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PRESENT METHODS OF TESTING MATERIALS

WITH SPECIAL REFERENCE TO THE WORK OF THE INTERNATIONAL TESTING ASSOCIATION—A PAPER READ BEFORE THE IRON AND STEEL INSTITUTE, BRUSSELS

By Professor H. HUBERT,

Department of Engineering, Liége University.

THE increasing importance of the use of metals in every description of construction, both of the stationary type, such as bridges and roofs, and of mobile type, such as the parts of machinery; the ever-increasing intensity of the stresses they are expected to withstand and of the energy they are required to transmit, have during recent years necessitated a more and more intimate knowledge of the properties of the materials employed and of the laws which determine the distribution of the stresses in the elements of the structure themselves.

Before dealing with the actual subject it might, perhaps, be advisable to make the following generalization: The most conclusive test, from the point of view of the strength of a structure, is obviously that which consists in subjecting the structure to the maximum it is required to undergo, or even to still greater stresses, so as to ensure complete security against all possible accidents. That is what is done, for example, in the case of ropes, in bridges, in boilers, and in pipes. Such tests are obviously of extreme interest from the point of view of the confirmation of the accuracy of the formulas employed in the calculations of dimensions, and of the hypotheses that it is often necessary to introduce into these calculations. They may also often be made to yield valuable data for the building of similar structures. An attempt has been made to introduce such tests into current practice. In this connection reference should be made to the methods and apparatus of Mr. Rabut, which have been applied to begin with in France, and to those of Mr. James Howard, which have been adopted by the Bureau of Standards in Washington, and were made the subject of a memoir presented to the Congress of the International Testing Association in New York in September, last year.

The first-named allows of the determination, with very close approximation to the truth, of the deformation l which a given length of piece L, forming part of a structure, undergoes, and of the stress being deducted from the formula $t = E\frac{l}{L}$, t being in this instance the tensile stress; or of plotting a diagram having as abscissæ the time, and as ordinates the deflections a metallic bridge undergoes under the influence of moving loads; or, finally, of measuring the angular deviation required in investigating the separate influences of overload and of wind pressure.

Howard's apparatus consists of telescopic callipers, furnished with points bevelled to an angle of 55 deg., which can fit into cavities tapering at an angle of 65 deg. in the pieces undergoing test. Mr. Howard has used this apparatus to investigate the deformation and stresses in the elements of bridges, flood-gates, "sky-scrapers," steam boilers, etc.

In the same connection may be mentioned the tests which have to be applied to the plates intended for the armouring of warships, or for the outsides of gun turrets in forts. These plates have to resist the violent impacts of projectiles. This property is one which can only be made manifest by tests carried out on plates placed in conditions identical with those they have to undergo in practice. In a paper, likewise presented to the New York Congress, Mr. Leonardo Fea shows, from numerous experiments carried out on chromium-nickel and on chromium-nickel-vanadium plates, that none of the tests to which metals are ordinarily submitted, such as tensile tests, compression tests, hardness tests, or fatigue tests, can afford an adequate conception of their behavior under fire. Fortunately such considerations do not obtain in every case, and it often happens that the determination of one or more of the elastic properties of a substance affords an engineer sufficient insight into its behavior in some other respect. For instance, tensile tests are carried out on cement intended for masonry buildings, where it will have to undergo compressive stresses. Experiment, as a matter of fact, has established a certain relationship between the two modes of resistance in cement, provided that the tests are carried out under special conditions, that is to say, on test-pieces always prepared in the same way and always stressed in the same manner. It is in this way, likewise, that a tendency has arisen to substitute hardness tests for tensile tests in iron and steel.

Great modern industries no longer confine themselves to the supply of their own national markets. The works of all civilized countries compete amongst themselves for the markets of the whole world. It has therefore become necessary that the conditions specified as to materials and the estimates of the cost of construction should be, as far as possible, uniform, and that indeed a single nomenclature should be everywhere adopted with the object of controlling the manufacture, of facilitating industrial relations, and of avoiding useless and often ruinous disputes. This standardization has been one of the leading objects which the founders of the International Association have had in view.

Before dwelling in greater detail on the work of the Association, it is necessary to enumerate the different kinds of test to which metals, and in particular iron and steel, are subjected, or to which it has been proposed to subject them. We can adopt the plan of the French Committee on methods of testing, and divide them into three groups:—

(1) *Chemical Tests.*—These are more especially carried out during the progress of manufacture, in order to ascertain the composition and degree of purity of the products. They are, however, also carried out by the purchaser as a check on the specifications controlling the sale.

(2) *Physical Tests.*—These consist of the examination of the exterior of the products and noting their fracture. The superficial examination may yield, to an expert, a general idea. The examination of the fracture, however, particularly when the surface can be projected, under strong illumination, on a screen and suitably enlarged, can yield more definite indications as to the qualities of steel and of cast iron, and as to the defects they may possess. Of late this method has been improved by polishing the surface of fractures and etching it with a dilute solution of acid, or of iodine, potassium iodide, alcoholic solution of hydrochloric acid, chloride of iron solution, or, finally and preferably, with a 10 per cent. ammoniacal copper solution which allows of a micrographic examination being made forthwith.

(3) *Mechanical Tests*, which were for long the only ones to which recourse was to be had in studying metals, still remain some of the most important and practical of tests. The rules or recommendations published by the International Association classify these tests, so far as metals are concerned, into resistance tests on subjection to various forms of stress (tensile, compressive, shearing, bending, and torsional) either applied gradually or suddenly, and workshop tests (bending double, bending single, hammering down, up-setting, punching, and drift tests). They differentiate besides the tests undertaken with a definite object in the case of (1) rolled and forged iron and steel rails, axles, tires, bridge sections, boiler material, shipbuilding material, wire, and wire ropes; (2) for cast iron; (3) for copper; and (4) for other metals and alloys.

The necessity of using, for tests of this nature, accurate and very costly machines, of taking rather large test-pieces from the materials to be tested, of subjecting these test-pieces to most careful and therefore somewhat expensive preliminary treatment, and of entrusting the tests themselves to an expert staff, renders the expense and the time required for such tests relatively large. Many inventors have sought to supersede them by more rapid and cheaper methods, even at the expense of sacrificing some degree of accuracy. Amongst such methods may be instanced the Frémont punch test, with automatic recorder, and the hardness test. The latter in particular has been for many years the object of numerous researches, and has given rise to lively discussions in the technical papers at Congresses of the International Association and at meetings of the National Testing Associations.

As Professor Martens points out in his important work on the testing of materials, "hardness" has been made the subject of many definitions amongst which it is not easy to make a satisfactory selection, and which have led to a number of methods for measuring it. He classifies these methods into two groups:—

(1) In the first group the hardness is ascertained by the penetration of a given body by another at a fixed point, the penetration being effected either by pressure or by impact.

(2) In the second group the penetrating body makes space for itself at the surface of the other body, which it scratches.

When penetration is effected by pressure, penetrants of various shapes are employed. In 1900 Brinell suggested the employment of a very hard spherical steel ball applied by the instrumentality of a hydraulic press, or by a weight, to the surface of the metal to be tested. It produces a depression of semi-spherical shape. If S be the area of this depression in square millimetres and P the pressure in kilogrammes applied to the ball, the ratio $\frac{P}{S}$, called the coefficient or hardness number, may be taken as a measure of the resistance of the metal to the ball, as it increases in proportion as the metal is harder. The ratio $\frac{P}{S}$ increases in any given metal when S is increased, or when the diameter of the ball is diminished. It also depends, within certain limits, on the time taken in making the test. To obtain comparable results it is necessary, therefore, to employ a ball of constant diameter, generally 10 millimetres, and a constant pressure, generally, in the case of iron and steel, 3,000 kilogrammes. On the other hand, from experiments made by Captain Grard, of Paris, it would appear that five minutes is sufficient for S to attain its maximum.

By carrying out numerous tensile tests on steel and comparing the results with those of the ball test, Brinell believed himself able to show that a definite relation exists between the breaking strain and the hardness number. If this be so, the ball hardness test would furnish an easy, rapid and cheap means of ascertaining the strength of a steel. It would also have the advantage of being capable of being applied to finished parts without injuring them, or to ascertaining the homogeneity of metal by making depressions at various situations. It would also furnish the manufacturer or user with an easy means of controlling the influences of thermal or of mechanical treatment, such, for example, as hardening or planishing. The interest which this process aroused may therefore be readily understood. Numerous investigators have sought to verify the relationship. In some instances it may be made to yield results very closely approximating to the truth by adopting the process of multiplying the hardness number by various coefficients in the case of hard or mild steels, and according as the impression is made in the direction of rolling or across the grain. Other observers, such as Mr. Breuil, have found that this method may result in very erroneous results, and the Brussels Congress would not consent to the substitution of the ball hardness test for the tensile test in specifications. The Congress, nevertheless, recognized the value of the process by recommending the determination of the hardness number in testing supplies. Since that time numerous other researches have been made and have given rise to another process of ascertaining the hardness by a method suggested by Martens and Heyn, which consists of taking the depth of the depression as indication of the hardness instead of its diameter.

At the Copenhagen Congress Mr. Ludwik, of Vienna, who had been deputed to report on hardness tests, concluded, on the evidence of all the previously published data, that no simple relation existed between the elastic limit, the breaking strain, and the hardness, but that this did not exclude the possibility of deducing the elastic limit and the breaking strain from hardness tests by means of certain empirical coefficients. By determining the coefficient for each group of sufficiently similar materials, a fairly satisfactory approximation can be arrived at. Mr. Ludwik further notes that for metals that display contraction, the breaking strain does not yield an exact idea of the specific strength. The Copenhagen Congress came to no decision as to ball or cone hardness tests.

The last Congress, at New York, again had occasion to examine the question of hardness from the point of view of resistance to wear. From an important memoir by Mr. Saniter it appears that the relation between these two qualities is too uncertain for either to be deduced from the other. Nevertheless, Mr. Hibbard found that, of two steels of equal hardness, the one with the highest tensile strength had a higher resistance to wear, and that of two steels of equal tensile strength the hardest displayed the greater resistance to wear.

Side by side with ball and cone tests are other methods less frequently employed, but by no means devoid of interest. We may specially refer to the scleroscope method, described by Shore and Breuil, which consists in measuring the height to which a steel ball falling, through a given distance, on to the surface of the metal under test, rebounds, and Colonel Martel's method, which consists in measuring the volume of the impression produced by a pyramidal point falling from a certain height, and, finally, the sclerometers, which measure the depth of scratch produced by a steel point loaded with a predetermined weight.

Up to a certain point some degree of reliance may also be had on the method of photographing the sparks produced by steel when acted on by an emery wheel. Bermann, of Budapest, proposed at the New York Congress that this test should be adopted in the programme of the Association, pointing out that the results obtained show that the percentages of carbon silicon, and manganese in alloy steels can be accurately ascertained by comparing the sparks they produce with those produced by steels of normal composition.

Amongst circumstances exercising considerable influence on the strength of materials there is one which has been the object of numerous researches, and which has forced itself in the most urgent manner on the attention of designers ever since the speed of machines has risen considerably; it is the alteration and rapid succession of stresses which induces what is at present known as "fatigue" in metals. The earliest investigations of this subject were those of Wöhler (1857-1870). Later Spangenberg and Bauschinger (1870) devoted themselves to the question. Some earlier experiments are, however, attributed to Fairbairn.

Without recapitulating here the laws enunciated by Bauschinger, it may be said that both fatigue and hardness tests have as their object the ascertainment of the resistance of metals during use, that is to say, the stresses they can withstand indefinitely without breaking, applied in various ways and undergoing rapid variations and, in particular, changes in direction. Many methods have been thought out for applying such stresses by tension, by bending in one or more planes, and by reiterated shocks. The Brussels Congress did not deal with the matter. The Copenhagen Congress received a communication from Mr. Howard on tests carried out on two kinds of steel containing respectively 0.55 and 0.82 per cent. of carbon, and one by Messrs. Schule and Brunner on the endurance of copper wire under repeated tensile and bending tests. The subject was treated more fully at the New York Congress, where it gave rise to six important papers. That by Mr. Roos, of Stockholm, may be specially mentioned. He carried out experiments by subjecting test-pieces to static stress, by rotary coiling, and by repeated shocks of definite amount. He found that the limit of endurance increases in the same ratio as the limit of proportionality, of which it is on an average 0.65. Mr. Roos believed it possible to conclude from his own personal experience that 80 per cent. of the fractures in pieces that he had examined were due to fatigue and that much importance is to be attached to hardness tests. This conclusion was also arrived at in another paper contributed by Mr. Kommers on tests carried out on the Landgraf Turner machine. He attempted to deduce therefrom a "factor of quality" that might serve for commercial use. It may also be pointed out that the National Arms factory of Herstal, near Liége, which is one of the most important producers of automobiles, motor bicycles, and bicycles, tests the metals it employs by means of a machine which produces shocks of low intensity, rapidly repeated, on test-pieces of a given size.

This leads us, by a natural transition, to deal with a question which has been most strongly ventilated during the last few years, but upon which no agreement has as yet been reached. I refer to the determination of the resistance of metals to shocks of given intensity by means of a determination of their resilience.

The regulations published by the International Association as a result of the Brussels Congress contain a chapter relative to impact tests but dealing exclusively with tests made with a heavy weight (500 to 1,000 kilogrammes falling vertically), and the question of tests made on notched bars is not discussed. The Budapest Congress of 1901 had, however, already recommended this form of test. At the Brussels Congress Mr. Sauvage presented a detailed report on this subject, on behalf of the sub-committee of which he was a member. He gives a history of the publications relative to this type of test, and describes the different apparatus that had been suggested for carrying them out, particularly the Barba and Leblant spring tup, Frémont's spring pressure tup, the pendulum weight employed by Messrs. Bent, Russel, Charpy, and Unwin, and Guillery's rotating weight.

This test is made on a rectangular-sectioned test-piece notched on one side and resting on two supports. It is struck in the middle opposite to the notched side, so that fracture takes place with one blow. The work in kilogrammetres expended in delivering the shock divided by the cross section in square centimetres of the metal left at the bottom of the notch gives the resilience of the metal. The object is to reveal the brittleness of the metal. These tests are easily made, require but small test-pieces, and are inexpensive. Those who have investigated them claim in their favor that they are practical tests, as the parts of a structure during use often display reductions in section, and that they serve to bring out differences in metals that no other type of test reveals. It has, nevertheless, to be admitted that the results of these tests vary with the shape and dimensions of the test-pieces and of the notches, and it has not been proved that the brittleness such tests reveal is of the same nature as that which operates during the actual use of such pieces. This was shown by Mr. Le Chatelier at the Budapest Congress of 1901. Mr. Sauvage's conclusion was likewise that they had failed to establish their claims. At the Brussels Congress Mr. Ast sought to establish a relation between impact tests on notched bars and tensile and bending tests. Comparison does not establish this relation. On the other hand, numerous facts observed by two officers of the Dutch artillery similarly led to a negative conclusion. The Brussels Congress also negatived the suggestion of inserting notched bar tests in specifications, while at the same time recognizing that the method was capable of yielding highly interesting results.

In a lengthy and important memoir which Mr. Breuil published in the "Revue de Mécanique" (1908-1909) he criticizes the different methods of testing notched bars and investigates the influence of different factors on the results, a subject he had previously dealt with in 1904 in his Carnegie Scholarship report to the Iron and Steel Institute. He concludes that this class of test exaggerates the differences between metals, without, however, conforming to any fixed law, and that it is better to make tensile tests on thin bars to ascertain brittleness. The notched bar test should only be employed to reveal the homogeneity of the metal.

The general meeting of the German Association on Methods of testing, however, held in Berlin on April 5, 1907, in adopting the conclusions of a report by a committee under the chairmanship of Mr. Martens, recommended impact tests on notched bars and recorded a preference for the Charpy swing weight. The delegates defended this resolution at the Copenhagen Congress in 1909, at which Mr. Charpy presented, on his own account, an important memoir on bending tests on notched bars. His conclusions were to the effect that these tests served to bring out the differences which failed to reveal themselves in tensile tests, and that it was not wise, therefore, to ignore them, although it was advisable to adopt a standard method in order to render comparable the results obtained by different investigators. The Congress discussed the question—which was, indeed, the subject of eight memoirs—at length, and adopted the following resolutions:—

The test bars should measure 30 x 30 x 160 millimetres, and should be notched to a depth of 15 millimetres. The bottom of the notch should have a curvature to a radius of 2 millimetres.

In the case of plates the bars may have the thickness of the plate itself and a width of 30 millimetres. The notch should be perpendicular to the rolled surfaces and have a depth of 15 millimetres, and a curvature at the bottom of 2 millimetres radius.

For pieces not admitting of the employment of bars of 30 x 30 millimetres, the bars should be 10 x 10 millimetres, and be notched to 5 millimetres with a curvature at the bottom of the notch to a radius of ⅔ millimetre.

The bars subjected to a bending test by receiving in the middle, and on the surface opposite to the notch, the impact of a falling weight rounded off to a radius of 2 millimetres. The bars rest on knife-edges 120 millimetres apart in the case of large test-pieces and 60 millimetres apart in the case of small test-pieces. As far as possible the temperature during testing should be between 15 degs. to 25 degs. C.

The bars should be fractured by a single blow by means of an apparatus which allows of the energy absorbed in breaking the bars being ascertained.

Finally, the Congress authorized a committee, under the chairmanship of Mr. Charpy, to study the relation existing on the one hand between the results given by notch bars tested under different conditions, and on the other, between the results of tests and the behavior displayed by metals under service conditions. The question was bound, therefore, to come up again at the New York Congress. It gave rise to nine memoirs. Mr. Charpy presented the report of the special committee, from which the following chief findings may be extracted:—

(1) The tests carried out by Messrs. Bartel, Ehrensberger, and Charpy appear to have proved that the resilience shown by small test-pieces is always lower than that shown by large test-pieces geometrically similar. The difference is greater in proportion as the resilience is greater.

(2) Tests by Messrs. Mercier and Mimey have proved that energy required to deform to a similar degree two similar test-pieces of similar metal is proportional to their volumes, and that if the height of fall, the masses of the falling weights, and the distances between supports satisfy the following ratios:—

$$\frac{\sqrt{H_1}}{\sqrt{H_2}} = \frac{M_1}{M_2} = \frac{D_1}{D_2}$$

the energy expended in producing deformation is proportional to the cube of their dimensions and not to the square.

Mr. Charpy recognizes that the employment of two types of test-pieces has not yielded the anticipated results, and that it would be advisable to increase the diameter of the notch in the case of the smaller test-pieces. It does not as yet appear possible to definitely impose any special type of testing appliance, but it is necessary to call attention to the importance of reducing losses of energy due to friction and vibration, and to the necessity of introducing a method of calibrating the apparatus.

The attention of the members of the Congress was pointedly directed to the declaration of Mr. Derihon, whose die-stamping works at Ans, near Liége, produce a large amount of automobile parts, exported to almost all parts of the world. Mr. Derihon used the Frémont weight and test-pieces, measuring 10 x 8 x 60 millimetres, with a notch of 1 millimetre in depth. From 80 to 100 tons of steel are used in his works, and 10,000 to 12,000 impact tests made per month. From 18 to 30 kilogram-metres of resilience is required according to the properties of the steels. To begin with, the specimens rejected amounted to 40 per cent. This result led to improvements in the method of treatment, until at the present time the number of failures has fallen to 3 per 1,000. On the conclusion of the discussion the special committee proposed to ratify the decisions of the Copenhagen Congress, and to collect together for the next Congress descriptions of the machines employed and of numerous comparative tests. The Congress confirmed this decision, and commissioned the committee to present at the next Congress definite suggestions as to the height of fall, the weight of the tup, the process of calibration, the form to be given to the supports of the test-piece, and a definition of the notch for small test-pieces.

According to Capt. Bernier, the Canadian Arctic explorer, who returned on Sept. 25th from Baffin's Land, there is no gold in that region, and previous statements attributed to him that gold had been discovered are pronounced incorrect.

THE BRITISH COLUMBIA ENGINEER.

On October 13th, the Vancouver Branch of the Canadian Society of Civil Engineers held its first meeting for the winter session. It was largely attended, and was quite representative of both the Vancouver and Victoria Branches, as a large delegation from the latter was present to hear the address of Mr. G. R. G. Conway. Mr. Conway, who is Chief Engineer of the British Columbia Electric Railway Company, is Chairman of the Branch, and is an enthusiastic advocate for a more thorough organization of the engineering profession in Western Canada, and particularly in British Columbia.

In his address, the speaker referred to the benefits accruing to the Branch from its association with the Chamber of Mines, thus affording permanent headquarters, and the prediction was set forth of an Engineering Societies' building before a great lapse of time, this building to be the permanent home for the professional organizations of the province.

Reference was made to the many great and serious problems confronting the British Columbia engineer during recent years, occasioned by the enormous development of the national resources of the province, the building of railroads, the utilization of water powers, the construction of irrigation works, and the advancement of manufacturing industries, and a tribute was paid to the manner in which this engineering work was being directed and carried out. The Canadian Society of Civil Engineers came in for no small measure of credit, as, with few exceptions, the men who are responsible for these great engineering works, as well as their indispensable and important associates, are members of the Society.

Speaking of the members of the Society resident in British Columbia, Mr. Conway makes the following remarks:

"It is because of our real as well as our numerical strength, that the British Columbia members feel that a closer union between themselves is vital and necessary. It is true that we have important branches in Vancouver and Victoria, but we feel that our parent Society with its headquarters at Montreal is somewhat out of touch, both geographically and in spirit, with our Western ambitions. The local branch in Vancouver has been in existence now for about four years—but that is a long time as we measure our growth here. The Victoria Branch is even more youthful. We feel that we must rouse ourselves into vigorous activity so that our honored and venerable Parent will appreciate that her lusty western branches have arrived at years of discretion and are able to judge what is good for their own progress, and how that progress can assist the national Society. In anything we suggest, we wish to be quite emphatic that nothing shall be done that will divorce us from, or alienate the sympathies of, the parent Society; but that the wish of all of us is to broaden and increase the influence of the Canadian Society of Civil Engineers so as to make it a truly representative national Society, weilding a more powerful and beneficient influence over the whole Dominion than it does at present. We do not want it to become—as Western members are sometimes inclined to think it may—a purely local Society for members in the neighborhood of Montreal and Ottawa, living under the influence and fostering care of McGill University, but rather a Society that shall adequately represent the engineering activities in all the great provinces.

"At the present time we have about 240 members in British Columbia, who gain practically nothing from the parent Society, and who feel that any benefit that comes to them from membership is entirely dependent upon local efforts. We have been discussing for some time past, the formation of a British Columbia section of the members, so that our influence in the province will be more fully recognized, and to obtain for ourselves a greater share in the government of the Society so far as our Provincial interests are affected, than is possible under present conditions. We have taken these matters up with the Council of the Society, and are now proposing to forward for consideration at the Annual Meeting in January, at Montreal, a definite proposal which I hope will be cordially endorsed by all the members in British Columbia. Briefly, the proposal is that we shall form a Provincial Division of the Society and still retain the local branches, who will cooperate in all matters that are vitally important to the members in British Columbia. This co-operation, we believe, is of great importance when approaching the Provincial Government on public matters, so that in any petitions it will be felt that we are a united body of trained specialists, who in an advisory capacity might be of great assistance to the Government in the many problems that arise where engineering counsel is necessary. Furthermore, we wish it to be recognized that in the ranks of the Canadian Society of Civil Engineers the best engineering talent in the Dominion of Canada can be found. It is our ambition to place the Canadian Society upon the same influential plane as that occupied by the Institution of Civil Engineers of Great Britain and the American Society of Civil Engineers, whose recommendations to their Governments are not only welcomed but eagerly sought."

Another matter upon which Mr. Conway dwelt to some extent, emphasizing the interest it held for members of the engineering profession in British Columbia, was the provincial university, and its proposed facilities for the training of men in the engineering. He urged the establishment, in addition to the essential departments of civil, electrical, mechanical and mining engineering, of course in economic geology and mineralogy, and a department for the special study of irrigation and the conservation of water, stating the future of the central portion of British Columbia was dependent upon a scientific understanding of the proper storage and proper disposal of water for irrigation. Courses in forestry and in naval architecture were also urged.

In speaking of the engineering works of the province reference was made to the many problems involved in the construction at the present time of 3,000 miles of railway at the cost of $175,000,000; of the magnitude of municipal work; of the development of the vast water power resources, which are conservatively placed at 3,000,000 h.p., and of the difficulties to be surmounted in mining engineering and the lumbering industry. Considering what remains to be accomplished, and considering also the field for harbor engineering, there are unlimited opportunities for the engineer on the Pacific Coast.

Industries are being crippled by lack of proper dock accommodations in Vancouver, and it is difficult to predict how prepared Vancouver will be in 1915 when the Panama Canal begins to make its influence felt. It was emphasized that more attention should be directed to accommodation for water traffic.

"In Burrard Inlet we have, with the exception of San Francisco, the finest harbor on the Pacific Coast, one that needs no great expenditure to protect it from storms, as many famous harbors have done, but one where the requirements are chiefly wharves and docks that will be absolutely necessary, if we are to maintain a great trade with Europe and with the awakening Orient. The engineer can transform Burrard Inlet into one of the finest harbors in the world, and although some activity has already been shown by our parliamentary representatives in rousing interest in these enterprises, we are delaying too long in starting the project."

Following a discussion of the status and needs of the engineer in British Columbia and of the part which the Vancouver Branch of the Canadian Society of Civil Engineers, was destined to play a resolution was put, and unanimously adopted, to submit to the parent Society in Montreal, the following proposal.

Proposed Change in the By-Laws of the Canadian Society of Civil Engineers.

A new By-law to be numbered 56, and to read as follows:—

A Provincial Division of the Society may be established under the authority of the Council at the request of the majority of the corporate members residing in the Province.

All members residing within such Province shall be members of the Provincial Division so formed.

The officers of a Provincial Division shall be a Chairman, a Secretary-Treasurer, or a Secretary and a Treasurer, and a Committee of four or more members. The Committee shall be elected by a letter ballot of the corporate members residing in the Province. The Chairman and the Secretary-Treasurer, or the Secretary and the Treasurer, shall be elected by the Committee.

The Constitution and By-laws of all Provincial Divisions shall be subject to the approval of the Council of the Society. The Secretary of the Provincial Division shall transmit to the Council, copies of all minutes of meetings, and reports of all proceedings of the Division. The Secretary and the Treasurer shall present a yearly report to the Annual Meeting of the Society.

The Parent Society shall, in addition to the rebate to the branches, grant a further rebate to the Provincial Division of One ($1.00) Dollar per head for every corporate member in the Province, other than those connected with the local branches.

The proposal was forwarded to the Secretary of the Society, formally signed by the most prominent and representative engineers in the West, some of whom are among the oldest members of the Society. The names of those signing were: H. J. Cambie, Thos. H. Tracey, T. H. White, A. E. Hill, F. L. Fellowes, F. C. Gamble, G. R. G. Conway, J. H. Kennedy, R. F. Leslie, G. H. Webster, H. M. Burwell, J. F. Garden, H. B. Smith, H. Carry, and J. R. Grant.

Great interest has been taken in the proposal of the British Columbia members, their object being to strengthen the hands of the Provincial members, and in so doing it is their belief that the parent Society's influence will be strengthened.

INDUSTRIAL DEVELOPMENT IN FORT WILLIAM.

The tremendous growth of Fort William's transhipping trade within the past few years has given great impetus to the development of the city, but Fort William was not contented to remain merely a transhipping point, her citizens realizing the importance of what nature had already done for the city in the way of harbor facilities, etc., and, seeing that the geographical situation destined the city for a strategical manufacturing point of importance, they have through various channels aided and encouraged manufacturing industries to establish at the head of the lakes, and as a result Fort William is to-day rated as one of the important manufacturing centres of the Dominion.

During 1912 Fort William secured some ten manufacturing industries which are erecting plants valued at nearly $4,000,000 and giving employment to close on to 3,000 men.

Among the leading manufacturing industries of the city it is important to note the following:—

The Canadian Car and Foundry Company, Limited, whose plant is now under construction and will cost in the neighborhood of $2,000,000 and give employment to 1,600 men.

The Canada Iron Corporation, Limited, with a million-dollar plant employing nearly 500 men.

The Canadian Steel Foundries plant, to be erected within the next twelve months at a cost of $250,000 and to employ 250 men.

The National Tube Company, Limited, with a plant and equipment valued at $400,000 and practically now ready to begin operations with a staff of 150 employees.

One of nature's valuable gifts to Fort William is the water power available. Within a radius of 50 miles of the city there is water power to the extent of probably 1,000,000 horsepower available. Some 35,000 horsepower has been developed at Kakabeka Falls, on the Kaministiquia River, 17 miles above Fort William. This power has been developed by the Kaministiquia Power Company.

Fort William's harbor and rail facilities are well known. In connection with western Canada's grain crop, it is of some interest to note that Fort William has 23 elevators, with a combined capacity of close on to 30,000,000 bushels. The largest elevator at present in Fort William is the Grand Trunk Pacific, which has a capacity of some 6,500,000 bushels. Additional annexes are being added from year to year that will ultimately bring the total capacity of this elevator to 40,000,000 bushels. This city has been chosen as home of the board of grain commissioners and is to be the headquarters of the grain sample markets.

Iron and other mineral deposits exist in the immediate vicinity. Quite recently considerable development work has been undertaken and samples of iron ore, assaying from 43 to 65 per cent., have been procured.

Lumbering forms a very important industry at and near Fort William and gives steady employment to a great many men and within a fifty mile radius of the city is much arable land.

ELECTRIFICATION OF THE LÖTSCHBERG RAILWAY.

The recent opening of the Lötschberg Railway affords a rapid connection between Italy and the western countries of Europe. The enterprise included a tunnel nine and one-fourth miles in length through the Alps. Reference was made to the construction of this tunnel, which is the third longest on the continent, in July 24th issue of *The Canadian Engineer*, where it was also stated that electric traction would be used.

The locomotives which have been put into service upon this line are claimed to be not only the largest locomotives so far constructed, but, generally speaking, the most powerful locomotives in the world. They are described in detail in a recent issue of *The Electrical Review*, (Eng.,) from which the accompanying illustrations and much of the data are reproduced. Experimental operation on the Spiez-Frutigen section showed the suitability of the single-phase system for the operation of trunk railways, and electrical operation was definitely introduced in 1910 on this portion of the Lötschberg Railway, the trolley line pressure being 15,000 volts, and the periodicity, 15 cycles. The Oerlikon Company supplied the first locomotive with an output of 2,000 h.p. during an hour's working at a speed 42 km, (26.1 mi.) per hour, and this was equipped with two motors each of 1,000 h.p. The satisfactory results obtained with this locomotive during the last two years induced the railway company to entrust the same company with the design of 13 locomotives equipped with motors of even greater power, for the through service on the Thun-Spiez-Brigue Line.

These new locomotives, are designed to develop 2,500 h.p. during 1½ hours' uninterrupted service, at a speed of 50 km. (31.07 mi.) per hour, and have five coupled axles and two free axles. The pull on the drawbar at normal speed is 10,000 kg. (11.02 tons), which suffices for hauling a train of 310 tons over a gradient of 27 per cent., or a train of 530 tons over a gradient of 17 per cent., at a speed of 50 km. (31.07 mi.) per hour, the pull at the wheel circumference being 13,500 kg. (14.88 tons). The maximum speed has been fixed at 75 km. (46.6 mi.) per hour. The locomotives are able in starting to develop a pull 30 per cent. above the normal figure, that is, of about 18,000 kg. (19.82 tons).

As regards the mechanical part, the longitudinal frame carries the body of the locomotive, which comprises three compartments, viz., the engine room and the drivers' cabins, which are separated from the former by partition walls and doors. In order to ensure the greatest possible freedom on curves, the central (driving) axle has been given a side-play of 25 mm. (0.984 in.), the two inner coupled axles are located rigidly in the frame, and each of the two outer ones, having a side-play of 40 mm. (1.5748 in.) is connected with the corresponding fee axle, thus forming what is called a Krauss-Winterthur bogie. In the case of the free axle an even greater side-play has been provided, thus allowing curves of only 120 m. (393.7 ft.) radius to be negotiated in spite of the considerable length of the locomotive. The central axle has spiral springs and the coupled and free axles plate springs.

The hand brake in each driver's cab acts on the free and coupled axles situated near by and on a brake block on the driving axle. In view of the considerable gradients on the line, the locomotives have been equipped with the Westinghouse automatic brake and a regulating brake. From the driver's platform are also controlled the whistle and sanding device which, like the collector bow, and part of the safety devices, door-locks and ladders are operated by compressed air.

All the electrical equipment has been duplicated, thus allowing the locomotive to be operated with half of its equipment, that is, with one transformer and one motor and accessories. Provision has also been made for the two halves of the equipment to work either in series or in parallel, the two motors being fed from either transformer, so that the locomotive will, for instance, develop its full tractive effort with a single transformer and controller, and both motors arranged in series, and be able permanently to keep up its full speed with one motor.

The current goes from the 15,000-volt line through the two bow collectors over two choking coils, to the two halves of the electrical equipment, viz., through two high-tension oil switches to the two transformers and two earthing slip-rings fixed on the rigid axles, to the rails.

The high-tension oil switches allow the whole of the machinery to be switched off. For the sake of safety there have been fitted on both sides of the oil switches, earthing switches which are closed while the doors of the high-tension compartments are kept open.

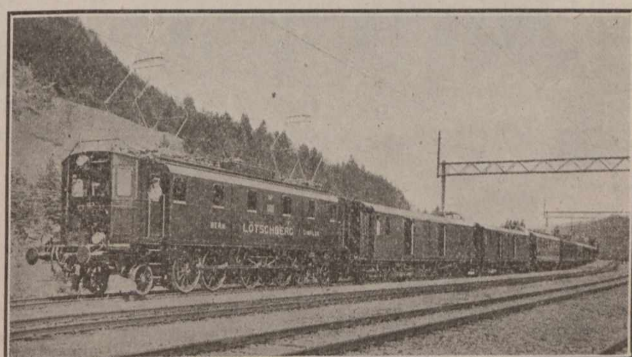

Fig. 1.—Locomotive and Train, Lötschberg Railway.

The transformers are air-cooled, the low-tension coils having 12 tappings for controlling the speed. A special fan fitted to each transformer ensures thorough cooling.

In operating the controller, perfectly smooth starting with a practically constant pull is obtained, on account of the low pressure difference (45 volts) between the various steps, the power factor being about .95 with all loads at normal speed. These favorable starting conditions are, or course, of the utmost importance to the power station supplying the line, especially during the simultaneous starting and shunting of several trains.

Fitted on the transformer, and combined with it, is the controller, the contacts of which are connected directly with the low-tension windings of the transformer. All parts of the switch subject to wear are readily exchangeable. Current interruption proper takes place on a secondary drum with magnetic spark damping, whereas any alterations in the connections of the main-switch drum occur under no-voltage conditions. The switching is effected mechanically by a small auxiliary motor fed with direct current, which, through the intermediary of a wormgear, actuates a pawl mechanism. The pawls are controlled by electro-magnets energized from the driver's platforms. According as one or other of the pawls is actuated, the switch drum will rotate in either direction, thus making or undoing the connection.

These controller switches, as well as the low-tension oil switches, are designed for a maximum current of 3,600 amperes.

The two motors, each designed to give 1,250 h.p. on the rails during 1½ hours' uninterrupted operation, are of the Oerlikon compensated series type, rigidly fitted into resilient frames. They drive through tooth-wheeled gearing with a ratio of 1:2:23, fitted into the motor housing, on to the motor shaft, which is a loose axle connected by the driving gear to the coupled driving axle. The cranks of the two main shafts of the motors are connected by a triangular rigging to the cranks of the driving axles. This arrangement avoids practically any non-resilient part, the spring action in the triangular rigging with the central driving axle being accommodated by a vertical rubbing plate.

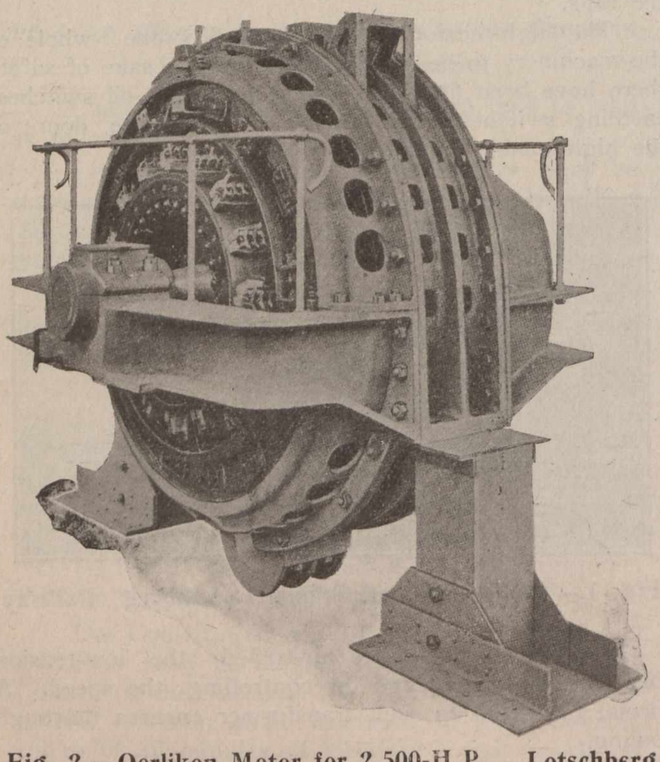

Fig. 2.—Oerlikon Motor for 2,500-H.P. Lotschberg Locomotive.

The motors are of the 16-pole open type, the air being allowed free access everywhere. They are fed at a maximum pressure of about 430 volts, and are designed to absorb about 3,000 amperes, at their maximum output. A ceiling fan fitted above the motors ventilates the whole of the motor compartment. This motor system which has also been used in connection with the 2,000 h.p. experimental locomotives previously referred to, shows most favorable starting conditions, thus greatly facilitating the shunting of the locomotives. In starting at full power, the locomotive only requires about a third of the normal overhead line current. Another advantage of this system is its practical independence of the number of cycles and of any speed limitation by synchronous number of turns. The normal speed of the locomotive is reached with four times the synchronous number of turns of the motors. The power and speed of the motor are also independent within wide limits of the overhead line voltage, any considerable drop in the line voltage being compensated by suitable transformer winding, while the motor with only one-third of its normal voltage, is able permanently to develop its full power. This provides for great overload capacity of the motors at normal pressure.

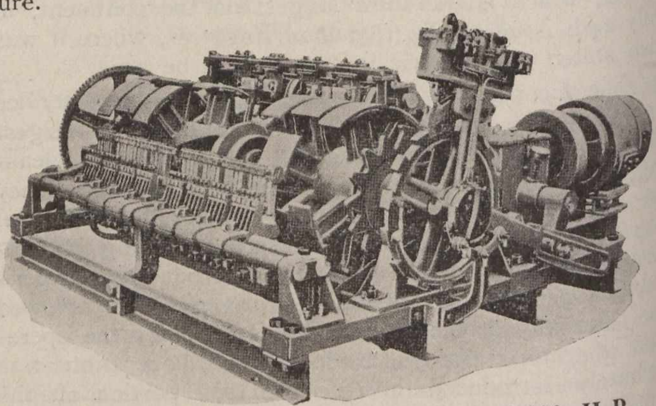

Fig. 4.—Motor-Operated Controller, 2,500 H.P., Lötschberg Locomotive.

Fitted direct on to each motor and electrically connected with it, is the controller for reversing the direction of travelling. This alters the current direction in the exciter coil, and is controlled through electro-magnets from the driver's cabin. In case of emergency these controllers, as well as the remaining apparatus, can be operated by hand.

Current for the auxiliary motors and for heating, can be derived from either transformer by means of switch fuses, the heating current being switched in from the drivers' platforms.

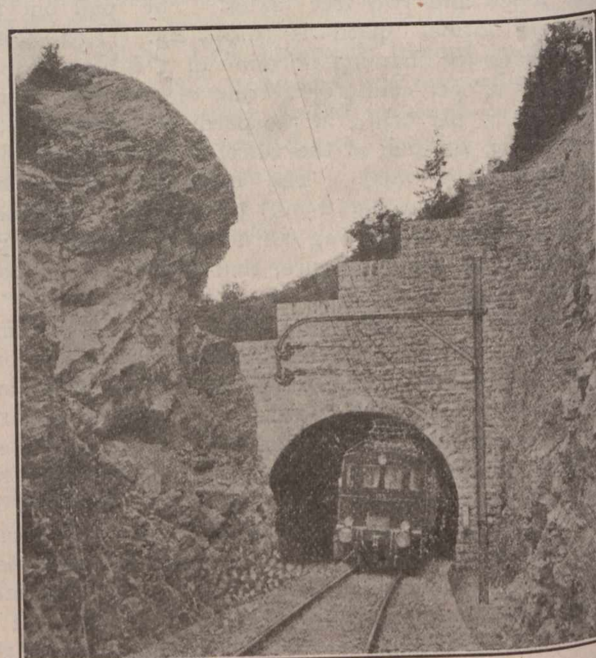

Fig. 3.—Entrance to the Lötschberg Tunnel.

A converter set supplies continuous current to the remote control and the lighting, in parallel with four ordinary train lighting batteries, and is also controlled from the driver's cabin. All the requisite switches and instruments are installed in the drivers' cabins.

The two high-tension compartments in the motor room of the locomotive are closed by lattice-work doors, which are so locked that the high-tension circuit in front of and behind the high-tension oil switch has to be earthed before opening them. The key used in undoing this lock is arranged on a tap connected to the bow air conduit and cannot be removed unless the tap is opened, thus causing any air in the bow conduit to be discharged. This key cannot be withdrawn from the lock before closing all the doors, thus preventing the high-tension compartment from being opened while "alive." Means have also been provided for the oil switches to be operated by hand only while under no-voltage. In order to keep the operator informed of the actual position of the apparatus in the case of hand operation, signal lamps have been provided for the controller and direction of travelling. The folding ladders for climbing to the roof are mechanically connected with alarm whistles, which are actuated in the event of there being any compressed air left in the bow air conduit on lowering a ladder.

The following is a summary of the principal data:—

General data: Single-phase alternating current system, 15,000 volts and 15 cycles per second.

Gauge, 48 ft. 8 in.; maximum gradient, 27 per mile.

The principal data of the locomotives themselves are as follows: Maximum length between buffers, 52.5 feet; total wheelbase, 36.86 feet; rigid wheelbase, 14.76 feet; diameter of driving wheels, 4.43 feet; diameter of free wheels, 2.79 feet; maximum axle weight, 16.6 tons; friction weight, 78.2 tons; total weight, 104 tons; output during 1.5 hours, 2,500 h.p.; pull on wheel during 1.5 hours, 1,488 tons; speed for 1.5 hours, 31.07 miles per hour.

COPPER-ZINC ALLOYS.

Considerable discussion has taken place lately regarding the several advantages for engineering work of the copper-tin alloys, or true bronzes, and the copper-zinc alloys, which are usually generically termed brasses. It will be remembered that quite recently a firm of continental engineers introduced a new alloy of the latter type, which is expected to prove of special value. It would not appear possible yet to give any details as to the behaviour and durability of this alloy in actual service, owing to the fact that it has only recently been obtainable. An interesting paper was recently read by Dr. C. H. Desch and Mr. S. Whyte, both of Glasgow University, on the "Corrosion of Copper-Zinc Alloys," from which much valuable information can be obtained, and which throws considerable light on the subject. It appears that the results of certain tests carried out emphasized the importance of distinguishing between material which was actually dissolved and that which merely lay in strata in the mass. It was found that the effect of quenching from above, the transformation temperature increased the tendency to corrode. It was demonstrated that there was no evidence that the alloy containing tin had any less tendency initially to corrode than any of the high-grade brasses. It was proved, however, that the presence of iron, as had long been suspected to be the case, did increase the tendency of the alloy to corrode.

MICA DEPOSITS IN CANADA.

Concerning the importance of Canada as a mica-producing country, very interesting information is given in a report issued by the Department of Mines in a pamphlet by Mr. J. McLeish, called *Economic Minerals and Mining Industries*. The following paragraphs have been taken from the same:—

"With the exception, perhaps, of Ceylon, Canada is the only country, as far as is yet known, in which the variety phlogopite—or 'amber mica,' as it is termed in the trade—is known to occur in economic quantities. The mica of commerce is of two kinds—muscovite, or 'white mica,' and phlogopite, or 'amber mica.' The former is obtained from both India and the United States, while the latter is secured almost wholly from Canada. Of the two varieties, phlogopite commands rather the higher price, being softer and more flexible and altogether more suitable for use as an insulator—this being the principal use to which mica is put at the present day.

"The amber mica deposits of Canada are comprised within an area of approximately 1,200 square miles in the province of Quebec, and 900 square miles in the province of Ontario. The two districts are separated geographically by the Ottawa River, and geologically by a belt of sedimentary rocks about 40 miles wide. The city of Ottawa lies between the two productive areas and is the seat of the mica industry—all the important works engaged in trimming and in otherwise preparing the mineral for the markets being located in that place.

"Deposits of white mica, also, occur in Canada, and occurrences of this variety (some few of which have been worked at various times), are known from Labrador in the east to the Rocky Mountains in the west, while several Arctic expeditions have returned with good specimens from the far north.

"Though the average dimensions of mica sheets do not much exceed 3 x 5 inches, plates of enormous size are sometimes obtained. Crystals have been found which measured over 4 feet across and weighed nearly two tons.

"About 300 mines have been worked for mica at various times in Canada, but at the present day no more than 25 are in active operation. Among the large operators may be named:—The General Electric Company of Schenectady, N.Y.; Webster and Company, Ottawa; Blackburn Brothers, Ottawa; Wallingford and Company, Ottawa; O'Brien and Fowler, Ottawa; Kent Brothers, Kingston."

NATIONAL MUNICIPAL LEAGUE.

The National Municipal League convenes in Toronto on November 12th, 13th, 14th and 15th.

USES OF COAL TAR.

Tar, a bye-product from the coking of coal, is used largely for two purposes, namely, distillation for production of creosote and light oils and pitch, and for use in road-making, giving a smooth and dustless surface to macadamized pavement. Both of these uses of tar have increased very greatly in the last few years, and the tendency for still further increase indicates a very large proportion of the future production will be similarly used. Tar is further being used successfully in open-hearth furnaces, replacing producer gas; also in heavy oil engines, providing it does not contain too much free carbon.

SANITARY SURVEY OF RIVERS.

By R. O. Wynne-Roberts,
Consulting Engineer, Regina.

(Continued from last week's issue.)

THE authors then state that in Sept., 1911, the Des Plaines at Lockport was much more offensive than the canal, its organic contents being evidently in far more advanced stage of decomposition. Stones and pebbles were completely covered over with septic growth of sphœrotilus and algæ, mainly blue-green species. The water had a grayish look and a filthy smell, evidently much too foul for even the most indifferent species of fish. The content of dissolved oxygen was, however, higher in the Des Plaines than in the canal, being 44 per cent. of saturation.

At Dresden Heights, the dissolved oxygen content averaged 13.1 per cent. at 68 deg. Fahr., but in the Kankakee River, close by, it averaged 126.8 per cent. at a temperature of 71.6 deg. Fahr. In other words, the Kankakee River water was supersaturated with oxygen. Kankakee River water held in solution 2.1 parts per million of carbon dioxide as compared with 12.8 parts in the Des Plaines.

Slime worms (*Tuberficidæ*) were rare in the soft, black sludge in the Des Plaines.

Decomposition of its sewage material had not reached its climax, which came at Morris and Marseilles, at low water in the hottest weather.

"Conditions in the Kankakee at its mouth are particularly interesting and important, since they give us a close approximation to those of the natural water of the Illinois River, derived, as they are, from a territory similar in character to the valley of the Illinois below, and contaminated but slightly, if at all at this place, by way of contributions from comparatively small towns at some distance above."

The average of nine determinations of oxygen in this river was 103.8 per cent. of saturation. In the forenoon it averaged 101.7 per cent. and in the afternoon 121.2 per cent. The afternoon increase was doubtless due to the liberation of oxygen by submerged plants under the influence of sunlight. This phenomena is corroborated by Messrs. Clark and Adams, who found green growths (Chlorophyll) to give off free oxygen when growing in light, and that water containing chlorophyll-bearing organisms take a greater part in overcoming sewage pollution in surface waters than is at present generally realized.

Messrs. Forbes and Richardson found no blue-green algæ, no fixed form of protozoa, no oligochæte worms, no sewage fungus in the Kankakee River water.

At Morris, the Des Plaines River water flowed more or less along the north bank and the Kankakee River water along the south, and it was plain by the dissolved oxygen tests that the waters had not mixed.

An extensive deposit of sludge, 5 to 6 feet deep in places, was formed at the lower end on an island. Some gases from this sludge were collected and analyzed, with the following results: Carbon dioxide, 18.96 per cent.; oxygen, 0.03 per cent.; carbon monoxide, 0.56 per cent.; methane, 79.25 per cent.; nitrogen, 1.19 per cent. The abundance of carbon dioxide and the almost complete absence of oxygen are, of course, to be understood as due to organic decomposition in the presence of oxygen, and the methane is evidence of the continuance of the decomposition after the available oxygen was exhausted.

"**Sludge Worms.**—It is clear that neither plants nor animals requiring oxygen could live in these sediments at the bottom of the stream. The abundance of Tuberficidæ imbedded in this is explained by the extraordinary respiratory capacity of these worms, and by the fact that their respiratory structures are situated at the anal end of the body, which projects above the bottom and is kept continually waving back and forth. Their circulatory system likewise specially adapts them to live in water with a minimum of oxygen, the blood containing sufficient hemoglobin in solution to give it a red color, and being kept in active circulation through a closed system of blood-vessels."

"**Marseilles Dam.**—The situation of quarter of a mile above the dam may best be described by a comparison with that at Morris, these points being but seventeen miles apart, with no important tributary of the river or other modifying factor coming in to interfere with the spontaneous development of conditions within the stream itself. Another important and interesting comparison is that of chemical and biological data from above and below this dam, since this comparison will show us what and how great are the effects of the fall upon the polluted water."

"The analyses for August, 1911, show oxygen ratios of 20.4 per cent. at Morris on the 11th, and 11 per cent. at Marseilles on the 12th, 16.35 per cent. at Morris on 22nd and 23rd, and 7.4 per cent. at Marseilles on 24th and 25th. The carbon dioxide ratios, on the other hand, were much larger at Marseilles than at Morris on these dates. Active decomposition of organic matter was thus clearly evident in this midsummer weather, at low stage of water then prevailing. With higher water and cooler weather the difference between Morris and Marseilles were greatly diminished, the percentage of saturation, February 16th to 20th, standing at 48.76 for Morris and at 43.70 for Marseilles. In the fall of the following year these ratios were, in fact, reversed, the Marseilles determinations being 5 per cent. higher than at Morris, Sept. 27th and 9 per cent. higher, Nov. 14th."

"**Below the Dam.**—Turning now to the situation below the dam at Marseilles, in July and August, 1911, the ratios of dissolved oxygen three-fourths of a mile below were more than three times as great as those above; that under winter conditions in February and March they were 13 and 14 per cent. greater; and that in August and September, 1912, with cooler weather and higher water levels than in the previous year, they varied from one and a half to two times as great. The necessity of taking samples for analysis at some distance below the dam was shown by the fact that the oxygen content of the water, September, 1911, an eighth of a mile below was more than ten times that above—a discrepancy to be accounted for only on the supposition that the air mechanically caught in the water at the fall had not yet had time to escape."

At Starved Rock, which is 95 miles from the mouth of Chicago River, the odor of the water in August, 1911, was still disagreeable, and sewage fungus sti!l found floating in the current.

At Chillicothe, 145 miles down stream, in July and August, 1911, the water had a distinct greenish cast, without odor and mud taken from the bottom had a good, fresh smell. In March, 1913, however, the sludge from a deposit 2 feet deep had a distinct sewage odor. The cooler temperature of the water—41 deg. Fahr.—delayed decomposition. The river was, however, still far below a normal unpolluted stream in oxygen ratios, and contained much more carbon dioxide. The average of dissolved oxygen tests in August, 1911, gave 3.76 parts per million, but in Nov., 1911, it was 10.15 parts per million, equal to 84 per cent. of saturation.

"**Summary by Stations.**—The Sanitary Canal at Lockport.—Although the water of the canal at Lockport was comparatively clear, with an inoffensive odor, even in August and September, 1911, it was not only heavily loaded with putrescible materials from the Chicago sewage, mainly as yet undecomposed, but it was lower in oxygen content at most times than the river water either of the Des Plaines or the Illinois at any point where our tests and collections were made. In the winter, however, the amount of oxygen in solution approximated the ratios of an unpolluted stream, being actually higher in February, 1912, than at any point between Lockport and Peoria. This is to be understood, of course, as due to the gradual start and slow decomposition of the self-purification process in cold weather."

"**The Des Plaines River at Dresden Heights.**—The Des Plaines at its mouth was heavily loaded with putrescible sewage materials so far advanced in decomposition that oxygen ratios were always very low. They differed, however, according to seasons, in comparison with those of the next lower stations, being higher than these in the hottest weather and lower at lower temperatures. In July, 1911, for example, when the water of the Des Plaines contained 1.21 parts per million, that of the Illinois stood at 1.07 at Morris, and at 0.83 above the Marseilles dam. In November, 1912, on the other hand, the corresponding figures were 4.90 for the Des Plaines, 6.80 for the Illinois at Morris, and 7.90 at the Marseilles dam. This seasonal difference is again to be accounted for by the different effect of low and high temperatures upon the beginning and rapidity of decomposition process in a polluted stream."

"**Morris to Marseilles.**—In the seventeen-mile section of the Illinois from Morris to the upper dam the river reaches its lowest point of pollutional distress, becoming, when very hot weather coincides with a low stage of water, a thoroughly sick stream. Its oxygen is nearly gone; its carbon dioxide rises to the maximum; its sediments become substantially like the sludge of a septic tank; its surface bubbles with the gases of decomposition escaping from sludge banks on its bottom; its odor is offensive; and its color is gray with suspended specks and larger clusters of sewage organisms carried down from the stony floor of the polluted Des Plaines, or swept from their attachments along the banks of the Illinois. On its surface are also floating masses of decaying debris borne up by the gases developing within them, and covered and fringed with the sewage fungus (*Spheorotilus natans*) and the bell animalcule (*Carchesium lachmanni*), usually associated in these waters. The vegetation and drift at the edge of the stream are also everywhere slimy with these foul-water plants and minute filth-loving animals."

The authors, in bringing their report to a close, express a few results of their investigations, and the following extracts are, perhaps, sufficient to indicate what they are:—

General Summary of Chemical Features.—"The lowest ratios of dissolved oxygen in the upper Illinois were found in July and August, 1911. When determinations at the mouth of the Kankakee varied but little from 10 parts per million, those from the mid-stream at Morris, nine miles below, ranged from 0.24 to 1.78; at Marseilles, above the dam, 2.18; and at Starved Rock, 3.18. At Chillicothe the ratios varied on different days from 2.10 to 4.21 parts per million, with an average of 3.47. Single determinations at the lowest of our river stations yielded as little as 19.5 per cent. of saturation, and the average of all our midsummer determinations here for 1911 was but 40.8. As the Kankakee River average at this time was 112.2, it appears that during the upper ninety-three miles of its course the Illinois did not regain much more than a third of the oxygen lost to the Chicago sewage."

"A trip was made for chemical determinations, February 1st to 8th, 1912, from Lockport to Chillicothe, and another, March 18th to 28th, from Lockport to the mouth of the Illinois at Grafton. The water temperatures averaged 34 deg. Fahr. on the first trip and 35 deg. Fahr. on the second trip, the upper river being quite frozen over much of the time.

"The oxygen determinations of these trips differ widely from those of the preceding midsummer in the much higher ratios found in the winter, and in the fact that the lowest point for oxygen was very much farther down the stream. In all our midsummer trips this lowest point was reached at the Marseilles dam, but in February there was less oxygen at Chillicothe than at Marseilles, and in March, when the whole of the river was traversed, the oxygen ratios declined down stream from Marseilles to Havana, rising then gradually to the mouth of the Illinois. At Morris the ratio of oxygen was more than six times as great in February as in midsummer; above the dam at Marseilles it was more than eight times as great; below the dam more than three times; and at Chillicothe it was 30 per cent. greater. The March ratios from Morris down were much higher still, reaching a maximum of 10 parts per million below the Marseilles dam, falling thence rapidly to Peoria (6.8), dropping a trifle only at Peoria below the outlets of the sewer system (6.5), declining slightly to Havana (6.2), and rising steadily to the mouth of the Illinois (9.4), the water of the Mississippi standing at the same time at 10.5. In the entire distance from Lockport to Grafton the percentage of oxygen saturation on this March trip did not fall below 44 (Peru), nor rise above 75 (south shore, Morris)."

The Effect of a Dam on Dissolved Gases.—"The fall over the Marseilles dam in the hot weather and low water period of July and August, 1911, had the effect to increase the dissolved oxygen more than 4½ times, raising it from an average of 0.64 parts per million to 2.94 parts. On the other hand, with the cold weather, high oxygen ratios, and higher water levels of February and March, 1912, and the consequent reduced fall of a large volume of water at Marseilles, the oxygen increase was only 18 per cent.—from 7.35 parts per million above the dam to 8.65 parts below; and in August and September, 1912, the weather being still cooler, and the water lower than in the midsummer of the previous year, the increase was only 77 per cent.—from 2.05 parts per million above the dam to 3.62 parts below. It should be noted, however, that this beneficial effect is greatest when it is most needed—when the pollution is most concentrated and decomposition processes are most active. In the absence of a dam at this point the recovery of oxygen used up in decomposition would be greatly retarded in midsummer, and heavily polluted water would be carried much farther down the stream."

Seasonal Phases of Chemical Condition.—"The midsummer and the winter phases represent, of course, the extremes between which the fall and spring conditions come as intermediate or transition stages. The midsummer phase, with its high temperatures and low stage of water, is characterized by a concentrated pollution and an early and rapid decomposition and deoxygenating process, with lowest oxygen readings at Morris and above the dam at Marseilles, followed by a sudden increase of oxygen below the dam and a gradual rise in ratios thence down the stream to its mouth. The winter phase contrasts with this by a delay of decomposition such that the oxygen ratio is highest at Marseilles, declines slowly to the middle of the river's course (about Havana), and then rises gradually to its mouth. In the autumnal transition phase the oxygen ratio is at its lowest point in the Dresden Heights-Marseilles section, although much higher there than in midsummer, rises thence slowly to Peoria, and continues on an approximately level line to the mouth of the Illinois. In the spring phase a transition in the opposite direction probably gives somewhat similar results, modified, however, by the spring floods, which are usually much larger than those resulting from the fall rains, and by differences in the antecedent seasonal conditions from which this spring transition makes its start."

"These periodical changes in the distribution of oxygen and carbon dioxide within the stream are, of course, consequent upon seasonal differences in temperature and stage of water, influenced considerably by the upper dam, at Marseilles, and the above descriptions may perhaps need modification to make them applicable to notably unusual years."

The writer has endeavored to give the essential features of this valuable report, but there are other interesting points dealt with which cannot be referred to in the space of a review such as this. The comprehensive character of the investigations made under a variety of conditions and over lengthy periods and on the same river, afford a useful index into what may be expected in Canadian rivers, where dilution is contended to sufficiently purify large volumes of sewage. It would seem from Messrs. Forbes and Richardson's report that in the case of Chicago sewage dilution is either insufficient or it is not effective enough. Without the necessary data it is, of course, not possible to express opinions on this score. Hoping the foregoing will be of some service to your readers, who, if they require further information, should obtain a copy of the bulletin in question, by writing to the Director of the State Laboratory, Urbana, Illinois.

ITALY'S WATER POWER DEVELOPMENT.

The *Scientific American* gives an interesting account of the enormous power plants planned, involving irrigation works, for Southern Italy. It is expected that water storage reservoirs sufficient to produce 50,000 horsepower, can be laid out in the Calabria region; while, in the Sila mountain country, where there is an abundant rainfall, though irregular, throughout the year, four great reservoirs will be used, the largest to contain 5,000 million cubic feet of water. It is planned to erect at the outset a 50,000 horsepower turbine electric plant, from which part of the current generated will be utilized by the nitrate of calcium fertilizer works, and the remainder will be transmitted over long power lines throughout Calabria and surrounding regions. Additional profit is to be gained for agriculture by this new enterprise; for the regular water supply will provide a very satisfactory irrigation system. For the island of Sardinia a somewhat similar scheme is contemplated; and for the Cagliari plain the water of the River Tirso, which is to supply a reservoir of 10,000 million cubic feet for use with a 15,000 horsepower hydraulic plant, will provide irrigation, as well as power in the place of coal for the use of the numerous mines of the country.

THE REJECTED McGREGOR LAKE SCHEME FOR OTTAWA WATER SUPPLY.

As announced on page 78 of last week's issue, the city of Ottawa has decided to adopt the scheme advanced by Sir Alex. Binnie, for the supply of water from Thirty-One Mile and Pemichangaw Lakes. *The Canadian Engineer*, in its October 16th issue, outlined the water situation in Ottawa and published the important features of the report upon the recommendation of which the City Council decided, on October 17th, to act.

This report also included the results of an investigation of the McGregor Lake series as a source of supply. By the term "McGregor Lakes" are known a large number of lakes which are situated at distances varying from about 15 to 30 miles to the north of Ottawa and lying about mid-way between the Gatineau and the Lievre Rivers. They are small when compared with Thirty-One Mile Lake, the largest being McGregor, which has an area of 2.13 square miles, or about one-ninth of the area of Thirty-One Mile Lake. Mr. Hazen in his report, dated the 10th of May, 1910, gave a table setting out the various lakes, 37 in number, and their areas, which either discharge into the Blanche River by way of McGregor, or the waters of which can easily be diverted into that lake:

McGregor, with an area of 2.13 square miles,
Wakefield, with an area of 1.47 square miles,
Grand, with an area of 1.37 square miles, and
St. Germains, with an area of 1.12 square miles, are the only lakes of any size; the others enumerated varying from about a square mile to a few acres in extent. The drainage area which contributes, or which can economically be made to contribute, to the water flowing from McGregor Lake into the Blanche River amounts to about 94 square miles. Taking the same figure for average rainfall, as in the previously described Pemichangaw Lake scheme, viz., 37 inches, and assuming the same figure for evaporation from which the figure of 13.6 inches is arrived at as representing the run-off during the three driest consecutive years as being applicable to both Thirty-One Mile and McGregor areas, the report estimates, a figure of 51,000,000 gallons per diem as the yield of the drainage area.

As in the previous case, the ground surrounding the lakes is for the most part rocky and covered with trees, but the hills surrounding Thirty-One Mile Lake rise to greater altitude, and far more clearing has been done around McGregor Lake and Wakefield Lake, the resident population being given as between 7 and 8 persons per square mile. The effective storage in improving the purity of the surface water and in bleaching and removing the color is now very generally recognized, and it is important in this respect to bear in mind that whereas the total water area of Thirty-One Mile and Pemichangaw Lakes amounts to 24 square miles, the total area of the four principal McGregor Lakes amounts to only 6 square miles. Thirty-One Mile and Pemichangaw are also lakes of great depth, whereas there is a considerable area of comparatively shallow water in the McGregor and Wakefield lakes. Taking these circumstances into consideration, the report suggests that the water stored in Thirty-One Mile and Pemichangaw Lakes would be superior in quality to the McGregor Lake water, and such is unquestionably the case.

Whereas, the water of the former lake was bright and clear in the early part of September, the water of McGregor contained a considerable amount of amorphous matter in suspension. The McGregor Lake water is, of course, very much superior to the Ottawa River water, but in order to render it as bright and clear at all times of the year as the Thirty-One Mile Lake water filtration would be necessary. If the McGregor Lakes are adopted as a source of supply, that the farms and residence surrounding the lakes should be purchased, as there are far too many possibilities of infection of the water taking place. In fact, the population in the drainage area is considerably higher than that of the basin of the Ottawa River.

Filtration.—The best way of treating the McGregor Lake water would be by means of mechanical filters. The cost of such filters works out at about $20,000 per million gallons treated per diem, when the filter house and various pipe work is included. It is very difficult to say what amount of coagulant would be required, but a very small quantity would be sufficient, seeing the character of the water, and it has been assumed that one half grain of sulphate of alumina per gallon would be sufficient as a yearly average. The working expenses of the filtration plant would exceed $19,000 per annum for an output of 25,000,000 gallons per diem. The loss of head through such filters is considerable; twenty feet was allowed in the estimate for that purpose. This had an important bearing on the lay-out of the scheme.

Method of Collecting and Storing the Water.—As in the previous case, a service reservoir was included in the scheme, and the most suitable site for the service reservoir for the McGregor Lakes scheme would be the same as for the Thirty-One Mile Lake scheme, as there is no other area of ground at a suitable elevation near the city. The present water level of McGregor Lake is about 466 feet above datum, and if the water were filtered 20 feet would be lost, which would reduce the pressure to 446 feet above datum, or to about the same level as the top water level of the service reservoir, namely, 445 feet above datum. It was, therefore, proposed to construct a dam at the outlet of McGregor Lake, where an excellent site exists, so as to raise the water in that lake to give the necessary head. The distance between McGregor Lake and the service reservoir is 78,500 feet, and if the same hydraulic gradient is taken as for the Thirty-One Mile Lake project (1 in 1960), a pipe 54 inches in diameter would be sufficient, the loss of head in the pipe when discharging 25,000,000 gallons a day amounting to about 40 feet. Adding to this the loss of head in the filters, namely, 20 feet, the total loss between the storage and the service reservoirs would amount to 60 feet, and the minimum draw-off level at McGregor Lake would be 445 + 60 = 505 feet, which would mean raising the level of the present lake 39 feet. Assuming McGregor Lake can be raised 50 feet, the top 11 feet could be used for storage.

Here, however, arose a difficulty. At some future date it would be necessary to increase the supply, and this storage would no longer be sufficient. Another excellent site for a dam exists at the outlet of Double Dam Lake, which would store water in Grand Lake. This site would be under water if McGregor Lake was raised 50 feet, and, therefore, it would be necessary to construct, at all events, that portion of the dam which is below water as part of the first instalment. It would, however, be necessary to complete the dam right away for several reasons:—

1. So as to avoid the possible chance of pollution of the water supply of the city by the large body of workmen who would have to be employed in its contruction.

2. It would assist in the storing of flood water, which would otherwise have to run to waste, and would delay bringing the scheme into operation.

3. The water which now flows from Grand Lake into McGregor by way of Double Dam Lake is utilized to develop electric energy to work the air-compressing plant for the Blackburn Mines.

It would either be necessary to compensate the owners for depriving them of this power or to provide an alternative. By constructing the dam this power could readily be given by means of the water held up at the higher level in Grand Lake discharging into McGregor. For these reasons the estimate provided for the supply of 25,000,000 gallons per diem, a second dam at the outlet of Grand Lake which will raise the water in that lake to 550 feet above datum, and would flood back into Wakefield Lake, raising the level of this lake 11 feet. The effect of the works outlined above would be to flood a very large area of land now under cultivation. In making comparison with the Thirty-One Mile Lake project it must be borne in mind that storage is there provided for the full yield of the drainage area for 81,000,000 gallons a day.

Pipe Line.—After leaving the McGregor Lake the pipe line would follow the same route as that proposed by Mr. Hazen for about 5 miles; it would then turn to the west, crossing the Gatineau River about a mile north of Wright's Bridge, and would then proceed in a southwesterly direction to the service reservoir, the total length of the pipe line being 78,500 feet. The estimate assumed that the Gatineau would be crossed by means of suspension bridges having a total length of about 1,000 feet divided up into three spans, the pipes being protected from frost as already described. The first four or five miles would involve a good deal of rock-cutting but the effect of raising the level of the outlet gives an easier route just after leaving the lake, and enables pipes to be carried the whole way up to the dam. The remainder of the route is through fairly easy country as far as the service reservoir. This reservoir and the pipe line forward to the city would be the same as for the Thirty-One Mile Lake project, and, therefore, calls for no further description.

Provided the work were put in hand at once it might have been possible to bring in the water from this source by about the year 1917. The sites for the proposed dams to impound the water of this watershed were not so favorable as that of Mitchel's Dam, where the waters of Thirty-One Mile Lake would be impounded. For this reason they would take longer to construct, although the pipe line itself would be shorter.

Annual Working Expenses.—The working expenses of this scheme would be higher than for the Thirty-One Mile Lake scheme on account of the filtration expenses, which are given as being $19,000 per annum. The aqueduct being shorter would mean a saving of about $5,000, and the total working expenses would amount to approximately $29,000.

The following estimate was based upon the proposals as above:—

Head Works.

Dam to raise McGregor Lake to 515 ft. level with valve tower, etc.........	$ 327,500
Dam to raise Grand Lake to 550 ft. level with outlet works	260,000
Clearing and burning area to be submerged	38,400
Road diversions, with bridges and culverts	80,000
Diversion of water from St. Germain, Battle and Rheaume Lakes	25,000
Plant for Blackburn Mine	25,000

Aqueduct.

54-in. steel main 7-16-in. thick, from McGregor to service reservoir—78,500 lin. ft.	1,448,325
Small stream crossings	9,500
Bridge on Gatineau River	130,000
Service Reservoir and Mains.	
Service reservoir (as in Thirty-One Mile Lake scheme)	260,210
51-in. steel mains to city (as in Thirty-One Lake scheme)	1,101,120
Small stream crossings (as in Thirty-One Mile Lake scheme)	20,000
Bridge on Ottawa River (as in Thirty-One Mile Lake scheme)	180,000
Filters.	
Filtering plant	500,000
Total for works	$4,395,055
Add 15 per cent. for engineering and contingencies	659,258
	$5,054,313
Land and lakes, compensation, etc.	2,000,000
Total estimate	$7,054,313

The entire report concluded with a comparison of the two schemes, as to their relative merits, as follows:—

	Thirty-one Mile Lake and Pemichangaw Lake	McGregor Lakes
(1.) Total quantity of water available.	81 millions gallons per diem.	51 million gallons per diem
(2) Quality of the water.	Bright and clear.	Somewhat turbid contains amorphous matter in suspension
(3.) Filtration.	Not required.	Required.
(4.) Aqueduct	235,000 ft. 54" pipe; 64,000 ft. 51" pipe;	78,500 ft. 54" pipe; 64,000 ft. 51" pipe.
(5.) Service reservoir.	To hold 295 million gallons.	To hold 295 million gallons.
(6.) Pressure (static)	118 lbs. at Pumping station.	118 lbs. at Pumping station.
(7) Estimated cost.	$7,985,200.	$7,054,313.
(8) Working expenses.	$15,000 per annum.	$29,000 per annum.

Referring again to the intention of the city to go ahead with the former scheme, which has been approved by the Dominion Government and by the Ontario Board of Health, preliminary arrangements for the early commencement of work are being made.

ALASKA RAILWAY DEVELOPMENT.

The British, Canadian, and United States Governments are considering a proposal, it is stated, to construct a railroad through Canadian territory to join Alaska to the United States. The proposed railway would be of obvious commercial value. Sir Richard McBride strongly favors the scheme, and is shortly to visit Washington to discuss the question with the Administration. It is proposed that branch lines should be built to connect the main line with the harbors of Alaska. It is believed also that the projected line will stimulate railway building throughout Alaska, which is required to connect Cordovia and Seward, the two leading ports of Southern Alaska, with the interior and with the Dawson line.

BUSINESS METHODS IN CONSTRUCTION WORK.*

By James L. Stuart,
Constructing Engineer, Pittsburgh, Pa.

PERHAPS there is no business which responds more quickly to what is termed "modern methods" than does the average piece of construction work. Certainly, there is no business with more diversified interests and trades connected with it than the modern structure, be it railroad terminal, factory, office building, hospital or hotel.

It has not been more than twenty years, at most, since the construction of buildings was left entirely to practical men who had themselves worked up from positions as artisans or laborers to positions of leadership in constructional lines. Some of these leaders in the past were most talented and even brilliant, but they did not bring with them into the business, excepting in rare instances, the methods of the trained engineer or the progressive business man, their principal assets being nervous force, executive ability and practical knowledge of the building trades. However, as building construction became more complex and of greater magnitude, the necessity of trained men who understood the engineering problems and who appreciated the application of business methods necessary to bring "order out of chaos" became more apparent, and now both engineering knowledge and modern business methods are most necessary to get proper results as to economy and quality in all of the larger undertakings.

In order to successfully construct a building, it is necessary that one should anticipate each step in the progress of its developments and outline a complete system for its erection, including the various steps from the time the drawings are received from the engineer or architect until the building is turned over completed to its owner. The first step in such a process is to make a complete estimate of the cost of the structure from the drawings and specifications, including every item mentioned in the specifications or shown on the drawings. In addition to this there are other small items which are not mentioned in the specifications, but which are necessarily a part of the cost of the building and should be included as such. Under the latter are such items as the cost of administration, liability insurance, temporary buildings, expediting, tools and machinery and numerous smaller items. These estimates of cost were originally made up by the contractors themselves and were but approximations as compared with the present method of compiling them. In the later method every advantage is taken of the prevailing market prices when the estimate is made, of the conditions of the labor market, the physical condition under which the work is to be done, and the season of the year. In a properly prepared estimate the unit prices should vary on each individual piece of work, whether figured at the same time or not.

After the estimate has been made of the total cost of the building—and I think an estimate should be made of every building whether the work is to be let on a lump sum contract, cost plus a fixed sum, or on a time and material basis—the next step is to make up a time schedule allowing fixed periods of time for the completion

*From a paper presented Jan. 14th, 1913, to the Cleveland Engineering Society.

of each part of the building. This must be done most carefully, as on this schedule is based the dates of completion of the different contracts for material and the contracts with sub-contractors for furnishing such portions of the work as are not to be executed by the general contractor's force in the field. This time schedule is made after a thorough study of the drawings, the site of the new project and a familiarity with the estimate which, as I have said before, gives the quantities of the different kinds of material and assists in estimating the length of time required to complete the various stages of the work.

After the estimate and the time schedule are completed and the contracts for material and labor have been entered into, the real work begins.

A dozen or more sets of drawings are procured from the architect or engineer, a copy of same placed on file in the main office of the builder, one copy sent to the job office and the others distributed among various sub-contractors who have to make up their shop drawings and prepare certain materials to be later installed in the building. A careful record must be kept of these drawings and to whom they are addressed and the date on which they are sent. While the various departments of the main office keep thoroughly in touch with the work in the field and the material in preparation, at this point, if the work is of sufficient magnitude, it is turned over to one particular member of the contractor's force, preferably a trained engineer, whose duty it is to keep in thorough and constant touch with all the drawings and all of the correspondence. He also has access to the files of the sub-contractors, contracts, contracts for materials, the original estimate and all other information pertaining to that particular piece of work. It is then his duty to follow up the sub-contractors in the preparation of their shop drawings, the submitting of same to the architect for approval, the ordering of materials by the sub-contractors, and the progress being made through the fabricating shops and mills. This following-up process is part of his daily routine and from time to time reports are made to the superintendent in charge of the actual field work to enable him to know when the material is going to be received, when the sub-contractors will have their men and material on the job, all of which enables him to shape up the field work so that certain portions of the building will be ready for certain sub-contractors at a fixed time. It is also his duty to keep track of the change orders and the changes made in the construction of the building, whether it be addition or subtraction. You can readily understand how necessary it is that all sub-contractors should be advised of changes, for often when they are conceived in the mind of the owner, their interference will be more far-reaching than he or anybody else anticipated.

A proper executive organization to do the field work is most important. It is far better to have too much assistance in the field than too little. First, there must be a superintendent who possesses rare abilities as an executive, who understands drawings and specifications thoroughly, who has had wide experience in building work and who has a knowledge of the different trades so as to be able to anticipate far in advance of his requirements. Above all, he should be able to create in those working under him, including the workmen employed by his department, and foremen and workmen of the different sub-contractors, an enthusiasm in their work, a desire to see it grow steadily, and to do it in the most substantial manner possible. If the work is of sufficient magnitude he should have an assistant superintendent, or possibly two or three of them, a large enough clerical force to do the timekeeping, and to keep an accurate cost record, and he should segregate the cost of the additional work which was not originally provided for. All of this work, if permitted to lag for even a day, becomes most complicated, and if not accurate, its value is entirely destroyed. In addition to this it is the duty of one of the clerks to send to the main office each day an accurate and concise report of what has been done during the day, the state of the weather, temperature, etc. As the building nears completion, work in the main office lessens and it is usually an excellent idea to have the man in charge of the particular job in the main office to get in actual touch with the building and assist the superintendent in picking up the loose ends and getting each trade completed as rapidly as the progress at the building will permit. This man (from the main office) is thoroughly familiar with each trade, knows just what changes have been made in the work, has a splendid knowledge as to how long it will take each trade to complete its work, knows the difficulties under which each has been laboring and can finish his "following-up process" from the field more intelligently than if he were to remain at the main office.

The cost of a piece of work is always of interest. The estimating department has access to the daily and weekly cost reports which are compiled in the accounting department, and from these they can compare and report to the proper person whether or not the work is being done each day or each week within the amount allowed for same in the original estimate. If the work is not being done within this cost and if the unit prices vary considerably from day to day investigation is at once made at the building to ascertain the reason for such fluctuations, to advise the superintendent of the discrepancy and to see if ways and means cannot be found to bring the cost within its proper allowance—the estimate having been based on the cost of similar work under the same conditions, the proper average should not vary greatly from the amount allowed in the estimate.

Some time during the latter part of May, 1910, a large manufacturing plant in Pittsburgh, covering approximately fifteen acres, was almost totally destroyed by fire. All of the buildings were brick, some with wood trusses and slate roofs, but the greater number were constructed with steel frames and cement tile roofs. The fire in and around these steel structures was so intense, however, that most of them collapsed of their own weight and were but a mass of twisted steel, broken cement tile, brick and mortar, all of which it became necessary to remove in order to reconstruct the plant. We first received orders to clear the site and subsequently were instructed to proceed with the reconstruction of the buildings. Fortunately, the power plant had not been greatly damaged and, as a large portion of the plant had been driven electrically, we were able to get sufficient current of high voltage to use in cutting up, or burning apart, the collapsed steel frames, all of which was so badly damaged that it was loaded on cars and sold as junk.

After the site was cleared we began excavating for the new foundations, starting on the buildings that would be required first and those in which the greatest amount of machinery was to be installed. This scheme was followed so as to enable the entire plant to be completed at about the same time. It was the desire of the manufacturing company to commence manufacturing about the first of October, or earlier if possible. The key to this particular situation was to get the steel, of which there was about 4,800 tons. After consultation with the operating and executive departments of the manufacturing company, the order in which the different buildings were to be completed was decided on and the dates were fixed for the delivery of the steel for each building and were included in the schedule for the completed buildings. The structures were quite simple, similar to most of the modern factory buildings, but in order to live up to our schedule we knew we must keep continually in touch with the Bridge Company and see that nothing was permitted to lag or be left undone in order to make the deliveries as they promised. Our expediter was put in charge of the job at once and during the first month spent most of his time between the order department of the Bridge Company and the steel mills at which the plain material was being rolled. After the last of the orders for the plain material had been sent to the rolling mills he devoted his time more particularly to the drawing room of the Bridge Company and reported daily just what progress was being made in designing, detailing and checking, the number of draftsmen employed and the progress made on each building. At times it was found that the checking department was overbalanced by the detailing department and that the designing department was not turning out sufficient work to keep the draftsmen doing the detailing and the checkers busy. This was adjusted by numerous meetings between the Bridge Company, the executive department, the manufacturing company and ourselves. It might be said here, that the principal requisites of an expediter are, a thorough knowledge of the work to be performed, a pleasant personality and the ability to interest the people who are actually doing the work—in this case, the men who made out the mill orders, the draftsmen, different foremen in charge of the rolling mill and the foremen in the fabricating shop. All should be made to feel that their interests are parallel and that what is good for one is good for all. As soon as the drawings for one of the buildings were completed, we saw that this work was put in the shop at once where someone had already seen that the plain material was delivered, and that no time was lost in fabricating and shipping same.

At times during the preparation of the drawings it was found necessary to urge the Bridge Company to employ additional men in all departments. This required considerable tact and force as, naturally, the heads of the different departments do not care to have their routine changed or, as they express it, "meddled with." This phase of the difficulty can be overcome only when it is possible to get sufficient interest aroused in that particular piece of work. When the work was started our expediter received from the rolling mills from which he knew the steel was to be furnished, a list of their daily rollings and we saw to it that certain materials were gotten in on the dates at which the first rolling of that particular material was made. This saved not a little time and we were able to get all of the plain material delivered before the shop drawings were entirely completed on the first building. The meetings between the heads of our department and the heads of the Bridge Company were most useful. Our expediter was usually on hand and we were able to discuss the progress made since the last meeting, the condition of the work in the drafting room and shop, and to devise ways and means for overcoming any obstacles that had arisen either due to lack of men or want of materials.

The steel was erected as fast as the work was gotten out of the mill, fabricated and delivered. We insisted on its being fabricated in sequence so that any materials delivered at the building could be immediately put in place. It had been previously decided at which end of the building the work would commence and our superintendent in the field was advised of this fact and was also kept in thorough touch with the progress of the different stages of the steel. As the cars of steel were loaded and shipped out, they were put in the hands of the tracing department of the manufacturing company and our own tracing department as well, and shipments were followed up until they were finally landed at the site. Our tracing department had, prior to this time, made the acquaintance of the different employees of the railroad through whom the records of the movement of the cars was to pass, as well as those who had direct charge at the transfer points. After the steel had been delivered the rest of the work was a mere question of brick, mortar, sand, gravel, cement, window frames, sash, roofing material and sufficient workmen. Of course, there were large quantities of all these materials required and in order not to delay the work it was imperative that certain amounts of same be delivered and put in place prior to the delivery of the steel.

This same method was applied to the construction of the Statler Hotel, Cleveland, except that the work was much more complicated and required many more details. There were approximately ninety sub-contractors and material men in and around the building from almost the day it was started until its completion, and it required a great deal of patience, perseverence and hard work to get the different trades to dovetail into each other throughout so that those who did the preparatory work would be completed and away in time to permit the finished material to be erected in a proper and substantial manner. On the Statler Hotel we found it necessary from about the first of June until a few days before the building was turned over to Mr. Statler, to insist on daily meetings of all of the sub-contractors on the work, together with the architect's representative and others interested in the building. At these daily meetings each trade was taken up separately with the principal representative of that particular trade and the representatives of all the other trades present. He was asked regarding the progress of his work and was told to state whether or not he was being retarded by any of the other trades. If it was found that he was being hampered he was made to state explicitly and in detail to what extent and how.

The advantage of having all of the sub-contractors together at one time can readily be seen, as it eliminated innumerable quarrels between the foremen of the different trades and many misunderstandings which invariably arise due to the fact that the workmen and foremen are not always capable of expressing their troubles in an intelligent manner and, when they are busy, many times do not take the trouble to express themselves at all. It was rather hard to get them to continually attend these daily meetings, as they were held in the evening after they were supposed to be through with their work. We always tried to make the meetings as pleasant and as short as possible and never permitted ill-feeling to exist between the several trades arising from the discussions at the meetings. A typewritten report of each meeting was posted up on the general bulletin board so that each of the sub-contractors would have access to same during the following day.

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CONTENTS OF THIS ISSUE.

AGITATION FOR PROVINCIAL DIVISIONS OF THE CANADIAN SOCIETY.

British Columbia members of the Canadian Society of Civil Engineers are strongly advocating a change in the by-laws of the Society to enable them to establish a provincial division, whose jurisdiction shall extend over the entire province, its membership comprising all members, whether connected with existing branches of the Society or not. The movement has become prominent during the past year, and a strong effort will be made at the annual meeting of the Society in January to present convincing arguments for its adoption. On page 639 of this issue appears an account of a joint meeting recently held by the Vancouver and Victoria branches. A full discussion of the question was indulged in and a resolution adopted, which has been included in the article. Briefly, the necessity for such an organization was emphatically urged, and it is understood that other branches of the Society concur pretty generally with the contention prevailing on the Pacific Coast.

This expression of a keen desire for more activity and influence on the part of the Canadian Society of Civil Engineers, coming as it does from within, is one that should be supported, as upon it hinges several vital factors. One, for example, is the necessity for the establishment of a better relation between the Society, as a representative body, and the grounds for, and extent of, the responsibilities of the engineering profession in its position in the van of the forces that are furthering the development of the country. The engineer has been rightly termed the advance agent of civilization, and with his work is associated a vast personal responsibility which, in case of failure, is all his own—wherein exists a noticeable difference between professions. If his work is a success, the engineer may receive a little credit; if it is not, he is held accountable. Disparagement is inevitable, praise is probable.

Be that as it may, the profession is being moulded by the Society and, with the illimitable outlook for engineering activity in Canada, it is timely that measures should be advanced to substantiate the grounds for the responsibility which falls to the Canadian Society of Civil Engineers in the country's development. An unsuccessful piece of engineering construction stands in the eye of the public a glaring monument to incompetency. Nor can it be denied that the profession falls for a goodly share of derision as well as the unfortunate individual. There is work for the Society in the prevention of incompetency in engineering. The formation of provincial divisions, with a grant of sufficient leeway to foster the interests of engineering in their own provinces, is a plan worthy of consideration.

THE PAVING "DETERMINATOR."

Webster defines the word "determinator" as one who fixes, settles or decides. In that sense the word certainly cannot be properly applied to the machine that was labeled "Paving Determinator" at the recent American Road Congress. Two large, heavy wheels were driven around a two-foot circular path, constructed for three-quarters of the way of concrete, the remaining quarter of the circle being of vitrified brick. The machine was driven at high speed night and day for a week.

Both materials stood the "test" remarkably well. Like all abrasion tests, however, it differed so much from practical, working conditions that little importance can be attached to the results. It is doubtful whether any entirely successful abrasion test has ever been made with any material. They have been frequently tried by the large laboratories such as Capt. Hunt's and others, but have always been disappointing. Chilled cast iron vs. forged steel, enamelled tile vs. other floorings, brick vs. concrete—in all of these tests conditions have been created by the test itself that are not met with in actual practice. Heat is created and a grinding action induced instead of a rubbing action; or a kneading effect is produced that in practice is eliminated by frequent scrubbings and cleanings; or the expansion and contraction, due to gradual differences in temperature throughout the seasons, cannot be similated; or any one of a dozen of other discrepancies between the test conditions and actual working conditions make the test of little value. Moreover, no two brick roads are the same, nor are any two concrete roads. It would, therefore, be the sheerest folly to condemn either brick or concrete as the result of an abrasion test on a few feet of each pavement. Local conditions, prevailing prices and some explicit suitability to the particular work in hand, will govern the choice of the engineer far more than the results of the "paving determinator."

EDITORIAL COMMENT.

The proposal of the Hydro-Electric Power Commission to furnish electrical power to Owen Sound from Eugenia Falls, was accepted by the town council on Monday last. The commission's investigation into the stream flow has been of a convincing nature as far as supply is concerned, which point has been a bone of contention for two years. As stated in these columns early in September, the commission found 1,400 h.p. available at little cost, or with the use of a storage basin 4,000 h.p. Thus assured, Owen Sound has expressed its willingness, and the work of power development will proceed. Construction will commence at Eugenia Falls early in the spring, and power will likely be turned on before 1915.

* * * *

The Ontario Highway Commission has arranged a series of meetings throughout older Ontario at which representatives from surrounding municipalities will gather, voice their needs, and acquire from the Commissioners a clear understanding of the good roads movement. The sessions are educational in motive and are to be strongly commended. No doubt the Commission will be the recipient of many potent and valuable suggestions, as the individaul demands of the different localities accumulate. Likewise the representatives will receive an insight into the magnitude of the undertaking and the advisability of bringing strong argument before the Legislature next spring for the furtherance of the needful improvement. Meetings are scheduled for: Ottawa, Oct. 28th; Belleville, Nov. 4th; Hamilton, Nov. 11th; London, Dec. 16th; Toronto, Jan. 13th, 1914, and Guelph, Jan. 20th, 1914. The older part of the province has been divided into sections with these cities as centres, and all counties are to be represented.

THE EFFECT UPON DESIGN IN REINFORCED CONCRETE OF ALTERATIONS IN THE MODULAR RATIO.

THE London (Eng.) City Council has recently drawn up a revised code of regulations for reinforced concrete buildings, supplanting those which were adopted in 1911, and which were subjected to much criticism from structural men, the chief claim being that of inadequate and incorrect assumptions in the matter of designs. The subject has received wide attention during the past season, largely owing to the belief that the new regulations, as were then in the stages of preparation, were again being based upon wrong assumptions, viz., that the concrete takes no tensile stress, and that the stress-strains line of concrete and steel, acting in conjunction, is straight. The subject received a thorough treatment by Mr. Percy J. Waldram, F.S.I., M.C.I., in *Engineering*, (issues of June 13, 20, and 27), to which the reader may very profitably refer. The articles discuss the previous regulations, point by point, and show the value of drawing up regulations that will assist in, rather than retard, the application of sound engineering principles by providing for periodical revisions or for the alternative use of future modifications of a theory which may at present be used largely, but tentatively.

The same writer again takes up the subject in *Engineering*, for September 26th (since the revised code was drawn up), and calls attention to the lack of elasticity in the obligatory use of the purely theoretical formulæ specified in the new regulations, many of which are well known to be based upon inadequate data and upon hypotheses which are patently incorrect, even though the errors may be negligible.

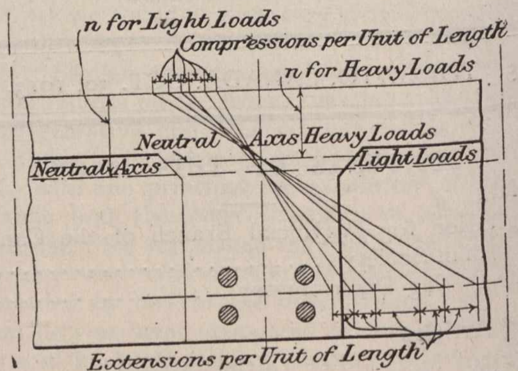


Fig. 1.—Determination of Position of Neutral Axis by Extensometer Measurements.

There are many phases of the discussion that will be found to apply with almost equal force to regulations in America respecting reinforced concrete construction, and the following extracts from Mr. Waldram's paper should prove of value.

It is unfortunate that no machinery is provided (in these new regulations of the London City Council) for the automatic revision of the code at stated periods, in order that advantage may be taken of our rapidly increasing knowledge of a new and intricate subject. These matters will doubtless be fully considered by the institutions to whom is entrusted the statutory duty of criticizing the code. With regard, however, to the extensive alterations which are made in the permissible stresses and the modular ratio, there is no small danger of full consideration being hampered by lack of data upon which calculations showing their effect can be worked out readily.

In the following article an attempt is therefore made to supply such necessary machinery without in any way attempting to anticipate any conclusions which the institutions may arrive at with regard to the desirability or otherwise of the alterations of stresses and modular ratios now suggested by the Council. These alterations appear at first sight to be merely prudent, even if somewhat excessive, concessions to a not unnatural distrust of a method of construction based upon intricate theory and comparatively new to many designers. But when carefully examined it will be found that their cumulative effect upon the design of actual

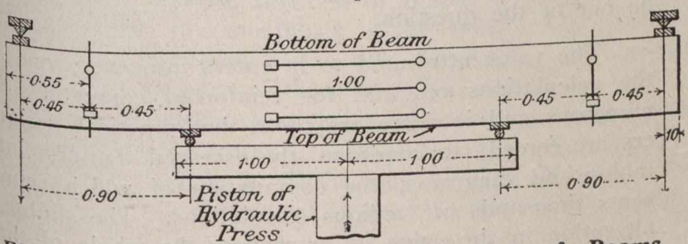


Fig. 2.—Typical Arrangements for Test of Beams, Adopted by French Government Commission, 1900 to 1906.

members would be very severe, and, in fact, almost revolutionary. The new material would by them almost certainly be barred physically by excessive weight, as well as economically by excessive cost, from undertaking many tasks which are well within its ordinary field of employment; and it would appear to be no exaggeration to say that very few of the large buildings now being erected or completed for Government or public authorities would come even within a reasonable distance of complying with the proposed code.

It will be found that mixtures richer than the stereotyped 1:2:4 are so severely discredited that in all work carried out under the code they will of necessity be penalized out of existence. The risk of making concretes too rich in cement would scarcely explain such drastic treatment, and one can only conclude that the Council feared the contingency of district surveyors being imposed upon by approving calculations for rich, strong concretes in situations where ordinary 1:2:4: mixtures would subsequently be substituted in the district surveyor's enforced absence. There may be more cogent objections to stronger mixtures; but considering the great economies in weight and cost which can often be effected by their use, and the importance of eliminating unnecessary dead weight, it is at least open to question whether they should be prohibited for no better reason than that district surveyors have not been given adequate discretion to insist upon the necessary supervision of mixing.

Not only are the permissible stresses on rich concretes severely cut down, but the modular ratio is also lowered in respect of them; the net result being, as will be seen later, a virtual permissible stress actually lower than that of the poorer 1:2:4 mixture, thus preventing a designer even from calculating for 1:2:4 concrete, and subsequently carrying out the work in a stronger and more expensive material. The tasks which are imposed upon the concrete of a reinforced member, in addition to that of resisting the bending moments, are so numerous, so complex, and so important, that many prudent designers might still desire to enrich their mixtures, in spite of the increase of dead weight and cost which would be incurred by doing so under the proposed code. Any such desire to strengthen a constituent whose relative weakness is universally admitted would in the vast majority of cases be promptly checked by the stipulation that new values of the fundamental modular ratios must be used whenever rich concretes are employed. To comply with this regulation the user of rich concretes must either calculate at interminable length, or else recompile, at least twice, the whole of the tables, data, or diagrams which he ordinarily uses; and the district surveyor who checks his calculations must do the same. No one who has attempted, even in part, the enormous labor involved by such a task would care to undertake it unless he were assured that something like reasonable finality had been reached with regard to the values specified. But we have no means of knowing whether these are based upon reliable data, compiled by scientists of standing, upon observations of the behavior of actual beams under load, or are merely deduced from the results obtained by subjecting plain specimens of rich concretes to evenly-distributed compression. Such specimens would certainly act quite differently under flexural stress in a beam, and probably still more so if the beam were reinforced.

Members under Flexural Stress.—In any member of reinforced concrete the proportion of the total work done which is borne by the concrete and by the steel reinforcement respectively is determined not by the relative ultimate strength, but by the relative stiffness of the two materials. In other words, it is governed by the ratio existing between the modulus of elasticity of the steel E_s, and that of the concrete E_c, and known as the modular ratio $\frac{E_s}{E_c}$, or m.

The calculations of the designer in reinforced concrete depend absolutely upon the accuracy of his forecast of the relative stiffness of his materials at working loads. Such a forecast can only be obtained by noting the behavior of his materials when in double harness in a beam. The observer must be prepared to find that it will vary at different stresses, and that direct compression and tension tests on different specimens are no criterion of what will happen when the materials are subjected to the varying intensity of stress which is imposed upon the fibres of a beam section under flexure.

The modular ratio at different stresses can be obtained by measuring the relative extension and compression of the concrete fibres and the steel, and thus locating the neutral axis, as in Fig. 1. Then for any given position of the neutral axis in any beam of given proportions there must be one modular ratio consistent with that position, and also with the formulæ used. Thus in a rectangular section reinforced with a proportion r of tensile rods, if the distance n of the neutral axis from the top of the beam were determined by the ordinary formula in which $n_1 = \frac{n}{d}$

$$n_1 = \sqrt{m^2r^2 + 2\,m\,r} - m\,r$$

then the value of m would be

$$m = \frac{n_1^2}{2\, r\, (1 - n_1)}.$$

If the beam experimented upon were a T-section of which the proportion of depth of slab to depth of beam were s_1, then the value of m, which would have to be inserted in the ordinary formula

$$n_1 = \frac{s_1^2 + 2\, m\, r}{2\, (s_1 + m\, r)}$$

would be

$$m = \frac{s_1\, (2\, n_1 - s_1)}{2\, r\, (1 - n_1)}.$$

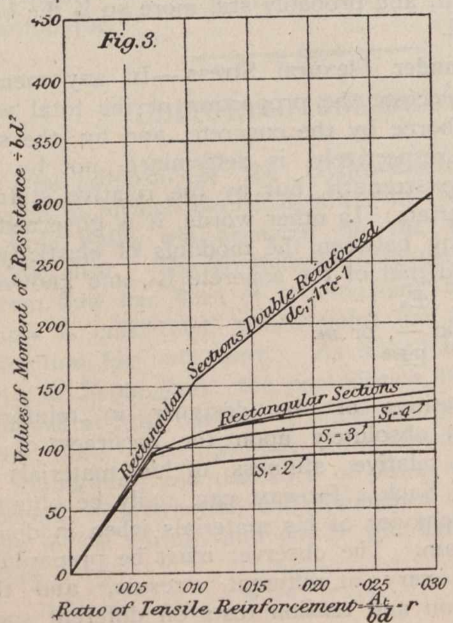
If the section were rectangular and reinforced in tension and compression, the ratio of compression to tensile reinforcement — $\frac{A_t}{A_c}$ being r_c, and the depth of the former below the top of the beam were $d_c\, /\, d$, or d_{c1}, then the value of m would be

$$m = \frac{n_1^2}{2\, r\, (1 - n_1) - 2\, r\, r_c\, (n_1 - d\, c_1)}$$

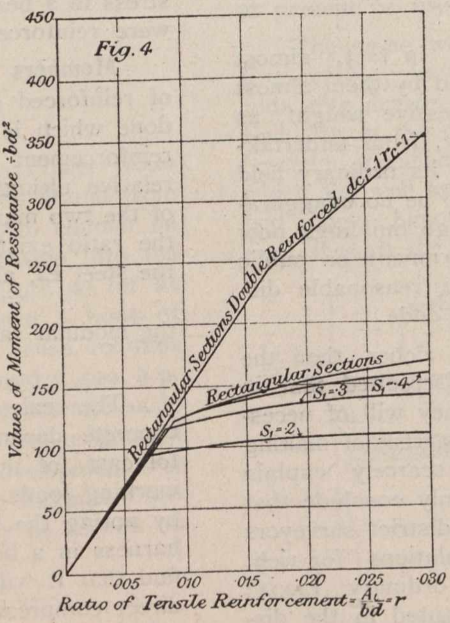
In view of the importance of fixing a correct modular ratio for different classes of concrete, and of the fact that expenditure upon experimental research was specifically authorized under the London County Council General Powers Act of 1909, it is certainly a matter for regret that the Council have not taken advantage of the facilities which thus lay ready to their hand, before attempting to fix new modular ratios in their proposed code of 1913. The ratios specified (11 for 1:1½:3 and 8 for 1:1:2 concrete) may prove eventually to be correct at working stresses, but engineers will need to be authoritatively assured of this before undertaking the huge task of recompiling their data to agree with them. In fact, to permanently fix them by any means other than carefully digested research ought to be out of the question.

The value attributed to m enters into every one of the calculations required for reinforced concrete. So numerous and intricate are these that practical designers are forced to condense the essential factors into tables and diagrams, the compilation of which represents thousands of tedious calculations. The slightest alteration in the value of m renders the whole of that

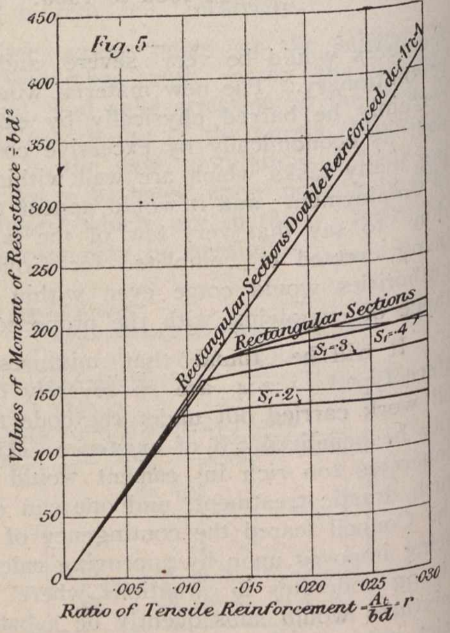
1:2:4 Concrete, $c=600$, $m=15$



1:1½:3 Concrete, $c=700$, $m=15$



1:1:2 Concrete, $c=900$, $m=15$.



The modular ratio for different classes of concrete can therefore be determined without much difficulty by testing a number of beams under different loads and noting the position of the neutral axis shown by extensometer readings of the extended and compressed fibres.

The French Government Commission, which sat from 1900 to 1906, tested a large number of beams and recorded the extensometer readings. Fig. 2 reproduced from M. Nivet's *Cacul de Beton Armé*, show the arrangements adopted for a typical beam. The details of these tests are available, but, unfortunately, they did not include beams of richer concretes.

Until sufficient exact data have been collated of extensometer tests upon beams of rich concretes, T-sections, and of sections reinforced in compression, any value attributed to m for such sections must be at least only conjectural.

labor useless for any purpose for which the altered value of m is to be used. Such alterations can materially affect the calculated strength of beam sections, as is shown by comparing Figs. 3 to 9, in which are plotted the moments of resistance of some typical single reinforced rectangular and T-beams, and of rectangular sections reinforced both in compression and tension.

No examples of double-reinforced **T**-sections are included, on the ground that under the heavy stresses which demand double reinforcement, it is unwise to consider the material of a relatively thin slab to be a fully efficient working partner in the compression flange; and only such part of it should be taken into account as is consistent with the assumption of a vertically rectangular section. The value of d_c, or depth of centre of compressive reinforcement from top of beam selected, is $\frac{d}{10}$. Other values could, of course, be added, but allowing for ½ in. of cover in slabs and 1 in. in beams, this value will be found to be a fair average for double reinforced sections. All the types shown are calculated for a permissible tensile stress of 16,000 lb. per sq. in. on the steel, and for a compressive stress of *m* times the stress on the concrete immediately surrounding the steel.

Figs. 3, 4, and 5 show the unit safe working moment of resistance of beam-sections, calculated with a modular ratio of 15 at the concrete stresses recommended in the Reports of the Joint Committee on Reinforced Concrete of the Royal Institute of British Architects, which stresses are also one-fourth of the ultimate test loads at 90 days, stipulated in the new London County Council code for concretes of the proportions stated.

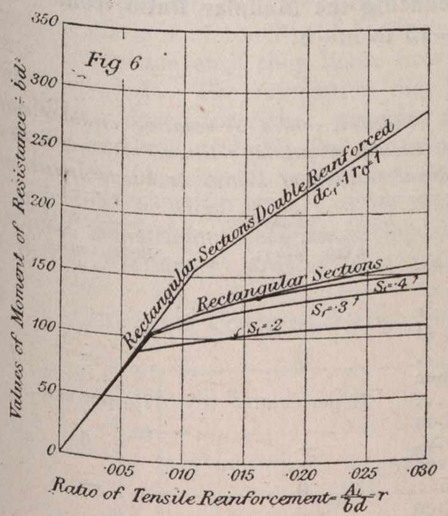
Figs. 6 and 7 show the same sections calculated with modular ratios reduced to 11 and 8 respectively for the richer mixtures. It will be seen that the effect is a reduction in the theoretical strength, which is more severe

ordinary that it would appear to be doubtful whether the compilers of the code really intended to bring it about. The high shearing stresses still permitted by the code make any unnecessary dead-weight more than usually undesirable; and unless very excellent reasons can be shown for the extremely low stresses, and, therefore, very bulky sections involved, it would appear to be reasonable to consider a revision of the present proposals so as to conform with the results shown in Figs. 6 and 7, giving designers the option of either working to reduced modular ratios, or of suitably reducing their working stresses to give the same result.

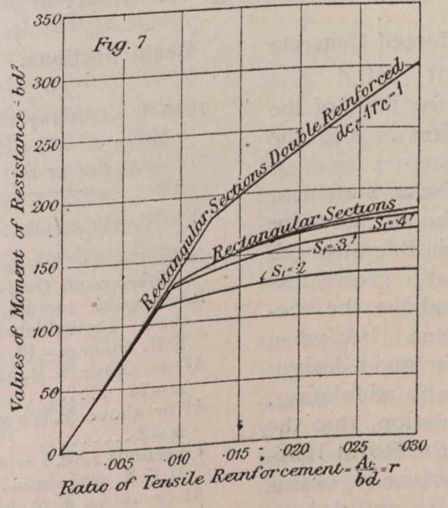
The effect of altering the modular ratio only, leaving the Royal Institute of British Architects' stresses unchanged, is shown in Figs. 10 and 11 in the shape of a percentage reduction in the strength as calculated by the Royal Institute of British Architects' rules, upon which the tables and diagrams generally found in text-books and drawing-offices are based.

At proportions of reinforcement below the economic ratio the stress on the concrete becomes of no importance, and the effect of any alteration of the modular ratio is

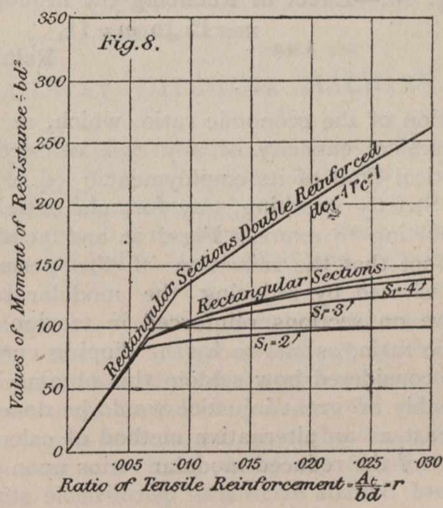
1:1½:3 Concrete, $c=700$, $m=11$.



1:1:2 Concrete, $c=900$, $m=8$.



1:1½:3 Concrete, $c=650$, $m=11$.



on beams with double reinforcement than on those reinforced in tension only. The reason of this is that any reduction of the modular ratio postulates that the stiffness of concrete more nearly approaches that of steel. It, therefore, picks up more readily that proportion of the load which taxes its strength to the full permissible limit, and the capacity of the combination is thus more quickly reached; in double reinforced beams the same excessive zeal of the concrete to overwork itself not only causes it to reach more rapidly the limit of its strength, and calls for more assistance from the compressive reinforcement which is harnessed tandem with it, but also reduces the efficiency of that compressive reinforcement by causing it to work in conformity with a more easily exhausted partner.

Figs. 8 and 9 show the joint effect of applying to the same sections the reduced modular ratios and also the reduced concrete stresses stipulated in the proposed London County Council code.

It will be seen from these figures that, in order to comply with the code, the designer must consider his beams to be much weaker if he uses rich concretes than if he uses poorer mixtures. This result is so extra-

practically negligible, the slight reduction of tensile stress (or the corresponding increase of nominal tensile strength) obtained by it being too small to take into account. It is necessary, however, to carefully note that the reduction in compressive strength commences at the economic ratio fixed by the lower modular value, and not that fixed by the higher value. The former is indicated by the point on the base line of the diagram from which each graph starts, and the latter by the point at which the graph abruptly changes direction. Fortunately it is possible to fix with but little labor the economic ratios of any class of beam section for any given values attributed to *t*, *c*, and *m*. If, therefore, Figs. 10 and 11 could be expressed in tabular form, the labor involved by altering *m* could be very sensibly reduced for the great majority of cases arising in actual design. The object of the designer is, or should be, to select the section which will do the work required of it without unnecessary cost in reinforcement. If one type—say, a T-beam in which $s_1 = 0.3$—would require a proportion of reinforcement greater than the economic ratio, then it is cheaper to make the rib wider until it will contain the full triangular area forming the virtual compression flange of a rectangular section. If this is still insufficient, the designer can most economically increase the deficient compressive strength by going to a still more efficient class, and selecting some suitable double reinforced section. It pays better to use the section properly adapted to any task rather than to over-reinforce an unsuitable one; and the most important result of reducing the modular ratio is therefore the effect which it has upon the

1 :1½ :3 Concrete, $c=700$ lbs. per sq. in.

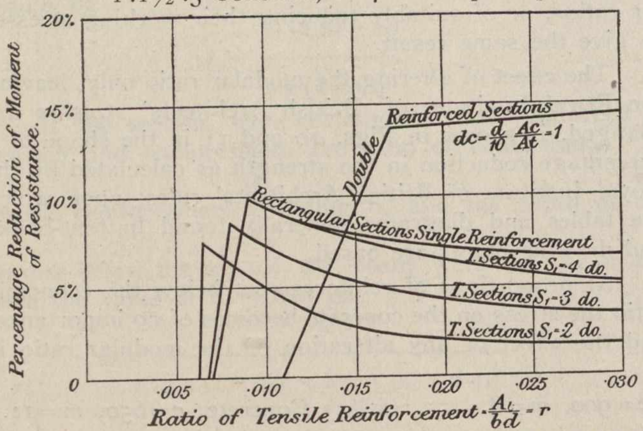


Fig. 10.—Effect of Reducing the Modular Ratio from $m=15$ to $m=11$.

Reinforced Concrete

position of the economic ratio, which, as the limit of the economical capacity of any type of section is also the practical limit of its employment.

Strictly speaking, any formula or tabular statement purporting to express Figs. 10 and 11 should allow for the fact that the reduction of the permissible strength necessitated by reducing the modular ratio grows less severe on sections reinforced in tension above the economic ratio, as shown by the dipping curves. But when it is considered how seldom this obtains in good design, probably no great injustice would be done by stipulating, at least as an alternative method of calculation, that the effect of the reduced modular ratios upon the Royal Institute of British Architects' permissible stresses on beams may be taken by calculating as for $m = 15$ and deducting the percentages shown in Table I. The somewhat rare cases of beams reinforced considerably beyond the economic ratio can be calculated specially. The economic ratio could be easily defined as that proportion of tensile reinforcement at which $R_c = R_t$.

The table, like the diagrams, is intended to be illustrative only. Additional percentages would be required for intermediate values of s, in single reinforced **T**-beams, and, in double reinforced rectangular sections, for values of $\frac{A_c}{A_t}$ greater or less than 1, and possibly for values of d_c greater or less than $\frac{d}{10}$.

Columns Under Axial Load.—The methods of calculating columns under axial loads lend themselves very readily to standardization in straight-line graphs easily calculated and easily drawn for any given modular ratio and stresses. An alternative method of calculation, whereby a percentage reduction may be made from the Royal Institute of British Architects' diagrams, is therefore not so much needed as is the case with sections designed to meet flexural stresses under bending moments. It is, however, very important to note that the effect upon column stresses of reducing the modular ratios does not necessarily tend towards increased safety. In a section subjected to bending moment, the limiting stress on the concrete is almost invariably the vital criterion. In columns, however, it is much more frequently the stress on the steel. The large extent to which the use

1 :1 :2 Concrete, $c=900$ lbs. per sq. in.

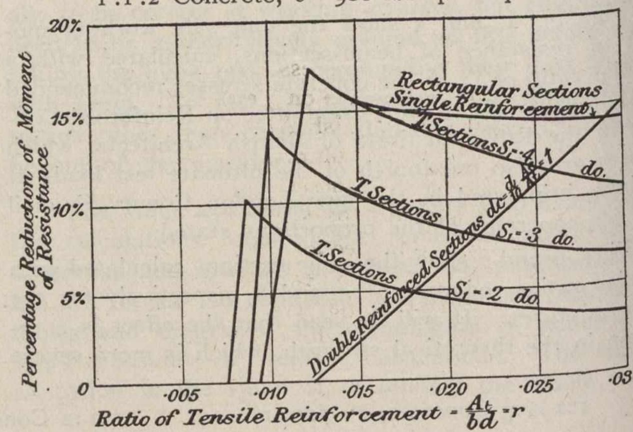


Fig. 11.—Effect of Reducing the Modular Ratio from $m=15$ to $m=8$.

Beam Sections.

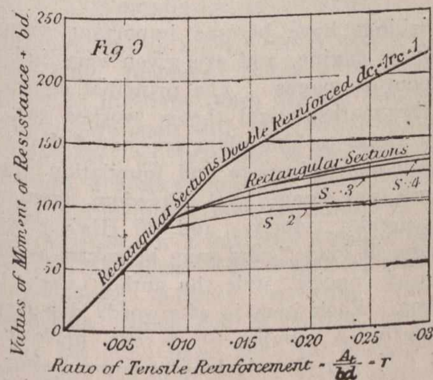
Table I.—Showing the reduction, caused by reducing modular ratio below $m=15$, of permissible moment of resistance of beam sections calculated at the Royal Institute of British Architects' stresses.

Type of Section.	1 : 1½ : 3 Concrete $c=700$, $t=16.000$. $m=11$.	1 : 1 : 2 Concrete. $c=900$. $t=16,000$. $m=8$.
Sections with Tensile Reinforcements Only.		0
Rectangular sections or their equivalents at E.R. when $m=15$	0	—
At or above E.R. when $m=11$	10 per cent.	17½ per cent.
At or above E.R. when $m=8$	—	0
T-sections $s=0.3$ or over at E.R. when $m=15$..	0	—
At or above E.R. when $m=11$	8 per cent.	14 per cent.
At or above E.R. when $m=8$	—	0
T-sections $s_1 = 0.2$ at E.R. when $m=15$	0	—
At or above E.R. when m=11	7½ per cent.	10 per cent.
At or above E.R. when $m=8$	—	
Sections with Compressive and Tensile Reinforcement.		
Rectangular sections $d_c = \frac{d}{10}$, $A_c = A_t$, at E.R. when $m=15$....	0	0
At or above E.R. when $m=11$	14 per cent.	—
At or above E.R. when $m=8$	—	23 per cent.

Proportionate reductions to be made at ratios of tensile reinforcements between the economic ratios stated.

in columns of hard, stiff steels with high yield-points is advocated serves to show how frequently the designer finds that a given column can only be adequately reinforced by steel which is harder or more willing than the British standard mild structural steel. The effect of reducing the modular ratio is in effect to assume that the concrete will take a greater proportion of the joint load, so that the steel must necessarily take a smaller share. For any given loading, less stress will be debited to the steel than would be the case if the concrete were credited with a relatively lesser degree of eagerness to pick up work. If the modular ratio be fixed without due care, or upon considerations which do not apply to the actual behavior of fibres under joint stress, there is obvious danger of giving it too low a value. Whether such unduly low value would be liable to overtax the steel depends upon the limiting stress on the concrete. In the proposed London County Council regulations this is reduced so drastically that even if a modular ratio of 15 actually obtained in place of 11 or 8, as stipulated, the permissible stress on the steel would still be greater than m times the greatest permissible stress on the concrete. But the London County Council concrete stresses on columns are only one-half to one-third of those recommended in the Royal Institute of British Architects' report, which was drawn up by well-known men selected to represent great institutions. As the Committee's report attached to the London County Council's code carefully throws upon the Local Government Board the responsibility of these reductions, it is scarcely probable that in any case outside the small legal scope of the new code engineers and designers will discard the considered recommendations of the Royal Institute of British Architects' Committee until they know how the new stresses were arrived at. The suggestion that the modular ratio should be reduced for richer, stronger concretes is not a new one and will probably find many adherents. But if this be done, it must be recollected that it is equivalent to relieving the steel of part of its responsibility. For instance, if a prudent designer, using the Royal Institute of British Architects' stresses on 1:1½:3 concrete for a

1:1:2 Concrete, $c=650$, $m=8$.



column 100 sq. in. area, with 3 per cent. of vertical reinforcement, adopted a ratio of 11 instead of 15, he could load his concrete up to 1,456 lb. per sq. in. (or 0.52 U) under which conditions his speed would be stressed to m c, or 16,016 lb., if $m = 11$. The equivalent section would be $100 + \{3 \times (m - 1)\} = 130$ sq. in., and the permissible load would be $130 \times 1{,}456 = 189{,}280$ lb., or, say, 84 tons. But if at working stresses the proper value of m were really 15, then the equivalent area would be $100 + \{3 \times (m - 1)\} = 142$ sq. in., and the stress on the steel would be $\frac{189{,}280}{142} \times 15$, or 20,000 lb. per sq. in., instead of 16,000.

The correct practical value to be attributed to the modular ratio is therefore at least worthy of exact and authoritative determination, not only in justice to the capabilities of the material, but also on the score of safety.

PROPOSED CANADIAN INSTITUTION OF MUNICIPAL ENGINEERS.

The following gentlemen have consented to act on the provisional committee appointed to draft out the constitution and arrange the preliminaries of the proposed Canadian Institution of Municipal Engineers: Mr. J. Antonisen, street railway superintendent, Brandon, Man.; Mr. M. H. Baker, city engineer, Prince Albert; Mr. Willis Chipman, consulting engineer, Toronto; Mr. G. T. Clark, city engineer, Saskatoon; Mr. G. W. Craig, city engineer, Calgary; Mr. Arch. Currie, city engineer, Ottawa; Mr. F. L. Fellowes, supervising city engineer, Vancouver; Mr. G. D. Mackie, town engineer, Swift Current; Mr. T. Aird Murray, consulting engineer, Toronto; Mr. F. McArthur, city engineer, Regina; Mr. H. H. Phillips, city hall, Toronto; Mr. R. Potter, town engineer, Battleford; Mr. J. B. Sterling, city engineer, North Battleford; Mr. L. A. Thornton, city works commissioner, Regina; Mr. R. O. Wynne-Roberts (convenor), consulting engineer, Regina.

A NEW RAILWAY DITCHING MACHINE.

An excavating machine adapted to railway ditching has been patented by Naylor Johnson, Montreal. The machine consists of a framework mounted on skids, having at one end a mast and at the other end a steam winch. The excavator is arranged to draw itself and a train of flat cars.

The point of greatest interest is the arrangement of the single hoisting rope which is rove through blocks on the boom and buckets bail to make a tackle, and then passes over the mast to the winch. When the rope is wound up, the bucket is first drawn up to the boom, and the boom and bucket are then drawn up together to dumping position. In order to return the bucket to cutting position before the boom drops, a check rope is provided for the boom passing over a brake-controlled drum. By tightening the brake as the hoisting rope is slackened off, the check rope holds the elevator boom while the bucket drops to cutting position. The brake is then released to let the check rope slacken with the hoisting rope, so that the boom lowers the bucket into the cut. The boom is arranged to swing through a considerable angle to the line of excavation, and the swing of the bucket is radially adjustable with respect to the boom, so that it will always swing parallel with the car carrying the machine. An adjustable, inclined rail controls the lateral movement of the boom.

There is also an independent boom with a plough attached to it. The plough is arranged to give batter to the ground outside the ditch, this batter being formed to the angle of forty-five degrees. The plough is provided with a rooter point and is also intended for use in levelling rough ground before ditching. The bucket can be detached in a few minutes by withdrawing one pin and cotter. There are many other uses to which it can be put when not in use as a ditcher. Mr. Johnson claims for this machine great simplicity and large capacity combined with great ease and flexibility of operation.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

Steam Power Plant Engineering.—By G. F. Gebhardt, Professor of Mechanical Engineering, Armour Institute of Technology, Chicago. Published by John Wiley & Sons, New York. Agents for Canada, Renouf Publishing Company, Montreal. 990 pages; 606 illustrations, besides charts and tables; cloth; 6 x 9 inches. Price, $4.00.

Reviewed by George Service, Wh.Sc.

In his preface to the fourth edition Mr. Gebhardt says: "Although primarily intended as a text-book for engineering students, it is hoped that the new edition will be of interest to practising engineers," and a study of the book convinces one that both the claim made, and the hope expressed, are justifiable.

The author has gathered together from many sources, and arranged in logical order, a large amount of up-to-date practice and discussion covering the subject, and, while the text is sufficiently full for ordinary purposes, the value of the book, especially to practising engineers, is greatly augmented by the extensive bibliography incorporated with the text, forming a splendid reference index for anyone wishing to make independent investigations. The book is remarkably free from "faddishness," such as some novel (and unusual) system of notation, or of nomenclature; and, indeed, the author has taken special pains, by the use of italics, to bring the generally accepted terms to the notice of the student.

In addition to dealing very fully with successful practice, attention is called to various parts of the subject, which, so far, have not been developed to be commercially successful, probably with the object of stimulating investigation along these lines; as, for example, the use of powdered coal. The advantages of such material are very clearly stated, as well as the practical difficulties which have been met with in the attempts to use it.

It has obviously been the intention of the author to deal chiefly with the various details constituting a steam power plant, and very little space has been devoted to the discussion of complete plants, only two central station plants, and one isolated power plant, in Chicago, being described. But one cannot help feeling that the volume would have been more complete had it included, even if only in table form, particulars of a number of typical power stations, which data would probably show that certain fixed proportions existed between the various departments of the plant, and would be of use for practising engineers in making preliminary lay-outs, as well as for advanced students.

The chapter on fuels and combustion contains data drawn largely from United States Government reports, and, unfortunately no reference is made to Canadian coals. The desirability of classifying coals according to the carbon-hydrogen ratio, as adopted by the United States Geological Survey, is pointed out, as it appears to apply satisfactorily to all grades of coal. The subject of combustion in general is treated fully and well, and considerable attention is paid to the use of oil fuel, a number of tests of an oil-burning boiler showing an efficiency of 75.8 per cent. to 83.3 per cent. being given.

Subject matter on the Reciprocating Steam Engine covers over 80 pages, dealing with theory, description of types, and the latest performances obtained, the lowest steam consumption recorded to date being given as 6.95 pounds per indicated horse-power hour. The author points out the advisability of giving the performance in heat units instead of pounds of steam, now that superheated steam is being used.

Steam turbines have become important competitors of the reciprocating engine, and are given very full treatment, taking up about 80 pages. The principal types are illustrated, and the mathematical theory worked out. The advantages of a steam turbine plant are stated thus: "(1) Simplicity; (2) Economy of space and foundation; (3) Absence of oil in condensed steam; (4) Freedom from vibration; (5) Uniform angular velocity; and (6) High efficiencies for large variations in load;" and may be taken as an example of the clear and concise style the author uses throughout the whole book. Each item is afterwards discussed at considerable length. A number of recent performances are given, the B.T.U. per electrical horse-power being as low as 204 for a 2,000 K.W. machine. Comparative costs of the installation and operation of steam turbine and engine plants are given, the balance being in favor of the steam turbine plants.

The high vacuum necessary for recent turbine practice has necessitated considerable modification in the design of the condensing plant, and this part of the subject is treated very fully in the excellent chapters on Condensers and Cooling Towers, and Pumps; and in line with the plan adopted throughout the book, recent data as to the power required, and costs, are given.

One of the most interesting chapters, and one not usually inserted in a technical work of this kind, deals with finance and economics, and the cost of power. At the outset the author points out the necessity for a clear understanding of such much-used (often loosely) terms as "load factor," "curve load factor," "rated capacity," and so on; and gives definitions of their generally accepted meanings. The cost of each section of the plant is taken up in detail, and a large amount of data given from actual practice, which should be of use to the practising engineer in particular.

All the other chapters, including a very good one on Superheated Steam and Superheaters, are well written and illustrated, but do not call for any special remarks.

In printing the tables an occasional decimal point has been misplaced, and in one place the author states that turbine plants of over 60,000 K.W. capacity can be installed for $65.00 per K.W., while in another he gives the cost as $75.00. Occasionally he touches on debatable ground, as, for instance, when discussing the use of kerosene in boilers he says: "Kerosene oil and other refined petroleum oils are sometimes used with good effect in boilers to prevent scale from adhering;" while later on he adds: "Evidently oil does not have the same effect or give the desired result in all cases." But as a rule his conclusions are extremely definite.

Throughout the book are many diagrams plotted from actual results, which are useful in themselves, and also as illustrating the graphical method of making records and compiling data. The author recommends the use of the "Mollier Total Heat Entropy Diagram" in place of the usual steam tables, and a copy of this diagram is given in the appendix.

Although the volume consists of nearly 1,000 pages, it is extremely concise in its treatment throughout, excessive elaboration being entirely absent; and after a careful study one is satisfied that it is well worthy of a place in any technical library, be it that of a student or practising engineer.

Hydraulic Turbines, with a Chapter on Centrifugal Pumps.—By R. L. Daugherty, Assistant Professor in Sibley College, Cornell University. Published by McGraw-Hill Book Company, New York. Cloth; 6 x 9¼ inches; 156 pages; 96 illustrations. Price, $2.00.

Reviewed by T. H. Hogg,
Assistant Hydraulic Engineer, Hydro-Electric Power Commission of Ontario.

This little volume is a most timely addition to the literature on hydraulic turbines. While a number of treatises have appeared at different times dealing with the design of turbines, these have dealt with the subject in such a manner that they have been of little use to the busy engineer who desires to make a proper choice of wheel under given conditions. Comparatively few men are interested in the design of hydraulic turbines, for a relatively small number are called upon to design machines. The design of water turbines is a highly specialized industry, requiring considerable empirical knowledge, which can be learned only through experience. On the other hand, with the great increase in the number of power developments, a vastly increasing number of engineers are finding it necessary to familiarize themselves with the construction of turbines and to understand their characteristics, in order that they may be able to make an intelligent selection of a type and size of machine for any given set of conditions. This book will appeal to this latter class, for it presents in short, concise form the conditions that bear on the choice of turbines. The general question of the development of water-power is dealt with only in so far as it bears on the choice of turbines.

The author states that his purpose in proposing the text was to give a general idea of water-power development and conditions affecting the turbine operation, a knowledge of the principal features of construction of modern turbines, an outline of the theory and the characteristics of the principal types, commercial constants, means of selection of type and size of turbine, cost of turbines and water-power, and comparison with cost of steam power. A chapter is also included on centrifugal pumps, covering the essential points an engineer desires to know to aid him in the selection of a proper type of pump.

The book should appeal to all engineers interested in the subject of hydraulic turbine selection.

Toothed Gearing.—By Geo. T. White, B.Sc. (London). Published by Scott, Greenwood & Son. 210 pages; 4½ x 7 inches; 136 illustrations and diagrams, also tables. Price, $1.00 net.

Reviewed by Chester B. Hamilton, Jun., B.A.Sc.,
Manager, Hamilton Gear and Machine Company, Toronto.

This is a treatise on Toothed Gearing, as distinguished from Gear Cutting, or practical applications of gears. These latter subjects are excluded and reserved for separate treatment. In this there is no doubt that the author is wise, as the subject in hand is amply large for the size of the book.

The work is modern, being dated July, 1912. Some of the data is new, having been previously published only in the Proceedings of technical societies. Most of the material is old and standard, but is compiled and presented in an effective and clean-cut manner.

The work leans toward the theoretical, rather than the practical, but this cannot be avoided. It is a suitable presentment of the theory for the use of the practical gear-man, as well as for one interested in the theory for itself. That is far more than can be said of most books handling such subjects.

Below is the list of chapter headings: I.—Kinematics. II.—The Spur Wheel, Cycloidal Teeth. III.—Annular Wheels, Cycloidal Teeth. IV.—The Spur Wheel, Involute Teeth. V.—Obliquity of Action. VI.—Pin Gearing. VII.—Non-Circular Wheels. VIII.—Lobed Wheels. IX.—Helical Wheels. X.—Bevel Wheels. XI.—Skew Bevel Wheels. XII.—Worm Bearing. XIII.—Oblique Worm and Wheel. XIV.—Screw Wheels or Spiral Wheels. XV.—Strength of Teeth. XVI.—Durability. XVII.—Trains of Wheels. XVIII.—The Odontograph.

The whole field is quite well covered, and, taken all around, it is a book to be recommended for anyone having a serious interest in gears.

Diagrams for the Solution of the Kutter and Bazin Formulæ.—Prepared by Karl R. Kennison, M. Me. Soc. C.E., Providence, R.I. Published by the author. Two diagrams and explanatory notes. 4 pages; size, 9 x 11 inches. Price, $1.00, postpaid.

Reviewed by J. J. Traill, B.A.Sc.,
Lecturer in Hydraulics, University of Toronto.

These diagrams are so arranged that when any three of the four variables, Slope, Hydraulic Radius, Roughness Factor, and Velocity, are known, the fourth may be scaled. There are two very decided advantages over most graphical representations of the Kutter and Bazin Formulæ, namely, the facts that the desired quantity may be scaled without a straightedge, and that the fourth variable plotted is the velocity and not the Chezy Coefficient. The author makes the claim that the results obtained are as accurate as the uncertainties in the application of the formulæ warrant. A careful examination indicates that this is true for the great majority of cases, the exceptions being for materials so uniform in surface that the value of the roughness factor is well fixed. A weak point in the diagram of Kutter's Formula is the omission of a number of the lines of roughness that might readily have been plotted, and, if inserted, would add greatly to the ease with which the diagram could be used. The diagrams are, however, extremely simple to use, both on account of convenient size and good arrangement.

Laboratory Manual of Testing Materials.—By William Kendrick, Hatt, C.E., Ph.D., Professor of Civil Engineering, Purdue University; and H. H. Scofield, M.E., Assistant Professor in Laboratory for Testing Materials, Purdue University. Published by McGraw-Hill Book Company, Inc., 239 West 39th Street, New York. Cloth; 5 x 7½ inches; 125 pages. Price, $1.25 net.

Reviewed by Robert J. Marshall, B.A.Sc.,
Department of Applied Mechanics, University of Toronto.

In the mass of engineering literature published on all sorts of technical subjects, this book by Professors Hatt and Scofield is the first work of its kind which has come to my notice on this particular subject. There is a real field for a student's text in Testing Materials, and this book is the first of its kind which deals in detail with experiments and methods of performing the tests, and seems to fulfil the above need.

The book, which is of convenient size, is well edited and nicely bound. It is divided into two sections. The first forty pages contain: a chapter on general instructions to the student, such as the necessary precautions for successful experimenting; a chapter of definitions which serves to refresh the instruction of the earlier years and a chapter descriptive of the ordinary machines and instruments used in an average experimental laboratory. Chapters VI. and VII., which comprise the second section, outline the experiments and give detail methods of performing each experiment. The instruction is precise and to the point. The references are well chosen, and in all the book appears to be the result of long experience in this kind of work.

Reinforced Concrete Construction.—By M. T. Cantell, Head of the Technical Department of the Kelvin Technical High School, Winnipeg, Man. Published by E. F. & N. Spon, London, Eng., and Spon & Chamberlain, 123 Liberty Street, New York. 240 pages; 250 illustrations; 7 plates; 7 x 10 inches. Price, $5.00 net.

Reviewed by Prof. P. Gillespie
Department of Applied Mechanics, University of Toronto.

This well-printed volume, comprising some 240 pages, is the second and more advanced of two works by Mr. Cantell on reinforced concrete design. A knowledge of the elements of design in this material is really necessary to an understanding of the text, and it is assumed by the author that the reader possesses such a knowledge. The book favors the British in its notation, in its illustrative typical designs, and in the authorities which it follows. This is apparent, for example, in those somewhat arbitrary rules of design which all regulations contain, and which are necessary in cases where theoretical treatment is impossible or unduly involved. Such matters as the limiting ratio of width of slab to thickness of web in tee-beams, and the minimum spacing of rings in columns reinforced by hoops are decided according to R.I.B.A. practice rather than American. This circumstance, however, should not spoil the text for American readers nor deprive them of its benefits. Indeed, it is the reviewer's opinion that had American practice been leavened somewhat more by British caution and thoroughness during the past decade, fewer fatal failures of reinforced concrete structures on this continent would have occurred.

An excellent feature of the work is the large number of actual problems which have been worked out in detail by the author. These comprise a great many types of construction in reinforced concrete, and are admirably adapted to the needs of the inexperienced designer. Graphical and analytical methods are employed, and the problems present great diversity.

The chapters on Retaining Walls, Water Tanks and Towers, Bunkers, and Arches and Bridges are among the most interesting in the book, and, as the reader will observe, investigate fields among the latest of those invaded by this material, whose applications in building construction are daily increasing in number. The volume is a marked improvement over the ill-digested amateurish stuff that, during recent years, has appeared on this side of the water, and could very properly find a place in the library of both young and old students of the subject.

Locomotive Boiler Construction.—By Frank B. Kleinhan, with additions by George L. Fowler, M.E. Published by Norman W. Henley Publishing Company, 132 Nassau Street, New York. 478 pages; 5 folding plates; 40 tables; 350 illustrations; cloth; 5½ x 8 inches. Price, $3.00 net.

Reviewed by R. W. Angus,
Professor of Mechanical Engineering, University of Toronto.

This is a practical treatise for the use of boiler-makers, boiler-users and inspectors; and, since it is designed for the practical man, there is none of the so-called theory, to speak of, in its subject matter.

The chapter on the types of boilers is very short and is purely introductory, no illustrations being inserted. The laying out of the various sheets of a boiler, which is next dealt with, is a quite complicated and difficult matter, requiring much skill for exactness. The author has omitted the elaborate methods, substituting for them approximations which are probably accurate enough. Explanations as to why things are done are usually not given, and for this reason the reader might have trouble applying any of the methods to slightly different designs.

Considerable space has also been devoted to flanging, which has been treated entirely in a descriptive way, and illustrated quite fully. This is followed by chapters on punching, shearing, plate-planing, etc., the effort being to follow the various parts through the shop in order in which the work would be done. Riveting and staying receive some fair share of attention, and such matters as the mountings and general assembling are dealt with.

The concluding 120 pages contain tables of various sorts, many of which would be helpful, while the back of the book contains five folding plates.

To the builder or mechanic wanting general ideas on working out the details of a locomotive boiler the book would be of some interest, but as it deals only with the locomotive boiler it can scarcely be said to be of general interest. The problems connected with the building of the locomotive boiler are, however, similar to those with other types.

PUBLICATIONS RECEIVED.

Office and Field.—Seventh annual convention number of the L.U.A.C., Ottawa, 1913. 372 pages, 6½ x 10 inches. Published by W. B. Campbell.

Carbon Circuit Breakers.—Circular No. 1205, of the Canadian Westinghouse Company, Limited, Hamilton, Ont., is descriptive of a half-dozen types, and their auxiliary mechanisms.

Handbook of British Columbia.—Bulletin No. 23 (seventh edition) of the Bureau of Provincial Information, descriptive of British Columbia, as to its position, resources, climate, industries, etc.

The Resources of Tennessee.—This is a magazine published quarterly by the State Geological Survey, and devoted to the description, conservation, and development of the resources of Tennessee.

The Inflammability of Coal Dust.—Bulletin 50, of the United States Bureau of Mines, comprises the results of laboratory experiments by Messrs. J. C. W. Frazer, E. J. Hoffman, and L. A. Scholl, Jr.

Report of Nelson P. Lewis, Chief Engineer of the Board of Estimates and Apportionment of the City of New York for the year 1912. It is a volume of 300 pages, including 37 tables, together with various maps, etc.

Hamilton.—A 340-page book, published by Herbert Lister, Hamilton, Ont., descriptive of the city, its history, commerce, industries, and resources, and published in connection with the Centennial Industrial Exhibition held recently.

The Geology of the Gowganda Mining Division.—Memoir No. 33 of the Geologic Survey Branch, Department of Mines, Ottawa. It is a 120-page book, supplemented with maps and photographs covering the general and economic geology of the district.

Society of Railway Club Secretaries.—A 24-page booklet, indexing the papers and subjects discussed by railway clubs during the year ending May 31st, 1913. The secretary of the Society is Harry D. Vought, New York and Central Railway Club, New York City.

The Theory of Loads on Pipes in Ditches, and Tests of Cement and Clay-Drained Tile and Sewer Pipe.—Bulletin No. 31, Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts. The authors are A. Marston and A. O. Anderson.

Mineral Production of Canada.—Bulletin No. 238, Mines Branch, Department of Mines, Ottawa, contains a general summary of the mineral production of Canada, 1912, compiled by John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics.

The Textile Industry and the Tariff.—An address by A. F. Greene, delivered to the National Association of Cotton Manufacturers by Mr. Greene, retiring president. Published in booklet form by Lockwood, Greene Company, architects and engineers for industrial plants, Boston and Montreal.

Le District D'Ungava, Le Nouveau Quebec.—231 pages, 7½ x 10½ inches, illustrated, with map appended. Extracts from reports on the district of Ungava, recently annexed to the Province of Quebec. Published by the Bureaus of Mines and Fisheries, under the authority of the Minister, the Hon. C. R. Devlin.

Report on the Health of the City of Manchester, 1912.—203 pages, 6 x 10 inches, dealing with notified infectious diseases, and the work done to combat these under the various branches of the department of health. Issued by James Niven, M.A., M.B., LL.D., under the authority of the Department.

Commerce and Finance of the United States.—105 pages, 10 x 12 inches. Monthly summary of the foreign commerce of the United States, and of tables of commercial finance for July, 1913. Issued by the United States Bureau of Foreign and Domestic Commerce. A. H. Baldwin, Chief of Bureau, and O. P. Austin, Assistant Chief.

Oil and Gas Prospects of the North-west Provinces.—99 pages, 7 x 9 inches, with illustrations and map. Discusses the character of the district, and its general and economic geology. Published by Wyatt Malcolm, and by authority of the Hon. Robert Rogers, Minister of the Dominion Government Department of Mines.

Analyses of Coal.—Bulletin No. 22 of the Bureau of Mines, Department of the Interior, Washington, D.C. It is published in two volumes, Part I. of 320 pages, dealing with the analyses of coals in the United States, collected over a period of six years; and Part II., of 1,200 pages, dealing with descriptions of the various samples.

Forest Products of Canada—Poles and Cross-Ties.—A 16-page pamphlet published by the Forestry Branch, Department of the Interior, as Bulletin 39, containing statistics, compiled by R. G. Lewis, B.Sc.F., based upon reports from 389 companies, representing 95 per cent. of the wooden-pole users in Canada, concerning their purchases for 1912.

The Titaniferous Iron Ores in the United States.—First edition, June, 1913. Illustrated, 145 pages, 6 x 9 inches Discusses the chemical composition of titaniferous iron ores, the economic importance of the deposits, and their character, situation, and possibilities. Published by Joseph T. Singewald, Jr., by authority of the United States Government Bureau of Mines.

Oil and Gas Prospects of the North-West Provinces of Canada.—Memoir No. 29E of the Geological Survey of Canada. Compiled by Wyatt Malcolm, and containing full information concerning the geological formations in that portion of the Dominion, comprising practically all of the Provinces of Manitoba, Saskatchewan and Alberta. The report occupies 100 pages, and is supplemented by tables and maps.

Report, Minister of Lands, Forest and Mines, Ontario—This report for the year ending October 31st, 1912, deals with the management, etc., of the Crown Lands of the Province of Ontario. It includes returns, statements of sales, of revenues, receipts and disbursements, timber dues, municipal surveys, Crown surveys, etc., etc. Several appendices are devoted to the construction of roads in Northern Ontario, and Mr. J. F. Whitson's report is included.

Wood-using Industries of Ontario.—Bulletin No. 36, Forestry Branch, Department of the Interior, Ottawa. It is compiled by R. G. Lewis, B.Sc.F., and contains an account of the quantity, value and source of supply of the different kinds of wood used by the industries of Ontario. It includes detailed descriptions of the different classes of industries, and the properties of the woods used. A classified directory of manufacturers is appended.

Long Sault Rapids, St. Lawrence River.—By Arthur G. White, M.E., Engineer to the Commission of Conservation, Canada. This is an engineering report upon the rapids, containing an inquiry into the constitutionality of the Long Sault Development Company's charter, and into the effect on navigation, and the general advantages or disadvantages accruing to the people of Canada from the project to develop electric power from these rapids. The volume comprises 384 pages. It is accompanied by about 25 illustrations and maps. This is the Commission's report upon a question which was dealt with editorially in Sept. 4th issue of this journal.

Precise Levelling is the title of a publication of the Dominion Observatory, Ottawa; W. F. King, C.M.G., LL.D., Director. Mr. F. B. Reid, D.L.S., is the author. The report deals with the results of precise levelling done by the Geodetic Survey as far as they are ready for publication at the present time. Table I. outlines the routes followed between terminal points, and describes all bench-marks established. Table II. gives the distances between bench-marks; the difference between forward and backward levelling for each section between bench-marks; the elevations of the bench-marks; and the elevation also of bench-marks established by other surveys and connected with Geodetic Survey work. Table III. gives the elevations at railway stations along different lines of levels. The publication is supplemented by several maps descriptive of the routes.

American Society for Testing Materials, Index to Proceedings, Vols. I.-XII.—158 pages, 6¾ x 9 inches. An index of the contents of Vols. I.-XII. of the proceedings of the American Society for Testing Materials, excluding only portions which relate to routine business. From 1898 to 1902, the society issued 28 bulletins, and these have been compiled as Vol. I. From 1902 to 1913, the association has issued a report of its proceedings annually, and these successive reports have been published separately in Vols. II.-XII.

Completing the Index is a Table of Contents of Proceedings, which gives the contents of the final eleven individual volumes. In this volume the titles of papers have been distinguished by quotation marks, and committee reports and specifications have been indexed under subjects appropriate to their titles. Prefixed to the Index is a list of key-words under which these subjects have been indexed; and the Index itself is classified under subjects and authors. The publication is issued by the society at the University of Pennsylvania, Philadelphia, Pa.

The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming, Report of the Bureau of Mines (Fourth Edition).—279 pages, 7 x 10 inches, fully illustrated and well supplied with inset maps. The book is divided into three chapters and four appendices. Chapter I. contains 132 pages, and deals with the district of Cobalt proper, the character and origin of its veins, ores and minerals. Chapter II. considers for 63 pages the Outlying Cobalt Areas, and a like discussion of their mineral products. Chapter III. gives in 30 pages an analysis of Lake Superior silver deposits, other Canadian Nickel-Cobalt ores, and foreign Cobalt deposits. The four appendices discuss respectively the Paleozoic Rocks of Lake Temiskaming, a profile from Toronto to Hudson Bay slope, the early history of the Cobalt industry in Saxony, and mining and concentrating methods at Cobalt. In this edition little is added to the economic geological description given in former editions; but some features have been treated more fully, such as underground work in the mines, which has furnished many details concerning the structural relations and the character of the veins.

Twentieth Annual Report of the Massachusetts Highway Commission, 1912.—333 pages, 6 x 9 inches, with map appended, containing Parts I. and II; the former dealing with State highways and motor vehicles; the latter, with the supervision of telephone and telegraph companies. Part I. comprises in 200 pages the report of the Massachusetts Highway Commission, consisting of Wm. D. Shier, chairman F. D. Kemp, and J. W. Synan; the report of Chief Engineer A. W. Dean, as Appendix A; and twelve additional appendices. A thorough discussion of the department's work upon State roads and in the supervision of automobiles marks the first portion of Part I. as most valuable, though the traffic census is also discussed at length, and constitutes a special phase of the book, which is elaborated in Appendix L by 28 pages of traffic records. Part II. consists of the annual report of the Massachusetts Highway Commission concerning companies engaged in the transmission of intelligence by electricity, which is supplemented by three appendices. There are three half-tone illustrations, two showing improved roads, and the third is of a 42-foot span reinforced concrete bridge. The appendaged map shows in tones of red the roads petitioned for, roads laid out, and town roads improved in Massachusetts. Wright & Potter Printing Company, Boston, Mass.

CATALOGUES RECEIVED.

Fractional Horse-Power Motors and Applications.—Illustrated leaflet, showing the various forms of fractional horse-power motors offered by the Canadian General Electric Company, Toronto.

Universal Bulletin.—Illustrated monthly, showing use of Portland cement in concrete bridges and buildings of various kinds. Published by the Universal Portland Cement Company, of Chicago, Ill.

A Thousand Uses for Gas.—The September number of an illustrated periodical issued to manufacturers by the Industrial Division of the United Gas Improvement Company, Philadelphia, Pa.

Efficient Roundhouse Lighting is the subject of a small pamphlet published by the Canadian General Electric Company, Limited, Toronto, and dealing with a type of reflector for use in roundhouses.

Incineration.—A neat 22-page pamphlet descriptive of some of the plants of the Decarie incinerator for the disposal of garbage and refuse. Published by the Decarie Incinerator Company, Minneapolis, Minn.

Steam-Driven Compressors.—A 12-page catalogue is published by the Canadian Pneumatic Tool Company, descriptive of Class "M" Chicago Pneumatic Corliss type compressor. It is Bulletin No. 24-T.

Country Sewage Purification.—Tuke & Bell, Limited, Sewage Specialists, London, E.C., describe their semi-septic system of sewage purification which they install for cottages, country houses, institutions, etc.

Condulets.—New types for railway requirements are listed and illustrated in Bulletin 101 of the Crouse-Hinds Company of Canada, Limited, of which Canadian General Electric Company are the selling agents.

Annual Report of the Quebec Railway, Light, Heat and Power Company, Limited.—An illustrated pamphlet, including maps, giving the report for the fiscal year ending June 30th, 1913, adopted by the company at its third annual meeting.

Mesta Gas Engines.—The Mesta Machine Company, Pittsburg, Pa., have issued a bulletin descriptive of their gas engines, which they build for any gas fuel—producer, blast furnace, coke oven, or natural, and in sizes from 350 B.H.P. upwards.

Catalogue "C" of the DeLaval Steam Turbine Company describes class "C" velocity-stage type. It is a catalogue of 108 pages, well illustrated and full of interesting data. The Turbine Equipment Company, Limited, Toronto, look after the sale in Canada.

Smut Diseases of Cultivated Plants.—Illustrated bulletin, giving a description of the different varieties, their history and treatment. Issued by H. T. Güsson, Dominion Botanist, and published by direction of Hon. Martin Burrell, Minister of Agriculture, Ottawa.

Illumination of Construction Work.—This is an illustrated description of the G. E. Type "W" flame arc lamp, and of its suitability for use by the modern contractor on his night-work jobs. The Canadian General Electric Company, Toronto, are selling agents.

Hand-Drills and Portable Compressors.—Illustrated pamphlet dealing with the Chicago Valveless Hand-Drill and the "Chicago Pneumatic" Portable Gasoline Engine-Driven Air-Compressor. Published by Chicago Pneumatic Tool Company, of Chicago and New York.

Wizard Rock Drills.—This product of the McKiernan-Terry Drill Company, New York, is described in a 12-page illustrated booklet. Prices and specifications of the various types and of their duplicate parts are given. Canadian Allis-Chalmers, Limited, Toronto, are agents.

Coal-Mine Fatalities in the United States.—A catalogue of tables, giving statistics of July coal-mine fatalities, and revised figures for preceding months. Compiled by Albert H. Fay, and published under the direction of the Bureau of Mines, United States Government, Washington, D.C.

Multi-Stage Type DeLaval Steam Turbines.—Described in Catalogue "D." The book is a 120-page description of the field, design, construction, and adaptation of the multi-stage DeLaval Turbine. A section of the catalogue is devoted to the company's double-helical speed-reduction gear. The catalogue is educative in the information which it contains, and shows, among other important details, the use of the DeLaval diagram and steam scale for determining the consumption of an engine or turbine under given steam conditions.

COAST TO COAST.

Regina, Sask.—To encourage the growth of smaller industrial companies, a movement has been begun in Regina to secure cheaper power for concerns using from 50 horsepower up. This means that the city council will be requested to grant the minimum rate to users of 50 horsepower or over instead of 100 horsepower as at present.

Ottawa, Ont.—The civic waterworks committee has appointed a sub-committee to investigate the meter system on water services as in vogue in some cities. This action has been taken merely to gain information concerning a method that might show how much water each place is consuming, so that the water rates might be based on the quantity of water consumed.

Fort William, Ont.—Actual work is now in progress on the extension of the Empire Avenue street-car line across the new C.P.R. bascule bridge to island number two. The work on the island has been proceeding for some time, and before the frost sets in, it is expected that all the rails will be laid from the bridge approach along Sixth Avenue to Eighth Avenue, and from thence down to the Mission River.

Hamilton, Ont.—Engineer Sifton, of the Hydro-Electric Department, has submitted statements to the board of control showing that the gross profits from the department for the past eight months have been over $26,000, the net almost $6,000. He furnished in addition an estimate of the amount required to complete the system so as to provide for the increased demands, showing an expenditure of $335,264, according to one plan, and $320,330, according to an alternative plan. For the larger amount, he informed the board that he would be in a position to supply eight times the number of customers that could be accommodated by the original system; and that cost about $500,000.

Fredericton, N.B.—The repairs and improvement being undertaken on the Fredericton-St. Mary's highway bridge are progressing satisfactorily both as far as efficiency and economy are concerned. The original estimate of cost was between $45,000 and $50,000; and President Remington, of the Foundations Company, Limited, the contracting company for the work, has stated after carefully inspecting the work and accounts thus far, that the estimate will not be exceeded, but rather that with favorable conditions, the work will be completed at less than the estimate, and will be a permanent piece of construction with which the best experts in America will be unable to find fault.

Ottawa, Ont.—Mr. L. G. Denis, expert for the Hydro-Electric Commission, has taken a thousand-mile trip through the northern Manitoba and Hudson Bay districts, and has given a report of his survey of important water powers, which disburses the possibility of the operation of the Hudson Bay Railway by hydro-electric power, an idea which has at times been promulgated. He states that though there are many water powers, economic conditions for development are not probable; since a continuous market for the power, for which there is little prospect, would be necessary to insure profit. The economic potentialities of the territory are such that any saving which might be effected by the operation of the road would hardly repay the cost of development.

Vancouver, B.C.—Mr. O. B. Dickeson, president of the White Pass and Yukon route, who has spent the greater part of the summer in the north, upon arriving in Vancouver, confirmed previous statements sent from Dawson City that his company will undertake important extensions to the transportation system in the North, and will also make every effort to provide for the present activity along the trails into the Shushanna country and the scene of the recent gold strike. The company's extensions into the White River district will be carried out, provided the development continues and it is possible to secure Governmental assistance. This he did not doubt, since the company's mining engineer had examined the territory, and had reported that, if transportation could be offered, the future of the White River country copper deposits was very promising.

Victoria, B.C.—Mr. Chambers, of the Irrigation Board of the Department of the Interior, recently visited Victoria, and while there made some interesting statements relating to the irrigation projects being developed in the Northwest provinces. He claimed that thousands of acres of semi-arid lands are being turned into valuable tracts and gave concrete evidence in instances of vastly improved germination that had come under his personal notice, to the greatest extent in the Bow River district. He said concerning the Bow River scheme that it was one of the largest projects of its kind on the continent, that the first two sections are completed, and their contributory lands under tillage, that the third section, which is fed by the Bassano dam, is rapidly nearing completion, and that the water will soon be let into the dam. The first section, which embraces an area of 300,000 square acres, is situated almost entirely south of the Calgary and Medicine Hat line down to the Bow River, and has been an important factor in the agricultural development of a section that was not looked upon very favorably in pre-irrigation days. Although these three units serve an immense area, it is the general opinion in Alberta that the C.P.R. will further develop this scheme and make it eventually one of the largest irrigated areas in the world. The dams are of concrete and splendidly constructed, and it is expected that there will be a big demand for the affected land when it is put on the market. In addition to the C.P.R., the South Alberta Land Company has irrigated large areas in that province. The Irrigation Board is not concerned with the actual work of construction, but it issues licenses for the utilization of the necessary number of cubic feet of water per second required for the development of the project, and all irrigation schemes and the structural details of the dams and ditches are submitted to the engineers of the board for sanction before the work is begun.

PERSONAL.

B. W. SETON, of the Dominion Engineering and Inspection Company, Montreal, has been appointed Toronto manager of his firm in order to handle the inspection work on the new Royal Bank Building, the Central Technical School, etc.

F. B. TAYLEY, resident engineer at London, Ont., for the Canadian Pacific Railway, has been transferred to the Montreal division, and is being succeeded at London by S. S. ROSSITER, of Cranbrook, B.C.

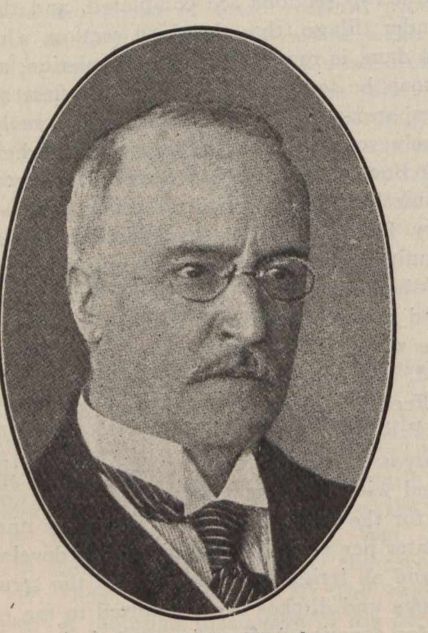
WALTER J. FRANCIS, C.E., consulting engineer, Montreal, read an address to the University of Toronto Engineering Society at the opening meeting for the 1913-14 session. The subject was "Engineering as a Profession."

CUNNINGHAM CRAIG, former geological surveyor of Great Britain and of Trinidad and Tobago, consulting geologist to the British Government, is in Alberta at present, conducting a rigid survey of the oil lands to the south-west of Calgary. He has announced, unofficially, that the territory indicates that the possibilities for oil in abundance are tremendous. The Province is receiving wide attention from oil experts at present.

W. S. HARVEY, the new city engineer of Lethbridge, as recently announced in this column, has been connected with the department of the city engineer for two years as assistant engineer in charge of sewers and waterworks. Previous to his going to Alberta, he spent some time in Toronto, as assistant engineer in the main drainage department. He spent eleven years on engineering work in England—on dock work at Bristol and Hull; on pumping station installation at Somerset; pier and coaling station construction at St. Vincent, Cape Verde Islands; sea defence work at Barry, South Wales; tramway construction at Chesterfield, and jetty work at Newport.

OBITUARY.

DR. RUDOLPH DIESEL, Hon. M. Am. Soc. M. E., of Munich, Germany, famous as an inventor of the Diesel oil engine, while on his way to London to attend the annual meeting of the Consolidated Diesel Engine Manufacturers, mysteriously disappeared from the steamer en route on the evening of September 29th, and, although for some little time hope was entertained of his being alive, it later developed that his disappearance was due to death by falling overboard through some mischance.



Dr. Rudolph Diesel.

Dr. Diesel was born in Paris in March, 1858. After courses of study at Augsberg, he entered Munich Technical College, where he graduated in 1879, specializing in thermodynamics. After spending some years on the staff of the college as assistant to Prof. von Linde he became manager of the French company for the manufacture of the von Linde refrigerating machinery in Paris.

Dr. Diesel's theories regarding prime-movers with higher thermal efficiency than the steam engine attracted world-wide attention in the early nineties, and in 1893 the first Diesel engine made its appearance. This experimental engine was wrecked by explosion at the first injection of fuel. The second Diesel engine, however, confirmed the inventor's theory of initiating combustion by compressed air. The third Diesel engine, built in 1897, and the fourth in the following year, were those that fixed the type upon which all slow-speed stationary Diesel engines have since been built. The progress and development of the engine during the past fifteen years is familiar to readers of this journal, it being now in service in practically every industrial country of the world.

Besides his honorary membership in the Am. Soc. M.E., Dr. Diesel was a member of the managing board of the Verein Deutscher Ingenieure. He was a director of five of the leading companies building Diesel engines in America and Europe.

W. F. DE VOE, connected with one of the British Columbia Government survey parties at Strathcona, lost his life by drowning while crossing Campbell River on October 19th. Mr. De Voe was a native of Los Angeles, Cal.

H. S. WESTBROOK, ex-Mayor of Winnipeg, and a prominent figure in the city's municipal development, died at his home in Winnipeg on October 19th. Mr. Westbrook was the father of President Wesbrook of the University of British Columbia. Another son is a prominent mining and metallurgical engineer in Duluth.

BRIDGE BUILDERS IN MONTREAL.

The American Railway Bridge and Building Association held its twenty-third annual convention last week in the city of Montreal. This is the second occasion of the Association's choice to convene in a Canadian city, Quebec having been previously chosen.

Mr. A. E. Killam, of Moncton, N.B., is president of the Association.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

Mr. James Spelman, vice-president of the John S. Metcalf Company, addressed the Montreal meeting of the Canadian Society of Civil Engineers, on October 16th, on the subject of the development of grain elevator construction. Mr. C. N. Monsarrat, chief engineer of the Quebec Bridge Company, was chairman.

At the November 6th meeting in Montreal, an important paper on "Filtration" will be read by Mr. F. F. Longley.

POSTPONED MEETING.

The convention of the Great Lakes International Pure Water Association, to have been held in Toronto, November 6th and 7th, has been postponed until further notice. The Secretary is Paul Hansen, Urbana, Ill.

A NEW CENTRIFUGAL PUMP.

At its meeting on November 11th in New York City the American Society of Mechanical Engineers will hear an address by Mr. C. V. Kerr, on a new centrifugal pump with helical impeller. Mr. Kerr, who is a sales engineer for the A. S. Cameron Steam Pump Works, claims that the reason for seeking a new type of pump is based on the characteristic behavior of the small steam turbine, which is commonly used in power plants, as the driving power for circulating pumps for condensers. The mathematical theory of the new type of impeller will be presented, also an illustrated description of the 8-in. experimental pump used, with methods and results of tests.

COMING MEETINGS.

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

NATIONAL MUNICIPAL LEAGUE.—Annual meeting will be held in Toronto, November 12-15. Secretary, C. R. Woodruff, 705 North American Building, Philadelphia, Pa.

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting will be held in New York, December 2nd to 5th, 1913.