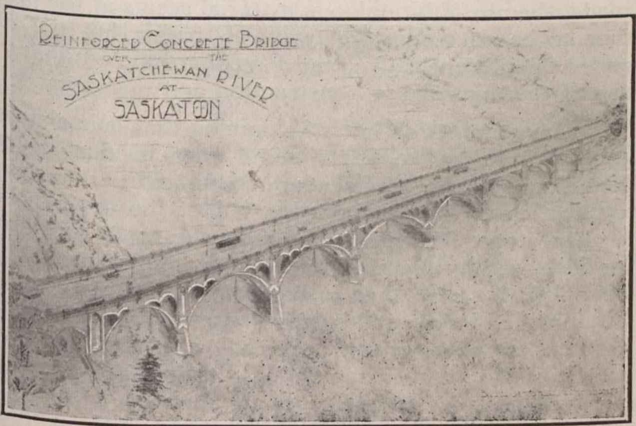


Fig. 1.—Accepted Design for Saskatoon Traffic Bridge.

The site chosen offered various difficulties from an engineering standpoint. The elevation of the bank at the University side is some fifty feet higher than on the city side. The river is about 1,100 feet wide during high water at this point. The bridge was to cross from a park on the city side to the University grounds on the other, and the aesthetic treatment demanded great care.

The Board of Highway Commissioners designed bridges of two types for this crossing—a steel superstructure on concrete piers, and a bridge composed of a series of reinforced concrete arches. The estimated cost of the two types varied by only about $6,000, and the selection became a question of type rather than cost. The steel bridge required a long approach on the city side of the river in order to overcome the grade as it was not considered practicable to build a large steel structure with so large a grade. This approach was at the best an unsightly structure, and would have caused considerable claims for property damage from residents of Twenty-fifth Street.

The reinforced concrete bridge was chosen because of greater permanency and better appearance, and as best suiting the requirements. An agreement was drawn up with the city of Saskatoon by which they agreed to pay one-third of the cost of the structure. Plans were prepared of a bridge consisting of a series of arches with a floor on a grade of 2.88 per cent. The total width of the bridge is to be 65 feet, and two 8-foot sidewalks are to be cantilevered from the roadway. Provision was made for two street car tracks, and two 14-foot roadways.

The total length of the bridge and the retaining walls at its approaches is about 1,490 feet. It consists of one arch of 25 feet span, one arch of 66 feet span, one arch of 92 feet span, one arch of 103 feet span, one arch of 136 feet span, four arches of 150 feet span, and one irregular arch of 94 feet span. The arches of 150 feet are notable as being longer in span than any in Canada.

The design was most carefully worked out and the allowable stresses are most moderate. The bridge is designed for a temperature range of from 50 degrees below zero to 90 degrees above. This variation of temperature is thought to be larger than that used in designing any other concrete bridge.

Tenders were called for the construction of the bridge and closed on July 15. The R. J. Lecky Company, of Regina, was the lowest bidder and its tender was accepted. The price for the estimated quantities was some $240,000. Cement and reinforcing steel are to be supplied by the Board, and the estimated quantities are 725 tons of reinforcing steel and 114,000 bags of cement. The cost of these must be added to the contract price to obtain the actual cost of the work.

The bridge was designed under the personal direction of Mr. A. J. McPherson, chairman of the Board of Highway Commissioners, by the engineering staff of the bridge branch, of which Mr. A. P. Linton is assistant chief engineer. Mr. Daniel B. Luten, of Indianapolis, who is an authority on concrete bridges, acted in an advisory capacity, and examined and approved the general arrangement and the working plans.

In Western Canada the bridge will only be surpassed in size and importance by the bridge over the North Saskatchewan at Battleford. It will, however, be by far the largest reinforced concrete bridge in this country, and will take high rank among the big bridges of the North American continent. The illustration gives an idea of the accepted design, a more detailed description of which will be published at a later date.

According to the report of Mr. J. McLeish on Economic Minerals and Mining Industries in Canada, these statistics are given for the total production of petroleum in the Province of New Brunswick; in 1911, an aggregate of 2,461 lbs., valued at $3,019; and in 1912, 2,679 lbs., valued at $3,799.

Railway building in Western Canada is one of the wonders of the age, over seven miles of new track being laid down for every day in the year. Each year the railway map of Western Canada shows hundreds of miles of extensions laid in all directions. The railway mileage of the Western Provinces in 1900 was 3,680, and is now 13,560 miles, and before long, instead of one, three transcontinental railroads will belt the prairies, with branches and feeders extending in every direction, opening up large areas of new territory for agricultural and commercial development. The railway extension programme laid down for completion this year by the Canadian Pacific, Canadian Northern and Grand Trunk Pacific Railways is the largest yet attempted. Active work is now in progress on the Hudson's Bay Railway, which, in addition to forming a new outlet and more direct ocean communication for the Western Provinces, will open up a large area of new and undeveloped territory to the north. This extensive increase in transportation facilities will, without doubt, increase the acreage cultivated, which will in turn, create an ever-increasing demand for manufactured goods.

MASSACHUSETTS HIGHWAY COMMISSION REPORT, 1912.

THE Massachusetts Highway Commission has under its charge road work, motor vehicles and the supervision of telephone and telegraph companies, each with its own practically separate department. The commissioners are Col. Wm. D. Sohier, chairman; Mr. F. D. Kemp, and Mr. Jas. W. Synan. The highway department has charge of all road and bridge work, advice to municipal authorities, etc. At its head is the chief engineer, Mr. A. W. Dean, whose assistant is Mr. S. A. Parsons. The office engineering department which makes the surveys, prepares all plans and estimates, etc., is in charge of Mr. A. M. Lovis, and under him are employed 20 to 50 engineers, draftsmen, instrumentmen and rodmen, depending on the season of the year and the amount of work on hand.

The State is divided into four divisions, each in charge of a division engineer, who has one or two assistants in charge of particular work, like "small town" work, maintenance, etc., and as many resident engineers are assigned to his division from time to time as are necessary to supervise and inspect the actual work which is in progress. Most of the principal engineers and assistants have been in the service for over 10 years, and quite a number for a much longer period. The various departments report to the commission through its secretary.

During the year ending November 30th, 1912, the commission completed 11.25 miles on contracts that were pending at the beginning of the year and 21.57 miles of roads commenced during the year, making a total of 32.82 miles of construction for the year, or a grand total of 920.51 miles since work began. Construction was commenced, but not completed, on 20.16 miles of road in 1912.

Of the above 32.82 miles, 4.58 miles were of water-bound macadam; 6.72, gravel; 3.19, sand-bound with oil; 12.02, bituminous macadam; 3.93, water-bound macadam with an oil surface applied; 2.24, gravel with the top service bound with bituminous binder. The costs of construction of these highways are shown in the accompanying Table I., in such a manner that comparisons may be made between the different costs of work in different portions of the State under varying conditions.

In Massachusetts, as elsewhere, the increase in travel by automobiles, and the use of motor trucks for long distances to and from cities, has augmented the question of maintenance into one of vital importance. The report of the commission, from which this information is derived, states that in 1912 over $500,000 was spent in maintaining state highways, $200,000 of which was provided by direct appropriation by the Legislature and the balance secured from motor vehicle fees. (The total expenditure by the commission up to the end of last year for the construction of state highways since the work began, amounted to $8,379,080.) Bituminous material was used in maintenance work during 1912, on 283.55 miles, and in construction on 21.38 miles, there existing at that time 729.83 miles of state highway on which bituminous material was used either in construction or maintenance. In his report, Mr. A. W. Dean, chief engineer, states: "While there have been a few failures of bituminous roads, the use of bituminous material seems at the present time to be an economical way of preserving the roads under the present traffic, and I recommend continuing the use of this material in construction and maintenance."

The commission is of the opinion that it is absolutely necessary to-day to apply some form of dust layer or bituminous binder to macadam roads, either by a surface application or by incorporating it into the upper 3 in. of broken stone. If this is not done the roads will shortly be destroyed by the high-speed motor vehicle travel. The commission states that it has found the application of bituminous binders under pressure produces more uniform results than were formerly secured by the so-called gravity method. The cost of maintaining the roads is over $500 per mile per year and will probably be more in the future, certainly until many miles of the older roads on through

TABLE 1—APPROXIMATE COSTS OF ROADS COMPLETED IN 1912

Town	Type of Surface	Length of calculations		Drainage, culverts and bridges	Grading and foundation	Cost of surface	
		Miles	Sq. yds.	total cost	cost per mile	Per mile	Per sq. yd.
Amesbury	Macadam, 4½-in., trap rock, bituminous binder	.28	2,464	$ 907	$3.564	$7,593	$0.86
Ashby	Macadam, 5-in., local stone	.60	5,280	592	3,133	5,275	.60
Ashby, 1911	Macadam, 5-in., local stone	.44	3,872	296	4,600	4,968	.56
Bourne	Macadam, 3¾-in., trap rock bituminous binder	.68	5,984	624	1,348	7,135	.81
Chelmsford, 1911	Gravel, 5-in.	1.42	12,496	672	2,447	1,201	.13
Dighton, 1911	Macadam, 4¼-in., local stone, bituminous surface coat	1.02	8,976	141	1,140	3,727	.42
Erving	Concrete, 5-in., bituminous surface coat, concrete beam bridge	.03	264	2,299	4,977	10,833	1.25
Franklin, 1911	Gravel, 6-in.	1.17	10,296	467	2,915	1,795	.20
Haverhill	Macadam, 5 in., trap rock, bituminous binder	.43	3,784	1,140	3,602	7,116	.80
Lakeville	Macadam, 4¼-in., local stone, bituminous binder	1.24	10,912	282	2,890	5,690	.64
Lanesborough	Macadam, 4-in., trap rock, bituminous binder	.34	2,992	400	5,490	5,976	.66
Montague, 1910	Macadam, 5-in., local stone	.82	7,216	253	2,058	4,416	.50
Plymouth, 1911	Sand and oil, 3½-in., mixed	1.00	8,800	859	8,192	4,027	.45
Raynham	Macadam, 4-in., local stone, bituminous binder	.96	8,448	326	3,731	6,262	.74
Salisbury, 1911	Macadam, 4¼-in., local stone, bituminous binder	1.22	10,736	621	2,160	5,225	.59
Sandwich	Sand and oil, 3-in., mixed	.85	7,978	318	1,245	4,545	.48
South Hadley	Macadam, 5-in., trap rock	1.31	11,528	1,131	5,754	4,575	.52
Spencer, 1911	Macadam, 5-in., trap rock, concrete arch	.03	264	4,727	10,166	9,441	1.07
Swansea, 1911	Macadam, 4-in., local stone	.78	6,864	543	1,356	2,946	.43
Tyngsborough	Macadam, 4-in., trap rock, bituminous binder	.72	6,336	1,581	1,525	6,740	.76

routes, especially near the cities and larger towns, where the traffic is extremely heavy, have been reconstructed with some more permanent surface.

In a subsequent issue the part of the commission's report dealing with the traffic census will be summarized.

CONCRETE ROADS IN WAYNE COUNTY, MICH.

WAYNE County, Michigan, in which Detroit is situated, is credited with having the finest system of concrete roadways in the world. They are over 100 miles in length. The upkeep expense is less than $5 per mile per year, which includes the cleaning of ditches and the cutting of weeds along the roadside; and they are always smooth and dustless.

Practically every government report that has been issued during the past five years has told of the failure of the ordinary macadam road to withstand the traffic of the present day. In New York State the maintenance expense has gone as high as $1,000 per mile per year. And within a few years these highways have had to be completely rebuilt. The concrete highway, which originally costs a third more, is practically permanent. But several conditions govern the building of concrete roads which must be observed. In the first place they must be placed honestly as to the proportion of gravel, sand and cement; they must be "cured," that is, watered and allowed to stand for several weeks before being used; and they must be built under good weather conditions. When these features are complied with the concrete highway will generally last for many years without being touched.

"The Story of a Country Road" is the title of a booklet that Edward N. Hines, road commissioner of Wayne County, is distributing, and which explains clearly how the concrete road is made.

"We prepare and shape the subgrade, roll it hard with a 10-ton roller and lay the concrete right on the natural sub-soil," writes Mr. Hines. "Side rails are used and when the concrete has become sufficiently hard to remove the rail the finishers pare off the outer edges to prevent a sharp dividing line between the concrete and the gravel shoulders.

"Our trunk roads are built 16 feet wide with gravel shoulders four feet wide on each side. The lesser-travelled roads have 12 and 15 feet of concrete with a minimum width over-all of 24 feet. We have also built concrete roads from 10 to 18 feet wide. They are always wide enough to make passing of teams or automobiles going in the opposite or the same direction very easy.

"The concrete is put down wet so that no tamping is necessary after it is placed. When this is done no workman is permitted in anyway to disturb the concrete by stepping in it or throwing anything on it. Smoothing is done with simple wooden floats.

"Each day's work is finished up to an expansion joint and no more than 20 minutes is permitted to elapse between batches of concrete during the day. The work of the day is covered with canvass and the next day the canvass is removed and the concrete covered to a depth of about two inches with any sand or loose soil available to keep the concrete from drying too rapidly. The concrete is sprinkled continuously for eight days. Roads are not opened for traffic until at least two weeks after the last concrete is put in place.

"Machinery is used whenever the same or a better result can be secured and large hauling engines trail from two to four wagons each loaded with stone or gravel. Graders are also drawn by steam, doing the work of from 6 to 8 horses more efficiently and rapidly. Old roads are rooted up with a scarifier or plow. Water is pumped in pipes for miles by gasoline engines. Stone and sand on some of the roads is unloaded with a grab bucket and many smaller and economical labor-saving devices are employed. Cement is mixed in a mechanical batch mixer.

"The cost of the roads averages from $12,000 to $16,000 per mile, as Wayne County has to have all materials shipped in. It would be higher if it were not for our labor-saving devices. When far from the city the men are boarded and given cots in tented cities. We have nearly 1,100 employees, and politics cut no figure in the employment of them."

A NOTABLE PONTOON BRIDGE.

A wooden pontoon bridge to temporarily cross the Panama Canal at Paraiso, is briefly described in the Canal Record. The plans are based upon designs obtained from the Chicago, Milwaukee and St. Paul Railway, which has used pontoon bridges of this type for many years. One of the most notable of its bridges is that over the Mississippi River at Prairie du Chien, Wis., which has been in service 35 or 40 years. In the construction of the Canal pontoon bridge, a somewhat simpler design will be followed, consisting of a timber scow 55 feet wide, 378 feet long, and six feet deep. On top of this hull, a wooden trestle, following quite closely the ordinary type of construction, will be built to an elevation of about 113.5 feet, and on this will be placed a railroad track and a highway for vehicles. The spans will be 14 feet between centres, and at these points, a transverse wooden truss, with iron rods, will be placed in the hull to carry the concentrated loads. Lighter trusses, without rods, will be placed at 2-foot intervals between the heavier trusses. The sheathing on the hull will be four inches thick at the bottom and sides, and three inches on top. To minimize the bending and shearing stresses to which the structure will be subjected, the design includes two heavy stiffening trusses, the stringers under the rails being utilized as top chords, while the lower chords are placed at the bottom of the hull. In addition, there will be heavy longitudinal keelsons.

The bridge is designed for a train load of 4,000 pounds per running foot. In order to reduce the expense of the approaches as much as possible, it is proposed to use as a connection between the bridge and the shore some of the spare lock gate girders, supported on rockers. These rocking approaches will have a downward grade when the water is at a low level, and an upward grade when it is at a high level. The pontoon will turn about a fixed pivot, and to avoid its projecting into the fairway of the canal, a recess will be excavated in the east bank, so that when the bridge is opened, it will leave the canal channel unobstructed. About 600,000 feet B.M. of yellow pine, or fir, timber, and 375,000 pounds of steel and iron, will be required.

Mr. Harry Croswell, surveyor and prospector, after a visit to the Sibola Creek goldfields, B.C., gave it as his opinion that immense wealth in gold, copper, lead, iron and zinc lies buried in British Columbia awaiting the opening up of railways and other means of transportation to make it possible for prospectors and miners to penetrate to the heart of the province. At present owing to natural obstructions, it is impossible to reach the wild districts where these minerals undoubtedly abound.

DESIGN OF FOOTINGS IN REINFORCED CONCRETE.

By A. N. Worthington,
Trussed Concrete Steel Company, of Canada, Limited.

THE design of footings in a reinforced concrete building presents perhaps more unusual features and difficulties than does any other portion of the building. This is due to a great extent to the fact that very little satisfactory information may be obtained on the subject from texts.

The first step, of course, is the calculation of the column loads. Great care must be exercised in this particular, as unequal pressure on the soil from two adjacent columns will, in all probability, result in cracking of the beams and slabs.

Consider a building, say, five stories high. The load which will come on the wall column footing is usually about 70% dead load which is always present, and about 30% live load which is seldom all present; while the load on an interior column footing is about 40% dead load and 60% live load. From this it is readily seen that unless the above facts have been considered in the design, the load under average conditions is less per square foot on the interior footings than on the exterior footings.

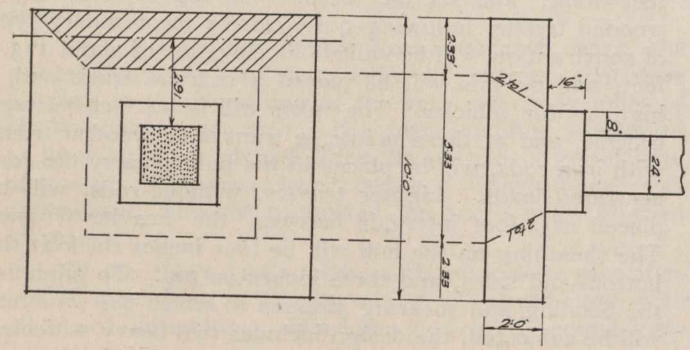


Fig. 1.

The practice of reducing the live load figured on the footing of a building over a certain height eliminates the above to some extent, though it would appear more logical to allow a greater live load reduction on the interior footings than on the exterior footings.

The principle underlying the design of a simple footing is that the portion inside the dotted lines which are at a 30-inch slope from the edge of the cap, in Fig. 1, are considered as self-supporting, and the portions outside these lines, i.e., the shaded portions in plan, are to be carried as cantilevers.

An example of the above is as follows:—

Allowable soil pressure = 4,000 lbs.; load on column = 400,000 lbs.; size of column = 24″ x 24″; size of cap = 3′ 4″ x 3′ 4″ x 16″.

$$\text{Required area of footing} = \frac{\text{load}}{\text{soil pressure}} = \frac{400{,}000}{4{,}000} =$$

100 sq. ft. = 10′ 0″ x 10′ 0″.

Total soil reaction represented by shaded portion:

$$(2.33 \times 2.33) + (2.33 \times 2.17) \times 4{,}000 = 17.5 \times 4{,}000.$$

Since this reaction is to be distributed over 5.17 ft., the reaction per ft. width $= \frac{17.5 \times 4{,}000 \text{ lbs.}}{5.17}$. Then area of steel required

$$= \frac{17.5 \times 4{,}000}{5.17} \times \frac{2.91 \times 12}{.86 \times 16{,}000 \times 22}$$

= 1.54 sq. ins.

In the case where the edge of a building extends to the lot line, and it is not permissible to encroach on the neighboring property, it is seen that the load on the footings would be of an eccentric nature which would cause the footing to have an overturning tendency and throw tension into the outer face of the column. This may be

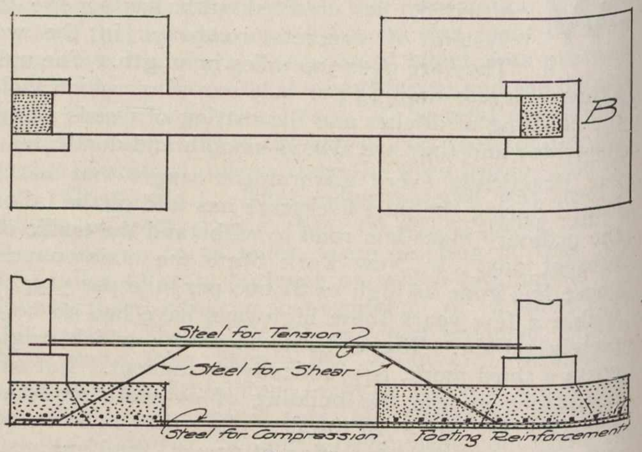


Fig. 2.

overcome by tying the wall column footing to an interior column footing by means of a wide concrete beam. Another method of accomplishing this, of course, would be to employ a raft footing spanning the entire length of the building along the walls. The former, however, is, under average loads, better engineering practice and more economical, and the writer will endeavor to illustrate briefly the designing of a footing by this method.

In the plan and section shown in Fig. 2, as previously assumed in simple footings, the portions inside the dotted lines are self-sustaining and the remaining portions are carried as cantilevers. The load which the beam will sustain will be the sum of the areas of these cantilevered portions and the area of the beams multiplied by the allowable soil pressure.

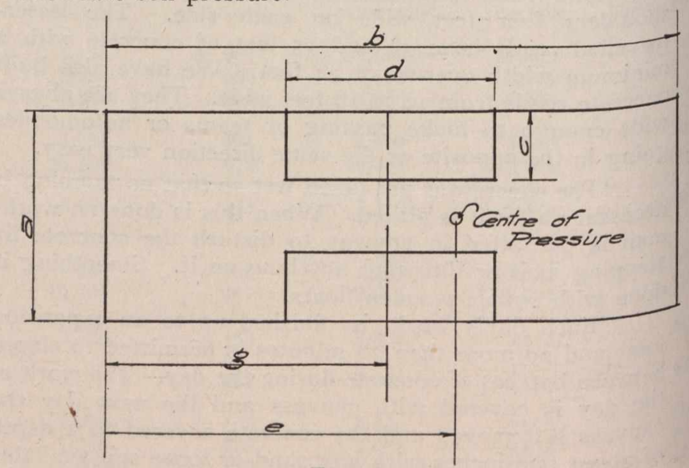


Fig. 3.

The most important adjustment to be made in the design is to have the centre of pressure of the column loads passing through the centre of gravity of the areas supporting them. If these areas do not coincide, the soil will settle on the side which is most heavily loaded, which condition may result in cracking the beams and slabs in the floors above, if not in failure.

A complete design of a footing of this type would be as follows: Let us consider a building in which the columns are spaced 24′ 0″, centre to centre. The load on the wall column "A" is 267,500 lbs., and on the interior column "B" is 504,000 lbs. Distance of centre of pressure from line x-x (Fig. 2)

$$= \frac{\text{moment of loads about x-x}}{\text{sum of loads}}$$

$$= \frac{(504{,}000 \times 24) + (267{,}500 \times 0)}{771{,}500} = 15.679 \text{ ft.}$$

To distribute the area so that the centre of gravity of the area corresponds with the centre of pressure of loads, we will assume a rectangle, a b, with two pieces, c d, deducted from it in such a way that the above condition holds.

Let area required to resist load at given soil pressure = P sq. ft.

Therefore P = a b — 2 c d

$$C = \frac{P + a\,b}{2\,d}$$

$$\text{Moment of whole rectangle (Fig. 3)} = \frac{a\,b^2}{2}$$

Moment of portion to be deducted = 2 c d y

Moment of adjusted portion = (a b — 2 c d) × e

$$\text{Therefore } (a\,b - 2\,c\,d) \times e = \frac{a\,b^2}{2} - 2\,c\,d\,y$$

$$Y = \frac{\frac{a\,b^2}{2} - (a\,b - 2\,c\,d) \times e}{2\,c\,d}$$

By using these formulæ we would proceed as follows:

Total load = 711,500 lbs.

Area required to resist this load with allowable soil pressure of 4,000 lbs. = 192.875 sq. ft.

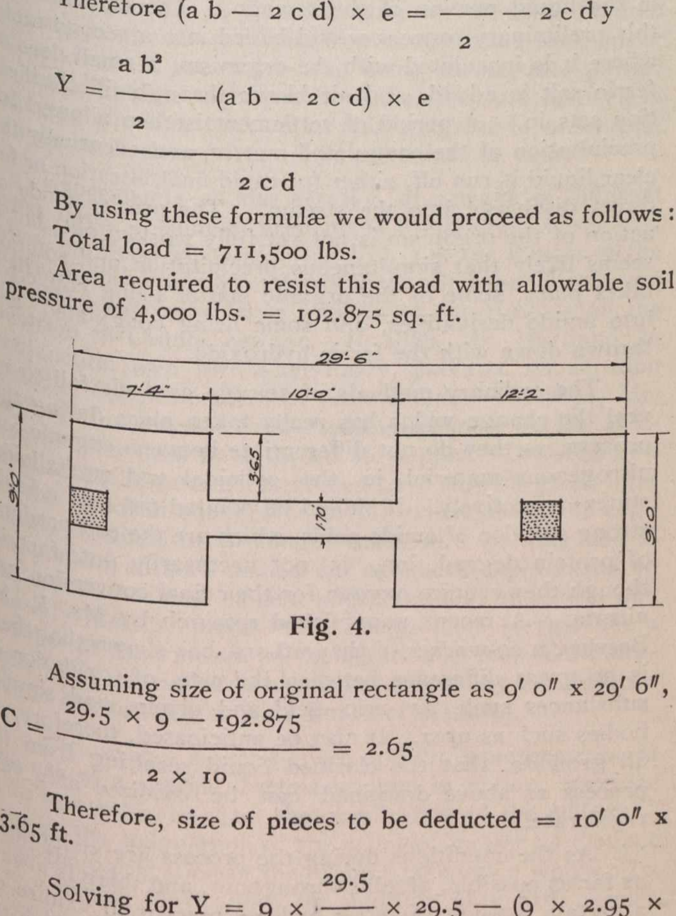


Fig. 4.

Assuming size of original rectangle as 9′ 0″ x 29′ 6″,

$$C = \frac{29.5 \times 9 - 192.875}{2 \times 10} = 2.65$$

Therefore, size of pieces to be deducted = 10′ 0″ x 3.65 ft.

$$\text{Solving for } Y = \frac{9 \times \frac{29.5}{2} \times 29.5 - (9 \times 2.95 \times 15.69)}{2 \times 10 \times 3.65}$$

$$\frac{15677 - 20 \times 3.65 \times 15.69)}{} = \frac{3920 - (4160 - 1142)}{73} =$$

12.3 ft.

With this information we may now design the shape of the footing. (See Fig. 4.)

The depth of the footing is governed by the shear along the line c—c— and is equal per foot to the area of a strip one foot wide and 3.65 feet long multiplied by the soil pressure = 14,600 lbs.

Safe resisting value of concrete to shear = 60 lbs.

Therefore, resisting shear = 60 lbs. × 22 × 12 = 15,840 lbs.

Therefore the assumed thickness of 24″ is correct.

The area of steel in the footings is found in a way similar to that used previously in simple footings. The reinforcement is placed in one direction only in footing "A" and that at right angles to the beam and both ways in footing "B."

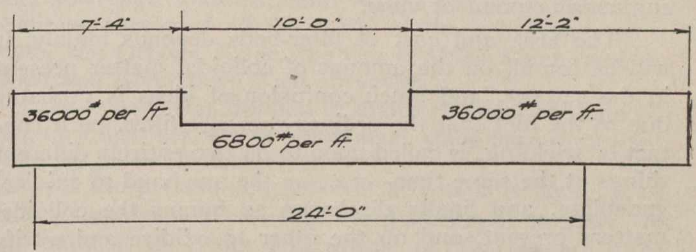


Fig. 5.

In the design of the beam, we have to consider the loading, as shown in the diagram (Fig. 5), found by the method already described. The span of the beam is figured as 24′ 0″.

$$\text{Let reaction} = \frac{36000 \times 7 \times 18.12}{24} = 190{,}000 \text{ pds.}$$

$$\frac{6800 \times 10}{2} = 34{,}000 \text{ pds.}$$

$$\frac{36000 \times 6.08 \times 300}{24} = 27{,}750 \text{ pds.}$$

Total = 251,750 pds.

Maximum bending moment will occur at centre of span and = (25175 × 12) — (36000 × 7.3 × 8.66) + $(6800 \times 5 \times \frac{5}{2}) = 833{,}000$ foot-pounds.

$$\text{Area of steel} = \frac{833000 \times 12}{.86 \times 160 \times 46} - 15.72 \text{ sq. in.}$$

This result is the area of steel required for the entire width of beam.

Therefore, area required per foot of width = $\frac{15.72}{1.7} = 9.25$ sq. in.

As the available depth of concrete will not develop this steel in compression it will be necessary to place additional steel in the compressive side of the beam.

The above is only one of a number of ways of arriving at these results and, as mentioned previously, only one of a number of accomplishing the desired end. It may, however, be stated in conclusion that the type of footing designed by this method has been recently employed in numerous buildings with unvarying success.

PURIFICATION OF SEWAGE EFFLUENT.

By Gilbert J. Fowler and E. Moore Mumford.

IT will hardly be disputed that the most costly part of a modern sewage works, certainly in capital expenditure and often in revenue charges, is the filtration area. Just as the difficulty of land treatment of the sewage of large cities forced on the consideration of more compact processes, so these in their turn are becoming impracticable when great centres of population have to be considered. This conclusion was impressed upon the senior author of this paper when called upon recently to report on the proposals of the Metropolitan Sewerage Commission of New York for the disposal of the sewage of that city. This conclusion was shared by his colleague, Mr. J. D. Watson, who reported simultaneously from an engineering point of view.

The area and cost of filter-beds depends mainly, it will be found, on the amount of colloidal matter present in the sewage, and much confusion of ideas is probably due to the fact that the ordinary sewage filter, be it contact or trickling, is called upon to do two entirely different things at the same time—viz., on the one hand to oxidize, granulate, and finally discharge as humus the colloidal matters present, and on the other to oxidize and nitrify substances in true solution.

A very open grade deep filter is best suited for the first purpose, a shallow fine-grained filter is the most economical for the second. It is true that a tank effluent well clarified by sedimentation can, by accurate distribution, be very efficiently purified on filters of fine material, but even then the area and cost involved when exceptionally large works are under consideration make the problem a very serious one. For these and other reasons the thoughts of many workers in sewage treatment have been turned to the possibility of more efficient removal of colloidal matter before the filtration process.

Hitherto almost the only practical method has been heavy chemical precipitation. The cost and difficulty of this process when really efficiently carried out (and it should be emphasized that a mere perfunctory addition of a few grains per gallon of precipitant is money thrown away) become very great as the volume of sewage increases. Not only are enormous quantities of chemicals necessary, but the disposal of the vast volume of resultant sludge, without menace in some way to the community, becomes increasingly difficult and costly.

The thought which has been in the minds of the authors of the present paper has been to find a method of obtaining a thoroughly clarified effluent without the use of large quantities of chemicals and with the minimum production of sludge. By a thoroughly clarified effluent is meant one which will not eventually deposit solid matter either on the bottom of a stream into which it flows or in the interstices of a bacterial filter. It is clear that in a sewage filter a combined oxidation and coagulation of the colloidal matter must go on, resulting in the production of the so-called residual humus, which either is collected in humus tanks or is periodically washed out of the medium. If this oxidizing and coagulating process could be brought about by suitable open-tank treatment before the filtration process, it is obvious that the latter could be enormously accelerated, if not dispensed with altogether, and the whole operation of sewage treatment could be conducted on a much smaller area.

In the course of a research on another matter, one of the authors had occasion to study the reactions of an organism occurring in nature in pit water impregnated with iron. This organism is a true facultative organism, preferably an aërobe, and exercises a specific action on iron solutions.

The action of the bacillus on iron solutions proceeds in two stages, in which the aërobic and anaërobic actions appear to be symbiotic, at any rate under the conditions occurring in nature. The aërobic action is to precipitate ferric hydroxide from iron solutions, while the anaërobic action is to transform the hydroxide thus precipitated into bog ore, with partial reduction of the iron to a ferrus state. It was found that in order to precipitate the iron sufficiently the organism required a certain proportion of albuminoid organic matter. It was therefore natural to expect that ordinary sewage matter could be utilized in this way. Experiment, in fact, showed that a sewage effluent could be effectively clarified in this way when acted upon by this organism in presence of small quantities of ferric salts, aërobic conditions being maintained in the liquid by means of a current of air.

The process, therefore, by which it is proposed to clarify sewage is, in the first place, to remove the grosser solids, either in a plain sedimentation tank, an Emscher tank, or a Dibdin slate bed, in such a manner, i.e., as shall give rise to the least amount of putrefactive change in the liquid portion of the sewage. The effluent from this preliminary process would be led into a second tank, where it is inoculated with the organism, a small dose of ferric salt is added, and air blown through till clarification sets in. A period of settlement is then allowed for precipitation of the coagulated matter, and eventually the clear liquid is run off, either for rapid final filtration or for direct discharge into the stream. The precise mode of action of the organism is not yet fully worked out, but it seems likely that simultaneous precipitation and solution takes place, some of the organic matter being converted into amido derivatives, and some being coagulated and thrown down with the ferric hydroxide.

The ordinary methods of sewage analysis fail to reveal the change which has really taken place during this process, as they do not differentiate between organic and nitrogenous material in the colloidal and crystalloidal states respectively. It should be pointed out that a fairly strong solution of amido acids, which are the end products of protein degradation, is not necessarily putrefactive, though they require oxygen for their final conversion into nitrate. A recent unpublished research by Mr. R. M. Beesley, a co-worker of the authors, has shown that there is no great difference between the rate of oxidation of substances such as uric acid and glycin, and simpler bodies such as urea. It may be anticipated, therefore, on all grounds, that the clarified liquid resulting from the process as above described can be oxidized at a very rapid rate.

As the conditions during the process are maintained, as far as possible, aërobic throughout, and there is always a certain amount of ferric hydrate present to oxidize offensive sulphur compounds, it is not anticipated that the aëration can give rise to nuisance, and none has been observed in laboratory trials where these conditions have been fulfilled. Experiments in the laboratory with quantities up to four litres have shown that it is possible to clarify a strong fæcal emulsion in this way.

* From a paper read at the Exeter (England) Congress of the Royal Sanitary Institute.

A limpid, sparkling and non-putrefactive effluent was obtained from domestic sewage drawn from a sewer near the laboratory. Ordinary tank effluent from the Manchester Corporation sewage works at Davyhulme has been rendered non-putrefactive on incubation. So far only approximate estimates can be given of the amount of iron salt required and the duration of the blowing process. Experiments would indicate that 1 grain of iron-salt per gallon is the maximum need, and that a total of twelve hours' tankage—i.e., six hours' aëration and six hours' settlement—will be sufficient.

As regards the inoculation of the organism, once the growth has been established in a tank there appears to be no difficulty in maintaining it. The fact that large bodies of water in the old colliery workings at Worsley, near Manchester, are teeming with the organism, is sufficient evidence of its vitality. An experimental plant has been erected at the University of Manchester which will permit of accurate observations of this process to be made, and sufficient data to be collected to serve as a basis for work on the larger scale. It is already evident that the conditioning factor is the cost of an air blast; the pressure of air will, of course, depend simply on the depth of water to be blown through, and a number of engineering conditions will naturally affect this part of the problem.

It is reasonable to suggest that much of the power required could be obtained on the one hand from gas collected from the fermentation of the main bulk of the sewage solids, either in Emscher tanks or by some kindred process, or the fall available from the aërating tank might often admit of the water-head being turned into power. In any event the authors believe that they are justified in bringing the idea forward at this congress in order that it may be discussed from different points of view.

Experiments on the aëration of sewage in different ways have, of course, been made by different observers. Dr. Dupré and Mr. Dibdin, in Vol. 2 of the Report to the Royal Commission on Metropolitan Sewage Discharge, in 1884, describe a large number of experiments on the aëration of London sewage. In 1888, Mr. Hartland, in conjunction with Mr. Kaye-Parry, patented an aëration chamber for purification of tank effluent. In 1892, Mr. Sydney R. Lowcock conducted experiments on the aëration of filter-beds by a forced air supply. Dr. Adeney's long series of careful researches have thrown great light on the chemical changes occurring when sewage is completely oxidized by prolonged aëration. In 1897 one of the present authors carried out extensive experiments on the aëration of tank effluent under various conditions, and recently Messrs. Black and Phelps have carried out a number of experiments on the aëration of New York sewage, while the subject is also being studied by the chemists of the Massachusetts State Board of Health.

The advance claimed in the present communication is the use of a specific organism found in nature, together with iron salts, to effect the clarification of the effluent—that is, the coagulation of the colloidal matter as distinct from the purification of the effluent taken as a whole. To use a simple illustration, the addition of a little rennet does not appreciably alter the composition of milk as a whole, but separates it into a solid and liquid portion. The endeavor of the authors has been to obtain a similar result in the case of a sewage tank effluent; to collect the precipitated colloids, and purify the liquid portions by high-speed filters, or it may be in large tanks stocked with suitable aquatic plants.

PUBLIC HEALTH MEASURES IN QUEBEC.

Public health legislation in the Province of Quebec began in the reign of Louis XVI., when Canada was still under the French regime. The system has been steadily extending since Canada passed under English domination in 1795, until the present decade, which has witnessed a marked spread of recognition and power.

The provincial by-laws concerning municipalities, establish a standard which all municipalities have to obey, but in no way prevents them from making municipal regulations, which would be more adapted to their needs, provided that, in the opinion of the Provincial Board of Health, such municipal regulations are at least equivalent to the provincial provisions.

In October, 1909, the Board organized a sanitary engineering division, which took charge of waterworks and sewerage systems, and which makes a systematic sanitary survey of all the rivers of the province. Up to date, the Ottawa River, the des Prairies River, and the Richelieu River have been surveyed.

In 1910 it was decided to divide the province into ten sanitary districts, six of which have since been organized, with an inspector located in each.

At the present time careful attention is being given to the important question of the pollution of streams. As so many of the cities and towns of Quebec are using these streams to supply the citizens with the water necessary for drinking and domestic purposes, it is regarded by the Provincial Board of Health as absolutely imperative that proper legislation be enacted to prevent streams being polluted to such a degree that it might increase unfairly the burden of the municipalities which have to go to these streams for their supply of water.

TUNGSTEN.

The tungsten bearing mineral scheelite has been found at a number of localities in Canada, but the only place at which it has been worked commercially is at Scheelite Mines, Moose River district, N.S., according to report by J. McLeish, in Economic Minerals and Mining Industries of Canada. Here it occurs in quartz veins cutting the quartzites and slates of the gold bearing series. The quartz veins also carry mispickel and several other minerals but are not gold bearing. A mill has been erected and about 15 tons of concentrated ore (72 per cent. sheelite) have already been shipped. Sheelite also occurs in the Malaga gold mining district, Halifax county, while at one locality near South East Margaree in Inverness county, C.B., from 300 to 500 lbs. of hübnerite (Fe, Mn) WO_4 were recovered from a large detached mass of quartz. The mineral has also been noted at New Ross, in Lunenburg county, and at Perry Lake, West Waverley, Halifax county, N.S.

In the province of Quebec, scheelite has been found in Beauce county, in a quartz vein traversing Pre-Cambrian rocks, while in Ontario it is found occurring in small nodular masses in parts of the veins around Pearl Lake, Porcupine gold mining district.

In British Columbia its occurrence has been noted in quartz veins on the Meteor claim, Slocan City mining division, West Kootenay, and also in the Cariboo district at Hardscrabble creek where the scheelite appears to be very irregularly distributed in the country rock.

In the Yukon territory at Dublin gulch, scheelite is encountered in small water worn nodules of yellowish color, which are caught in the sluice boxes at Highet Creek.

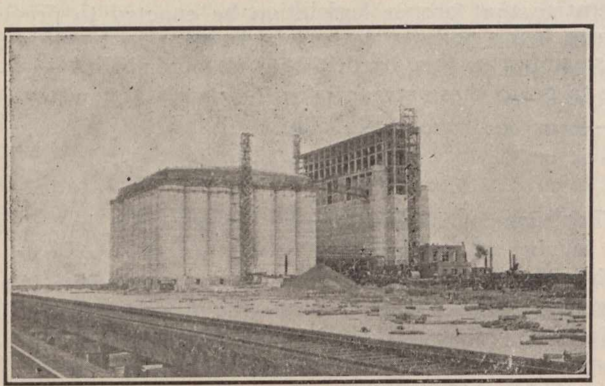
The mineral is employed in the steel manufacturing industry making a tungsten steel of high tensile strength.

GOVERNMENT ELEVATOR AT PORT ARTHUR.

THE construction of the Dominion Government grain elevator at Port Arthur has reached the final stages and the structure is just being put into commission. The machinery is practically all installed and the high potential power line into the plant is almost completed. Tracks have been laid to give the Canadian Pacific and Canadian Northern access to the elevator and arrangements will shortly be made to give the Grand Trunk Pacific Railway a similar connection.

The elevator is of reinforced concrete construction throughout, except that in the walls of the working house brick panelling is used in a skeleton of reinforced concrete. This latter construction was used to facilitate rapid erection of the house, and adds to its appearance as well. No inflammable material is included in either building or machinery.

The elevator will be operated by electric power throughout, and a separate motor has been installed for each machine. Twenty cars can be unloaded simultaneously, the unloading capacity of the house being about forty cars per hour. An interlocking device connecting the valves of the car hoppers prevents any possibility of mixing the contents of one car with those of another. The normal loading capacity to boats will be about 75,000 bushels per hour, but for the first hour this can be increased to 115,000 bushels.



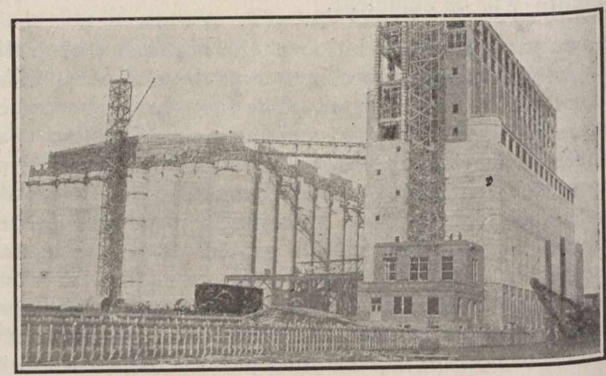
The Government Elevator at Port Arthur in Course of Erection.

The working house towers to a height of 185 feet above the water level. It contains seventy-five circular bins of about 7,000 bushels capacity each, fifty-six interspace bins of 3,000 bushels and thirty-six outer-space bins of 1,500 bushels capacity each. Its total capacity is about 750,000 bushels. The storage house has seventy circular bins, each 24 feet in diameter and ninety feet in height of 30,000 bushels capacity, together with fifty-four interspaces of about 8,000 bushels capacity each. The total capacity of the elevator is 3,250,000 bushels. In designing the elevator especial provision was made for a large number of bins of small capacity for storing small lots of grain that may require separate binning.

The working house is equipped with ten hopper scales of 2,000 bushels capacity, with a garner of equal capacity over each scale. The elevator legs are as follows: five for receiving, five for shipping, five for cleaning, one for screenings, one for drying, one for oats, and two for flax. Fifteen sets of receiving cleaners are provided for cleaning oats, wheat and barley, and fifteen additional cleaners can be installed when they are needed. Special machines are also installed for separating oats from wheat, in addition to two screenings separators and two flax separators.

At the south end of the working house a drying plant is installed in a separate building. This has a capacity of 48,000 bushels per day, and is for drying damp, tough or wet grain, and putting such grain in condition for storage.

A revetment wall is being built around three sides of the site, which contains about 32½ acres. The site was formerly covered by water, but is now being filled in level



Another View of the Structure.

with the top of the revetment wall. A slip 1,200 feet long will provide ample space for the largest lake boats alongside the working house. Four lines of railroad tracks extend through the house and beyond it for a distance of 800 feet, so that eighty cars can be spotted at one time, and taken into the house by the car pullers. Provision has been made for increasing the capacity of the elevator to a total of ten million bushels, should additional capacity be required, and the site affords ample space for increasing this capacity still further.

The production of peat in 1912 in Canada given in Mr. McLeish's report on Economic Minerals and Mining Industries was 700 tons, and was valued at $2,900.

The total production of pig-iron in Canada in 1912 was 1,014,587 short tons and of steel ingots and castings 957,681 short tons. That the domestic production is insufficient to meet home demands is indicated by the large imports which in 1912 exceeded 1,300,000 tons of pig-iron, ingots, blooms, etc., plates, bars and rods, structural steel, rails, pipe, nails, wire forgings, castings, etc. The opportunity in so far as the market is concerned for the development of Canadian iron resources is evident.

The Eighth Annual Convention of the Federation of Trade Press Association in the United States will be held at the Hotel Astor in New York, September 18th, 19th and 20th. It is expected that a great majority of the technical and trade journals in Canada will be represented. Relative to journalism of this nature, it is stated that the capital invested in trade journals in the United States has been estimated at not less than $50,000,000, and that the Federal papers represent a capital investment of more than $35,000,000. The Federation was organized in 1906. At the start it concerned itself chiefly with press problems, but in later years more consideration has been given to ways and means of promoting best interests of the trade press in many other directions. Managers, manufacturers and advertising men interested in the idea of business promotion through trade press efficiency, which are to be featured at the coming Convention, should consider well the invitation to attend, as there will be papers and addresses to all these, as well as to paper and book publishers.

WATERWAY STRUCTURES.*

By A. R. Hirst,
State Highway Engineer of Wisconsin.

Among the most important considerations affecting the construction of public roads is that of drainage. The life of every road structure depends upon the drainage given it, and the culverts and bridges necessary must be built not only to serve the purpose of drainage, but must serve also the convenience and safety of travel. The failure of a road results only in the additional expence necessary to replace it in proper condition, but the failure of a bridge results also in the suspension of travel, and if it occurs at the wrong moment, may cause considerable loss of property and possibly injury or death to those travelling the road.

For many years both the design and erection of highway bridges was practically entirely in the hands of the steel bridge companies, who used their opportunity to the utmost, an decorated the landscape with structures which had little to commend them except the fat prices they brought from an unknowing public.

Within the last few years, however, many States have created highway commissions which have effectually taken up the problem of bridge design, and a considerable change for the better has occurred, both in the strength of bridge superstructures and in the foundations, more especially in the latter, which was the place where most of the older structures were especially deficient, if one point of weakness can be selected from the mass of general ineffectiveness.

A properly designed waterway structure should fulfil the following requirements:—

1. Waterway sufficient to carry off promptly the water coming to it.

2. Proper foundations to bear the loads, resist undermining, and give long service.

3. Superstructure designed to bear for a long period of years any load which may legally be imposed upon it.

4. Superstructure wide enough and so constructed as to serve the comfort and convenience of travel.

5. Economy of maintenance.

A sixth factor, that of æsthetic design and fitness of the structure to the surroundings, has been and is little considered in bridge and culvert design, but will probably be demanded more and more as public appreciation of the value of pleasing design grows.

In the short compass of this paper we cannot enter into a discussion of bridge design, or give any details of any specific type of structure. We will, however, give some account of the standard practice in the State highway work in Wisconsin, and probably this will be sufficient evidence as to what constitutes a proper waterway structure.

Wisconsin is a State-aid State, and gives State aid to bridges and culverts, as well as to road construction. All waterway structures 6 feet and under in span are classed as culverts, and are built out of the funds available for the construction of the road. All waterways structures over 6 feet in span are considered as bridges, and must be provided for by separate appropriations, the State paying 20 per cent. of their cost instead of 33 1-3 per cent. as in the case of culverts on roads.

Wisconsin has a drastic bridge law, which provides that culverts under 18 in. in span must be so constructed or reconstructed as to stand without planking a load of 18 tons, and waterway structures over this span must be designed, "in accordance with standard engineering practice," to stand a load of 15 tons without planking.

In addition to the duty of designing all State-aid bridges and culverts, the State Highway Commission has imposed upon it by law the duty of approving as to their safety and engineering sufficiency the plans of all bridges constructed with county aid. In the seven seasons of the existence of the Wisconsin Highway Commission and its predecessor in highway work, the Wisconsin Geological and Natural History Survey, we have designed about 1,000 highway bridges of a span exceeding 10 feet for counties, and about 400 bridges exceeding 6 feet in span, and innumerable culverts under this span for the State-aid construction. In addition to this, we have approved the plans for probably 500 bridges not designed by our engineers, but simply checked as to engineering sufficiency. Actual culvert and bridge construction under our own designs has cost about $2,000,000.

We may roughly divide our bridge superstructures into five classes as follows:—

Class 1.—*Spans from 18 inches to 10 feet.*—Almost invariably constructed of reinforced concrete of the slab type. We are building even the smallest culverts of reinforced concrete, as we find in Wisconsin that they are entirely serviceable, easily constructed, and in probably 50 per cent. of the cases cost less than any other type of culvert except wood, which is not allowed on any of our work. The smallest concrete structure we are now building is 18 in. x 12 in., as we have found the smaller sizes equally as expensive and very easily blocked with ice and debris.

In some cases where the foundation conditions are extraordinarily soft and difficult, or concrete materials are not reasonably available, we use culverts of corrugated metal with concrete or stone end walls, but such culverts are used only where it is impracticable to use concrete, and probably not 1 per cent. of our culverts are now built of this material. Vitrified clay is not used at all on State-aid work, as they have been found almost invariably to crack by filling and freezing. Concrete pipes moulded in place and afterwards moved to the job are not used for the same reason. Under conditions favorable to their use, both make excellent culvert, and we could recommend them in less severe climates. Cast-iron water pipe has not been used on account of its cost, which invariably exceeds that of concrete.

We find in the small concrete culverts from 18 inches to 10 feet the average cost per cubic yard complete, including the excavation and back-filling, is about $8.00, and very seldom runs above $10.00 per cubic yard; sometimes as low as $6.00.

Class 2.—*Spans 10 feet to 40 feet.*—Either reinforced concrete, the slab type up to 18 feet and the through girder type up to 40 feet, or I-beam structures with concrete floors are used. We are building many true reinforced concrete bridges, but with public lettings open to any bidder, the workmanship and finished appearance has been so poor in many cases that we are using more I-beam structures than we otherwise would. In the case of I-beams, a five-inch concrete floor is placed on top of the I-beams, and the corrugated arch type of support for the concrete between the I-beams is but seldom used.

Class 3.—*Spans from 40 to 80 feet.*—We are using the Warren riveted pony truss practically exclusively, though a few plate girders are being used where the conditions of hauling are favorable. All of these structures have concrete floors.

* Read at American Road Congress, held at Detroit, Mich., September 29th to October 4th, 1913.

Class 4.—*Spans from 80 to 135 feet.*—We use the riveted Pratt high truss with a horizontal top chord, also with a reinforced concrete floor.

Class 5.—*Spans over 135 feet.*—We use a Pratt riveted high truss with a curved top chord. Practically all of these larger spans are also built with a reinforced concrete floor. Very seldom do we use a pin connected truss, either for Class 4 or 5, probably not once in twenty-five cases.

From our cost figures on all bridges so far constructed, we find that for any span the price erected (including substructure and superstructure) figures out very closely to $40 per linear foot of the over-all span. Reinforced concrete floors average about 20 cents per square foot. Steel in plate girder and truss spans averages from $25 to $70 a ton erected, and I-beam spans figure from $50 to $60 a ton erected.

Widths of Structures.—We have adopted for widths for concrete culverts and bridges the standards recommended by the Association of State Highway Department, which are as follows:—

First Class Roads.

Culverts under 12 ft. span, minimum width	24 ft.
Slab bridges over 12 ft. span, minimum width	20 ft.
All other concrete spans, minimum width..	20 ft.
Very long bridges less if necessary.	

Second Class Roads.

Culverts less than 12 ft. span, minimum width	20 ft.
Slab bridges over 12 ft. span, minimum width	18 ft.
All other concrete bridges, minimum width.	18 ft.

Third Class Roads.

Culverts less than 12 ft. span, minimum width	20 ft.
Slab bridges over 12 ft. span, minimum width	18 ft.
Longer bridges may be, minimum width....	16 ft.

Steel bridges are built almost invariably with a 16-ft. roadway; that is, 16 ft. clear distance between trusses or rails, no matter what the class of road, although for spans under 80 ft. some 18-ft clear roadways have been built.

Abutments under practically all structures are plain concrete, as with concrete materials as cheap as we have them in Wisconsin, and with the difficulty of getting first-class workmanship in reinforced concrete foundations without constant inspection, we find that this is the cheapest type of abutment. Occasionally cement rubble masonry abutments are used, and once in many times driven steel I-beam piles surrounded by a concrete wall are used. The last type of abutment has been found to be very satisfactory and economical for high abutments on sandy bottoms, and has largely displaced the use of cylinders with steel backing. Steel backing is not allowed on any State-aid structure. The price of concrete in bridge abutments and piers averaged last year about $8.00 per cubic yard.

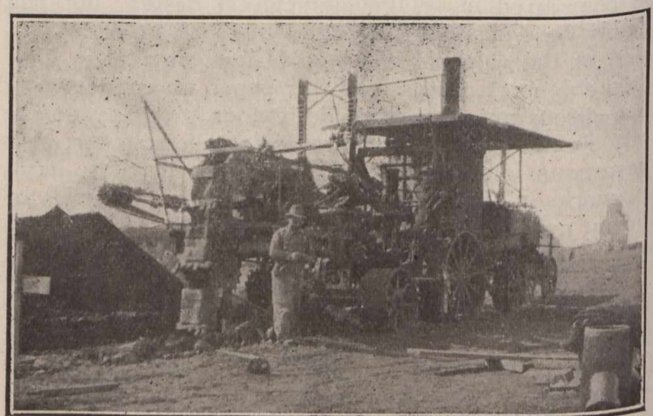
A large share of the trouble with bridge structures results from improperly designed foundations. A common fault is stopping work before a proper depth below stream bed is reached. Seldom should foundations extend less than four feet below stream bed, and whenever doubt as to the bearing power of the soil at that point is entertained, or as to undermining from a rapid stream, they should be carried down to solid soil or thoroughly piled. All foundation work should be inspected as the excavation is made and material is placed, not necessarily by an engineer, but at least by an honest man with good judgment and backbone. All concrete work in any part of the structure should be inspected as it is placed. Inspection of steel and workmanship on it as it is erected is not so necessary, as it can be inspected and its compliance with the specifications determined after erection at the time acceptance is to be given.

As to methods of letting the work. We have found it necessary to have open competition and sealed bids on bridge work, and by asking for mailed bids on all work have established true competition, and have to a very large extent broken up the old system of "pooling," and combinations of the bridge agents who may be on the ground at the letting. We furnish complete plans for foundations and for reinforced concrete, I-beam and plate girder spans, and all bidders submit prices on our uniform plans. For truss spans, we furnish the truss diagram showing the stresses in the truss members and the make-up of the truss members, floor system, and principal connections, and the successful bidder submits for approval the shop drawings before fabrication is commenced. For trusses, we believe the latter system is preferable to that of furnishing complete shop drawings, as it allows manufacturers to follow their standard shop practice in detailing so long as these details are satisfactory.

The proper design for culverts and bridges is an engineering problem which should always be left to engineers. Probably a State highway department can handle it more economically than can private engineers, as so many bridges will be built of one span that superstructure plans can be standardized, and even the same foundation plan may fit several bridges. The cost of designing, letting and accepting bridges in Wisconsin has averaged about 3½ per cent. of the total cost. Inspection has been paid for separately by the local units. It would probably be better to have a State inspector on each bridge, but we have gotten very good results through local inspection at probably 25 per cent. of the cost of placing a man on each job. Important jobs should have a skilled inspector by all means.

MODERN DITCH DIGGING.

Machines are rapidly supplanting manual labor in digging trenches for water mains, sewers, irrigation, etc. The illustration below, which was made from a photograph taken by Willis Chipman, C.E., of Toronto, shows one of many dif-



ferent types of modern trench diggers. These machines have been especially successful in Western Canada, but are gradually coming into great favor in the East, also, for all large contracts where the material to be excavated does not contain too much stone of large size. Among the many types of these machines, the best known in Canada are the Parsons, the Austin, the Harris, the Monahan, the Potter, and the Carson excavators.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MINING, MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

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Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (17s).	$1.00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

JAMES J. SALMOND—MANAGING DIRECTOR.
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A. E. JENNINGS, BUSINESS MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont.
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Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.
Winnipeg Office: Room 820, Union Bank Building. Phone Main 2914. G. W. Goodall, Western Manager.

Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor.
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910

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Printed at the Office of the Monetary Times Printing Company, Limited, Toronto, Canada.

Vol. 25. TORONTO, CANADA, OCT. 9, 1913. No. 15

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STREAM FLOW IN SEWAGE DISPOSAL.

On another page reference is made to a recent publication of the Royal Commission on Sewage Disposal, which body, acting under the direction of the British Government, has attempted to present standards of purity of sewage effluents and streams to serve as a guidance in the installation of sewage treatment plants and the disposal of sewage by dilution. These standards are not definitely fixed and may be varied at the discretion of a central authority.

In America no concerted effort has been made to establish standards to regulate the use of streams and lakes as receptacles for sewage and sewage effluents, although various fundamental principles have been suggested, based largely upon observations of existing conditions. For instance, it has been determined by various investigators that untreated sewage must receive a dilution of from 3.5 to 6 cubic feet per second per thousand persons tributary to avoid objectionable conditions. Another authority has tentatively suggested a formula to determine the safety of discharging sewage into streams used for water supply purposes, and various other ill-defined standards have been suggested.

While commenting upon the standardization of dilution of sewage, the Ohio State Board of Health recently expressed the hope that provision would be made at an early date whereby an accurate and comprehensive knowledge of the streams of that State might be made available. The same applies generally to Canada, and particularly to the Province of Ontario.

The fundamental factor which is required in the application of any standard is the volume of flow of the stream considered. Little is known of the actual flow of streams in this country, although the Hydro-Electric Power Commission has been carefully accumulating data for several years, in connection with power investigation. The United States Government has attempted to obtain this very important information for sewage disposal purposes, in addition to similar statistics which have been collected with respect to power development during the past half century. In the proper consideration of problems attending the disposal of sewage, such a knowledge of the flow of streams is absolutely necessary.

Ontario's sewerage problem is one that cannot be satisfactorily solved by the application of systems such as have been evolved for the disposal of dangerous effluents in European cities. Although the standard of purity attained in Birmingham, England, and in Essen, Germany, is for the world to admire, the cities bordering upon Ontario waters have entirely different conditions to meet, and such systems, although the most scientific that have yet been developed for the handling of sewage, would be quite inefficient here. One reason for this is that the water of our rivers and lakes is restricted and is not subject to the beneficial influence of tides.

Not a few Canadian cities are taking chances in the matter of water supply, because of the effluents from their own or neighboring sewers, and as the seasons come and go these effluents assume greater proportions, Nature being expected to extend her purifying agencies to an ever-increasing degree. It is to be hoped that the study which the provincial departments of public health are making will bring forward many requisitions in this matter, tending toward greater care and safety.

Disposal by dilution should be carried out only under scientific methods. Absolute surety of a generous factor of safety is essential for healthful and wholesome water. The sentiment that is associated with the question of water supply should not be entirely disregarded, either.

And, science in the matter of disposal by dilution must have, as a basis, an accurate and comprehensive knowledge of stream flow. When Canada has acquired this necessity, to it may be applied certain safe and standard rules governing the degree of purity which an effluent must possess before its entrance into our streams and lakes should be permitted.

CANADIAN OIL RESOURCES.

It is said that the British Admiralty is endeavoring to ascertain the extent of oil deposits within the Empire, with a view to securing requisite supplies for naval purposes. It is also stated that from present knowledge of Imperial oil lands, the supply will be derived mainly from shale rather than from wells yielding liquid petroleum.

At the present moment interest is centred upon the enormous deposits of oil shale which are known to exist in Albert county, New Brunswick. These deposits have been known to exist for a long time, though they have not been worked hitherto on any large scale. Now, however, these shales appear to have become of inestimable value, capable of yielding from 27 to 48½ gallons of fuel oil per ton of shale. The reports of English experts, as well as those made by the Geological Survey of Canada, show that, without doubt, there are between 200,000,000 tons and 300,000,000 tons of shale in one section alone of the Albert fields; so that a calculation on the basis of 40 gallons per ton means a supply of fuel oil of 10,000,000,000 gallons, or 40,000,000 tons. Another important point about the shales of New Brunswick, also, is that they are very easily and economically worked, and it is estimated that fuel oil derived from these can be supplied at a very low rate, in consequence of the fact that the oil shale may be obtained by open pit mining. By this means it is stated to be possible to provide 2,000 tons per day for over one hundred years. Apart, however, from this bed, there are other deposits north and south which are as rich in shale as the deposit referred to.

In Western Canada even greater interest is being shown toward the newer sources of fuel, and activities in the quest of oil and gas are assuming importance. Reference is made in another column to the report upon the prospective wealth of these fields, by Mr. Wyatt Malcolm. In this connection it is worthy of note that one large stretch of country being very actively prospected at the present time is that of the Province of Alberta. In consequence of the recent discoveries of asphalt and natural gas deposits in various parts of the Western Provinces, an active campaign has set in among prospectors and experts, who are making an exhaustive search for indications of oil in Central and Southern Alberta. The experts of the Dominion and Provincial Governments are engaged in this work of prospecting and mining, and drilling outfits have been shipped from Edmonton recently. The wells which have been put down are at the present time over 2,000 ft. in depth, and there is a sanguine feeling that good results will be obtained at an early date. The Canadian Pacific Railway is keenly interested in the development of these new sources of fuel supply in the West, especially oil. Drillers are at work close to the railway at Calgary, in the Athabasca and Peace River territories, and at a number of different points on the Pacific Coast. Enlargement of storage facilities in the neighborhood of Vancouver is also contemplated, as larger quantities of liquid fuel are being purchased for use upon their passenger steamers on the Pacific.

Mr. Malcolm, in his report, calls attention to the possibilities of the Western part of Canada as an agricultural country, in which towns are rapidly springing up as distributing centres and villages growing into cities. With an increase of population will come an increased demand for material for light and fuel, so that, taken altogether, the finding of a market for oil and gas will be an easy problem, and the demand will be sufficient to greatly stimulate the effort of drillers.

COMMISSION CONTROL OF ONTARIO WATER-POWERS.

"In view of the comprehensive schemes outlined by the Dominion Government for the creation and improvement of waterways in connection with the St. Lawrence River, Welland Canal, French River, Sault Ste. Marie, Trent, Ottawa and others, involving a large expenditure of public money; and in view of the extensive power developments which are possible in consequence thereof; also, in view of the rapidly increasing power requirements of the Province, be it resolved that this Association request the Dominion Government to put all such water-powers under the jurisdiction of the Hydro-Electric Power Commission of Ontario, to be developed by them for the use of the municipalities of the Province for the benefit of the people."

In adopting this resolution at its recent convention in Toronto, the Ontario Municipal Electrical Association, a body whose membership consists chiefly of mayors and aldermen of various cities and towns of Ontario, fairly representative of the whole province, has expressed a general note of disapproval against control by private corporations of the valuable assets to be developed from waterpowers. The resolution is going forward to the Dominion Government in the form of a memorial, it being pointed out by those prominently in support of the action, that it frequently happened that the control of these powers passed on to private companies before the people got a chance to express any wish to control them for themselves.

The Hydro-Electric Power Commission of Ontario has, by request of various municipalities, exercised its judgment over a number of proposed developments throughout the Province, and already a great deal of unnecessary expenditure has been averted by its timely investigation.

In the establishment of a power service there are many features, especially in connection with mechanical and electrical details, that are more or less of a stereotyped nature, and apply to all plants with approximate equanimity. But these factors are governed by and depend upon the quantity, consistency and other characteristics of the available water supply. It is to be regretted that the present accelerated movement toward a wider use of the waterpowers of the Province for electrical energy is not in possession of stream flow data extending back through a greater period. Except for the past few years, a cursory knowledge based upon the memory and integrity of the "oldest inhabitant," is too frequently the only available information bearing upon the conditions in the past that are of great importance. The result is that there have been plants installed that are quite out of proportion with the available supply of water; and in the prevention of similar occurrences the Hydro-Electric Power Commission is rendering a service that is being felt. Further, the records which it commenced several years ago to acquire relative to Ontario stream flow emphasize the fact that the matter of the resolution referred to above is quite in keeping with the object which promoted it.

EDITORIAL COMMENT.

It is now several months since the position of city architect was made vacant in Toronto. The Board of Control is at last considering the appointment of a successor to Mr. McCallum.

* * * *

In discussing the question of Canadian freight rates, Mr. Ben. H. Morgan introduced the subject of Canadian duties on British machinery, steel and iron girders, and heavy material of that class, stating that if concessions, by way of reduction or abolition, were made in the tariff with respect to these items, the resulting attraction of British goods to the Canadian market would assure such a freightage in the direction of Canada that British tramp steamers would be encouraged at once to ply between British and Canadian ports. Without the tramp steamer low freight rates are claimed to be an economic impossibility at present.

* * * *

The Burrard Peninsula Joint Sewerage Board was constituted last month by the Provincial Government of British Columbia. It consists of a chairman and four members, all appointed by the Government, the chairman receiving a salary of $5,000 per annum and the members $600. The latter are nominated by the four municipalities in the Sewerage District—Vancouver, South Vancouver, Point Grey and Burnaby. The Board was appointed to construct and operate a system of trunk sewers, interceptors and outfalls on the lines laid down in Mr. R. S. Lea's report to the Join Committee, the construction of the subsidiary sewers being left in the hands of the municipalities, who must submit all plans to the board for approval. The Board controls an area of nearly 90 square miles, and has powers to borrow a sum of $11,000,000, the principal and interest being guaranteed by the Provincial Government. Interest and sinking fund charges will be met by an assessment on the municipalities, who have the right of appeal to the Lieutenant-Governor-in-Council from any assessment made by the Board. The works will be constructed as the necessity arises, and, as much of the territory is at present very sparsely populated, it will probably be many years before the scheme is completed. The Provincial Government and the municipalities concerned are, on the advice of their engineers, profiting by the experience of the older cities of the world, where, in most cases, the sewerage systems, like Topsy, have "just growed," and have to be revised and readjusted from time to time at very considerable expense, together with the abandonment of points of outfall and lines of sewer often before the loan under which they were originally constructed has been paid off.

* * * *

In the organized counties of old Ontario there are 50,000 miles of road, according to a report made by Mr. W. A. MacLean, of the Highways Department of the Provincial Government. A classification would be approximately as follows:

Trunk roads connecting the large towns and cities	2,500 miles
County or leading market roads	6,000 miles
(a) Main township roads	25,000 miles
(b) Secondary township roads	16,500 miles

The roads described as trunk roads are, with the exception of a few connecting links, amongst the most important of the county roads. Main township roads comprise principally the concession roads on which numerous farms front and which converge into and create the traffic of trunk or county roads. Secondary township roads include the little travelled connecting roads.

OIL AND GAS PROSPECTS IN WESTERN CANADA

In Memoir No. 29-E of the Department of Mines, Canada, Mr. Wyatt Malcolm outlines the prospective industrial field for the production of oil and gas in the northwestern provinces of Canada. This memoir is a compilation of information obtained in great part from the reports of Canadian geologists. The object is to lay before the public what is known regarding the oil and gas possibilities of these provinces. To this end it was thought advisable to present in a concise form the geological conditions to be met, and for the benefit of those who are interested in boring operations stress is laid on the lithology and thickness of the different geological formations. Logs of wells of different localities are also given, and evidence bearing on gas and oil production and possibilities is presented.

The most important areas considered in the report are: (a) the Athabaska River district, where the Dakota sandstones are impregnated with a bituminous substance, a petroleum product, and where gas is known to occur in abundance; (b) the country about Medicine Hat and westward where gas has been found at different horizons but in greatest abundance probably in the Dakota sandstone; (c) the Pincher Creek district where there has been some prospecting for oil.

The plains of Western Canada are underlain by a great body of sediments, nearly horizontal in attitude, and resting on a Pre-Cambrian base. The eastern contact between the Pre-Cambrian rocks and the later formations runs in a generally northwest direction from Lake Manitoba past Athabaska, Great Slave, and Great Bear lakes. In the eastern part of the plains a great unconformity exists between the Palæozoic systems, consisting of limestones, dolomites, and shales, and the Cretaceous system, consisting of shales and sandstones, so that we find the Dakota sandstones of the Cretaceous system resting directly upon limestones of the Devonian system. The Palæozoic strata are exposed by faulting in the Rocky Mountains and much of the later sediments has been eroded, only traces of the lower members being left. In the west, deposition during Carboniferous, Triassis, and Jurassic times has to a great extent bridged over the unconformity seen in the east, and the geological column includes formations found in nearly all the great systems from the Cambrian to the Recent. In western Alberta and in some parts of south Saskatchewan the Cretaceous sediments are overlain by Tertiary deposits. Overlying all is a mantle of unconsolidated Pleistocene and Recent deposits.

Little has been done yet to test the gas and oil possibilities of the district. A few wells have been sunk, and in a number of these gas in commercial quantities has been struck. Prospecting for oil has been less successful.

Prospecting for oil has been carried on in two different areas in the Pincher Creek district, southwestern Alberta, one on the south branch of the south fork of Oldman River, and the other on Oil Creek, which flows into Waterton Lake. This has apparently resulted in no great measure of success. In northern Alberta the Dakota sandstone, where exposed along the Athabaska and its tributaries, is impregnated with a bituminous substance believed to be a petroleum product, and it is thought that liquid petroleum exists in this porous rock at some distance from the outcrop. To test the validity of this belief, wells were drilled during the nineties by the Dominion Government at Victoria on the Saskatchewan, at Athabaska Landing, and at the mouth of Pelican River. In the first two wells the Dakota sandstone was not reached, while in the last it was reached at a depth of 750 feet, penetrated about 87 feet, and found to carry maltha or heavy, tarry petroleum.

Prospecting for gas has been much more encouraging. The boring at the mouth of Pelican River, although disappointing so far as oil is concerned, proved the presence of a great reservoir of gas in the Dakota sandstones, and heavy flows were struck at 820 and 837 feet. In southern Alberta, also, gas is found in paying quantities. A good field exists at Medicine Hat, and flows have been obtained at several different points west of that city. At Bow Island a flow of several million feet is obtained.

Thus, while the presence of oil in commercial quantities remains to be proved, boring operations have demonstrated beyond a doubt the existence of large reservoirs of natural gas, and it seems probable that further exploratory work throughout the wide area underlain by the Cretaceous rocks should lead to the discovery of other reservoirs.

It is believed that the Devonian limestone is the source of the gas and petroleum products of northern Alberta, while the porous Dakota sandstone forms the reservoir into which they have risen and in which they have been retained by the overlying shales. The Dakota sandstone is the productive formation at the mouth of Pelican River, and it is also believed to be the gas-bearing formation at Bow Island in southern Alberta. As the Devonian limestone and Dakota sandstone are of wide distribution and probably underlie the western part of Manitoba and a great part of Saskatchewan and Alberta the prospects for the discovery of other gas fields seem favorable. On account of the great thickness of sediments overlying these formations, the driller, however, must be prepared to go to a considerable depth.

INCREASE OF "RUN" IN MECHANICAL FILTERS.

In a paper presented to the American Waterworks Association at Minneapolis Mr. Frederick H. Storer, Bacteriologist and chemist to the Louisville Water Company, has dealt with one of the causes of trouble in mechanical filters.

It is shown that though it might reasonably be inferred that the operation of the mechanical filter would be easiest at times when bacteria and suspended matter are present in the raw water in the least amount, many filter superintendents are finding that such is not always the case, and that warm weather and clear water bring troubles peculiarly their own, shortening the filter runs and producing odors in the filters. At such times the unfiltered waters are found to contain very minute forms of life, diatoms and a few algæ, accompanied by considerable amounts of very fine matter of indeterminate form capable of adhering together in flakes. This matter is supposed to be the result of bacterial action on organic substances. Thus, conditions of clear, warm, shallow water, abundant sunlight and sluggish current afford these micro-organisms the most favorable conditions for development, and their numbers increase rapidly at such times, while the sedimentation basins give the required conditions.

An instance is quoted where, during a period of twenty-six days, the number of micro-organisms present in the unfiltered water remained practically constant; yet during this period the length of the filter runs steadily decreased, and this result was considered as being due to the cumulative effects of a constant number of organisms. When, however, copper sulphate was added to the water in the sedimentation basins there was a general increase in the length of the runs. Also later, when the organisms had died from natural causes, a similar increase in the length of the runs was noted. During this time the degree of turbidity of the water had remained unaltered, and it was found that the length of the filter runs followed quite closely the variations in the number of micro-organisms present. The manner in which the clogging occurred is described as differing from that experienced with water of greater turbidity.

It was at first believed that with waters of very low turbidity, owing to the fact that the size and consistency of the film formed on the filter surface was reduced, the very fine suspended matter was able to penetrate into the sand in a manner which was not the case with water of greater turbidity, and in the absence of any considerable number of organisms the shortening of the filter runs was first attributed to fine turbidity alone. It was, however, found, on microscopic examination, that the sand generally showed the presence of numerous diatoms and other organisms apparently cemented together in a matrix of amorphous matter and fine turbidity, and the author is of opinion that the living organisms accelerate the formation and retention of this gelatinous film upon the sand grains. Practically, the surface of the sand under these conditions became abnormally hard and compact in a short time, and when broken up the sand grains showed a slight tendency to stick together, and this condition could not be wholly corrected even by thorough washing.

Under these conditions it was considered that some method of treatment should be adopted to prevent the clogging, and three methods were tried, though it seems that only one of these—the successful method—received any great degree of care, owing to the difficulties of application under the particular circumstances. The killing of the micro-organisms by chemicals was attempted, but owing to lack of equipment for applying it accurately as a continuously fed solution, hypochlorite was applied to one of the filter beds in the form of powder. This was done by draining off the filter till about 3 in. of water remained on it, and scattering the powder over the surface and allowing the bed to stand thus for twenty-four hours. The result did not prove to be useful, and the bacterial efficiency of the bed was, moreover, impaired. Copper sulphate was then applied in the second sedimentation basin, and in the coagulant basin, and favorable results were at once obtained. The method adopted was that of dragging bags of the copper sulphate through the water. The third method was that of using the river water without preliminary sedimentation, the water being run direct to the coagulant basins. This was done on two occasions, and in both cases encouraging results were obtained, although in each case an increase in turbidity followed within a few days, and thus left no opportunity to see how long the improvement would have lasted.

The summary at the end of the paper states that the water of the Ohio River, when of a turbidity below 30 parts per 1,000,000, almost invariably causes decreases in the lengths of the filter runs. If such turbidities are accomplished by micro-organism and much amorphous matter, still greater decreases follow. Filter runs may be greatly increased by the judicious use of copper sulphate, although aftergrowths of bacteria sometimes follow its application, and must be guarded against. Small doses of hypochlorite of lime do not affect these micro-organisms in such a way as to increase the length of the filter runs. The determination of the time of filtration of samples of water through small laboratory filters will in some instances enable the operator to select the water from that point of his system which will give the longest filter runs.

PRESENT STAGE OF SCIENTIFIC WATER SUPPLY IN AMERICA

REPORT OF AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS' COMMITTEE ON WATER WORKS AND WATER SUPPLY—PRESENTED AT 20TH ANNUAL CONVENTION, WILMINGTON, DEL., OCT. 7TH.

By A. F. MACALLUM, C.E.,
Chairman

In looking over the legislation of the past year and the greater amount of knowledge on water supply displayed by the press, it must be confessed that the different States and municipalities have not been developing their laws for the proper protection of the people from contamination of water supplies as rapidly as is considered necessary: This has been due principally to the ignorance of the average legislator, and sometimes the political pressure brought to bear upon him from interested sources.

Legislation in Minnesota.—In Minnesota a bill was placed before the State Legislature for adequate protection of the water supply throughout the State. This bill provided that all persons, corporations, and municipalities, other than first class cities, supplying water for private or public consumption within the State must file with the State Board of Health certified copies of plans of their water supply, and that no such source of water supply shall be used until plans have been placed before the State Board of Health and favorably considered. This also applies to new places for the disposal of sewage. This State approval would have been a step in the right direction, and Minnesota, following in the steps of New York, New Jersey, Pennsylvania, Massachusetts, Ohio, and the Province of Ontario, but unfortunately the opposition was so strong that the bill was withdrawn.

Water Waste.—In Philadelphia water is still wasted, and its water system is now heavily overworked, with the result that in attempting to keep up with this waste the quality of the water, along with efficiency and economy in operation, have been sacrificed for the sake of quantity, and the present filters are being worked at a higher rate of filtration than is thought advisable, or that would be necessary under normal restrictions. This applies to other cities also, and the public seem very slow in awakening to the tremendous unnecessary expense, although brought to the fore by probably every manager of municipal waterworks in the country, and every advance made to curtail the water to reasonable limits is only gained after hard and very often bitter opposition.

In New York it was found that 33,500,000,000 gallons of water were saved at a total expense of $138,000.00 by careful house-to-house inspections, which amount was ascertained after careful pitometer gaugings before and after district inspections.

Pollution of Lake Erie.—During the spring a conference was held at Cleveland between the Ohio State Board of Health and representatives from cities on the south side of the lake to discuss the sewage pollution of Lake Erie, and it was thought probable that there was no general pollution of that lake, and that any pollution was confined to zones within limited distances of cities and rivers contributing sewage. It was also brought out that the sewage from any particular city was more detrimental in its effect upon its water supply if taken from the lake than upon that of any other city, taken from the lake, and that water supplies taken from limited distances from the shore should be purified. At this meeting a resolution was adopted asking the State Board of Ohio to investigate the degree and extent of the pollution of Lake Erie, and also a resolution was adopted providing for the appointment of a committee to fix standard methods of analysis of samples and the nature of the determinations to be made in the investigation.

Commenting on this, we may say that, while the pollution would generally be within limited distance of cities and rivers, yet there are authentic cases on these great lakes where islands of polluted water have been found fourteen miles distant under certain weather conditions, which, however, are not common.

Analysis.—In the chemical and bacteriological determination for the purity of water the procedure originally developed by the Massachusetts State Board of Health has almost universally been followed. That analyses estimate the amount of chlorine, nitrates, nitrites, oxygen consumed, oxygen dissolved, odor, turbidity, hardness and sediment, along with bacteria count and tests for B. Coli; yet it has recently been pointed out by Dr. H. E. Barnard, chemist of the Indiana State Board of Health, that in many tests made the values for chlorine, nitrates and nitrites under varying conditions are of little value. For instance, the nitrite factor, of considerable value in the determination of well supplies, is of little value in rivers or lakes, varying more widely during conditions of low and high water than of varying amounts of sewage inflow. The same remarks apply to the presence of free ammonia. It was found, however, that two factors of oxygen consumed and dissolved were of prime importance, although they varied also in rivers somewhat according to the variable flow and by turbidity. However, the determination of these two factors, with the bacterial count and test for colon bacillus, is of great benefit in ascertaining the purity of a water supply at the time the tests were taken; but to be of prime value there should be a large number of tests extending over different conditions of the river or lake, for no chemist can definitely say that any water supply is good or bad upon the result of isolated tests, and without knowing the local conditions and surroundings at the time the samples were taken. We have dwelt on this because of the almost universal idea held that one determination of a water supply is quite sufficient, and of the habit of some chemists of approving or condemning a supply upon such a test and without a knowledge of the locality from which the samples were taken.

In looking over the typhoid statistics of some fifty large American cities a considerable decrease has been noticed, there being only twelve cities in this list where the rate has been greater than last year. This is due, no doubt, to the betterment of the water supplies and the general improvement in sanitary conditions.

Filtration.—The filtration of water is practically limited to two standard methods on this continent—one being by means of graded sand and without the use usually of any chemicals; the other by mechanical methods for treatment with chemicals. Each method gives equally effective results, although the selection of which method adopted is governed generally by local conditions.

In the slow sand method of filtration the water is passed through beds of graded sand and gravel, without the addition of chemicals, at the rate of about four million gallons per acre per day, which at times may be increased 25 per cent. without loss of efficiency. The water is then collected in reservoirs.

With the mechanical system the water is first impregnated with a coagulant, such as sulphate of alumina, and allowed to stand in sedimentation basins for a few hours to allow a sufficient precipitation, after which the comparatively clear liquid is pumped through rapid sand filters at the rate of from 100 to 150 million gallons per twenty-four hours. It is then ready for distribution.

The first cost of mechanical filtration is considerably less than for slow sand filtration, besides requiring much less area for the plant, which ratio of cost will vary according to local conditions—as, for instance, the material upon which the filters are to be built, with the resulting foundations. The mechanical system can usually be built in half the time that is required to build slow sand filters. On the other hand, the cost of operation is largely in favor of the slow sand method, which averages, for operation, about $1.90 per million gallons, while for the mechanical mehod the cost would be about $4.70 per million gallons. This difference is principally due to, and varies with the cost of, the coagulant. This does not include pumping or capital charges in either case, although the additional head required for the mechanical operation is included.

The mechanical method will successfully treat any water, regardless of turbidity or color, while the slow sand method works best when there is comparatively little suspended matter or color.

With the conditions existing at Philadelphia it was found necessary to eliminate some of the suspended matter by means of a roughing filter, which removed a considerable amount of this suspended matter, and allowed the slow sand filter to be operated above their rating. This combination was effective in obtaining results at a lower operating cost than with mechanical filters, and at the same time successfully treated a water otherwise not altogether suitable for the slow sand method.

It might be supposed that mechanical filters would work best when bacteria and suspended matter were least, but many filter superintendents are finding that such is not always the case, and that in warm weather with clear water odors are produced in the filter, with shortening filter runs, caused by clogging of the sand. Examinations of the unfiltered water showed minute forms of life diatoms and a few algæ, accompanied with a fine, flaky matter, supposed to be the result of bacterial action on organic substances. This matter formed a gelatinous firm upon the sand grains, causing the surface of the sand to become abnormally compact, and with a tendency of its grains to stick together, which was not altogether corrected by washing. This clogging was successfully overcome by the judicious use of copper sulphate. After the copper sulphate treatment bacteria increased, probably because it reduced or removed unfavorable conditions, but no B. Coli was detected, and the increase in bacteria was eliminated by adding 0.25 parts per million of available chloride. While this trouble has developed and has been successfully treated at Louisville of the Ohio River water, using mechanical filters, on the other hand, at Toronto, with slow sand filters and Lake Ontario water, it was found that on account of the amount of suspended matter and sand carried to the filters that the filters were almost clogged up. It was also found that from the inset of frost until the warm weather in the spring it was not possible by the means provided to wash the sand scraped from the filter beds. The pipe lines and sand would freeze up during the washing process,, necessitating the removal of the sand scrapings until the spring and the washing and re-sanding of the filters. From this we wish to point out that where any installation is contemplated there is need of a very careful study of the quality of the water, the local conditions governing not only the method of treatment to be used, but also the location of the plant.

It has been found that raw water can be treated with seven pounds per million gallons without developing any taste, and if after treating the water can be stored for three or four hours in a reservoir, or aerated, as much as 12.5 pounds per million gallons can be introduced without noticeable taste. It is better to obtain water of the best quality rather than depend upon the efficiency of purifying apparatus, chemicals, and the skill of employees, and in the case of New York a very interesting discussion has been going on as to the advisability of filtration outside of chlorination. Because of the diametrically opposite opinions advanced by the engineers of various municipal bodies interested, filtration outside of hypochlorite treatment was decided against, although it was shown that such treatment did not remove bacteria embedded in particles of suspended matter, decrease turbidity, lessen color or vegetable stain, or remove swamp tastes or odors.

The application of ultra-violet rays for purifying large quantities of water has not advanced very materially during the past year on this continent, although it has been used at Rouen, France, for the past three years. The simplicity of the apparatus, easy maintenance, and high efficiency seems to open a wide field for its application. It is necessary, however, before submitting the raw water to the rays that the suspended matter be removed, otherwise germs protected by such matter do not come directly under the effect of the rays. An ordinary sand filter can be run from five to ten times its ordinary rate and still produce satisfactory water for the after treatment of the ultra-violet rays. The water is exposed for the fraction of a second within an inch of the source of the rays, and this is accomplished by means of various mechanical apparatus, one or two of which are now on the market.

It is our opinion that this treatment of ultra-violet rays is worthy of consideration by consulting and municipal engineers in this country in future installations, and should also be investigated on a commercial basis by engineering colleges.

Andrew F. Macallum, Chairman.
J. Walter Ackerman.
G. A. Roess.

Ohio led the states in the value of her clay products with an output amounting to $34,811,508, or over one-fifth the total production for the United States. Pennsylvania was second, with a production valued at $21,537,221; New Jersey third, with $19,838,533; and Illinois fourth, with $15,210,990. Eight states produced clay products in 1912 to a value exceeding $5,000,000, and 26 states to a value exceeding $1,000,000.

REINFORCED PILE FOUNDATIONS FOR BLAST FURNACES.*

By Armand Baar.

THE question of foundations often plays an important part in iron and steel works, where engineering skill requires to be exercised with special care, in view of the responsibilities which devolve upon the engineer when erecting heavy plant on a poor subsoil. The frequency with which such poor subsoils occur in works is due to three causes: (1) The price of land often compels the utilization of certain areas hitherto undeveloped, owing to their unsuitability for building purposes. (2) The need of a water supply for steam engines often necessitates a works being installed close to a river, which by the gradual shifting of its bed, may have undermined the adjoining areas. (3) Lastly, the production of dump heaps for the embankment of railway junctions require constant filling up with debris either as simple ash-shoots, or by the tipping of slags from blast furnaces into mounds which often attain a height of 65 ft., and upon which it is dangerous to install machinery in motion owing to the lack of stability of the foundations.

In Belgium in particular, as well as in the North of France, and in the Grand Duchy of Luxemburg, a new system of foundations known as Franki piles is being employed with considerable success in most of the big works. The principle is, briefly, as follows: A conical perforator armed with a hard steel point is driven into the ground by the help of a pile-driver. This perforator carries with it telescopic tubes which serve as tubbing, and have an average diameter of 2 ft. The perforator thus passes through the hardest ground. An instance may be adduced at Ougrée, where the process has been applied on a slag tip 30 ft. in height, and consisting entirely of slag blocks from a basic steel works, of a size extending to about 80 cu. ft. each. Reference may also be made to instances where the ground has been exceedingly soft and highly water-bearing, as at the Courrières Collieries, where the soil consists of peat and water-bearing sands, and where three bridges have been erected. The object of the system is to bore through the overlying ground until a solid foundation of clay or gravel is encountered.

The perforator is then withdrawn and replaced by concrete, which is rammed down by degrees as the tubes (commencing with the lowest) are withdrawn. By means of the ram the concrete is compressed so as to press against the sides of the bore-hole and to consolidate them, until ultimately the bottom is enlarged and a cone obtained, pressing against the side walls of the cavity.

Amongst applications of this process which may be referred to, one of the most interesting was the strengthening of No. 2 blast furnace at the Esch-sur-Alzette works of the Sociétá des Aciéries Réunies de Burbach-Eich-Dudelange in the Grand Duchy of Luxemburg, and its supercession by a furnace of twice the size.

The masonry batter of this furnace rested on gravel 14 yards below the level of the soil, and the ground had been packed up entirely with goaf of an inferior description. Several break-outs from the furnace had, however, penetrated the packing at different times, and it was feared that lumps of metal might be encountered at several points, which actually happened later.

* From a paper read before the September, 1913, Convention of the Iron and Steel Institute, Brussels.

Forty-one piles were driven, each calculated to sustain a load of 70 tons, and in order that the concrete arch, which had to rest simultaneously on the batter and on the pile itself, should distribute its load uniformly, there was placed, above the masonry, a layer of granulated crystalline slag 4 in. thick, mixed with a little cement, so that if, under pressure, the fresh cement should spread, any further increase in the load would bear upon the crystalline slag and further compress the latter by crushing it, after which the injection of water at the bottom would finally mortar the arch to the masonry, by the action of the cement originally introduced as an addition, with the dust of the powdered slag.

The furnace is in full working order, and the method of construction has been perfectly successful, and shows no sign of settlement.

Another interesting application of Franki piles was made in erecting the rolling mills of the Ougrée Marihaye Company. On a tip composed entirely of slag blocks to a height of 30 ft., resting on 15 ft. of bad subsoil, these mills work 35 ft. above the level of the Meuse gravels. The whole plant, including mills, buildings, gas producers, etc., rests on 180 piles, which were driven through this thick layer of slag. Not a single pile had to be left unfinished during boring, and the whole of the work proceeded without interruption.

The Athus-Grivegnée Company has erected a similar plant at Athus, under analogous conditions, but in this instance the piles are only 30 ft. long. Franki piles have also been most satisfactorily employed as foundations for gas engines at the works of the Société Métallurgique de la Basse Loire, at Trignac (St. Nazaire), at the Aciéries de Micheville in Meurthe-et-Moselle, and at the works of the Société des Hauts Fourneaux de la Chiers at Longwy.

It may also be interesting to add that before constructing the foundations of the Ougrée Marihaye rolling mill plant, the company carried out a test on a Franki pile, which was loaded with a charge of 473 tons.

Discussion.—Mr. Andrew Lamberton, Coatbridge, said that the subject was a very interesting one, but he would like the author to give some additional information with regard to the stiffening up of insecure foundations. It was largely a question of cost. He would like to know what was the time taken to put down a pile of about 3 ft. in diameter through 30 ft. of solid basic slag, and what was the cost; also whether there was any difficulty in withdrawing the tubes, which he would expect to find was the case. The paper contained a cross-section of a pile which had been put down, and it was obvious that the tubing was much less in diameter than what the slag pile was depicted as being, that diameter being reached by filling in concrete in the metal tube and hammering it down till it expanded. There seemed to be some difficulty about that, and in getting a section resembling that shown in the illustration. A good deal appeared to depend upon the porosity of the material and the number of fissures present, while the concrete might get out of the true line of the pile. The method described was certainly ingenious, and if it could be done satisfactorily and was commercially sound the author would have accomplished a smart thing in engineering.

M. Baar, in reply, said that the cost of driving was about $10.00 per yard in hard soil and about $5.00 in easy soil. With regard to the time element, they had put down one pile per day of 12 hours to a depth of 49 ft., and in the case of one big contract a thousand piles had been put down.

Later, by letter, he replied in respect to a suggestion of simply consolidating the ground by an injection of cement, as follows: When the tip consists simply of slag blocks from blast furnaces, the space left between the blocks being pretty large, the work would require the injection of a vast amount of cement, and the operation could not be conducted easily over a certain height. In most cases, however, the tip is formed of debris of all kinds, especially clay and earth, and in this the injection of cement is attended with bad results. The Franki pile gives full security, because it not only passes through the tip, but also through the bad soil which lies underneath it, and rests on a strong foundation of clay or gravel.

Mr. Lamberton asked further whether it would be possible to drive tubes having a diameter of 1 yard into a tip of 10 yards in height; in the affirmative, what was the time required for the operation and the cost of the pile. We have driven 180 Franki piles, at the Société d'Ougrée-Marihaye, into a tip composed entirely of slag blocks to a height of 30 ft. resting on 15 ft. of bad soil. The work, therefore, was more difficult than the one alluded to by Mr. Lamberton, and, nevertheless, we regularly made one pile a day with each pile-driver. That the first tube at the ground level had a diameter of 1 yard and a height of 1½ yards was due to the necessity of first digging a hole of such dimensions as to enable the use of tube lengths suitable for the required depth. The upper tube had a diameter of 24 in., the mean one a diameter of 20 in., and the lower one a diameter of 16 in. In a strong ground, free from water, it is not necessary to work with tubes of great diameter, the concrete spreading easily against the walls of the cavity, and agglomerating round the stony materials forming the pile, and increasing the diameter of the latter.

As to the price of the Franki piles, it is generally of $5.00 per yard, for piles driven into an easy, soft, or marshy soil. But in tips of slag blocks, where piling is slow and difficult, the price rises up to $10.00 per yard. From the economical point of view, the following may be regarded as a typical instance:—

One thousand Franki piles are now being driven on account of the Vilorde Coke-Ovens Company. Each pile contains 123.5 cu. ft. of concrete. The total volume of the concrete thus poured in a relatively small area is about 45,800 cu. yds. If reinforced concrete piles made in advance had been used, the cost of the foundations would have been three times as high as that paid by the Vilvorde Coke-Ovens Company to the Frankignoul Company, supposing that, in order to obtain the same compression of the soil, an equal volume of concrete had been driven in the shape of such ready-made piles.

ELECTRICAL POWER IN CHICAGO.

Chicago leads the world in the production of electric power. The output of 303 electric-supply undertakings in Great Britain for the year 1911-12 amounted to 1,127,499,742 units, but Chicago by itself has an annual output of over 800,000,000, and expects within a year to turn out a billion. The Chicago Commonwealth Edison Co., generates more current than the local Edison companies of New York, Philadelphia, Brooklyn and Boston combined. The Eastern companies, however, do not supply power for local transportation, while the Chicago company does. The latter operates the largest single electric-power-generating plant in the world and its price for its product is said to be lower than that of any other electric power-vending company in the world.

TREATMENT OF WORN OUT AND RAVELLED MACADAM SURFACES.*

By Col. Edmund A. Stevens,
State Highway Commissioner of New Jersey.

BEFORE discussing the cure it is well to define the trouble, and to analyze its causes. The word Ravelling is used rather loosely. For my purpose I shall consider it as the loosening of the bond of a road surface until the macadam stone lies loose and free on the road. By macadam stone, I mean, not the small stone used to fill voids and give a smooth finish to the surface, but the stone that constitutes the body of the road's surface. In macadam work this stone when compressed to its final form occupies about 60 per cent. of the volume of the road surface. The 40 per cent. of voids is filled in varying proportions with surface stone, screenings, stone dust, sand, earthy materials and any chemical binder used to "hold the road." The mixture of fine stone, sand and earth filling the voids has no appreciable tensile strength. Its duty is to wedge the macadam stone in place and prevent internal movement. Such a structure is called on to carry loads, to receive and absorb propelling thrusts. The road should be of sufficient depth to transfer the stresses thus imposed to the sub-base without serious internal movement and at unit pressures less than the resisting power of the soil. It is thus subjected to vertical and horizontal forces that contribute largely to ravelling.

Let us briefly consider these.

A draft horse weighing 1,200 lbs. will have all his weight at one time on two feet. He will exert, say, one horse-power at a speed of 4 miles. The vertical force at the foot is 600 lbs., the horizontal $\dfrac{23,000}{2 \times 4 \times 88} = 47$ lbs. These forces are or may well be concentrated on a toe calk two inches in width; the resultant force slightly exceeding 300 lbs. per linear inch.

A motor truck, loaded, 16,000 lbs. and exerting at the wheel rims, say, 30 horse-power at 10 miles an hour, will, with 60 per cent. of load on rear axle, exert a vertical force of 4,800 lbs. and a horizontal of 562.5 lbs. at each rear rim, the resultant being about 800 lbs. per lineal inch for six-inch tire.

For a pleasure car weighing 4,000 lbs. with 60 per cent. of weight on rear axle and exerting 40 horse-power at the wheel rims with a speed of 35 miles, the vertical force at each wheel is 1,200 and the horizontal 214. The resultant is about 400 per linear inch for a bearing width of 3 inches.

At curves with high-speed cars, the horizontal force is considerably increased, for it is impossible to so "bank" a curve as to suit the speed of all classes of traffic.

In the case of wheels transmitting vertical loads only, observation indicates but little dust raising from a road not overlaid with loose dust. Such a wheel will at the point of mathematical tangency have no velocity relative to the road; a vertical velocity is imparted to it, and as any section leaves the surface it will raise with it any of the lighter particles that are loose and may come into contact with it. At the driving wheel there is a slight slip which in addition to lifting will throw particles backwards.

* Read at American Road Congress, held at Detroit, Mich., September 29th to October 4th, 1913.

These are the forces tearing at the road surface. In some cases they are more than the road can stand. The horse's calk acts somewhat like a chisel. It will pry out the binding material between the stones as well as the latter themselves when the bond is weakened. The driving wheels of motor vehicles push or suck any material thus loosened out of place. The binder loses weight as it parts with moisture; besides this, without moisture it also loses, not only its property of recementing itself under pressure, but to a great extent, its binding power as well. The real work of transmitting the stresses due to traffic must be borne by the stone. These are merely held in place by the binder. The latter is gouged out by the horse, drawn or pushed out by the automobile tire, blown away by the wind, or washed off by the rain, and a loosening of the upper stone results.

Even on a well consolidated road climate stresses impose a heavy duty. If, however, there be voids the risk of failure increases. Voids may be due to deficient rolling or to the rise of too much clay in the earthy binder. Lumps of this material will bridge the space between stones even under hard rolling. The bridge will break down eventually either from pressure or moisture or a combination of them. A void forms where the bridge was and continues rising until near the surface, when ravelling results. The same may be true in the cases of too light rolling.

When bituminous material is used as binder it is liable to disintegration from weathering, from overheating, or from admixture of earthy materials.

An ordinary water-bound macadam may lose material by wear up to a thickness of about a half an inch a year without being overloaded. The thickness that can thus be lost will vary with conditions, one of which probably is the ratio of the maximum wheel load to the total tonnage borne by the road.

Whatever the rate of waste, it must be replaced if the road is to be maintained.

To summarize the foregoing:—

Roads ravel from:

1. Improper construction.
2. Overload.
3. Neglect.

In all cases these affect the binder.

Poor workmanship in construction can only be cured by remedying the original defects. These generally show themselves by small local depressions in the surface from which ravelling spreads, in certain cases at an almost incredible speed. In bituminous surface faulty material and thin spots generally show up clearly. In both cases the only remedy is to rebuild the work properly, if necessary, from the sub-base up. This is not strictly repair work.

In considering the effect of overloading and neglect it must be borne in mind that any given type of construction may be so maintained as to vastly increase its carrying capacity. The problem is largely one of economics and administration. As an illustration, assume in two cases the same foundation—let one road have a water-bound macadam surface dressed with a heavy bitumen forming a sheet about ½ in. in thickness and the other a bituminous concrete (mixed method) surface of, say, two inches. The former will cost about 40 cents for stone and 15 cents for dressing, or 55 cents per square yard, and the latter about $1.00 (both exclusive of the foundation). With proper care the lighter surface will last about three years under fairly heavy traffic, the heavier one an unknown period, but let us assume twelve years. The total yearly charges against the two may then be stated about as follows:—

	Cents.
Dressed Macadam:	
Interest on cost, 55 cents at 4 per cent...	2.2
Depreciation, 1-3 of 15 cents...........	5.
Labor (patrol system)	1.9
Materials—Stone, ⅜ cu. ft. at 9 cents...	3.4
Bitumen, ⅛ gallon at 12 cents	1.5
Total	14
Bituminous Concrete:	
Interest on cost, $1.00 at 4 per cent......	4.
Depreciation, $1.00/12	8.3
Labor	.9
Material	.8
Total	14

The fixed charges are 7.2 cents against 12.3 cents.
The operating charges, 6.8 cents against 1.7 cents.

I do not claim that these figures are more than illustrations of the principle involved. They show a great saving in operating charges, those that show up in the yearly tax bill. The fixed charges, however, are just as real, and must be met at some date.

For a road with 9,500 square yards per mile the costs as shown in yearly tax charges, where depreciation and interest are not visible, would in this case be,

For the dressed macadam, per mile.... $636.50

For the bituminous concrete 161.50

yet as shown above the real cost of the two roads is the same. This case affects our subject, because the treatment of a raveller road surface must depend on the system of maintenance.

In most communities the great consideration is the next yearly tax bill. If that can be kept down for a period the ultimate economy of such a policy receives but slight attention. It is generally easier to get money for a new road than for repairs. A road requiring a large yearly repair charge is condemned without a hearing. The road calling for heavy interest and depreciation charges may be an equally or even more expensive solution; but the interest charge is not so apparent, and the depreciation charge is not made. This is simply putting off the day of reckoning, which is sure to come. However, the troubles of those in charge ten years hence are usually lightly borne by the officials of to-day.

If we consider the structure of the road surface we can easily see that the 40 per cent. of voids in the macadam stone will be filled somewhat as follows:—

	Per cent.
Surface stone, passing 1-inch ring and caught on ½-inch ring.....	15 to 20
Screenings, passing ½-inch ring....	15 to 10

The other 10 per cent. should be composed of sand and clay.

When dry, the clay is driven off to a greater or less extent as dust, washed away or splashed off as mud. Its place is supplied to some extent by detritus, the result of the wear of the larger and heavier materials. These also blow or wash away and the road loses its bond. If our road is not overloaded we can retain its usefulness by making good its losses, with proper materials in their needed proportion. It is here that the trained road man is most needed. Nothing can replace his experienced judgment.

In the case of a ravelled road, having first determined that the road was well built, we must decide whether the traffic is too great for the type of surface, or whether the failure was due to neglect. If the former, we must resurface with some better type. If the latter, we can repair the old surface.

Resurfacing should always be preceded by scarifying and by bringing the road up to the necessary depth of stone. For water-bound macadam needing greater surface strength, several classes of chemical binder may be used, of which I shall discuss two, bitumen and lignin.

The bitumen may be applied either by penetration or mixing methods. The former is the cheaper, the latter the more trustworthy. Which method is to be used will, after consideration of the care the road will receive, depend on the estimate of the overload, as will also the depth of the bituminous sheet. My own observation leads me to question the wisdom of attempting to get any thickness exceeding one-half inch by penetration methods. It also leads me for this class of work to prefer tar to asphalt. The former material appears less sensitive to injury by dirt and to yield better results in repair work.

The lignin binders are derived from the waste products of wood pulp or tannin manufacture. They are cements, being also used to bind core sand in foundry work and impart a tensile strength to the binding materials. They will not act on materials soaked in the so-called road oils. The action of some of these materials on slag and red shale is quite remarkable. They are slightly soluble in water, and will, therefore, need renewal. Their application, however, is easy and inexpensive, and the effect of successive applications seems cumulative, increasing not only the depth of penetration, but the strength of the bond. The waterproofing of lignin-bound roads with bituminous tops has been carried out in Connecticut, but I am unable to give any facts as to the results.

For water-bound macadam roads that have failed through neglect a thin coat of gravel carrying some earthy matter, or of screenings or coarse sand mixed with earth, will usually cure cases that have not gone too far. In some of the counties of New Jersey it is usual to fill all ruts, depressions, etc., with fine stone, and to give the middle of the road a coat of the same mixed with a little clay. Much of this material is wasted by being thrown off the road by the traffic, and the old ruts almost invariably reappear. This method, however, is very successful in preventing ravelling. It seems a false economy to omit rolling, and wet rolling at that. The same is true of patching holes with anything but macadam-size stone. The roads treated with small stone are yearly losing depth. The moisture for wet rolling is usually bountifully supplied by nature, in the early spring. It can also be had by the use of hygroscopic salts where water is hard to get. Traffic will usually throw off from the road surface enough stone to pay for rolling.

A treatment of clay, without rolling, will often give astonishing results. Such treatment, however, seems only a palliative, not a cure. Roads thus treated become dusty or muddy according to the weather, show a tendency to ravel again, and are hard to properly treat with bitumens. They will, however, take the lignin binders with good results, if the dose of clay has not been excessive, or if the excess is swept off before treatment.

In closing, a word of warning as to the use of the so-called cold oils may not be out of place. Those of the so-called non-asphaltic class, to a greater extent than the so-called light asphaltic oils, seem to act as lubricant on road materials and to foster pot-holes, ravelling, and other failures. It may be possible to properly apply these materials, but if so it is rarely done. It is certain that even slight depressions will cause a deep penetration of the road. The dust-laying qualities of the material thus absorbed are lost, and its lubricating effect given the best possible conditions to get in its pernicious work. Local authorities, and even private individuals, seem to select roads with uneven surfaces as those on which to use these oils.

ELECTRIC WELDING FOR TRACK REPAIRS.

There are many methods by which electric welding can be carried out, one of the most interesting being, perhaps, that of Zerener, which consists of a combination of an electric arc and an electro-magnetic device whereby the arc can be controlled. Two heavy carbon electrodes are used, and the arc which is struck between them is blown to the position in which it is required by means of the magnet. The most simple is the Bernardos process, which consists of drawing an arc directly between a carbon electrode and the metal which is to be treated. The outfit consists merely of a rheostat for controlling the current, a carbon electrode which consists of a hard, solid carbon rod about 4½ ins. in circumference and some 8 ins. or 10 ins. long, fitted with a clamp to take the conductor, and with an insulated handle and shield to protect the operator. There is also the Lorain system, which requires a comparatively costly plant, with generator and hydraulic grips, used principally for making rail joints by welding on splice bars.

An interesting method of building up new metal in the worn parts of tram and other rails by electric welding is now being used, the special feature of the process being that it requires no carbon electrode. The electrode is a rod of specially treated steel, and the arc between it and the rail, according to information made public by the engineer of the firm using it, fuses the electrode and welds it to the steel, building up new metal in the worn or defective places. Current is taken from the trolley wire, and the equipment consists of a light car provided with rheostats for controlling the current and the necessary switch gear. An insulated handle is provided for holding the metal electrode, which is, of course, the positive terminal, the negative being the rail on which the repair is to be carried out. The electrode is placed in momentary contact with the defective portion and withdrawn, an arc being thus formed which carries metal from the positive bar of steel into the faulty place. The action continues as long as the electrode is held in position, and can be stopped at any moment, either by opening a switch or moving the electrode away, so that the arc is broken.

With a galvanometer receiver reflecting a beam of light on a moving photographic strip, H. Abraham, of the Paris Observatory, makes accurate photographic time records of Hertzian waves. With a clock making second marks on the strip, he claims to make measurements to 1-1,000 second, and to estimate 1-40,000 second on the wave charts.

Clay Products Industry in United States.—The magnitude of the clay-working industry of the United States is shown in a chart just issued, compiled by Jefferson Middleton of the United States Geological Survey. This chart shows a total value for 1912 of $172,811,275, which is an increase of $10,575,094 over the figures for 1911. These products include the several varieties of brick, drain, and other tile, and of sewer pipe, terra cotta, pottery, fire brick, and other clay products, the various building bricks representing the greatest value, with a total of $73,425,819. The number of building bricks manufactured was 10,281,114,000.

ELECTRIFICATION OF MOUNT ROYAL TUNNEL.

ANOTHER stage in the construction of the Canadian Northern terminal and tunnel has been reached, with the letting of the contract for the electrification of both. The contract, which involves a sum of half a million dollars, calls for the complete electrification of the tunnel and terminal, seven electric locomotives and about eight cars for the local service being provided, while the system will be such that it can be extended at any time to any part of the service. Yards near the Back River will be opened, giving track facilities for changing the electric locomotives for steam and vice versâ, and within a year from now trains are expected to be running.

In the construction of the tunnel beneath Mount Royal there have been many new features and much to attract the attention of the engineering world. These features have been currently described in previous issues of *The Canadian Engineer.* Readers will also remember the announcement early in June of a world's record in tunneling in connection with the piercing of the mountain. In the electrification another record will be marked. Of all the great railway systems of the world using electricity for the operation of their terminals, there is not one which has not adopted this system only after previously using steam. The Canadian Northern terminal in Montreal, therefore, will be the first to be operated entirely by electricity from the commencement. No steam locomotive-drawn trains will enter the tunnel. Specially constructed electric locomotives will be exchanged for the steam engines at the Back River yards. For the local service between Montreal and the Model City there will be some eight multiple-unit cars of very heavy construction similar to those in use in some of the New York subways.

The contract, which has been let to the Canadian General Electric Co., provides for the installation of the system at a cost of about half a million dollars.

The installation of this electrically operated system will ensure the entire absence of Canadian Northern locomotives in or near the city, none coming closer than the yards near the Back River. On reaching these yards trains approaching Montreal will have their steam locomotives exchanged for electric motive power, which will take them to the terminal station to be opened on Dorchester Street. In the city there will, of course, be no steam engines as the railway enters and leaves only by way of the tunnel.

Progress on the tunnel construction has of late been rapid, despite the very hard rock now being encountered, and it is practically certain that the headings will meet well before the end of the year. There remains but 2,000 feet of rock separating the two headings, and this is being bored at the rate of 200 feet each week. Already a mile of tunnel has been completed, this being a broadening and enlarging of the heading to a height of 22 feet and a width of 30 feet.

In connection with the electrification of this tunnel it might be mentioned that the same company who will supply its electrical equipment also secured the order from the Canadian Pacific Railway for the electrification of the Castlegar branch in the Kootenay Division. Heavy power locomotives are to be used in this case also, and the voltage adopted is 2,400 volts in both.

Canada is one of the three principal mica-producing countries of the world, the others being India and the United States. The average value of the mica produced annually in Canada during the last ten years has been about $185,000.

FELDSPAR.

According to reports in the Economic Minerals and Mining Production of Canada, by J. McLeish, feldspar is employed at the present time almost entirely in the pottery industry (where, in a finely ground form, it is mixed with the clay to act as a flux), or in the enamelling of cooking and similar utensils. Attempts are being made, also, to utilize the mineral as a source of potash, of which it contains as high as 14 per cent.

Feldspar has been mined in Canada since the year 1890, and the present average annual production is 12,000 tons. Practically the whole of the output is exported to the United States, where it is consumed in the New Jersey and Ohio potteries. Almost the entire production of Canadian feldspar is derived from the province of Ontario—the principal mines being located in the county of Frotenac, about twenty miles north of the town of Kingston on the St. Lawrence River. A few small deposits, also, have been worked in the Parry Sound district, in the vicinity of the Muskoka lakes. Formerly feldspar was mined to some extent, also, in the province of Quebec—the deposits being located in Ottawa county. No development of these properties has taken place during recent years—the distance from the United States factories rendering mining unprofitable. One mine in this region yields a remarkably pure white feldspar, which is in demand for the manufacture of artificial teeth.

Veins or dykes of pegmatite (a rock having feldspar as its main constituent) are of common occurrence throughout large areas in both Ontario and Quebec, and have in some instances been mined for the mica which they often carry. These deposits vary in width from mere stringers of a few inches to massive bodies of over a hundred feet. Such deposits, while, at the present time, often too remotely situated, or containing too many impurities in the way of accessory minerals to allow of the feldspar being employed for pottery purposes without considerable expensive cleaning, constitute large reserves of the mineral, which may ultimately prove of value as a source of potash or for other purposes.

The addition of trass slightly retards the setting of mortars and concretes, increases their resistance to water, greatly increases the strength of mixtures gauged with lime-water, and decreases the detrimental effect of soap solution. Lime-water increases the strength of trass mortars, but has no influence on the strength and water-tightness of mixtures which do not contain trass. Soap solution renders mortars and concretes water-tight and diminishes the hardening of mortars without trass, which weakening effect is counteracted by the addition of trass.

Scientific methods are giving great exactness to processes for hardening valuable tools and drills. Uniform and easily controlled heating is necessary, and this is easily obtainable with the electric furnace. A special form recommended has a crucible 8 ins. square and 12 ins. deep, lined with firebrick surrounded by heat-insulating material in a sheet-iron case. This crucible contains the heating bath, the temperature of which is regulated by a transformer for varying the voltage, and a pyrometer gives quick and accurate determinations of the degree reached. The bath varies with the temperature required. A mixture of barium chloride and potassium chloride is used for hardening carbon steel, at 750 deg. to 1,000 deg. C., the proportion of barium chloride increasing with rise in temperature, and this salt alone being advised for high-speed steel, at temperatures up to 1,300 deg. The crust of salt which adheres to the tool, preventing oxidation, falls off in the cooling liquid.

COAST TO COAST.

Niagara Falls, Ont.—The Ontario Power Company is seeking permission from the Queen Victoria Niagara Falls Park Commission to construct a third pipe line from its gate house on the upper river to its power house below the Horseshoe Falls. At present the company have two pipe lines, one of steel, which has been in use since the power house was put in operation, the other of concrete which was installed two years ago. Through these the company is diverting about 8,000 cubic feet of water per second, which is approximately two-thirds the amount of water permitted to its use under the provisions of the international treaty. By this amount of water, twelve units in the power house are operated, each generating 1,400 electrical horsepower. Providing the water is increased, the company propose enlarging their battery to 14 units; and where now only 130,000 horsepower can be developed by the plant, the company will be able to transmit 196,000 horsepower. The patents of R. O. Blainey, who assisted in the construction of the second pipe line, for a continuous concrete pipe are being investigated by power company officials, and should they be approved, it is possible that a monolithic pipe, which is the first of its kind in the world, will be constructed.

Hamilton, Ont.—An industry has been secured for Hamilton which gives much promise towards the further expansion of the city and the location of more industries at this centre. It is announced that the Hamilton By-Product Coke Ovens, Limited, has been incorporated at a capitalization of 1,000,000 dollars. The purpose of the company, primarily, is to manufacture coke for smelting and foundry usage in Hamilton and Central Ontario, and also for domestic and minor industrial supply. In addition, the plant will provide a permanent supply of gas of high candlepower and of a very high heat value, which will be of great value in the event of the depletion of the natural gas wells of Haldimand county and its vicinity.

Halifax, N.S.—Considerable discussion is being given to the question of ornamental street lighting in Halifax. The City Improvement League have been bestowing their efforts to bring to the citizens the best opinion of experts on the subject. Recently, at the request of this body, Mr. F. H. Winckly, of Lynn, Mass., an authority on street illumination, gave an address in which he sketched its history from the age of streets clothed in darkness to the present of the "Great White Way."

Montreal, Que.—A new work, which is occupying the attention of the Harbor commissioners at present, is the wharf being constructed by the Canada Cement Company at Point aux Trembles. It is of cement, and will be, when completed, about 600 feet in length.

Montreal, Que.—The end of this season will see unfinished little, if any, of the program of harbor works published at its beginning. The additions to grain elevator No. 1., have already attained a height of about 135 feet from the level of the wharf. Concrete bins, 52 in number, have been constructed with a capacity in totum of over a million bushels, the largest to hold upwards of 21,000 bushels, the smaller, from 3,000 to 8,000 bushels.

Port Colborne, Ont.—Inaugural ceremonies, attended the opening of the new plant of the Canadian Furnace Company, Limited, at Port Colborne. It is the most modern of its kind in the world, and has been constructed at a cost of seven million dollars. Miss Theresa Yates, daughter of the vice-president of the Buffalo Union Furnace Company, owners of the Port Colborne plant, applied the torch that lighted the furnace; and William Weller, Esq., Superintendent of Canals for the Dominion of Canada, sounded the whistle of the plant for the first time. The signal was thus given for an answering medley of shrieks from all craft in the town harbor, from the company's locomotives, and from neighbouring factories. Mr. Frederic Nichols of Toronto, president of the Canadian General Electric Company and Mr. R. S. Logan, vice-president of the Grand Trunk Company, responded to toasts; while Mr. E. H. Butler of Buffalo, commended highly the Canadian enterprise and spirit of co-operation which, he declared, is responsible for Canada's rapid development, commercially, agriculturally, and industrially.

Toronto, Ont.—Commendable progress is being made on the power transmission equipment for Eastern Ontario by the Hydro-Electric Power Commission. Plans are deposited with the department of public works for approval of an arrangement for towers and cables across the St. Lawrence River at Morrisburg. The Commission has secured an option of 1,500 horsepower from the New York and Ontario Power Company at Waddington, N.Y., and are awaiting the partial completion of the plant to import a portion of this power to Canada. Until the new plant is entirely complete, the heavy exportation cannot commence. The Canadian line from Morrisburg to Prescott is finished, and it is expected that the line from Winchesteville, Chesterville, and Russell, will be in readiness in a short time.

Regina, Sask.—The Regina Municipal Street Railway showed a deficit of $42,868.11 for the eight months ending August 31, after provision for capital charges had been made.

Ottawa, Ont.—The greatest area under wireless contract in the world, a distance of 2,000 miles will soon be completed in Canada. With the completion of stations at Port Burwell, Toronto and Kingston, a complete chain will extend from Port Arthur, through the Great Lakes, and along the St. Lawrence to Cape Race.

Vancouver, B.C.—The wiring inspector of Burnaby, Mr. Burns, has been experimenting for some time on a power switchboard for the municipal service. It is not yet complete, but is in use and is found to act very successfully. The features of the board are the means of taking the electric light current, transforming it and charging the storage batteries used in the phone service. Another thing that is said not to be in general use in telephone work except in large installations, is the construction of an artificial line, by which by the principle of the Wheatstone Bridge method of testing wires, it will be possible, in the event of trouble occurring on any line, to measure its exact distance from the municipal hall, and also to determine the nature of the trouble, thereby saving time and unnecessary work. Another outstanding feature of the board is a bank of switches the purpose of which is the coupling together of the storage batteries; and any particular cell may, by means of the switches, be disconnected from the service for charging, repair, or any other purpose. It is also the intention of putting on the board, all repeating coils, induction coils, condensers and other apparatus, so that they will be under observation at all times. The keener protective devices are also on the board, their purpose being to take the first effect of any abnormal currents that come over the system. Coupling and disconnecting switches, by which any particular line may be disconnected for repairing, testing, or other purpose, are also on the board. The use of the board is expected to obviate a great amount of trouble in connection with the working of the municipal telephone system.

Fort William, Ont.—It is probably not generally known that the grain storage elevator capacity of Fort William-Port Arthur has now reached the enormous amount of 41,935,000 bushels, and ranks second among the cities of the world as a grain storing centre, exceeded only by Chicago, Ill., with elevator capacity of 45,360,000. With the additional elevators now under construction and others projected at the Canadian head of the Lakes, it will only be a matter of 12 or 18 months before Fort William-Port Arthur will have the distinction of being the largest elevator storage centre in the world.

Rainy Lake, Ont.—Midway between Port Arthur and Winnipeg, the C.N.R. has been effecting an engineering achievement of no ordinary value. A bridge of solid rock, a great double track causeway of granite almost three miles long and costing approximately one million dollars per mile, will span the Rainy Lake in a not distant future. The contracts were let early in the summer of 1910 and preparations for the work were begun; yet the great task has been conducted so quietly that few people in Canada have been aware of the magnificent and unordinary construction.

Kingston, Ont.—Now that the Hon. Adam Beck is free to further the distribution of power throughout eastern Ontario, Kingston is feeling the cry of need of several of its industries for cheap power to insure their future expansion, and is agitating that arrangements for supply be concluded with the Hydro-Electric Commission.

St. Catharines, Ont.—St. Catharines is struggling with natural barriers towards progress similar to those encountered by Toronto in its primal growth. The Welland Canal and some creeks running through the west and south are preventing expansion in somewhat the same manner as did Garrison Creek and the Rosedale and Don ravines in Toronto. Toronto has now her Riverdale and Rosedale bridges, but St. Catharines is still struggling with her bridge problems.

Edmonton, Alta.—Mr. A. T. Fraser, District Engineer for the C.N.R., is of the opinion that steel on the Canadian Northern main line should reach the summit at the boundary of Alberta and British Columbia about the end of October. On the Brazean branch, construction is very difficult, owing to the great amount of trestling to be done. Steel is within 30 miles of the Brazean coal fields, but it will be December before the line is connected with the colleries. The Peace River branch west of the McLeod River is being graded.

Telkwa, B.C.—Men who went south from here over a week ago to investigate the discovery of placer gold, reported by Price, Ecksley and Pearson, have returned to Telkwa satisfied with the richness of the field. The men who have returned, Colin Munro, Ira McLean and King, state that in no instance where panning operations have been carried on by men on the ground has a single barren pan been found. All showed coarse gold in varying quantities. The new find is on Sibbola Creek, one of the tributories of Tahtsa River, about 110 miles in a south-easterly direction from Telkwa, and about 50 miles from the headwaters of Kemano River, which empties into Gardner Channel. The men who have gone in from here have taken the Morrice River trail. It is hardly necessary to state that the stampede is on in full blast in this locality. In fact, construction work on the G.T.P. may be seriously impeded, as five thousand men are now employed within a radius of 125 miles of the new find. The field can be reached from the outside by boat up Gardner's Channel, thence up the Kemano River, but there is a most difficult country to traverse for over 50 miles. Outside expeditions would have to carry all supplies from the point of embarking. The lack of provisions for men in the field is causing not a little anxiety here, as every pack horse is on the trail coming out.

Montreal, Que.—Many prominent officials of the C.P.R. and Dominion Bridge Companies were present when a made-to-order steel bridge, weighing 2,600,000 pounds was swung across a 270-foot gap in one hour and 25 minutes, a feat accomplished by the Dominion Bridge Co., when placing the third of the four great spans, each 400 feet in length, of the Lachine bridge. The Gazette says in regard to this piece of bridge engineering:—"The admirable manner in which all these great spans have been raised to position, while the regular traffic continued, marks a triumph of engineering. Indeed, the whole double-tracking of the bridge has been accomplished while every train ran on schedule time."

Brighton, Ont.—Water was turned on last week in the new system of supply that has just been completed by J. G. Mill, contractor, Toronto. The water, obtained from Spring Valley, is very pure. The springs have a daily capacity of 700,000 gallons. The water is distributed by gravity, having a two hundred foot head two miles from town. Consulting engineer, T. Aird Murray, Toronto, made a test of the system, which showed 86 pounds pressure on the main street with 100 pounds as the best, and 70 pounds as the worst, pressure throughout the entire town. A reservoir has been constructed in Spring Valley providing storage sufficient to supply six lines of fire hose continuously for twenty-four hours, as well as to accommodate the town's domestic requirements. Brighton, which has a population of 1,600, has not previously had a public water supply.

Vancouver, B.C.—The directors of the Burrard Inlet Tunnel and Bridge Company have decided not to take any action with regard to the Second Narrows bridge project until a definite reply as to the Provincial Government's intentions has been received. The provincial authorities have been asked by the bridge company to assume control of the scheme for spanning Burrard Inlet, and an answer is expected from the British Columbia government within a month when the premier shall have returned from England. Concerning the subsidies sought by the company from the Dominion Government, rumors at Ottawa that the Second Narrows bridge project had been abandoned, have delayed the efforts of the company's agents at the capital; but the president and secretary have denied the reports, and have explained that the company has asked the province to assume control of the enterprise.

Victoria, B.C.—The growth in the establishment of private wireless stations by commercial firms throughout British Columbia has been commented upon by Mr. E. J. Haughton, district superintendent of the Dominion Radio-Telegraph service. In addition to five private installations in Vancouver and twelve in Victoria, which are, for the most part, used by students engaged in the scientific study of radio-telegraphy, there is one firm operating its own plant and sending all its messages to the nearest Government station. The Canadian Explosives Company, on Bowen Island, keeps an operator on duty during working hours, while a high power plant at Cousins Inlet, operated by the Cousins Inlet Pulp Company, transmitted messages to the Government station at Triangle Island until recently. This equipment was of five kilowatt power, owing to the fact that the factory was surrounded by hills, which interfere with wave transmission. Plants have also been proposed for the B.C. Fisheries Company on Queen Charlotte Islands and the Powell River Pulp Company, which, if put into operation, would transmit messages with Alert Bay and Cape Lazo stations respectively. In addition to these wireless plants, a telephone line is now in operation between Suquash Mines and the Government station at Alert Bay, while a second line to transmit telegraph and telephone messages is now under construction between Masset and Dead Tree Point.

Guelph, Ont.—The Ontario Municipal Electric Union carried unanimously the following resolution by the meeting of its representative held recently in the Guelph city hall:—

"In view of the comprehensive scheme outlined by the Dominion Government for the creation and improving of waterways in connection with the St. Lawrence River, Welland Canal, French River, Sault Ste. Marie, Trent, Ottawa and others involving the large expenditure of public money, and in view of the extensive developments which are possible in consequence thereof, also in view of the power requirements of the province, be it resolved that this association request the Dominion Government to put such water powers under the jurisdiction of the Hydro-Electric Power Commission of Ontario, to be developed by them for the use of the municipalities of the province for the benefit of the people." This step was taken to forestall any action on the part of the Government to hand over the control of such a valuable asset to a private corporation.

Spokane, Wash.—The Pacific Logging Congress, held at Spokane, in the latter part of September, announced that the association will make an endowment of $600,000 for instruction in logging engineering in five state universities and in a university in British Columbia.

Montreal, Que.—This year the city of Montreal has carried out a scheme of work and repair on its pavements and sidewalks unprecedented in extent and thoroughness. Mr. G. B. Garneau, superintendent of repairs, gave the following report to the city's board of control:—"In the three divisions of the city, 54,500 square yards of asphalt and 24,000 yards of granite and scoria blocks, a total of 78,880 yards, were repaired this year. In the same three divisions, 13,000 yards of cement sidewalks, 13,000 yards of asphalt sidewalks, and 13,500 yards of stone flag sidewalks were repaired. In addition must be counted repairs to cuts in the pavement. In the eastern division the following cuts were patched up:—5,250 yards of asphalt and 200 yards of granite and scoria block pavements; 625 yards of asphalt, and 150 yards of cement sidewalks."

PERSONAL.

JORO NAGATO, mechanical engineer, is in Canada as a representative of the Japanese Government, to study recent discoveries and developments in mechanical constructions. All the larger cities of the Dominion will be visited.

F. J. HERLIHY has been appointed supervising engineer of the Montreal aqueduct. Mr. Herlihy comes from Great Falls, Mont., where he was in charge of bridge and building construction for the Great Falls-Lewiston division of the Milwaukee line.

MR. W. B. GAIR, director of the Great Central Railway, England, has reached Canada after an extended trip over several of the important American roads. Mr. Gair is accompanied by several engineers, their object being the study of transportation methods in America. They will travel for some distance over the G.T.R. and C.P.R. to further their researches in respect to the Canadian procedure in the handling of frieght and of passengers.

GUY H. MORTON, B.A.Sc., manager of the Calgary office of the Canadian Westinghouse Company, has been appointed lecturer in electrotechnics by the technical education committee of the Calgary Board of Education. Mr. Morton is a graduate of four years' standing of the University of Toronto. CARL STERNBERG, a graduate in electrical engineering, of the University of Minnesota, is in charge of laboratory work.

A. D. CREER, M.Can.Soc. C.E., A.M.I.C.E., who has been in charge of the investigations and reports of the greater Vancouver sewerage scheme, with R. S. Lea of Montreal as consulting engineer, is now engineer to the recently-formed Burrard Peninsula Joint Sewerage Board. Mr. Creer has specialized in hydraulic work and previous to his coming to this country, some three years ago, he was for 13 years on the staff of the late James Munsergh, F.R.S., past president Inst. C.E.

OBITUARY.

A. L. ADAMS, a prominent engineer of San Francisco, Cal., died at his home a few weeks ago. Mr. Adams was well known in Victoria, B.C., where he made several reports in connection with the city's waterworks system.

THE REGINA ENGINEERING SOCIETY.

The first meeting for the season of the Regina Engineering Society, took the form of a banquet at the Hotel Metropole, Regina. The speakers included Lieut.-Gov. Brown, Hon. J. A. Calder, Mayor Martin, J. F. Bole, A. J. McPherson, R. O. Wynne-Roberts, A. P. Linton, L. S. Cockburn and O. W. Smith.

THE CANADIAN RAILWAY CLUB.

The October meeting of the Canadian Railway Club will be held at the Windsor Hotel, Montreal, October 14th. Mr. R. F. Uniacke, Bridge Engineer, National Transcontinental Railway, will deliver an illustrated lecture bearing upon engineering problems encountered in the construction of the N.T.R.

COMING MEETINGS.

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

RAILWAY SIGNAL ASSOCIATION.—Annual meeting will be held at Nashville, Tenn., October 14th to 16th. Secretary, C. C. Rosenberg, Times Building, Bethlehem, Penn.

NATIONAL SOCIETY FOR PROMOTION OF INDUSTRIAL EDUCATION.—Annual convention to be held at Grand Rapids, Mich., October 19th to 25th. Secretary, C. A. Prosser, 105 E. 22nd Street, New York City.

AMERICAN MINING CONGRESS.—Annual convention will be held at Philadelphia, Pa., October 20th to 25th. Secretary, J. Callbreath, Majestic Building, Denver, Colo.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.—Annual convention will be held at Montreal, Que., October 21st to 23rd. Secretary, C. A. Lichty, 319 N. Waller Avenue, Chicago, Ill.

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

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

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