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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Strength of Various Long Columns

Formulae Derived from the Results of a Large Number of Tests on Columns for Mild Steel and Wrought Iron—Value of the Constant in Euler's Formula for Different Conditions of the Bases—Elastic Limit of Normal Steel In Tension and Compression Similar

By WILLIAM JACKSON
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THE accompanying article regarding the development of formula covering strength of long columns will be of interest to many readers.

Safe load	Equals	P
Area of cross-section	"	A
$\frac{P}{A}$	"	p
Maximum eccentricity or deflection	"	a
Width	"	h
Radius of gyration	"	r
Stress on outside fibre	"	f
Average stress on outside fibre	"	f′
Stress and outside fibre due to bending	"	f″
Length	"	L
Constant	"	K
Modulas of elasticity	"	E
Distortion of fibres or shrinkage under load	"	d
Angle	"	i

Radius=R

Referring to small sketch of column

$$i \text{ Equals } \frac{L}{R} \text{ Equals } \frac{d}{h} \text{ and } R \text{ Equals } \frac{Lh}{d}$$

$$a \text{ Equals } 2R \sin^2 \frac{i}{4} \text{ Equals } 2R \text{ arc}^2 \frac{i}{4}$$ angles under consideration are small

$$\text{then } a \text{ Equals } \frac{2Lh \times d \times d}{d \times 4h \times 4h} \text{ Equals } \frac{Ld}{8h} \quad \ldots\ldots 1.$$

If the load be applied so that it is evenly distributed over the end of the column and in such a manner as to allow the column to move freely one way, and if it be assumed that the curve of a bent column can be figured as a parabola, as curves under consideration are very flat, then f′ on the inner side of the column will be

$\frac{2}{3}$f″ plus p Equals f′
but $\frac{2}{3}$f″ plus $\frac{2}{3}$p Equals $\frac{2}{3}$f
then $\frac{2}{3}$f″ plus $\frac{1}{3}$p Equals f′

$$\text{Then } d \text{ Equals } \frac{(\frac{2}{3}f \text{ plus } \frac{1}{3}p)L}{E} \quad \ldots \text{ Inner side} \ldots\ldots 2.$$

In the same way f′ on the outer side of the column will be
f′ Equals—$\frac{2}{3}$f plus $\frac{5}{3}$p

$$\text{Then } d \text{ Equals } \frac{(-\frac{2}{3}f \text{ plus } \frac{5}{3}p)L}{E} \quad \ldots \text{ Outer side} \ldots\ldots 3.$$

Subtracting equation No. 3 from No. 2 will give the difference in shrinkage between the inner and outer edges.

$$\text{Then } d \text{ Equals } \frac{\frac{4}{3}(f-p)L}{E} \quad \ldots\ldots 4.$$

substituting this value of d in equation No. 1

$$\text{then } a \text{ Equals } \frac{(f-p)L^2}{6Eh} \quad \ldots\ldots 51.$$

Formula for eccentric loading is

$$p \text{ Equals } \frac{f}{1 \text{ plus } \frac{ah}{2r^2}} \quad \ldots\ldots 6.$$

Substituting the value of in equation 5,

$$\text{Equation No. 6 becomes } p \text{ Equals } \frac{12E}{\frac{(L)^2}{(r)}} \quad \ldots\ldots 7.$$

which is the same form as Euler's formula, it being for columns with round ends

$$p \text{ Equals } \frac{10E}{\frac{(L)^2}{(r)}} \quad \ldots\ldots 8.$$

It is a question whether or not the constant 12 is in error owing to the asumptions made, although a column loaded as above mentioned would be stronger than a column with round ends.

Theoretically, for a perfect colunm, centrally loaded, the strength is constant for increasing lengths, this strength being "for practical purposes the true elastic limit of the material" until the critical length is reached under which the column bends indefinitely under its maximum load, when for any further increase in length the load which will produce this bending regularly diminishes in accordance with the law of Euler's curve.

The theoretical locus, therefore, of the maximum strength, for the value of P plotted to $\frac{L}{r}$ would be a horizontal line at the true elastic limit of the material, extended to an intersection with Euler's curve "plotted for the maximum value of E of the material and then down along this curve indefinitely.

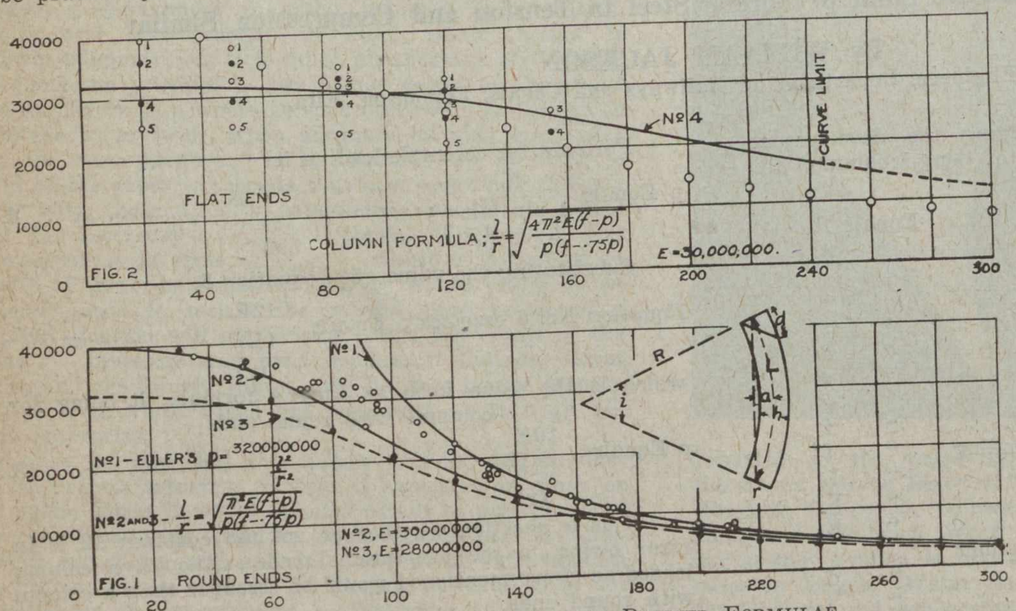
A large number of tests of columns have been made and all possible care has been taken to insure that they are centrally loaded, but the result of these tests of short columns do not follow the above mentioned locus, as it would appear that the columns must have different values of E on each side which could be caused by minor defects. As soon as this is assumed this neutral axis is moved and the radius of gyration is decreased; a theoretical formula could be developed so that the minimum strength of a column, with different values of E, could be found, but it would then be necessary to find from actual tests the correct value of E to use; the same result can be obtained by making E in equation 3 equal to kE and formula 7 then becomes

$$\frac{L}{r} \text{ Equals } \sqrt{\frac{12E\ (f-p)}{p\ (f-kp)}} \quad \ldots\ldots 9.$$

This formula would then give the minimum strength of a centrally loaded column with different value of E.

The next step is to find the value of the constant in Euler's formula No. 8 for the different conditions of the ends; it has been shown by various authors that this is 10 for round ends, 40 for rigidly fixed ends, and about 22.5 for one round end and one rigidly fixed end. Columns with pin connected ends show a great difference in strength even for the same size pins and the writer believes 10 should be used. Columns with flat ends should be as strong as columns with rigidly fixed ends until tension occurs in the ends at the inner edges of the bent column. This occurs when f is equal to 2p, so it would appear that 40 is the constant until this limit is reached. This limit is shown in figure No. 2.

If the top chord of an ordinary through truss be considered, the end at the bridge seat could be taken as a flat end, and if the member between the bridge seat and panel point number one curved to the right when the bridge was loaded and the members in the other panels curved to the left, and right alternatively, the intermediate members would be practically columns with rounds ends, and it would ap-



Comparison of Euler's Curve with Derived Formulae

pear that 10 should be the constant to use for the intermediate members and 22.5 for the member in the first panel.

On page 685, "Engineering News" dated December 26th, 1907, there is an article, by C. P. Buchanan on tests of pin connected columns, made by the Engineering Department of the Pittsburg, Cincinnati, Chicago and St. Louis Railway. The measurements to find the change in length of the members under loads were taken from the centre of the end pins of the columns, therefore, these measurements must include all rivet slip so it would appear that this is the reason for the low elastic limits (from 13,200 up) shown by these tests. It has been shown that the rivet slip between two members with a number of rivets is progressive, and this would account for the uniform curves of sets.

On page 644, "Engineering News-Record," June 28th, 1917, there is shown typical tests, curves of solid riveted columns. These tests were made for a committee of the American Society of Civil Engineers, and the writer presumes these are the basis of their new formula. This article does not give the true or apparent elastic limits of the material but the curves show that the set increases at a load of about 15,000 lbs. and this is due to rivet slip. If rivets be driven in a piece of steel and the steel is stressed in compression or tension the stretch or shrinkage will only occur in the material between the rivets until the pressure overcomes the friction between the steel and the rivet heads. This means that the true or apparent elastic limit of the material cannot be found by testing a riveted column.

The writer has not seen any explanation of the great decrease in strength of the columns built with heavy material. The specifications according to the article called for a yield point in tension of 37,000 to 39,000 pounds per square inch, and it was left to the mills to adopt any method to procure these results. The analysis showed that practically no chemical differences existed in the thick and thin material. The question now arises, how were the yield points of the heavy material increased and what effect had it on the elasticity of the material when in compression. The writer has very little data on the effect of increasing the elastic limit of the material in tension by rolling, but if the elastic limit in tension be increased by loading, it has been shown that this destroys the elasticity of the material in compression. The method and its effect on the yield point in compression would be of considerable interest to engineers.

The point that interests engineers is the true elastic limit of the material There is a great difference between this point and the ultimate strength in short column as the value of $\frac{L}{r}$ increases, these becoming practically the same point. The tests shown in the last article referred to do not extend far enough to enable a curve to be fitted to them. The writer plotted all the results and then eliminated the tests that did not appear to have a uniform decrease in strength as the ratio of slenderness increased.

Formula No. 9 was then fitted to the tests so that the difference between it and the ultimate strength of the shorter columns was greater than the difference between it and the ultimate strength of the longer columns, and this gave a value of 75 for k. The large circles in Figure 2 show the average of Christie's tests of wrought iron columns with flat ends, but a curve through the true elastic limits would have an entirely different form. Figure 1 shows formula No. 9 plotted for round ends and is merely to show the form of the curve. The small circles show Tetmajor's test taken from page 365 of "Johnston's Materials of Construction." The solid circles are the average of Christie's test of wrought columns with round ends. The writer believes that a constant could be found for formula No. 9 so that a uniform minimum strength of columns could be found.

The writer is of the opinion that the earlier authorities were correct when stating that for practical purposes the elastic limit of normal steel in tension and compression were the same.

The town of Woodstock, N.B., is contemplating the adoption of the Town Manager System. W. P. Hammersley, manager for the town of Norwood, Mass., met the Woodstock council and gave an interesting account of his experiences. In Norwood, the tax rate was reduced by 69.5 per cent. under this system. It is understood that the Woodstock town council will ask for applications from men experienced along these lines.

The Engineering Corporation, Limited, is the name of a new organization just formed to engage in general engineering and construction work, to be associated with DuCane, Dutcher & Co., Vancouver. The directors will include Jasper S. Connell, Major G. A. Walkem, R.E., Howard K. Dutcher and Lieut.-Col. C. G. DuCane, O.B.E., upon his return from Europe. The corporation's offices will be 903-906 Rogers Building, Vancouver.

W. N. McEachern & Sons, Ltd., of Windsor, who are building a model home community of 500 houses to provide homes for the increasing population of Walkerville, Ont., have been awarded the contract for a similar community at Goderich, Ont., for the Lake Huron Steel Corporation, at a contract price of $1,500,000. The town of Leamington and the city of Sarnia are also considering similar propositions and may begin construction in a short time.

BITUMINOUS MACADAM*

By A. W. Dean,
Chief Engineer, Massachusetts Highway Commission

A BITUMINOUS macadam pavement is one having a wearing course of macadam with the interstices filled by a penetration method with a bituminous binder.

Such pavements were built in a rather crude manner in England and France in the early part of the nineteenth century, but were nowhere extensively built until little more than ten years ago, when the change in vehicular traffic and consequent increased destruction of waterbound macadam pavements made necessary the construction of a surface to withstand the new destructive forces on the roads. In the United States, the year 1908 marks the real beginning of this type of pavement, although a few small experiments or attempts were made previously. The first results achieved, while at the time appearing successful, were not durably satisfactory, due to the fact that improper materials and workmanship were used. Further experimental construction and careful observation of results obtained by varying the character of material and method used have resulted in a widespread use of this type of pavement at the present time, and when properly constructed it has proved to be an economical type where the vehicles to be propelled over it are not extremely heavy.

Preparation of Foundations

In the construction of this pavement, as in that of any so-called permanent type, proper drainage and foundations are absolutely essential. Moisture and frost action under the road crust are just as destructive as in the cheapest or most expensive pavements.

If the subsoil is a gravel or suitable sand, no artificial foundation may be necessary, but if of clay or other improper material, a foundation course consisting of stone or coarse gravel should be placed. If of stone, the interstices should be thoroughly filled with gravel to prevent the clay subsoil from gradually working up and filling the voids in the stone, thereby permitting the moisture to permeate and destroy the foundation and pavement during frost action.

Upon the properly prepared natural or artificial foundation the first course of broken stone should be spread evenly and to sufficient depth to be of the desired thickness after rolling. No universal rule can be made covering the thickness of this course, as the local conditions vary so extensively. For example, in some localities, the subsoil is of such nature, and the materials available in the immediate vicinity are of such nature, that an artificial foundation of stone ten inches or more in depth may be laid and the first course of the pavement need be only about two inches in thickness. This is economical and satisfactory in localities where suitable stone for foundation is plentiful, but stone suitable for the first course of the macadam has to be imported at considerable expense. On the other hand, if the subgrade is a proper one so that artificial foundation is not necessarily used, the first or bottom course of the macadam should be not less than four inches in thickness after rolling, and, if heavy loads are to be sustained, a thickness of six inches is desirable.

Laying First Course

The stone in this course should be of uniform and good quality, and should be spread in such manner that there may be no segregation of large or small stone. The stones composing this course may vary in size from one-half inch to three inches in their longest dimensions, provided, however, that the percentage of the small size shall be very small. If the course is four inches or less in thickness, the best results are obtained, however, by using stone varying in size from one and one-quarter to two and one-half inches. The same minimum size is preferable in a six inch course, but the maximum size may then be three inches.

In laying this course the same methods should be used as in the laying of ordinary waterbound macadam, including thorough compaction by rolling, and securing a uniformly smooth surface. Unlike the first course in waterbound macadam, however, the voids in this first course must be filled with stone dust, fine gravel, or sand, in order to prevent wasting of bitumen by penetration into this course during the construction of the top course. It is essential that the surface of the bottom course be even and without depressions before laying the top course. After the construction of this course is completed, all surplus dust and fine material should be swept off, leaving the upper stones bare to receive the second or bituminous course.

Laying Second Course

After the completion of the first course as above set forth, the second course is spread at such thickness that it will be two inches thick after rolling if for medium or light vehicular traffic, or three inches thick if for heavy vehicles in large volume.

It is extremely important that the stone used in this course be of good quality, uniform in character, and so spread that there is no segregation or large or small sized stones. If building for light weight vehicles only, the stone used may have a French coefficient of wear as low as eight and a hardness value of eight, but for heavy vehicles a better quality of stone should be obtained if possible, using in such case a stone having a French coefficient of not less than twelve, and preferably even greater, and a correspondingly higher hardness value.

The best and most lasting results are obtained if the sizes of the stone in this course vary from three-quarters inch to two and one-half inches, with the larger sizes predominating. This has been proven; even though it appears inconsistent to use a two and one-half inch stone in a course two inches thick.

Extreme care should be had in the laying and rolling of this course to have it uniform in its component sizes of stone and rolled to a uniform thickness. The rolling should be thorough, in order to reduce the voids and make the surface hard and smooth, although not as thorough as in the case of water bound macadam roads.

After rolling, the bituminous material should be applied at a temperature of 250° to 300°F., with a mechanical distributor that will force the material onto the surface uniformly, such force being equivalent to that obtained under a pressure of thirty pounds or more to the square inch. The amount of bituminous material used per square yard in this application will vary from one and one-half gallons on a two inch course to about two and one-half gallons on a three inch surface. Great care must be had in the distribution of the bitumen to prevent getting too much or too little material in spots or streaks, otherwise "bunches" or depressions, as the fault may cause, will soon develop.

Surfacing With Bitumen

After spreading the bitumen, it should be lightly but completely covered with pea stone (½-in. stone) and thoroughly rolled, using a fifteen ton roller if available, and if the stone is of hard quality, or a somewhat lighter roller if of a poorer quality stone. Success will not be obtained if this course is not thoroughly rolled.

A seal coat of the same quality of bitumen is then applied, using one half gallon of bitumen to the square yard for this application, then covering again with pea stone and finishing with the heavy roller.

When the bitumen is applied the stone should not be wet but may be moist, and in all cases must be absolutely clean and free from dust. The bitumen used may be an asphalt or tar product, and as this paper is somewhat limited, the details of specifications for this material are necessarily omitted.

Whether of asphalt or tar, the bitumen should be properly refined and prepared for use in this type of construction, its properties varying slightly with the climatic condition of the territory in which it is to be used.

In northern climates like that in the New England States and lower Canada the best and most lasting results

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*Paper read before the Sixth Canadian Good Roads Congress, May 22nd, to 24th, 1919.

appear to be obtained by using an asphalt having a penetration of ninety to one hundred and ten, as determined by the standard method of testing adopted by the American Society for Testing Materials.

The United States Department of Agriculture has published a bulletin, (No. 691), giving specifications somewhat in detail for bituminous materials of different kinds and for different uses, which bulletin is available for distribution. Reference is here made to that pamphlet for more details, but the writer believes from experience and observation that for penetration work in northern climates the asphaltic material should be a little heavier than that suggested in said specifications.

Precautions

Where properly built under suitable climatic and traffic conditions, the bituminous macadam pavement is economical both in construction and maintenance. If a hole appears in the surface it should immediately be patched, using a mixture of small stones and hot asphalt or tar. If a general breaking of the top surface appears imminent, it should be given a seal coat of hot asphalt and pea stone before such breaking up occurs.

A few condensed rules are here given for the prevention of unsatisfactory results with bituminous macadam.

Be sure that the drainage, subgrade and foundations are suitable.

Have the surface of the bottom course even and without depressions before laying the top course.

Have the larger sizes of broken stone predominate in the top course.

Use dumping platforms or self-spreading wagons for spreading all broken stone.

Use a sufficiently hard bitumen for both penetration and seal coat, as a soft material permits the surface to soon become wavy.

Get all penetration work complete during the spring and summer months. If done in the late fall the penetration is not complete and the pavement is liable to become loose in the following winter.

Patch holes immediately if they appear in the surface.

If tar is used, apply a light seal coat at intervals of two or three years.

PUBLIC UTILITY COMPANIES IN 1918

Large Increase in Volume of Business, but Profits are Less Owing to High Operating Expenses

COMPARATIVE statistics of express, telephone and telegraph companies in Canada during the year ended June 30th, 1918, were given in the Dominion House of Commons on April 24th by Hon. J. D. Reid, Minister of Railways. The statistics were compiled by the statistical branch of the Department of Railways. Those dealing with the express companies show that the operating mileage on June 30th, 1918, was 43,247 in Canada, which was about the same as in the previous year, while foreign mileage was 19,296, an increase of about 3,000 miles. The cost of property and equipment of express companies was $1,949,246. Gross receipts totalled $18,680,092, as compared with $16,836,373 in the previous twelve months, while the net operating revenue was $450,243, as against $1,096,111 for the year ending June 30th, 1917. The net corporate income of the express companies was $443,535. In 1917 a dividend of 10 per cent., amounting to $200,000, was paid by the Dominion Express Co. and a similar amount applied to reserves, leaving a credit balance for the year of $522,123. Dividends were not declared by the express companies in 1918, nor were any sums set apart as reserves.

Telephone figures indicate a substantial development of the telephone business for the year ending June 30th, 1918. The number of reporting units increased from 1,695 in 1917 to 2,007 in 1918. The growth was greater in Saskatchewan than in any other province. The number of reporting units by provinces were as follows: Prince Edward Island, 32; Nova Scotia, 143; New Brunswick, 31; Quebec, 173; Ontario, 528; Manitoba, 38; Saskatchewan, 727; Alberta, 8; British Columbia, 14; Yukon, 1. It is noted that the governments of Alberta and Manitoba own practically all of the telephone systems in the two provinces. Saskatchewan is also a large owner of telephones, but there are in addition, in that province, about 1,000 lines in the hands of private organizations. The capitalization of telephone companies operating in Canada is given as $85,274,691 and the cost as $104,368,627, an increase of $10,000,000 as compared with 1917. Earnings of the telephone companies in the last twelve months under review amounted to $22,753,289, while operating expenses totalled $13,644,524. Net earnings as represented in the difference between gross receipts and operating expenses were $9,108,765 in 1918, as compared with $8,025,855 in 1917. Additions to and subtractions from primary net earnings reduce that amount to $5,187,323.

Coming to the telegraph companies, the figures presented show that on June 30th, 1918, their cost was placed at $10,226,988, a slight increase over the previous year, while the capitalization of the companies having headquarters in Canada was $6,300,000. The gross revenue was $7,770,646, as compared with $7,272,755 for the previous twelve months. Operating expenses were $5,820,335, as compared with $4,940,228 during the previous year. The net operating revenue amounted to $2,016,429. Wire mileage totalled 210,100, a slight increase over the previous year. The number of telegraph offices totalled 4,664, as against 4,615 at the end of June, 1917.

PULLMAN HEATING TUNNEL*

By C. M. Dibble

OF the many details necessary to the installation of the new shell shop, for the Pullman Car Works, one of the largest, and at the same time, one of the most important, is the heating tunnel. It runs from the rolling mill to the north end of the shell shop, and then around to the west side, where it meets the present tunnel from the boiler and power house, a length of about 1,170 feet.

This tunnel is made of reinforced concrete, and is four feet wide by five feet high inside. The top of the tunnel is practically at yard level, and is designed to carry a load of about one thousand pounds per square foot.

In the tunnel is a fourteen-inch steel pipe line which carries the exhaust steam from the rolling mill engines to the radiators in the shell shop. This steam was formerly allowed to escape into the air.

Ordinarily the pipe would have been put in with flanges screwed on both ends of each 20-foot length, the ends then being bolted together with gaskets between them. We have done away with all this by welding our individual lengths together by means of the acetylene torch. In addition to this saving, we are able to use a thinner walled pipe, there being no threads to cut.

Each length before being placed in the tunnel has both ends chamfered with an air chisel. The lengths are then placed with the ends butted together, the chamfers joining a V-shaped groove. The welder fills the groove with the acetylene torch, revolving the pipe on temporary rollers as he proceeds around it.

After the lengths are all welded into one long pipe, permanent rollers are placed under it to permit free travel for its expansion when heated by the steam. This expansion causes a lengthening of the pipe of from eight to nine inches in the run from the rolling mill to the shell shop. This travel is taken up by means of an expansion joint which is in effect an enlargement of the pipe on one side of the joint within which the other side slides back and forth. The steam is prevented from escaping by means of packing between the outer and inner pipes.

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*The Pullman Car Works Standard.

Letters to the Editor

ACT RESPECTING THE ENGINEERING PROFESSION

Sir,—The attention of engineers throughout Canada is at present focussed on the draft of the proposed "Engineering Profession Act." Members of the Engineering Institute of Canada will shortly have the opportunity to approve the bill or reject it. In the meantime an interchange of ideas on the subject between engineers is very desirable, and I would ask some space to voice my own observations.

I take it that the general intention of the proposed Act is firstly to raise the standard of what one might call professional capability among men to whom engineering works of importance are entrusted, and secondly to protect qualified engineers by securing better recognition of the value of their services. Taking a charitable view of the draft and interpreting it broadly we find that these results are likely to be attained. In some individual cases injustice may occur, but in general, admission to practice may be secured either on the grounds of past experience or unquestioned ability, or by means of passing an examination or successfully completing a course at a recognized engineering college.

On the other hand those who are less charitably inclined see in the Act an instrument whereby consulting engineers who have been practising for five years previously to the passing of the Act secure for themselves, and any who may be associated with them as assistants, a perpetual and indisputable inheritance. The highly trained engineer employed by a corporation must submit to an examination before he is admitted to the association. A man many years his junior who stuck out a shingle and called himself consulting engineer several years before the passing of the Act has nothing to do but pay his fees.

What guarantee have we that the broad interpretation of the Act will be made, and not the narrow? How shall we read clause 7, paragraph (i)? In any large corporation the head of an engineering department is not materially responsible for the results of his work. The corporation assumes the material responsibility. But he *is* morally responsible to the engineering profession and the public. The ability to shoulder this moral responsibility should undoubtedly entitle him to admission, for he is unquestionably acting as professional engineer. Likewise, his assistants are unquestionably in the service of a professional engineer.

If the association recognize the right of the corporation's paid engineer to admission a somewhat complex problem arises. Any engineer who carries out engineering works in the course of his duties must be registered engineer, unless it can be shown that he is working under the direct supervision of a registered engineer, otherwise he "usurps the functions of a Professional Engineer," and is liable to heavy penalties. This direct supervision implies not merely the affixing of a seal, but an intimate knowledge of the work on the part of the chief. The chief must be qualified to judge whether the safety of life and property is assured, and he must actually satisfy himself that this is the case. The Act is virtually controlling the engineering staffs of private corporations, an undertaking not to be assumed too lightly. Yet it is the individual who is mulcted for infringement of the Act and not the corporation. If the association deny the right of the paid engineer to admission the foregoing difficulties are obviated, but a gross injustice is perpetrated.

Again, the field of the professional engineer's activities is described in embracing terms. There is no distinction between works of greater and lesser magnitude. Is the designer a builder of small machine tools, marine motors, electrical apparatus and so forth eligible for admission? If not, is he liable to the heavy penalties prescribed for practising as a professional engineer in as much as he designs and supervises the construction of "steam engines, turbines, pumps, internal combustion engines, . . . electrical machinery and apparatus, etc."? We engineers have no right to impose such restrictions on the operations of men with practical knowledge.

Section 11 is fraught with terror for the aspiring applicant for an engineering position unless he be provided with the "Open Sesame"—a certificate of registration. He must be very modest indeed with regard to his accomplishments otherwise he is in danger of "acting in such manner as to lead to the belief that he is authorized to fulfill the office of or to act as professional engineer." Before we run the risk of such terrors we want to know that we can obtain admission on our merits.

Another important point is to settle what limits there are to the privileges bestowed upon the professional engineer. There is nothing in the title to show what branch of engineering the holder is proficient in, nor is there anything to prevent a structural expert trying his hand at hydraulic turbine design, or an electrical engineer designing a steel structure. Yet, unless the admission to practise is made fairly and squarely upon the basis of proficiency the Act will bestow upon the fortunate holder of a registration certificate a most unfair advantage over the non-registered man who is an expert in some particular branch.

In conclusion I wish to accord due credit to the committee for the results achieved.

The scope of the Act, however, is so far reaching, and the pitfalls to be encountered in legislation are so many, that I hope and feel sure the matter will be considered at much greater length, and by the engineering body of Canada as a whole, before we are committed to a final draft.

H. S. GROVE.

Lachine, Que., May 15th, 1919.

Sir,—Before voting on the proposed "Act Respecting the Engineering Profession," it is to be hoped every engineer with a vote will carefully read the document as printed in the May Journal. I would particularly ask the attention of of those engineers, who are employed professionally by private and public corporations, by industrial concerns and contracting companies, to the provisions of the proposed Act and would respectfully ask them *what earthly chance they have* of becoming "Professional Engineers," protected by such legislation as the proposed Act. From first to last, as with all the schemes for legislation, the bill is for the protection of the engineer in private practice. His status and not his qualification is the criterion as to his eligibility to belong to the new association. Notice, gentlemen, that is is a *new* association, that your membership, whether Associate or Full, in the Engineering Institute of Canada has nothing to do with the question of your being a "Professional Engineer" within the meaning of the proposed Act. Qualification enabled you to reach membership in the Engineering Institute of Canada—qualification will never get you into the "Association of Professional Engineers." It is an entirely separate and distinct organization established or to be established on a provincial basis, and a cumbersome system of interprovincial licensing is referred to under Section e and g of Article 7, page 412. Quebec members should also refer to the Quebec Act as printed in the By-Laws of the Engineering Institute of Canada, Article 2, Sub-head b, where they will find a clause suggesting that certain individuals cannot be kept out of this proposed association whether qualified for membership in the Engineering Institute of Canada or not. Section b of Article 2 of the proposed Act, page 411 tells us what a "Professional Engineer" may do, but doing these things does not make you or me a "Professional Engineer" under the Act, or even eligible for membership in the proposed association The last clause of this Section b, together with Section i of Article 7, carefully excludes all such engineers as are employed by other engineers, whether under individuals, companies, or even governments. The question, therefore, arises, "When does an engineer become a "Professional Engineer"? It may be argued that the proposed Act is not intended to apply to engineers not in private practice. If so, why should the members of the Engineering

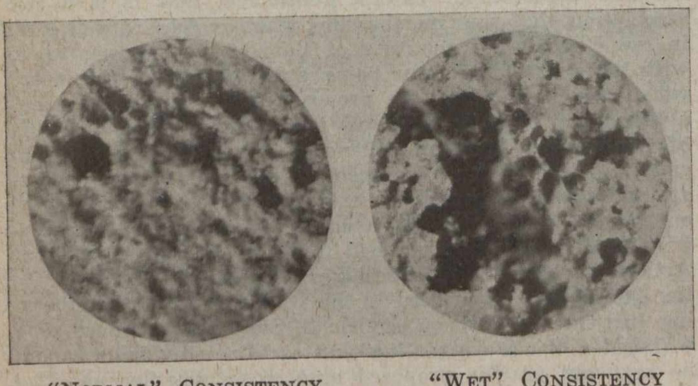
Institute of Canada as such be requested to vote upon it? But even assuming that the Act applies only to engineers in privtee practice, surely we may ask whether this is the full fruition of the legislative hopes that have been raised in the Institute meetings, and is this the only outcome of all the proposals and questionnaires that have been laid before us? Are the rest of us to shift for ourselves? Meetings have been suggested and have actually been held in certain branches for the promotion of the interests of professional technical employees or employed engineers. These gentlemen constitute a numerous section of the Institute membership, but within the Institute form probably an uninfluential group; however, it is the group that most assuredly and most urgently needs recognition and consideration. The bait of "legislation" has been hung out for such engineers to bite at and their votes have apparently been obtained in favor of some degree of legal action, but what are they going to gain? By the present bill—Nothing! From the present activities of the Institute branches—also nothing! (seemingly). What is to be the solution? It would appear from the general trend of opinions expressed that some solution is desired. Have we, therefore, an official precedent or example set for us in this protective measure for engineers in private practice? Must we also seek an "Association of Employed Engineers," separate and distinct from the Engineering Institute of Canada to attend to this feature of our joint welfare? Such a scheme has been suggested, and in other countries such associations are being shaped. Should the association, if formed, seek government recognition and have its members rated as professional men? These are some of the questions that should attract the attention of the corporate members of the Institute, and it is seriously hoped that some means may be found, apart from a pure union, by which the general interests of the professional employees may be advanced. In the meantime *READ THE PROPOSED ACT AGAIN* and ask for a meeting of your branch *BEFORE THE BALLOT IS CALLED.*

P. L. PRATLEY.

Westmount, Que., May 13th, 1919.

CORRECTION

IN the placing of Figure 1 on page 449 of last week's issue of *The Canadian Engineer* the cut was inadvertently reversed. Those who are interested in "The Bulk



"NORMAL" CONSISTENCY "WET" CONSISTENCY

FIG. 1—TEXTURE OF CEMENT MATRIX IN CONCRETE OF DIFFERENT CONSISTENCY (x 60)

ing Effect of Moisture in Sands" will please note the change in the accompanying corrected reproduction of Fig. 1.

It is rumored, although unconfirmed, that the steel contracts for the proposed bridge over the Niagara River, near Bridgeburg, have been let. The construction of this bridge, if proceeded with, will take five years to complete.

HOT MIX ASPHALT PAVEMENTS*

By FRANCIS P. SMITH, Ph. B.
Consulting Engineer, New York

THE very desirable quality of flexibility possessed by bituminous pavements makes it necessary to provide a stable foundation. If the foundation is unstable and sinks after the pavement has been put down, the pavement will gradually sink with the foundation, thus forming a depression in which water will collect and eventually destroy it. The wheels of vehicles passing over such depressions will drop into them, the force of the blow depending upon the weight of the load and its speed, and this will still further exaggerate the depression by forcing up a portion of the pavement immediately in front of it. It will also set up a vibration in the springs of the vehicle which will cause successive blows to be dealt to the pavement until the spring vibration returns to the normal. This action, especially in commercial vehicles where the springs are short and stiff, results sooner or latter in wave formation which is unpleasant to ride over and which, when it once sets in to any considerable extent, rapidly increases until it becomes necessary to resurface the street or road. The same effect will be produced on a rigid foundation when the bituminous pavement is lacking in stability, due to a poorly graded mineral aggregate, too soft or too much bituminous cement, or a combination of these.

Drainage

The character of the foundation required will depend upon the traffic, climate, character of subsoil and drainage conditions. The heavier the traffic the stronger must the foundation be. In cold climates where the ground freezes to considerable depth in winter, the spring thaws produce a very unstable condition of the subsoil and in such cases the foundation must be stronger than is required in climates where there is little or no frost. A well drained sandy soil is much less affected by these temperature changes than is a heavy clayey soil. In all foundations, drainage is by far the most important single consideration. With adequate drainage, a much thinner foundation can be laid than where it is absent or imperfect and the cost of proper drainage is often far less than the added cost of an adequate foundation on imperfectly drained ground.

A number of different types of foundations have been successfully employed, such as old Macadam or Telford; broken stone rolled dry or cemented together with some form of bituminous cement; old cobblestone, Belgian block or granite set pavements, old brick or asphalt block pavements; bituminous concrete; natural cement and Portland cement concrete.

Where the traffic is light, as on country roads which are not main arteries from or between large cities and in some residential streets, old Macadam or Telford roads have proved to be suitable foundations for bituminous surface mixtures. In the opinion of the writer, Telford is preferable to Macadam owing to the fact that the larger stones composing its base have a partial slab effect and therefore resist more strongly any pressure tending to displace them or to force them into the subsoil. In some cases, notably the Thames embankment in London, a macadam foundation covered with an asphalt pavement has successfully carried very heavy traffic, but the layer of stone has been built up during many years and is very thick and the drainage is nearly perfect. Under very severe conditions the use of Macadam or Telford as a foundation for bituminous pavements is to be deprecated and more failures than successes have resulted from it.

Existing Pavements Utilized

Many roads are classified as Macadam which contain no base course of large stone and are in reality old dirt roads which have never been properly drained and on which fine stone has been dumped and consolidated by traffic. Before using any Macadam road as a foundation, its history,

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*Abstracts from paper read before the Sixth Canadian Good Roads Congress, May 21st, 1919.

and more particularly its condition in the spring of the year, should be investigated. A sufficient number of test holes should be put down to determine the character and depth of the stone and provision made for proper under and side drainage. It will usually be necessary to rebuild the road in a number of places and in most instances the crown must be reduced.

Old pavements of brick, granite, etc., should not be used as a base if it is first necessary to re-set them. In their original condition they are satisfactory if the traffic is not too heavy. Relaid blocks, until bedded by traffic, are not rigid, and have a tendency to rock, and asphalt pavements laid on such foundations in New York City have rapidly disintegrated wherever they were exposed to heavy traffic.

Portland cement concrete foundations vary according to conditions from 4 to 9 inches in depth, and in every case, before laying them, the subsoil should be thoroughly compacted and drained. In certain localities in the northwestern portion of the United States and Canada very heavy clay soils are found, which in winter frequently develop cracks 4 to 5 inches in width and heave very badly. In such cases cross trenches should be dug every twenty-five or thirty feet, and filled with coarse broken stone and connected with longitudinal trenches at the side of the street, similarly filled and draining to catch basins. Concrete should not be laid directly on such a soil. Sand or gravel should first be spread upon it to such a depth that when rolled it will form a layer 3 to 4 inches in thickness and the concrete should be placed on this.

Mineral Aggregates

Having briefly considered the questions of foundation and subgrade, we now pass to the wearing surface. This is composed of mineral aggregate and bituminous binder. The mineral aggregate constitutes from 80 to 90% of the pavement, and takes practically all the wear resulting from traffic. It must therefore be selected with great care. It must be hard enough to carry the traffic; it must have clean grains or particles to insure the bitumen adhering to them, and these grains or particles must be graded from coarse to fine so as to make a pavement of the maximum density, with the smallest sized voids obtainable and with sufficient inherent stability to resist displacement under the shoving action of traffic. The surfaces of the grains or particles must be of such a character that the bituminous cement will adhere satisfactorily to them. Earth, sand, gravel, broken stone or slag, and finely ground limestone or Portland cement or combinations of them, are the materials used in the type of pavements under discussion.

Earth. This is used in a special type of pavement which has been developed within the past five years. It should be of such fineness that at least 50% of it will pass a 200-mesh sieve and it should contain from 15 to 70% of clay, depending upon its character. This material requires a special kind of plant to handle it.

Sand should be clean grained, hard and moderately sharp. The grains should be chiefly quartz and should have rough pitted surfaces. Where necessary, the proper grading of the different sized grains must be obtained by mixing several sands or in certain cases by the addition of unweathered crushed screenings. When using the ordinary type of bituminous mixing plants the presence of clay is undesirable, either as a coating to the grains or disseminated throughout the mass. For medium or heavy traffic pavements all particles retained on a 10-mesh screen should be discarded. For light traffic, 3 to 5% of 8-mesh particles can be incorporated in the pavement with advantage or broken stone of the sizes and in the amounts described under "Topeka Mixtures." Sands containing a large amount of flinty grains should be avoided as bitumen does not adhere well to flint.

Gravel should be clean grained, hard and free from adhering clayey particles. It is lacking in stability owing to its roundness and is usually considerably improved by passing it through a crusher. Gravel with a rough pitted surface is to be preferred and gravel containing a large percentage of flinty particles is to be avoided. It is unsuitable for the construction of pavements carrying heavy traffic and inferior in all respects to crushed stone.

Broken Stone should be freshly crushed, preferably in cubical shaped particles. The size and hardness required depend upon the traffic which the pavement is to carry. Dense hard limestone will carry medium and light traffic satisfactorily. Where the traffic, even though comparatively light in volume, is composed of heavy iron-tired units, a dense hard trap is required. Trap is now commonly used in the manufacture of asphalt block, although in the past a large number of asphalt blocks made from limestone gave excellent service under light traffic. Granite is not usually satisfactory as it is too coarse and uneven in texture and much of it is friable and it is liable to shatter in crushing. Mesh composition or grading of the various sized particles is just as important as with sand. It is not suitable for use in pavements carrying very heavy traffic.

Slag: Hard, dense basic slag is to be preferred. It should be stable when exposed to the weather and not show any tendency to slack or disintegrate. It is only suitable for light traffic and should preferably be coated with a very fluid bitumen.

Filler:—This should be finely ground limestone or Portland cement, the latter being preferable for mixtures designed to carry extremely heavy traffic. For light traffic the writer prefers the limestone dust as it does not have such a marked drying effect. Whichever is used, it should be ground so that at least 65% of it will pass a 200-mesh sieve. Pulverized clay also makes an excellent filler but is difficult to handle owing to its tendency to ball and cake if it becomes the least bit damp.

Bituminous Binder, or asphalt cement as it is termed in the sheet asphalt industry, must possess such properties that it will firmly bind together the mineral particles and resist the disintegrating action of traffic and the elements. The necessary tests for determining whether or not it is possessed of these properties are fairly well standardized and are embodied in most standard specifications. The consistency of the bituminous binder varies somewhat with the type of mineral aggregate, but otherwise its general characteristics are about the same for all types of the pavements under discussion.

Types of Hot Mix Pavement

Out of the raw materials which we have discussed, four distinct types of hot mix pavement are laid. They are as follows:—

Sheet Asphalt, in which the mineral aggregate contains no particles which would be retained on a ¼-inch screen.

Topeka Pavements, which usually consist of a standard sheet asphalt mixture to which has been added from 15 to 25% of stone passing a ¼-inch screen and retained on a 10-mesh screen and approximately 10% of stone passing a ½-inch screen and retained on a ¼-inch screen.

Bituminous Concrete Pavements—(Bitulithic, Warrenite, etc.)—having a mineral aggregate consisting largely or wholly of stone of varying sizes from 1½ inches down.

Pulverized Earth Pavements—(National Pavement)—having a mineral aggregate composed wholly of pulverized clayey earth of such fineness that at least 50% of it will pass a 200-mesh sieve.

The following are typical analyses of the foregoing types of pavements:—

	Sheet Asphalt, Light Traffic. Per Cent.	Heavy Traffic. Per Cent.	Topeka Mixture. Per Cent.	Bituminous Concrete. Per Cent.	Pulverized Earth Pavement. Per Cent.
Bitumen	11.0	10.5	8.5	7.0	17.5
Passing 200 mesh ...	14.0	10.5	8.5	5.0	55.5
" 100 " ...	14.0	10.0	6.0	4.0	12.0
" 80 " ...	13.0	10.0	6.0	2.0	6.0
" 50 " ...	19.0	14.0	6.0	5.0	5.0
" 40 " ...	11.0	14.0	10.0	4.0	3.0
" 30 " ...	10.0	13.0	10.0	4.0	1.0
" 20 " ...	5.0	10.0	9.0	3.0	...
" 10 " ...	3.0	8.0	6.0	5.0	...
" 8 " ...	...	...	6.0	3.0	...
" 4 " ...	...	...	14.0	7.0	...
" 2 " ...	...	...	10.0	20.0	...
" ¾" " ...	...	...	...	14.0	...
" 1" " ...	...	...	...	12.0	...
" 1½" " ...	...	...	...	5.0	...
	100.0	100.0	100.0	100.0	100.0

Sheet asphalt will sustain a very heavy traffic. This statement applies more especially to a traffic largely composed of quick moving, light to medium loaded vehicles, such, for instance, as prevails on Ffth Avenue, New York. It is not the most suitable type of pavement for a very dense, slow moving, heavily loaded iron tired traffic. Wood block and granite block will outlast it under these conditions. It will not give satisfaction where there is practically a total absence of traffic, as it then is liable to develop cracks, apparently requiring the kneading action of traffic to equalize the stresses set up by contraction and expansion and to keep it in proper condition. It is entirely suitable, however, for traffic varying from the light delivery traffic of residence streets to the dense but quick-moving traffic of Fifth Avenue, New York, or the Thames Embankment, London.

Sheet Asphalt Pavement

Generally speaking, the heavier the traffic, especially iron tired traffic, the finer should be the mineral aggregate used, owing to the fact that the coarse particles are more liable to fracture than the smaller particles. Where fracture takes place to any considerable extent, rapid deterioration of the pavement will ensue, as the bituminous cement ordinarily used is not sufficiently fluid at atmospheric temperatures to rebond and re-coat the fractured particles, and these will quickly be pulverized and washed out, leaving depressions where water will accumulate and eventually rot the pavement. Where the traffic, *even though heavy,* is largely or wholly composed of rubber tired vehicles, a greater proportion of coarse particles is permissible and desirable. In proper proportions they add greatly to the stability of the pavement and under the conditions stated the light traffic mixture given in the table would be entirely suitable if the bitumen were increased to say, 11%.

The standard sheet asphalt construction of the present day is one and one half inches of binder and one and one half inches of wearing surface. The binder should be of the "close" type; i.e., should contain approximately 20% of material passing an 8-mesh sieve, and approximately 15% each of ¼-inch and ½-inch stone.

A close binder properly made and laid will be superior in many respects to the mixtures which have been laid on a large number of country highways and will carry a fair amount of traffic for a considerable time without suffering any serious damage. Poor binder will break up very easily—sometimes it can be kicked up—and the hauling of the hot surface mixture over it will damage it very seriously. Surface mixture laid on a binder of this kind which has been badly broken up might almost as well be laid on loose broken stone and will not give satisfactory service under heavy traffic. The binder should, of course, be thoroughly compressed with a steam roller before laying the wearing surface on it. Lack of compression will produce an unsatisfactory foundation for the wearing surface, and binder which is too cold or made with too hard an asphalt cement or an insufficient quantity of asphalt cement can not be properly compressed into a dense, tough mass. In hauling the binder to the street over long distances or in very cold weather, it may become chilled below the danger point. During the hauling process a certain amount of surplus asphalt cement usually drains off of the stone and accumulates on the bottom of the cart or wagon. If these excessively rich portions be laid on the street, what are called rich or fat spots in the binder course will be produced. As the name implies, these are places carrying an excess of asphalt cement. If these are permitted to remain, the surplus asphalt cement will be absorbed by the hot surface mixture when it is placed over them. This will make a soft spot in the finished pavement which will be displaced by traffic and eventually produce a hole or depression in the pavement. They should, therefore, be cut out and replaced with normal binder.

Before laying the surface mixture on the finished binder course the latter should be dry and swept clean of dirt; otherwise the layer of wearing surface will not adhere properly to it. Binder should be covered with surface mixture as soon as practicable after laying it. In many large cities it is required that all binder laid should be covered the same day with surface mixture.

Extreme care should be taken to insure a proper union between the surface laid on successive days. The first loads laid in the morning at the point of termination of the previous day's work should be a little hotter than normal so that the hot mixture may soften the cold edge of the pavement and bound perfectly to it. The joint should be bevelled and freshly cut away unless the rope joint or a similar method is employed.

The practice of painting the edge of the joint with hot asphalt cement is not to be recommended, as unless extreme care is exercised, too much asphalt cement will be used and that portion of the pavement will be too rich in bitumen and consequently softer than the rest, which will result in uneven wear and possibly shoving. Great care should be taken not to leave any hump or depression where the joint is made.

Topeka Pavements

Topeka mixture pavements are laid from two to three inches thick and are frequently placed directly on the foundation. Much better results are obtained by using a binder course one and one-half inches thick next to the foundation with a one and one-half or two inch wearing surface. This greatly reduces the tendency of the finished pavement to shove. With a well graded mixture a squeegee coat is unnecessary although it is frequently employed.

The mineral aggregate as fed to the drier consists of a mixture of broken stone and sand which is liable to segregate in the bin. The hot aggregate should, therefore, be screened and separated into two sizes and kept in separate bins. Definite amounts of coarse and fine material should be weighed into each batch. Unless these precautions are observed, portions of the pavement will have an excess of coarse material and vice versa and the normal bitumen contents for an average mixture will be too rich for the coarse portion and too lean for the fine portion.

The bitumen content of these mixtures is somewhat lower than for sheet asphalt and must be very closely watched and kept within much closer limits than are necessary with sheet asphalt mixtures. One-half per cent. above or below normal is about the permissible variation. Too little bitumen will make a pavement which is too open and porous and too much bitumen will render the pavement very liable to shoving.

The general methods of manufacturing and laying and the precautions to be observed are substantially the same as for sheet asphalt. The surface of pavements of this type is somewhat rougher than sheet asphalt, hence they can be laid on somewhat steeper grades. They will normally carry a somewhat heavier iron tired traffic than the coarser bituminous concrete mixtures but not as heavy a traffic as sheet asphalt. Unless laid under very rigid and competent inspection, it is far safer to use sheet asphalt.

Bituminous Concrete

Bituminous concrete pavements, as previously noted, have a mineral aggregate consisting wholly or largely of stone of varying sizes from 1½ inches down. Some of them are made of run of the crusher stone and some of them (Bitulithic, etc.) are made of carefully graded aggregates. Where the aggregates are graded it is customary to separate the different sized particles in from three to five bins and weigh out definite amounts from each bin for every batch. The normal bitumen content is lower than in Topeka mixture. An excess of bitumen will affect them in much the same way as a Topeka but to a smaller extent. From two to three inches of the surface mixture are usually laid directly on the foundation. It is very difficult to completely close up such a mixture by rolling. It is usually therefore given a squeegee coat of hot bituminous cement after which stone chips are spread over the surface and rolled in, the excess being left to be ground away by traffic. In some cases a thin layer of what is substantially a sheet asphalt surface mixture is used as a seal coat and if this practice

(Concluded on page 482)

The Engineer as a Citizen

The Engineer Essential to Civilization—Should Study Legislation and Administration — Morale Important — Responsibility in Civic Life — His Relation to Public Opinion—Eliminate Expensive System of Competition in Production and Distribution

THE CIVIC RESPONSIBILITY OF THE ENGINEER*

PHILIP N. MOORE

THE engineer, waking from long sleep of indifference and self content, satisfied with himself in his professional successes, has suddenly waked to the fact that he is not politically potent. He has not counted as a class politically, because he has not served politically; he has not, save in rare cases, developed in himself the political sense. In the professional heart-searching, momently the dominant mood, he seeks the reason.

Broadly speaking, the answer is plain. He has not cared enough to exert himself personally or professionally to attain an end which now at last seems to him worth while and vital.

Given like heredity and culture, there is no inherent reason why an engineer should react differently from any other citizen to the patriotic call or civic responsibility. But, unfortunately, things have combined to leave him too often unwanted and uncalled. What are these things?

First, lack of local attachments. With few exceptions, the engineer's tasks are scattered countrywide, or worldwide, and mostly are those of construction, which, completed, he goes his way to build again. He works under strain, he has little time to forgather with his fellows, or to think in terms of political or national interest and service, save as great emergencies come like that of the late war. And without local responsibilities a man feels little sense of civic duty and finds less opportunity for participation in national questions.

Second, a large proportion of the total body of engineers serve the great business consolidations, many of which have interests adverse to the public, or by their very size induce criticism and political attack, and in self-defence they think they must hold their staffs to strict neutrality on all public questions.

Third, the engineer's training has failed to teach that the greatest task of all is the ability to persuade men, and unwillingness or incapacity to enter public discussions, either through modesty or lack of readiness, have held him back. False professional pride, and the same indifference which holds back many high-class men through unwillingness to mingle with and rub shoulders against the great majority, have also deterred him.

Fourth, the past habits of the great organizations which the engineer forms (and which voice his profession) to hold themselves aloof from political affairs as collectively unethical.

What shall be the remedy for the engineer's isolation? It is within himself. He must realize that the duty is in him first and then in his society. By virtue of his exact knowledge of the things which build so large a share of civic affairs, for so much is engineering, he is particularly fitted to render expert advice and service.

We need fearless men who, in the market place and from the housetop shall proclaim to the world: That since the beginning of history brains have ruled brawn; that the brain deserves, and in the ultimate will inevitably receive, greater reward than the hand; and that any proposed condition which puts brawn over brains plans the pyramid on its apex and necessarily is one of unstable equilibrium.

These are a few of the things we can preach, and because we fear no political backfire. We have no fences to mend. We can stand in the open and say everlasting truths, and the time will come when some men may believe them.

*Abstract from paper read before the Metropolitan District Engineers, New York City, "Mechanical Engineering."

THE RELATION OF THE ENGINEER TO LEGISLATION

CALVERT TOWNLEY

WHAT the attitude of the engineer should be toward legislation is a question that has been debated with considerable vigor for many years. Opinions differ widely, and range all the way from that of the ultra-conservative, who believes that the engineer should have nothing whatever to do with legislation or politics, to that of the ultra-radical, who thinks that he should direct all legislation—in fact, that no government function should be exercised except under his direction.

It may help us to visualize the present situation if we examine briefly one or two of the ways in which engineers have attempted to influence legislation heretofore. In 1911 the American Institute of Electrical Engineers, on invitation from the National Waterways Commission, sent a committee to Washington to appear before the commission. The committee was assisted by a special advisory committee, and held several meetings before proceeding to Washington in order to determine just what should be their policy and what sort of a presentment they should make. It was decided that the committee should confine itself strictly to a statement of engineering and allied facts which engineers were peculiarly competent to testify and which were beyond the field of controversy. They were instructed to refrain from expressing views as to the wording of any legislation or to give opinions regarding legal matters.

In 1911 a bill was introduced in the New York state legislature to license engineers and which aroused the alarm and stirred up the strenuous opposition of the four national engineering societies. A joint committee was appointed from these societies, and from the Institute of Naval Architects and Marine Engineers as well. This committee sent a strong representation to Albany, which appeared before the Legislative Committee and vigorously opposed and assisted in defeating this attempted legislation. It was found desirable to take somewhat similar action again in 1913. Feeling that it would be advantageous to have some means of co-operation among the national engineering societies, this committee was continued under the title of a Joint National Committee of Engineering Societies and continued to serve for several years, its activities, however, not by any means being confined to legislative matters. One of its functions was to serve with respect to the National Engineering Congress held in California in 1915, and out of it grew the discussion which finally resulted in the organization of the Engineering Council.

The Engineering Council has been in existence since May, 1917. It has been in receipt of many requests to favor or oppose legislation, and this legislation is by no means confined to questions of engineering, but covers every sort of subject from the fixing of a minimum wage for labor up to the organization of the army for the conduct of war.

The Engineering Council was created to speak for its constituent societies on matters of common concern to engineers, and to afford a means for joint action when desirable. Its by-laws give it wide latitude, and there have been no limiting instructions issued to its delegates by the appointing bodies. The council has therefore had to determine upon its own line of action, and it is by no means certain what that should be with respect to legislation.

It has been my lot to have to do with this question for a number of years, and while I have earnestly sought to get the opinions of my engineering friends and to act upon them, I confess that I do not know what engineers want, and therefore what our policy should actually be. Of course, we believe in ourselves. We believe that an engineer's training, designed as it is to make him think clearly, to deal with essential facts and to arrive at logical conclusions regardless of outside influence, peculiarly qualifies him to express opinions on legislative as on other subjects, but we shall have to choose which of two places to occupy. Shall we be a united body of technical men, speaking only with deliberation and a certain amount of proper dignity regarding subjects which the public recognizes us as qualified to speak upon, or shall we be as a body of somewhere from 30,000 to 100,000 citizens who have a common interest and desire to exert political pressure by reason of our numbers?

I would like to think that we could combine these two positions, but my logic tells me that we cannot. Personally, I believe we should not try to influence legislation which concerns us only as citizens, but if we undertake the task at all, we should concentrate our efforts on certain specific lines and thereby stand a better chance of having them prove effective.

THE RELATION OF THE ENGINEER TO ADMINISTRATION

Nelson P. Lewis

HEADS of great industrial enterprises, transportation companies, and all other public service activities, are required to perform functions which are largely administrative. Such places were once almost always filled by business men or lawyers; later by men who had come up from the ranks, hard-headed men who had begun as boys and passed through the various branches or divisions of the work and had demonstrated qualities of men, leadership and executive capacity, but seldom were they of technical education. During recent years, however, we have seen such places more frequently filled by men who knew the science as well as the art of the business, keeping in mind the old distinction between the two—namely, that science teaches us to know and art to do. There have been many conspicuous instances where spectacular success has been achieved by young men of this type, a success which would only have been gained under the former system through long service, beginning at the very bottom and slowly mastering the details.

But the term "administration," as commonly used and understood, relates more particularly to public business; business of the city, state and nation. From this type of administration the engineer has been more completely excluded than in the case of industrial concerns or public-service corporations. In this exclusion the engineer himself has appeared to acquiesce. He has been so long accustomed to doing things when he is told, as he is told, and because he is told by those whose function he has thought it to be to determine general plans and policies, that he is in no small degree responsible for the idea which has been generally prevalent, that the duty of the engineer is simply to carry out the ideas and policies of others. But if it be admitted, as it must, that what is commonly called the administration of public business is largely the formulation and execution of engineering projects, why should not engineers themselves take a conspicuous part in their formulation as well as their execution?

The machinery of municipal administration, as prescribed by city charters, has usually been very cumbersome and ill adapted to meet emergent conditions. In 1900 the city of Galveston was practically wrecked by a violent storm and tidal wave. The city was already in a bad financial condition and the municipal government was unable to cope with the situation. In order to meet existing conditions, a form of commission government was adopted under which the entire management of the city's affairs was placed in the hands of five men. So successful was the plan that within a dozen years it had been adopted by about four hundred cities and towns within the United States.

In 1913 the city of Dayton went a step further and adopted what is known as the commission-manager plan. This also consisted of a commission of five citizens, elected at large, who constituted the governing body, but they appoint a chief administrative officer, designated as the city manager. It will be noted that these two forward steps in municipal government were taken by cities which had suffered great disasters.

Thus was developed a public office which the engineer with executive capacity is especially well qualified to fill, and that this opinion is held by those responsible for the selection of the managing executives is evidenced by an examination of the list of city managers who have been appointed. Of the 124 cities now operating under some form of the city-manager plan, the speaker has been able to secure information as to the previous experience and training of 88 of the managers, the classification being as follows: 50 professional engineers; 9 merchants; 6 minor city officials; 5 general business; 3 superintendents of construction; 2 journalists; 13 miscellaneous (these including one each of contractor, railroad president, railroad purchasing agent, public-utility manager, professor of government, training school for public service, office manager, league secretary, real estate, lawyer, physician, broker and plumber).

But what about the training of the engineer to fit him for such positions? Business sense is certainly an essential qualification for success in such work as the management of a city, a public-service corporation or an industrial enterprise. Are the courses given in our engineering schools calculated to fit him for these most attractive fields of activity? We will be told that all of the time of the student is required to enable him to cover the strictly technical curriculum, and that if such things as culture and business courses are to be added, the period of training will have to be lengthened or some of the technical courses will have to be curtailed or omitted. Perhaps this would not be as serious a loss as professional educators imagine, while it would broaden the student and might account for the difference between success and failure in administrative positions.

THE RELATION OF THE ENGINEER TO PUBLIC OPINION

Spencer Miller

THE engineer is assuming an ever larger position in public life, and in spite of himself he is at the very centre of life. The more we realize this great truth, the more seriously do we contemplate our responsibilities. This thought fills some with pride and others with humility. Eliminate the engineer from the world and civilization would soon pass through other Dark Ages comparable with savagery and barbarism. It is clear, therefore, that we individually and collectively, should make every possible effort to mould public opinion in the right direction, especially as at present to counteract the propaganda of those stirring up class hatred. Even to-day the engineer stands, with all law-abiding citizens, facing the dark cloud of Bolshevism—not timidly, not indifferently, but in full strength, courage and faith that Bolshevism cannot survive in America because it stands squarely against the code of morals upon which our civilization was founded.

We observe that the engineer is successful in public life because of his technical training and his upright character.

But who may say that a well-trained lawyer with upright character to his credit would not make an equally good public servant? Is it not evident that both engineer and lawyer are needed in public and political life and are any comparisons advantageous?

A Congress half lawyer and half engineer surely would be superior to one all lawyer or all engineer. Do we not also recognize that experienced business men, manufacturers and farmers of upright character are also required to serve the nation in Senate and Congress?

What is the relative importance of the training of an engineer as one element and his upright character as the remaining element? Let us look for an answer in the recent struggle to find that element which President Wilson so aptly called "the very stuff of victory."

The program for the United States involved billions upon billions of money. Ships by the thousands, aeroplanes by the thousands, guns by the hundreds of thousands, shells by the millions, tanks in hundred thousand lots, and several million men besides. A small fraction of these materials of war ever arrived in France, and yet both France and England frankly acknowledge that our troops turned the scales against Germany. What, then, is the answer? Who won the war? What won the war? The answer to the riddle is the same that Napoleon announced one hundred years ago: "The relation of morale to materials of war is as three to one." And Marshall Foch only last week said: "Faith won the war." Both faith and morale are things of the spirit. If the stuff of victory at arms is largely a thing of spirit, why is it not also true of any victory in engineering? Are not the greatest engineering victories due more to perseverance, industry, good habits, courage, pluck, steadfastness than to simple engineering training? Is it not the spirit, after all, that wins all victories?

If the engineer finds that in the complete fulfilment of his life work about one-quarter is material and the remainder spiritual, should not engineering societies make adequate recognition of this important fact? Is not morale as important to the engineer as to the soldier? Is it not as important to an engineering association as it is to a military division? If these facts are conceded, then can we refuse to give the fullest and most complete consideration to the development of these traits among engineers?

THE RELATION OF THE ENGINEER TO PRODUCTION AND DISTRIBUTION[1]

COMFORT A. ADAMS

TWO of three speakers have spoken of engineering education, and one spoke of matters of character and spirit. I have long been concerned with engineering education, and certain things have been impressed very vigorously on my mind, and one of them is that it is not the curriculum and the subjects that are taught that count, it is absolutely and solely the way in which they are taught. That is really a conviction so strong in my mind that I am not concerned with the subjects that are taught, but vastly concerned with the men who teach them.

Coming now to the subject assigned to me on the program, let me say that the civilized world is to-day facing a crisis second to none within the memory of this generation or of many preceding generations. Discontent is rampant throughout the proletariat in many European countries, and is spreading rapidly in our own.

The situation may be stated roughly as follows: Labor feels that in the past it has not had its fair share of the wealth it has helped to create; it wants, is beginning to demand, and in some instances is getting so much, that the balance will soon be a minus quantity.

What are we going to do about it? Shall we sit tight, and because we are comfortable satisfy ourselves by criticizing vociferously the discontented because of their unreasonable demands, or shall we use our brains and training and at least to try to remove the cause, and to meet the situation intelligently? We are engineers, and the machinery of production and distribution is largely of our making and largely in our hands; is it not possible that this machinery can be so improved as to increase the productivity of labor and thus make possible a really living wage and still have a fair return for capital?

"But," I hear you say, "that is our normal job—we are doing that all the time, and as rapidly as possible; moreover, the United States already leads the world in that direction."

In answer may I point out a few facts: First, our industrial success has been due in considerable part to our enormous natural resources, the cream of which we have been squandering in prodigal fashion, and also in part to our exploitation of cheap foreign labor, for which exploitation we may have to pay a very high price, as it is in that group that most of the active discontent is found.

Second, in many of our old-established industries there still remain many grossly inefficient, almost traditional, processes which we accept without thinking, because "it has always been done that way."

Third, and this is my chief point, there still remains an almost untouched field of possibilities in the elimination of our present excessively expensive system of competition.

One instance of this wastefulness which has come under my close observation during the past year is in the field of electric welding. Here a dozen or fifteen manufacturers were each found selling welding apparatus under claims relating solely to the characteristics of the electric machine which supplied the current. The claims were so conflicting that no ordinary purchaser or customer could possibly come to any sane conclusion as to the best apparatus to purchase. And, as a matter of fact, even of all the factors which go to make up a good weld, the characteristics of the electric machine are practically of the least importance.

I can cite specific instances in this field where the cost of accomplishing a certain result was two or three times as great as the reasonable cost might well have been, and others in which the whole expense involved was practically thrown away; and although the problem of the electric weld is not a simple one, still information was available and knowledge was available of the art which, if collected together, under any reasonable co-operative system, would have largely eliminated the wastefulness mentioned. In other words, the answer to this problem is well covered by the one word "co-operation"—co-operation in research, in standardization, and even in some cases in design.

The chief obstacles to this are traditional fears as to the loss of independence and initiative, and the distrust of our competitors. I only wish that I might by some telepathic process convey to you my firm conviction after some experience, much thought and study, that these fears are largely ungrounded, that the result of such thorough-going co-operation as here urged is sure to be a gain to all concerned, and that under such a system real merit would prevail even more than now.

Finally, may I add a plea that we engineers, whose normal work is so much concerned with organization in industry, accept as a part of our responsibility as citizens the broader problems relating to the organization of society, that we face the facts fairly and prepare to take an intelligent step forward, rather than wait until the great tank of discontent has gained momentum enough to crush us and all that we represent.

On May 26th, 27th and 28th there will be a conference of the City Planning Institute of America at Niagara Falls, N.Y., and Ontario. On this occasion officials of the Town Planning Institute of Canada will co-operate with those of the United States in considering some problems associated with the municipalities and territory along the international border.

MOOSE JAW, SASK., WATER WORKS

Proposed Extension to the Saskatchewan River—70 Miles of Pipe Line—Using 24" Continuous Wood Stave Pipe—Two Million Gallon Reservoir—No Filtration Required

CITY engineer, G. D. Mackie, Moose Jaw, Sask., at a recent meeting held in that city, proposed three different methods of increasing the present water supply. The existing system is fed from Moose Jaw Creek, and gives a maximum summer flow of about 1,000,000 gallons per day, and a maximum winter flow of from 700,000 to 800,000 gallons per day. The average consumption during the year 1918 was 883,000 gallons per day, with industrial consumption increasing steadily each year.

Mr. Mackie states that there would be sufficient water in Moose Jaw Creek to supply the needs of the city for several years to come. The average run-off of the creek per year, for eight years, was seven and one-half billion gallons. To utilize this water it would be necessary to construct a reservoir with a capacity of ten billion gallons, sufficient to supply the present population for three years. The land needed for the basin of this reservoir would approximate five thousand acres and the estimated cost including necessary supply pipe lines, would be about $1,250,000. This proposed construction, however, does not allow for industrial growth, and as the city expanded, the water works would again have to be reconstructed. It would be possible to augment the present supply, by a maximum amount of 150,000 gallons per day, beyond which figure the city would be forced to obtain additional supply from other sources.

Major McPherson proposed that the city obtain a supply from Pelican Lake by an open ditch. The estimated cost of this project would be $850,000. The disadvantage, as pointed out by Mr. Mackie, would be that the city would have such supply available for but seven or eight months of the year, and to obtain one million gallons per day at Moose Jaw, it would be necessary to pump ten or twelve million gallons per day, at the lake to counteract evaporation and percolation throughout the 60 miles of open ditch that would be required; also that the velocity in the ditch would be only one-half foot per second which, he claimed, was entirely too slow.

The third proposed construction as outlined and recommended by the city engineer gives an adequate supply for the immediate future, with ample allowance for industrial expansion. It also permits of successive enlargements as required, up to a maximum of 600 million gallons per day —the average volume of water in the Saskatchewan River in the dry periods. This project calls for an expenditure of $1,630,000 and consists essentially of a 24 inch continuous wood stave pipe line approximately 60 miles in length, a two million gallon reservoir, a pressure pipe line against a head of 330 feet to the height of land and suitable pumping equipment. This installation would provide the city, daily, with 4,000,000 gallons of Saskatchewan River water, drawn through suitable infiltration galleries constructed in the river bed, and would require no additional filtration.

The pipe line would be of the continuous wood stave design, bound with individual bands ensuring minimum leakage in case of accident. The pipe would be covered throughout the entire length with an average depth of four feet, sufficient to protect it against frost, etc.

Mr. Mackie explained that he had recommended wooden pipe for financial reasons. He quoted figures showing the cost of piping laid in position, exclusive of excavation or backfill, to be as follows:—

24-in. wood stave pipe per foot	$ 2.30
24-in. steel pipe per foot	5.74
24-in. cast-iron pipe per foot	10.51

which, for the total distance, allowing 70 miles, would amount to:—

24-in. wood pipe	$ 850,000
24-in. steel pipe	2,123,000
24-in. cast-iron	3,890,000

Considering the total cost of the entire system for the three types of conduit, Mr. Mackie gave the following table of costs:—

Wood pipe system	$1,630,000
Steel pipe system	2,900,000
Cast-iron pipe system	5,000,000

Figuring the life of the wooden pipe line at but fifteen years, he said the saving on the carrying charges would be about $60,000 per year, which would amount in fifteen years to $900,000. This would be sufficient to replace the entire pipe line.

The detailed cost of the wood stave pipe line system was estimated as follows:—

Diesel engine and pump at river	$ 148,000
Pressure pipe to height of land, 300 feet	65,000
2 million gallon reservoir at river	65,000
Pipe line (laid)	1,184,925
Damages	88,630
Engineering and contingencies	78,445
Total	$1,630,000

The total expenditure on the city water system is, at present, $67.65 per capita. With this proposed construction the amount would be increased to $149.15 per capita, which Mr. Mackie states to be greater than that of the Greater Winnipeg water area.

NEW ENGINEERING COMPANY

THE Henry Engineering Company announce the opening of offices at 71 Bay St., Toronto, as consulting engineers. The company has also opened a department which will specialise in the purchase and sale of power equipment. The company is composed of Mr. Thomas Henry, Mr. James A. Rumgay and Mr. Edwin B. McBryde. All of these gentlemen are well-known in the power field. Mr. Henry was for a number of years chief engineer of the Erindale Power Co., later with the sales department of the Toronto Electric Light Co., and for the past eighteen months has conducted a general consulting and sales agency business in Toronto, which business is to be taken over by the new company. Mr. Rumgay was for several years with the Canadian Allis Chalmers Co., and latterly with the Polson Iron Works, Toronto, while Mr. McBryde has had considerable experience with the Toronto Electric Light Co., and for the past two years manager of the Fisher Electric Company.

The rural municipality of Portage la Prairie has given its consent to the use of the highways for the construction of a power transmission line by the Government of Manitoba.

The following Canadians have been elected to membership in the American Institute of Electrical Engineers:— Member,—H. E. Hunter, sales engineer, Canadian General Electric Co., Toronto. Associate members:—F. J. Allen, Benjamin Electric Co., Toronto; F. Bowness, Canadian General Electric Co., Peterboro, Ont.; Prof. E. F. Burton, University of Toronto; G. J. Doane, Canadian General Electric Co., Ottawa; N. I. Fisher and S. L. Hallatt, Toronto Hydro-Electric Co., Toronto; E. G. Hobs, Northern Electric Co., Toronto; C. B. Hookway and C. H. Hopper, Canadian Westinghouse Co., Toronto; A. D. Jardine, Moloney Electric Co., Windsor; H. H. Leeming, Hydro-Electric Power Commission, Toronto; J. C. Macfarlane, Canadian General Electric Co., Toronto; J. C. Martin, Hydro-Electric Power Commission, Toronto; G. N. Middleton, C.E., Good Engineering Co., Toronto; W. Packman, Canadian General Electric Co., Toronto; A. S. Phillips, Electrical Machinery Co., Toronto; G. O. Phillip, Ontario Power Co., Niagara Falls; V. K. Stalford, Hydro-Electric Power Commission, Toronto; A. C. Stansfield, Canadian General Electric Co., Peterboro; G. P. Thomas, Canadian Northern Railway, Toronto; A. E. Wilkes, C.E., Good Engineering Co., Toronto.

LEGISLATION FOR ENGINEERS

Toronto Branch of Engineering Institute of Canada Discusses Draft Bill

A SPECIAL general meeting of the Toronto branch of the Engineering Institute of Canada was held in the lecture room of the Engineers' Club on Monday night, May 19th, to consider and discuss the draft bill of the proposed legislation for the purpose of obtaining an expression of opinion on this important question. Owing to the absence from the city of Mr. A. H. Harkness the chair was occupied by Prof. H. E. T. Haultain, and after the minutes of the previous meeting were read, and the reading of a letter from the Niagara Peninsula branch of the Engineering Institute of Canada on the preparation of a schedule of salaries for different classes of engineers, which was referred to the sub-committee on salaries, the members were invited to discuss the draft bill. Mr. Willis Chipman stated that one of the most difficult tasks was to define, "What is an engineer?" and he thought that the one given was too diffused, and that the suggestion of the Joint Committee of American Societies was both shorter and better. He gave the views of different branches and expected that the members will be invited to vote on the bill in June. In reply to a question put by Mr. Goedike, he thought that transitmen and structural engineers could become professional engineers by passing the examination and being responsible for their work. Mr. Goldman considered the point raised by Mr. Goedike was important because the object of the bill was to place the profession on a higher level and to protect the public. Only a small proportion of engineers will be professional, the others being employed or acting as assistants. Many engineers depend upon their assistants to design structures and consequently the public would not be fully protected. Mr. Chipman said it was difficult to provide for these points and that the door must at first be very wide. Mr. Clarke thought that present members of the Engineering Institute of Canada, holding subordinate positions, would be recognized as professional engineers. Mr. Stewart was of the opinion that the bill was open to revision although it was generally good. The Engineering Institute of Canada was a technical organization but the association under the bill would be one of protection to the public and to the engineer. The term "operating and maintenance" requires to be more carefully defined because on railway work these were often attended to by men who are not engineers. It was necessary when the ballot was taken that only the cardinal principle of the bill should be voted upon.

Mr. Wynne-Roberts expressed the view that the committee had devoted a great amount of labor and had produced a draft bill which was excellent in many respects. There are a few points, however, which need to be clarified. For example, the definition of "What is a professional engineer?" does not seem to be satisfactory. For example, the expression "advising on, making measurements for, laying out and the design and supervision of the construction," means that the engineer must be engaged upon each of the four points and not upon any one individually. For example, a consulting engineer may advise upon and not do anything else. The supervision of work, especially of large undertakings, should be in the hands of engineers, and the maintenance of works should also be in the hands of engineers, for maintenance often constitutes just as important a feature of engineering as the actual construction.

Clause *5a* provides for the discipline and the honor of the members, which implies that the Engineering Institute of Canada need not perform the same function on the same points. The Engineering Institute of Canada will require to revise the requirements with regard to the qualification of members.

Clause *7e* is not clear. For example, it states that if a person is unable to obtain his license within three months he is entitled to practice during the same period. In other words, immediately he makes his application he can go on practising. This does not seem what is intended.

Clause 9 should provide for an election of the council within six months after passing the act. The question whether the certificate to be issued by the registrar should be an annual one or not is not clearly stated.

Clause *14e* might be altered to allow candidates to sit for examination at any interval of one year.

Clause 18, The term "Registered Engineer" is mentioned but there is no definition what is meant by this. Candidates acting under this clause, should have the privilege of making up the six years under any number of engineers, because engineers' work is migratory.

Clause 29, dealing with offences against the Act, should not limit the action within one year, as it is possible to have offences committed and not be discovered for perhaps two years.

Mr. Rust thought the committee were to be complimented on the work they have done. He remembered that in Ontario some years ago an aplication for legislation received a very cold reception by parliament and that parliament generally is chary to give any class of legislation these days. Nevertheless, legislation of this character should be very beneficial for the protection of the public. He thought that this bill might tend to interfere with the development of the E.I.C. for some time.

Mr. Haultain stated that the reason why the bill presented to the Ontario Legislature years ago was rejected was because the late Mr. B. T. A. Bell, who energetically promoted the Mining Engineers' Society, was jealous lest the legislation would interfere with that body and injure its progress. Mr. Harris of Kingston was another opponent of legislation to the Canadian Society of Engineers. Mr. Chipman thought there would be no objection to the members sending in suggested amendments to the executive and he recommended that the engineers should meet again periodically during the summer.

Mr. Haultain stated that he was making a confession of conversion, because he thought that any legislation to include all branches of engineers was impossible, but this opinion he now recanted. He thought that all branches and all stages of engineers should be included in the bill. It was evident that the bill substituted for experience and ability, the quality of mind and the point of view known in the term "profession." Engineers' attitude was always professional. Chainmen, transitmen and all men should be included and, if they were, the new association would aggregate at least 10,000 engineers in Canada. This association would have a great educative effect, it would have no jurisdiction but would be of great influence. The bill might hinder the growth of the E.I.C. for some time, but thereafter it will constitute a great feeder to it, and will tend to bring all branches of engineers together. This depends on whether the bill can be worked out satisfactorily in details If so, it would be an accomplishment of a great idea. Legislation would not be granted to engineers if they were divided. Politicians would take advantage of any dissension and it would be injurious to engineers to attempt it unless we are united. There must be harmony among engineers. He was glad to say that this harmony now prevailed between engineers and doctors.

Mr. Charters, of Edmonton, referred to engineers last summer in the West trying to obtain legislation in Alberta and Saskatchewan, but the engineers were advised to postpone action and no doubt the present bill was the result. Western parliament will no doubt insist on appointing the examiners. He is glad to say that the mining and civil engineers had come together in the west and it will be a great help to get the passage of the bill later on. Mr. Chipman thought that the engineers should endeavor to secure the control of the examining body and if it is refused, then accept what is granted.

Resolution moved by Mr. A. F. Stewart and seconded by Mr. C. H. Rust: "That this meeting of the Toronto Branch of the Engineering Institute of Canada does hereby endorse the general principles of the proposed Act respecting the engineering profession, but is of the opinion that there should be a very careful revision of the details before submitting it to the legislature." Carried.

THE ADAPTABILITY OF OIL FUEL TO INDUSTRIAL PURPOSES*

In 1917 the largest quantity of oil fuel used for furnace purposes was for heating billets in connection with the manufacture of shells, while in pre-war times the principal consumers were glass bottle manufacturers and makers of rivets, bolts and nuts. For forging or drop stamping wrought-iron materials the metal must be heated up to about 2,500 deg. F. This temperature was formerly obtained by placing iron bars in a coke furnace of the type used by the wayside smith, though of improved construction and larger dimensions. Till gas and oil fuel were introduced the process was rather a slow one, but since oil has been used in an intelligent manner the output of each new or converted furnace has been trebled. Further the size of the furnace is reduced by 30%. The working area occupied by a furnace and its adjacent machines is only about 50%, more area has to be occupied by a stack of coal and behind it by the resultant ashes. With oil fuel these spaces can be used as furnace pitches.

In recent years many metal-melting manufacturers have either scrapped their coke-fired furnaces or converted them to gas or oil. Of these two gas is probably to be preferred, except that its calorific value in any town may vary hourly while that of oil is constant. The principal metals melted at present are aluminium and 70/30 brass. The former is usually melted in "lift out" crucibles, the melted metal being carried to the moulds, whereas brass is melted in tilting furnaces, to which the moulds are brought. For liftout furnaces melting low fusion metals the average oil-fuel consumption is about 15%, and for tilting furnaces about 10%, of the metal melted; that is, for every 100 pounds of metal melted the former would consume about 1½ gallons and the latter 1 gallon.

In the early years of this century a French engineer took up the case of oil as an auxiliary to coal. Several evaporative trials were made with the boiler of a French Navy ship burning coal alone at the rate of 18.8 lb. per sq. ft. of grate, per hour, and burning coal and oil in different proportions at the rate of 21.3 and 21.7 lb. of mixed fuel per sq. ft. When a mixture containing 45% of petroleum was burned, the evaporation showed an increase of 25% over that with coal only, and when the proportion of petroleum was 64% there was an evaporative increase of 56%.

About four years ago power-station engineers began to take an interest in the subject, on the theory that in conjunction with oil fuel a poorer class of coal could be used than could be burnt satisfactorily under the boilers. Poor coals tend to cake on the links of the chain grate stokers, preventing the quantity of the air necessary for complete combustion from being drawn in; hence a smouldering mass travels along the bars and is dumped into the ashpit only partly consumed. But with oil fuel the argument was that, owing to the almost perfect combustion obtained, the combustible gases rising from the coal fuel bed would be quickly ignited and would cause the mass to become much more incandescent, thereby tending to aerate the bottom mass, which would then allow sufficient air to be drawn through to complete the combustion of the rest of the poor coal. Tests were carried out under a coal-fired Stirling water-tube boiler. One burner was placed on each side, about 25% from the back of the grate, and oil gravitated from an overhead tank to the burners, which were of the Kermode steam-jet type, working with steam at 25 lb. pressure. In the first test a nutty slack having a calorific value of 10,400 B.T.U. was employed, and a boiler efficiency of 69.25% was obtained; the temperature of the combustion chamber was 2,648 deg. F., and of the uptake 660 deg. The last of the tests was carried out with a nutty slack of 10,300 B.T.U., and Mexican fuel oil of 18,750 B.T.U., the proportion of oil to coal being 8% on a B.T.U. basis and 4.96% on a weight basis. A boiler efficiency of 74% was obtained, and the temperature of the combustion chamber was 2,850 deg., and of the uptake 628.

*Canadian Machinery.

THE ORGANIZATION OF A STANDARD MUNICIPAL TESTING LABORATORY*

By J. O. Preston,
Ass't. Engineer, Rochester Bureau of Municipal Research, Inc.

A STANDARD testing laboratory should be owned by every progressive municipality. The cost of the protection furnished by it over public purchases and the saving through the prevention of losses by overcoming many irregularities of usage is cheap insurance.

In private purchasing it is unwise to purchase, unless one is a fair judge of value, without the advice of someone familiar with the qualities of the thing bought. If without personal knowledge of the material or thing in question, it is natural to ask the judgment of an acquaintance who may be a competent judge of value to see that a fair return is obtained for a pecuniary outlay.

Likewise in industry, the sellers of materials know what firms check, weigh and test materials purchased, and they give their short weights and inferior goods to those who are not practicing the modern methods.

Experience has proved that the eye and the hand are no longer adequate to determine the quality of materials. The coal, iron and steel, as well as the glue, flour, etc., need chemical and physical analysis. Furthermore, in nearly every form of production, expert analysis is valuable in the process of manufacturing, for only thus can the insufficiencies be caught in time to prevent serious loss.

The problem of obtaining the best materials for use in public work is a big one. Rapid progress in the manufacture of materials, and the frequency with which substitutes are coming to be offered for acknowledged standards, makes laboratory control over the purchase and use of such materials especially important. First-class materials can be procured and their proper use can be ensured in no other way.

Proper standards aid in reducing the cost of work, especially those standards of materials and workmanship which can be maintained only with the aid of the laboratory. Not only should the materials purchased shade the minimum standards set up by specifications, but preference should be given to the best of those offered.

Testing has been considered only as a science to be occasionally used to determine the ability of a material to meet standard requirements. Rarely has it been utilized as a regular function to determine relative quality. Less often has it been the practice to utilize the knowledge of trained technicians on the laboratory staff to aid in obtaining the best usage from the materials after their purchase.

As usual, government has been slower than industry to acknowledge the economies which follow the scientific purchasing and use of materials. Laboratories have been developed by the federal government, by various states, and even by a few of our more enterprising cities. But the cases where the majority of the possibilities of a laboratory have been developed are negligible. Generally it is a matter of chance as to what men compose the organization or even that an organization exists whose function it is to do the work of testing. Moreover, its field of operation or scope of activities is narrow and irregular.

Duties and Functions

The essential duties of a properly operated testing laboratory for any city are:—

1—To develop uniform standards,

2—To establish a fair basis for the purchase of materials,

3—To obtain proper qualities in materials purchased,

4—To insure the proper usage of materials,

5—To reduce risk costs to both the contractor and the city,

6—To aid in the advancement of knowledge of materials.

*From The Cornell Civil Engineer.

Any municipal testing laboratory that fails to completely fulfil these duties neglects its useful field.

Clean cut competition, based on the contractor's ability to furnish the best of those materials desired can be obtained only by the use of clearly defined standards as set forth in the specifications and in their uniform and continuous enforcement by the testing laboratory. The Committee for the American Society of Civil Engineers in reporting on "Materials for Road Construction and on Standards for their Test and Use" (December, 1917) states, that "the description of a material by means of a trade name is permissible only in the most unusual cases and such a description as 'equal to' another similar material should never be used. Qualities of a material or methods of its use should not be left 'to the satisfaction of the engineer' or 'as determined by' or 'in the opinion of the engineer.' Specific tests and such description of methods of performing each test as will leave no room for doubt as to whether materials and methods proposed by a contractor will come within the limits of tolerance, should always be expressed in specifications, either in detail or by reference to the accessible standards of some reputable authorities." Thus has that national body placed itself on record in favor of unmistakable standards.

Insures Standard Desired

Many modern standards for materials have been developed by practical field experience and by laboratory analysis and research. Many of these standards have been set forth in the publications of our national technical societies. The consistent use of these, and other standards that should be developed by the local laboratory, establishes a fair basis for purchasing materials and reduces the risk cost to both the contractor and the city.

The laboratory's responsibility does not cease after it has determined which contractor has offered satisfactory materials. Able contractors realize the necessity for standards and not only willingly abide by the specifications but prefer to do so. Less scrupulous contractors, however, resent being held to the letter of the specifications and frequently find some way to deviate from them. So it is evident that picking the lowest bidder, with the aid of the careful comparison of the values offered, does not end the laboratory's responsibility. It must insist that contractors honestly furnish the same standards of materials as they proposed with their bids. If this is not done the less scrupulous contractors readily can underbid their competitors and yet make large profits. If the laboratory does not prevent this, the able contractor is compelled to make similar substitutions or else fail to be able to bid low enough to obtain contracts. The municipality does not get what it pays for when such conditions exist.

Furnishing staff advice to the various municipal departments and bureau heads on problems of specifications, etc., is another laboratory duty which properly cannot be disregarded.

The degree to which the laboratory fulfills its duties is reflected in the service and life, not only of the materials, but in the public work in which they are incorporated. Excessive maintenance is necessitated if the materials are not of the proper grade so that materials which had a relatively cheap first cost ultimately become unduly expensive.

Co-operation With Inspectors

The supervision over the use of materials is not complete without the assistance of the laboratory. Ordinary inspection aids in directing the proper use of the materials in public construction, but too much reliance cannot be placed on "practical judgment" in the field, because too frequently this results either in unfairness to the contractors, to the public, or both. Inspectors often put faith in the policy of "give and take" to cope with any tendency on the part of contractors to "put something over." Moreover, field inspectors do not have the opportunity to understand the effects of certain neglects or misuses that to them appear minor and unimportant. This latter condition not infrequently applies to the contractor who may have good intentions. The most efficient method of ensuring the proper use of materials is for the laboratory specialists to co-operate with field inspectors, and thus not only protect the city but give valuable assistance to the contractor as well.

Guarantee Not Necessary

Many contractors justify themselves in slightly deviating from specifications when they furnish a guarantee on their work. This policy is not justifiable. Moreover, economy and fairness have made obsolete the practice of requiring a contractor to guarantee that the materials and products constructed by him, under specifications devised by others, will last for a definite length of time and render definite service. Such practice increases the first and ultimate costs of materials and work without any resulting benefit to those who pay the bill, because the contractor simply adds the cost of his guarantee to the cost of actual construction, and incorporates the sum of the two costs to him, (plus a profit on both), as his bid price for the work. The retention of this guarantee money creates a false feeling of safety on the part of the city that the contractor will furnish the best materials or construct the improvement to the best of his ability. The following quotation is from a written statement by a prominent engineer and former contractor:—

"It does not seem that at this late stage of the game it should be necessary for a city to exact a guarantee on any well-known type of pavement. City authorities have in their hands the drawings of the specifications for, and the full inspection of, all paving work; and to ask a guarantee, especially on a standard of well-known construction, would seem an admission of incompetence. . . . . if in place of carefully drawn specifications and competent inspection, the five-year guarantee is substituted, the city may get a good pavement; again it may not. The odds are heavy that it will not. What it is most likely to get, when it relies on the five-year guarantee, is a pavement that will last five years and a day. And it should be added that usually the contractor has to make numerous repairs to the pavement in order that it may last the five years."

This same principle applies to all of the materials purchased by the city. The only excuse for using a guarantee is lack of faith by city officials and by the public in the specifications and in the system of inspection and laboratory control.

Moreover, according to law, if the methods to be employed in construction work are specified by the owner to the contractor, the contractor then cannot be held to guarantee the result of work done as according to those methods. The guarantee system originated when each contractor used his own "scheme" to perform work, and in many cities it is still adhered to in municipal work mainly because of inadequate supervision. The fact that methods have been standardized, that guarantee is an extra cost, and that adequate protection can be afforded by inspection (of which testing is a most essential part), makes it economically necessary that a testing laboratory do regular sample collection and sufficient analysis or testing to act as the staff control over the purchase of materials and over construction.

Fields of Service

The fields of service of the municipal testing laboratory are practically limitless. The first question that should be asked before entering any one field of service, or before expanding existing branches of service, is "What is the importance of this field relative to the others?"

The municipal laboratory usually originates in the engineering (or public works) departments because of the technical nature of the work done there. For this work the laboratory should not only do routine testing but should investigate local sources of materials such as sand pits, stone quarries, etc. But the laboratory should expand from a purely construction or engineering laboratory into the city's standard laboratory and be under the supervision of the Board of Contract and Supply for the city. It should serve, not only the engineering field, but also the city's fire, police, water, purchasing, and other bureaus, shops, garages and utilities. For example, it should determine the relative value of the city's fuel, foods, materials of building construction, rubber for fire hose and firemen's boots, etc.

Until the laboratory can be organized and equipped as a "Standard Laboratory" to handle the testing that is warranted by the entire field of municipal activities, the scope of the work will be mostly engineering testing. The question naturally aroused is how will the men be usefully employed during the winter months. If the letting of contracts is planned in advance, then many samples of materials will be received with bids for work during the early spring of the year. Investigations of materials and specication remodelling would fill in the partly vacant time freed by the curtailment of work in the late fall. In the beginning, the mid-winter testing may be confined to sewer work, for example, and the remaining time could not be more profitably applied than if used for research work. An example of this possibility is the determination of the applicability of magnetic testing of iron and steel. Determining the practicability of ideas received from the field and arising in the laboratory during the busiest times of the construction season, is another item of work properly belonging to the winter season.

As the volume of testing increases and the scope of the laboratory expands, occasional special studies will warrant even more highly specialized apparatus than is needed for routine testing. In order that such special work may receive accurate analysis, and, at the same time, that the investment in special equipment be made economical, it is recommended that the laboratory do some local commercial testing.*

The laboratory then not only would serve all of the city departments but aid local industry. This would materially facilitate civic business, procure better materials for citizens, and would bring revenue to the city. The more frequent use of special apparatus would make its purchase economical. Experiments then could be performed that ordinarily would not be made because of the lack of facilities. The extra money and work to be done would be provided, thereby enabling the employment of highly specialized scientists in many branches of the work. In performing this function it is essential to keep all interests secondary to the official city requests, giving each class of work the relative attention that it deserves.

Development of Personnel

The successful operation of any enterprise depends upon the personnel responsible for it. This is especially true of a testing laboratory. No matter what plans are adopted, they will be fruitless unless energetically carried into effect. Moreover, efficient growth depends upon the initiative and earnest effort of the laboratory personnel to cover its useful field.

Naturally a capable and experienced director is very important. He should be given money and authority to gradually build up a modern testing laboratory that will properly safeguard the city's interest. If he is qualified to determine the relative value of expenditures and purchases for the city, he is fit to be trusted with an expense account ample enough to enable him adequately to cope with the ever-changing conditions in his work. The director should not be restricted by any influences except limitations similar to those placed upon a thoroughly business-like, energetic manager of an industrial enterprise. This is no more than fair to the taxpayers whose public purchases he would endeavor to safeguard, improve and cheapen. The testing laboratory, rightfully considered, is a municipal business enterprise in which the taxpayers are the stockholders. The laboratory director is the manager of the enterprise by right of his special knowledge and experience. Not only money, but authority to spend it must be allowed him. Dividends in the form of decisions as to the best materials are the economic products.

(Concluded in next week's issue)

*In some cities a charter change or some form of state legislation is necessary to give the authority to do this.

HOT MIX ASPHALT PAVEMENTS

(Continued from page 474)

is followed the pavement will carry a heavier traffic than if a coarse stone surface, liable to fracture, is left exposed. Pavements of this type will not carry as heavy an iron tired traffic as sheet asphalt or Topeka. The method of laying them is substantially the same as in the case of Topeka.

Pulverized Earth Pavements (National Pavements) are usually laid without any binder course and from 1½ to 2½ inches in thickness. They are very rich in bitumen (15 to 20%) but are extremely stable and so malleable that at a temperature of 60 to 75°F., a piece may be cut out of them and hammered back with a hammer and a perfect cold weld obtained. Their stability is due to the extreme fineness and absorbent properties of the mineral aggregate, and for the same reason it is impossible to wear away the surface by any fracturing or grinding of the individual particles, as they have been reduced to practically their ultimate state of fineness before incorporating them into the pavement. In many respects they resemble the old French Rock Pavements, which had an unequalled record for long life. As compared with the French Rock Pavements, they do not become polished under traffic but maintain throughout a very wide range of temperature, a consistency very closely approaching that of sheet lead, and as they contain from one and one-half times to twice as much bitumen, they are more waterproof and wear resisting. The clayey material of which they are composed has a much greater affinity for bitumen than any other known paving material, which still further adds to their permanence. With the exceptions noted under the discussion of plants, their manufacture and laying are very similar to sheet asphalt. A National Pavement weights about 170 pounds per square yard 2 inches thick as compared to 200 pounds per square yard for sheet asphalt of the same thickness. Their cost is somewhat higher than sheet asphalt owing to the large amount of water frequently contained in the mineral aggregate and the high percentage of bitumen used in them. They are capable of carrying the heaviest kind of traffic, and when properly constructed mark less in summer than do sheet asphalt pavements and are much less susceptible to shoving and displacement. They are equally suitable for very light traffic. The bituminous cement used in them is about 90 penetration at 77°F. which is much softer than is used in other types of mixed pavements. For this reason they do not become hard and crack, even if not subjected to traffic for a considerable length of time.

The choice of routes on the provincial highway between London and Windsor, Ont., has not yet been definitely decided upon. Extensive surveys have been taken along both routes. The tenders will soon be awarded and construction work on the chosen route will commence immediately thereafter.

Along the National Transcontinental Railway, extending over that area north and west of Cochrane, a large amount of road building is to be done this summer. Graded roads already extend west beyond the Driftwood River. Seventy miles west from Cochrane a good road has been started from Kapuskasing toward the east, and has already been graded for a considerable distance. Only a few miles remain to be built in order to complete the road from Cochrane to Kapuskasing. South from Cochrane, along the T. & N. O. Railway, a good deal of road building is being done, in some instances gravel for grading having been hauled during the winter months. Ultimately, it is hoped, these roads will connect up with the Cobalt-Haileybury-New Liskeard-Englehart road, and thus constitute a highway direct from Cobalt to Kapuskasing, a distance of about 225 miles. This would leave that section from Cobalt to North Bay as the only link lacking in the chain of roads that would make travel possible between old Ontario and the great silver and gold camps of the north as well as the agricultural districts along the Cochrane clay belt.

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PRINCIPAL CONTENTS

TOWN PLANNING IN CANADA

REFERENCE was made in last week's *Candian Engineer* to the formation of the Town Planning Institute of Canada, the inaugural meeting of which is to be held at an early date.

The object of the new organization is primarily to advance the study of town planning coupled with the proper development of land in urban and rural districts.

One of the immediate objects of the institute is to promote educational courses on town planning provided the necessary funds are forthcoming and, in view of the very great importance from an economic and health point of view of the necessity for intelligent direction along these lines, there is no doubt the money for this purpose will be obtainable. Courses in town planning in the Universities of McGill and Toronto are being looked forward to. In some of the British universities courses in town planning are already an actuality, while Harvard and Cornell Universities in the United States have similar course under contemplation.

Slowly, but none the less surely, the conviction is gaining ground that nothing is to be gained by overcrowding. The houses we occupy must be built upon some preconceived plan and not subject to caprice. So, too, communities cannot and ought not to be allowed to drift along and only wake up after the damage has been done, usually at a time when to correct the mistake means the investment of such enormous sums of money as to make such a proposal almost prohibitive.

The Town Planning Institute of Canada is starting out on original lines for a professional body. It has no chartered members, who enjoy election without proving their qualifications. Every member must, as a first condition, be a member of an existing architectural, engineering or surveying professional institution. He must also undertake special study on town planning for a year and submit a thesis or pass an examination on the subject at the end of that probationary period. Legal members of recognized standing will be admitted as a special class.

There will also be associate members from other professions, just as journalists and medical men who are interested in those aspects of town planning, that are not strictly technical in character.

Most of the evils that are associated with defective housing—the lack of air and light—are the direct results of time worn methods of permitting communities simply to "grow up" with no attempt made to provide intelligent direction.

The day surely has gone and the time arrived when, to a greater degree than has heretofore obtained, communities shall be built up in acordance with a really comprehensive plan, and not allowed to "expand" in an uncontrolled manner.

The new institute will, in this country, find unlimited scope for its activities and will contribute much toward preventing the development of undesirable conditions, so far as community planning and housing are concerned.

EDUCATIONAL VALUE OF ROAD CONFERENCES

THERE is being held in Quebec this week, the Sixth Annual Congress and Exhibition of the Canadian Good Roads Association. Gatherings of this kind are of decided assistance to the Good Roads movement in a variety of ways. They provide ample opportunity for engineers, superintendents, contractors, municipal officials and others interested in the design, construction and maintenance of roads to get together by twos and threes and discuss in a comapnionable and informal manner the different phases of the road problems with which they are one and all at different times confronted. It also affords an opportunity for many men to get into practical contact with those who are regarded as authorities on highway construction.

This is all along the right line and contributes not a little toward a better understanding of the highway problems of our country and all that is involved in their solution. Millions of dollars are being spent annually for better roads and anything that enables those responsible to do their work more intelligently and scientifically, is a step in the right direction. Conventions of the kind held this week in Quebec can, if properly conducted, be made useful educational agencies along these lines.

GOVERNMENT OWNERSHIP OF RAILWAYS

IN the course of his address at the annual meeting of the shareholders of the Canadian Pacific Railway at Montreal on May 7th, the president, Mr. E. W. Beatty, discussed government ownership of railways, and stated emphatically that he had no fear for government competition. In outlining the position of the company he said:—

"The gross receipts in the past year were larger than in 1917, but that the net earnings were $12,043,630 below those of the previous year. This was the outcome of increased salaries and other operating expenses, coupled with a decline in traffic following the signing of the armistice. The first three months of this year were disappointing. The results of the year were, however, satisfactory, despite this shrinkage, 70 per cent. of which was the outcome of increased wages.

"The volume both of freight and passenger traffic decreased in comparison with 1917, the increase in gross earnings of $5,148,363 being due to increases in rates granted in March and July of last year. The fact that, notwithstanding the heavy increases in the cost of operation, there was a surplus after payment of all charges and dividends, is a satisfactory evidence of the foresight and wisdom of the shareholders in having approved substantial expenditures in previous years, which undoubtedly permitted the operations of the company to be carried on with a cheapness which would not have been possible had such adequate facilities not been provided. A conspicuous example of the results of such foresight is found in the difference in the cost of rolling stock acquired during the years 1911 to 1914 and the approximate market value of an equivalent amount if required to be purchased in 1918. The rolling stock purchased during the former years, if required to be furnished at the 1918 prices, would have represented an increased cost of approximately $96,000,000.

"Your directors are of the opinion that a reasonable amount of additional branch line construction should be gone on with as soon as conditions warrant, and the necessary statutory authority obtained. Resolutions will be submitted for your approval for the construction of the lines which are most urgently required. In this connection, I should point out that in the matter of railway construction the country is faced with a condition quite unprecedented in the recent history of Canada, in that the National Railways and your company are the only large companies with resources sufficient to enable them to provide additional railway facilities to any substantial extent.

"Serious and continuing blunders in our railway policy have resulted in the government being required to assume the ownership at present of 11,400 miles of railway, with the prospect of the acquisition of an additional 6,400 miles. When this acquisition has been accomplished the principal competing systems in Canada will be your company and the Canadian National Railways.

"I have no apprehension as to the ability of your company, with its splendid facilities and equipment, and loyal and efficient officers and men, to obtain a fair share of the traffic, and to handle it expeditiously and well. I have no fear of government ownership, but government ownership, apparently, has some fear of private competition under equal conditions.

"The subject of government ownership has received much attention recently, but not nearly as much as the importance of the subject justifies. Notwithstanding our previous experience and that of the United States and Great Britain, government ownership and operation of railways is to be attempted on a large scale. The situation is full of danger, which cannot be avoided or even minimized, except by rigorously independent and non-political administration, which is at least difficult of establishment under our system of government. This fact must, however, be obvious—that in no other way can the people of Canada obtain a correct appreciation of the results of government operation of the systems which are or which may hereafter come into its possession, than by their being administered in strict accordance with the laws of the country under which other companies have to operate, by their financial and accounting methods being made as precise and as accurate as the law now requires of private corporations, and by the exact financial results being submitted to parliament each year.

PERSONALS

MR. GABRIEL HURTUBISE has been appointed chief engineer of the St. Lawrence Pulp Co., with headquarters at Chandler, Gaspé County, Que.

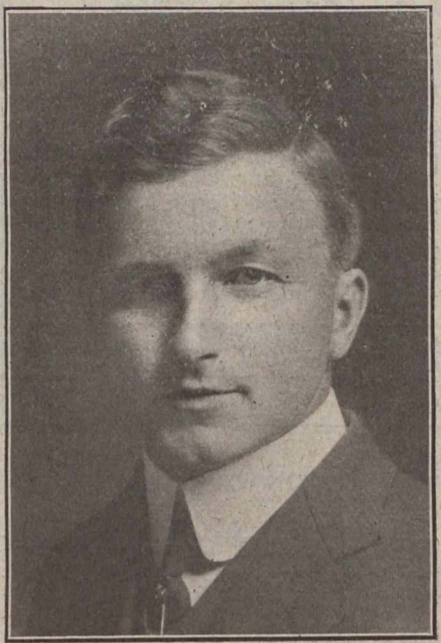
J. M. SMITH, recently the managing engineer of the Triumph Electrical Company of Cincinnati, has accepted a responsible post with the Texas Company.

ALEXANDRE LARIVIERE, until recently engineer in the Highways Department, Province of Quebec, has accepted the position of chief electrical engineer of "Les Enterprises Electriques Reg.," Quebec.

J. W. HOWARD has finished serving in the Ordnance Department of the U. S. Army and has resumed the practice of his profession of consulting engineer on roads and pavements, with testing laboratory in Newark, N.J., and office at No. 1 Broadway, New York.

LIEUT. C. H. R. FULLER, of the Tenth Canadian Railway Troops, has arrived home after three and a half years active service, two years of which were spent in France and Belgium. He saw service at the Somme, at Nieuport, and in the Ypres Salient in 1917. Mr. Fuller was a graduate of the Faculty of Engineering, Toronto University, in 1914, and was formerly secretary of the Toronto Branch Canadian Society of Civil Engineers (now the Engineering Institute of Canada) in 1915. He was formerly assistant engineer of dredging, Canada Stewart Co., at Toronto, and was also in the Ontario government highway department.

MR. JOHN TAYLOR, the subject of our sketch, was born at Elgin, Scotland, on March 19th, 1882, and educated at Elgin and Aberdeen. In accordance with the old country system of training engineers, Mr. Taylor was apprenticed with Mr. James Barron, consulting harbor engineer of Aberdeen. Mr. Barron was consulting engineer for about thirty-five harbors throughout the north of Scotland. While associated with Mr. Barron, Mr. Taylor was engaged in the design and supervision of construction of numerous harbor improvement works, among others being the construction of Stonehaven, Peterhead, Macduff, Buckie, Wick, Stromness, Stornoway, etc. He spent between four and five years in this class of work and at the time of leaving was chief assistant. Following this he accepted a position on the engineering staff of Messrs. Easton Gibb & Sons, engineers, of Westminster, London, and while with them was engaged in dock construction work. He was afterwards resident engineer for Messrs. W. Hill & Co., Westminster, England, and spent four years in the construction of breakwaters and coal and fuel docks at the Portland Naval Base in the English Channel. This work cost about $6,000,000 and consisted of the construction of two breakwaters, each a mile in length, with fortifications, with coal storage and fuel docks, as well as the construction of a new torpedo range testing pier and station. Coming to Canada in 1907, Mr. Taylor was engaged for about five years in various government positions, on the Transcontinental Railway, International Boundary Survey, Public Works of Railways and Canals departments. In 1913, he became associated with the Ottawa Contractors Ltd., as a member of the firm and superintendent of the company, having charge for about three years of harbor work at Hamilton, Ont. Since 1916, he has been a member of the firm of McAllister and Taylor, is a director of the Windsor Dredging Company, Ltd., and also represents the Canadian interests of Messrs. W. Hill & Co., engineers and contractors, of London, England.



OBITUARY

LOUIS ARTHUR KINNEAR, B.Sc., Port Colborne, of the engineering staff of the Hydro-Electric Commission, was drowned on May 12th, on Lake Jessie, near Nipigon. He graduated as a mining engineer from Queen's University, Kingston, in 1912. He was also an Ontario and Dominion land surveyor.