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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Demolition of the Ragged Rapids Dam

Removal of Obstructions Necessitated by Inclusion of River Severn in Trent Canal System—Reinforced Concrete Dam Dynamited Under Full Head of Water

By SIDNEY BOWEN

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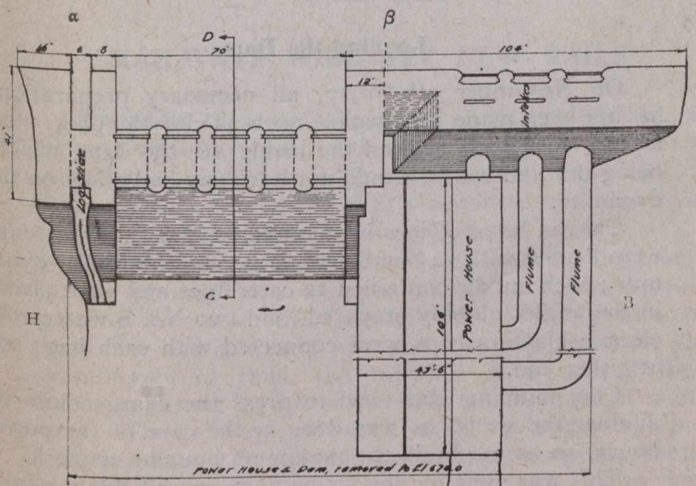
WHEN it was decided by the Department of Railways and Canals to make use of the River Severn as part of the Trent Canal system, consideration had to be given to the fact that the dam and powerhouse at Ragged Rapids obstructed the route.

Various plans were considered as to the best means of overcoming this difficulty, it being finally decided to build a new dam, powerhouse and lock at Swift Rapids, about 1½ miles downstream, and to remove the present power development. If only the piers from the deck to the spillway level had to be removed, the problem would have been one of extreme simplicity, but as the water coming down the river during the spring freshet amounts to quite an appreciable quantity, reaching a maximum of

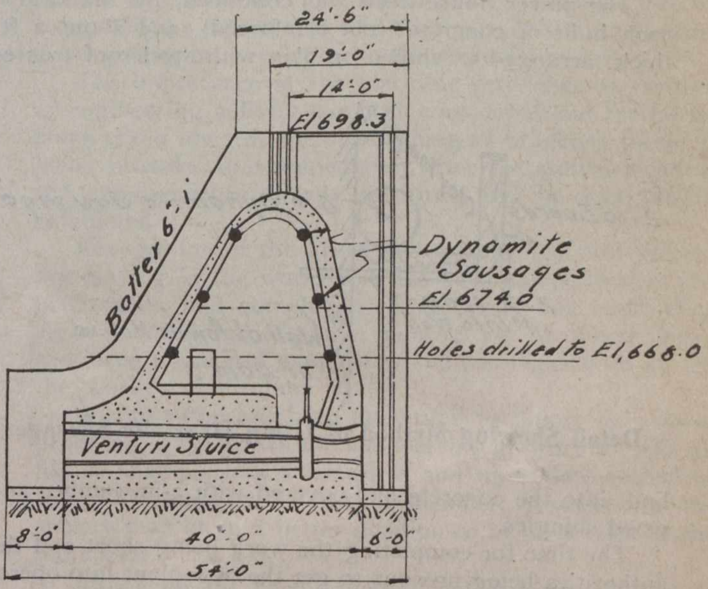


Plan of Ragged Rapids Dam

about 10,000 sec.-ft., it was deemed advisable to remove the whole development to a depth of 24.3 ft., *viz.*, from elevation 698.3 to elevation 674, thus giving an area of about 4,000 sq. ft.

The contract for that portion of the canal known as Section 2, Severn Division, Trent Canal, was awarded to the Inland Construction Co., Limited, who decided to call in Mr. Russel, of the Canadian Explosives, Limited, Montreal, to consult with the writer as to the best methods to be employed to obtain the desired result.

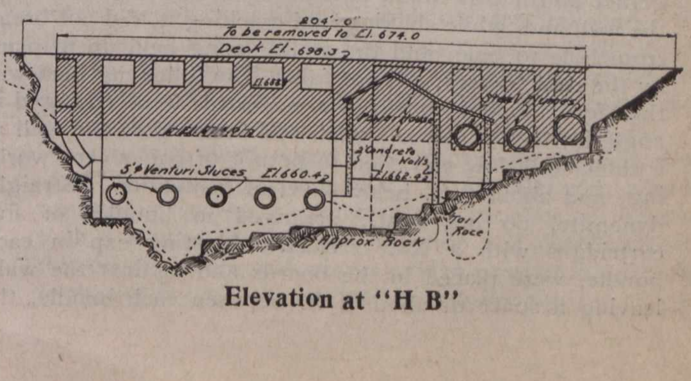
The dam in question was built about 10 years ago (to replace a dam which had proved unsatisfactory) to the plans, specifications, and under the direct supervision of Mr. J. B. MacRae, consulting engineer, Ottawa, and since that time had been used to impound water necessary for generating power for the use of the town of Orillia and surrounding districts, having been constructed to withstand a head of 46.5 ft., the head water being at elevation 697.5 and tail water at elevation 651.0, regulated level.



Section at "C D"

As shown on the accompanying plan, the dam consisted of a series of five spillways, each of 10 ft. opening. An abutment 30 ft. thick or thereabouts, containing a log-slide 6 ft. wide on the north side, and a gravity wall 12 ft. thick on the south side, connected to the open penstocks and steel flumes by means of a gravity wall 7 ft. thick at deck level, with the downstream face sloping five inches to the foot.

Above the spillway crest the piers were 5 ft. thick, with the usual stop-log and emergency checks of steel framing, while inside the dam the piers were increased to a thick-



Elevation at "H B"

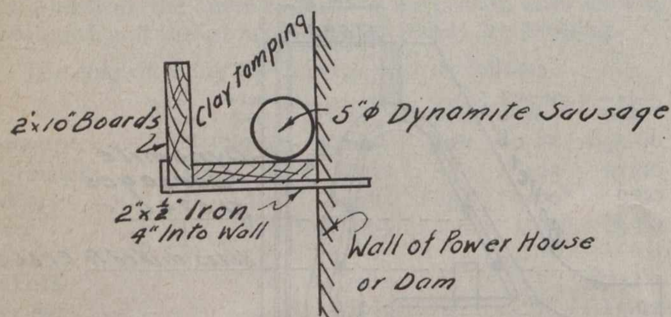
ness of 6 ft., with an opening in each to give access to the Venturi sluices, of which there were five, *viz.*, one under each spillway.

By thus increasing the thickness of the piers inside, a ledge 6 ins. wide was left on the upstream face of each pier and against this was placed a heavily reinforced concrete curtain wall, varying from 36 ins. thick at the floor level to 30 ins. thick at the top of the spillway. It will therefore be noted that the reinforcing did not pass into the piers at all, the only connection between curtain wall and piers being the above-named ledge and some stop-water timbers, half in one and half in the other. On the other hand, the curtain wall on the downstream simply rested on the piers, the reinforcing passing directly from end to end of the dam and into the abutments.

The deck of the dam consisted of a 6-in. slab of concrete in which was embedded expanded metal and 25-lb. rails for stop-log winches.

The penstocks require little or no description as they were simply steel flumes passing through a concrete gravity wall, with emergency gains of steel framing and gates, as shown on plan.

The power house itself was contained by six walls, each built of concrete (not reinforced) and about 2 ft. thick, arranged as shown on plan with steel roof trusses



Detail Showing Method of Using Dynamite Sausage

built into the concrete and covered with 2-in. lumber and wood shingles.

The time for completing the work being short and the authorities being anxious to get the new plant into operation, the company decided to meet their requests so far as lay in their power and therefore concluded to remove the dam and power house in three operations instead of two, as first intended, *viz.*, 1st, power house; 2nd, dam between the points marked α β on plan, and 3rd, the remaining intakes as convenient.

Demolishing the Power House

In order to ascertain the best way to remove the power house, holes about 6 ft. apart and half-way through the wall were dug in part of one wall. Two to four 1½-in x 8-in sticks of 60 per cent. N.G. dynamite were placed in each hole and mudcapped. These charges were exploded together and it was found that the dynamite broke through the wall and, while shaking and cracking it, did not break from hole to hole, and the walls, being held up in place by the roof trusses, did not fall. The following plan was therefore adopted: 10-in. x 2-in. boards were arranged in angle formation as per sketch and fastened to the wall at a sufficiently low elevation to permit of convenient working, and about 6 ft. below level of demolition. Straight dynamite, 60 per cent., arranged in bundles of five cartridges with a No. 6 electric blasting cap in each bundle, were placed in the boards and against the wall, leaving a space of about 2 ft. between each bundle, the bundles of explosives being pressed against the concrete by means of clay tamping, in other words, "mud-capped."

To fire the charge, the electric blasting caps were connected with the leads in series of ten, the whole being set off by throwing in a switch connecting to the 100-volt leads, which were close at hand. The result was all that could have been wished for, the walls being cut clean and the whole power house collapsed as anticipated.

In 1½ hours, five men placed and mud-capped the charges used to demolish the power house walls. Approximately 200 ft. of wall was thrown down.

Preparations for Dynamiting the Dam

When blasting out the dam, the abutment on the north side of the river, the four piers and the south gravity wall, all between the points marked α and β, were drilled to a depth of 30 ft. and in such way that the distance between each hole at the bottom was 4 ft.

A piston drill was used for drilling the holes; seventy holes being drilled in approximately 45 machine shifts of 10 hours each.

Now, instead of drilling holes in the upstream and downstream curtain walls, an operation which would have been tedious and expensive, if not almost impossible, owing to the network of reinforcing iron, instructions were given to procure 10-in. x 2-in. boards, nailed firmly together in the form of an L and arranged and supported against the inside of the curtain walls by means of 2-in. x ½-in. brackets. These angles were to be placed at 8-ft. centres, the first ones being at the same elevation as the bottom of the 30-ft. holes, thus accounting for six L's for each spillway, as per sectional elevation.

Loading the Dam

On November 9th, 1917, all necessary preparations having been made in advance, such as clay tamping, etc., a start was made to load the inside of the dam, which, being dry and warm, would not have any bad effect on the dynamite.

Canvas bags, 5 ins. in diameter and 9 ft. 0 in. long, were loaded with 14 bundles of 60 per cent. straight dynamite; each bundle contained 12 cartridges and were placed in the angles already prepared, and two No. 8 waterproof electric blasting caps were connected with each bag, one at either end.

Clay tamping was used to press the charge close up against the walls, as was done in the case of the power house, so as to obtain the maximum amount of work.

This was done for the six bags in each of the five spillways and great care was taken with the tamping as, although it has not been mentioned so far, a full head of water was against the dam and therefore the explosive had to work not only against the concrete reinforcing, but also against the water, which would minimize its effect to a great extent.

It was not thought advisable to flood the inside of the dam, as fears were entertained that the water might creep in between the bags and the wall, which might or might not have been disastrous.

On the morning of the 10th, loading of the holes was started from the deck and 60 per cent. polar forcite gelatine was used. The whole operation of loading was completed by 4 p.m.

The object of using two kinds of explosive for the work was as follows: To cut off and break up the reinforced concrete by mudcapping and to start it moving before the piers were smashed, an explosive of high velocity was necessary, so C.X.L. 60 per cent. straight dynamite was used (C.X.L. forcite gelatine being of equal strength but with a lower velocity of explosion) so that the dynamite would not only break up the piers, but also heave the debris a certain distance, so that the rushing water could easily wash it away. The polar variety of forcite does not freeze until a low temperature is reached, so that although the work was done in November, the forcite needed no thawing.

All that now remained was to connect up the electric blasting caps, 150 in all, with the leads. This was arranged in multiple series of 15 caps each. Two pairs of 14-gauge copper lead wires were used; one pair took the caps from the holes in the piers and the other pair took the caps from the charges in the inside of the dam. One pair was then connected to the other at the river's edge and one pair ran from this junction to the switch. In this way the electric current reached the two sections of the blasting charge at practically the same instant, preventing cut-offs.

A 500-volt alternating current was used to explode the caps, the switch being thrown by Mr. Russel at 4.30 p.m.

The result obtained was all that could be desired, the dam being completely demolished within the lines intended, not a vestige of concrete, rock or reinforcing being seen, the water having done its work of sweeping the debris away in excellent fashion.

Contrary to expectations, very little jar was experienced. The explosion was very muffled, being due no doubt to the two different forms of dynamite used and the variation in the speeds in which they did their work.

RAILWAYS WILL GET NEW RAILS

According to a press despatch sent from Ottawa, an increase of 20 per cent. in the steel production of Canada over that of last year is promised as the result of conferences held between the War Committee of the Cabinet and the Canadian steel manufacturers.

The immense amount of steel required for the manufacture of munitions has prevented the railways from securing rails from the Canadian mills. While in some cases they had contracts with the steel companies for the manufacture of rails, the railways have waived their claims to permit the fullest possible manufacture of munitions. The railways, however, could no longer continue without a supply of rails for maintenance purposes, therefore the government called the manufacturers into conference.

In a discussion of his own paper on "Multiple-Arch Dams of Rush Creek, California" (Proceedings Am. Soc. C.E., September, 1917), Mr. L. R. Jorgensen states that "good concrete is fairly watertight and gunite is remarkably so." He says:—

"Some tests were carried out in the laboratory of the University of California on the watertightness of plaster 'shot' on the dam face with a cement-gun. Several plaster slabs, from 3/8 to 1½ ins. thick, made at Gem Lake, were tested with water pressures ranging from 700 to 1,600 ft. for several hours, with no moisture coming through the slab. One 1-in. slab held a head of 1,610 ft. for 2½ hours without showing moisture, then the water pressure was raised gradually to 3,400 ft., and the specimen broke in bending, having leaked a little just before breaking.—From Engineering-Contracting, of Chicago.

REPORT OF THE COUNCIL OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

THE council of the Canadian Society of Civil Engineers have prepared a report covering the year 1917, which will be submitted to the membership at the annual meeting to be held next week at Montreal. The report includes the financial statement, additions to and removals from the membership roll, an outline of the society's activities during the year, and the report of the library committee. Following is an abstract of the council's summary of the year's activities:—

The suggestion of the president that an executive committee of the council be formed was carried into effect, and this committee, consisting of the president, the local vice-presidents and the chairmen of the committees of council, handled a large part of the detail, the results of these committee meetings being submitted to council in the form of a series of recommendations from the executive.

A legislative committee was appointed to look after all legislative matters affecting engineers, consisting of three members of council, through whom three members of each branch co-operated. The legislative committee's report to council has shown that this departure was an important development in its relation to the society's future.

The importance of the maritime provinces as centres of engineering activity has been considered and the initial steps taken towards the establishing of branches there, it being intended that immediately after the annual meeting the arrangements already instituted will be successfully completed.

Recognition of the great part members of this society are playing in the world war has been exemplified in the preparation and completion of an honor roll containing eight-hundred and fifty-nine names; all of whom have sacrificed much and many of whom have sacrificed all for the world's civilization.

A committee has been appointed to report on a form proposed to be sent to the membership in order to have on file at headquarters a complete and up-to-date record of the professional career of each member, in order that the society may be in a better position to be of service to the individual.

Following the newly adopted policy of the society to engage in useful public service, the decision of the council to co-operate with the Honorary Advisory Council for Scientific and Industrial Research, resulted in the membership at large taking an active part in assisting the Research Council to distribute an industrial questionnaire, the major portion of the detail for Montreal and Quebec being handled from headquarters office.

The spirit of closer affiliations with other organizations has been exemplified in the invitation from the Institution of Civil Engineers, extending to members the use of the Institution's library and reading rooms, and the cordial resolution of the Board of Direction of the American Society of Civil Engineers.

The completion of the Quebec Bridge during the past pear, erected from designs and constructed under the direction of members of this society, is an achievement worthy of a permanent place in the society's annals and it is intended to place at headquarters a memorial commemorating this event.

It is with deep regret that council records the death of the late secretary, Professor C. H. McLeod, who for twenty-five years, as secretary and member of council, took a leading part in the direction and development of this organization, and whose sudden passing is a real loss to the society and the engineering profession.

MANITOBA ENGINEERS DISCUSS POSSIBLE ENGINEERING LEGISLATIVE ENACTMENTS

THE executive committee of the Calgary Branch, Canadian Society of Civil Engineers, recently submitted for the consideration of the other branches, a resolution regarding possible Dominion legislative enactments defining the status of engineers. The Manitoba Branch of the society met two weeks ago to discuss the Calgary resolution, and as a result of the discussion forwarded the following resolution to the council of the society:—

"Resolved that it is the consensus of opinion of the Manitoba Branch of the Canadian Society of Civil Engineers that some organization and legislation be consumated for the purpose of defining the qualifications of an engineer and in the line of organization would suggest the following:—

"That the council at the general meeting in 1918 be authorized to devise ways and means to obtain with the help of the kindred societies, a census as complete as possible of all the professional men engaged in any class of engineering work in Canada and at the Front. When this is done and the men properly classified according to their age, education, training and achievements, that the council be authorized to arrange with the kindred societies to gather all these engineers worthy of the name, under one flag, which would be that of the Engineering Institute of Canada, and carefully enact new by-laws which should be strictly adhered to. This in order to show that this country possesses in the engineering profession a potential strength ready to be conscripted by the government, who should make full use of it not only to do its full share in helping to obtain a speedy victory for humanity, but also, after the war, to make this Dominion one of the foremost countries of the world."

Commenting upon the above resolution, J. G. Legrand, M.Can.Soc.C.E., bridge engineer of the G.T.P., Winnipeg, writes to *The Canadian Engineer* as follows:—

"It is instructive to note the wording of this resolution, which would seem to show that the majority of the members present at the meeting were not quite clear in their minds as to what precisely constitutes an engineer, and desired legislation to define for them the qualifications necessary for an engineer. But I know that a definition of the qualifications of an engineer was not the only advantage expected from legislation by the majority of the members present.

"If engineering is to be put on the same footing as law, medicine, etc., the necessary legislation should, it seems to me, contain the following main clauses:—

"1st. A correct definition of what constitutes an engineer. In order to obtain this, the main divisions of the engineering profession should be consulted.

"2nd. An accurate estimate of the minimum amount of knowledge, both technical and practical, required for the different grades of membership in each division.

"3rd. The appointment of a governing body composed of legal men chosen by the members of the Institute belonging to the different divisions of the engineering profession. This governing body should have powers corresponding to those of the governing boards of law, medicine, and so forth.

"In conclusion I should say that the seeking of legislation should be done in the broadest spirit, in order to offer the public at large a profession in which they could have full confidence."

Mr. Legrand had been asked to uphold the negative side of the discussion as to the advisability of seeking Dominion legislation for the purpose of bettering the standing of the engineering profession in Canada. In part, Mr. Legrand's speech was as follows:—

"The question of legislative enactment to place the engineering profession on a footing similar to that of the other professions, such as medicine, law, surveying, architecture, etc., is not new. It was taken up some years ago when there was so much public work being done in this country, but in those days the engineers were kept so busy that there was no time left to look after their own personal interests. But now this state of affairs has been greatly modified, particularly during the past three years, in which there has been a decided decrease in public works.

"The progress of the war has, however, changed the conditions so materially that our profession is coming more and more into prominence every day.

"There is no doubt in my mind but that the engineering profession, especially at this time, should be considered supreme in the professional realm.

"It is the duty of the engineer—I call an engineer a man who devises ways and means and plans the various public and private works necessary for the comfort and well-being of his fellowmen—to demonstrate to the public that he is a man of inventive ability, ready at all times to do them service, and on whom they can rely as a true friend.

"It seems most extraordinary that it should be necessary to explain to any one that even the ordinary comforts and conveniences utilized from day to day, such as transportation, lighting, heating, clothing, home facilities, food, etc., in fact, everything entering into the daily routine of an ordinary man's life, emanate from the brains of engineers.

"It is an undoubted fact that the public at large are not in a position to understand or appreciate the work done by our profession, but the reason for this is that we engineers do not sufficiently inform the public of our doings.

"The engineering profession embraces such a wide field that it has necessarily been divided into quite a number of classes, such as general engineering, embracing railways, highways and canals, etc.; mining; hydraulic; naval; aeronautical; chemical; structural; mechanical; electrical engineering; and so forth. All these classes are of equal importance and are so intimately governed by the same general principles that one cannot progress and develop without the help of all the others.

" 'Noblesse oblige.' That is, 'Position and standing impose obligations.' The obligations of a man who chooses the engineering profession involve hard work at all times in order to improve not only scientifically but socially as well. He must read the best authors and learn how to speak clearly in order to show himself to the best advantage. Further, he must live a clean life, both from the physical and moral standpoint, so that he may enhance the value and reputation of his profession and ultimately bring it to be looked upon as 'The First of the Professions,' the position which is rightly hers.

"With such ideals, which should be inculcated in college, the engineering profession will not need any legislative enactment. Indeed, let me remark, as I close, that legislative enactment as applied to the other professions has certainly not improved either their moral or their material standing."

REVIEW OF NEW SPECIFICATIONS FOR STEEL HIGHWAY BRIDGES

By Geo. Hogarth, A.M.Can.Soc.C.E.
Engineer of Highways, Ontario.

THE General Specification for Steel Highway Bridges which has been prepared by a committee of the Canadian Society of Civil Engineers, is very comprehensive and complete, and covers the construction of highway bridges carrying the ordinary highway traffic or combined highway and electric railway traffic.

The various chapters are: Introductory; General Features; Floor; Loads and Stresses; Unit Stresses; Proportioning of Parts; Details of Design; Movable Bridges; Workmanship; Materials; Full-Sized Tests; Inspection and Testing at the Mills; Inspection and Testing at the Shops; Painting, Creosoting and Asphalt; Motor Truck Loads; Electric Car Loads; Detail of Wooden Handrail; Data to be Supplied by the Engineer; and Index.

An examination of the specification shows that a broad choice of loadings for bridges is presented. A new heavy loading, noted as Class "A", consisting of a 25-ton motor truck is suggested. This is along the lines of present-day tendency in motor truck design. Such loading is proposed for manufacturing districts in cities. A concentrated loading of 15 tons is proposed in residential districts in cities and towns, while the same concentrated loading is proposed for country highways. A new light loading for mountainous districts is very useful, and consists of a concentrated load composed of a 6-ton motor truck, with a uniform load of from 70 pounds per square foot for 50-foot spans and less, diminishing to 40 pounds per square foot for spans 200 feet and over. The T-chord design is recognized and approved for spans up to 80 feet, for structures in mountainous districts, and in such structures metal ¼ inch thick is also permitted. A slight change has been made in the requirements for strength of handrail posts, which would accordingly be reduced slightly in size. Planking of sidewalks may have ½-inch open joints which would hardly seem desirable on account of small objects being able to pass through the floor.

Creosoted timber flooring is recommended for all bridges requiring a small dead load. The application of impact stresses has been changed so that the impact is only added to stresses produced by the concentrated loads. In the case of motor truck loads 30 per cent. of the computed stresses is added for impact, while for electric car loads the usual formula is given. The distribution of the concentrated wheel load on the floor is given, specifically, and results in rather heavier loading than used in present practice.

A departure from present specifications has been made in the column formula which as proposed is $12{,}000 - 0.3 \left(\frac{l}{r}\right)^2$ in pounds per square inch. The stress allowed on steel castings has been reduced, while an allowable compressive stress on iron castings has been included. Unit stresses in bending are also given for steel and iron castings, while allowable stresses for bending in timber is included. Present-day improved shop and field methods in the driving of rivets have been recognized by increasing the shearing and bearing value for such rivets. Hard bronze expansion bearings are recommended, and the unit stress in bearing for such members is given. Granite masonry has been allowed a bearing pressure of 800 pounds per square inch, and the bearing capacity of concrete has been increased.

In arriving at the net section of tension members, a minimum of at least two rivet holes must be deducted. The size of compression members has been reduced, and it is proposed to permit a length of 175 times the least radius of gyration. A formula for the minimum thickness of cover plates and web plates in compression and also for the minimum thickness for unstiffened flanges of compression members is given. Bridges less than 50 feet in length and composed of T-chords may have single web trusses. The design of connections for all members is definitely settled by requiring that such connections be detailed for the net sectional area of the member and the allowable unit stress on that area is given. Diaphragms are required in the ends of certain sizes of compression members and such a detail is desirable in the interests of stiffness of the member. The design of the latticing of compression members is to be based on the stress in the member, and such latticing shall resist cross shear equal to 2 per cent. of that stress.

The minimum size of expansion roller is to be increased from 3 to 4 inches, while plates for expansion bearings of spans 80 feet and over are to be of hard bronze or other non-corrosive material. Spans of 100 feet and over are to be preferably supported on hinge or disc bearings.

A very satisfactory paragraph containing some 47 clauses covers the complete design of movable bridges, and brings the design of such structures up to date.

Under "Workmanship" it is stated that rivet holes must be drilled from the solid or sub-punched and reamed. This marks a step in the proper direction that all shop work should take and undoubtedly connections under this specification should have a much better fit.

The other paragraphs on materials, tests, inspection and bending are composed of the usual general clauses, and the last three or four pages are taken up with diagrams of concentrated loads, dimensions of handrail details, data required and the index.

U.S. POWER DEVELOPMENT BILL

The United States Administration Water Transportation and Power Development Bill, which is designed to inrease transportation and power facilities, is ready for introduction into Congress.

The bill creates a commission, composed of the Secretary of War, Secretary of Agriculture and Secretary of the Interior, to have charge of developing the country's water power.

President Wilson is authorized to appoint an executive officer for the commission through whom its policies shall be carried out. He is to serve for five years at $10,000 a year. He is given power to issue licenses for construction of dams, reservoirs, power houses, transmission lines or any other projects which will aid in power development or improve navigation. Licenses are for fifty years. Licensees must submit all plans for improvement to the commission, which may alter them if it sees fit.

The federal government is to be given free power to operate locks. If the government wants any power plant for manufacture of explosives or fixation of nitrogen to use in explosives manufacture, the bill empowers the commission to commandeer such plants. Rates to be charged for power are subject to regulation and reduction by the commission, to which they must be submitted.

NOTES ON WATER SUPPLIES AS SOURCES OF POWER*

By Cecil H. Roberts, M.Inst.C.E.
Water Engineer, Aberdeen, Scotland.

IN few branches of engineering has progress been so rapid as it has been, for the last few years before the war, in water power engineering. Not only have the design and efficiency of water turbines and generators of electricity been greatly improved, but the transmission of power to considerable distances by high-pressure three-phase alternating current has become a comparatively simple matter. Owing to the great advances made, and to the demand for power which is to-day almost insatiable, many water power schemes, considered impracticable 20 or even 15 years ago, must be now possible and ready for development.

In Italy, no doubt owing to the limited supply of coal available in that country, there are at present some 400 large water power schemes which are apparently giving every satisfaction, and the total water power already harnessed is stated by Dr. Liuggi to be some 1,300,000 horse-power. Water power has also been considerably developed in Sweden, Norway, Spain, France and Switzerland, and other European countries. In Switzerland, electric power from plants of moderate size is distributed in the rural districts and used for agricultural purposes. Under favorable conditions, water power can be obtained at 40s. and less per horse-power per annum. Many large water power schemes have also been carried out in the United States and in Canada.

The subject of water power can hardly, perhaps, be so important in this country, where coal of good quality is so easily obtainable, as in countries where coal, oil, and other forms of fuel are more costly and difficult to obtain. Nevertheless, there are several important water power installations in the British Isles, among which may be mentioned: (1) The Kinlochleven Works in the West of Scotland, the present capacity of which is 30,000 horse-power, with provision for extension; (2) works of about one-fourth this capacity at Foyers; (3) the works of the North Wales Power Company, in the Snowden district, which supplies a number of large quarries; (4) works at Conway, in connection with which an Act of Parliament was obtained last year (1916), authorizing the linking of the works with the water supply works of the Conway Water Board; and (5) an installation at Chester, where power is obtained from the River Dee, the head utilized varying from about 1 ft. to 9 ft. This latter plant is understood to be capable of supplying power at a maximum rate of about 500 horse-power, depending on the discharge of the river. The works are linked up with the steam plant of the Chester Electricity Works, the cost of the current obtained from the water power plant being much less than that of the current generated by the steam power plant. There are also some small works in Ireland.

Although there is not very much water power available for development at a remunerative cost in this country, owing to the smallness of the rivers, the scarcity of large lakes at high elevations, and the necessity generally of building costly storage reservoirs, the total being estimated at about 1,000,000 horse-power, there is likely to be a great development of water power in other countries, such as Canada, Australia, New Zealand, Africa, India, Mesopotamia, South America, as well as in Europe after the war, and the subject should not be neglected by water engineers who desire to share in the pioneering work to be done in other countries than Britain. The subject should also be interesting to such manufacturing firms as may be in a position to provide the hydraulic and electrical plant which will be required.

Mechanical power of all kinds is destined to take a more important place in the future activities of the world than it does at present, and water power will become especially valuable owing to the increased cost of coals, oils, and other fuels.

Quite apart from the hydraulic power supplies at high pressure, it is, of course, common for water undertakings to supply water power within their areas of distribution for operating hydraulic lifts, and small water motors used in various trades, but in recent years this demand has been seriously diminished by the competition of electricity, which, at a charge of 1½d. per Board of Trade unit—the charge for large powers is often much less than this—or about 1⅛d. per horse-power, is equivalent to a charge of less than 1d. per 1,000 gals. of water under a head of 150 ft. It is not, however, feasible for waterworks to make such very low charges for the supply of power from their distribution systems.

Low electric power charges are, no doubt, due very largely to the desirability of cultivating power loads to neutralize as much as possible the effect of high peaks on the station load diagram, due mainly to the lighting loads. The generating station plant has to be large enough to deal with the peaks and the power loads designed to fill the gaps or valleys can be accepted at charges approximating to the running costs of the plant, which are often little more than one-third of the total costs of current.

The load or supply factor (*i.e.*, the percentage of average to maximum load) has a much less important influence on the costs of supply in a waterworks where the power can be accumulated in elevated reservoirs, and there is little advantage to be gained in encouraging power loads in preference to supply loads by selling water power from the distribution mains at a lower charge.

On the other hand, the question of load factor in a public supply electricity generating station in connection with the ability to accumulate power possessed by a waterworks appears to suggest certain advantages in the combination of electricity and waterworks, as for example, in pumping into a service reservoir. A regular all-day pumping load dovetails very satisfactorily into an electricity generating station load, especially if the pumping can be discontinued during the period of peak load, as is possible in some cases. Another factor which suggests advantage in combining electricity and waterworks is that the consumption of water for ordinary purposes is generally lower in the winter, when not only is the available supply of water greater, but the consumption of electricity is at its maximum, and coal supplies are in more general demand.

Many waterworks are in a position to generate power from the water before it reaches the service reservoirs, and in some cases, especially in districts far from coal supplies, water power could be generated and supplied at a reasonable cost. Some watersheds are capable of supplying as much as 100 million gallons of water per day from a considerable elevation, and the difference in level between the impounding reservoirs and the service reservoirs varies in different waterworks up to and over 500 ft. Of course, there must be many cases where the cost of the works necessary to utilize power externally would be out of proportion to the available revenue which it would command, but, on the other hand, there would be other

*From a paper read before the Institution of Water Engineers, December 7th, 1917.

cases where it would be decidedly advantageous to so modify the design of waterworks as to bring some of this water power into external use, and seeing that every 1,000 horse-power developed by the combustion of coal absorbs some 10,000 or more tons of coal per year, it is evident that the use of this asset would be to the national advantage.

In most upland waterworks a large proportion of the water caught in the impounding reservoir overflows in the winter, and the power from this, as well as that available from the compensation water, is generally wasted. A further loss of power is caused by throttling the outlet valves of the reservoir, the amount lost varying with the season, and being greater in the winter than in the summer.

As an illustration, it may be pointed out that, assuming the surplus power available between the impounding reservoir and the beginning of the aqueduct amounts to 500 horse-power, this could be utilized to operate turbines driving direct-current or alternating-current dynamos, and the electric power so generated (which could, if necessary, be transmitted to a considerable distance) would be sufficient to provide all the light and power required by a town of considerable size and importance, and the revenue obtainable, with very reasonable charges, would be in the neighborhood of £15,000 per annum, sufficient to warrant a substantial outlay of capital on the necessary works.

A further advantage of combining power plant with upland waterworks lies in the fact that, as storage works on a large scale are often an essential part of a waterworks, a small proportion only of the cost of such works would be chargeable against the power scheme, and the outlay on pressure pipes, which would probably be comparatively short in length, ought not to be heavy.

In some cases where suitable loads can be obtained, it should be possible to harness for power purposes most of the floods, and thus to utilize a large proportion of the mean rainfall, instead of only the average of three dry years, as is the case with waterworks alone.

The idea of utilizing surplus water power in upland waterworks is not by any means new. A proposal to use for lighting and power purposes the power (about 400 horse-power) available at the Longdendale works of the Manchester Corporation was reported on by Sir Alexander Kennedy as long ago as 1899; although nothing was done at that time, hydro-electric works have since been constructed for utilizing some of the power locally by Mr. Holme Lewis, the present water engineer of Manchester. Dr. Deacon, in 1902, described how a portion of the surplus power in the aqueduct of the Vyrnwy works was utilized at Oswestry to operate "Brotherton" engines. More recently, in the Birmingham waterworks, water turbines and dynamos have been installed for using a portion of the power available in the compensation water.

When the difference between the level of the impounding reservoir and that of the town to be supplied is considerable, it may be at times possible, without prohibitive additional cost, to construct the power house some distance from the impounding reservoir, and at a lower level, in order to secure a greater pressure at the turbines and utilize a larger proportion of the potential power. Although such a case might be complicated by compensation questions, it would afford some advantages, such as the possibility of taking additional water from neighboring watersheds, and thereby increasing the capacity of the power plant, and the reduction of cost of the machinery due to the greater head of water. The cost of generating power (the load factor remaining the same) varies inversely with the power and the pressure of water.

One very important problem which would arise in connection with water power works is that of providing a market for the power available. In some districts, small towns or villages in the neighborhood of the works could be supplied with electricity in bulk for lighting and power purposes; in other districts, light railways, saw-mills, wood pulping, mines, quarries, chemical and other works might be supplied on mutually advantageous terms; and in the future agriculture should also provide a market for electric power; in fact, there should be few districts in which a market could not be obtained or created.

It is possible that, in the first instance, some opposition might be raised in parliament to the combination of works for the joint supply of water and of power, but in view of the national value of cheap power for industrial purposes and the necessity of conserving coal supplies as much as possible, such opposition might not be great.

The importance attached by parliament to the supply of power after the war can be gathered from the fact that the Board of Trade had recently appointed a committee "to consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom, particularly industries which depend upon a cheap supply of power for their development."

The writer has not attempted to deal exhaustively with this subject, but has rather endeavored to bring forward some considerations which appear to him to arise in connection with water power installations, in a form likely to provoke useful discussion.

SALT ROADWAY IN UTAH

Part of the Wendover highway in Tooele county, Utah, is constructed of solid salt. Between Timpie and Wendover the line of the highway traverses a flat area, crossing at one point a salt bed about seven miles wide. For a considerable portion of the year this bed is covered with water, which, while it thoroughly saturates the roadway, is never of sufficient depth to impede the progress of vehicles. When dry, the bed is found to make an admirable pavement, with salt two to three feet deep, hard and smooth.

A bill to empower the president to take possession and control of Niagara Falls power plants, and appropriating $20,000,000 for the purpose, was introduced into the United States Congress January 9th by Representative Waldo of New York.

Canada Foundries and Forgings Company is understood to have had a prosperous year. The company is still operating all its Welland plants to capacity, and in fact did so throughout the year. The Delaney plant in Buffalo, recently purchased by the company, has received additional orders for ship forgings, and the earnings have permitted the retirement already of $100,000 bonds, reducing the outstanding issue to $130,000.

The annual report of City Engineer Brian, Windsor, Ont., shows that during the past year the city has laid 45 miles of paving, 43½ miles of sewers, and 125 miles of cement sidewalks. The paving cost approximately $200,000. Fifteen thousand dollars worth of new sidewalks have been constructed, and two large bridges are almost completed at a total cost of approximately $75,000. This year's sewer construction included the Gladstone Avenue sewer, which has been completed, and the Parent Avenue sewer, furnishing an outlet for the east end of the city, and which will cost approximately $38,000. The Parent Avenue job will not be completed until the coming spring. In addition to these big trunk sewers, smaller ones, namely, the Louis, Catarabui, and Montmorenci, the Grove and Jeannette Avenue sewers have been built, costing approximately $20,000.

RECENT DEVELOPMENTS IN THE DESIGN AND CONSTRUCTION OF ROAD SURFACES*

By H. Eltinge Breed
First Deputy Commissioner, New York State Highway Dept.

UNDER the new and heavier traffic the old 6-inch waterbound macadam, which for a number of years was thought adequate for all needs, has been cut through and broken up like pie-crust in many sections of the country. Especially has this been true in the spring of the year when the soil conditions are unstable.

The waterbound macadam roads at the war front in France to-day have shown astonishing endurance because they had such splendid foundations. Now they are being built with from 2 to 3 ft. of stone in order to carry the concentrated military traffic.

Everywhere this tendency to increase foundations is obvious; it is essential, because without a good foundation we can have no road that is lasting.

More Complete Drainage

We have noted that the roads broke up owing to heavier loading and unstable soil conditions. It is possible in many instances to make the soil conditions so stable that they will withstand the extra loading placed upon them. This can be done by drainage so placed as to lower the ground water and carry it away from the roadway proper. In flat country large ditches have sometimes been dug over one-half mile long in order to take the water away from the roadway. A number of miles of the Coleman duPont Road in Delaware gives a good example of this kind of construction.

Banking of Curves

This is becoming a more general practice every day. Objections are raised because it encourages people to travel at high speed, but fools will risk their necks anyway and this banking of curves certainly makes the road safer for those driving under strange conditions and lessens the casualties resulting from sharp turns.

Further to obviate the danger of these curves on roads that are 16 ft. in width, in our practice in New York State we have been widening or mooning them out so that in many cases for those of small radius at the centre the actual curve is as much as 24 or 28 ft. wide. This helps by giving an increased range of vision. The banking of the curve gives a further factor of safety because its superelevation makes steering easier and lessens the likelihood of skidding.

Split Curves

Sight distances could not be procured in some cases where the curve was sharp and dangerous, and then in order that the traffic might be held to its own side of the road, the curve was separated and a parking place with curb was provided.

Approaches to Bridges, to Grade Crossings and at Intersections

Many serious and fatal accidents have been caused by approaches to intersections or grade crossings being on a grade and without proper sight distance. If the grade crossing of a railroad is above the roadway proper it is safer if the roadway be carried out level 25 ft. or more on each side of the track so that it may not be necessary to change gears in driving across. This is also applicable to approaches to bridges which should have a level stretch before passing on to the bridge floor as long as is economically possible to get. This makes easier riding.

Street intersections also should be approached as nearly on the level as possible and greater safety may be secured by cutting the corners to a longer radius. This permits the cars turning sharp corners to keep on their own side of the street until a full turn is made, rather than encroaching upon the opposite side.

Danger Signs

These signs should be visible night and day. To accomplish their purpose and not be in themselves a danger, they should be placed at standard distances from the condition to which they call attention.

There has been a tendency to a more frequent use of guide signs. These should be large and legible enough to be read easily at the average rate of speed. Some States have banded the guard rail and telegraph poles with different colored paints to indicate certain prominent routes. Massachusetts has done this and one can travel practically anywhere in the State without the use of a guide book and without inquiry.

Guard rail, as used, is an unsightly adjunct to a highway. The Interstate Palisades Park Commission has solved this problem from the standpoint of safety as well as esthetics by placing large boulders on edge along the road. This gives as much protection as the guard rail and does not mar the appearance of the work.

Size of Stone Aggregate

There is a general tendency throughout the country to increase the size of the stone aggregate from 1½ to 2½ inches in waterbound macadam, bituminous macadam (penetration method), and concrete pavements. This has the advantage of making a larger amount of the product at the crusher available for use and thereby cheapening the cost of top-course stone. It has the further advantage of giving structural stability to the mass of compacted stone for it may readily be seen that there is greater strength in a uniformly graded aggregate properly fitted together than there can be in single size stone. The use of the larger size aggregate also gives a better surface, because with more stone in the surface and with the use of larger pieces there is less chance for ravelling. Where it is necessary to use softer stone the rolling of consolidation will not fracture or grind up the larger particles as rapidly as it does the smaller ones.

Waterbound Macadam

There have been two methods in use in the past few years in the treatment of this type of road. One has been to form the last puddle with light cold tar or light cold oil. This has the advantage of holding the bond together on the top surface of the road as well as making it dustless. Maryland has some of this class of road and from reports it would seem that it is very satisfactory.

The other method is to treat all waterbound macadams with calcium chloride and a surface treatment of light cold tar or light cold oil, provision for both items being made in the contract. All work that has been properly puddled and bound and subjected to traffic for a period of from 3 to 6 months should be swept clean and the surface application made of bituminous material which is covered lightly with stone chips or coarse sand. This has the advantage of making the pavement dustless and the mat or cushion formed upon the surface prevents it from disintegration and ravelling.

(Continued on page 42, Construction News Section)

*Abstracted from paper read before the Association of State Highway Officials.

ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS

THE annual meeting of the Canadian Society of Civil Engineers will be held in Montreal next week for the fourth time during the war, for the thirty-second time in the history of the society, and probably for the last time under the society's existing name, as the members are now voting to change the name of the society to the Engineering Institute of Canada.

The meeting will be held in the society's building, 176 Mansfield Street, Montreal, and it is expected that it will be fully as well attended as previous annual meetings. The first session will open at 10 o'clock Monday morning, January 21st, with the reading of minutes and the appointment of scrutineers for the election of officers and members of council, for the revision of by-laws and for the vote on the change of name. The remainder of the morning will be taken up by reports of council, library committee, treasurer, finance committee and branches, with adjournment at 1 o'clock.

Opens Next Monday Morning

The afternoon session will be devoted to reports of committees, including those on conservation, roads and pavements, electro-technical commission, steel bridge specifications, education and board of examiners, reinforced concrete, steam boiler specifications, general clauses for specifications and committee on society affairs.

At 7 p.m. an informal dinner, complimentary to visiting members, will be given in the University Club, to be followed at 8.30 p.m. by an entertainment and smoker in the auditorium of the society's building. The committee in charge of this entertainment is as follows:—

J. Duchastel, J. de G. Beaubien, W. D. Black, J. A. de Cew, E. S. Mattice, D. C. Tennant, R. M. Wilson and Julian C. Smith.

The following have consented to act as a reception and introduction committee throughout the annual meeting:—

William McNab, H. V. Brayley, J. A. Burnett, C. R. Coutlee, G. A. McCarthy, F. B. Brown, G. G. Gale, George Hogarth and Aurelian Boyer.

Address on Fuels

At 10 o'clock Tuesday morning the members will meet again to continue to receive reports of committees and to act thereon, should this business not have been completed the previous afternoon. At 10.30 a.m., B. F. Haanal, B.Sc., of Ottawa, will deliver an address on "Fuels." This paper will outline the present fuel situation and discuss the future supply. It is expected that C. A. Magrath, fuel controller of Canada, will be present to take part in the discussion, also R. A. Ross and Arthur Surveyer, members of the honorary advisory council for scientific and industrial research.

The retiring president, Col. J. S. Dennis, will deliver an address at 3 p.m. Tuesday, preceding the unveiling of the honor roll. It is intended to make this unveiling one of the main features of the annual meeting. Major-General Mewburn, minister of militia, and delegates from several other technical societies, have been invited to be present and to speak.

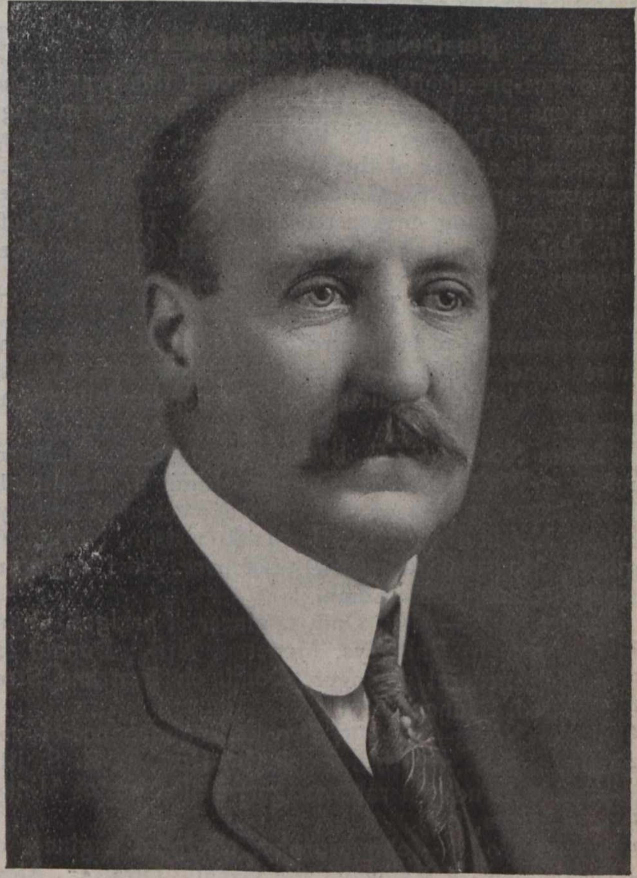
A theatre party, complimentary to visiting members, will be held Tuesday evening.

The reports of the scrutineers will be brought in at 10 a.m. Wednesday, following which the newly elected president will take the chair preparatory to the transaction of new and unfinished business. A meeting of the new council for 1918 will be held Wednesday afternoon.

In previous years arrangements have been made with the Eastern Canadian Passengers' Association, whereby members and their families who paid a full one-way fare to Montreal were returned free of charge on presentation of a standard convention certificate, but it is not certain whether similar arrangements can be secured this year owing to war conditions.

The President-Elect

At this annual meeting, Col. John Stoughton Dennis, C.E., D.L.S., D.T.S., assistant to the president of the Canadian Pacific Railway Company, will be succeeded as



Henry Hague Vaughan, President-elect of the Canadian Society of Civil Engineers

president of the society by Henry Hague Vaughan, vice-president and general manager of the Dominion Bridge Co., Limited.

Mr. Vaughan was a member of the council of the society in 1910 and 1911, and was vice-president in 1912, 1913 and 1914. He joined the society as a member on October 11th, 1906.

He was vice-president of the American Society of Mechanical Engineers from 1910 to 1912, and president of the American Railway Master Mechanics' Association in 1908. He is a past president of the Montreal Engineers' Club and of the Canadian Railway Club, and is a member of the Institute of Mechanical Engineers.

Mr. Vaughan was born in Forest Hill, England, December 28th, 1868, and was educated at Forest House School and King's College, London. Before going to the United States in 1891, he had some experience in railway shop work in England. He was with the Great Northern Railway until 1898, when he became mechanical engineer of the Q. and C. Co. and of the Railway Supply Co., of

Chicago. In 1899 he was appointed assistant superintendent of shops for these companies. In 1902 Mr. Vaughan became assistant superintendent of motive power of the Lake Shore and Michigan Southern Railway, Cleveland, Ohio, resigning in 1904 to accept a position with the Canadian Pacific Railway as superintendent of motive power for eastern lines. He was appointed assistant to the vice-president in 1905, and resigned this position in 1915 to accept the presidency of the Montreal Ammunition Company, which office he still retains. Mr. Vaughan is also vice-president and manager of the Dominion Copper Products Co., vice-president of the Albany Car Wheel Co., and is a member of the board of directors of the Dominion Bridge Co.

Nominees for Vice-President

Two vice-presidents are to be elected this year. The nominations are: H. E. T. Haultain, professor of mining, University of Toronto; R. F. Hayward, chief engineer and general manager of the Western Canada Power Co., Vancouver; and J. G. G. Kerry, of Kerry & Chace, Limited, consulting engineers, Toronto. The late Prof. C. H. McLeod had also been nominated for the vice-presidency.

The Council

Two members to be elected to the council to represent Montreal and vicinity (District No. 1), and one member from each of the other districts. The nominations are as follows:—

District No. 1—C. F. Bristol, construction engineer, Armstrong-Whitworth of Canada, Limited, Montreal; Ernest Brown, professor of applied mechanics and hydraulics, McGill University; J. M. Robertson, consulting engineer, Montreal; Olivier O. Lefebvre, chief engineer, Quebec Streams Commission.

District No. 2—Alex. Duff, engineer of bridges, Canadian Government Railways, Moncton, N.B.; Donald H. McDougall, general manager, Dominion Iron and Steel Co., Limited, Sydney, N.S.

District No. 3—Noel E. Brooks, maintenance-of-way engineer, C.P.R., Sherbrooke, P.Q.; Hon. G. R. Smith, vice-president and general manager, Bell Asbestos Mines, Thetford Mines, P.Q.

District No. 4—John Murphy, electrical engineer of the Department of Railways and Canals, Ottawa; Alex. Gray, mining engineer, Ottawa.

District No. 5—L. M. Arkley, assistant professor of mechanical engineering, Toronto University; Peter Gillespie, professor of applied mechanics, University of Toronto.

District No. 6—G. D. Mackie, engineering-commissioner, Moose Jaw, Sask.; L. A. Thornton, city commissioner, Regina.

District No. 7—A. E. Foreman, assistant city engineer, Victoria, B.C.; E. G. Matheson, professor at McGill University College, Vancouver.

A Solemn Meeting

The annual meeting of the society this year promises to be more solemn than many of the past meetings. The loss of so many members at the front will be brought home to the members more forcibly by the unveiling of the honor roll and the speeches in that connection, and also by the speeches which will no doubt be made in testimonial of the services of the late Prof. Clement Henry McLeod, who was for twenty-five years secretary of the society.

Prof. McLeod died Wednesday afternoon, December 26th, while in his office at McGill University. He had been ill about six weeks before but had made a rapid recovery, and appeared to be in good health just before his death. Prof McLeod was 66 years of ago. He was one of the charter members of the society, having joined as a member on January 20th, 1887. He succeeded the late H. T. Bovey as secretary in 1891, and occupied that position continuously until February, 1917.

Death of Former Secretary

In his death the society loses one of its most energetic organizers and the public, a scientist who has accomplished considerable valuable research work. Born at Strathlorn, Cape Breton, N.S., Prof. McLeod graduated from the Truro High School and in 1873 from McGill University. Following his graduation he was engaged in railway work in Newfoundland and in the maritime provinces, being called to McGill as a professor in 1888.

He was professor of geodesy and surveying and since 1908 had been vice-dean of the engineering faculty. He held the degree of Master of Engineering, was a Fellow of McGill, a life member of the Royal Astronomical Institute and a Fellow of the Royal Society of Canada. Recognized as an authority upon astronomy and surveying, many of his writings have been widely used as texts in advanced scientific courses. One of his achievements was to fix definitely the longitude of Montreal. He was often called by the legal profession as an expert witness on engineering questions as well as regarding his records as to weather conditions.

Prof. McLeod organized his department at the University with great ability. He conducted, in addition to the work at the University itself, a summer school in surveying which has probably not been surpassed by any other on the continent. His ability as an organizer was frequently made use of by the University in the management of public functions and entertainments.

At one time a leading member of the McGill football team, Prof. McLeod was an enthusiastic supporter of athletics in the University. He was chairman of the Grounds and Athletics Committee for many years and was also a member of the Intercollegiate Athletic Governing Board.

Was Noted in Astronomical Work

The observatory at McGill University adjoined Prof. McLeod's residence, and he spent a great deal of time there during the evening, and frequently until a very late hour of the night. He was more than once offered the position of chief astronomer of the Dominion, but he refused to leave McGill. He was the official time-keeper for the Grand Trunk Railway until a year ago when the time-keeping systems of the G.T.P. and G.T.R. were merged.

Prof. McLeod is survived by his widow, four sons and two daughters. The sons are, Norman M. McLeod, contractor, of Toronto; C. K. McLeod, of Nobel, Ont.; W. M. McLeod, a fifth year medical student at McGill University, and Lieut. G. D. McLeod, of the Royal Flying Corps, at present in England. The daughters are Mrs. G. S. Raphael, of Vancouver, and Mrs. (Dr.) R. E. Powell, of Westmount.

The funeral was held from the late residence, the services being conducted by Rev. I. A. Montgomery, pastor of Knox Church. Dr. Symonds, vicar of Christ Church Cathedral, Montreal, a very old friend of the family, delivered an eloquent address on the life of the deceased. The services were attended by a number of representatives of McGill, Toronto and Queen's Universities, and of the Canadian Society of Civil Engineers and other scientific bodies. Interment was in Mount Royal Cemetery.

DESIGN OF RESTRAINED BEAMS CARRYING HYDROSTATIC LOAD

By E. H. Darling, M.E., A.M.Can.Soc.C.E.

THE conditions are sometimes met with in construction, as for example, in rectangular tanks, where a vertical wall must be designed to sustain hydrostatic pressure on one side. If the wall is to be made of steel or reinforced concrete it is necessary to know something of the probable stresses which will be developed and also the effect of stays, ties, or other supports which it may be convenient to provide. There is very little information on this subject to be found in engineering handbooks and a theoretical analysis is tedious work. The accompanying diagrams give coefficients for bending moments, reactions and shears for eight simple conditions, and these may serve as guides in approximating more complicated arrangements.

It will be noted that we are dealing with a special case of a continuous or restrained beam carrying a uniformly varying load. Any movement of the supports, which are here the ties or stays, will seriously alter the stresses in the beam. Consequently, in actual practice, ample allowance must be made for possible movement. Not only should a large factor of safety be used for the beam but ties and struts, especially long ones, should be designed for low unit stresses so as to minimize the elongation or contraction. In very special cases a more accurate approximation could be obtained by first making a preliminary design, using these coefficients, and then going through the theoretical analysis, allowing for the calculated movement of the supports.

Another assumption that has been made is that the moment of inertia of the wall is the same for all horizontal sections. Where this is not the case these coefficients would not apply. It would be necessary to first obtain the correct equation for the elastic curve and use it in the mathematical analysis, or else resort to a graphical method.

These diagrams might also be found useful in the design of bins, caissons, retaining walls, etc., where there may be opportunities for the use of ties or other supports. The pressure exerted by granular material is approximated by substituting an equivalent fluid pressure. The weight of the fluid per cubic foot may be found by the formula

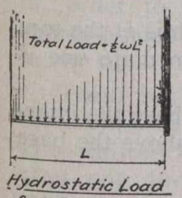
$$w = \tan^2 \frac{90 - \text{angle of repose}}{2} \text{ weight per cubic foot.}$$

The following table gives the weight per cubic foot of the equivalent fluid for a few granular materials, but these values should only be used where the width of the bin is great enough to insure that there is no arching effect such as is found in deep grain bins.

	Wt. per cu. ft.	Angle of Repose.	Wt. per cu. ft. equivalent fluid.
Earth ...	100 lbs.	45 degs.	17 lbs.
Sand ...	100 lbs.	34 degs.	28 lbs.
Anthracite	56 lbs.	27 degs.	21 lbs.
Bitu. coal	52 lbs.	35 degs.	14 lbs.
Wheat ..	50 lbs.	28 degs.	18 lbs.

As intimated above, the mathematical analysis is merely that given in the text books for the solution of problems in restrained beams, of which this is a special case, and is more tedious than difficult. The following examples will illustrate the method:—

1. Beam supported at the one end and fixed at the other.—Let L be the length in feet of a beam one foot wide, fixed at the right-hand end and supported at the other (Fig. 9), carrying a uniformly varying hydrostatic load which equals wx at any point, x, where w equals the weight per cubic



Hydrostatic Load
Same for all cases.

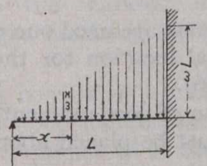


Fig. 9

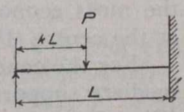


Fig. 10

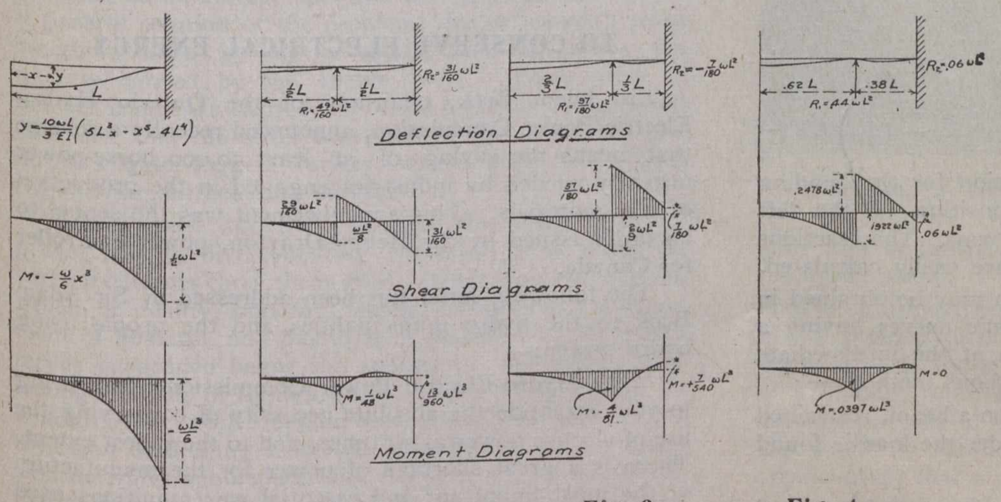


Fig. 1 Cantilever
Fig. 2
Fig. 3
Fig. 4
— One Intermediate Support —

Reaction, Shear and Moment Coefficients for Beam Fixed at One End and Supported at Various Points

L = length of beam in feet.
w = weight of fluid per cubic foot.

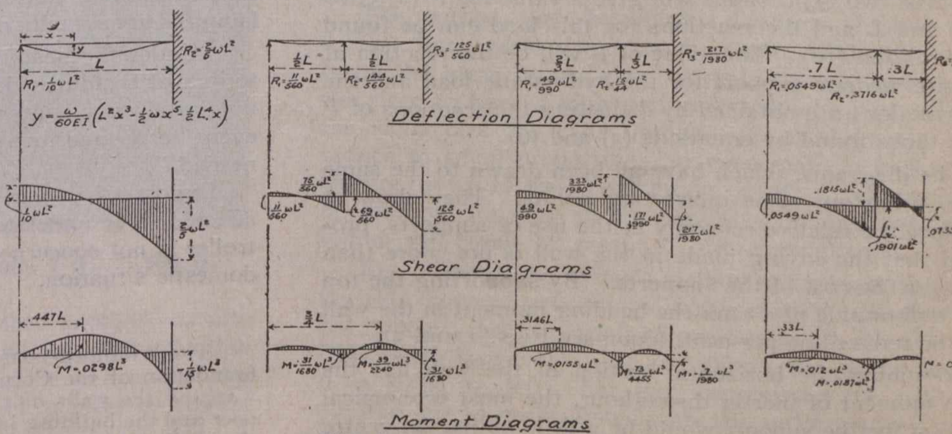


Fig. 5 End Supported
Fig. 6
Fig. 7
Fig. 8
— Two Supports —

foot of the fluid. Let R_1 and R_2 be the reactions at the supports. Then the equation for the elastic curve, where y is the deflection, is

$$EI\frac{d^2y}{dx^2} = \text{moment at } x = R_1x - \frac{1}{6}wx^3 \qquad (1)$$

Integrating twice

$$EI\frac{dy}{dx} = \frac{1}{2}R_1x^2 - \frac{1}{24}wx^4 + C_1 \quad - - - \quad (2)$$

$$EIy = \frac{1}{6}R_1x^3 - \frac{1}{120}wx^5 + C_1x + C_2 \quad - \quad (3)$$

The value of C_1 is found from the condition that the tangent of the elastic curve, $\frac{dx}{dy}$ in equation (2), equals zero when x equals L. Also, in (3) $y = 0$ when $x = 0$, therefore, $C_2 = 0$ and the equation becomes

$$y = \frac{1}{EI}\left(\frac{1}{6}R_1x^3 - \frac{1}{120}wx^5 - \frac{1}{2}R_1L^2x + \frac{1}{24}wL^4x\right) \quad (4)$$

When $x = L$, $y = 0$, and we obtain

$$R_1 = \frac{1}{10}wL^2 \text{ and} \quad - - - - - \quad (5)$$

$$R_2 = \frac{2}{5}wL^2 \quad - - - - - - \quad (6)$$

and substituting these in (4)

$$y = \frac{w}{60EI}\left(L^2x^3 - \frac{1}{2}wx^5 - \frac{1}{2}L^4x\right) \quad - \quad (7)$$

By employing the proper expression for the bending moment in (1) the solution for any position of the left support can be obtained in the same way. The reactions once found, the bending moments are easily calculated.

2. For two supports.—A solution may be obtained in a similar way, there being two elastic curves having a common tangent and zero deflection at the intermediate support. The following is a less tedious method:—

For a single concentrated load P on a beam, restrained as before (Fig. 10), the deflection under the load is found from text books to be

$$y = \frac{PK^2L^3}{EI}\left(\frac{1}{12}K^4 - \frac{1}{2}K^2 + \frac{2}{3}K - \frac{1}{4}\right) \quad - \quad (8)$$

and the reaction

$$R_1 = \frac{1}{2}P(2 - 3K + K^3) \quad - - - \quad (9)$$

$$R_2 = \frac{1}{2}P(3K - K^3) \quad - - - - \quad (10)$$

If, then, kL gives the location of the proposed intermediate support, find the deflection of the beam at this point under the hydrostatic load by means of equation (7) and also for a concentrated load P by equation (8). Equating these two expressions will give a value for P in terms of w and L and the reactions for this load can be found from (9) and (10). The value of P will be the reaction at the intermediate support for the hydrostatic load and the end reactions are obtained by deducting the reactions of P from those found by equations (5) and (6).

The diagrams, which have all been drawn to the same scale, bring out some interesting points. They show at a glance the relative economy in the use of supports, provided that the saving made in the wall is not more than offset by the cost of the supports. By supporting the top of a wall or side of a tank the bending moment in the wall may be reduced 60 per cent. (compare Figs. 1 and 5).

Assuming the horizontal section of the wall has the same moment of inertia throughout, the most economical position for the support would be a little above the centre as this gives minimum and equal bending moments at the base and support.

With the support at the lower third point (Fig. 3), which is the centre of gravity of the hydrostatic pressure, instead of this giving a reaction at the support equal to the pressure and zero shear and moment at the base, as we would expect from the theory of rigid dynamics, we have a reaction at the support greater than the total pressure and a positive shear at the base. This, of course, is due to the fact that the right-hand is fixed and does not yield so as to allow the load to balance itself over the support.

With the support at a point about $.38L$ above the base we obtain a condition of zero moment at the base. In some practical cases it is very desirable to eliminate bending at this point, where the sides of a tank join the bottom.

When two supports are used one of which is at the top, the most economical location for the intermediate one is at the centre (Fig. 6).

For the condition of zero moment at the base the intermediate support must be placed about $.3L$ above the base (Fig. 8).

TO CONSERVE ELECTRICAL ENERGY

Sir Adam Beck, chairman of the Ontario Hydro-Electric Power Commission, announced recently a scheme that means the saving of at least 50,000 horse-power urgently needed by industries engaged in the production of war materials. This announcement was the sequel to an order issued by Sir Henry Drayton, power controller for Canada.

The following letter has been addressed by Sir Adam Beck to the hydro municipalities and the people using hydro power:—

"The Hydro-Electric Power Commission again bring to your attention the absolute necessity of conserving the use of electric power at all times, and to the fullest extent. There is a great shortage of power for the manufacture of the most important and essential war munitions used in the manufacture of high-grade steel for shells and guns, and also explosives, as well as many other important war materials.

"The Commission, therefore, orders and directs that all municipalities, commissions, companies or persons being supplied by the Commission, exercise the strictest economy in the use of electrical energy, and that, on and after January 15th, 1918, and until further notice, the use of electrical energy for advertising or ornamental lighting shall be discontinued entirely, and that electric street lighting be reduced to the utmost possible limit, discontinuing cluster lighting entirely, and only using such lamps as are actually necessary for the safety of the public.

"Under the heading of advertising is included the interiors of buildings during the hours when the latter are not open for business. Turn off every lamp, switch off every heater and motor, the use of which is not absolutely needed."

Export of power to the United States will not be affected, it is understood, as the Dominion power controller is not concerned so much with exports as with the domestic situation.

The Winnipeg board of control have been warned that the foundation of the Cornish bath and library is slowly giving way and the walls of the building cracking. The city engineer and the building inspector have been instructed to make a thorough investigation, and an early report to the board on the necessary repairs to prevent any further damage to the building.

ICE DIVERSION, HYDRAULIC MODELS AND HYDRAULIC SIMILARITY*

By Benjamin F. Groat, M.Am.Soc.C.E.

THIS paper treats of a new method of diverting surface water and all floating materials carried thereby for the purpose of preventing jams in canals and rivers. The paper also shows how hydraulic works may be designed by studying the performance of small-scale models.

On many of our northern rivers, notably the Niagara and St. Lawrence, there is an immense annual crop of ice which must be taken care of in one way or another in order to protect the various interests along the shores against damages resulting from shoves, jams, and heavy runs.

These heavy floes consist of ice in all its forms and conditions, so that no one method of treatment is likely to be entirely effective against all of them. There is, however, one property, more or less pronounced, which is common to all forms, and this fact is available toward a general solution of the problem. Ice is buoyant unless weighted down by heavier solids, such as stones, frequently carried by the anchor form. Even when no heavier solids are carried, there are forms of such spongy character that the water contained by the interstices produces a water-logged variety, which, once submerged, rises to the surface very slowly.

Some years ago it occurred to the writer that the proper way to divert floating materials is to make the surface currents carry them away, rather than use a boom, which, in reality, opposes, instead of assists, the movement of floatage, and has little or no effect at all on materials suspended below the surface of the water. Following this line of thought, a patent has been applied for which covers both method and means for effecting a diversion of floating materials superficially, and a diversion of water sub-superficially, so that all, or nearly all, the water containing ice can be diverted in one direction,

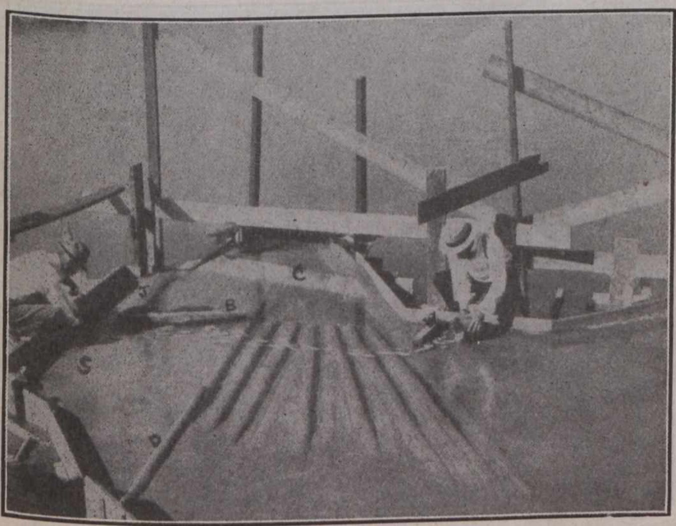


Fig. No. 1.—Model of River; Scale, 1 ft. = 100 ft.

while the remainder can be turned into another—as into a power canal—practically free from ice and all other floating débris. In addition, it is possible to prevent jams and to control the surface currents of a river or stream so that it will be capable of carrying off all floating materials as fast as they are supplied from above, or can form within it.

As it is principally the surface currents which carry floating materials, it will be possible to measure, more or less exactly, the transporting capacity of a river at a particular place by means of the product of the witdh and mean surface velocity at the place. For brevity, this pro-

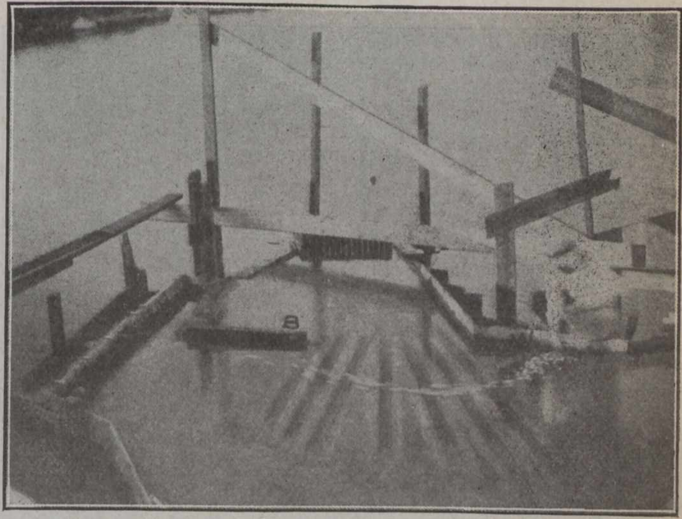


Fig. No. 2.—River Model After Removal of Jetty

duct may be called the "transportivity" of the river at the given place.

The transportivity of a river, then, furnishes a test of the probability of a jam or congestion of ice at any place. If it be found, for example, that the transportivity of a stream, relative to the number of square feet of floatage per second to be discharged, is great at one point and small at another a short distance below, it would appear likely that a jam might form at some intermediate place. Such a condition would exist in a reach of a river which consists of a wide, deep pool fed by a broad, shallow section and discharged by a narrow, deep outlet of relatively large sectional area. Evidently, the pool might be supplied with floating materials more rapidly than it could discharge them, the transportivity of the feeder being much greater than that of the outlet, saying nothing of any ice which might originate in the pool itself.

The foregoing statement is not based merely on theory, but rests on firmly-established facts connected with the winter conditions obtaining on our northern streams generally.

The method, then, by which a diversion of water from a river to a power canal can be made, while all the ice is carried away by the river or main stream, is to cause the river to have a high surface transporting capacity in the vicinity of the canal intake and at the same time reduce to small proportions, or even make negative, the transportivity of the canal intake itself. It is clear that no material increase in its likelihood to jam below the intake will result by reason of this arrangement.

Fig. 1 shows the writer's method and means for securing this important result. A model of an actual river has been constructed to a scale of one-hundredth the full size. This reach is marked *SS'*, and shows the water flowing from right to left. The ice, represented by cakes of paraffin cut to scale, flows with the surface water. The intake of the canal is shown at *C*. In this particular instance, the entrance, or intake, of the canal, is too wide,

*From paper presented to the American Society of Civil Engineers, 1917.

and the first step toward reducing the transportivity of the intake is to introduce a jetty, *B*, extending part way across the opening. The transportivity of the intake may now be further reduced by dredging, or otherwise excavating, several channels in a transverse, or oblique, direction across the main stream and leading toward, to, or even into, the intake of the canal. As the channels must be separated by ridges, or other elevations, between them, the transportivity of the main stream will not be

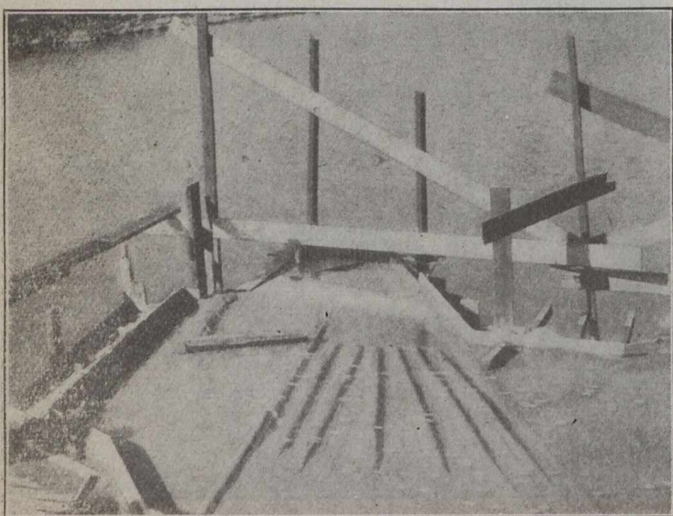


Fig. No. 3.—How Intake Performs When Ice Is Scattered All Over River

altered materially if the crests of the ridges are left at the original surface of the bed of the stream. This condition must maintain because the effective transverse cross-section of the main stream has not been altered materially, though the effective transverse cross-section of the intake has been enlarged to any desired extent. If it should be required to increase the transportivity of the main stream, the ridges may be built to any desired elevation higher than the original bed. This joint control of the surface transporting capacities of stream and canal intake can be exercised by adjusting proportions *ad libitum*.

In many cases it will be found necessary to provide a wing, *W*, to prevent materials from floating into the intake around the up-stream head, and it may be of advantage to construct a jetty, *D*, extending from the shore opposite the intake, or to build some other kind of structure for the purpose of narrowing the main stream in the vicinity of the intake, the object being to concentrate the surface water of the river over the diversion channels or ridges, thus reducing the length of the channels, and, consequently, also the excavation and ridge construction.

It may be further explained that so many transverse channels and ridges will not always be required, though the locations and dimensions of the jetties, wings, channels, ridges, or other elements for effecting a separation of the ice and canal water, must be determined in each particular instance by careful theoretical study most effectively aided by digesting the results of tests on models. As an illustration of such a change from the conditions shown in Fig. 1, the writer may refer to Fig. 2, wherein the jetty, *D*, has been removed. The illustration shows the result of a test with the same hydraulic conditions as in Fig. 1, the ice diversion being nearly as satisfactory, but the wing, *W*, requires considerably more extension into the channel of the main stream. This would be objectionable if navigation would be seriously impaired thereby.

The writer has a theory for the design, construction and operation of such an ice and water separating and diverting works, but will not enter into many details for the present, as it would tend to distract the technical reader's attention from the main principles and facts established, and might be subject to some criticism by persons less accustomed to formal methods of thought and research. However, it may be permissible to explain briefly the operation of the sub-surface diversion channels and ridges.

It is evident that water must flow from the main stream to the divergent canal if there is any draft by consumers along the canal. This will cause a greater or less tendency for all parts of the water in the main channel and diversion channels to flow toward the canal, as the water consumed or otherwise taken from the latter would naturally cause a fall of the water surface at the intake within the canal, and this would leave a surplus head or pressure of water at all parts in the main stream and diversion channels toward the intake.

The water in the main current, however, is flowing rapidly down the main channel because of the restricted cross-section in that direction, and the water in the transverse diversion channels is not, as it can have no component motion of any consequence at right angles to the direction of the adjacent ridges. The water in the trans verse oblique channels, between the ridges and below their crests, can flow with facility only in the direction of, or toward, the intake of the divergent canal, which it does.

Not so with the water at or near the surface of the main stream at places which are not below the crests of the ridges. This water does tend to move toward the intake, but only by reason of divergent or transverse accelerations which cause the main currents above the ridges to become more or less curved and concave toward the intake.

If the widths of the main stream and intake, the elevations of the crests of the ridges, the depths of the transverse channels, and the geographical configuration of earth and water in the vicinity of the intake have re-

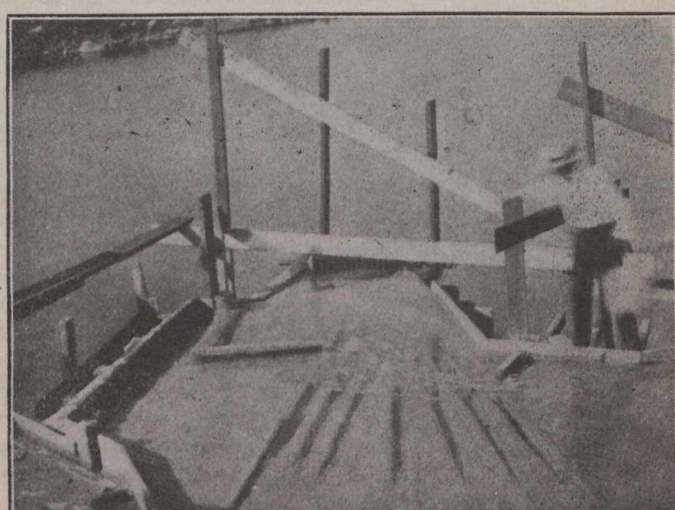


Fig. No. 4.—Showing Effect of Plugging the Downstream Ends of the Diversion Channels

ceived proper attention with a view to design, alteration, construction, and operation, the surface currents of the main stream will not be impelled toward the intake sufficiently to cause any of the water at the surface to move into the intake and down the canal while it is at the surface.

It is a fact that the writer's method and invention put the forces indicated by this theory into actual operation and furnish a means for constructing and operating the intake of the canal and main channel in the vicinity of the intake, so that no surface water, and, therefore, no floatage, will enter the canal from the main stream. With sufficient intelligent application of the theory, the surface transportivity of the intake can actually be made negative, so that the surface of the water will flow outwardly therefrom into the main stream, the canal receiving a sufficient supply of water from the sub-surface or lower portions of the main stream to take care of the combined requirements of the canal and negative currents.

This effect can be produced with more or less intensity by making what may be called a sub-surface diversion of water to the canal from the lower portions of the main stream in greater quantity than would be necessary simply to supply the water required for the canal. The result of this is that the excess water diverted sub-superficially must cause a counter or compensating current flowing outwardly from the intake into the main stream.

Fig. 3 shows how the intake performs when ice is scattered all over the river. It may be remarked that the density of paraffin is only a trifle less than that of the heaviest ice, and about the same as that of the lightest. When the cakes of paraffin have been used for a time they become covered with particles of dirt and grains of sand adhering to the faces, which have the effect of increasing their weight. It will be observed that no paraffin, and, therefore, no ice, enters the canal.

Fig. 4 shows the effect of plugging the down-stream ends of the diversion channels. Nearly all ice passing near the wing enters the canal, but it will be noticed that ice which chances to be over the unobstructed parts of the channels is not drawn into the canal, but passes on down the main stream, away from the intake, beyond the influence of the canal draft. This is all clearly shown in the figure.

Fig. 5 shows the result obtained when the channels are completely obstructed by filling them with clay to the

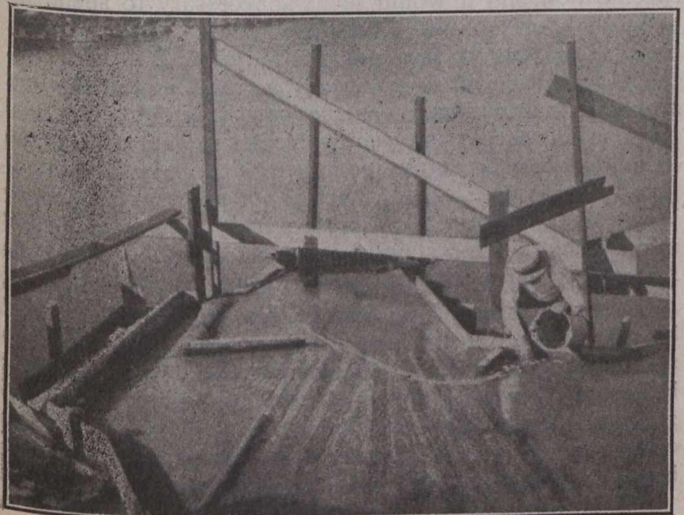


Fig. No. 5.—Channels Completely Obstructed

original elevation of the bed of the river. Here all the ice placed in the river at the wing passes into the canal.

Fig. 6 shows the operation of the intake in its natural condition, without diversion channels, ridges or wings. The outlines of the diversion channels show in the illustration, because the clay with which they are filled differs in color from the sawdust concrete out of which the bed of the river was constructed. A large proportion of river ice—more than half on the average—enters the canal.

Performance of Models

The writer has experimented with small-scale hydraulic models several times. His conclusion concerning this matter is that models perform in much the same way as the full-size prototype. In fact, there was nothing in the results of the experiments to indicate that they did

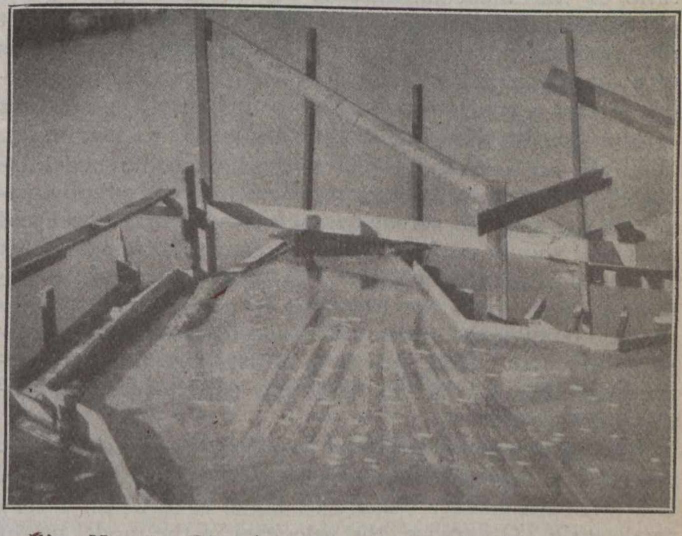


Fig. No. 6.—Showing Operation of the Intake in Its Natural Condition

not perform exactly as their prototypes. These statements apply equally to hydraulic models of all kinds, whether they be of machines, such as water-wheels and pumps; of structures, such as overflow dams, weirs and spillways; of sections of an actual river or canal, or of ships.

If, for example, a model of a section of a river has been constructed of sufficient size to prevent undue influences from properties of the fluid and materials which do not change by proper amounts with a change of scale, for example, viscosity, surface tension, etc., it will be found that the model performs almost exactly as the real section of river. Velocities, direction of flow, slopes of water surfaces, configuration of eddies and bends, are all repeated in the model with great fidelity, supposing, of course, that the model has been accurately constructed and that we understand what is meant by mechanical similarity, as well as by geometrical similarity.

In the case of hydraulic models, it can be shown that homologous velocities in models of different size must be proportional to the square roots of homologous linear dimensions. When the quantities of water have been properly adjusted to comply with this requisite, it may be said that the mechanical and hydraulic conditions in the two models are mechanically and hydraulically similar, just as the configurations of fluids and solids in the models are geometrically similar.

This requirement of mechanical and hydraulic similarity has certainly been overlooked in some of the most important tests of models. Its neglect has led to the belief among many that models cannot be relied on except as a means leading to rough approximations of doubtful value. Perhaps the tests of model water-wheels afford the most striking example. So far as the writer is aware, little heed has been taken to see that model water-wheels are tested under the proper heads; or, what is the same thing, if the head is fixed, as at Holyoke, that the size of the model wheel is properly proportioned to the head.

This is saying nothing at all of the setting of the model water-wheel, which frequently bears no resemblance to the full-size setting.

Suppose, for example, that a water-wheel 110 in. in diameter is to be erected on a waterfall of 180 ft. If the test is to be of a model operated under 16.5 ft. fall, then the diameter of the model should be only about 10 in., as the head for the model is only about the eleventh part of the total fall of water at the waterfall. In short, the actual fall and that in the model must be in the same ratio as the linear dimensions of the homologous parts of the water-wheel and its model. It is this important requirement which is frequently lost sight of. As wheels of 30 in. or more are usually tested, it can be easily inferred that a test on such a size would result in too high a value for the efficiency in the case cited.

If the surfaces of the water passages in the model are made sufficiently smooth to represent correctly the homologous parts of the actual passages, the actual wheel and its model should perform alike. It can be shown that this simply imposes the condition that the resistances to the flow of water over the homologous areas vary jointly as the homologous areas and the squares of the homologous velocities. This, we know, is nearly realized in practice. It follows that the foregoing statements are substantially correct.

The fact that homologous velocities must be proportional to the square roots of homologous linear dimensions is a fortunate matter, when the model is to be on a very small scale. Otherwise, the velocities in the model might be so small that they would not exceed Reynold's critical velocity, and thus the requirement of mechanical similarity would not be realized.

PRESENT STATUS OF GRANITE BLOCK PAVEMENTS*

By Clarence D. Pollock
Consulting Engineer, New York City

THE early specifications for granite blocks called for blocks of about the following dimensions: Length, 8 to 12 inches; width, 3½ to 4½ inches, and depth of 7 to 8 inches. These were paved upon a sand bed spread upon the earth sub-grade and the joints were filled with sand.

The next step was to use a concrete foundation under the sand cushion and a joint filler of gravel poured with bituminous material. The maximum width of joints was usually ¾ inch. The pavement was rammed and back-rammed, after which an attempt was made to scratch out the gravel from the top portion of the joints, and then the bituminous material was poured in while hot. This was unsatisfactory, as the filler simply matted on the top of the gravel unless the conditions were almost ideal. The next change was to put a small amount of gravel in the joints and then pour this part of the joint, after which dry and hot gravel was added and the joints were given a second pouring. This was an improvement, but as the joints were wide, the blocks chipped on the edges under traffic, and the pavement became rough and uncomfortable to ride on.

These blocks were large, having a depth of from 7 to 8 inches and were often 13 inches and even as much as 14 and 15 inches in length. With such deep blocks it was not practical to cut them so that they would lay with close joints.

Finally, some seven or eight years ago, at a conference between municipal paving engineers and the granite quarrymen, it was agreed to use a smaller and better cut block. This was the beginning of our modern granite block pavement. The present standard block has a width of from 3½ to 4½ inches, a length of 8 inches to 12 inches, and a depth of 4¾ inches to 5¼ inches.

Further requirements are that "the paving blocks shall be of medium grained granite, showing an even distribution of constituent materials, of uniform quality, structure and texture, without seams, scales or disintegration, free from an excess of mica or feldspar. The blocks shall be so dressed that the faces will be approximately rectangular in shape, and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ½ inch in width at the top, and for 1 inch downward therefrom, and not exceeding 1 inch in width at any other part of the joint. The top surface of the block shall be so cut that there will be no depressions measuring more than ⅜ of an inch from a straight edge laid in any direction on the top and parallel to the general surface thereof."

The above requirements are in the specifications of the American Society of Municipal Improvements, and are now in very general use. Of course, there are numerous exceptions to these standard blocks. A few cities specify a block with a length of 6 to 10 inches with a top surface or head cut so that there will be no depressions measuring more than ¼ of an inch and to lay to a joint not exceeding ⅜ of an inch. Such a specification may produce a pavement with possibly 10 per cent. of the joints better than with the standard specifications, but as the area of the head of the block is smaller and consequently more blocks are required to the square yard, it adds considerable to the cost of the pavement and the writer is of the opinion that this extra expense is not warranted except in rare instances. When standard blocks are well cut and properly paved under the specifications that the joints shall not exceed ½ of an inch in width, something like 75 per cent. of the joints will comply with the more rigid specification and it would seem unnecessary to spend an additional forty or fifty cents per square yard to have possibly another 10 per cent. of the joints a little closer. Such a requirement is practically as rigid as that for cut stone joints in building construction. It is not a practical proposition to split out paving blocks so that a ⅜ of an inch joint can be rigidly complied with. If a cement grout filler is used, such a joint is not necessary, and it is very questionable if it is ever necessary with even a bituminous filler. It certainly is not desirable to specify something which it is not practicable to obtain.

Other variations from the standard are so-called 4-inch blocks, Durax blocks, and the like. It is sometimes necessary because of freight charges, etc., to use shallow blocks, or else use a pavement which is less durable than granite blocks. This condition is more likely to prevail on road work and in inland cities where there is a rail haul.

Then there is another condition which requires a shallow block, and that is where the traffic conditions have changed so much that it is necessary to use granite to replace a lighter material, and yet it is desired to utilize the old concrete foundation. For such a condition a resurfacing block is made which has a depth of 3½ to 4 inches. It is preferable to lay such a block upon a cement mortar cushion, especially if the traffic is heavy.

The standard block, when properly cut and laid, is the most suitable for general conditions. This pavement is

*Abstracted from paper read before the Annual Meeting of Section D Engineering of the American Association for the Advancement of Science, Pittsburg, December 28, 1917.

laid in various ways. In cities and localities where it is possible to block off traffic for a sufficient time to permit the use of a cement grout filler it is usually laid with such a filler, and if the traffic is heavy enough to warrant the expense, it is often laid on a cement mortar cushion mixed in the proportion of one part of cement to three or often four parts of sand. This makes a very solid and durable pavement when properly done. The blocks should be sorted and laid in courses so that blocks as nearly as possible of the same width are in a course and the blocks should be paved with close end or longitudinal joints, the courses running transversely from curb to curb. The transverse joints should be as close as possible and yet keep straight courses. The longitudinal joints should be broken by a lap of at least three inches.

The pavement should be thoroughly rammed and all poorly bedded blocks raised and back-rammed until the blocks are all well and evenly bedded and the surface of the pavement is true and even to the grade and crown of the street. It is advisable to use no sand or gravel in the joints. Proper ramming will cause the blocks to sink into the cushion so that a little ridge of the cushion will separate the blocks and be sufficient to hold them until the filler is poured, provided wheeling and other traffic is not permitted over the surface.

Now the pavement is ready for the filler. If it is to be a cement grout filler, it should be mixed in the proportion of one part of Portland cement to one part of fine sand, preferably an even-grained sand, and, when possible to obtain it without excessive cost, one which will pass a 20-mesh sieve. The finer and more even the sand particles, the better they will remain in suspension and make a uniform filler. A machine mixer should be used in order to secure a uniform product and the grout should be delivered directly upon the pavement by means of a chute or spout. The grout should then be broomed into the joints thoroughly until they stand full and flush with the surface of the blocks, but a surplus should not be left over the surface. The wear should come upon the granite. The traffic will then wear down any small irregularities in the heads of the blocks.

When a bituminous filler is used the best practice is to add a fine hot sand and mix it before pouring the joints. A straight coal-tar pitch is too susceptible to temperature changes to be used in this climate, but a mixture of one part of asphalt with five parts of coal-tar pitch gives good results, as does also an asphalt filler. With either of these there should be added not to exceed 50 per cent. by volume of fine sand similar to that used in a cement grout filler. The amount of sand added should be at least 35 per cent. The sand should be mixed into the hot bituminous material and then drawn off into wheelbarrows or the like and dumped at once upon the pavement. It can then be worked into the joints by means of hose or the like. When the joints are thoroughly filled so that they stand up flush with the surface of the blocks, then a small amount of sand should be spread over the surface. This will prevent traffic from sticking and will help to harden the surface of the joint filler.

Brooklyn, N.Y., uses a mixture of coal-tar pitch, 100 parts; refined residual asphalt, 20 parts; to which, after thorough mixing, is added not to exceed one part of sand to one part of this bituminous mixture. The sand is fine, passing a 20-mesh sieve and is stirred in usually by a mechanical mixer.

In the Borough of Manhattan one part of hot asphalt cement is mixed with not to exceed one part of sand, the latter to pass a 10-mesh sieve. The mixture is made in a concrete carrier or pushcart of about seven cubic feet capacity.

The mixing is done with a rake or a perforated hoe. Both here and in Brooklyn the hot bituminous mixture is dumped directly upon the pavement and is pushed into the joints by means of hoes or squeegees.

These forms of bituminous fillers give the best results for this class of filler.

Bituminous fillers are most suitable for use when the traffic conditions are such that it is not practical to block off the street a sufficient time to permit the proper setting of a cement grout filler.

The cushion course on top of the concrete is usually sand and it should not be greater in depth than an average of one inch. This is sufficient with a specification allowing only a maximum variation of ½ inch in the depth of the blocks. Of course, the surface of the concrete should be smooth and it should conform to the crown of the finished pavement.

In some localities a dry mortar cushion of one part cement to four parts of sand has been used with success, especially where the joint filler was cement grout. This makes a very rigid pavement, and where the traffic warrants the additional expenditure of about fifteen cents per square yard it is probably advisable. The mortar cushion has been used also with a bituminous filler, but this seems to the writer to be a useless expense as the traffic is allowed on the pavement before the cushion can obtain a proper set and an examination of many openings has failed to show him a case of a bond between the bottom of the block and the mortar cushion. The claim is made that this cushion does not wash if any water finds its way through the joints of the pavement. If the joint filler is properly placed in the joints there should be no trouble from this course, even with a sand cushion. With a cement grout filler the blocks are held rigidly and the cushion obtains a proper set as the traffic is blocked off in order to permit the grout to set, and the cushion has the same opportunity.

Even with the great strides which have been made in granite block pavements in the past half-dozen years, there are still a great many people in our cities who still picture the old-style rough, open-jointed granite pavements when they hear granite mentioned in connection with pavements. As a matter of fact, these same people will ride over the modern smooth surface granite block pavements laid with cement grouted joints or with the latest form of bituminous joints and not recognize that it is a granite block pavement, and consequently fail to give it the credit which is its due.

The modern granite blocks, when properly laid, make a pavement which is as near permanent as it is possible to lay, and which is smooth and yet not slippery. While it is not wholly noiseless under metal tire traffic, yet because of its smoothness and the fact that the percentage of this kind of traffic is getting smaller and smaller each year, it is rapidly becoming a noiseless pavement.

The great improvement in the surface and the joints of this pavement in recent years has been due wholly to the co-operation between the engineers and the granite quarrymen. They have worked together in the endeavor to produce as good a block as it is practicable to make on a commercial scale, to have these blocks paved better and closer than formerly and to have the joints really filled with more permanent kinds of joint fillers. Neither the engineers nor the quarrymen could have accomplished this alone, but both working together with the same goal in mind resulted in great improvements in granite block pavements in a comparatively short time.

THE EFFECT ON ORIFICE AND WEIR FLOW OF SLIGHT ROUNDINGS OF THE UPSTREAM EDGE*

By Jacob O. Jones

THE effect on weir flow of the upstream vertical curvature has been investigated by Messrs. Fteley and Stearns, the results being reported in Vol. 12 of the Trans., Am. Soc. C.E., pages 97-101. Also Mr. G. Wells Ely and Mr. Francis M. Dawson, each investigated this problem for his graduate thesis. Ely's experiments were upon weirs with the upstream corner rounded to a radius of from 1 in. to 36 ins. Dawson experimented with roundings of ⅛ in. to 1 in. Fteley and Stearns investigated the effects upon weirs with crest radii of ¼ in., ½ in. and 1 in. Fig. 1 shows the percentage increase in discharge at 0.4 ft. head due to roundings of from ⅛ in. to ½ in., the plotted points being computed from the results of the experiments of Dawson, and Fteley and Stearns.

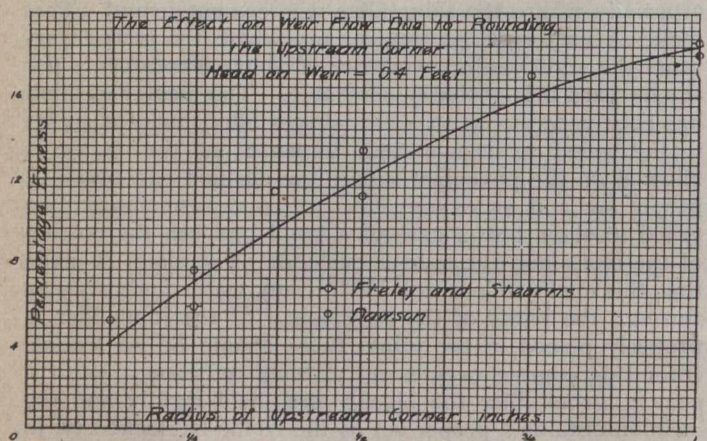


Fig. No. 1.—Curve Showing Increase in Discharge at 0.4 ft. Head Due to Roundings of ⅛ to ½ in.

It was the desire to determine the location of this curve from the ⅛-in. radius down to a sharp-edged weir, that constituted the second reason for this investigation.

Description of Apparatus for Weir Experiments

The weir experiments were performed with the apparatus which is permanently set up in the Cornell University Hydraulic Laboratory. The weir channel is made of reinforced concrete, is 24 ins. wide, 48 ins. deep and 30.33 ft. long. Water is admitted to the canal from a 10-in. pipe which brings the water from Beebe Lake. Just below the 10-in. gate valve, which controls the supply, is a flaring tube which serves to reduce the velocity somewhat and probably reduces the boiling action of the water. At the connection with the gate valve its cross-section is a 10-in. circle, and in a distance of about 2 ft. it changes to a 16-in. x 20-in. rectangle.

Two feet downstream from the discharge tube is a galvanized iron baffle, which consists of strips of galvanized iron 6 ins. wide placed in a horizontal position and ½ in. apart vertically. Another baffle is placed 1 ft. 4 ins. downstream from the first one.

Three feet downstream from the baffles is a "fence." This consists of strips of 1-in. boards nailed to upright pieces and rigidly fastened in the channel. Its purpose is to control the velocity distribution in the channel. It was desired to have as nearly uniform velocity as possible. To that end several fences were tried, velocity measurements being made with the current meter with the several fences successively in place. For the highest head the velocity was greatest near the surface and seemed to be less on the right side than either on the left or in the middle.

The head was measured by the means of float gauges. The floats had fins projecting outward from the sides to render them unsusceptible to the influence of capillarity. They were located 8 ft. upstream from the weir, one on either side of the channel. The still wells were sections of 6-in. wrought iron pipe, and were connected to the channel by 1-in. pipe. The 1-in. pipe entered the channel through the side wall at right angles to the direction of the current, at a point near the bottom, and the inner end of the pipe was flush with the face of the wall.

Over the channel between the float gauges was a current meter gauging station. An upright frame fastened securely, had notches cut to receive the current meter rod, so that the current meter was held vertically and always in the same vertical cross-section of the channel. The verticals designed as middle, left and right, were in mid-channel, 6 ins. from left wall, and 6 ins. from right wall, respectively, looking downstream. The current meter used was a small Price single-point meter.

The weir crest was a brass plate 2 ft. 3/16 in. long, 12 ins. wide and ¼ in. thick, the top edge of which was machined. This plate was fastened to the wooden bulkhead with eight brass screws, and after being thus securely fastened, the ends were further secured with a neat cement mortar. Great care was taken to make the crest level.

Inasmuch as the investigation had to do with the effect of slight roundings of the upstream corner on the discharge, it was exceedingly important to have a truly square, sharp corner to begin with. Accordingly, after the crest plate was received from the machinist it was carefully dressed with a small fine-grained corborundum stone. At all times care was exercised to protect the edge from blows or any accident which would nick it, and after the sharp-edged series was completed only one very small nick was found.

The bulkhead to which the weir plate was fastened was made of 2-in. tongue and grooved lumber. It was securely fastened with screws and in addition a neat cement filler was placed in the corners where the ends and bottom joined the sides and bottom of the channel. This made it so nearly water-tight that not even a drop of leakage was observed.

The nappe was confined by a prolongation of the sides of the canal which extended down to the level of the bottom of the channel. To provide aeration, strips of tin, concave downward, were fastened to the bulkhead and projected outward through the nappe.

The lower end of the canal terminated in a galvanized sheet iron hood. The lower part of this hood discharged the water into a flexible sheet iron spout, by means of which the stream could be diverted at will in a fraction of a second either into the 70 cu. ft. iron tank No. 2, into the 400 cu. ft. concrete tank or into the waste channel.

Observations and Observing

The work involved the measurement of the following variables: (1) Total quantity of water discharged, (2) the time necessary for the quantity of water to be discharged, (3) the head that prevailed during the time interval above mentioned. In addition to these variable quantities there were several more or less constant quantities to be measured. These were length of weirs, zero readings of all gauges, and the precision of the quantity measuring

*Abstract of article in "The Cornell Civil Engineer."

devices. The standard that the writer set for himself in the beginning was an accuracy of 1 in 1,000.

The length of the weir crest was obtained by the use of two ¼ in. square rods which were arranged to slide upon each other in the manner of inside calipers. They were placed in the canal and adjusted until the points were in contact with the sides of the canal and then removed and the distance between points ascertained with a brass scale graduated to .01 ft. It was necessary to estimate .001 ft., but this can be done with a fair degree of accuracy, and an error of even .002 would mean only 1 in 1,000, inasmuch as the crest was something over 2.00 ft. long.

The zero readings of the float gauges were determined in the following manner: A hook gauge was clamped to the bulkhead, to which the weir plate was attached, by means of an ordinary carpenter's clamp. The point of the hook was carefully brought to the level of the crest by means of a small pocket level and the hook gauge slow-motion screw; one end of the level, which was about 6 ins. long, resting upon the crest and the other end upon the point of the hook. The distance below the crest of the surface of the water in the approach channel was determined by lowering the hook and adjusting the point to coincide with the surface in the usual manner. Simultaneously the readings of the float gauges were observed. By adding the distance (from the surface of the water to the crest level) to the float gauge readings, the zero reading was obtained. In this operation care was exercised to have the surface of the water in the approach channel not more than 0.2 ft. below the level of the crest, and to maintain the surface at a fairly constant level. Because of leakage from the flume it was necessary to keep a small stream of water running into it to equalize the loss. These precautions were necessary to obviate error. In the first case, if the distance moved through by the hook gauge

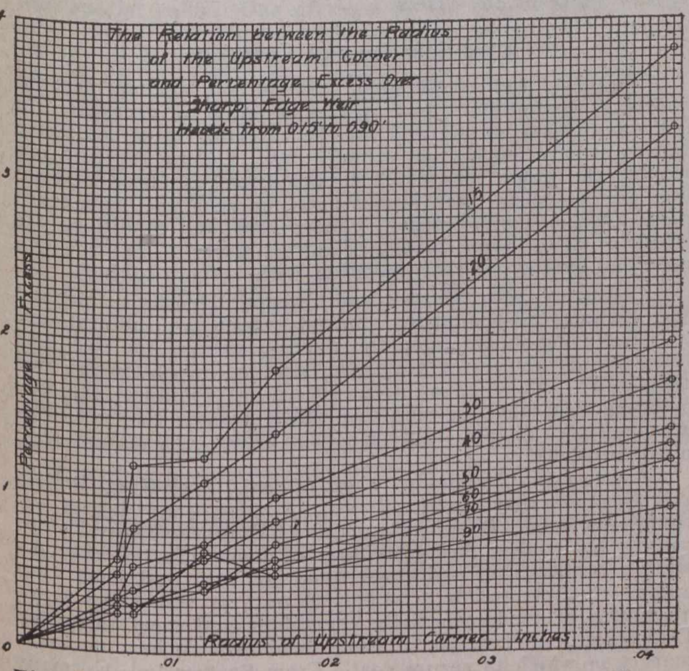


Fig. No. 2.—Relation Between Radius of Upstream Corner and Percentage Excess Over Sharp Edge Weir

from the crest level to the water surface were great, some error might be introduced due to a failure to make the hook gauge plumb. In the second case, if the surface of water should be falling rapidly, unless the readings of the hook gauge and the float gauge were simultaneous an error would be introduced.

The weir discharge measurements were made with iron tank No. 2, and with the 400 cu. ft. concrete tank. In either case the discharge measurements are believed to be accurate to well within 1 in 1,000.

The head observations for the weir experiments were made with the float gauges.

The operating conditions were for the most part very steady. For the weir experiments the flow was steady up

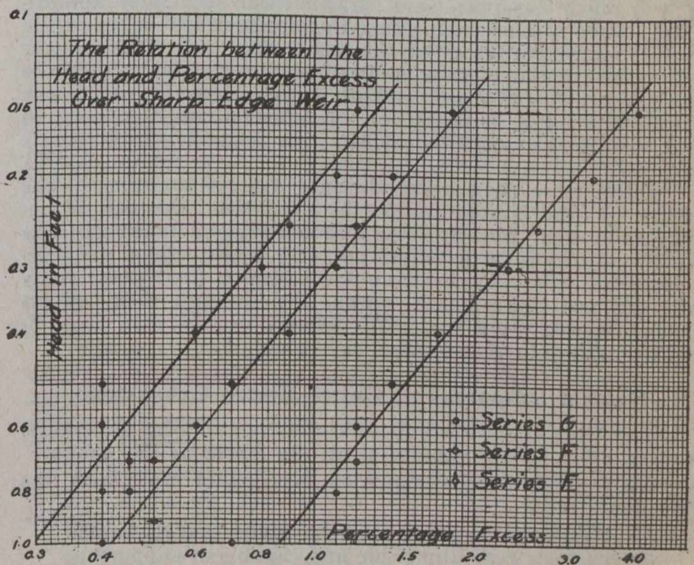


Fig. No. 3.—Relation Between the Head and Percentage Excess Over Sharp Edge Weir

to a head of 0.5 ft. Above this head the following range of gauge readings are representative:—

Mean observed head, in feet.	Range of readings, in feet From	To
0.6015	0.6005	0.6035
0.6981	0.6965	0.7005
0.8003	0.7980	0.8030
0.8979	0.8955	0.9025
1.0010	0.9975	1.0055
1.0985	1.0955	1.1045
1.3542	1.3515	1.3590

A raft of 2-in. x 10-in. plank 5.0 ft. long was placed in the approach channel just below the fence. This served to still the surface and eliminate standing waves. The head gauge was under constant observation during a run in both the orifice and weir experiments, and the mean observed head is the average of a large number of readings.

In the weir experiments the discharge measurements were reduced to cubic feet per second per foot of weir length.

The weir was rounded without removing it from the channel. For series B the edge was rubbed once across, with a piece of fine emery paper tacked on a board, under pressure of two or three pounds. For series C it was gone over twice more. The rounding for series D and E was accomplished in much the same manner except that a pad of felt was tacked on the board and covered with fine emery cloth, the result being that when the weir was rubbed with this, it being somewhat yielding, produced more of a real rounding, rather than an octagonal effect. For series F and G the edge was rubbed across twice with a fine file and then smoothed with the emery pad. For each series care was exercised to rub all parts of the edge

(Concluded on page 42, Construction News Section)

Coal Problem of Canada Demands National Action*

Vital National and International Question—Our Natural Resources Not Inexhaustible—Canada's Present Dependence Upon the United States for Coal—The Dominion Possesses Independent Fuel Resources Which Must Be Developed

By ARTHUR V. WHITE

SO much has been said, drawn from seemingly authoritative sources, respecting the "unbounded extent of the natural resources of Canada," that it is little wonder the popular view is entertained that Canada's resources are practically unlimited, and perpetual prosperity only waits upon their fuller development. For Canadians, however, to hold and be governed by such a view is to live in a "fool's paradise."

Little more than a decade ago, a large majority of the people of the United States believed that the natural resources of their country were unbounded, and that there was hardly any limit to material progress based upon their development. Even in that country, however, there were many who did not share these views, and through their efforts special investigation was made respecting the actual conditions of the natural resources of the nation.

Natural Resources of United States Exhaustible

The President called for a conference of the governors, leading officials and experts of all the States of the Union.

Addressing the conference on the 13th of May, 1908, the President stated:—

> "This nation began with the belief that its landed possessions were illimitable and capable of supporting all the people who might care to make our country their home; but already the limit of unsettled land is in sight, and, indeed, but little land fitted for agriculture now remains unoccupied save what can be reclaimed by irrigation and drainage. . . We began with an unapproachable heritage of forests; more than half of the timber is gone. We began with coal fields more extensive than those of any other nation and with iron ores regarded as inexhaustible, and many experts now declare that the end of both iron and coal is in sight. . . . The enormous stores of minerals, oil and gas are largely gone. . . . Our natural waterways are not gone, but they have been so injured by neglect and by the division of responsibility and utter lack of system in dealing with them that there is less navigation on them now than there was fifty yars ago. Finally, we began with soils of unexampled fertility, and we have so impoverished them by injudicious use and by failing to check erosion that their crop-producing power is diminishing instead of increasing. In a word, we have thoughtlessly, and to a large degree, unnecessarily, diminished the resources upon which not only our prosperity, but the prosperity of our children and our children's children must always depend."

Canada's Natural Resources Also Exhaustible

No country possesses, within its own borders, more varied and extensive resources than the United States, yet it is now recognized that many of these are within measurable distance of exhaustion. This fact was so clearly demonstrated that prompt action by the trustees of the nation became imperative. So far as one can judge, natural resources from the 49th parallel to the Gulf of Mexico are better situated, geographically, and must always be more desirable than those from the 49th parallel to the Arctic ocean; thus, by reason of situation, Canada's usable natural resources are in variety and extent less than those of the United States.

Those who have observed the rapid disappearance of many of the natural resources of Canada and the present alarming rates at which some are being consumed, realize that the situation, as a whole, is one of great gravity. Consequently, true conservation in Canada is as great, if not greater, a necessity than in the United States.

On the 6th of December, 1917, at the annual meeting of the Bank of Montreal, its president, referring in hopeful terms to Canada, said: "Our natural resources are unbounded and our credit is irreproachable."

Now, as a matter of fact, our resources are not unbounded, and our very credit is involved in the use we are making, and shall make, of the resources at our disposal. Many of these, as just stated, at present rates of depletion, and without proper methods of conservation being rigidly applied, are within measurable distance of exhaustion. By way of illustration: There was a time—and not so very long ago either—when the buffalo and the carrier pigeon existed in the United States and Canada in countless millions. To-day they are gone.

Resources Must Be Wisely Used and Conserved

It is true that some resources, such as minerals—perhaps more especially coal, oil and gas—if used, must in time, necessarily become exhausted. On the other hand, such resources as the soil, plant growth, waterways and ground waters, may be conserved and transmitted to posterity unimpaired, or at least unabused, just as a good husbandman passes on his farm in an improved condition to that in which he received it. The policies advocated by the Commission of Conservation of Canada have aimed at passing on to succeeding generations in an improved condition the heritage of the natural resources of this country.

By intelligent and thrifty use, the natural resources of Canada may beneficently serve the needs of a large population. If, however, Canadians become really dependent upon necessary commodities supplied them by other countries, they must be prepared to accept the circumstances in which they may suddenly find themselves if the supply of such commodities is cut off. Such circumstances will be aggravated by any abuse of our assets.

Coal Scarcity and Coercion

There is, apart from food, raiment and shelter, perhaps no single commodity which has been found so necessary for the maintenance of life and for the carrying on of commerce and transportation as fuel—chiefly coal. During the past few months the public interest has been keenly aroused respecting the nation's fuel supply and increasing dependence upon hydro-electric energy. The present war conditions are going to drive home to Canadians as never before the tremendous gravity of their position with respect to fuel.

Countries like Norway and Sweden, Denmark, Holland and Switzerland—countries, indeed, which are neutral—are practically dependent upon the warring nations for coal, and have found themselves seriously curtailed in obtaining this commodity. They have been forced to recognize the momentous fact that the countries which possess coal are able, absolutely, to dictate the terms upon which coal will be supplied to others.

Norway and Sweden are short of coal. Both Great Britain and Germany have released coal to these countries in exchange for food. Britain has required European neutral ships calling for coal to bring cargoes of foodstuffs or other desirable commodities. Holland must get its coal from Germany, which consents to supply it only in return for large quantities of food, especially vegetables and meat raised on Dutch soil. Holland at present has open to her no other market in which to secure coal. From Switzerland, Germany demands cash at the rate of 40,000,000 francs monthly for nine months at five per cent. in return for a monthly delivery of 200,000 tons of coal; and within the last month it has been reported that Germany has liberated some hundreds of agents instructed to secure control of the hydro-electric resources in Switzerland, so that, with these under their direction, and in control, also, of the coal supply, Germany would more completely dominate Switzerland. One of the chief factors which has existed in connection with Alsace-Lorraine has been that Germany wishes to maintain this outlet for her coal and in return derive from these areas the supply of iron which

*From the "Monetary Times Annual."

she herself lacks. The necessities of life—not the precious metals—are the real arbiters of exchange.

Now, a very large portion of Canada—and for this one may hold in mind much of the populated territory extending, say, from Quebec to Winnipeg—has become increasingly dependent for its fuel supply upon the coal fields of the United States, and absolutely dependent upon that country for its annual supply of some 4,500,000 tons of anthracite coal.

Portion of Canada Dependent Upon United States

In addition to the use of imported anthracite coal for fuel for heating and domestic purposes, large quantities of bituminous coal—some 10,000,000 to 14,000,000 tons—are also imported from the United States, largely for power purposes.

The known anthracite coal fields of the United States are within measurable distance of exhaustion. Upon this point there seems little difference of opinion. The time during which the supply will last, at rates of consumption existent prior to the war, is placed at about one hundred years. Doubtless, in the near future, the United States will feel compelled to conserve this valuable commodity, and the exportation of it may be largely restricted, if not entirely cut off.

There are available scores of examples, arising out of the present war conditions, where the United States has found it necessary to place stringent embargoes upon natural and manufactured products.

If Canada is to be in a position to command special consideration under possible restricted conditions, she must realize the value of her own resources and have them strictly under national control in order that she may be enabled to deal on a basis of *quid pro quo*. When the commodities of commerce are exchanged there must, of course, be a substantial basis for barter. When Germany demanded gold from Switzerland she offered to exchange coal. Suppose that the United States, in the conduct of her commerce, concluded that it was in the general interest of her citizens only to *barter* coal for certain commodities which she specially required, what desirable commodities has Canada to barter?

Canada an Exporter of Electrical Energy

Other than the products of her agricultural lands, mines and forests, there are certain resources in Canada of unique and special value. One of these is the hydro-electric energy which may be developed from Canada's waters, including her equity in international waters. At the present time the United States is importing from Canada about 275,000 horse-power years of electrical energy.* Many factors, of course, enter into the determination of the equivalent of this electrical power in terms of anthracite coal. Electric power has great advantage for many purposes over steam. Speaking in round figures, and taking cognizance of some of these special factors, the electrical power now imported by the United States would be the equivalent of probably not less than 3,000,000 tons of coal—it may be a quantity substantially greater.

Canada has been richly endowed with water-powers, although those serviceable from the standpoint of present economic development should be carefully conserved so that they may be used in the general public interest.

Any estimate for the water-powers of Canada must be presented and considered with a due appreciation of its limitations. The following table representatively sets forth the water-power situation in Canada. By no means may all the water-powers be economically developed:—

Estimate of Water-Power Resources of Canada**

Province	Total possible horse-power.	Developed horse-power.
Ontario	5,800,000	760,000
Quebec	6,000,000	640,000
Nova Scotia	100,000	26,000
New Brunswick	300,000	15,000
Prince Edward Island	3,000	500
Manitoba	....	76,000
Saskatchewan		
Alberta	3,500,000	33,000
North-West Territories		
British Columbia	3,000,000	250,000
Yukon	100,000	12,700
Total	18,803,000	1,813,200

Men far-sighted in the fields of industry and finance have foreseen the extent to which present and future generations will be increasingly dependent upon power, whether it be steam or hydro-electric.

Concentration of Control

In the United States, for many years past, special efforts have been made to concentrate control of water-powers. Most of the water-powers which are more readily capable of economic development in Canada, as well as in the United States, either have been already developed or are privately controlled. Concentration of ownership is a noticeable feature of this control. It has been authoritatively published that in the United States, in 1913, about 6,300,000 horse-power was controlled by ten groups of interests. This concentration is still going on. Owing both to provincial and federal legislation, it has not been possible for interests so readily to obtain control of water-powers in Canada. Efforts, however, are continually being made to secure the rights for such desirable water-powers as are yet vested in the Crown. The efforts made by the powerful financial interests behind the Long Sault Development Company to obtain control of the almost unequalled power rights at the Long Sault rapids, on the St. Lawrence River, are still in mind.†

Power Monopoly

The public cannot be too well informed respecting the extent to which they may be compelled to pay tribute to those concentrating hydro-electric powers, by reason of the control which such interests have over the distribution and supply of electrical energy.

In this connection no words are better fitted to express what is going on than those of Mr. Gifford Pinchot when he states:—

> "And whoever dominates power, dominates all industry. Have you ever seen a few drops of oil scattered on the water, spreading until they formed a continuous film, which put an end at once to all agitation of the surface? The time for us to agitate this question is now, before the separate circles of centralized control spread into the uniform, unbroken, nation-wide covering of a single gigantic trust. There will be little chance for mere agitation after that. No man at all familiar with the situation can doubt that the time for effective protest is very short. If we do not use it to protect ourselves now we may be very sure that the trust will give hereafter small consideration to the welfare of the average citizen when in conflict with its own."

Respecting the water-powers of the United States and the attempt to create a monopoly of same, Mr. Roosevelt, in accurate, prophetic terms, as true for Canada as the United States, has stated that:—

> "The people of this country are threatened by a monopoly far more powerful, because in far closer touch with their domestic and industrial life, than anything known to our experience. A single generation will see the exhaustion of our natural resources of oil and gas, and such a rise in the price of coal as will make the price of electrically transmitted water-power a controlling factor in transportation, in manufacturing, and in household lighting and heating. Our water-power alone, if fully developed and wisely used, is probably sufficient for our present transportation, industrial, municipal and domestic needs. Most of it is undeveloped, and is still in National or State control. To give away without con-

*Respecting various phases of this subject, consult an article by Arthur V. White on the "Exportation of Electricity," which appeared in the *University Magazine*, October, 1910, pages 460 *et seq.* Consult, also, *Toronto World*, March 18th, 1912; also, "Exportation of Electricity—An International Problem: Relation of a Possible Coal Embargo by United States to a Curtailment or Stoppage of Canada's Electric Power," by Arthur V. White, in *The Canadian Engineer* of January 11th, 1917, pages 21 *et seq.* Consult, also, *Annual Reports of Commission of Conservation*. Ottawa.

**See *Conservation*, Ottawa, for December, 1917.

†For a review of the water-power situation on the St. Lawrence River, consult report of recent annual meeting of the Commission of Conservation, Canada; also *Electrical News*, Toronto, 15th December, 1917.

ditions this, one of the greatest of our resources, would be an act of folly. If we are guilty of it, our children will be forced to pay an annual return upon a capitalization based upon the highest prices which 'the traffic will bear.' They will find themselves face to face with powerful interests entrenched behind the doctrine of 'vested rights' and strengthened by every defence which money can buy and the ingenuity of able corporation lawyers can devise. Long before that time they may, and ve y probably will, have become a consolidated interest, dictating the terms upon which the citizen can conduct his business or earn his livelihood, and not amenable to the wholesome check of local opinion."

This prophecy of the ex-President is daily in process of fulfilment. In view of all the exigencies facing her—both national and international—Canada cannot afford to have great water-powers, like those of her boundary waters, pass into the hands of powerful private interests, but must retain full command of all the nation's resources.

Common Aims and Aspirations a Great Asset

Nothing is further from the thought of the writer than to suggest that it is, or that it would become, the arbitrary desire of the United States to deprive Canada of the coal which at present is so necessary to life in Canada. It is important, however, to take cognizance of the fact that a nation, pressed by the demands of its own people, may be compelled, under certain conditions, to deprive other nations—in part, at least—of even the necessaries of life until the needs of its own citizens are met. No country can be expected to send out of its confines that which is essential to the very existence of its own people.

Canada is, indeed, exceedingly fortunate in being neighbor to a country whose national aims and sympathies are so akin to its own. Our great Ally to the south has extended to Canada specially generous consideration in the present coal shortage. Dr. H. A. Garfield, United States Fuel Controller, has announced that recognition will be given to Canada's needs for coal as though she were one of the States of the Union.

No one can contemplate the hearty efforts made to relieve the suffering begotten of the Halifax catastrophe without placing the greatest value upon the readiness of our neighbors to co-operate where assistance is really needed. In response to the distress of Halifax the governor of Massachusetts telegraphed assuringly: "The people of the Commonwealth of Massachusetts are ready to answer any call that may be made upon us. Massachusetts stands ready to go the limit in rendering every assistance you may be in need of." The governor of Maine telegraphed: "Any help Maine can give is yours," while many others sent corresponding messages. Sentiments like these, however, cannot better be summed up than in the inspiring message sent by President Wilson to:—

"His Excellency the Governor-General of Canada:

"In presence of the awful disaster at Halifax the people of the United States offer to their noble brethren of the Dominion their heartfelt sympathy and grief, as is fitting at this time, when to the ties of kinship and community of speech and of material interests are added the strong bonds of union in the common cause of devotion to the supreme duties of national existence."

Obviously, so long as such sentiments govern men's actions, the people living on the North American continent cannot be deprived of that which is essential to their existence; nevertheless, with the growing scarcity of coal, the United States, no matter what her goodwill or desire for exchange of commodities, may not be able to cope with the prevailing need, and Canadians must be prepared to help themselves by the development of their own fuel resources in a way that they have never done before. There is no doubt that if this effort is made, the United States, in the spirit and disposition recently manifested in the statements above quoted, will see that Canada is fairly dealt with. We should not, however, trespass unduly upon friendly accommodation.

Coal Resources of Canada

The alternative open to Canada, and it is this to which special attention is directed, is to develop, and that as rapidly as possible, her own fuel and power resources, and by co-ordination of transportation and other cognate agencies to provide for the early annual distribution, including reasonable reserves, of fuel to all communities in the Dominion. In some respects it is more important to move coal and have it adequately stored and distributed throughout Canada than it is to move the grain out of the country

The coal fields of Canada may conveniently be divided into four main divisions:—

(1) The bituminous coal fields of Nova Scotia and New Brunswick.

(2) The lignites of Manitoba and Saskatchewan, and the lignites, sub-bituminous and anthracite coal fields of Alberta and the eastern Rocky Mountain region.

(3) The semi-anthracite and bituminous fields of Vancouver Island, Queen Charlotte Island and the interior of British Columbia, and the lignites of Yukon.

(4) The low-grade bituminous and lignites of the Arctic-Mackenzie basin.

The coal areas and estimated quantities for the different provinces are shown in the following table. There should, of course, for practical consideration, be a substantial reduction made in these quantities, due to waste in mining operations:—

Estimated Coal Resources of Canada*

PROVINCE	Area of Coal Lands Square miles.	Semi-Anthracite Tons.	Bituminous Tons.	Sub-Bituminous Tons.	Lignite Tons.
Nova Scotia .	521		10,691,000,000		
N. Brunswick	121		166,000,000		
Ontario	10				27,500,000
Manitoba	48				176,000 000
Saskatche'an	13,406				65,793,000,000
Alberta	81,878	845,900,000	217,918,000,000(a)	932,053,000,000	29,095,000,000
Brit. C'l'mbia	6,045		77,923,000,000 (a)		5,715,500,000(b)
Yukon	2,840		275,000,000(a)		5,159,000,000(b)
Northwest Territories	300				5,280,000,000
ArcticIslands	6,000		6,600,000,000		
Total	111,169	845,900,000	313,573,000,000	932,053,000,000	111,286,000,000

(a) Includes some anthracite coal. (b) Includes some sub-bituminous coal.

*Consult "Coal Situation in Canada" by W. J. DICK, in *Transactions of the Canadian Mining Institute*, 1916.

Canada's coal and coke production in 1916 was as follows*:—

	1916 Short tons
Nova Scotia	6,912,140
New Brunswick	143,450
Saskatchewan	281,300
Alberta	4,559,054
British Columbia	2,584,061
Yukon	3,300
Total	14,483,395
Distribution of coal production:	
Sold for consumption in Canada	10,701,530
Sold for export to United States	1,451,075
Sold for export to other countries	284,513
Total sales	12,437,118
Used by producers in making coke, etc.	804,814
Used for colliery operation and by workmen	1,241,463
	2,046,277

Peat Resources of Canada

Respecting the peat bogs of Canada, Dr. Eugene Haanel, Director of Mines, Canada, from time to time, has strongly urged the necessity of developing our peat resources, and at the recent annual meeting of the Commission of Conservation of Canada he gave an able, forceful and serious address upon this subject which the people of Canada cannot too carefully consider. Dr. Haanel again affirmed the commercial and economic practicability of peat production. Throughout

(Continued on page 50, Construction News Section)

*From figures issued by Mr. John McLeish, B.A., F.S.S., Chief of Division of Mineral Resources and Statistics, Ottawa.

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Principal Contents of this Issue

HIGHWAY BRIDGE SPECIFICATIONS

The Canadian Society of Civil Engineers has just issued a general specification for steel highway bridges. Much valuable work has apparently been done upon this specification, and the members of the committee are to be congratulated upon the general thoroughness with which the specification has been prepared.

There are a few points, however, upon which the specification might be criticized if it is intended to have it generally adopted throughout Canada as uniform standard specification for all highway bridges. There are other valuable specifications for highway bridges now in use in Canada which differ somewhat from the society's new specification, and a thorough discussion and adjustment of these matters at the forthcoming annual meeting of the society would no doubt do much to facilitate the uniform adoption of the society's specification.

For instance, section 5 permits the use of ¼-in. metal, provided that the bridge is not located near salt water or other deleterious elements. Bridges in inaccessible wooded country, particularly in altitudes subject to damp weather, and especially if more or less roughly constructed and poorly painted, would be safer if a greater thickness of metal were to be specified as the minimum, as it is sometimes impracticable to give close and constant attention to the maintenance of such bridges.

Section 6 specifies a clear width between roadway curbs of not less than 15 ft. With the increasing use of 8-ft. motor trucks, this width as a minimum would seem insufficient for bridges in cities and large towns where two trucks might try to enter the bridge at the same time. And the specification does not state the minimum width of roadways which carry street car tracks.

Section 31, in specifying the method of calculation for floorbeams, hangers and other truss members, does not provide for computation of stresses due to concentrated axle loads.

Section 40 specifies an increase of 50 per cent. in the smaller stress to be computed for members subject to reversal of stress or stresses of opposite kinds. An interesting calculation bearing upon this subject was given in the October 5th, 1916, issue of *The Canadian Engineer* by David A. Molitor, formerly designing engineer of the Toronto Harbor Commission.

Section 89 permits butting joints to be spliced for 50 per cent. of the axial stress in the members. Some other specifications insist upon such joints being fully spliced, and it would appear to be a question as to whether the latter is not the better practice.

Regarding movable bridges, the specification does not provide for protection of the operator by guards over all exposed gears; also no provision is made for the protection of gears situated beneath the bridge floor and exposed to debris falling from the roadway.

OUR COAL PROBLEM

The coal situation on this continent has reached a point at which we may reasonably expect adequate action from the government with a view to future supplies. The coal resources of the United States, while greater than those of Canada, are sorely taxed to meet the demands. The Dominion will not be given preference over other countries in the matter of coal supplies. It will have to fall in line with the export regulations of the United States. An increasing number of commodities is being subjected to embargoes and those already in force are being stiffened. It is pointed out on another page of this issue, in the notable article by Mr. Arthur V. White, a student of this subject, that no country can be expected to send out of its confines that which is essential to the very existence of its own people. No matter what is the goodwill or desire for exchange of commodities, the United States may not be able to cope with the prevailing need. Canadians must be prepared to help themselves by the development of their own fuel resources in a way that they have never done before.

Since the latest editorial on this subject was published in *The Canadian Engineer*, just a week ago, the United States has found it necessary to declare a policy providing that no coal may be exported from that country during 1918 except for purposes contributing materially to the conduct of the war. As pointed out by Mr. White, there is no need to start again learning the A B C of this fuel problem. Officials of the government of Canada, such as those in the Geological Survey, Department of Mines, the Commission of Conservation and other organizations, have knowledge of existing conditions and of practical means by which much of the stress may be relieved. Mr. White says: "To carry out these measures of relief and to place Canada in a reasonably independent position with respect to fuel will take time; but there is no doubt that if matters are dealt with in a broad, statesmanlike manner, and the necessary encouragement of financial and other assistance is given to those who are competent to handle same, Canada will, at a minimum of effort and expense, be relieved of a menace with respect to her coal supply which threatens not only her economic life, but the physical life and well-being of a large proportion of her citizens."

If our outside supply of coal is cut off, we must look to our peat, lignites, and coal in East and West. Under the circumstances, the public naturally want to know what is being done to obtain this coal in East and West and what is being done for its distribution to the central portions of the Dominion. There is a proper desire to know what action the Dominion government is taking in these matters; whether conferences are being held; whether expert knowledge is being applied; and what time and funds are necessary to obtain lignite and peat in order satisfactorily to relieve the situation, not so much for the present, but more especially for the future.

PROVINCIAL CONSULTING ENGINEERING

Just as this issue goes to press, we are in receipt of thirteen typewritten pages from Mr. Thomas Adams, town-planning adviser of the Commission of Conservation, in reply to the editorial, "Provincial Consulting Engineering," in our issue of December 13th, 1917. As the reading portion of the paper has already been prepared for press, we cannot print Mr. Adams' reply in full until our next issue, in order to avoid missing the mails with this week's paper, but in fairness to Mr. Adams we desire to make immediate acknowledgment of his well-prepared reply.

The editorial above mentioned was written not so much in a spirit of criticism of Mr. Adams' report, as from a desire to do something to curb the growing tendency toward the ill-considered creation of too many provincial bodies with wide and autocratic powers. It is apparent from Mr. Adams' reply, and from another review of his report in the light of the explanations made in his reply, that he intended no slight upon the present efficiency of the work of the municipal and consulting engineers in Canada. In fact, Mr. Adams appears to have been a genuine and staunch friend of the engineering profession in Canada, and we believe that he is fully awake to the possible evils suggested in our previous editorial, and that he would surround any legislation which he might propose, with ample safeguards against injustice to individual engineers.

Mr. Adams is in a position to recommend and secure the employment of engineers by municipalities which now ignore the profession, and his ideas upon the subject are doubtless essentially sound. It is important, however, in the working out of these ideas, that the engineers in Canada should be fully consulted at every turn, and we would suggest that close co-operation between the Commission of Conservation and the new legislative committee of the Canadian Society of Civil Engineers would be productive of the best results.

PERSONALS

Lieut. JAS. BOYD MCLACHLAN, B.Sc., Montreal, has been elected an associate member of the Institution of Civil Engineers.

WALTER ROBINSON MCRAE, of Toronto, has been elected a member of the American Institute of Electrical Engineers.

Lieut. JOHN CUMMINGS, of the Canadian Railway Troops, has been elected an associate member of the Institution of Civil Engineers.

W. B. FORTUNE, formerly superintendent of erection of the Quebec Bridge, has been asked to join the American International Corporation, to superintend ship construction.

CARL ERNEST ROGERS, draftsman for the Montreal Public Service Corporation, Montreal, Que., has been elected an associate member of the American Institute of Electrical Engineers.

HAROLD L. WOOLCOTT, assistant to light, heat and power superintendent, Canadian Explosives, Limited, Nobel, Ont., has been elected an associate member of the American Institute of Electrical Engineers.

F. F. BACKUS, general manager of the Toronto, Hamilton & Buffalo Railway, with headquarters at Hamilton, has been appointed railway traffic expert in charge of traffic at the Canadian terminals on the Niagara frontier.

WILLIAM STEVENSON, formerly mining engineer for the Brazilian Collieries, has been appointed district inspector of mines for the Crow's Nest Pass and Pincher Creek districts, Alberta.

REGINALD H. BALFOUR, B.A.Sc., sales manager of the Eugene F. Phillips Electrical Works, Montreal, has been elected a director of that company. The capital of the firm has been increased to $4,000,000, practically all paid up. When interviewed by *The Canadian Engineer*, Mr. Lawford Grant, the general manager, stated that a new charter, with more extensive powers, had been obtained, and admitted that the company looked forward with confidence to greatly increased business, both foreign and domestic, after the war.

ARTHUR V. WHITE, of Toronto, whose article on the coal situation appears in another part of this issue, is one of the consulting engineers to the Commission of Conservation, and is also consulting engineer to the International Joint Commission on the Lake of the Woods reference. He was formerly consulting engineer with Brown Brothers, London, England, for whom he executed commissions in France, Belgium and the United States. Mr. White became associated with R. A. Ross, of Montreal, in the field investigations of the Ontario Power Commission, the precursor of the Hydro-Electric Cower Commission of Ontario, and later was for a time with the Department of Public Works, Canada. He has persistently urged energetic action with respect to Canada's national fuel and power problems.

OBITUARY

GEORGE KENRIC BORIGHT, of Cowansville, Que., whose death occurred on January 10th, was an electrical engineer, a graduate of McGill University, Montreal, class of 1910.

The construction of the new mill at the Davidson property in Porcupine is proceeding satisfactorily, and will probably be completed by February.

The problem of conserving the waters of the Grand River is being worked out by N. Cauchon, of Ottawa, who suggests that two districts be developed, not only in the way of conserving the water supply in the tributary districts, but also developing the irrigation system. These districts, in Mr. Cauchon's opinion, should be the Hamilton and Ottawa sections. The Hamilton includes the Grand River as far as Fergus and Elora.