PAGES

MISSING

Volume 27. Toronto, July 23, 1914

Contents of this issue on page 3

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

SOOKE LAKE WATER SUPPLY FOR VICTORIA, B.C.

A PROJECT TO CONVEY 16,000,000 GALLONS PER DAY THROUGH 27.3 MILES OF REINFORCED CONCRETE GRAVITY PIPE LINE AND 10 MILES OF STEEL PRESSURE PIPE, WITH A 136,000,000-GALLON INTERMEDIATE RESERVOIR.

THERE is some interesting history associated with the present undertaking by which the city of Victoria, B.C., will be supplied with 16,000,000 gallons of water daily through the Sooke Lake system. The question of water supply for the city extends back to 1868, when a system was adopted whereby a private company supplied the city through wooden pipes from a series of wells. Four years later the city began to investigate Elk Lake (see Fig. 4) as a possible source of supply. The official report concerning it estimated a supply of 25 gal. per capita per day for a population of 90,000. A scheme was entered into whereby for many years the city has received its supply from Elk Lake through open gravity sand filters and by a gravity system. Later, a pumping plant was installed, necessitated by fire protection requirements and by increased consumption. As the daily consumption further increased, the level of Elk Lake became lowered considerably and the quality of water impaired. Meantime the Esquimalt Waterworks Co. supplied Victoria West from the Goldstream Lakes. The cost to the city of the former is 2 cents per thousand Imp. gal. and of the latter 6 cents per thousand Imp. gal. Compared with this, the old well system in vogue before the Elk Lake scheme cost the city 0.75 cents per gal.

Fig. 1.—Portion of Reinforced Concrete Flow Line Near Humpback Reservoir.

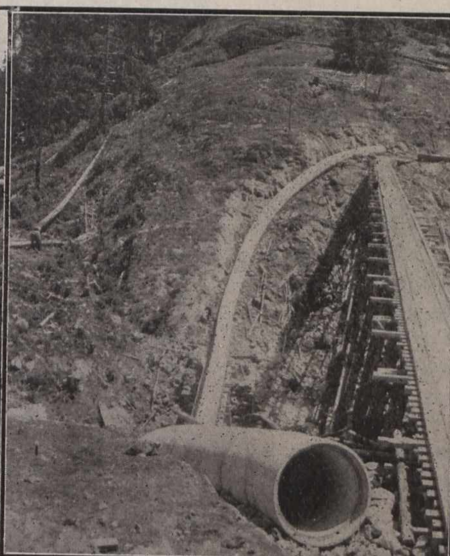


Fig. 2.—One of the Inverted Siphons. Construction railway is also shown.

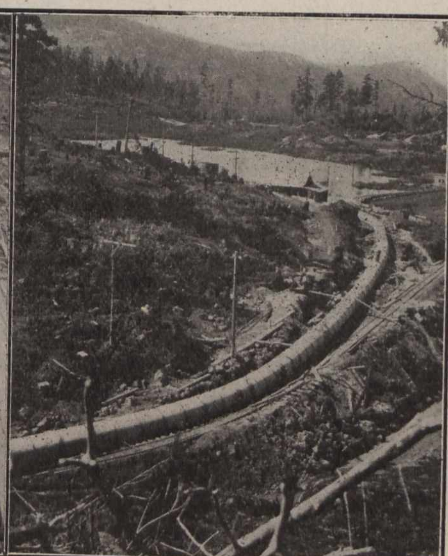


Fig. 3.—Site of Humpback Reservoir.

In July, 1911, the city decided to actively engage without delay upon plans for the extension of its water supply. Sooke Lake, which lies about 18 miles northwest of Victoria, was subjected to careful hydrographic investigation, including the study of rainfall, run-off, contour surveys, determination of area of watershed and possible supply. Owing to the expeditious circumstances, this work was pushed ahead with all speed, and before the end of the year tenders were called for. This procedure was authorized by a by-law which had received the assent of the electors on January 12th, 1911, for the borrowing of $1,500,000 for acquiring and constructing the Sooke Lake water system. In January, 1912, the contract for the construction of the entire work was let to the Westholme Lumber Company, of Victoria, for the sum of $1,169,170, the system to deliver 16,000,000 gal. of water daily, as stated. In April, 1913, after completing 38½ per cent. of the work when, according to contract, 65 per cent. of it should have been completed, the Westholme Lumber Company abandoned the contract and Water Commissioner C. H. Rust thereupon took over the work, to be done by the city, charging the expense to the contractor, as he was entitled to do by the provisions of the contract. The city has since been carrying out the work by day labor, with the exception of sub-contracts for the construction of concrete flow line, pressure pipe line, and other small portions.

The scheme constituted the conversion of Sooke Lake into a reservoir with a 12-ft. lift of water level; the laying of a 40-in. reinforced concrete pipe line 27.3 miles in length from thence to Humpback reservoir, about 10 miles outside the city, and the connection of Humpback reservoir with the Smith's Hill service reservoir, in the city, by a 36-in. steel pressure main. This service reservoir has a capacity of 16,000,000 Imperial gal. daily and is located at an elevation of 213 ft. above sea level.

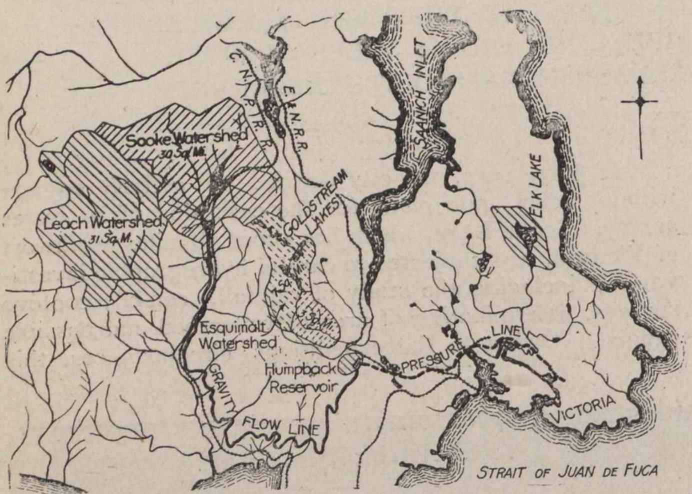


Fig. 4.—Watersheds Around Sooke Lake and General Layout of the Scheme.

Sooke Lake, as stated, is distant 18 miles from Victoria. It is long and narrow, being 4 miles in length and ½ mile in width at its widest point. It is in reality a series of three lakes, the farthest from the city being the largest and having a depth at several points of 150 ft. It has a remarkably pure and wholesome supply of water, outpointing in this respect the other two divisions of the lake. The three sections have an area of 964 acres and the watershed which they drain covers 31.35 sq. miles. At low-water the lake is 342 ft. above normal water level in the city service reservoir. Sooke Lake is fed by a large spring on the west and Ferguson Creek on the east side. The watershed is bounded on the west, south and east by the Leech River, Esquimalt, and Goldstream Lake watersheds, the first and third having areas of 30.33 and 10 sq. miles respectively.

The Sooke Lake water supply scheme includes also the use ultimately of the Leech River supply. It is proposed to build a diversion dam and to bring the water to Sooke Lake through a 5-mile conduit. The dam will have a height of 45 ft. above the present low-water level and will divert a supply equal to 100 ft. per second.

Early construction work entailed the devastation of the shores of Sooke Lake, which were cleared to 15 ft. above low-water level, thereby effecting the destruction of 300 acres of thick forest. It should be stated that the entire watershed is densely wooded with Douglas fir.

The plan and elevation of the Sooke Lake dam, showing the intake tower and channel, is given in Fig. 5. The channel is excavated to 4 ft. below low-water. In the intake tower the water will be controlled by seven sluice gates, four of which are 24 in. x 30 in. and three are 30 in. x 42 in. The gates will be protected by bar screen cages anchored in the concrete. Two 40-in. riveted steel pipes will convey the water from the intake tower to the concrete screen house. In the latter a set of twelve screens of 40 mesh will be installed. Past the measuring weir the water will be conveyed over cascades to the conduit pipe at a grade elevation of 12 ft. below the low-water level of the lake.

The cross-section of the dam is given in Fig. 7, together with a section of the earth-filled portion indicated in Fig. 5. This earth embankment has a concrete core wall bonded into the natural rock.

To the east of the screen house an ogee weir section 200 ft. in length is being constructed. This is also bonded into the natural rock with a cut-off trench at the upstream face. It will average 15 ft. above the foundation.

The reinforced concrete flow line has a reinforcement of wire mesh. It is being built by the Pacific Lock Joint Pipe Company, of Seattle, in 4-ft. lengths with a 3-in. thickness of wall. The contract was awarded to this company in November, 1913, for the sum of $329,760. The 40 in. in diameter is an internal measurement and is calculated to furnish a flow of 16,000,000 Imp. gal. per

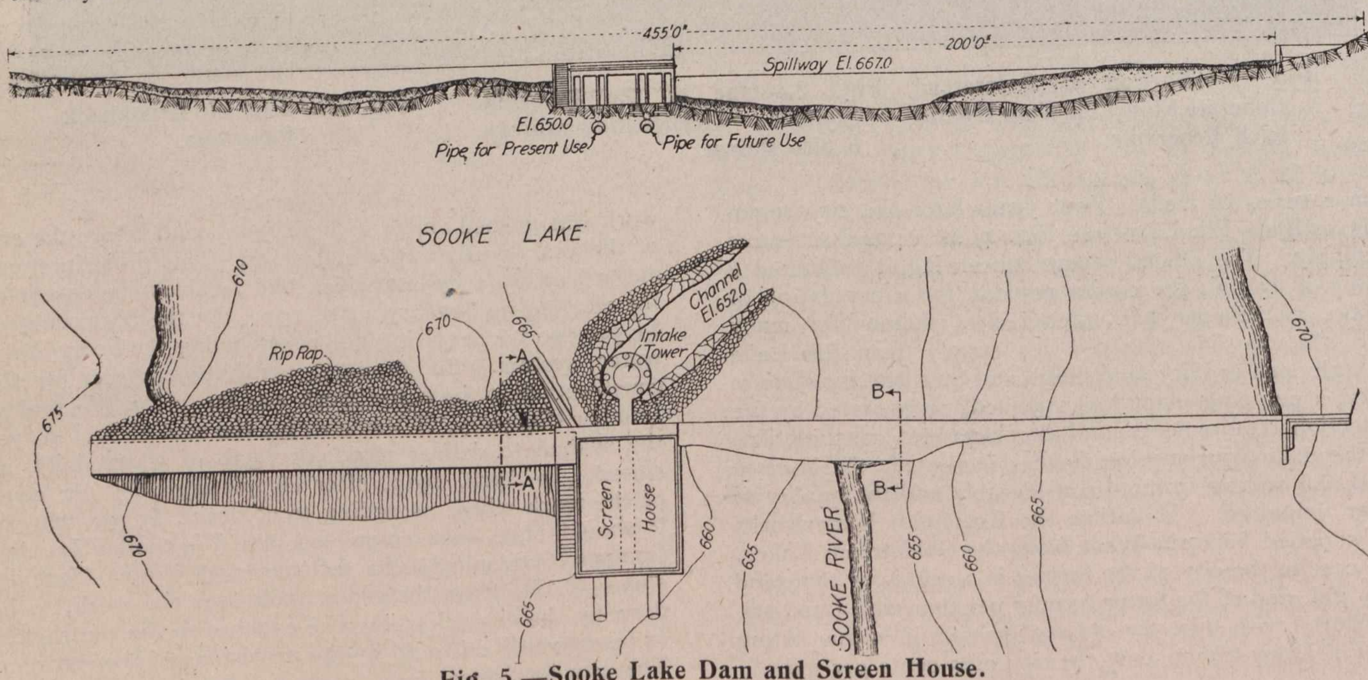


Fig. 5.—Sooke Lake Dam and Screen House.

day, the flow in the pipe being estimated for $C = 120$, in the Chezy formula, or $n = .012$, approximately, in Kutter's formula. The finished pipe is hauled from the site of manufacture at Cooper's Cove (see Fig. 8) by an incline railway to the grade and conveyed from there by the construction railway.

The pipe is laid on crushed stone ballast. The pipe line right-of-way is 100 ft. in width, from which all trees liable to fall upon it have been removed. At every 2,000 ft. on the line is constructed an open standpipe, while all inverted siphons will have steel reinforcement and will have waste outlets at the bottoms controlled by 6-in. gate valves. Fig. 2 shows one of these siphons under construction. There are six of them, the deepest being 600 ft. long with a maximum head of 90 ft.

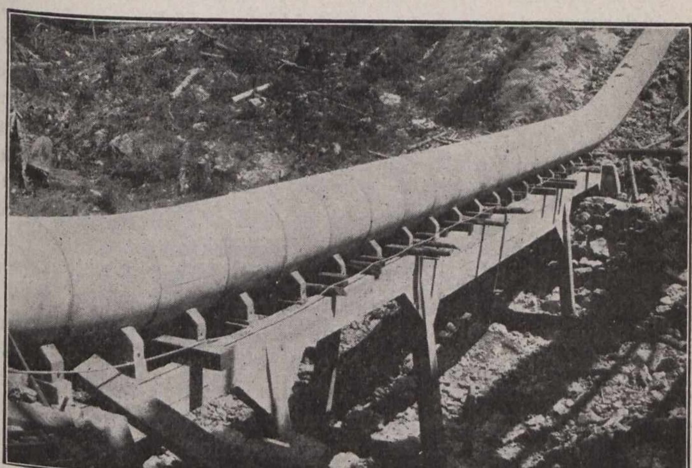


Fig. 6.—Concrete Trestle Carrying Pipe Across Gulley Susceptible to Floods.

In order to protect the flow line from water accumulating on either side, drainage openings of different types are being located where necessity demands along it. Usually the water will be carried along and passed under the pipe line through small holes which penetrate the ballast at points where the roadbed is in the rock. In cases where the volume of water may be considerable concrete side walls will support the pipe, if the span requires it, and also where it needs protection from scour of earthy material underneath. In cases where there is some embankment, drainage will be effected by vitrified pipe varying in diameter from 12 in. to 24 in. Where embankments are unusually large the pipe will be supported by open ravine culverts of about 15-ft. span. Steel bridge spans varying in length from 45 ft. to 80 ft. with concrete abutments will be used to cross transverse streams at low points of the siphons. The pipe line will not be covered except in deep cuts where protection from slides is necessary. Fig. 6 shows a section of pipe line supported by a concrete trestle.

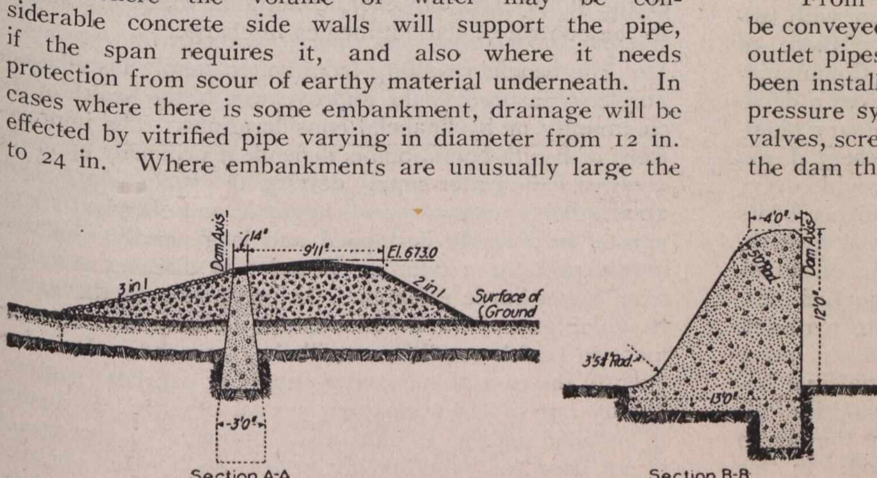


Fig. 7.—Sections of Sooke Lake Dam and Earthfill.

The Humpback reservoir, the site of which is shown in Fig. 3, was decided upon after a good deal of careful investigation. The location of a reservoir at a proper level near the city formed one of the difficulties to be contended with. The reservoir site has an area of about 40 acres and was densely wooded, requiring clearing. The soil is of a black peaty nature. This has been covered with an 8-in. layer of gravel and sand. The material for this covering was procured in the immediate vicinity. The reservoir will have a capacity of 136,000,000 gal., which may be held in reserve in case any accident occur in the flow line pipe. Ordinarily the water will be delivered directly from Sooke Lake to Smith's Hill reservoir through a by-pass pipe. The latter will act as a standpipe, the pressure from Sooke Lake being too great to permit delivery directly into the city distribution system.

Fig. 8.—Site of Manufacture of Pipe Sections at Cooper's Cove.

The dam at the Humpback reservoir has been constructed of concrete. Excavation to a depth of about 30 ft. provided a satisfactory rock foundation. The dam itself has a maximum height of 60 ft., a length of 600 ft., and contains over 8,000 cu. yds. of concrete.

From this reservoir to the city the water supply will be conveyed through a 36-in. riveted steel pipe. Cast iron outlet pipes, two in number and 34 in. in diameter have been installed at the dam for delivering the water to the pressure system. A gate house is provided with control valves, screens, etc. Waste water will be discharged from the dam through a 16-in. cast iron pipe.

The water is to be delivered from the pressure pipe line to Smith's Hill reservoir, which is situated at the southern limits of Victoria. There is a drop of 167 ft. between the two reservoirs. The riveted steel pipe line leading thereto consists of 20,500 ft. 5/16 in. in thickness and 36,500 ft. 3/8 in. in thickness. The pipe sections are about 22 ft. in length; i.e., four plate lengths. The specifications call for plate manufactured by the open-hearth process. The rivets are to be of extra soft steel, pneumatically driven, and the maximum angle of any joint must not exceed 3°. Specifications also call for a pipe coating of bitumastic, or some equally efficient preparation.

A short distance below Humpback dam a recording Venturi meter is being installed. Four concrete gate houses with 36-in. rising stem gate valves will be located along the line and 6-in. gate valves will be provided at the base of all depressions for use in emptying the pipe. Nozzles providing for corresponding air valves will be inserted in top of the pipe at every summit point. As announced in *The Canadian Engineer* for April 16th, the contract for the construction of this riveted steel pipe line from Humpback to Smith's Hill reservoir was awarded by the city council to the Burrard Engineering Company, the price being $304,000.

The work, since its abandonment by the Westholme Lumber Company, has been carried out under the direction of the City Water Commissioner, Mr. Chas. H. Rust. In July, 1911, Mr. Wynne Meredith was retained as consulting engineer on the project. Mr. Boyd Ehle is resident engineer.

It is estimated that the cost of delivering 16,000,000 gal., which is the maximum capacity of the concrete gravity flow pipe line, including all charges, will be 2¾ cents per thousand gallons. The proposed raising of the dam at Sooke Lake to include the Leech River supply, as outlined in Mr. Meredith's 1911 report, will provide approximately 54,000,000 gal. per day, and will lower the cost to about 1⅓ cents per thousand gallons. It will provide the city of Vancouver with a reservoir storage of 17,358,000,000 gallons from the combined watersheds.

WATER SUPPLY AND SEWERAGE SYSTEMS FOR SMALL COMMUNITIES.

THE benefits to be derived from a public water supply and sewerage system have been brought out very prominently by Mr. W. H. Dittoe, chief engineer, Ohio State Board of Health, in the official organ of the board. The advantages resulting from community life have been recognized since the beginning of history and we are told that in the most remote times the people banded together forming tribes or communities to mutually assist in their own betterment. Out of this tendency grew the ancient town in which the inhabitants were more or less committed to mutual protection. The advantages of community life have progressed with the advance of civilization and learning and in comparison with advantages offered by the modern community those of ancient cities or villages appear insignificant. Community life has its disadvantages, however, and becomes a detriment to the welfare of the people unless necessary municipal improvements are provided. In the present day a community to be considered modern must provide every possible municipal improvement for the convenience of its citizens as well as for its own development and growth. The large cities can, and do, expend great sums of money in providing public water supplies, sewerage facilities, street paving, collection and disposal of waste material, street cleaning, municipal lighting and numerous other public service advantages. This extensive municipal improvement is not possible in the smaller communities, but in every case those improvements which affect the health of the community may reasonably be demanded. In this classification fall public water supplies and sewerage systems. Unless a community can offer the benefits to be derived from such installations the advantages from community life are minimized and overbalanced by the dangers to which the inhabitants are subjected. This neglect results not only in general unhealthful conditions but also in retarding the development and growth of the community.

The installation of a public water supply, which will furnish the maximum benefit to the community, should be the first step taken in the development of municipal improvements. Following the provision of a public water supply and simultaneously with it, if possible, a complete sewerage system should be installed. After these most important improvements have been provided other municipal enterprises may be undertaken as the financial condition of the community will permit.

Public water supplies are obtained from two general sources, namely, from surface streams, lakes or ponds and from underground water-bearing formations. In either case it is well to remember that the original source of the water is the same, namely, precipitation. In spite of the popular belief, not all water supplies obtained from underground sources are suitable for public supply purposes. Water obtained from surface sources is rarely, if ever, to be considered satisfactory in its raw state. In the selection of any source, due attention must be given to the quantity available, for in many cases a disregard of this important factor has led to considerable financial loss. The development of the supply is also of great importance, as upon this may depend the maintenance of the good quality of the water. Proper management and operation of the works after they are installed is a factor influencing the benefits derived from the supply. Also, the advantages of a water supply cannot be fully derived until the supply has come into general use by the citizens. It may be stated that the maximum benefits resulting from the installation of a public water supply can be realized only by meeting the following conditions:

1st. The supply must be of adequate quantity;

2nd. It must be of good quality from a physical, hygienic and chemical standpoint;

3rd. Its development must be adequate, safe and economical.

4th. It must be maintained properly following its installation.

5th. It must be universally used.

The questions relating to quantity, quality and development are dependent upon preliminary study and the preparation of proper plans. The maintenance and use of the supply are, however, conditions which are subject to the control of the authorities in charge.

The benefit resulting from water supply installations may be measured by the improvement in the health of the community or by financial considerations. The improvement of health conditions is dependent primarily upon the quality of the water supply developed. If the supply is of good quality from physical, hygienic and chemical standpoints, is properly developed and is generally used, we may expect the maximum reduction in diseases resulting from water-borne infection. In proportion to the extent to which any of these features are deficient the improvement in health conditions will be lessened. It is frequently the case that a water supply of excellent sanitary quality but of objectionable physical or chemical quality is installed and on account of its unfavorable appearance is not used for drinking purposes. As a result, private wells continue to furnish water for this purpose and no marked improvement in health conditions results. Prejudice against public water supplies frequently contributes to prevent the general use of a supply entirely satisfactory. In such cases the maximum benefits are not realized. The method of development of a water supply of good quality may frequently determine the advantages to be derived, for instance, a ground water supply of a high degree of purity may deteriorate by storage in an uncovered pump well or reservoir. Algal growths may cause tastes and odors to appear at certain seasons of the year which will contribute to make the water supply generally unpopular.

One of the principal advantages to be derived from a water supply, and one which is generally recognized, is the introduction of modern plumbing facilities in the home. This permits the abandonment of private wells, which may be dangerously contaminated, and the use of indoor sanitary equipment, which makes possible the removal of the insanitary privy.

From a financial aspect the introduction of a public water supply is to be considered a good investment. There results an actual saving to the individual, a general increase in property values, the provision of fire protection and an attraction to industries in search of a suitable location. The financial measurement of the advantages of a public water supply is determined largely by the quality, quantity, development and use of the supply. The consideration of the financial value of a water supply from the standpoint of its quality has been dealt with completely by Whipple in his treatise on the "Value of Pure Water." Assuming absolute purity as a standard of greatest value, he has shown, for instance, that unsatisfactory physical quality may result in a loss of from five to twenty dollars per million gallons of water pumped; unsatisfactory hygienic quality, fifty to one hundred dollars per million gallons; and objectionable chemical quality, ten to twenty dollars per million gallons. The mere provision of a water supply may, therefore, not result in a great financial advantage; it is also required that the quality be such as to bring the maximum benefit to the community.

Considering next the advantages of a sewerage system, a few brief words of explanation of what a sewerage system is may be of benefit. Sewerage systems are divided into three classes, according to their use. The sanitary sewer system is employed for the removal of house sewage and all objectionable liquid wastes. Storm sewers are used for the removal of surface drainage, while combined sewers are utilized for the removal of all classes of wastes and surface drainage. For the small village, especially where treatment of the sewage may be required, the sanitary sewer system is by far more preferable than the combined sewer system for the removal of sewage. Any sewer system, to furnish good results, must be of proper capacity, laid with proper grades and in general designed according to good engineering practice. Its construction must also be carefully supervised. After its installation it must be maintained in its most efficient condition. Of course, the sewer system will not furnish maximum benefit until it has become universally used. We may, therefore, state that the full advantage of a sewer system will be realized only when the following conditions have been met:

1st. It must be properly designed and constructed.
2nd. It must be properly maintained.
3rd. It must be universally used.

The first two factors are dependent upon preliminary study and the plans under which the system is built, but the use of the sewers is a matter which can be regulated by the authorities in charge.

The benefits resulting from the installation of a sewerage system may be measured according to the same standards as a public water supply improvement, namely, by the effect on the public health and from financial conditions.

It seems unnecessary to refer to the improvement in health conditions resulting from the installation of proper sewers. First of all, a public water supply cannot be fully enjoyed in the absence of a sewer system. The provision of a system of sewers may, therefore, contribute some of the benefits resulting from the public water supply development. With provision of sewers the abandonment of cesspools and privies is facilitated and general cleanliness of the community is encouraged. Drainage and drying of the soil also results, which has an important bearing upon the general health. It may be expected that, following the installation and use of a system of sewers, the death rate from typhoid fever will be reduced about 50 per cent. Records of results obtained in a certain town in England indicate a reduction in deaths from pulmonary tuberculosis of over 50 per cent., following the introduction of sewers.

From a financial aspect the installation of a sewerage system is highly beneficial. It results in an actual saving to the individual as it provides an ever-ready means of disposal of house sewage at a cost considerably less than would be demanded in the installation and maintenance of cesspools. Increased property values also result from improved sewerage, and it may be expected that individuals and manufacturers will be attracted to a well-sewered community and thus enhance its value. The degree to which the sewer system becomes a benefit is, however, dependent upon the extent of its use. Frequently it has been found that the citizens of a community have failed to appreciate the value of a sewer system and have neglected to properly utilize it. The result has been a continuance of the privy and cesspool nuisances and general insanitary conditions of the community. It is well to remember that following the installation of a sewer system its general use should be required by the municipal officers in authority.

Having reviewed the advantages to be derived from public water supplies and sewerage systems, a brief explanation of the method of obtaining these advantages may be of value. A popular desire for the improvements is, of course, necessary before the village authorities can hope to make the actual installations. However, before the expression of the electors is obtained it is important for the village authorities to become thoroughly informed as to the general method of development of the works and the cost of the same. When the council of a village has determined to take steps to install a public water supply or sewer system a competent engineer, experienced in this field of work, should be retained to make preliminary surveys, general plans and an estimate of cost for the improvements. In case of a water supply the preliminary survey should include a study of available sources and in this connection the considerations of quantity and quality enter. No source of supply should be determined upon until a complete test as to its quantity and quality has been made. In the case of a sewerage system the preliminary survey should include the general layout of a sewer system and location for outlet or treatment plant. After the preliminary survey has been completed general plans and an estimate of cost should be made and these submitted to the village council for adoption. Following their adoption by the council they should be submitted to the Board of Health for approval and after this approval is secured the village authorities should immediately take up the question of educating the people in the advantages to be derived from installing the improvements contemplated. In some cases this campaign of education may require the utmost effort on the part of the village authorities. After a favorable expression of the electors on a bond issue is secured the village should again call upon their engineer to prepare detail plans and specifications for the work. These should be submitted to the Board of

Health for approval and following such approval the contract for the work should be advertised and awarded according to law. The duty of the village authorities does not cease at this point and during the construction of the work a competent engineer should be retained to protect the interests of the village and see that plans are strictly adhered to. When the works have finally been installed according to the plans and specifications the village authorities must assume the duty of properly maintaining them. Too much emphasis cannot be placed upon the necessity for proper maintenance of water supply and sewerage improvements. In small villages the authorities are likely to become lax in this duty, especially if political considerations govern the selection of men employed in public service. The beneficial effects of public water supplies and sewerage systems are largely dependent upon the care with which they are managed and operated. Aside from the financial considerations the beneficial effect upon the public health may be impaired if works of this character are carelessly maintained and operated.

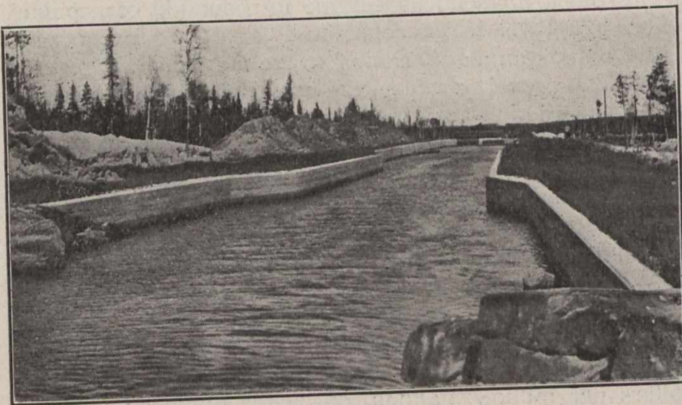
PIER CONSTRUCTION AT VICTORIA.

In connection with the construction, by the Department of Public Works of British Columbia, of several piers at Victoria, B.C., eighteen concrete cribs are being constructed. All of them, with the exception of two, are being built with the aid of a large, floating dry dock, recently leased by the contractors, Grant, Smith and Co. and McDonnell, from the Seattle Dry Dock and Construction Co. The dock, although not a new one, has a capacity of 8,000 tons. It is 325 ft. in length, with a 102-ft. beam, and towers 32 ft. 6 in. above the deck of the pontoon or scow. Its sides are 40 ft. in height.

The dry dock was delivered to the contractors on May 28th, and will shortly proceed to Esquimalt, where the concrete cribs will be constructed and floated, one by one, to the dock site upon completion. These cribs will be 100 ft. in length, 39 ft. in width, and have a height of 39 ft. Each will weigh 3,500 tons, and two of them will be built simultaneously on the dry dock. The first two cribs are being constructed by the method first adopted, that of building them on marine ways and launching them with rollers. This method is being abandoned, however, for the remaining 16 cribs, it having been found uneconomical.

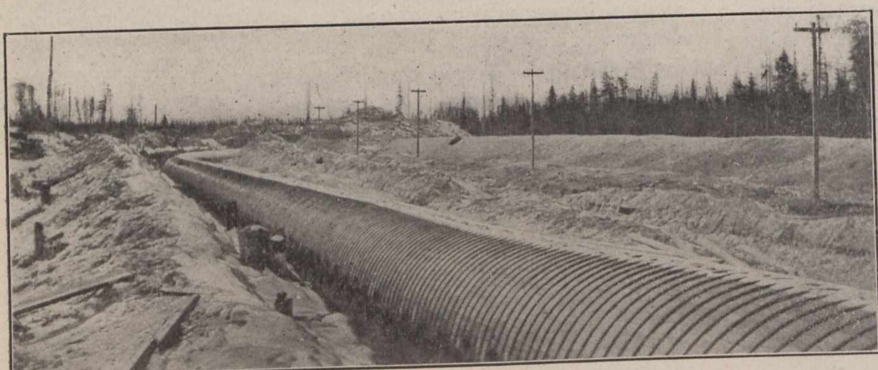
THE WAWAITEN FALLS AND SANDY FALLS HYDRO-ELECTRIC POWER PLANTS.

THE Northern Canada Power Company, Limited, operates two hydro-electric plants on the Mattagami River, namely, Wawaiten Falls, twelve miles southwest, and Sandy Falls, six miles northwest from the town of Timmins, Ontario. It is from these two plants that the gold mines of Porcupine derive their power. The following data concerning them are from the recent report of the Timiskaming and Northern Ontario Railway Commission, prepared by Mr. A. A. Cole, its mining engineer.



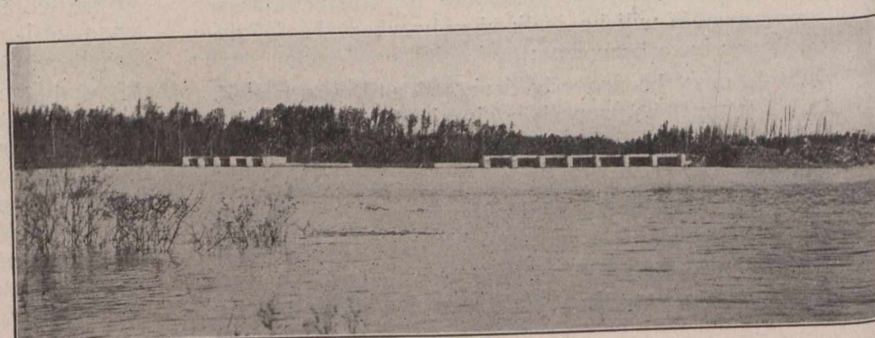
Headgate and Canal Leading to 12-ft. Iron Pipe Line, Wawaiten Falls.

Wawaiten Falls plant is located in the township of Thornloe at the foot of Lake Kenogamisee. A concrete dam 1,000 feet long at this point, diverts the water into a 1,200-foot canal. From the intake at the foot of the canal, water is carried by 1,500 feet of 12-foot iron pipe to a 40-foot diameter surge tank on top of the hill overlooking the power house. Two 8-foot iron pipes, 1,300 feet long, lead from this surge tank down the side of hill direct to the wheels in the power house.



Wood Stave Pipe, 1,550 ft. Long, 9 ft. Diameter, at Wawaiten Falls.

The power house is of reinforced concrete and contains two 3,300 horse-power Morgan-Smith water-wheels operating under a head of 125 feet, direct connected to two 2,500 k.v.a., 3-phase, 12,000-volt Canadian Westinghouse alternators; two 70 kilowatt exciter sets driven by independent water-wheels and Westinghouse switching and switchboard apparatus. During the summer and autumn of 1913, the power company installed 1,500 feet of 9-foot wood stave pipe line from the intake of canal to surge tank, duplicating the



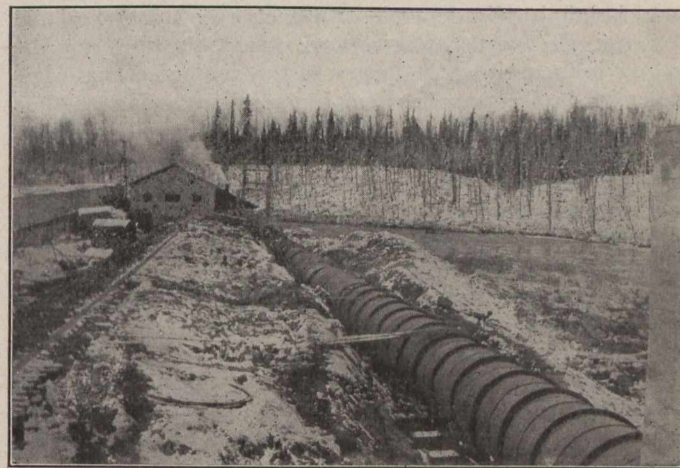
View of Wawaiten Falls Dam from Lake Kenogamisee.

present 12-foot iron pipe. Material for this line is 2-inch Oregon fir, and was installed under the supervision of the Pacific Coast Pipe Company's engineer.

Sandy Falls plant is located in the township of Mountjoy. A timber dam of approximately 1,500 feet in

Two 8-ft. Iron Pipes, 1,300 ft. Long, from Surge Tank (in distance) to Power House at Wawaiten Falls.

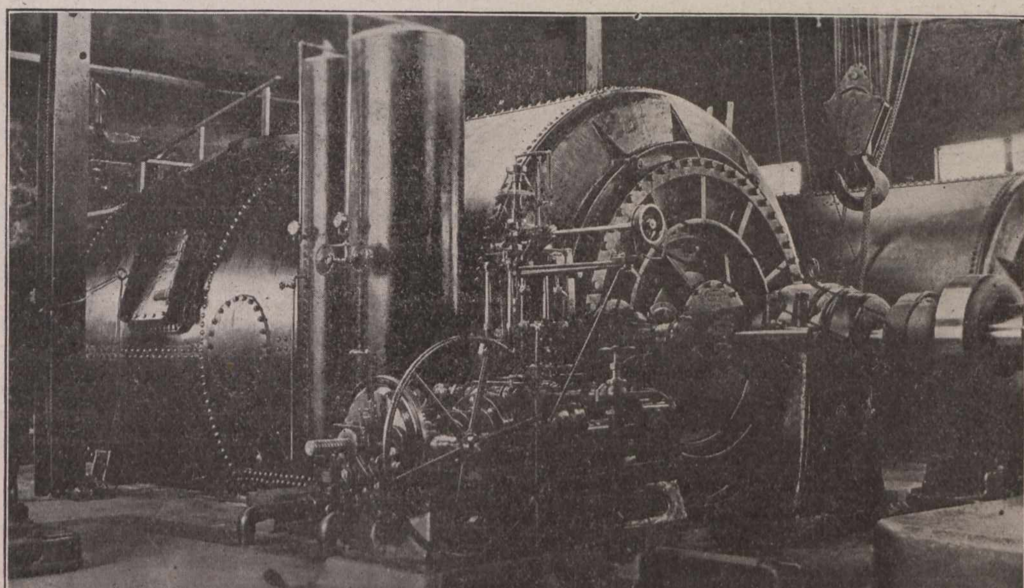
length diverts the water into a wooden flume 14 feet by 16 feet by 700 feet long. Water from the flume is taken direct to the wheels in the power house by means of short lengths of 10-foot pipe. The power house is of timber construction covered with asbestos and corrugated iron, and contains two 1,200 horse-power Morgan-Smith wheels operating under a head of 33 feet, direct connected to two 950 k.v.a., 3-phase, 12,000-volt, Canadian Westinghouse alternators with exciters on the same shaft. Switching and switchboard apparatus is of Westinghouse manufacture. During the summer of 1913, the power company commenced extensive improvements at this plant. The timber dam is being replaced with a concrete dam and wooden flume with steel pipes. It is expected this work will be completed during the summer of 1914. The transmission lines consist of two complete circuits on a single



Sandy Falls Power Development—New Steel Pipe Leading to Power House.

pole line from each plant, and are so built and connected that plants are operated in parallel. Power is supplied to consumers at approximately 12,000 volts, 3-phase, 25-cycle.

The power company has 35 miles of main and branch transmission lines now operating in the district.



Two Morgan-Smith 3,300 h.p. Water-wheels with Lombard Governors, Wawaiten Falls, Ont.

On Thursday, July 9th, the Westinghouse strike at East Pittsburgh was called off by the workmen, a large number of them reporting for work on the following day, and the works since the beginning of last week have been running full time.

On July 4, a section of the Port Arthur C.N.R. steel dock about 70 feet square and containing about 3,120 tons of steel rails, collapsed. The dock is practically new, having been built only three years ago.

As a result of the decision of the railway commissioners, made in Calgary on June 22, it is expected that the coal mines near Lethbridge, Alta., will go into operation on July 1. The understanding reached with the railways is that coal sent forward for storage and not used until after September 1 will get the new freight rate. The old rate will be paid up to September 1, and all the coal in bins on that date will be given a rebate to reduce the rate to that figure.

APPLIED GEOLOGY IN MUNICIPAL ENGINEERING.*

By Herbert Lapworth, D.Sc., M.Inst.C.E.

FEW municipal engineers of to-day can fail, after much experience, to realize the importance of practical geology in the construction of their works.

The success of underground water supplies, whether attained by knowledge, trial and error, or by a stroke of luck, is admittedly dependent in each case upon the local geology. In works of sewerage, again, the cost may be largely influenced by the nature of the geological materials met with in the trenches and tunnels, producing as they may do difficulties and expense in excavation, timbering, dealing with ground-water, and modification in the design and construction of the permanent work. The same general principles apply to all deep excavations or foundations that may be carried out by the municipal engineer, whether in the construction of new roads with deep cuttings; sea, river, and retaining walls; bridges, reservoirs, sewage tanks, or large buildings. The geology of building stones, road-metals, and similar materials, though in a lesser degree, is of importance in all those branches of municipal work in which they are constantly employed.

One of the most striking factors that has forced applied geology upon the attention of the engineer has been the number of disputes which have arisen between contractors and municipal authorities concerned almost solely with the "nature of the ground" encountered during construction of public works. A few of these cases have been taken to the courts, some to arbitration, while others have been privately settled. In most instances the cause of the dispute has been due to some misunderstanding as to the "nature of the ground," or, in other words, the geology of the excavations; and almost invariably the ultimate result has been costly.

Frequently this kind of trouble has been the result of providing intending contractors with inadequate or misleading descriptions of the strata, obtained from trial holes or borings. Another cause has been the enforcing under the contract of a type of construction unsuited to the kind of ground unexpectedly encountered in the trenches or foundations.

Quite outside the question of legal disputes, however, serious difficulties have arisen, and heavy expense has been incurred by locating works in bad ground, either through lack of previous geological investigations or by wrong deductions from haphazard exploration, when such troubles might have been avoided in the original location or largely anticipated by investigation with practical geological knowledge.

It is a remarkable fact that this branch of engineering, common as it is to all classes of the profession, and on which so much frequently depends, is so strangely ignored in our own engineering literature, and until recently so little considered in the scientific training of civil engineers. Thus we find in our engineering text-books the most minute mathematical investigations of structures, more or less without relation to the varying geological materials on or in which they may be placed.

As a minor example, retaining walls, the dimensions of which, other things being equal, depend entirely upon the geology, water-bearing nature, and dip of the materials to be supported, are subjected to detailed mathematical analysis which may, in the drawing office, be slavishly applied to practice by arithmetical and graphical calculations, without any knowledge of the ground in which the walls are to be built.

To a limited extent the design of tunnel and sewer sections, for example, in "good" and "bad" ground, are considered in text-books; but no account is given of the many types of material met with underground, under varying conditions; nor of the principles of the occurrence of underground water, the great variation in cost, and the difficulties of construction under different geological conditions. Under "earthwork" we find the usual tables of slopes, prismoidal formulæ, and the like, but practically nothing on the highly important subject of "slips," or treatment of soft, unstable, or "bad" ground.

It may be argued, and rightly, that these are matters of actual practice and experience; but this does not excuse the failure of these treatises to impress the student with the great variation in cost and difficulties of engineering construction in different deposits, and the fact that efficiency and economy in construction might be as much the result of geological knowledge and investigation as of skill and experience in calculation and design. In some degree this void in the engineering text-books is due to the extreme complexity and variation in the physical properties of the geological deposits, which render them incapable of mathematical analysis.

Another inconsistency is sometimes to be seen in the letting of large contracts, where we may have items in the schedule of quantities amounting to only a few shillings, yet the contractor may be wholly ignorant of the character of the ground in which the works are to be constructed, and may in consequence under-estimate by several thousand pounds the cost of excavation.

The causes which have contributed to the scant consideration of practical geology among engineers are not easy to determine. Probably the chief of these is the fact that, whatever geological difficulties do arise during construction, it is always possible to complete engineering works, whether economically or not, without geological knowledge, and the engineer is not likely to be blamed by his employers for what turns up unexpectedly below ground.

Secondly, there is a pessimism among certain engineers, some of whom, though they may be experienced in excavation work, have little time for geology, and see only a comparatively heterogeneous mass of deposits underground in no cort of order, and to be classified broadly into two types—"rock" and "muck." There is also the optimist, who expects the geologist by surface indications alone to prophesy precisely what will be met with in almost every yard of his proposed trench, and in consequence loses faith in the accuracy and practical application of the science.

Thirdly, we have scant consideration of the subject in the engineering and geological text-books. The former have already been discussed. The latter, while containing all the necessary elements for the study of the subject, rarely present the applied or practical side of the science, except on the very broadest lines, and include matter that is unnecessary to learn, and which has rarely any direct bearing upon engineering questions.

In the writer's opinion, every civil engineer should be familiar first with the elements of geology, i.e., the principles of stratification, and formation of rocks and deposits, and the various structures occurring in them as the result of formation, change, weathering, or earth movements. He should be able to recognize and describe correctly all the common solid rocks and unconsolidated

*From a paper read at the 41st Annual Conference of the Institution of Municipal and County Engineers, Cheltenham, June 24th-27th, 1914.

deposits. He ought also to understand a geological map as he does a working drawing, and be able to plot approximate geological sections from it, as well as accurate geological records from borings, trial-holes, trenches, and tunnels. A training in petrology is desirable for the road engineer; but expert knowledge in this branch of geology usually requires more time than the professional engineer can afford. A thoroughly practical geological training, however, cannot be acquired without considerable experience in the field.

Of equal importance is the subject of hydro-geology. This includes the principles of the occurrence of underground water in different geological deposits, the laws of flow through porous and permeable materials, underground water-levels and their fluctuations. The mathematical side of this subject has been considered in great detail by foreign scientists and engineers; but so far the quantitative results have been of little direct application to practice, owing to the extreme complexity of underground conditions. Nevertheless, the principles arrived at are of great value in clearing one's ideas, assisting one to anticipate or prophesy, and to deal more rationally with underground-water problems where a certain amount of local information has already been secured. The value of this science is not only found in questions of water-supply, but in the excavation of trenches, cuttings, deep foundations, tunnels, drainage, and the like.

It would be impossible in a paper of this kind to cover the whole of that region in municipal engineering on which practical geology has a direct bearing. The following are merely a few selected instances commonly occurring in practice.

Preliminary Geological Investigations on Important Works.—In the majority of important public works it is desirable to ascertain by means of trial holes or borings the nature of the ground in which the works are to be constructed. The object of these investigations may be to determine first, the necessary dimensions of the permanent work and its approximate cost; secondly, the ground-water levels; thirdly, whether any saving may be affected by a change in location, if practicable; and lastly, to enable contractors to make a fair tender for the cost of construction. As regards the latter, it has given rise to discussion among engineers, whether data obtained from trial holes and borings should be shown to tendering contractors, because of the possibility of future claims or litigation. Information of this kind, however, allows a contractor to put in a fairer price, and avoids the necessity of his protecting himself, as he often does, by increased prices for unknown ground. Without such knowledge, a contractor's tender must usually be either unfair to the municipal body or the contractor himself; but there are pitfalls, of course, although the more practical geological knowledge there is brought to bear on the investigation, the less will be the risk.

As regards the selection of sites for boring, etc., it is essential that the number of holes should be sufficient to give reliable information, and the strata must be correctly described. Each hole should be sunk to the full contemplated depth of the excavation, and located on the centre-line, or within the limits of, and not outside, the work itself.

An interesting example of the result of sinking trial holes clear of the work occurred recently in this country in connection with a tunnel sewer. The trial holes, in order to save expense, were sunk in a railway cutting parallel to the sewer. These proved the ground to consist entirely of sandstone and conglomerate, whereas at least half the length of the tunnel was found to be in marl, the discrepancy being due to the cross dip of the strata. In the sandstone and conglomerate the tunnel was driven without timber, while in the marls close-timbering was required throughout, owing to falls from the sides and roof. An action was brought by the contractor against the public authority on the basis that misleading information had been supplied to him.

In the solid rocks the selection of the sites for trial holes, etc., can often be much assisted by a knowledge of the surface geology. This is especially applicable to tunnel work and the like; but the majority of municipal works are founded close to the surface, and the nature of the ground is dependent more on the character and depth of the soils, sub-soils, and surface deposits of the districts. As the detailed structure and arrangement of these surface deposits cannot be foretold with any accuracy from surface indications, trial holes or borings are essential.

Water Supply.—It is perhaps in questions of water supply, and especially in schemes from underground sources, that a sound knowledge of geology and hydro-geology is essential. The selection of a site for a well or boring, which will yield a satisfactory amount of pure water requires intimate acquaintance with the local geology, the order, arrangement and structure and water-bearing characters of its various strata, both as regards its solid rocks and superficial deposits. Familiarity with hydro-geological principles will also assist the investigator in analyzing more rationally from data in local wells and springs the existing underground water resources of the district, and in considering questions of possible pollution from farms, fields, cess pits, cemeteries, and polluted streams. Similar principles apply largely to water supplies from springs.

Geological considerations are also highly important in the selection of sites for impounding and service reservoirs, dams, and embankments, and in the location and construction of lines of aqueduct, pipes, and tunnels; but these are matters, perhaps, more usually in the domain of the consultant, dealing with large schemes, than in the routine work of municipal engineers.

Lines of Sewers and Pipes.—In the construction of lines and sewers we find many questions arising, where applied geology may be of use in location, design, and construction. The most serious difficulties are generally encountered in the unconsolidated deposits of alluvial, glacial, and other recent origin. The beds of clay, silt, mud, running sand and peat, which so frequently occur in these formations, are usually capable of supporting only relatively low pressures, and require great skill and experience in the treatment of cuttings or excavations, being especially liable to slips, and to act as a semi-liquid when their existing stability is disturbed by any excavation within their mass. Occurring as they do in the low-lying areas in valley bottoms, estuaries, and mud flats, they are liable to be saturated with ground-water, which further reduces their stability, and adds greatly to the difficulties of engineering construction.

In addition to the obviously water-logged ground formed of these deposits in low-lying areas, many lines of pipes and sewers may be constructed in water-bearing rocks, and deposits below the saturation level. The opening out of a deep trench in porous or permeable material below the saturation level has the effect of draining the measures on both sides of the trench, and producing a lowering of the water-levels in the vicinity. This may often give rise to claims for damage to local wells and springs. Any trench excavated below river-level, in a valley bottom and in permeable strata, will tend to collect a large volume of water; and similarly where the saturation level rises from the valley bottom more or less parallel to the ground surface, a deep trench, although distant from the river, may require heavy pumping during construction. In all permeable surface deposits and permeable strata, such as chalk, sandstone, sands, and heavily fissured rocks, in which trenches are to be excavated, it may be often worth while to determine the underground water-levels in local wells, in order to see whether it is possible to fix the levels of the permanent work above them. Local wells have not infrequently been drained dry during the construction of a deep sewer, and sometimes permanently, so that it has been necessary to deepen them in order to restore their water supplies.

In considerations of this kind, hydro-geology has shown that the saturation level is subject to seasonal fluctuations; hence it may happen that a trench excavated in dry ground above the saturation level during one part of the year may be flooded during the winter and early spring seasons when the ground-water is high.

Heavy pumping, and consequent lowering of the saturation level in certain sands, peat-bogs, and marshes, may also seriously affect the foundations of adjacent buildings, producing cracks and settlement. Cases are on record where the saturation level has been lowered several feet by pumping, and accompanied at a distance of 200 feet by a settlement in the building of several inches.

In hilly districts, sewers and lines of pipes may require to be constructed in steep sidelong ground and scree slopes. Here there is a strong tendency for the surface material to slip into the trench, and great pressures may be brought to bear upon the timbering, and even upon the permanent work, which may be forced downhill and fracture. Such catastrophes have occurred both on lines of cast iron pipes and brick culverts in this country.

In certain types of ground again, such as those formed of steeply dipping shales or clay masses, or surface materials upon a highly inclined rock surface, slips are liable to occur, and even the permanent work may require to be strengthened.

Another curious phenomenon is occasionally found in deep trenches wholly in clay deposits, which may appear to be perfectly consolidated and firm during excavation. The weight of the material on both sides of the trench may be sufficient to cause the plastic material to flow, with the result that the timbering must be crushed in and collapse, accompanied by an uplift of the bottom of the trench, and of the permanent work. The writer has known of a length of over 100 yards of culvert invert, and side walls destroyed in this way. In some of the glacial clay deposits of Lancashire the trench bottoms have been observed to rise between the operations of trimming the trench bottom and bedding the pipes.

In ground of soft clays, mud, silt, running sand or peat, the difficulties of construction are, of course, at their worst. Special precautions must then be taken from the outset in timbering, strengthening the section of the permanent work, draining, and so dealing with the foundations below formation level, as to enable the ground to support the weight of the overlying structure.

The subject is too vast, however, to discuss here; but it may be taken for granted that in questions of this kind, the engineer armed with a sound knowledge of the local underground geology and its relation to the subsiding surface is likely to be more efficient, not only in dealing with lines of pipes and sewers, but with reservoirs, filters, bacteria beds, and other works.

Roads and Road Metals.—In the construction of new roads in the colonies or other foreign countries, practical geology may be a very important factor in location, where the choice of a route may be guided by the geology of the district to be traversed. Thus areas liable to slips, or former of very soft or very hard material, or requiring heavy retaining walls, may sometimes be avoided by deviation. In this country, however, the routes of the few new roads that are now being, or likely to be, constructed, are more or less fixed within rigid limits. Still, even here, practical geology and hydro-geology, when combined with engineering experience, are valuable aids in the excavation and drainage both of the cuttings and the road-bed itself.

As regards the materials for road metals, a sound knowledge of the occurrence and petrology of road stones is decidedly useful. The early experimental and scientific work of Lovegrove, Howe, Flett and others was a promising beginning in the scientific study of road metals. The introduction of tar and bituminous compounds, the tests of different materials in actual use on the road marked further stages. But road engineers are still finding difficulty in arriving at standards of value in road materials, and much practical and scientific work seems still to be necessary, both from the engineering and geological aspects. The modern road must necessarily be a complicated study, containing as it does problems in physics, chemistry, and geology. Perhaps with the establishment of courses in highway engineering at the universities, we may stimulate scientific research in this direction, and in conjunction with the practical results and experiments of road engineers, evolve a new technology, for which there seems to be a considerable need.

SUDBURY AND COPPER CLIFF SUBURBAN ELECTRIC RAILWAY.

Announcements have appeared from time to time in these columns respecting the organization and construction of the Sudbury and Copper Cliffe Suburban Electric Railway. Latest advices contain the following information relative to it:—

The provisional directors of the road are Messrs. L. Laforest, Bell, Cochrane, Morin, Mackey, McCrea and Norton. Mr. C. D. Norton is engineer for the company.

The only route upon which any survey work has been done up to the present is the Copper Cliff route, 5.1 mi. in length, with a grade of 4 per cent. The curvature is as follows: one 50-ft. radius, one 200-ft. radius, one 20°, two 15°, five 10° and a couple of curves of about 1½° or 2°.

There will be one 3-span trestle bridge, two single-span trestles and two small deck culverts. Corrugated iron pipe will be used for culvert work.

On the Copper Cliff route two miles have already been graded. The company is employing day labor and propose laying track by the same method. Some station work has, however, been let by contract. An 80-lb. rail is being used. On the 0.43 mi. of track in the town of Sudbury a permanent pavement is about to be laid. The ties will be laid on a 6-in. concrete base and filled in with concrete between. The Warren Bituminous Paving Co. is doing this work.

With respect to rolling stock, it is proposed to acquire two interurban cars and one city passenger car, although the entire question of rolling stock has not as yet been definitely decided upon. There will, however, be a combination freight and express car and a combination work and tank car and snowplow.

Mr. Norton states that it is proposed to use D.C. current at 200 volts on the Copper Cliff route outside the town of Sudbury and 600 volts D.C. within the town limits.

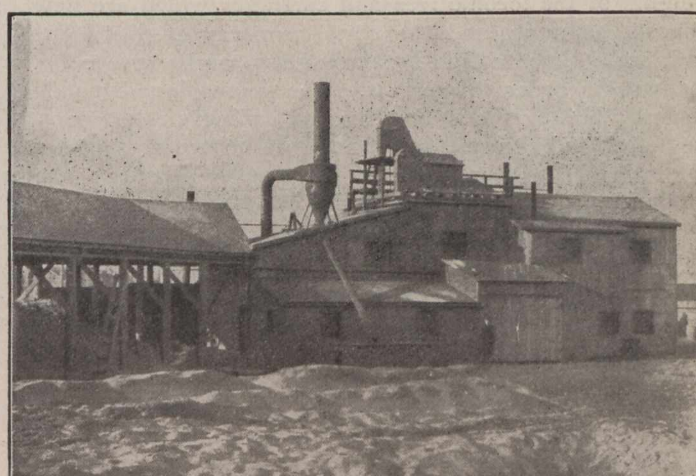
WOOD PRESERVATION.

A PAPER recently appeared in the Journal of the Royal Society of Arts, written by Mr. A. J. Wallis-Taylor and descriptive of modern processes for the preservation of wood. It is stated that wood should be seasoned for at least 6 to 12 months before treatment. (1) Kyanizing consists in steeping timber in a 1 per cent. solution of mercury chloride for 7 to 11 days. (2) Burnettizing comprises preliminary steaming, followed by impregnation in a 2½ to 2 per cent. solution of zinc chloride under a pressure of 7 to 8 atmospheres. In the zinc-tannin or Wellhouse process, treatment in a partial vacuum follows the preliminary steaming, a small percentage of glue is added to the zinc chloride, and after impregnation for 2½ to 6 hours at 100 to 125 pounds pressure per square inch, the timber receives a final treatment with a 0.5 per cent. solution of tannin under the same pressure for two hours. (3) Creosoting usually involves steaming of the dried timber, heating under reduced pressure, and treatment with creosote oil under a pressure of 100 to 180 pounds per square inch. The amount of creosote absorbed by the timber varies from 7 to 20 pounds per cubic foot, and the temperature of the treatment should be between 100° and 130° C. In the Curtis-Isaacs process, the timber and creosote are heated to above the boiling-point of the sap at ordinary pressure in a retort having vents open to the air; the vents are then closed and the creosote is forced into the wood under pressure. The Rueping process consists in forcing, first, compressed air at a pressure of 80 to 100 pounds per square inch into the pores of the wood, and then at a higher pressure creosote oil, without relieving the air pressure. In the Lowry process treatment with creosote oil at 77° to 82° C. under a pressure of 180 pounds per square inch is followed by draining and a rapid vacuum treatment. In the zinc-creosote or Rutger process an emulsion of ½ pound of "dry zinc" and 1.5 to 4 pounds of creosote oil per cubic foot of timber is used; the emulsion being continuously agitated (e.g., by a centrifugal pump). The Hasselmann process uses a solution containing copper, aluminum, and potassium sulphates, heated 118° to 126° C. under a pressure of 35 pounds per square inch. In the creo-resinate process (especially suitable for wood paving blocks) air at 121° C., under a pressure of about 100 pounds per square inch, is substituted for steam; the antiseptic agent consists of 50 parts of creosote oil, 48 of resin, and 2 of formaldehyde, and impregnation is followed by a treatment with lime water at 100° C. under 150 pounds pressure. The Guissani process uses a mixture of anthracene and pitch heated to 140° C., in which wood is submerged until it is free from moisture and sap, after which it is successively treated with cold, heavy tar oil, and cold zinc chloride solution. In the saccharine solution or Powellizing process, suitable for the treatment of green wood, a solution consisting mainly of sugar, with a small percentage of arsenic, is used. The vulcanizing or Haskinizing process consists in roasting wood, which has been previously dried by steaming, to a temperature high enough to coagulate its dried albumins (71° to 94° C.), and to resolve some of the fibre and sap with the production of wood creosote. In addition to the use of definite antiseptics and of a large number of metallic salts for wood preservation, mineral oils, preferably mixed with asphaltum can be used to fill up the open wood cells, thus protecting the timber from the action of heat moisture, and air. By the zinc chloride process the life of wood is more than doubled; creosoted wood lasts 25 to 50 per cent. longer than wood treated with zinc chloride, but costs three or four times as much. The amount of preservative injected into one cubic foot of various classes of timber ranges from about 3 pounds of mercury chloride in the case of hard woods to about 6 pounds for moderately hard woods and 10 pounds for soft woods, the corresponding amounts of creosote oil being 3, 10, and 20 pounds respectively. The average costs of preserving timber with zinc chloride, creosote oil, and mercury chloride are approximately 2.5 cents, 10 cents, and 16 cents per cubic foot respectively.

CIVIC WORK IN HAMILTON, 1913.

In the annual report for 1913 of Mr. A. F. Macallum, City Engineer of Hamilton, the population of the city is given as 100,808; and its acreage, 6,450. During 1913 a new 4-ft. intake into Lake Ontario, 2,120 ft. in length, was laid., the new pumping station at Burlington Beach was completed, and a new high-level pumping station of 4,000,000 gal. capacity also erected. A standpipe, 100 ft. in height, with a capacity of 80,000 gal., was erected on the mountain and connected by a 12-in main to the high-level pumping station.

The large trunk sewer on Ottawa Street and many small sewers were finished during the year. Construction



Asphalt Plant at Gage Avenue, Hamilton; 1,500 Yards Capacity.

work in connection with the West End sewage disposal works (for illustrated description, see *The Canadian Engineer*, Jan. 22nd, 1914), progressed very favorably. The grit chambers and sludge tanks were finished and the excavation and piling done for the six Imhoff tanks, three of which were partially completed before the close of the season.

In connection with pavement work, a new asphalt plant with a capacity of 1,500 yds. per day was built in the east end of the city. When it had been completed, the city operated both asphalt plants, with the result that more asphalt pavements were laid in Hamilton in 1913 than in any previous year. In addition to sheet asphalt, a considerable amount of creosoted wood block and asphaltic concrete pavements were laid. The total yardage of various kinds of pavement laid during the year was computed in our issue of April 16th to be 279,497 square yards.

The Province of Ontario has produced 200,000,000 ounces of silver since the Cobalt deposits were discovered in 1903.

THE TRAINING OF THE HIGHWAY ENGINEER OF THE FUTURE.*

By H. Percy Boulnois, M.Inst.C.E.

THERE can be no doubt that the introduction of self-propelled traffic by means of the internal combustion engine has entirely changed the problem as to the weights and speeds of the traffic which the road of the future may be called upon to bear. With horse-drawn traffic these weights and speeds were limited within almost rigid limits, but with modern traffic these limits are removed and no one can tell as to what weights, and at what speed, the traffic of the future may develop. It is true that legislation may, from time to time, impose restrictions on the traffic, as it has frequently done in the past, but the clamor of commercial needs and the popular outcry for increased means of transport will very soon break down any such artificial barriers to progress, and the highway engineer of the future will have to provide for these inevitable changes which are certain to take place.

The past evolution of our railways is one instance of the change that arose immediately mechanical methods of transport were introduced. The lightly constructed railway of the past has had to give way to a strongly built permanent way that will carry the enormously increased weights of the locomotives and carriages which are now imposed upon it, and the permanent-way engineer has had, from time to time, to strengthen and improve his roadway in order to meet the ever-increasing demands made on him by the locomotive and rolling stock departments. It is by no means inconceivable that the highway engineer of the future will shortly be called upon to make similar improvements in his roads, and he will suffer from the great disadvantage of not having that control over the user of his roads which the railway engineer enjoys.

But apart from this, we are already face to face with the fact that road construction is inevitably altering in its character. Where formerly there was but one form of construction for the ordinary road, viz., that which was known as "waterbound macadam," there are now already a large number of different methods of construction, for all of which special advantages are claimed. It is evident that the "road question" has entered a scientific field never before contemplated, and that something more will be required of the highway engineer of the future than the mere rule-of-thumb experience of the past. The question consequently arises as to whether there is a necessity for specializing in this direction, or whether the ordinary training of a civil engineer is sufficient for the purpose. The question is, therefore, is there a demand for the special profession of the highway engineer, and, if so, in what manner should he be trained?

That there is already a demand for the special profession of highway engineering is very evident, but the manner in which the highway engineer of the future should be trained is not so easily answered.

It is difficult to say exactly what this special training should be. In the United States an endeavor has been made to meet this question by giving a special course of training in highway engineering at the Columbia University in the City of New York, which might form the basis on which some such special training could be instituted in other technical universities and colleges.

*Abstract from paper read before the Institution of Municipal and County Engineers, of Great Britain, June 24-27, 1914.

It may, of course, be argued that technical instruction and laboratory experiments will not make roads, but I do not think it can be denied that the young man who is equipped with a thorough scientific and theoretical knowledge of his subject should be better able to cope with the present-day traffic problems than one who is not so equipped. The great Chinese philosopher Confucius, about 2,000 years ago, wrote:—

"The craftsman who desires to execute his work to perfection must first see that his tools are sharp."

This technical training must, however, be followed by practical experience, and there appears to be no better way of acquiring this experience than that of an articled pupilage under an engineer or surveyor who is responsible for the roads in his district.

If the road of the future will demand more science for its well-being, it is only right that science should demand better pay for its work. The specialist should always be able to secure better remuneration than the ordinary practitioner, and this should hold good for the highway engineer of the future.

I have endeavored to show in this short paper that:

(1) A new profession, viz., that of the highway engineer, is on the eve of commencing.

(2) He should receive a special training for the purpose of this new profession; and

(3) That his services require adequate remuneration.

UNIFORMITY IN BOILER INSPECTION.

A notable improvement that was arranged recently at a conference of boiler inspectors of the different provinces of Canada is the adoption of a uniform set of regulations for the entire Dominion. Doubtless the boiler manufacturers interested in Canadian business will appreciate the efforts that are being extended in an endeavor to bring the provinces into uniformity in this respect, as it will enable inspection in one province to be accepted in any other.

At the present time Manitoba, New Brunswick and Nova Scotia have no regulations, although legislation requiring them has been passed.

Mr. D. M. Metcalfe, chief boiler inspector for Ontario, is chairman of the conference.

RAILWAY ACCIDENTS IN CANADA.

During 1913, there were, according to the report of the Board of Railway Commissioners for Canada, 2,547 accidents on Canadian railways, involving the death of 643 persons, of whom 21 were passengers, 303 employees and 319 others. Of the 2,231 injured 410 were passengers, 1,603 employees and 21 others. With respect to accidents the report states:—

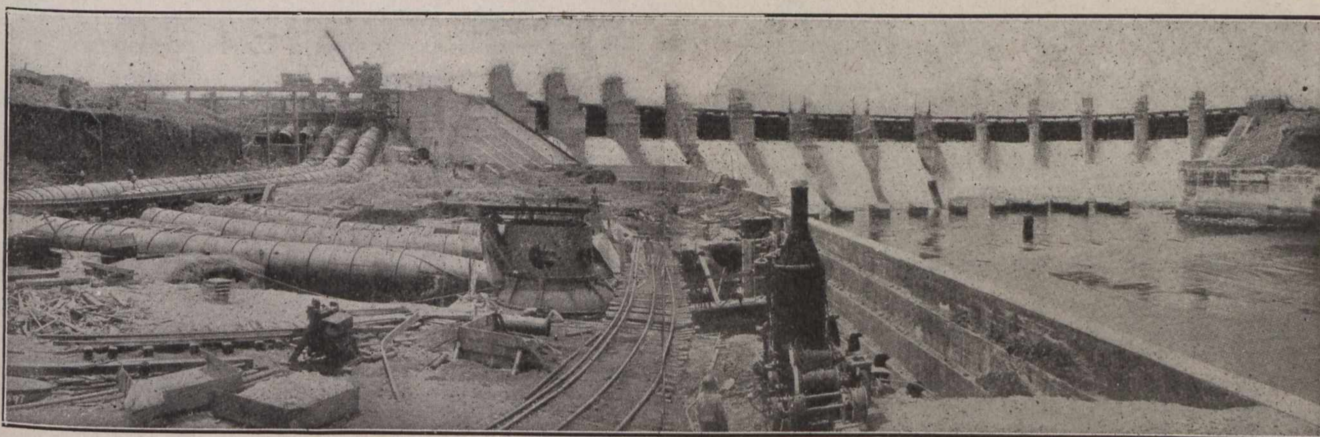
"Inquiries into derailments have brought out the fact that track conditions are largely responsible for such accidents. This is mostly accounted for by the fact that railway companies have not, on the whole, increased the efficiency of their roadbeds proportionately with the increases in the weight of their rolling stock." As to collisions it is said: "At first thought it would seem almost imperative that railway companies should be required to adopt, without undue delay, some form of positive block system on all lines. But we must not lose sight of the very important fact that the great majority of such accidents result from the non-observance of operating rules."

On June 26, the new municipal dock at Hull, Eng., was formally opened by their majesties, King George and Queen Mary. The dock has a frontage of one mile along the Humber, and embraces a water area of over 52 acres. Large new warehouses and 40 miles of railroad sidings have also been provided, together with special facilities for the shipment of coal. The total cost of construction exceeds $12,500,000.

HYDRO-ELECTRIC PLANT AT PANAMA

PROPOSED SUPPLY OF 12,000 KW. UNDER AVERAGE HEAD OF 75 FEET, TO BE DEVELOPED AT GATUN SPILLWAY FOR THE PERMANENT OPERATION OF THE CANAL.

Of particular interest in connection with the construction of the Panama Canal is the part which hydro-electric power is to play in its permanent operation. The supply of electrical energy for both lighting and power purposes on the canal is to be derived from a hydro-electric plant which is being installed at the Gatun spillway dam. It will utilize the surplus water of Gatun Lake, which is sufficient to supply 12,000 kw., of which 6,000 kw. will be developed by the plant at present under construction. The power will be used for lighting the canal, operating the gates and locking machinery, towing locomotives, and the general operation of machine shops, dry docks, waterworks and coal-handling plants at both ends of the canal. In conjunction with it there is a 4,500-kw. electrical supply, steam generated, at Miraflores, erected a few years ago to supply power for construction work. This will be used as an auxiliary to insure continuous service in case of accidents. The full utilization of the power available at the Gatun spillway, i.e., the entire 12,000 kw., will be brought into play with the proposed electrification of the Panama Railroad.



View of Gatun Hydro-electric Installation, Showing Pipe Lines, Turbines and Ogee Spillway Dam.

The head works of the development consist of reinforced concrete passages 12 ft. in width, fitted with wrought iron racks 29 ft. 7 in. high, to intercept floating debris from the surface of the lake. Through these passages water is admitted into the pipe lines by three head gates 10½ ft. in diameter. These cuts are of cast iron and watertightness is insured by bronze-capped seats. The available head from Gatun Lake to mean tide level of the Pacific varies between 79 ft. and 91 ft. representing extremely dry and flood seasons respectively. The plant is designed to develop full capacity under an effective head of 75 ft.

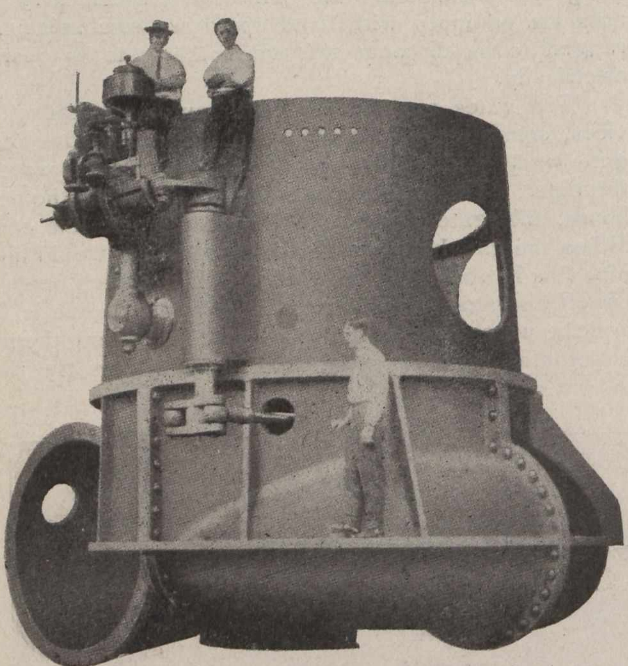
Intake Gates.—Each gate is equipped with two steel stems fitted with bronze nuts working in roller thrust bearings, and the nuts are fitted with steel bevel gears arranged to be operated by a 15-h.p., 220-volt, alternating current motor with a speed of 750 r.p.m. The motor is placed between the stems and has shaft-extensions on each side carrying two bevel pinions arranged to engage the gears on the stem nuts. The stands which carry these nuts are equipped with hand operating mechanisms, arranged to be disconnected when the gate is operated electrically.

The gates are equipped with automatic control devices, consisting of a limit switch geared to one of the gate stems and a float switch actuated by the water in the pipe. The gate-motor switch is closed at the power house, the gate being closed and the pipe line empty. When the gate has opened a distance which would fill the pipe line in about five minutes, the limit switch opens the circuit and stops the motor. When the pipe line is filled and the water rises in the 36-in. vent just below the gate, it actuates a float switch and again closes the motor circuit, thereby causing the gate to be opened fully, when the limit switch again operates to prevent over-travel. The gate is closed by reversing the main switch at the power house, causing the motor to operate, the limit switch stopping the motor when the gate has reached its closed position. An auxiliary hand-operated (2 men) mechanism is also installed for operating the gates.

Pipe lines 10.5 ft. in diameter and 420 ft. long lead from the gates to the turbines to which they are attached by 90-deg. bends of 70-ft. radius. Each of the pipe lines is arranged for attaching a Pitot tube, while its unit is in service. The pipes are of ⅜-in. plate, courses 8 ft. long and three sheets around the circumference. Each course has a centre ring ⅜ x 3-in. Z-bar. The pipes are covered with reinforced concrete as rust protection. Each pipe has two 6-in. saddle-nozzle connections located 45° on each side of the vertical centre line of pipe. From these connections there are two Pitot-tube guide supports placed across the pipe at right angles to each other. These are bolted in the pipes and, while intended to be permanent, can be removed readily if desired.

Each 6-in. outlet on the pipe is closed by a gate valve with tongued and grooved flanges which match the base on the Pitot tube apparatus. Each Pitot tube is arranged to measure both the static and velocity heads at practically the same point in the pipe, and readings are obtained by means of "U" tubes containing a colored liquid having a specific gravity of about 1.25. Carbon tetrachloride, thinned with gasoline to the proper specific gravity and colored red, is usually used for this purpose.

One end of each "U" tube is connected to the static and the other to the velocity side of the Pitot tube; the difference in height of the colored liquid columns is read, from which the velocity of flow in the pipe is calculated.



Pelton-Francis Turbine, 3,600 h.p.

The principal buildings connected with the actual operation of the canal are the hydro-electric station at Gatun spillway; the gate control house at the spillway; the four substations of the transmission system at Gatun, Miraflores, Cristobal and Balboa; and the three lock control houses. All these structures are designed along simple lines in harmony with the unbroken surfaces of concrete of the adjacent engineering works.

Generating Station.—The hydro-electric station measures 61 ft. by 137 ft. and has an extreme height of 74 ft. The building is designed on the unit principle, to admit of future extension, and consists of a single room open to the roof, exposing the trusses upon which are laid reinforced concrete roof slabs, which, in turn, receive red Spanish tiles. The walls are of poured concrete, 30 in. thick to the level of the crane rails, near the cornice. The exterior overhang of the main roof is 13 ft. 2 in. and that of the monitor roof 4 ft. 8 in., the exceedingly large projections having been generally adopted for all the permanent buildings in the Zone as a shelter from tropical rains, as well as from the heat of the sun.

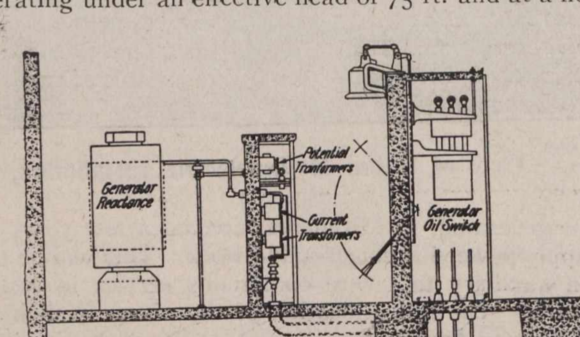
Beyond the general use of tiles for flooring, and an interior white-enamelled brick wainscot 14 ft. high, to relieve the coarseness of the walls, there is no difference in the finish of the concrete surfaces within and without. The dead surfaces of the concrete or stuccoed walls, which will probably be improved when weathered, are further relieved on the exterior by the red tile roofs. The principal ornamentation is on the under-side of the broad projecting cornice, which is broken up into panelled coffers. A number of these contain light outlets that cast light down on the walls and throw the structure into strong relief at night.

The interior has four principal elevations, namely, a pit for the three 2,500-kw. hydro-electric turbines, a main floor, and two galleries. The turbine pit, with an area of over 2,100 sq. ft., is located 6 ft. below the level of the main floor, and is reached by iron stairways descending alongside the turbines. From the pit other stairs lead down to the store room on the north side, and to the air-compressor and oil-pump compartments at the ends. The pit is lined with white-enamelled brick, and the 14-ft. wainscot extends from the main floor up to the first gallery elevation on the south wall of the pit.

The main floor is divided into two parts, one being devoted to the use of the electrical equipment, and the other forming an uninterrupted passage on the longitudinal axis of the building, terminating with two large entrance doors at either end. Easy access to railway wagons is afforded by means of a track which enters this floor through the northwest door, thus giving every facility for handling heavy machinery by the 30-ton electric crane running the length of the building overhead.

Concrete stairways at either end of the building give access to the mezzanine and second galleries, which are devoted to the switchboards, oil-switch compartments, reactance coils and other electrical equipment. Two such galleries extend the entire length of the station on the northeast side, and in the south corner are superimposed two smaller ones used as a machine shop and an office respectively. The sashes in the large side wall windows are operated in sections by a hand gear system, and the continuous bottom-hinged sashes in the roof monitor are operated by motors.

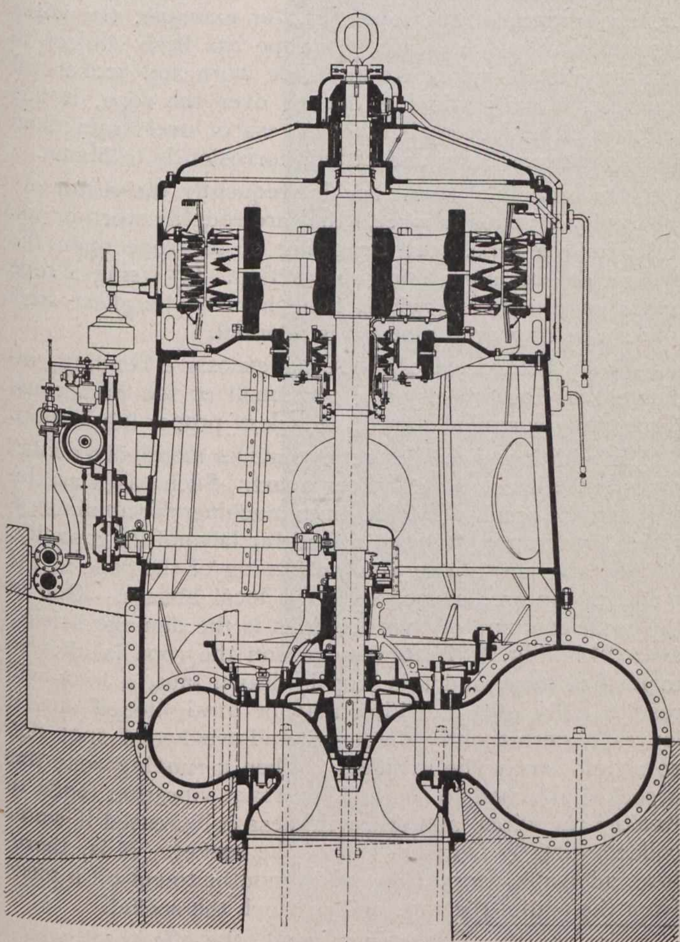
Water Turbines.—There are three 2,000-kw. main generating units in the hydro-electric station, each driven by a special, 50-in., vertical, single-runner, Francis turbine. Each has a maximum capacity of 3,600 h.p. when operating under an effective head of 75 ft. and at a normal



Arrangement of Switching Apparatus.

speed of 250 r.p.m. The centre of the runners is 20 ft. above tail water, and the discharge is through steel-lined concrete draft tubes 71 in. in diameter at the turbine and increasing to an elliptical section of 9 x 17 ft. at the outlets. The linings are of ¼-in. steel. A roller thrust bearing mounted on top of the generator carries the weight of the revolving parts of both the turbine and generator. The turbine is so designed, however, that, when running at full capacity, the runner exerts an upward thrust of 10 tons, thereby relieving the thrust bearing of that amount of load.

Oil for the thrust bearing is supplied by a small pump geared to the turbine shaft, and a tank is provided below



Cross-section of Turbine, Generator and Exciter.

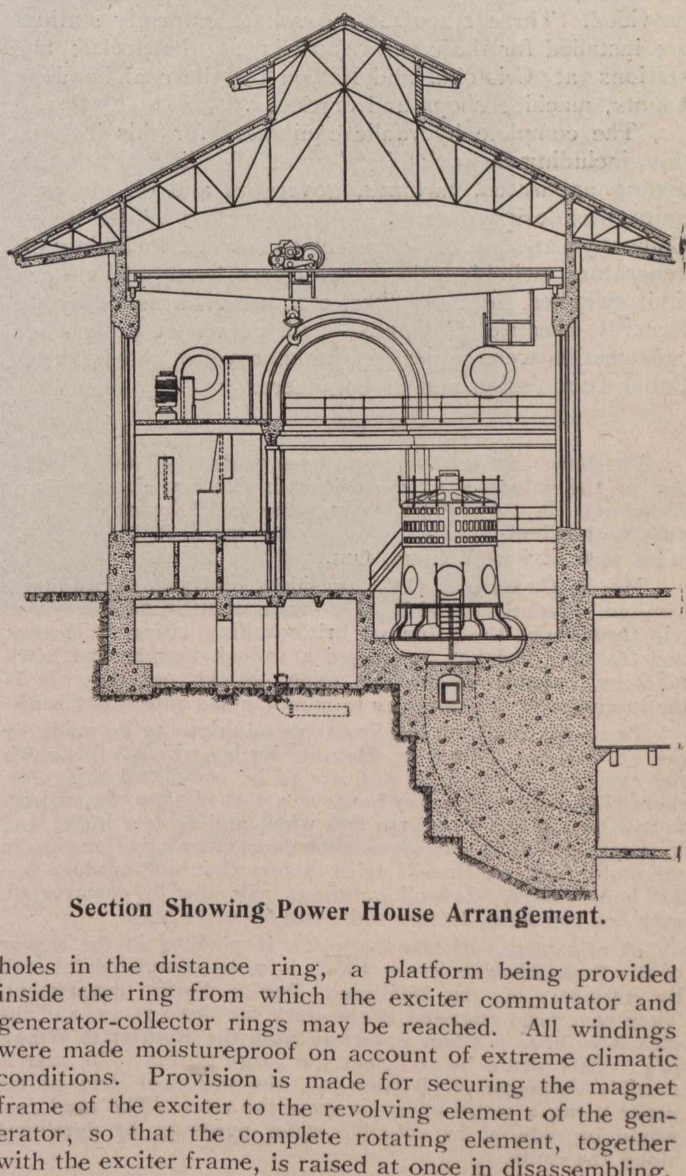
the pump to receive the overflow from the bearing. In this way a constant circulation of oil is maintained. As this oil returns to the suction tank, it passes through the lower guide bearing on the main shaft, lubricating it.

The runners are made of special bronze and weigh approximately 7,000 lb. each. They are taper bored and held in place on the lower end of the shaft by bronze nuts. The surfaces of the runner vanes are all hand finished to reduce hydraulic losses.

The speed of the turbines is controlled by Pelton oil pressure governors, mounted on the distance rings and driven by bevel gearing from the main shaft. Tachometers are mounted above the governors and are directly connected to the governor heads. The governors are fitted with small electric motors for varying the speed of the main units for synchronizing purposes, and a device is provided on each governor for varying the permanent drop in speed from no-load to full-load. This can be adjusted for any variation from 5 per cent. drop to absolutely constant speed from friction load to maximum load. The governors are also fitted with hand control mechanism for adjusting the gates independent of the oil pressure.

The wicket gates for controlling the supply of water to the runner of the turbine are steel castings with hand-finished surfaces. Each gate has its pivot stem extended upward through a packing gland and is fitted with an operating lever. All the gate levers are connected to the gate ring by means of bronze links, and the gate ring is connected to the governor rock-shaft. All the regulating mechanism is, therefore, outside the turbine case, except the gates themselves. The water passages on each side of the gates are provided with renewable rolled-steel wearing plates. Pressure oil for actuating the governors is supplied by two Pelton rotary pumping units, driven by 10-h.p. alternating-current motors at a speed of 375 r.p.m., each pump being capable of supplying the governors on all three units. The governors work on an open system, there being no vacuum chambers used. The discharge oil from the governors is led into oil-sump tanks, from which it passes into the suction of the pumps. Each oil pump is connected to a steel pressure-oil receiver with an air space above the oil. The oil-sump tanks and pipe connections are installed in duplicate, and valves are provided to enable one set to be cleaned while the other is in service.

Generators.—The three main generators are of a three-phase, 25-cycle, revolving-field type, developing 2,000 kw. at 0.8 power factor, 2,200 volts and 250 r.p.m. They have 25% two-hour overload rating, and are of General Electric Co. make. The exciter is mounted below the main generator but is readily accessible through large



Section Showing Power House Arrangement.

holes in the distance ring, a platform being provided inside the ring from which the exciter commutator and generator-collector rings may be reached. All windings were made moistureproof on account of extreme climatic conditions. Provision is made for securing the magnet frame of the exciter to the revolving element of the generator, so that the complete rotating element, together with the exciter frame, is raised at once in disassembling.

In addition, there are two motor-driven exciters. These consist of a 100-kw., 125-volt, 500-r.p.m. generator, direct-connected to a 150-h.p., 2,200-volt, 25-cycle squirrel-cage type induction motor. They are mounted on a common base plate and provided with three bearings. These exciters can also be used for charging the control battery.

Distribution System.—On account of the distance, current is transmitted at a voltage of 44,000 from the power station to both ends of the canal. The step-up transformers are, however, not located in the power plants, but in substations in their vicinities; therefore, the power plants generate and distribute only 2,200-volt current.

The system of connection throughout employs the double-switch scheme, with provision for disconnecting any oil switch for cleaning or repairs without interrupting the circuit. This system was naturally selected for this station because it was considered the most flexible for the requirement of uninterrupted service.

The double 44,000-volt transmission line runs across the Isthmus, connecting Cristobal and Balboa with the two power plants. There are four 44,000/2,200-volt substations stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power. Thirty-six 2,200/240-volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks have been provided. Three 2,200/220-110-volt transformer stations are installed for the control boards at the locks; and stations at Cristobal and Balboa for the coal handling plants, machine shops and drydocks.

The complete hydraulic equipment for this installation, including the racks, head-gates, pipe lines, Pitot tube testing apparatus, turbines, governors and oil pumping units, was designed and built by the Pelton Water Wheel Company; and all the electrical apparatus, including the generators, switchboards, transformers, head-gate motors, limit switches, float switches, etc., were furnished by the General Electric Company. All details of design and construction were subject to the approval of the Isthmian Canal Commission and its engineers.

Pittsburg business men, who are understood to be working in the interests of the Pickards Mather Company, of Cleveland, O., are investigating the iron deposits in the neighborhood of Savanne, a point on the C.P.R., about 75 miles west of Fort William, Ont.

Mr. P. C. Burpee, C.E., president of Concrete Builders, Limited, Fredericton, N.B., has made a business inspection trip throughout the principal brick-making cities of Quebec and Ontario, and has purchased a 10-inch tamper and brick machine, capable of making 10,000 bricks per day. It is the intention of the company to manufacture only fancy brick.

In connection with the extensive additions to be made by the Ford Motor Company, Detroit, Mich., which will double the capacity of its plant, and are to be completed this year, there will be erected a power house at a cost of about $5,000,000. It will be 240 feet long, 150 feet wide, and 85 feet high; and it is stated that it will contain the largest gasoline engine in the world, one which will drive motors that will produce 80,000 horse-power. Several buildings will also be constructed, each 900 feet long, 60 feet wide, and 6 stories high.

A new means of transportation is planned in the survey of the Saskatchewan River, which is to be completed this fall by engineers of the Dominion Public Works department. They have been engaged in the work for three years, and the idea is to have a 5-foot waterway from the Rockies to Winnipeg. This would be sufficient for barge traffic. The cost is roughly estimated at $15,000,000, the principal item of expense being a series of locks along the river. The total cost would be reduced by valuable water power to be developed along the route.

THE CARE OF WIRE ROPE.

EXPERIENCE has taught that there are four leading causes for the destruction of wire rope, namely, abrasion, overstrain, undue bending and corrosion. These, together with suitable methods to provide longer utility, are outlined in a recent issue of "Power," from which the following has been abstracted:

The cause of failure can usually be determined from the appearance of the rope. If, for example, the wires wear thin in a short time, the rope has been subject to abrasion; if the wires are but little worn and broken off squarely, usually sticking out all over the rope, it has suffered either severe bending stress or overstrain; and if the wires are rusty and pitted, corrosion is to blame.

Abrasion in a wire rope is frequently the result of: (1) Faulty grooves in wheels that are roughly worn or too tight for the rope. (2) Dragging of the rope upon the ground or over some fixed obstruction. (3) Using a rope under conditions for which none but the toughest steel (plough or improved plough) is adapted.

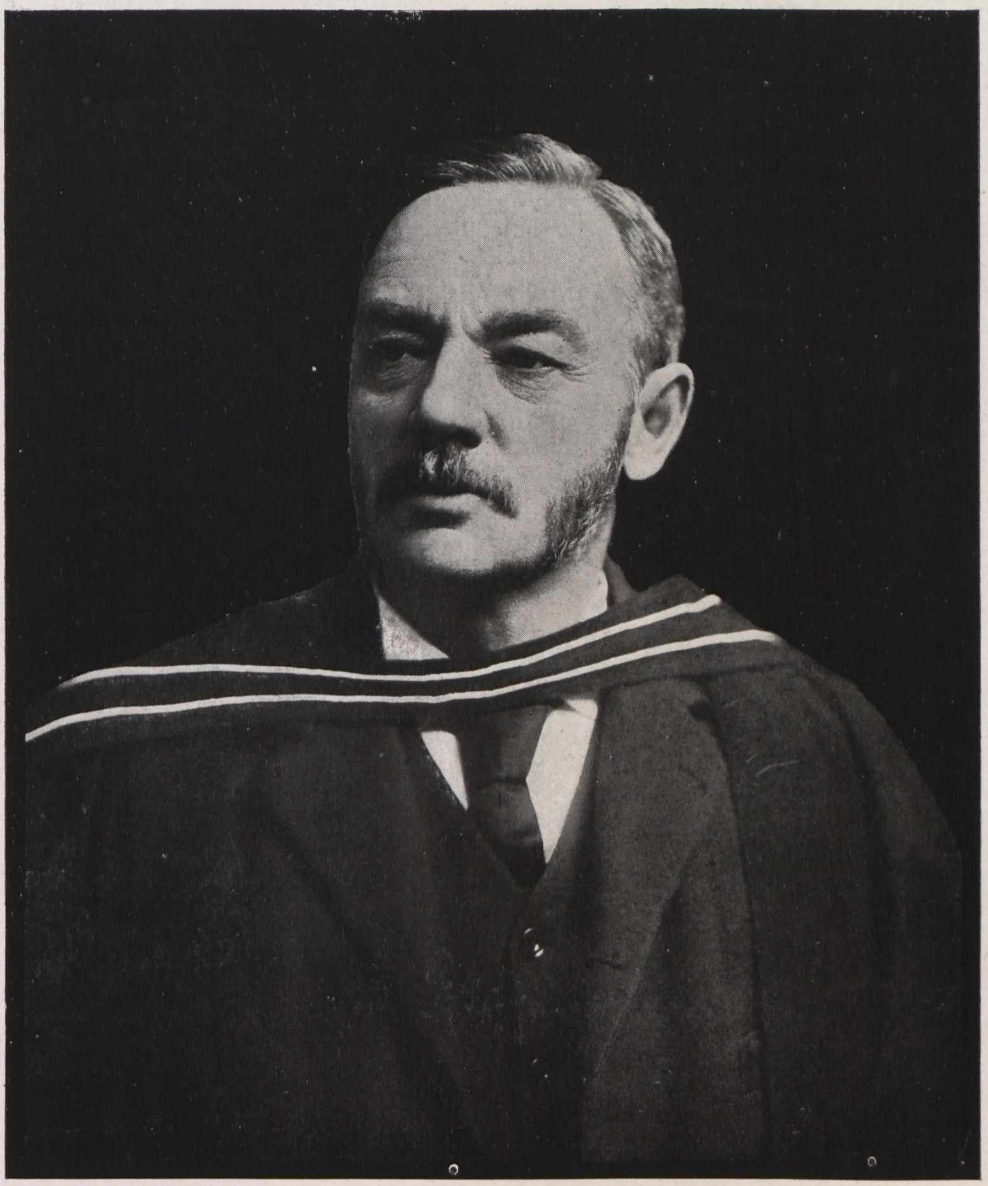
Badly broken wires, showing excessive bending, indicate that the wheels are too small or too numerous. Rope badly corroded shows the lack of proper lubrication.

In addition to the destructive causes mentioned above, ropes sometimes suddenly tear apart. Such cases are invariably the result of accidents to machinery or appliances, which bring upon the rope a load far beyond its capacity, or they are due to a serious weakening of the rope at the point of rupture, caused by some local abuses. One of the most common of these injuries is the damage arising from "kinking." If for any reason the rope is allowed to form a loop, and this loop is drawn taut, a kink will result. Though the kink may be straightened out, it leaves a permanently damaged and weakened spot and so should always be avoided. When a running rope has a socket attached to the end, constant vibration tends to weaken the wires, and this weakness is increased if water collects directly over the end of the socket. It is, therefore, advisable every three to six months to cut off a piece from the end of the rope and reattach the socket.

Besides the causes mentioned, the effects of which are usually revealed by inspection, temporary overloads producing excessive stresses are sometimes applied, and by straining the wires beyond their elastic limit tend to shorten the life of wire rope. Such excessive stresses are more apt to occur where a rope is slack, or is attached to a short length of slack chain, and the power to lift or haul a load is suddenly applied, with the result that, instead of the rope gradually adapting itself to the required pull, it is subjected to the jerk arising from the full inertia of the load. Lifting tests made on wire ropes, attached to chains having 2½ in. to 12 in. of slack attached, show that when loads are applied suddenly, the stresses are from one to four times as great as those sustained when the same loads are gradually applied.

When a complaint is made that a wire rope has not given satisfactory service, the first questions asked by the manufacturer are: "How was the rope lubricated?" "What is the condition of the inside wires?" These questions arise because the experienced wire-rope maker fully appreciates that a wire rope is a complex piece of machinery and knows that the importance of proper lubrication is too often overlooked.

A lubricant or preservative should not only penetrate to the hemp centre, in order to saturate it and prevent absorption of water, but it should also coat thoroughly the inside wires of each strand.



Born September 5, 1846
Died July 22, 1914

J. Galbraith

TRANSVERSE STRENGTH OF CUT SCREWS IN WOODEN JOINTS.

In *The Canadian Engineer* for March 14, 1912, an article was published giving the results of a nail test made in connection with the design of a hydro-electric plant at Sandy Falls, Ont. The purpose of the test was to ascertain the transverse holding power in pine lumber of 9-inch spikes (4½ to the pound), so that a well-proportioned joint could be designed. The results included several notable features of nailed joints, as follows:

(1) The permissible deflection value of 1/16 inch, i.e., the deflection which can be caused without weakening the joint is altogether too small. Joints tested to deflections of one inch or more seemed to be in no way weakened. This is a strong point in favor of the nailed joint.

(2) The percentage relation of elastic limit to ultimate load would depend on the assumed definition of the former. No satisfactory results were obtained, but they were sufficient to indicate that it is at least 50%.

(3) The relation between the strength of a joint and the number of nails is such that the former is proportional to the latter and quite independent of the arrangement provided failure did not occur by cracking of the timbers.

It is interesting to recall these tests in conjunction with similar ones, performed in Cornell University last year, to determine the transverse strength of ordinary cut screws in single shear in a wooden joint. The results were given in the Cornell Civil Engineer and from it the following has been extracted:

Three kinds of wood were used in the tests, cypress, yellow pine and oak. The cypress was fine grained and of uniform quality; its specific gravity was 0.442, and its rate of growth was 20 rings per in. The wood was thoroughly seasoned, and had a compressive strength of 4,980 lbs. per sq. in. The yellow pine was of a rather coarse but straight grain; its specific gravity was quite variable, the average being 0.648. The rate of growth varied from 8 to 15 rings per in., and this gave corresponding variations in results. The average compressive strength was 7,580 lbs. per sq. in. The oak was a good quality of red oak, well seasoned, of a firm straight grain and of uniform texture. Its specific gravity was of 0.701, its compressive strength was 8,440 lbs. per sq. in., and it had 20 rings per inch.

The test joint consisted of three pieces, each 12 ins. long and 6 ins. wide, the two side pieces *B* and B^1 (Fig. 1, a) having an 8-in. lap on the middle piece. The thickness of these pieces varied with the length of screw used, but the middle piece was always of sufficient length to cause the screws to be in single shear. The screws were arranged in the form of an equilateral triangle, the apex of the triangle being placed upward on one side piece and downward on the other (see Fig. 1, b). The test piece was subjected to compression, the forces acting as shown by the arrows in Fig. 1 (a).

It was found by experiment that screws could not be driven closer than 2½ ins. to an edge perpendicular to the grain without danger of splitting the wood. This distance was therefore used for all of the tests. It was found impossible to drive screws without previously boring holes, these holes having a diameter equal to that at the root of the screw threads. In oak, and where large screws were driven in yellow pine, separate holes had to be bored for the shank and for the threaded portion of the screw. A hole was also bored to receive the head of the screw, which brought the entire screw into action. In hard wood the driving of the screws was facilitated by lubricating them with thick, wet soap.

Method of Testing.—The procedure in testing was to measure the force at each 1/32-in. slip, up to a maximum of 6/32 in. This is more than would be allowed in any structure in practice, so it was not thought necessary to carry the test up to destruction. The deflection was measured by means of a steel pointer, attached to the middle piece, sliding over a celluloid scale, attached to the two outside pieces. The force was applied by turning the crank of the Olsen machine very slowly and at a uniform rate of speed. The result of rapid testing will be shown later. In making the tests it was found that the uniformity of results was materially affected by the bearing of the joint in the testing machine. To secure good results, it was necessary that the joint be so made as to have a full bearing on the table of the machine, and furthermore, that the axis of the joint be truly vertical.

Fig. 2 shows in a general way the forces acting on a screw in a joint. The screws were but slightly deformed in cypress, the wood being so soft as to crush readily without bending them. In yellow pine and oak, however, the screws were bent as shown. An attempt was made to derive a formula for the strength of a screw at a certain

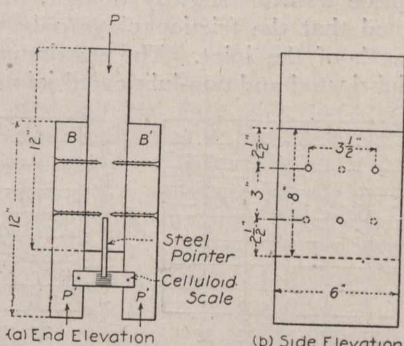


Fig. 1.—Arrangement of Screws in Test Specimen.

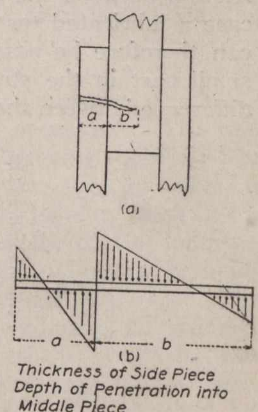


Fig. 2.—Distribution of Forces on a Cut Screw in Single Shear.

slip, but so many different factors, such as gripping of threads, amount of bearing, curvature of screw, etc., entered into the computations that it was found impossible to obtain anything of reasonable certainty.

Preliminary tests were made to determine the following items:

(1) Effect of driving, with and without boring holes.

(2) Effect of rapid testing.

(3) Effect of friction between adjoining pieces of the joint.

(4) Effect of varying the number of screws in the joint.

Effect of Boring Holes.—It was found, in the case of cypress, that there was a very small increase in the strength of the joint when the screws were driven without previously boring holes. In the case of yellow pine, there was a slight decrease in strength when no holes were bored.

The holding power of a screw driven in wood depends materially on the wood fibers securely gripping the screw threads; hence, if the screw is driven in such a manner as to break the fibers around the threads, the holding power will be decreased. The transverse strength, however, is not nearly so dependent upon the gripping of the threads by the wood as upon the bearing of the screw in the wood. In the case of cypress the fibers, not being broken in driving and being very soft, close tightly around the screw threads and tend to increase the area of contact between the screw and wood, resulting in a slightly greater strength when driven without previously boring holes. In the case of yellow pine it is necessary to drive the screws with the hammer before using the screw driver. The fibers are therefore broken to a certain degree, resulting in a considerable decrease in the area of contact between the wood and the screw. This is probably the cause of the lower transverse strength in the case of the screw which has been driven without previously boring holes.

Effect of Rapid Testing.—When the load was applied too rapidly the values were not uniform, showing a great range as compared with those with slow testing. The values obtained by rapid testing averaged about 20 per cent. lower than the others. The difference was especially marked in the first few increments of slip, after which the values seemed to approach each other. This shows the importance of applying the loads slowly in tests of this nature.

Lubrication Tests.—The purpose of these tests was to determine what part of the strength of a joint is due to friction between the surfaces. It was found that in any case a lubricated test piece was but slightly weaker. It can therefore be assumed that the friction plays only a small part in the strength of the joint. The maximum difference between the lubricated and non-lubricated joints

piece and a 2½-in. screw gives a proportion of 0.3 between side piece and screw; and a 1-in. side piece and 2½-in. screw gives a proportion of 0.4. For a 2-in. screw the ¾-in. side piece gives the stronger joint, especially with the smaller gauges, the proportion being 0.385. For a 1½-in. screw the best joint was obtained with a side piece of ⅝-in., the proportion being 0.4. Thus it seems that a side piece about 0.4 of the length of the screw gives the strongest joint. Decreasing the thickness of the side piece increases the strength of the joint up to a certain limit, this limit being reached when so little bearing area is provided in the side piece that the wood is rapidly crushed.

The strength of a screw, for a particular gauge, is independent of the length, but depends on the penetration into the middle piece. Thus a 3-in. screw with a 1½-in. side piece (1½-in. penetration) shows practically the same strength as a 2½-in. screw with a 1-in. side piece (1½-in. penetration), the gauge remaining constant.

In yellow pine or oak the ratio of strength to penetration is very closely proportional to the square root of the penetration into the middle piece. For cypress the strength was found to be directly proportional to the cube root of the penetration into the middle piece. These laws, however, will not hold if the side piece is made much less than 0.4 of the length of the screw; decreasing the side piece beyond this point, while giving a greater penetra-

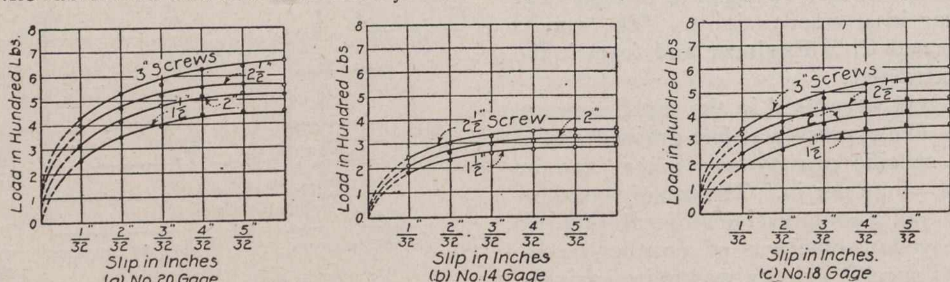


Fig. 3.—Relation Between Lengths of Screws, Load per Screw and the Slip of Nos. 20, 14 and 18 Gauge.

was shown in the first few increments of slip, the succeeding values showing little difference.

Effect of Variation in Number of Screws.—As the number of screws per joint is decreased, the strength per screw is slightly increased. This would naturally be expected, as the friction force remains constant in all the joints. An examination of the joints after testing showed that, as the number of screws per joint is decreased, there is a more uniform distribution of the total stress among the screws, thus giving a higher value for the joint.

Ratio of Strength to Penetration.—Curves, in which the load per screw, in pounds, was plotted against the slip, in inches, showed the following results:

In cypress, while a joint having a thin side piece may be stronger than one having a thick side piece during the first few increments of slip, it no longer continues to be so during the last few increments of slip. In yellow pine and oak, however, the thinner side piece remained the stronger throughout the entire slip. This is probably due to the fact that cypress, being softer, crushes after the first few increments of slip, and hence the difference in depths of penetration due to different side pieces affects the strength very little. In yellow pine and oak, the fibers remain intact a longer period, and therefore additional penetration gives additional strength. A number of typical load-slip curves for cypress are shown in Fig. 3, each curve representing an average of three tests.

An investigation of the relative thickness of side piece to the length of screw shows that, in general, the thinner side piece gives the stronger joint. A ¾-in. side

tion into middle piece, will give a weaker joint, due to insufficient area.

Transverse Strength Per Pound of Screws.—The following laws were deduced showing the transverse strength per pound of screws in the different woods:

(1) For a particular length of screw, the smaller the gauge the greater the strength per pound of screws.

(2) As the length of screw is increased, the gauge remaining constant, the transverse strength per pound is increased.

(3) As the gauges become larger, the difference in transverse strength per pound between screws of different lengths tends to become more nearly equal.

The curves in Fig. 4 show clearly that as the number of screws per pound is increased the strength per pound is increased, irrespective of the length or gauge. However, in actual practice, the additional labor cost of driving many small screws rather than a few large ones would offset the advantage of greater strength.

Relative Strength of Screws in Different Woods.—By taking the average strength of all tests made it was found that yellow pine was about 80 per cent. as strong as oak, and that cypress was about 40 per cent. as strong as oak. A comparison of the compressive strengths of these woods shows yellow pine to be about 92 per cent. as strong as oak, and cypress to be about 59 per cent. as strong as oak.

An attempt was made to establish a relation between the transverse strength per screw and the gauge or diameter, but no relation could be found.

The report contained tables giving the strength per screw, in each kind of wood, for increments of slip of 1/32 in. In yellow pine the strength varied with the specific gravity of the pine. After reducing all values to a common standard a difference of 0.1 lb. in the weight

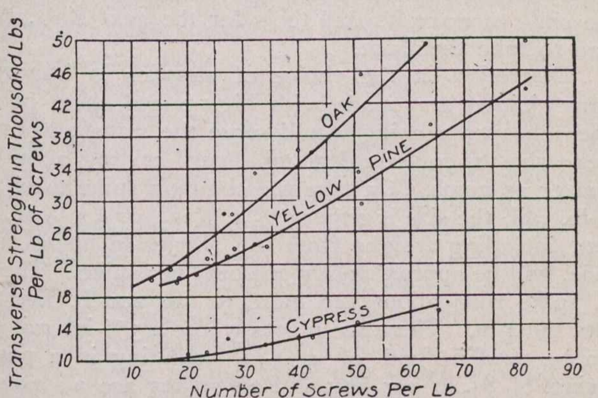


Fig. 4.—Relation Between Number of Screws per lb. and Strength per lb. of Screws.

of a joint was found to make a corresponding difference in strength of 10 lbs. at 1/32-in. slip and 30 lbs. at 3/16-in. slip. The following conclusions were drawn from the tests:

(1) In cypress the effect of boring holes for the screws is to slightly weaken the joint.

(2) In yellow pine the effect of boring holes for the screws is to slightly strengthen the joint.

(3) The effect of rapid testing is to give weaker joints and non-uniformity of results.

(4) Friction between adjoining pieces plays only a small part in the strength of the joint.

(5) Decreasing the number of screws per joint increases slightly the strength per screw.

(6) To secure the best results in a wooden joint, the outer piece should be about 0.4 the length of screw.

(7) For a particular gauge, equal penetration into the middle piece will give equal transverse strength, regardless of the thickness of the side piece, provided it supplies sufficient bearing area.

(8) The transverse strength per screw in yellow pine or oak varies directly as the square root of the penetration into the middle piece.

(9) The transverse strength per screw in cypress varies directly as the cube root of the penetration into the middle piece.

(10) For a particular length of screw the smaller the gauge the greater the strength per pound of screws.

(11) As the length of screw is increased the strength per pound is decreased, the gauge remaining constant.

(12) As the number of screws per pound is increased, the strength per pound is increased, irrespective of length or gauge.

(13) The strength of a yellow pine joint is about 80 per cent. of that of an oak joint.

(14) The strength of a cypress joint is about 40 per cent. of that of an oak joint.

(15) There is no apparent simple relation between gauge or diameter and transverse strength.

(16) The smaller the gauge the more economical the screw, the length remaining constant.

(17) The gauge remaining constant, the shortest screws will be most economical.

(18) The most economical screws of those investigated were: 2-in., No. 12 gauge; 1½-in., No. 8 gauge; and 1½-in., No. 12 gauge.

THE FUNDAMENTALS OF MINING EFFICIENCY.

THE following suggestions for increasing efficiency in mining operations, while not new, are such that, if conscientiously followed, an increase in production or a decrease in costs should be the result. While pertaining chiefly to mining, they apply with almost equal force to engineering construction and industrial work. They were presented in the Engineering and Mining Journal recently by Wilbur Meyers, of Negaunee, Michigan:

Efficiency in mining is as old as the industry itself. It is attained by the systematic analysis of existing conditions with continual study of how to improve these conditions so as to make operations safer and more productive for the same expenditure—this, combined with a common-sense attitude toward the ever-occurring emergencies that are a part of the business.

There are certain fundamental principles of efficiency that will apply whether mining is being carried on for coal, iron, gold or any other substance. The nature of mining makes efficiency particularly important. The policy of letting well enough alone because a routine management is paying small profits, is unreasonable when it is remembered that the wealth of the property is being exhausted and that there is no future chance to recover the money lost from year to year in producing at a higher cost per ton than was absolutely necessary. The main avenues of cost in any mine are labor and supplies; there are other expenses that must be met, such as taxes, insurance, royalties, personal injuries, legal expense in connection with damage suits, etc., but the cost of labor and the cost of supplies are the two great factors in mining costs, labor being the greatest of these two. One of the first necessary operations in introducing an efficiency scheme is to secure the good will of the workmen, since a contented workman in full sympathy with progressive ideas is much better material to work on than one suspicious and dissatisfied, antagonistic to innovations, which he fears are part of some new scheme to get the best of him. It is peculiarly necessary to get the good will of mine employees, since they work in isolated places, incapable of constant supervision. While it may be true that their work can be gauged by results obtained, yet these results will often be the maximum of the second- or third-class workman, the best workmen being afraid to let themselves out to their full capacity for various reasons. The management could do something to win and hold the good will of its workmen by getting their viewpoint, based on personal knowledge of working and living conditions.

Better light in the mine would be of benefit to the miner, eliminating some of the hazards surrounding his work and increasing productiveness, since he could detect and secure dangerous places more quickly, facilitating his work in different ways; it would help not only the miner but also the operator. Better ventilation, good drinking water, sanitation; all these have a direct bearing on a miner's comfort and safety, and incidentally on his productiveness, for as soon as the workman sees that the management is improving things for his benefit, he will begin to co-operate and his good will is won.

Harmony between different departments is another fundamental requisite of efficiency. Friction wastes power with men as well as in machinery. Sometimes there exist petty jealousies between the practical miner who has obtained his knowledge by years of experience and the engineer who has graduated from college after a four- or five-year mining course. Both types of men are necessary and working in harmony each helps the other, while the company gets the best results from both. Sometimes the men at the shaft-top fail to work together with the men below, signals are misinterpreted, hoisting is delayed, etc. A smoker or concert occasionally, even a picnic, will get the men together in a happy frame of mind and eliminate a lot of petty jealousies.

One great aid to efficiency is the bonus or premium system, or profit-sharing with the employees; this identifies the interests of the workmen with the interests of the company. Such a system properly administered will enable the miners to earn more money per day and the company to produce at a lower cost per ton.

Education of the workmen is of the greatest importance. Either the boss or a skilled fellow employee as a companion, can show the green workman how to obtain a maximum result with the minimum expenditure of labor and also how to detect and secure dangerous places. Racial characteristics can be taken advantage of in this way, thus an old experienced Italian could have a younger man of his own nationality put with him to good advantage. If increased pay is given for increased production, this plan will stimulate both men to their best.

A suggestion box to enable the more intelligent workmen to submit to the management plans for improvements in methods often yields practical and economical ideas. If these are paid for and proper credit given to the workmen submitting them, it is an incentive to draw out the best working ideas.

If the foremen of different departments where the work is similar, are made to hand in to the office daily reports made out on standard blanks, a comparison of production and of accidents under each foreman can be made and friendly competition stimulated among the foremen, especially if the reports are known to be the basis for promotion.

Standardizing equipment and supplies will tend to reduce the quantity of supplies carried in stock and the amount of money tied up at any one time, and will facilitate repairs, inasmuch as the workmen will become acquainted with the kind of supplies needed and used and transfers of both equipment and supplies can be made from one part of the mine to another. If tracks of different gauge are used for tramming, there must of necessity be various sizes of equipment such as cars, motors, etc., and this equipment would not be interchangeable, whereas if all tracks are standardized, changes can be effected readily. Again, trolley wire may be either grooved, figure-8 or round; if two or three of these sections are used, there will usually be necessary two sets of supplies to accompany the wire; while if one kind is used throughout the mine, both on the surface and underground, there can be no misunderstandings when trolley wire is ordered.

Recovering timbers, rails, switchpoints, frogs, rail spikes, pipe, trolley wire, hangers, etc., from places that are to be abandoned, or caved, instead of allowing them to be buried, will materially decrease the total expenditure for supplies. If supplies are standardized, this recovered material can be used at once, being already underground, and a saving of time secured, because new supplies would have to be taken out of the mine warehouse and sent below.

Workmen can be educated to economy in the use of supplies. The common waste of oil by motormen is unnecessary. Miners often break or lose their tools when they do not like them, or when they want new ones, but if they have to return the old tools to get new, or else be charged for the new, the management will be pretty sure of getting maximum length of service from all tools issued.

Prompt return of dull tools to the blacksmith shop for resharpening is another practice that makes for efficiency. Where two shifts are worked, it is a common thing for one shift to leave its dull tools for the next shift, rather than to take them out.

Discretion in the choice of supplies is important; many joints are made with high-priced sheet packing when cheaper packing would serve the same purpose, or even asbestos roll-board or mill-board costing about one-quarter as much. Or take the common spike used for a 30-lb. rail, the size is either 3½ x ½ in., or 4 x ½ in.; the cost, including freight from the wholesale house to the mine, will be approximately one cent per spike. The 3½-in. spike runs about 140 more to the 200-lb. keg than does the 4-in. There are places where a 3½-in. rail spike can be used instead of a 4-in. resulting in a possible saving of $1.40 per keg. Rail spikes are an excellent illustration, because so many are wasted in almost every mine, and in most mines are not recovered for use a second time, yet every 4 x ½-in. spike saved represents a saving of approximately one cent.

A NEW GOVERNOR FOR WATER TURBINES.

Fig. 1 illustrates an improved governor for water turbines, designed by Percy Pitmân, London, Eng. The characteristic feature of the device lies in the fact that floating levers have been entirely dispensed with. The inventor claims it to have a close speed regulation without hunting, to have all parts adjustable while in operation, and to be automatic, hand or distant controlled.

Referring to the figure, the governor sleeve is mounted on an aluminum crosshead *C*, which rises and falls with the sleeve *S*, it is adjustable to take up wear, and is prevented from revolving by stops. One end of the crosshead is directly connected to the piston valve *J* and the other end to the plunger of the oil brake *W*; this gives a direct force couple.

The compensating mechanism consists of a bronze sleeve *E*, which is a sliding fit in the valve body *A*, and inside of which the plunger *J* works. The sleeve is connected to the piston of the servomotor, as shown, or to some part of the gate-regulating mechanism; therefore, every movement of the piston valve is immediately duplicated by the sleeve.

An oil brake *W* is provided with a wide range of adjustment by means of the check valve *Y*. This controls the too rapid action of the governor, and prevents the valve sleeves or compensator from interfering with the action of the pendulum.

The body of the oil brake is coupled to the valve sleeves by the rocking beam *Z*, so that when the speed is changed and the valve sleeve moves upward, the compensating action causes the oil-brake body to move downward, and *vice versa*. The check valve *Y* on the oil brake can be so adjusted that, however sudden the change of load, the action of the governor pendulum is not interfered with by the back action of the sleeve. The rocking beam *Z*, the sleeve *E*, and the oil-brake body *W* are held rigid between every movement of the pendulum.

In the case of an impulse wheel with needle regulation or with a deflector, if it should be noticed that the governor carries a needle or deflector beyond the proper position and then oscillates several times after a change of load, it indicates that the oil brake is not slow enough in its action. The remedy is to close down the valve *Y* still further. If the governor does not open or close the nozzle properly, the valve on the oil brake is unscrewed a little more.

Another feature of the governor is that of throttling the exhaust instead of the supply to the valve *A*. This arrangement takes some of the strain off the piston valve, resists the wear, puts it in more perfect balance, and makes the relay piston easier to move.

The crosshead is fitted with double-ball thrust bearings to take the end thrust in either direction. The bottom of the main spindle also has a double ball-thrust bearing *H*, and the bearings at the top and bottom are ball-journal bearings, as at *N*.

The horizontal driving spindle is provided with two radial ball bearings *P* and a double thrust bearing *Q*, to prevent any tendency to end movement and take the thrust of the driving gear.

The inventor claims that the great advantage of using oil for the relay is that the parts require no lubrication and the wear is negligible. The best oil to use is a pure hydrocarbon, which must be without mineral or free fatty acids. It should have a low settling point, and must remain liquid at low temperatures. It is important to

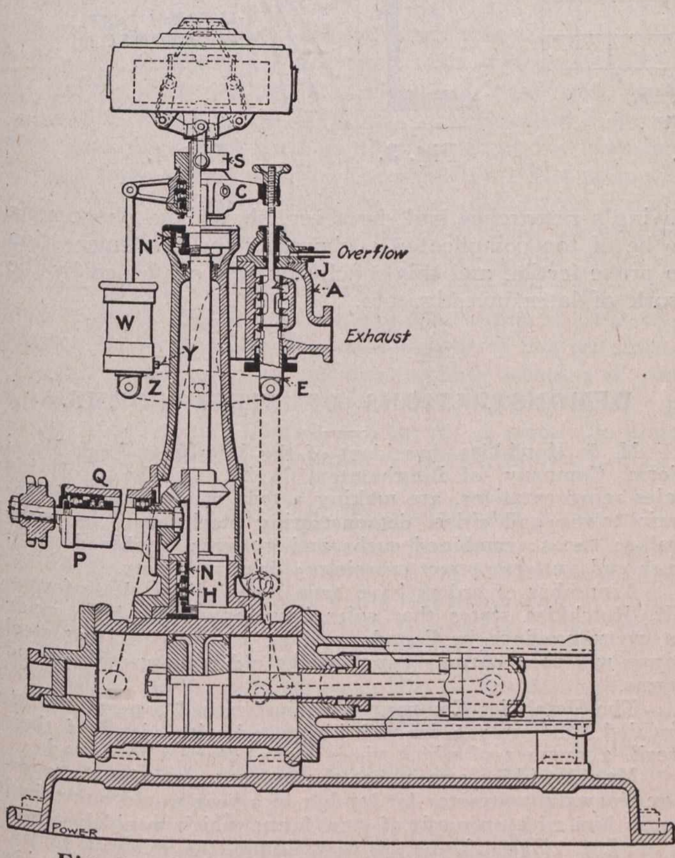


Fig. 1.—Sectional View of Hydraulic Governor.

select an oil suitable for the climate and the conditions under which it will be used. The viscosity of oil diminishes as the temperature rises, oils of high initial viscosity giving way more rapidly than oils of lower viscosity. An oil should be chosen which does not break down into vaseline after long use. Sometimes a really first-class oil, although it does not affect leather to any appreciable extent, is liable to affect packing-rings of the composition class, such as vulcanite or fibre, and its action on these is greater in hot climates. In cold climates a mixture of alcohol and glycerine can be used in place of oil to prevent risks of freezing.

THERMAL MEASUREMENT OF STRESS.

At one of his Cantor lectures before the London Society of Arts, Prof. E. G. Coker took up the subject of thermal methods of measuring stresses. He first dwelt briefly upon the history of the study since the discovery, by Magnus, that changes of stress were accompanied by slight changes of temperature. Then he gave a practical demonstration of a specimen, subjected to tensile stress, exhibiting a lowering of temperature, which was measured by a thermopile attached to a reflecting galvanometer. Of course, the experiment necessitated a careful protection of the specimen under examination from air currents, and flow of heat from surrounding objects. Such difficulties admit of easy control in a properly-equipped laboratory, and under proper working conditions. The illustrations are remarkably in evidence.

In discussing the phenomenon, Prof. Coker stated that the change in question was not to be confounded with the large and sudden rise of temperature observed when a specimen was stretched beyond its elastic limit, since within the elastic limit the stretching of a bar was accompanied by a fall, and not by a rise, of temperature. The theory of the matter had, he claimed, been worked out by Lord Kelvin, who deduced the following connection between the change of temperature and the change of stress:—

$$\Delta T = -\frac{T\alpha}{J s \rho} \cdot \Delta p.$$

In this formula ΔT denotes the change of temperature corresponding to the change of stress Δp. T is the absolute temperature of the specimen, α its coefficient of expansion by heat, J Joule's equivalent, s the specific heat of the material under constant pressure, and ρ its density.

In the case of steel this density may be taken as 7.5 and the specific heat as 0.11 at 20 deg. Cent., while α was 1.2×10^{-5}, so that we get:—

$$\Delta T = -0.000012\, p.$$

The order of the effect is better shown by the following table:—

Stress. Lb. per Sq. In.	Temperature Cent. Tension.	Compression.
0	20.0	20.0
5,000	19.94	20.06
10,000	19.88	20.12
15,000	19.82	20.18
20,000	19.76	20.24

Thus a change of stress from 0 to 20,000 lb. per sq. in. produces a change of temperature equal to only about ¼ deg. C.

It is assumed in the above formula that the specific heat of the material and its coefficient of expansion are independent of the stress. The former assumption has not been actually tested, but it is very unlikely that the specific heat is sensibly different in strained and unstrained material. That the coefficient of expansion is independent of the stress has, however, been proved in Prof. Coker's laboratory in the case both of mild steel and brass.

Joule was, according to Prof. Coker, the first to test the accuracy of Kelvin's law, which he proved to be true for a considerable number of materials, using thermoelectric couples inserted in holes drilled in the specimen. In the speaker's own experiments he had simply pressed a thermopile against the surface of the test-piece, insulating it by a layer of thin paper or a coat of insulating varnish. It was essential that the load should be applied to the specimen at a uniform rate, because the actual galvanometer readings had to be corrected for an inflow of heat by conduction and convection; and since these corrections were effected by means of "cooling" curves, it was necessary that the scale of time should be proportional to the scale of loads. A set of readings taken on a tension specimen were, the speaker continued, shown by the rising portion of the lower curve in Fig. 1. After the maximum stress was attained, the specimen was allowed to warm up, which gave the descending portion of the curve shown, and from this the rate of heat gain at any temperature could be deduced. It was assumed, for such small changes of temperature as were involved in experiments of this kind, that the rate of heat-flow was proportional to the temperature difference, and on this assumption it could be shown that the observed the stresses due to this warping of the web to those directly due to the bending moment, giving thus the results indicated in the figure. In an I-beam the web remained straight, and the thermal method gave results in exact accordance with ordinary extensometer observations.

Thermal methods of detecting changes of stress were, the speaker added, applicable to other materials as well as to metals. Excellent results had, for example, been obtained with a beam of slate. With cement and concrete, however, the results were discordant, unless the concrete was of an age measured by years rather than by months.

Since stressed and unstressed materials had different thermo-electric properties, it had been suggested that these might form a basis of stress measurements.

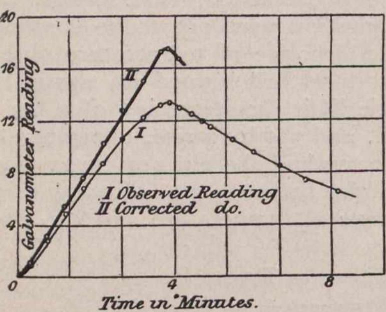


Fig. 1.

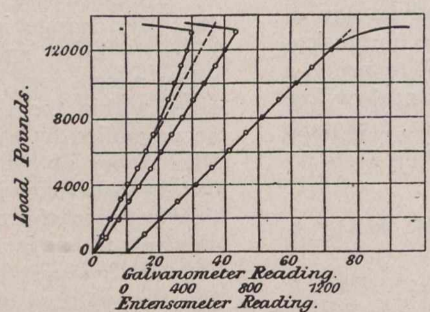


Fig. 2.

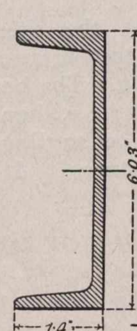


Fig. 3.

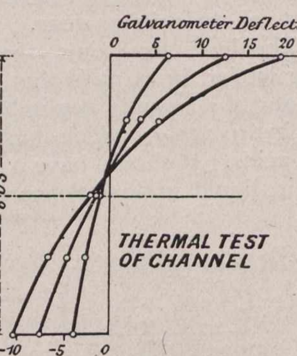


Fig. 4.

galvanometer readings should be multiplied by the factor ½ $c\ t\ D_t$, where D_t was the observed reading at the time t and c a constant deduced from the "cooling" curve. In this way the corrected curve shown by the upper curve in Fig. 1 was obtained, which corresponded, it would be seen, to a straight line law, the temperature rise being, therefore, proportional to the intensity of the stress.

It had at one time been thought that, by these thermal methods, an elastic limit could be detected below that observed in the ordinary methods of testing. The speaker had, however, found that this was not the case, the yield-point, as determined by mechanical means, coinciding with that indicated by the sudden heating of the bar. This was well illustrated in Fig. 2, where the two curves to the left were obtained thermally, and that to the right by an ordinary extensometer. When the yield-point of a bar was raised by stretching it beyond the elastic limit, the "thermal" yield-point was also raised to exactly the same extent.

Since a compression caused a rise of temperature, and a tension a fall of equal amount, thermal methods gave, he said, no indication of the existence of shearing stresses, since every shear could be replaced by a tension and a compression acting at right angles to each other. On the other hand, if a specimen were simultaneously subjected to two tensions at right angles to each other, the temperature change would be the sum of that due to each. Hence, if a channel, such as shown in Fig. 3, were subjected to bending, and an attempt were made to determine the stresses at different points by the thermal method, the results did not indicate the same linear distribution of stress as could be proved to exist by the extensometer. The curves yielded by the thermal method were, in fact, of the type represented in Fig. 4, and showed a marked departure from the straight-line law. This arose because a channel was not a symmetrical section, and when subjected to bending, the web also bent in a transverse plane. The thermal method added

Ewing's researches had, however, shown the phenomena to be of too complicated a character for this suggestion to prove fertile, and this conclusion was confirmed by the work of later investigators.

DEMONSTRATIONS OF STEEL FORMS.

M. S. Hotchkiss, president of the Hotchkiss Lock Metal Form Company, of Binghamton, N.Y., and three of his sales representatives, are making a tour of a number of Ontario towns and cities, demonstrating steel forms for sidewalks; curbs; combined curbs and gutters; combined walk, curb and gutters; street crossings; driveways; etc.

A number of orders have been received for these forms. Mr. Hotchkiss states that sales have previously been made in every province in Canada, and he is confident that steel forms will soon entirely supplant the old style wasteful wood forms.

The Hotchkiss Company have just issued a new catalog, entitled "Sidewalk Science," illustrated with views of their work, a number of which views were obtained in Canada.

Mr. Hotchkiss states that the amount spent by the average sidewalk contractor for lumber in a year would more than equip him with an outfit of steel forms which would last him a lifetime. These forms are very simple, the sidewalk forms, for instance, being composed of only two parts—the side rails and the templets, or dividing plates, which lock into the side rails. The side rails give perfect alignment and true surface, while the dividing plates provide an absolute cut and complete expansion. When put into position, they make a perfect form without the use of stakes or braces, and it is claimed that better work can be done with the steel forms than with the wooden forms, even when the construction with the steel forms is rushed at a much faster pace than is possible with wooden forms.

At the last meeting of the Lachine town council it was decided to see what could be done toward establishing better connections between Lachine and Dominion Park by writing to the Railway Commission with a view to building a tunnel on Sixth Avenue.

WATER SOFTENING BY MEANS OF PERMUTIT.

THE use of an artificial zeolite, known as permutit, for the purpose of softening water has recently undergone a two years' test in the boiler house of the government laboratories at Moscow. The advantage of the new process is that it requires only one filtering operation.

When hard water is slowly filtered through a layer of permutit, the lime and magnesia replace the soda in the substance; the soda passes into solution, so that an alkaline water flows off, while the lime and magnesia are retained by the permutit. When the permutit has become exhausted, it is regenerated by letting a solution of common salt enter through the layer from below; this time the chlorides of calcium and magnesium pass into solution, and the soda is retained by the permutit. The questions are: Can this exchange go on indefinitely and can the filtration be entrusted to a laborer, or does it require constant control by a chemist?

In the Moscow experiments, as described in "Engineering," two tubular boilers had in 1908 and 1909 been fed with water from an artesian well, the water not being treated in any way. A litre of water left 465 milligrammes of residue (88 mg. being CaO, 58 MgO, 131 CO_3, 7.4 Cl, and 0.4 mg. Fe); the total hardness was 16.9, and the temporary hardness 5. So much scale was deposited in the boilers that two permutit filters of cast iron, each charged with 230 kg. of permutit, were installed in January, 1910; they were used on alternate days, for filtration one day and for regeneration the next day. The permutit supplied was of coarse grain, the lumps being from 2 mm. to 5 mm. in diameter, and of the high water percentage of 55. The exchangeability percentage of the Moscow permutit was low, 1.35, as compared with the 2 per cent. now attained; this figure indicates the weight of CoO, expressed in per cent. of the total weight of the permutit, which is taken up from calcium-sulphate solution of 100 degrees of hardness. The rate of filtering was slow, 1.5 m. per hour. After filtering 8.6 cu. m. of water the filter was regenerated with a solution of salt containing 2.5 kg. of salt per cu. m. of soft water.

It had been noticed in the preliminary experiments that the filtered water had certain peculiarities, and when the filtering was prolonged beyond the exhaustion of the permutit, the filtered water contained increasing amounts of magnesia, and remained free from lime. Only when 62 mg. of MgO were found, did lime begin to appear in the filtered water. The investigation of this point showed that equivalent amounts of bases did not replace the same amount of soda in the permutit, but that the amount replaced increased. The permutit hence became sooner exhausted with regard to magnesia than with respect to lime, and as the water in question was comparatively rich in magnesia, considerable quantities of magnesia appeared in the filtrate before any calcium oxide passed through the filter. In calculating the amount of permutit required for softening water of a certain hardness, the lime hardness should hence be distinguished from the magnesia hardness.

When the filter was used for too long a period the filtered water contained magnesia, which would render it hard. This magnesia, however, proved harmless so far as scale formation was concerned. It made the water turbid; but the alkaline water cleared by settling, and the mud deposited was soft and could easily be removed from the boiler by a jet of water after six weeks' working; and no hard incrustation was found when the experiments were finally interrupted after two years of working. Thus it would appear that magnesium oxide (or rather hydroxide) did not create boiler scale, and that the control of the process is much more simple than might have been thought.

The records of the boiler performance demonstrated that the evaporation figure had been improved by 4 per cent. by the permutit treatment, although a poorer coal was being burnt in 1911 than before, evidently because the boiler-plates were now free of scale. The saving thereby effected was sufficient to justify the estimate that the softening plant would pay for itself in five years, provided that the permutit continued to do its duty. Careful observations showed that after two years the permutit operated as well as on starting and on weighing and analyzing the material a loss of only 3 per cent. was found. Thus permutit may be used for purifying water containing iron. The brass fittings on the boiler did not suffer from the permutit water, provided the boilers were blown off every day to prevent concentration of the soda in the water. This, however, does not prove that really high pressures and high superheating might not lead to corrosion in boilers fed with permutit-filtered water.

The investigations show that permutit softening cannot always be recommended. Sometimes the soda-lime treatment would be preferable. Water which runs turbid through a sand filter and is slimy is better treated with lime; as are also waters of very great hardness, or merely of high temporary hardness (rich in bicarbonates), for which the old softening would be cheaper. Where the price of salt is very high, the generation of the permutit may become too expensive. Little is to be gained by the sometimes advocated combination of the two processes, which would require an expensive plant and call for constant supervision by a competent chemist.

In connection with the Moscow tests, Mr. F. W. Hodson, M.Inst.C.E., of London, writes:

It is the common experience of all engineers who have been responsible for the adoption of softening plants with lime or lime-and-soda treatment, either for town or industrial purposes, that with most waters the performance of the softening plant, whatever its type, is not as perfect in practice as in theory, and that an after deposit occurs in the pipes and tanks through which the water passes after treatment. The effect of this may vary in importance from a considerable reduction in the diameter of a town's water-mains to a negligible accumulation of soft sludge in a boiler; but even in an industrial works it frequently leads to trouble and expense in connection with the stoppages of feed-pipes, valves, and economizers, and in numbers of cases has led to the abandonment of the softening plant installed.

Permutit apparently seems to offer a solution of this difficulty, for I have now had for several months comparative samples from a lime-soda softener plant before and after the water was passed through a sodium permutit filter. The former have varying amounts of deposit, the latter are perfectly clear. There are now three methods of using permutit:

1. By softening the water to zero with sodium permutit, and regenerating with common salt as described in the Moscow experiments.

2. By first softening the water with lime and finishing with sodium permutit in a smaller filter, and regenerating with a correspondingly reduced quantity of salt, owing to the prior removal of a portion of hardness.

3. By softening with lime and filtering through calcium permutit, and regenerating by washing back with raw water, thus saving all cost of salt. Calcium permutit has the remarkable property of being able to absorb free

caustic alkali, and of giving it up to water containing bicarbonates, and thus acts, within limits, as an automatic chemical regulator on the lime-softening operations, but without materially modifying the hardness of the water with which it is supplied. By acting also as a mechanical filter, it takes out the carbonate of lime remaining in suspension from the softening tank.

The practical questions which arise are in what cases, and with what class, of waters, are the lime and soda process, or the permutit process with its modifications, most suitable for use, and what are the relative costs of working in pence per 1,000 gallons treated.

For industrial purposes, in some cases considerations of space occupied by the plant would have a considerable influence in modifying the choice, and for the same quantity of the same water the sodium-permutit zero plant would apparently occupy much less area than the tanks and apparatus of a lime-soda plant. The choice may be further modified by the final composition of the water in respect of the purposes to which it is to be put, as a considerable difference can be made by adopting the sodium-permutit zero plant, in which all the calcium and magnesium salts are replaced by soda, or by adopting the lime process first, in which case only the permanent hardness is replaced by soda, and practical experience in the difference in composition of the resulting treated water would be of great value if any comparative results from combined lime-soda and permutit plants are available in this country.

The conclusion arrived at by Bahrdt, that little is to be gained by the combination of the two processes seems to require modification from this point of view, and it is also difficult to see why the combination should require the constant supervision of a chemist to any greater extent than lime-soda plant always does, as the permutit filter would tend to take care of the errors made in the lime-soda plant.

It also appears from Bahrdt's experiments that, as in the lime-soda process, magnesia is more difficult to remove than lime. In the older process the time element appears to have great influence in the result, and it may be that in the zeolite process the depth of the permutit, as influencing the length of time the permutit is in contact with the magnesia, may have a bearing on the results found.

PUNCHED HOLES IN STRUCTURAL STEEL.

IN "Le Genie Civil," C. Birault, chief of the department of testing materials of l'Ecole Centrale, Paris, discusses the effect on the elastic limit and tensile strength of drilled and punched holes in mild steel, such as is usually employed in building construction. He claims to have established that the resistence to rupture of solid bars, and perforated bars of the same metal, is not proportional to the section of the bars, making proper allowance for the perforations. Section for section, the advantage is in favor of the perforated bars if the holes have been drilled. The holes weaken the steel much less than would be expected, provided care is taken in drilling the holes, and in reaming them after they have been punched; and the elastic limit and the resistance to breaking are higher than before drilling.

Three bars were cut from one piece of steel. One bar was pulled in its original condition; the second bar was perforated with two drilled holes located on the small axis of the bar, and the third bar was perforated similarly, except that the holes were punched. The holes in each case were of 15 mm. diameter, and spaced three diameters from centre to centre. Several series of tests were made. The writer refers to a set of 3 bars from the same steel, the fractured ends placed in contact. The plain bar elongated more than the other two, since the molecular fatigue was less than in the perforated bars. The bar with the drilled holes (the middle one) elongated further than the one with the punched holes, and the holes were decidedly oval, which was not true of the punched holes. Comparison of the two perforated bars showed how the drilling or punching modified the properties of resistance. The fracture of the punched bar was not along the diameter of the holes, probably due to fissures in the metal caused by the action of the punch. The bar with drilled holes parted on their centre line. The numerical results also supported the evidence in favor of drilled holes. The results of three sets of tests were as follows:—

	Elastic. Limit, Kg.	Tensile. Strength, Kg.
Set from first bar—		
Plain bar	24.4	39.2
Bar with drilled holes	31.4	43.5
Bar with punched holes	33.4	37.6
Set from second bar—		
Plain bar	23.4	37.9
Bar with drilled holes	29.3	43.3
Bar with punched holes	31.3	36.5
Set from third bar—		
Plain bar	25.7	46.1
Bar with drilled holes	29.4	49.4
Bar with punched holes	34.4	34.8

It will be noted that the elastic limit is higher for the bars having perforations than for the plain bars, with an increase for the punched holes over the drilled; while in tensile strength there is an increase for the bar with drilled holes, over the plain bars, the bars with punched holes losing decidedly in strength as compared with the plain. Averaging the results in terms of percentage, the bars with drilled holes have 12.3 per cent. greater average elastic limit, and 9.2 per cent. greater average tensile strength than plain bars of the same steel; while the punched bars show an average increase of 13.5 per cent. in elastic limit and an average decrease of 8 per cent. in tensile strength, as compared with plain bars of the same steel.

The author finds upon bringing into contact the fractured ends of the plain bar, that the two parts are not complementary; that there is a hollow space near the centre where the metal has evidently drawn away first, the break then proceeding gradually to the two sides. If, however, the metal is perforated with smooth drilled holes, not having fissures as in punched ones, this tendency of the metal to separate and weaken is removed, and the mean resistance to rupture is more uniform.

These tests show that insistence cannot be too strong on the practical importance of reaming punched holes in mild steel, a practice too often neglected for economical reasons.

A report of activities at Moncton, N.B., for the month of June states work is progressing on the diverting branch from Nelson to Derby Junction on the Intercolonial Railway. On the Canada Eastern branch of the Intercolonial Railway twenty-three miles of 80-lb. rails are to be laid; and about 40 miles of track reballasted. The new brick station at Bathurst was completed, and the brick and stone station at Sussex nearly finished. Also the block signal system is being installed on the double track between Moncton and Parrisee, and from St. John to Hampton.

AN INVESTIGATION OF COARSE AGGREGATES FOR CONCRETE.

In an endeavor to develop some useful form of test for the coarse aggregates in concrete a method worthy of careful investigation and further development was described recently by Mr. Cloyd M. Chapman before the American Society for Testing Materials at its convention, June 30th to July 3rd, 1914, in Atlantic City, N.J. The method was used in the laboratories of Westinghouse, Church, Kerr & Company, New York, and consists essentially in determining the compressive strength of a specimen made up of a skeleton structure of the material under investigation. The interstices of the structure are filled with a standardized neat cement or a cement-sand grout in a sufficiently fluid state to flow into and fill all the voids. Before the grout is poured in the pieces of stone are in close contact with one another, the grout acting as a binder, holds the cement in place and prevents slipping of one upon another during the test. Mr. Chapman, who devised the method, submits that the com-

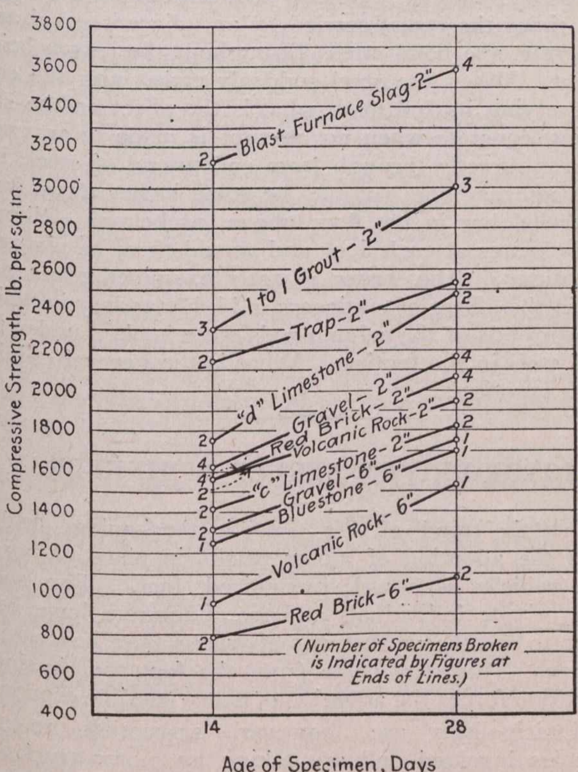


Fig. 1.—Compressive Strength of 1:2:5 Concrete in the Form of 2-in. Cubes and 6-in. Cylinders.

pressive strength is a function of many variables in any case, but observes that it is probably of a less number in a specimen made up in this manner than in one in which the stone and grout are mixed together to make the concrete before being placed in the mold.

The details of manipulation are described by Mr. Chapman as follows: The molds used are 6-in. cylinders, 6 in. high, and 2-in. cubes. The size of stone used is ¾ to 1¼ in. (averaging about 1 in.) for the 6-in. specimens, and ¼ to ½ in. for the 2-in. specimens. Sufficient stone to fill the mold is soaked in water for 24 hours to saturate it so that water will not be absorbed from the grout.

Sufficient grout is made up of a mixture of equal parts by weight of Portland cement and a good grade of sand, screened through a 20-mesh sieve, with about 35 per cent. of water added, for the 6-in. cylinder specimens, and of neat cement with about 45 per cent. of water added for the 2-in. cubes.

The wet stones are mixed in with the grout until they are thoroughly coated. The mixed stone and grout are poured on a ¼-in. sieve and the surplus grout allowed to drain off. The stones, coated with grout, are placed in the mold and are packed down well, shaken while being put in place, so that they are in close contact with one another.

The remainder of the grout is well stirred up and poured into the mold near one side, jarring the mold continually so that all the voids between stones will be filled. The top of the specimen is finished smooth by adding grout and by slight troweling after the cement has begun to harden a little.

The 6-in. specimens are stored in a damp closet until broken at the ages of 14 and 28 days, while the 2-in. cubes are stored in water. The specimens are faced with a thin layer of plaster of Paris a few hours before crushing.

Fig. 1 shows graphically the results of the tests. It will be noted that several stones tested ranged over wide limits. The points plotted represent averages of from one to four specimens.

Other tests of a similar nature are under way at the present time, the primary object being to acquire a most suitable method, to be used as a standard for testing these materials.

CONSIDERATIONS AFFECTING THE DESIGN OF REINFORCED CONCRETE COLUMNS.

Several considerations affecting the design of reinforced concrete columns were presented by Mr. Ernest McCullough at a meeting of the Western Society of Civil Engineers in February last. His chief object in so doing lay in the hope of creating a discussion that would bring out some new data on the subject. The existing literature pertaining to the design of reinforced concrete columns was summed up by the author, whereupon he presented the following questions and opinions:

(1) What is the cross-sectional area of a reinforced concrete column? Commercial designers, almost to a man, use the cross-sectional area of the column complete. Others omit a skin ½ in. thick over the entire surface, but place the steel at least three times that distance from the surface, for fire protection. Others count none of the concrete as effective that is not enclosed within the upright reinforcement. Some building ordinances are so worded that any one of these assumptions may be used.

(2) What is the maximum compressive stress advisable on a column? Experiments have shown that no evidence of flexure appears in columns having a diameter less than one-twentieth the length, but neglect to say whether the diameter is gross or net. Few ordinances permit a reinforced concrete column to be erected with a length exceeding twelve times the diameter, again omitting to state whether the gross or net diameter is meant. Granting that no bending occurs, what should be the maximum stress? Commercial designers almost to a man use 750 lbs. per square inch on the gross section.

(3) Should the vertically reinforced column be used? American experiments seemed to indicate in one or two instances that horizontal ties around vertical rods were of no greater value to prevent buckling than the tensional strength of the concrete. American practice in the design of such columns proceeds upon the theory that such ties are for the sole purpose of assisting in prevent-

ing buckling of the reinforcement. If the Joint Committee Report is correctly read such ties are not required for any other purpose than to hold the steel in place during construction.

European experience and experiments indicate that while such ties have a value to prevent buckling of the steel, a distinct gain is made in strength by their use which is contrary to the general belief in America. The French Commission found that the spacing of these ties and the size of the wire affected the ultimate resistance of the concrete so materially that a formula was prepared into which a letter representing the volume of steel in ties was introduced. The Royal Institution of British Architects adopted rules based on those of the French Commission. A development of the formula gradually leads to the Considère formula for hooped columns, wherein the strength of the column is based on the fact that steel placed spirally as a hooping is 2.4 times as effective as the same volume of steel placed vertically.

The concrete column with vertical reinforcement, with ties only, is at present under suspicion and a free discussion of its value is invited. If it should disappear, then the sooner we know this the better. There are thousands in use over the country designed with a stress of 750 lbs. per square inch over the gross horizontal section, and with small ties intended to serve no other purpose than to act as stiffeners to prevent the vertical steel from buckling.

(4) Hooped columns should have the amount of steel limited and where should the limit be set? To Considère is given the credit for developing this column and he advised the use of mild steel for hooping. Professor Withey, of the University of Wisconsin, found that the elastic limit of the steel hooping was reached about the time the concrete was stressed to its ultimate strength, so he advised the use of steel having a high yield point. This seems logical, since the only reason for hooping is that it adds to the ultimate strength of the concrete.

(5) Are hooped columns dangerous from the standpoint of fire risk, when their strength depends upon the hooping?

(6) Are the present methods of fixing the pitch of the hooping adequate? The writer proposes a pitch of one-sixth the core diameter for columns having cores less than 18 ins. in diameter; one-eighth the core diameter for columns having cores from 18 to 24 ins. in diameter; one-tenth the core diameter for columns having cores more than 24 ins. in diameter; provided that the pitch shall in no case exceed 3 ins.

(7) The writer has seldom seen a design of a reinforced concrete building in which the effect of wind on the structure seemed to have been considered. Is this typical of reinforced concrete buildings and why?

(8) Some building ordinances state that unbalanced moments carried to columns must be provided for. How often is this done? The writer has not known of its being done, but there may be a few high-minded designers who do look out for this point. The writer proposes the following clause for all city ordinances: "For unbalanced moments carried into columns there shall be added to the load, for which the column is to be designed due to dead and live loads, the following percentages: To the columns supporting the roof, 30 per cent.; to the next lower tier, 25 per cent.; with a progressive reduction of 5 per cent. on each floor to 10 per cent. of the total load, which 10 per cent. shall be added on each floor thereafter to the first. This load shall not be counted in designing footings and shall be in addition to wind load. In addition to this increment wall columns to be designed for full live loads."

On this point of unbalanced moments, American text books are singularly silent.

(9) How should columns be carried up through buildings? It is convenient to have the steel rods one story in length and to place stubs at the floor levels for the purpose of delivering stress to the next section. Of what value are these stubs and how far should they extend above and below the floor level? Some engineers consider these stubs as nothing more than vertical pins, assisting to a slight degree perhaps in case of heavy winds. Other engineers proportion them on the assumption that the stress travels through the concrete to them from the steel on the floor above to that in the floor below. Has this assumption any basis in fact?

(10) Is it right to place the vertical steel in the concrete without providing plates at the lower end and caps over the upper end to distribute the load over a larger area of concrete than is provided by the end of the steel? The steel is assumed to be carrying throughout its length fifteen times the stress carried by an adjacent equal area of concrete, the bond stress throughout the length being constant. When the steel suddenly ends, with the concrete carrying its full load, what is the effect on the surrounding concrete when no attempt is made to transmit the stress directly through from end to end of steel, but on the contrary one bar may be some inches away from the parallel bar in the floor above, or below? Should there be plates at each floor and should there be plates in the footings? The writer recently examined plans prepared in the offices of engineers in high standing in which the lower ends of the column rods were hooked under the mat of steel in the footing. What is the general opinion of such practice?

MOTOR-DRIVEN STREET SPRINKLERS

That the trend of the times in the haulage field is toward the adoption of motor trucks in place of horse-drawn vehicles is a well recognized fact. For some reason private individuals and manufacturers have been quicker to see the advantages of trucks than have municipalities. This may come from the fact that business competition forces the adoption of every possible economy.

Municipalities are, however, susceptible to the economies involved and are taking up motor trucks in various departments, such as the collection of garbage and fire department.

The Tiffin Wagon Company, Tiffin, Ohio, have opened up a new field in the use of trucks by cities. They have brought out a new motor street sprinkler, and this will probably be followed by other motor-driven street cleaning equipment.

For this new vehicle they state that it distributes the water more evenly upon a street, that it covers practically twice the territory for each filling, and that it will cover three times the territory of the horse sprinkler in each working day.

It would seem within the province of all municipalities to encourage the use of motor vehicles in every possible way—both in their own service and at large. This is urgent. Sanitation demands that the horse be eventually dispensed with on public thoroughfares. Because of the capabilities of motor vehicles to negotiate better in crowded traffic, congestion, which is coming to be a serious problem in large cities, is to an extent relieved.

Editorial

ENGINEERS AND THEIR EMPLOYERS.

Canadian engineers, with the exception of a few, have much to learn in the art of arousing public interest in their work. Generally speaking, they do not appear to realize the value to themselves of a closer union with the public. This is so unfortunately true as to be detrimental to the value of their work when it is compared with activity in other walks of life, and it hinders an otherwise healthy development, in no small sense.

In some of the great undertakings of the country, the irrigation of vast tracts of land, the generation of electrical energy from natural water powers, the penetration of mountain ranges by our transcontinental lines, and even the bridges, buildings and canals under construction at the present time—their greatness is known to everyone, but not generally as the product of engineering. The part which the engineer plays in such undertakings is popularized in ways that are most elementary.

A study of industrial economics vindicates the prevalent impression that publicity is an important part of business, in that it provides the shortest route to the establishment of closer association between the producer and consumer, with the manufactured product as the medium.

In the case of the engineer there are a thousand and one problems confronting the public to which his services might well and satisfactorily be applied. There is no prejudice in the one against the other, but there is not that union which the exigencies of the case at hand frequently demand.

How much truth there is in the statement made a short time ago by a prominent engineer that the Canadian engineer's most powerful asset at the present time is a good business training! Undoubtedly the work of the engineer can scarcely be considered successful unless it is remunerative in some way. It is to render possible the transportation of a greater volume of traffic in a shorter time and under safer conditions, or, as in the case of water supply and sewerage schemes, it is to confer health and years of life upon many who otherwise would have their efficiency reduced by ill health or their lives prematurely terminated. In any case, the schemes with which the engineer has to do are schemes the main object of which is to facilitate business. In order that there may not be a misunderstanding that will produce unlooked-for and unfortunate results the engineer must be a man who can see things through the eyes of his employers so that the views of both may not divert one from another. This makes most desirable a closer intercourse between engineers and commercial men. The benefit to the engineer lies in his being better able to appreciate the scale of values that prevail in commerce and finance and at the same time to adapt his arguments in favor of a high efficiency to the point of view of the capitalist who does not always appreciate that the most expensive method may be the cheapest in the end. One sometimes encounters an opinion in the financial world that engineers are all right, providing the purse strings are held by someone else, that they are not to be trusted to do what they like, but must be kept under control by commercial men. In this respect the president of the Institution of Civil Engineers of Great Britain is quoted in "Engineering" of some months ago as having told a tale in one of his addresses of a great man in the financial world who said that of all the ways of wasting money the worst was giving it to engineers to spend.

Such an unfavorable feeling as this is not the result of a belief that the engineer has less ability than the financier, but that his education has not been sufficiently directed to the economic side of the questions which are presented to him.

COST OF STEEL MAKING IN THE ELECTRIC FURNACE.

According to Bulletin No. 67 of the United States Bureau of Mines, the cost of power for making steel in the electric furnace does not enter so largely into the final cost as it does in some other electrometal processes, especially the refining of molten steel. Plants are operating successfully under a power cost of 1 cent per kw.-hour in localities where material can be obtained at the price common to other processes. Plants such as the one at Ugine, France, have been established in remote localities, where the cost of power is but 0.2 cent per kw.-hour, but the cost of material is high.

For many years all high-grade steels were manufactured by the crucible process, but since the advent of the electric furnace there has been a gradual adoption of that furnace for refining steel. For the complete refining of the highest grades of steel the use of the electric furnace is now thoroughly established in Europe. Any product that can be made by the crucible process can be made by the electric furnace, and in most cases with cheaper raw materials and at a lower cost. In the electric furnace complex alloy steels can be made with precision. The high temperatures attainable facilitate the reactions and alloys need not be used so largely for the purpose of removing gas. Very low carbon steels can be kept fluid at the high temperatures. Steels free from impurities and of great value for electrical apparatus can be made. With the electric furnace large castings can be made from one furnace, whereas in the crucible process steel from several crucibles must be used. For small castings, which require a very high grade metal free from slags and oxides, electrically refined steel is especially adapted. The electric furnace gives a metal of low or high carbon content as desired, hot enough to pour into thin molds and still free from slags and gases.

There is now a tendency among consumers of rail and structural steel to require a higher-grade steel at an increased price rather than steel at a lower price. With the high cost of power that now prevails throughout the steel centres of the United States, the electric furnace can not compete profitably with either the acid Bessemer or the basic open-hearth process in manufacturing steel of like grade from pig iron. It is in combination with either of these processes that the electric furnace seems destined to be prominent in steel manufacture. The cost of super-refining in the electric furnace the molten steel from either of these processes, exclusive of the cost of the molten steel, varies from $1.50 to $2.25 per ton, depending on the cost of power and the impurities to be removed.

EXAMINATION OF CONCRETE FAILURES FOR THEIR DETERMINING CAUSES.*

By R. S. Greenman.

CONCRETE is said to be its own best inspector, and it is a well-known fact that defects in concrete will sooner or later make their presence known. For every fault there must be a reason. The reasons for poor concrete have been proportioned as being 90 per cent. due to poor workmanship, 8 per cent. due to poor aggregates, and 2 per cent. to poor cement. These percentages are not the result of tabulations, but are those prevailing in the minds of many who have had considerable opportunity for inspection of concrete, both good and bad. But whether or not these percentages are correct, the statement raises the question, "What are the reasons for poor concrete and how do we determine these reasons?" It is a certainty that neither a laboratory test nor a field inspection alone will give them, unless, of course, it be a simple failure. Yet there are people who will examine a piece of concrete in the laboratory and offer a solution of the problem simply by tests made there. And again, an inspector will look over a piece of concrete construction and with no knowledge whatever of the characteristics of the materials used, nor of the method of making, will attempt to tell how such and such a condition developed. Concrete failures can only be explained after thorough investigation by men who know good or bad concrete from long and close acquaintance, and whose minds are of an analytical and judicial temperament.

The more one sees of concrete the more one becomes convinced that it is the most abused structural material being used. The science of making concrete has been looked upon too generally as being very easily learned, with the natural result that a great deal of poor concrete has been made. Now, however, builders, contractors and engineers apparently desire to make concrete that will meet the standard in quality required of other materials, and yet, with all the precautions now being taken, there is still a large amount of concrete that is not satisfactory. The larger the work the greater the care taken; and, vice versâ, the smaller the work the greater the carelessness and the greater is the ratio of the failures, and it is the sum total of these failures that makes the loss caused by poor concrete so great.

In trying to solve a problem of poor concrete the elements to be investigated are the three already mentioned —cement, aggregates and workmanship—and water. The common tendency is to first place the blame upon the cement, but if we find that in accordance with good and generally common practice, the cement has been tested and has met the standard requirements, the cement then becomes a negligible factor; but if it has not been tested, it must be considered as a possible cause, and it may become a large item in the study. We must admit that since so much stress has been laid upon the value of having cement tested before use, and since it must indeed be a small work where it has not been so tested, the percentage of failures due to poor cement has been reduced to a very small amount.

If the next element has been given equally as thoughtful consideration previous to its use, there could not be so much poor concrete due to poor aggregates. The strong and weak points in both the coarse and fine aggregates have been too often neglected. The coarse aggregates can usually be judged by easy inspections, but sand or other fine aggregates need very careful examination. Its characteristics—such as the grain, the grading, the cleanness, and its freedom from organic impurities and excess of loam—are items of knowledge which are obtainable mainly in the laboratory, but which are very essential for the correct diagnosis of a concrete failure.

The effect of workmanship is by far the largest factor, and in it all others are included, for a poor workman can destroy the value of the best materials. Under the head of workmanship must be considered such items as design, proportions, placing, and actions resulting from heat, frost, electrolysis, etc., which should have been taken care of during the process of making, hardening and preservation.

As another element of importance, it must always be kept in mind that the water used in making the concrete, or which may come in contact with it, may prove to be a very influential factor for harmful results.

Then, if one is given a concrete failure to diagnose one must look for a reason under cement, aggregate, workmanship and water. As stated, the easiest explanation is to look for some fault in the cement, but is, as has been suggested, the cement had passed the usual tests, then other reasons must be found. To find them requires that the investigator shall first know conditions and causes of failures, but these will not be further discussed except to point out the way to the reason; then the investigator must attack the problem with an open mind—that is, he must not jump at a conclusion and expect to be able to work out an explanation around that conclusion. Then it is even more essential that the investigator shall have had an opportunity to learn of results of tests, or to make tests that will enable him to judge the probable actions from the characteristics of the aggregates. Also, a very careful examination of the concrete in place is generally an absolute necessity.

To attempt to outline a plan for procedure in this examination would be folly, since each individual case has conditions that are decidedly its own, and the law of probabilities makes possible many combinations of causes which can only be worked out as one would solve any involved research problem. Clues must be sought, and a sharp eye, a quick ear, and a questioning tongue must be alert to grasp a clue and pursue it to a definite ending. If any one should be skeptical of the efficiency of this method, it is possible that a few illustrative cases, selected from a large number of diagnoses, may convince that one that the method has proven and can prove successful, far more than is generally expected.

Failure Due to Water.—A highway was being built and the plans called for several new concrete culverts. All but one of these culverts "set up," or hardened nicely. This one did not, and yet the same cement, sand and stone had been used as in all the other culverts. A reason for the failure of the one culvert was desired.

It was found that the brook which flowed through this particular culvert passed in its course the plant of a company engaged in the manufacture of medicine from herbs. The refuse from the plant so loaded the water with organic matter that it prevented a proper hardening of the concrete. No one connected with the construction of the culvert knew that water so contaminated would have that effect, and the complaint came in that the cement was not acting properly. The brook was temporarily diverted, other water was used and the concrete acted normally. A condition had existed there which would not have existed in city water, but which is found fre-

*Abstract of paper read before the American Society for Testing Materials, June 30-July 3, 1914.

quently in the country, especially in wooded sections. To detect the cause one had to know that certain elements, such as tannic acid, alkali salts, etc., foreign to most waters, do affect concrete.

Failure Due to Sand.—For an illustration of the effect of a poor quality of sand, consider the following case:

A cry of alarm came in from an engineer that the concrete in an important bridge abutment had been in place for over two weeks, and that in attempting to remove the forms it was found that the concrete was still so soft that it could be cut out with a knife. A brand of cement new to the work had been used, and the blame was, of course, placed on it. An examination showed that a footing for the abutment had been made of the brand of cement first used on the work and that, although ten days older, the concrete could easily be cut with a knife. The evidence eliminated the cement.

Examination of the sand showed it to be a well-graded, sharp sand, but a clue was furnished by some yellow-coated grains. The investigator had already had considerable experience with similar sand grains. A trip to the sand bank showed just what he expected to find. The bank had not been stripped of a top layer of yellow-coated sand, which gives a sand with which it is mixed a tendency to very materially delay the hardening of the concrete in which it is used. In time, usually several months, the concrete will harden and there is ultimately no harmful effect apparent. Lack of knowledge of this peculiar quality has caused an investigator of another piece of work to tear it out and rebuild.

Failure Due to Stone.—A very unusual condition existed in another case, but it emphasizes strongly the need of following clues. A concrete wall was apparently disintegrating due, as the engineers believed, to free lime in the cement. In various places on the face of this wall there appeared what can best be described as "blisters." By prying off these blisters there were produced small cones about 6 in. in diameter and 3 in. in height and in the apex of each could be seen a small, yellowish-white spot about the size of a small marble. The trouble was clearly not a case of free lime in the cement. One unusually large blister enabled the author to dig out from the apex a soft stone about 1½ in. in size. This stone did indicate the presence of free lime, and after a few weeks on the author's desk slaked into a powder. Examination of the stone composing the coarse aggregate soon brought out the following:

The crushed stone all came from the same quarry, but some came by a steam railroad and some by an electric railway. No concrete made by the former showed blisters. Concrete made from stone delivered by trolley did, but why? It seems that in the course of transportation by the trolley route, the stone was conveyed in waste dump-cars, across the grounds of the company owning the quarry and conducting a plant in which limestone is an essential raw material. These dump-cars had not been cleaned carefully, and to the good stone were added some small quantities of stone that had been through a chemical process and were on the verge of disintegration. In the concrete their expansive force blistered the face. By forbidding further deliveries by trolley the trouble was stopped.

These may be considered extraordinary cases, but it is the out-of-the-ordinary that makes trouble; if they were not the extraordinary they would probably have been guarded against. They are, at least, typical of points for which one must look if one would explain failures in concrete.

Failure Due to Workmanship.—Failures due to poor workmanship are seen so often that instead of citing particular cases it will be sufficient to briefly note some causes or results.

Failures from faulty design are shown in the mode of failure. The lack of proper proportioning may be clearly seen in a fractured surface; the grading of the aggregates is also similarly noted; and poor mixing and improperly placed concrete readily show themselves. All these are evident to an eye trained to know good or bad concrete. The failure to take care of laitance is made apparent by the seams that are bound to result from such a failure.

A concrete may be dense but not sound and hard, and "sounding" with a hammer will show up this characteristic. Too wet a mixture with fine sand or silt, or a crusher dust used as fine aggregate, may be a cause. It may be sound and hard and yet may be poor for certain uses because it is too porous. By scratching the face of unbroken concrete with a dull instrument, one may sometimes judge of proportions used and, in its early stage, can also judge somewhat as to the rate of hardening. A pocket glass in the field and a microscope in the laboratory help materially in determining the density, and in approximately the ratio of cement and fine aggregate to the coarse aggregates. The naked eye is all that is needed to observe concrete spoiled by sweepings of sawdust, shavings or blocks, or by waste carelessly dropped into a form. Lack of protection to fresh concrete from the sun or unusual heat may be noted by a "dried-out" and rapidly dusting surface, and from frost by a flaked and scaly surface.

Influence of External Forces.—Where concrete has apparently been good for a considerable period and has then begun to disintegrate, the reason for the failure must be sought in the character of the disintegration, whether it may be due to changes in the elements making up the concrete or to some external elements or forces that have entered into it. If due to an internal influence alone the fact will be noticed by the granular breaking up on the concrete. If due to an external force, such forces as sea water, alkali salts or electrolysis will be under suspicion as being responsible if the concrete has been under the influence of any of them. For many years all the failures of concrete were considered as being due to the formation of certain chemical relations; but as it is commonly acknowledged at present that an impermeable concrete will stand in sea water as well as elsewhere, although subjected frequently to more severe actions than other concrete, its failures are due frequently to the same causes as those of other concrete and therefore the same examinations should give the same results. Similarly, since electrolysis is considered as a cause for the breaking down of concrete, the liability of concrete being affected by its influence will depend upon whether the concrete comes under the influence of an electric current. If it does, then its influence needs to be examined. If it does not, then the examination should also follow the usual method.

The value of laboratory tests and analyses should not be overlooked. While perhaps not giving as definite information as a field inspection, they should be used to the fullest extent to help establish the strength or weakness of a reasonable theory for the cause of failure. Where time will permit, laboratory tests of concrete made of the aggregates under as nearly as possible the same conditions, will give results that should aid in determining the fault in the original. Test specimens so made and treated should give practically the same results, and when compared with test specimens made under ideal conditions or with standard materials, should give the investigator the reasons for the failure.

All means possible should be used by an investigator in making his examination, and his conclusions must be drawn only after he has considered the failure from every probable cause with reason and fairness. The object of the examination is either to place responsibility or to guard against future failures, and right conclusions are the only ones that should be drawn if justice to either objective is to be given.

Coast to Coast

London, Ont.—Six miles are to be added to London's paved street area this year, bringing the total up to 15 miles out of a total of 136 miles of streets.

Galt, Ont.—The installation of the 18-inch water main, the largest contract ever undertaken by the waterworks department of Galt, has been completed.

Sarnia, Ont.—It is rumored at Sarnia that a company of men, mostly of Sarnia and Petrolea, will commence very shortly drilling for gas on the Indian reserve close to Sarnia.

Hull, Que.—A loan of $50,000 to Hull has been received from the provincial bank; and the city is commencing at once to carry out certain local improvements, principally to roads and sidewalks.

Calgary, Alta.—Difficulty is still being experienced at Calgary in the matter of effecting an agreement between the city and Mr. Eugene Coste regarding the supply of natural gas to Calgary.

Irma, Alta.—A report of a further oil strike has been circulated from Edmonton. A small flow was encountered at a depth of 85 feet near Irma, which lies 10 miles east of Edmonton on the G.T.R.

St. Catharines, Ont.—Considerable difficulty is being experienced in reaching an agreement concerning the liability of cost of a pure water supply pipe line from Lake Erie to the towns along the Welland Canal.

Galt, Ont.—A well-grounded rumor is being circulated at Galt to the effect that negotiations are in progress to secure a site for a Union Station for Galt, to be used by the C.P.R., G.T.R., and Lake Erie and Northern Railways.

Fenelon Falls, Ont.—The Seymour Power Company has completed the construction of its new dam at Fenelon Falls. The plant is capable of developing about 1,500 horsepower, and is to serve the purpose of a reserve supply.

Winnipeg, Man.—Construction work commenced on July 8 on the new drill hall in the northwestern portion of Winnipeg city. The building will cost $110,000; and the contract is held by the Brown Construction Company, Limited.

Moncton, N.B.—A gas sand has been struck by the Maritime Oilfields Company in the Albert County gas field, which it is stated is giving a flow of 2,000,000 cubic feet of gas per day. The discovery was made by the deepening of an old well.

Cobourg, Ont.—It is now stated that the Trent Valley Canal will be opened from Peterboro to the Bay of Quinte this fall; and that next spring a regular service will be established. The new section of the canal from Balsam Lake to Lake Simcoe will be deepened.

Woodstock, Ont.—An inspection of the work that has been done in Oxford county in connection with the good roads movement was made by Engineer Huber, of the provincial highways department. Satisfaction with the work has been expressed by the engineer.

Chatham, Ont.—Civil engineers in connection with the Good Roads Branch of the Ontario Department of Public Works are at Chatham making a survey of this section of the country with the object of making recommendations to the Ontario Government regarding plans for improving the roads.

St. Thomas, Ont.—The Hydro-Electric power line from St. Thomas to Windsor will be connected at West Lorne in the course of a few days. The necessary work at the St. Thomas sub-station is practically complete; and it is stated that Niagara power will be available for distribution in Windsor during August.

High River, Alta.—Oil has been found to exist in the well which has been drilled within the limits of High River for the purpose of supplying gas to that town; and the substance is said to be of similar character to that struck in the Dingman well near Calgary. The well at High River has not been drilled below 505 feet.

Assiniboia, Man.—Another oil strike rumor comes from Assiniboia, Man., where it is claimed that the fluid was found in a well being bored for water supply at a depth of 1,000 feet. The discovery was made about 17 miles west of the territory of Verwood, in which district claims are now being filed and further drilling operations commenced.

Toronto, Ont.—Direct connection has now been made between the North Toronto district and the large water supply plant at Yonge and Heath Streets, Toronto. The increased pressure for the supply of water for North Toronto gives 130 pounds per square inch in the mains instead of 50 pounds. The booster pump has a capacity of 750,000 gallons a day.

Fredericton, N.B.—Mr. F. P. Gutelius, general manager of the I.C.R., together with other officials of the railway company, has been making an inspection of the St. John Valley line from Fredericton to Gagetown, with a view to selecting a terminal site for a prospective divisional point. Some announcement is expected as to its location in the near future.

Wallaceburg, Ont.—A report from Wallaceburg advises that satisfactory progress is being made on the new waterworks plant being constructed at that point. Nearly half a mile of the ditching for the main intake from the Suye has been completed; and the pumping stations will be ready for machinery within a short time.

Swift Current, Sask.—The local government board at Regina has authorized an issue of debentures by the town of Swift Current to total $196,000 for the financing of necessary local improvements. Of this amount, one issue will be for sewer construction amounting to approximately $112,000; one for an electric lighting plant at $60,000; and a third to provide for concrete sidewalks totalling $15,000.

Kamloops, B.C.—The drill hall which is to be erected at Kamloops will be what is known as the "class D" building, or the type generally constructed in larger cities. The total length of the new building will be 199 feet; and the overall width 82 feet. The foundations will be built of concrete; and the building proper, of red brick. A considerable amount of structural steel will be used in the gallery surrounding the main hall and for the roof spans; while, in the basement will be located the furnace which controls the one pipe low-pressure steam circuit system, which is to be installed.

Ottawa, Ont.—The Federal Town Planning Commission is now engaged in making a comprehensive study of the question of the location and elevation of the bridges on the Rideau Canal. The report will not be ready until September. It is likely that a deputation will be sent from the city council to ask that the clearance space be allowed to be made only 10 feet instead of having to be 30 feet. This would allow the construction of numerous bridges and provide for the rapid development of the section of the city south and east of the canal, and would do away with the occasional large ship traffic into the centre of the city.

Victoria, B.C.—Recently, the laying of the steel pressure pipe for Sooke waterworks from Humpback reservoir to the city commenced at Manchester road, near the Gorge road, where the work done by the Westholme Lumber Company in 1912 ended. The contracting firm for this work is the Burrard Engineering Company of Vancouver. Pipe laying on the concrete flow line between Cooper's Cove and the lake is being rushed by the contractors, the Pacific Lock Joint Pipe Company, two shifts laying from the Humpback Reservoir end and two from the Sooke Lake end. About 400 or 500 feet of concrete and steel pipe will be laid daily by the gangs of the respective contractors, though the rate will be increased on the flow line by the additions to labor which are being made.

Hamilton, Ont.—The National Steel Car Company of Hamilton expects that by fall, it will be running to capacity day and night, so numerous and promising are the recent orders for rolling stock for which the firm has taken contracts. Also a considerable addition is to be constructed to the passenger car shop, owing to the large number of passenger cars on order with the company; and the contract for this work is in the hands of the Hamilton Bridge Company. The firm expects that, with this addition, it will be able to construct 30 passenger cars at a time, with a capacity of 150 per year. This will be in addition to the output of street railway cars. It is not expected that orders for freight cars will be heavy this year, though next spring is expected to bring with it a very active demand for this stock and equipment.

Victoria, B.C.—The grading of the Marine Depot site and construction of the wharf on the eastern shore of the Songhees Reserve has reached such a stage that the contractors, Messrs. Parks, Tupper and Kirkpatrick, expect that the work will be completed by the end of this month. The excavation is about three-fifths complete, in spite of the fact that this section of the contract has been greatly retarded recently owing to the frequent encounter of solid rock. All the bearing piles of the wharf have been driven and capped, and the "L" portion of the wharf is floored, while practically all the joists are in position on the balance of the structure. The fender piles have yet to be driven after the flooring has been completed. The total length of the wharf will be 650 feet, running 424 feet north and south, and 225 feet inshore. By the time the contract is completed it is estimated that approximately 27,000 cubic yards of material will have been excavated and levelled off on a line with the wharf.

New Glasgow, N.S.—At the present time, the Canadian Provincial Power Company, recently incorporated in New Glasgow, N.S., is awaiting a report from a firm of Montreal engineers, specialists in power development, containing final figures and data in connection with the company's proposed power plant on the East River at Sheet Harbor. It is estimated that the entire cost of development and conveyance of power to towns concerned will be $1,500,000, and that the power lines of the company will cover a length of 42 miles in all in order to serve the towns of New Glasgow, Stellarton, Westville and Trenton. The company expects to have its lines completed and the power generating plant installed in about 18 months; though it is not intended that the development will stop with the towns named. Distribution lines may be carried later into Antigonish and Truro. Another feature of the proposition is that the distribution lines will run directly through the heart of the largest gold mining district in Nova Scotia; and the company expects that when its lines have been finally erected and the electrical power generated; then it will be able to give to these mining companies an abundance of power for the operation of mines at a very low figure.

Patricia Bay, B.C.—The wharf structure which has been announced recently to be constructed without delay at Union (Patricia) Bay by the C.N.P.R. company, will be of a temporary character; although it will be 40 feet long and 64 feet wide, or sufficiently large to accommodate the material which will be utilized in the final work necessary for completing for service the Patricia Bay branch of the railroad. It is to be capable of handling at low water a vessel drawing 24 feet, and to be ready for the shipments of rails, angle bars, bolts and spikes for 115 miles of road, which material is being obtained from the Dominion Steel Company of Cape Breton. The contract will stipulate that the work be completed within 90 days; and in that period, the first cargo, approximating 7,000 tons of steel, will be landed, and the final stage of construction will be initiated. Before the supplies are exhausted, another shipload will have arrived, which will permit the road to be finished to mileage 115. By the time this large section is ready for the inauguration of a regular service, plans will have been completed for the continuance of the line, for its Northern terminal. In connection with the latter point, it is stated that Sir Donald Mann is expected to visit Victoria this month with regard to the company's plans for railway development on the Island.

Edmonton, Alta.—Local reports state that over $10,000,000 will be expended by the C.N.R. in Alberta in 1914. Included in this amount is the $6,500,000 for the construction of the Canadian Northern Western, a subsidiary company to the C.N.R. The amount of work to be done includes the mileage from Onoway west to Pine River Pass, or what is generally supposed to be the main line of the Canadian Northern Railway to the Peace River country. Grading has been completed as far as Whitecourt; and 32 miles of steel have been laid. The rest will be laid this summer. The program includes also the line from Oliver northeast to St. Paul de Metis. This line is guaranteed for 100 miles at $13,000 per mile. Although some of the grading has been completed on this line, no steel has yet been laid. There is the road from Bruderheim by way of Vermilion, Wainwright and Medicine Hat to the boundary with the branch northwest of Vermilion to the eastern boundary. This line has been guaranteed at $13,000 per mile for a distance of 30 miles. Other sections are: Calgary northeast to Brazeau line, which leaves the Calgary-Edmonton line near Calgary; Camrose to Alsask from Camrose to the Saskatoon-Calgary section; Edmonton to Pincher Creek; Blackfalds to Goose Lake. Work has been done on some of these lines and an effort will be made to complete them as early as possible.

PROGRESS OF THE GRAND TRUNK PACIFIC RAILWAY.

Confidence is expressed by Mr. Collingwood Schrieber, general consulting engineer to the Dominion Government, and chief Government engineer inspecting the Western divisions of the Grand Trunk Pacific Railway, that the new transcontinental will be ready for through service this autumn. He claims that the new transcontinental is in excellent condition between Winnipeg and Edmonton, in very fair shape between Edmonton and McBride, and is rapidly being placed in first-class order on the other sections. The G.T.P. is operating regular express trains as far as McBride, 342 miles west of Edmonton, and service trains between that point and Fort George, 144 miles further on. From Prince Rupert, the company is running trains as far east as Priestley, 337 miles east of the Pacific terminal. Ballasting is now rapidly approach-ing completion on the intervening portion of the line, a distance of about 140 miles. No definite date has yet been set for the opening of through service; but the road is expected to be in good running condition by the middle of August. There is still a considerable amount of ballasting to be done between Prince George and Priestley, but rapid progress is being made with the work.

TORONTO BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

The executive committee of the Toronto branch of the Canadian Society of Civil Engineers has made arrangements for the following accommodation in the new Engineers' Club:

(1) A room for a joint technical library to which members of the societies to which the books belong shall have access.

(2) A small room adjoining the library for the exclusive use of members of the branch.

(3) A lecture room capable of seating one hundred persons.

A library committee of the branch, which has been at work since last January, is building up what should be a useful working library for engineers. While first consideration has been given to series of transactions and proceedings of important engineering societies, a considerable number of books are being added, this summer, to those already on the shelves. It is hoped to have the new additions completely bound, catalogued and ready for use by October 1st in order to extend the privileges of the library to those student members at the University, who desire to use them.

The following companies have kindly consented to allow the members of the branch to visit their works from time to time. Any member or group of members wishing to avail themselves of this opportunity are requested to obtain a card of introduction from the secretary of the branch: Canada Foundry Company, Limited, Toronto; Canadian Pacific Railway Grade Separation, North Toronto; Department of Works, Toronto; Hamilton Bridge Works Company, Hamilton, Ont.; Polson Iron Works, Toronto; Steel Company of Canada, Toronto; Thor Iron Works, Toronto; Toronto Harbor Commissioners, Toronto, and Welland Ship Canal, St. Catharines, Ont.

The secretary, J. S. Galbraith, announces that a programme of the meetings to be held this autumn will be issued shortly.

The Manitoba Gazette announces the following provincial appointments in accordance with the Good Roads Act: Chief Engineer, M. A. Lyons.

Engineers, S. A. Button, T. T. Wilson, J. B. Philips, W. Youngman, R. Whitside and F. Minvelle.

Assistant Engineers, W. R. Bertram, L. Cote, and W. H. Bladock.

Inspector, H. T. Thornby.

Draughtsman, C. N. G. Milne.

BACK COPIES FOR DISPOSAL.

A subscriber, who has copies of *The Canadian Engineer* practically complete from Volume 6 to date inclusive, and who, for certain reasons is anxious to dispose of them, would like to hear from readers who may be interested in the matter Address, in the first instance, James J. Salmond, Managing Director, Canadian Engineer.

PERSONAL.

ROSS H. McMASTER, Montreal, has become a director of the Steel Company of Canada, succeeding in that capacity the late Senator Gibson.

RALPH MODJESKI, Consulting Engineer, Chicago, and a member of the Board of Engineers of the Quebec Bridge, has been retained by the Burrard Inlet Tunnel and Bridge Company to report on the tenders which the company has received for the construction of the Second Narrows bridge, Vancouver. The structures will cost approximately $2,000,000.

W. P. DOBSON, B.A.Sc., has been appointed director of the experimental laboratories of the Hydro-Electric Power Commission of Ontario. The laboratories are located in Toronto. For the past eighteen months Mr. Dobson has been carrying on research work on electrical disturbances in high tension transmission systems, for the University of Toronto Engineering Alumni Association. The work has recently been completed and Mr. Dobson's results form a very valuable addition to the existing information respecting such phenomena as that produced by the switching of heavy loads of high voltage lines.

COMING MEETINGS.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

WESTERN CANADA IRRIGATION ASSOCIATION.—Eighth Annual Meeting to be held at Penticton, B.C., on August 17, 18 and 19. Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

AMERICAN ROAD BUILDERS' ASSOCIATION.—11th Annual Convention; 5th American Good Roads Congress, and 6th Annual Exhibition of Machinery and Materials. International Amphitheatre, Chicago, Ill., December 14th to 18th, 1914. Secretary, E. L. Powers, 150 Nassau St., New York, N.Y.

The Mayor of Halifax, City Engineer and Controller Hobur will represent the city of Halifax at the Union of Canadian Municipalities to be held at Sherbrooke, Que., early in August.