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The Canadian Engineer

ESTABLISHED 1893

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TORONTO, CANADA, MAY 1st, 1908.

A subscriber has for sale bound volumes of the Canadian Engineer for 1893, 1894, and 1895. What are they worth to you?

CONTENTS OF THIS ISSUE.

CLASSIFICATION OF MATERIAL.

And at last the Parliament of Canada is to investigate the charge that the classification of material excavated on the Transcontinental Railway is improper. Nobody has a better right to investigate the charge, but the investigation of this matter by a committee of the House will doubtless be most unsatisfactory. Politics, party advantage, and election campaign material are apt to play a much larger part in this investigation than the question as to whether the engineer and the Board of Commissioners are giving the country and the contractors a square deal.

The question as to why Major Hodgins was dismissed may be easily disposed. If it is a fact that the Chief Engineer did not, **for any reason whatsoever,** wish to retain Mr. Hodgins, that were reason enough, but the question of improper classification—that is a question far too large for a Committee of the House, especially with talk of a general election in the air.

A fair classification of material is one of the most difficult problems that the field engineer is "up against." The contractor takes the contract on the basis of so much per cubic yard for solid rock, so much for loose rock, so much for hard pan, so much for earth. These materials grade so finely one into the other that you cannot say solid rock ends here and loose rock commences here. It is all very well to say that "unless the classification of the work done is carefully supervised the contractor will be overpaid"; but unfortunately the contractor is sometimes underpaid, and from just the same cause. Careless supervision does not necessarily mean overpaying. The engineer, over-zealous on behalf of his company, does not allow the contractor a classification high enough. For the man who wishes to be fair with both parties, you cannot lay down any other law or rule than, "Do as you would be done by."

The classification on railroad work depends upon experience and observation alone, without regard to theory. The men responsible for this work must be men in whom the chief has every confidence as to their ability, integrity, and common sense.

Happily, the Transcontinental Commission have a Chief Engineer of wide experience and unquestionable honesty. If he has a free hand the classification will be fair and just; if he has not, that might properly be a matter for parliamentary investigation, but for a Committee of the House to attempt to pass on the correctness of a certain engineer's estimates—they had better take hook and line and canoe the St. Maurice. The trip will not cause the country any anxiety and they will have a pleasant outing.

LOCATION OF HIGHWAYS.

The location of a road is one of the fine arts of the engineering profession, and learned only in the school of experience. The proper location of a road is of greater importance than its construction. The mistakes of construction may be corrected year by year; but the mistakes of location remain a monument to the inexperience and poor judgment of the locating engineer. A settlement will grumble daily at having to use a certain piece of road, but attempt to re-locate that road and you will raise a storm of protests that you will long remember.

Many of our roads were originally located without any attention being paid to the general topography of the country. The straight lines and right angles of the original survey appear to be the determining force in locating Canadian roads. We go straight over a hill, never pausing to consider whether we might secure a better road by going around it.

Graceful and natural curves conforming to the lay of the land add beauty to the landscape, increase the value of the property, as well as give an easier road.

In the older countries this has long been recognized. Pretty, winding roads running from place to place give an added charm to the district, and lend themselves readily to the additional beauty that comes from hedges and avenues of trees.

The owners of suburban property and new town sites are recognizing the added value well-located streets and boulevards possess, and before they subdivide they are employing the landscape engineer to plan and lay out the roads.

In newer residential sections of our large cities some attempts at departing from the straight lines has been made. The added beauty is apparent, and we look for a greater display of good judgment and good taste in highway location in the coming years.

BUILDING TRADE.

That activity in building may be slow in returning in Canada is to be inferred from conditions existing in the States. It has been shown how greatly lessened the figures of building construction value in that country in three months of 1908 as compared with 1907. And other features of the American situation, combined with the known sympathy of this country with the other in financial and commercial affairs confirm the view. For example, one very well-informed firm of dealers in metals say, in their trade circular of April 15th as to structural steel and metals generally:—

"The demand (for steel) in the United States is extremely disappointing . . . and what with the presidential election in view and possible tariff changes it is difficult to expect anything for months, but dull and unsettled business. . . . The conditions which led to the October collapse were slow in accumulating, and will be slow in passing away.

"There still needs to be a radical adjustment of the price of labor and finished iron and steel commodities before the business position has been put upon a bed-rock basis."

EDITORIAL NOTES.

The Board of Railway Commissioners for Canada have issued a circular calling attention to their new rule that the Board will hold regular sittings at Ottawa on the first Tuesday of each month. Special sittings may be arranged for Ottawa or elsewhere. Any party to any matter, application, or complaint pending before the Board may set the same down for hearing at the next monthly sitting of the Board upon giving at least ten days', or such shorter notice as the Board may order, to all parties interested.

* * * *

In the half-tones illustrating the article on "Reinforced Concrete Columns" in this issue it will be noticed that failure has taken place in or about the upper third. This is not what one might expect. One would naturally look for failure nearer the centre of long columns. This peculiarity in failure is also noticeable in the failure of long posts when tested to destruction in testing machines. Whether this behaviour is the result of the system of loading caused by testing machines is yet to be decided. We would like to hear from engineers who have observed the failure of long posts and columns in actual construction as to whether the failures they have noted have occurred in the upper third.

NEW RAIL SPECIFICATIONS, C.P.R. SYSTEM.

Steel rails frequently show weakness where the web joins the head and where it joins the base of the rail. The C.P.R. system in their new standard rail section have attempted to overcome this weakness by adding more metal at these points. Long usage alone will demonstrate whether the defects that occurred here were the result of insufficient metal or to a mechanical defect in rolling.

Another noticeable change is in the shape of the head. In the new head there is a taper from the base of the head up, allowing better contact between the flange of the wheel and the rail, and not wasting metal by placing it where it will be quickly ground away.

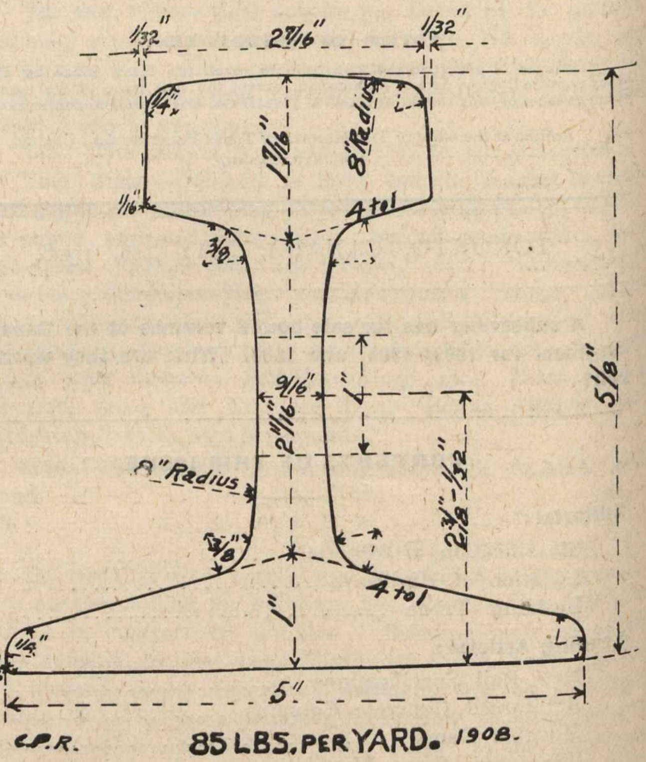
The investigations and discussions carried on by the C.P.R. Engineering Department have resulted in this new standard section, i.e., 85 pound section, and will doubtless be an improvement on the old standard.

Specifications for 1908 for 85 Pounds Open-hearth Steel Rails.

Lengths.—The standard length of rail shall be 33 ft. Railway standard 85 pound 1908 rail, in accordance with plans attached, with an allowance in height of 1-64 of an inch under and 1-32 of an inch over. The fit of the fishing or "male" template shall be maintained perfect.

The weight of the rail shall be kept as near 85 pounds per yard as is practicable after complying with Section No. 1.

Section 1.—The section shall be the Canadian Pacific at a temperature of 60 degrees Fahrenheit. Ten (10) per cent. of the entire order will be accepted in lengths of 27 ft. and 30 ft. All such short rails shall be painted green on both ends. A variation in length of ¼ of an inch longer or shorter will be allowed.



Finish.—The rails must be free from all mechanical defects and flaws. They shall be sawed square at the ends, and the burrs made by the saws shall be carefully chipped and filed off, particularly under the head and on top of the flange.

The rails shall be smooth on the heads, straight in all directions, both surface and line, and without any twists, waves or kinks, particular attention being given to having the ends without kinks or drop. The hot-straightening shall be carefully done, so that gagging under the cold-press will be reduced to a minimum. The supports of the rail in the straightening press shall be not less than 42 inches apart. Cold straightening shall be done so as not to injure the rails. "Lumpy" rails will not be accepted.

Drilling.—Bolt holes one inch in diameter shall be drilled through the web at 2 11-32 inches from the bottom of the flange. The centre of the first hole shall be 2½ inches from the end of the rail, and the centre of the second hole shall be 6½ inches from the centre of the first hole. These holes must be drilled accurately in every respect; all burrs to be removed. (See plan R-12-28, dated 22nd January, 1908.)

Branding.—The weight per yard of rail, name of maker, month and year of manufacture, shall be rolled on the web of each rail in plain letters and figures, not less than ⅞ inch high and in sufficient relief for future identification. The heat numbers shall be stencilled three times on the web of each rail in distinct letters at least 9-16 inches high, placed on the opposite side from the brand marks. A letter shall be stamped on the heat number side of the web of each rail, clear of the angle bars, to indicate the portion of the ingot from which it was rolled.

Composition.—The rail in composition must be hard, sound and tough, showing fine, dense, grained metal on fracture. The carbon shall average not less than .60 per cent., within limits of .56 per cent. to .66 per cent. The phosphorus shall not exceed .06 per cent. The sulphur shall not exceed .055 per cent. The silicon shall not exceed .18 per cent., nor less than .075 per cent. The manganese shall not exceed 1.00 per cent., nor less than .80 per cent. The sum of sulphur plus copper plus other injurious elements not more than .075 per cent.

Heat Treatment.—The number of passes and speed of train shall be so regulated that, on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saw of 6¼ inches for 33 ft. rails, and no artificial means of cooling shall be used between the final pass and the hot saw.

Tests.—While the heat is being cast two test-ingots shall be made; the first from steel going into the first regular ingot, the other from metal taken from the last one.

From each of these test-ingots a chemical analysis shall be made.

These and all final analyses made by the works, relating to this contract, shall be furnished this Railway Company for its records.

Drop Tests.—From each 50 ton heat three rail butts shall be tested. Each butt must not exceed six feet in length, and must be taken from the top end of the first, middle and last ingots cast of each heat.

These butts shall be placed heads upwards on solid steel or iron supports, the distance apart of which in the clear, shall be four feet, and upon it shall be dropped a weight of 2,000 pounds (whose striking face shall have a radius of not more than five inches) falling freely from a clear height of twenty feet. Should two of the tests stand and show a deflection of less than 3¼ inches under such test, this heat shall be accepted. If two fail, it shall be rejected.

The anvil blocks shall weigh at least 20,000 pounds, and the supports shall be a part of or firmly secured to the anvil.

Butts shall be tested to destruction as requested by the inspector.

Treatment of Ingots, etc.—After the ingots are cast they shall be either constantly kept in an upright position until ready to be rolled, or else be so maintained until the interior steel has had time to solidify.

No "bled" ingots or ingots from "chilled" heats shall be used in the manufacture of rails under this contract.

No ingots from badly-teemed heats shall be used.

Cutting of Blooms.—After cutting off or allowing for the "sand" or top-end of each ingot, at least 12 inches more of seemingly solid steel shall be cut off that end of the bloom—a greater length than 12 inches being preferred; and if, after cutting such length, the steel does not look solid, the cutting shall continue until it does.

Heating.—Care shall be taken to avoid overheating the steel, and under no circumstances shall a "cinder" heat be allowed—that is, a heat high enough to cause the cinder to run off the steel as it is being drawn from the furnace. This does not apply to cinder which may be sticking to the underside of the steel when drawn from a horizontal furnace, or to the bottom of an ingot when drawn from a soaking-pit.

Inspection.—Inspectors representing the purchaser shall have free entry to the works of the maker at all times while this contract is being filled, and shall have all reasonable facilities afforded to satisfy them that the rails are being made in accordance with these specifications. The makers shall furnish them with the carbon-determinations of each heat, and a sufficient number of complete analyses to represent the average steel of each day and night's turn. The drillings to be taken from the test ingots. (See Section 10.) On request borings for check analyses shall be furnished the inspector by the manufacturer.

The inspectors shall have authority to reject rails made from insufficiently sheared blooms, or from heats, the test pieces or drop-tests of which have failed, or from badly-poured heats, or from "chilled" heats, or from "bled" ingots. The rails made from insufficiently cut blooms, if otherwise perfect, to be afterwards received as short rails, if sufficient lengths have been sawed off to make an amount of steel equal to the original demand of 12 inches. By a badly-poured heat is meant one which from any cause has been teemed without the control of the operator. A "chilled" heat is one which by reason of the chilling of the steel has to be either pricked or poured over the top of the ladle. A "bled" ingot is one from the centre of which the liquid steel has been permitted to escape.

Imperfectly drilled, straightened (except "lumpy" rails), or chipped or filed rails shall be rejected, but will be accepted after being properly finished.

Rails failing to comply with Section 1 will be rejected.

Handling and Loading on Cars and Vessels.—All rails must be loaded in the presence of the inspector. Rails must be handled during manufacture, loading and while in transit in such a manner as not to bruise the flanges or cause other injury.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee

4620—April 15—Authorizing the Chatham, Wallaceburg & Lake Erie Railway Company to cross, by means of an undercrossing, the tracks of the Michigan Central Railway on the west side of the Town Line Road, near Charing Cross Station, Ontario.

4621—April 15—Authorizing the C.P.R. to construct an extra track across the road allowance at mile 4.9 of its main line, Fort William Section, district of Thunder Bay, Ont.

4622—April 15—Authorizing the C.P.R. to construct an extra track across the road allowance at mile eight (8) of its main line, near Neebing, Fort William Section, in the district of Thunder Bay, Ont.

4623—April 15—Authorizing the C.P.R. to construct an extra track across the road allowance at mile 17.3 of its main line, Fort William Section, district of Thunder Bay, Ont.

4624—April 15—Authorizing the C.P.R. to construct an extra track across the road allowance at mile 14.5 of its main line, Fort William Section, district of Thunder Bay, Ont.

4625—April 15—Authorizing the C.P.R. to construct an extra track across the road allowance at miles 3.6, and 4 of its main line, Fort William Section, district of Thunder Bay, Ont.

4626—April 15.—Authorizing the C.P.R. to construct two extra tracks across the road allowance at mile 13.4 of its main line, at Murillo, Fort William Section, district of Thunder Bay, Ont.

4627—April 14—Authorizing the C.P.R. to construct an extra track across the road allowance at mile 18.25 of its main line, Kakabeka, Fort William Section, Ontario.

4628—April 16—Authorizing the C.P.R. to construct a spur to and into the premises of R. Watson & Company, Toronto, Ontario.

4629—March 31—Authorizing the G.T.P. Railway to construct, maintain, and operate a branch line or siding leading from and adjacent to its main line, at West Fort William, Ont.

4630—April 16—Authorizing the C.P.R. to construct its railway across the highways at mile 20.74 and mile 20.61, between Lots 5 and 6, Concessions 6 and 7, in the Township of Albion, County of Peel, Ont.

4631—April 16—Authorizing the Windsor, Essex & Lake Shore Rapid Railway to open for the carriage of traffic that portion of its line of railway between the town of Kingsville and the town of Leamington, Ontario, a distance of 8.7 miles.

4632—April 16—Authorizing the C.P.R. to construct its railway across the highways at mile 19.85, between Lot 3, Concession 7, Township of Albion, County of Peel, and Lot 34, Concession 11, Township of Vaughan, County of York, Ont.

4633—April 15—Authorizing the G.T.R. and C.P.R. to operate their trains over the crossing in the village of Lennoxvile, P.Q., without being brought to a stop.

4634—April 16—Authorizing the C.P.R. to construct its railway across highway in the Township of Brant, County of Bruce, Ontario, at mileage 30.77 on the Walkerton & Lucknow Railway.

4635—March 27—Amending Order No. 4165, dated December 26th, 1907, in re location of Niagara, St. Catharines and Toronto Railway Co., in the city of Brantford, Ontario, from the fifty-sixth and one-quarter mile to the fifty-eighth and eighty-two one hundredth mile.

4636—April 21—Approving location of the Canadian Northern Ontario Railway through the townships of Ferguson, McKellar and Hagerman, District of Parry Sound, Ontario, mile 0 to mile 18, from Waubamik, north-easterly, to Whitestone Lake.

4637—April 22—Approving revised location of the Grand Trunk Pacific Railway from Surprise Lake, mile 150, to the junction with the National Transcontinental Railway at Pelican Lake, at mile 199.56, Province of Ontario.

4638—April 22—Authorizing Welland County Telephone Co., Limited, to erect, place, and maintain its wires across the track of the Grand Trunk Railway at Rosehill Station, in the county of Welland, Ontario.

4639—April 22—Authorizing the Bell Telephone Co. to cross with its wires the track of the Grand Trunk Railway at public crossing, 300 yards east of Waubaushene Station, Ontario.

4640—April 22—Authorizing the C.P.R. to reconstruct bridge No. 84.1 on its Toronto section.

4641—April 22—Authorizing the C.P.R. to reconstruct its bridge No. 79.4 over Quartz Creek, mountain section.

4642—April 22—Authorizing the C.P.R. to reconstruct bridge No. 93.9 on its Shuswap section.

4643—April 22—Authorizing the C.P.R. to reconstruct its bridge No. 1.2 over the Illecillewaet River, Arrow Lake branch.

4644—April 23—Authorizing the Canadian Copper Co. to carry its wires across the track of the Manitoulin and North Shore Railway Co. at Creighton Mine, Copper Cliff, Ontario.

4645—April 24—Authorizing the C.P.R. to reconstruct its bridges at fourteen different points in the Provinces of Alberta, British Columbia and Quebec.

4646—April 24—Authorizing the C.P.R to construct spur to and into the premises of the Maple Leaf Flour Mills Co., Kenora, Manitoba.

4647—April 24—Authorizing the C.P.R. to divert the highway in lot 33, concession 1 S, township of Bentinck, county of Grey, Ontario.

4648—April 24—Authorizing the town of Sudbury to carry its electric light wires across the track of the Canadian Pacific Railway Co.

4649—April 24—Authorizing the Canadian Northern Ontario Railway to open for the carriage of traffic that portion of Hutton branch of its line from Sudbury Junction North to Moose Mountain, Ontario, a distance of 27.74 miles.

4650—April 24—Authorizing the Canadian Northern Ontario Railway to open for the carriage of traffic that portion of the Garson spur of its line from a point on the Hutton branch to the Mond Nickle Mines, a distance of 3.6 miles.

4651—April 24—Authorizing the Canadian Northern Ontario Railway to open for the carriage of traffic that portion of its main line from the C.P.R. Co.'s crossing near Romford to Sudbury, a distance of 10.05 miles.

THE DESTRUCTION OF ARCH BRIDGES.

Mr. Duncan Scott, in a paper read on April 6th before the Society of Engineers, England, gave an account of the destruction of some of the bridges on the L. and N.W.R. The author commenced with the Oxleys and Broughton widening, which was about three and a half miles long, and was carried out at a cost of £50,000. The blowing up of Lightfoot Lane Bridge, consisting of three brick arches, was chosen for description. Holes were "jumped" in the haunches and crowns of each arch, the former being charged with 224 oz. and the latter with 192 oz. of "tonite." In addition, holes were "jumped" in the backing over the piers, and charged with 240 oz. of the same explosive. Instantaneous fuses were fixed to the charges, grouped together, and fired by time fuses, care being taken to prevent the charges exploding before their time. Before charging the holes, both main lines were blocked, and the rails, sleepers, etc., removed for safety. Both lines were blocked at 12 o'clock noon, and opened again between 4.30 and 5 o'clock p.m. The crown shots in the centre arch were the first to explode, followed some twenty seconds later by the crown and haunch shots of one of the side arches. A few seconds later the crown and haunch shots of the remaining side arch exploded, and then the shots in the top of the pier, which completed the destruction of the arches. One road was opened after 2½ hours' work and the other road 1½ hours later; 95 men were engaged. The cost of destroying this bridge was £200. About 30 yards to the west of the bridge is situated a chimney 100 feet high, but no damage was caused to it by the explosion. A widening near Clifton and Lowther, which was one mile long, was carried out at a cost of £8,500. In this case the arch to be removed was a masonry one, with a span of 30 feet. Holes were "jumped" in the crown, and charged with 9 oz. of gelignite, the rest of the work being carried out in a similar manner to that in connection with Lightfoot Lane Bridge, the roads in this case being blocked from 10.20 a.m. till 3.37 p.m.

A brick arch bridge of 20 feet span was also intended to be blown up at Preston, but the explosions were not successful, and the arch was finally removed by hand. Some of the prices given were of interest, as they are typical for work in the North of England. In cases where explosives cannot be used, the author said, the simplest method was to erect centres under the arches, which can then be removed by hand, and if the headway is too small to allow of centres, ribs could be formed of boards bolted together, bent and wedged up to take the form of the soffite of the arch. Altogether a very interesting paper on the subject was contributed.

The Milroy-Harrison Company of 66 Richmond Street East, have been appointed agents for "Novo" high speed steel, drills, etc., in the Province of Ontario, and will carry stock of these goods in Toronto. William Abbott, of Montreal, represents the manufacturers of this steel for Canada.

A party of 35 McGill engineering students left on April 25th for a tour of the mining countries of the West. Dr. John Porter, professor of mining and metallurgy at McGill, will be in charge of the party. They will stop first at Copper Cliff, and visit the mines there, after which they will proceed to the coal mines of the Crow's Nest Pass, and spend the balance of their time in the mines of the Kootenay district. The McGill men will travel by the Canadian Pacific, by special car.

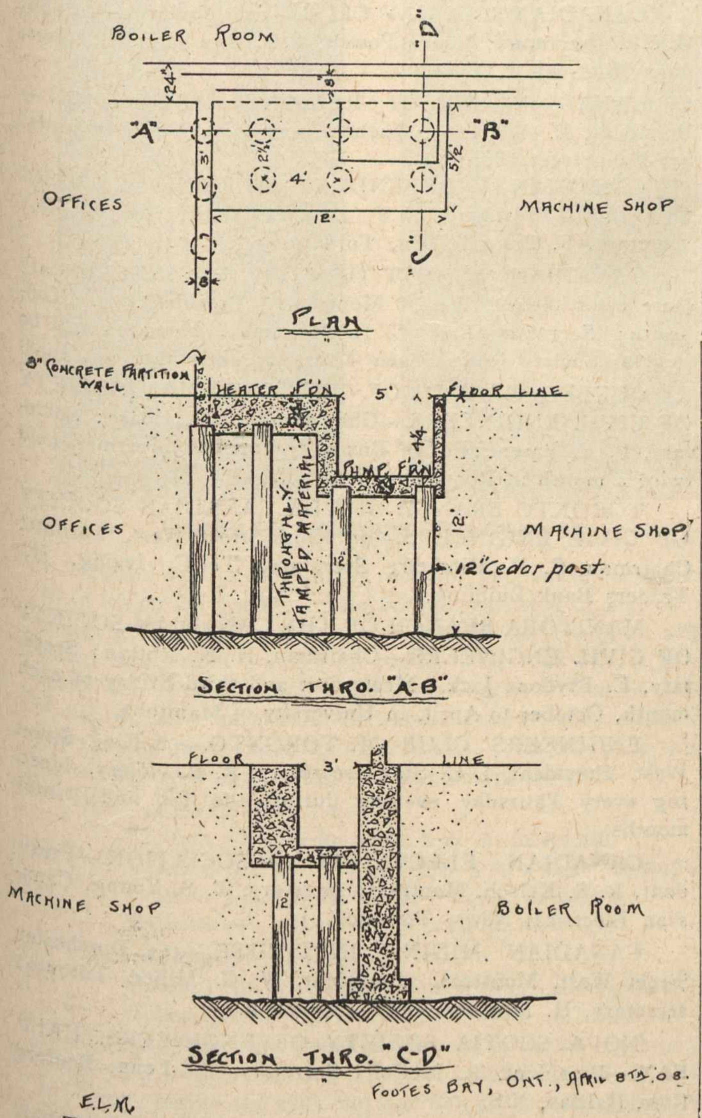
CORRESPONDENCE

[This department is a meeting-place for ideas. If you have any suggestions as to new methods or successful methods, let us hear from you. You may not be accustomed to write for publication, but do not hesitate. It is ideas we want. Your suggestion will help another. —Ed.]

FOUNDATIONS.

Sir,—Where concrete engine houses and machine shops are located in irregular ground with a solid rock foundation at a reasonable depth, it is sometimes necessary to excavate the entire area, owing to so many pits, etc., which occur within the building. If the main walls and foundation to carry heavy machinery have been brought up from solid foundations, it is then that the question arises concerning the foundation to carry light machinery—machinery with slight or practically no vibration—such foundation should be economical, and a saving in concrete is the greatest economy that can be made in actual construction.

The accompanying sketch shows the foundation for a 100 horse-power feed water heater, a 4½ x 2¾ x 4 duplex boiler feed pump; and an 8-inch concrete partition wall, as erected in the boiler house at the C.P.R. divisional yard at Muskoka, on the Toronto-Sudbury branch.



Twelve-inch cedar posts were placed as shown in the accompanying plan, and the filled in material thoroughly tamped around them. In placing on the "capping" of concrete the posts were allowed to extend into the concrete a half foot or more. A perfectly rigid foundation was thus secured and great saving in concrete effected. Yours truly,

Staney Brae, April, 1908. E. L. Miles.

REFORESTATION AND RIVER FLOW.

Sir,—I would gladly review Mr. Breithaupt's interesting discussion of River regulation on the Grand River, as reported in the Canadian Engineer of April 10th, if I had the advantage of being familiar with local conditions.

Without such local knowledge I could only speak on the generalities involved in river regulation, and especially on that part of the subject in which I am most interested,—the effect of reforestation. But this would hardly advance the practical solution of the definite problem of the Grand River floods. For, as Mr. Breithaupt fully realizes—or perhaps does not realize fully enough—local conditions vary the forest influence to such a degree, that instead of the forest cover being beneficial it may under some conditions even become detrimental, or at least nugatory, as regards regulation of water flow.

To tell the truth, while we know much of the general philosophy of the influence of forest cover on water flow, we are not so fully informed as to details of this influence as we might wish. Twenty years ago I compiled what definite knowledge was then in existence regarding these influences. and came to the following conclusions:—

"The surface drainage is retarded by the uneven forest floor more than by any other kind of soil cover. Small precipitations are apt to be prevented from running off superficially through absorption by the forest floor. In case of heavy rainfalls this mechanical retardation in connection with greater subterranean drainage may reduce the danger from freshets by preventing the rapid collection into runs. Yet, in regions with steep declivities and impermeable soil, such rains may be shed superficially and produce freshets in spite of the forest floor, and an effect upon water conditions can exist only from the following consideration:—

The well-kept forest floor, better than even the close sod of a meadow, prevents erosion and abrasion of the soil and the washing of soil and detritus into brooks and rivers.

Water stages in rivers and streams which move outside the mountain valleys are dependent upon such a complication of climatic, topographic, geological, and geographical conditions at the headwaters of their affluents that they withdraw themselves from a direct correlation to surface conditions alone. Yet it stands to reason that the conditions at the headwaters of each affluent must ultimately be reflected in the flow of the main river. The temporary retention of large amounts of water and eventual change into subterranean drainage which the well-kept forest floor produces, the consequent lengthening in the time of flow, and especially the prevention of accumulation and carrying of soil and detritus which are deposited in the river and change its bed, would at least tend to alleviate the dangers from abnormal floods and reduce the number and height of regular floods." (Bulletin 7, Forestry Division, United States Department of Agriculture, Forest Influences, 1887).

Yet even to-day we have not very far advanced in exact knowledge and must still remain doubtful as to the precise function of the forest, and all the general assertions that are found in literature on forest influences, except perhaps those on soil erosion, need more careful investigation. One point, for instance, on which Mr. Breithaupt seems to assume definite knowledge, namely the beneficial influence of forest cover on ground water has, indeed, only lately been thrown into doubt by the elaborate investigations of the Russian Otozky, who goes so far as to state:—"The doctrine of the hydrologic activity of the forest is a physiographic ideology, which is contradicted by exact observations and investigations."

In a very illuminating report before the International Forest Congress at Vienna this year, Dr. Fankhauser rehearses what knowledge exists or rather the lack of definite knowledge upon which the argument of forest influences rests. Diametrically opposite opinions have been based upon observed facts. Surrell seemed in 1841 to have beyond peradventure proved the beneficial action of forest cover on torrents. On the other hand the hydrographers, Laude, in Vienna; Honsell, in Karlsruhe; Hensel, in Munich; Cipolletti and Ponti, in Rome; Keller and Wolfschutz in Brunn, have denied wholly or partially the influence of forests on floods, the large floods being caused by climatic conditions which render the forest influences zero or so small that it may be neglected. These maintain that the amounts of water of severe and continuous flood rains are so large that the water taken up by the forest is relatively small.

Actual experience, however, has abundantly proved the favorable influence of forests and reforestation on the regime of torrents, and we come readily to the conclusion that this must be due not to the absolute capacity of retention, but to the ability to retard the run-off, to distribute it over a longer period. Real torrents originate as a rule in consequence of unusually severe but short rains of limited area, and usually in the summer time when the retentive capacity of the forest is at a maximum. Then, on the steep slopes of the upper water basin, when only a few minutes would suffice to collect and discharge enormous water masses the retarding effect of the forest cover becomes of value.

The floods in large rivers are conditioned by quite different phenomena, rapid snow melting and continuous rains. Here the value of the retarding quality becomes nugatory, and even with the same forest per cent. the effect of an intensive precipitation will be different in each case. Nevertheless, even here, the forest has its value, for, besides the water volume there is to be considered the erosion and detritus carried by the river, which have a very important bearing on floods. This office is freely acceded to by nearly all authorities as commanding conservative, rational treatment of mountain forests. Thus the hydrographer of Hungary, Krassay, states:—"If the considerable shortening in the length of the important Hungarian rivers has not led to their being filled with detritus (Geschiebe), this is due solely to the strict measures for the preservation of the mountain forests."

If by bringing forward these doubts I seem to have appeared as throwing cold water on Mr. Breithaupt's proposition, and on the question of forest influences in general, I wish to emphatically dispel that idea. All I desired to do was to show, as Mr. Breithaupt would no doubt agree, that without a definite local investigation of all surrounding conditions, and a careful and sane weighing of the value of various means for stopping the Grand River floods, nobody is entitled to prescribe for the evil. This careful procedure is the more necessary, as I find that of the area involved about 70 per cent. appears cleared farms, hence a return to forested condition must first be amply justified, not to speak of the large expense involved, which makes caution doubly needful.

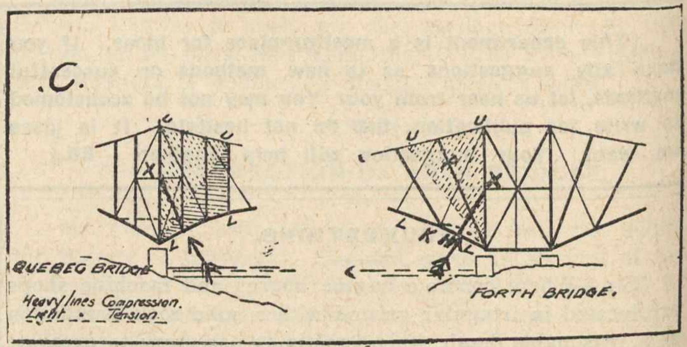
The appointment of a Commission to investigate local conditions would undoubtedly be the first rational step. To such a Commission the classic report of a similar commission appointed in Prussia some 15 years ago to investigate flood conditions of the Prussian rivers would serve as a most suggestive basis of inquiry.

Yours truly,
B. E. Fernow,
Dean of Forestry, Toronto University.

Toronto, April 22nd, 1908.

THE QUEBEC BRIDGE.

Sir,—I have read with great interest the article by Walter P. Chapman, M.C.S.C.E., in your issue of April 17th, and was much struck with his analysis of the problem in hand, but there is one point I would like him or some other equally competent of your readers to explain to us laymen, and that is, what absorbs the upward buckling strain on the lower compression cords. For instance, in his Figure "C" the chords are constructed with an upward curving sweep in panels of 200 feet. It appears to me that the point "K" rigidity supported from the point "U" would constitute itself a fulcrum in case of any laxity developing in the upper chords and eyebars, and the immense overhanging weight of the bridge arm would act as a lever on this fulcrum, and force the lower cord to buckle at the point "H" in an upward direction, there



being no provision made to take this and transmit the strain to the point "X" by a stout compression member. The weakness of the Quebec Bridge lay hereabouts from all data to hand, and it might bear looking into; the curve in this member seems to invite such a movement.

Yours,
R. E. D.

Hamilton, April 27th, 1908.

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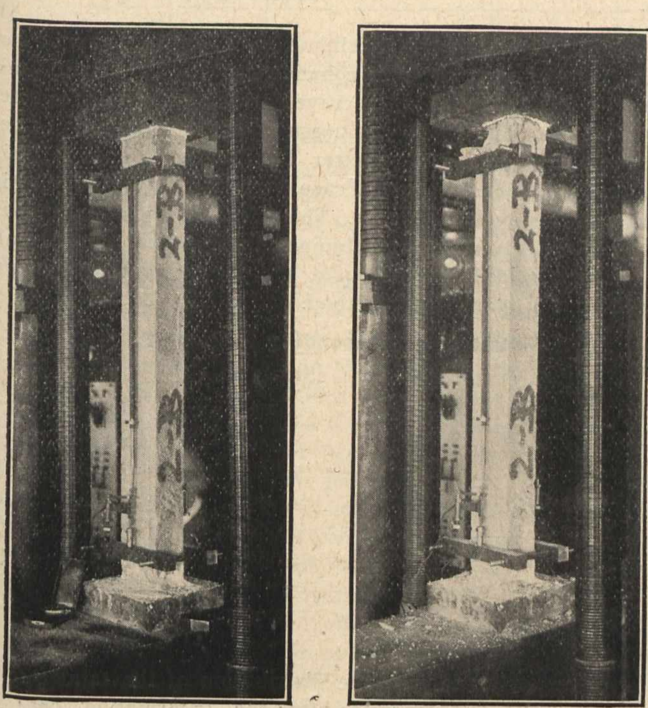
REINFORCED CONCRETE COLUMNS.

P. Gillespie, B.A.Sc.
W. G. Swan, B.A.Sc.

Perhaps no subject in the engineering world has excited more interest or comment within recent years than that of reinforced concrete. Its comparative cheapness, its adaptability to so many varieties of construction and the general satisfaction which it has given when the design has been careful and the work reliable, have given it ever-increasing popularity. The intention of this article is to discuss briefly in the light of some recent experiments, the subject of reinforced concrete columns, these experiments having been conducted in the testing laboratory of the Department of Engineering of Toronto University. We are indebted to a large extent for these results to the Roman Stone Company of Toronto, and to Mr. G. B. Ashcroft, its former superintendent, through whose kindness the columns in question were made and presented to the Department. With the outlook for better facilities, in the near future, in the Department of Applied Mechanics of the University, it is the intention to pursue carefully the study of this and allied problems.



Column 2-B Before and After Crushing.

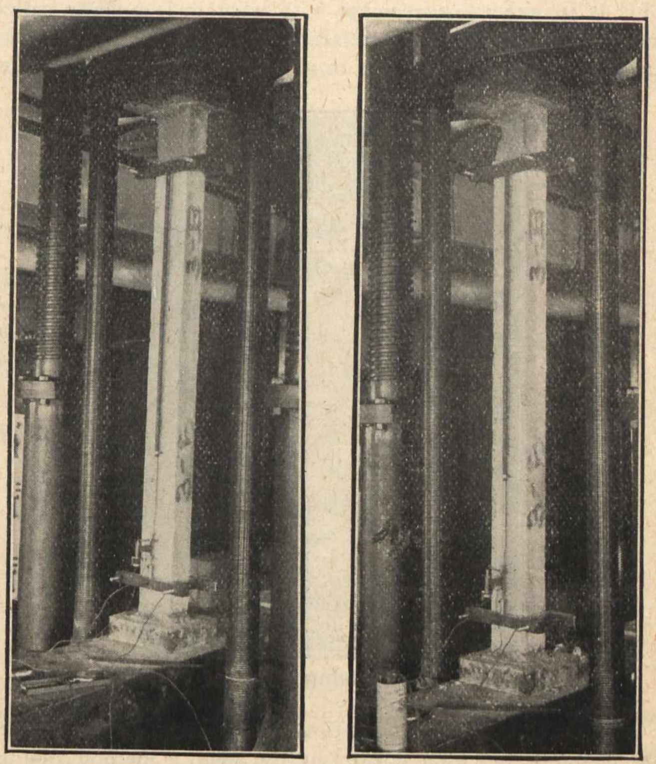
These reinforced columns were of two varieties:—Class A, in which the upright reinforcement consisted of four ⅜-in. round steel rods placed as shown in plate No. 1 with an additional rectangular hooping of 3-16-in. steel rods; Class B, in which the upright reinforcement was similar to that of Class A but where a spiral form of 3-16-in. reinforcement replaced the rectangular form of the other series. The following table gives the dimensions of the various columns tested:—

Reinforced columns:—
- Column 1-B, 3½-in. x 5-in. x 21-in. in length.
- Columns 2-A and 2-B, 3½-in. x 5-in. x 42-in. in length.
- Column 3-B, 3½-in. x 5-in. x 63-in. in length.
- Column 4-A, 3½-in. x 5-in. x 84-in. in length.

Non-Reinforced columns:—
- Column No. 1, 3½-in. x 5-in. x 20-in. in length.
- Column No. 2, 3½-in. x 5-in. x 23-in. in length.

The columns were tested in the 100-ton Riehle machine of the testing laboratory; they were set carefully in place so as to be truly plumb and each end was well cushioned against the cast-iron heads of the machine by the use of mortar. A mortar of neat cement was found to be most satisfactory provided the columns were allowed to stand over night before testing, in order to give time for the setting of the cement. Plaster of paris was used as cushioning mortar in the testing of columns 2-B and 4-A, but its rapidity in setting made it difficult to handle and did not permit of an even setting of the ends of the columns. It was also noted that the ultimate load borne by these two columns was considerably below the average.

The deformations due to loading were measured by means of the apparatus attached to the columns as shown in Plate No. 2. This apparatus consisted firstly of two collars attached to the column not far from its upper and lower extremities. To the upper collar and on opposite sides of it were made fast two telescopic rods which could be adjusted for a varied length of specimen. A pair of micrometer screws obtained from a dismantled Reihle compressometer were rigidly attached to the lower collars, and on the movable arm of these were made to bear the telescopic rods. The loading of the column thus caused the pillars to approach each other. These in turn caused the telescopic rod to force down the movable arms of the compressometer. The amount of this motion was registered by means of an electric contact device. The readings were recorded to $\frac{1}{10,000}$ part of an inch, the average of the two compressometer readings being taken to represent



Column 3-B Before and After Crushing.

the true deformation. The loads were applied at intervals of 2,000 pounds and the compressometer reading noted for each. It will be interesting to note that in each case the column failed in pure compression, no buckling of any kind such as usually accompanies the failure of columns of steel or wood having occurred.

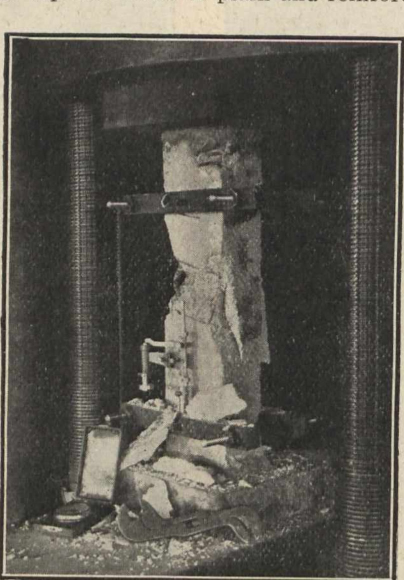
The concrete was of a fine aggregate and was cast in horizontal sand moulds, as is the custom in the manufacture of Roman stone. An examination of the broken specimens failed to show any settlement of the aggregate at the bottom of the moulds so that the columns were quite homogeneous in structure. The concrete was matured in sand for a time and afterwards in air under cover so that practically all moisture was excluded. The average crushing strength, found from a number of tests made on samples of this concrete, was 1,720 pounds per square inch. German Dykerhoff cement was used. It may be of interest to note that the crushing strength of these samples is considerably less than has been found for samples of similar age taken from other runs of stone manufactured by this company and tested in the engineering laboratory.

The reinforcement consisted of mild open-hearth steel, purchased in the open market. All rods were round. The elastic limit was a trifle high but otherwise it was comparable with what is usually sold under that name. A table showing the properties revealed in some six individual tests is given below:—

Commercial Tests of Steel Reinforcement.

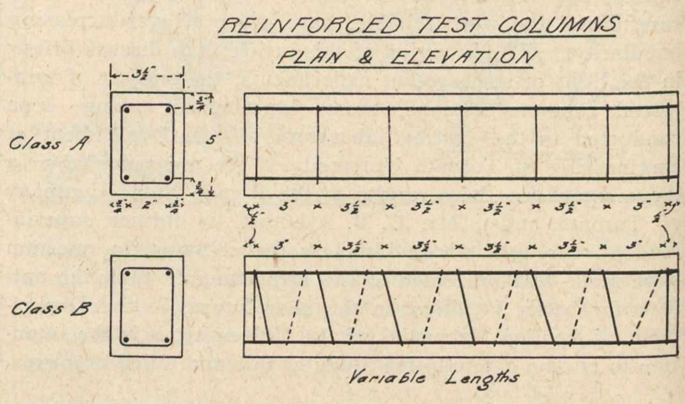
Number of Specimen	Elastic Limit Strength (Pds. per sq. in.)	Ultimate Strength (Pds. per sq. in.)	% Elongation in 8 ins.	% Contraction in Area
1	43,100	66,600	25	57
2	41,900	64,800	26	59
3	43,000	64,600	25	56
4	43,100	67,400	27	55
5	43,100	67,600	27	53
6	42,900	67,500	26	54
Average	42,800	66,400	26	56

Figures 1, 2, 3, 4, 5, 6, 7, and 8 are the stress-strain diagrams for the eight different columns described above. The ordinates represent stress, that is, the quotient of the total load on the column divided by the total area of the cross-section; and the abscissal represent the strains or the deformation per unit of column intercepted between the collars of the compressometer device. The absence of a constant ratio between stress and strain is apparent in every case, the curves deflecting downward in most cases almost from the start. This is in general agreement with what is frequently called the parabolic stress-strain relation and is in accord with the findings of all experimenters in plain and reinforced concrete.



Column 1-B, Showing Mode of Failure.

In order to find what portion of any stress was carried by the concrete and what portion by the steel, a method adopted by Talbot was employed. It was assumed that the steel and the concrete deformed together. If the elastic limit of the steel be not exceeded, the stress therein will be proportional to the strain. For a strain of .0014 say, the stress in the steel, taking Es, Young's Modulus, to be 30,000,000, would be f = .0014 × 30,000,000 = 42,000 pounds per square inch. This, it will be observed, is a stress slightly below the average elastic limit of the steel as given in the table of results of tests thereon. Let A denote the total area of the column cross-section and p the ratio between the steel and the concrete. Then the total load carried by the steel, corresponding to the stress assumed, will be 42,000 p A pounds. If this quantity be divided by the total area of the cross-section, A, we have as quotient, the number of pounds per square inch of total area which the reinforcement carries. The numerical value of this will be $42{,}000\ p = 42{,}000 \times \frac{2\frac{1}{2}}{100} = 1{,}050$ pounds per square inch. Through a point in the diagram whose co-ordinates are 1,050, and .0014, a straight line was drawn to the origin. This will be subsequently referred to as the line for steel. From what has been said, it is apparent that the portion of any ordinate below this line will give the stress in pounds per square inch, based on total area of cross-section which the steel supports. In consequence, therefore, that portion of the total ordinate intercepted between the line for steel drawn as described, and the curve as plotted, will be the stress in the concrete for the corresponding strain. Referring to figure 3, we see that the stress, 1,620 pounds per square inch corresponds to a strain of .001. The line for steel shows that 750 pounds per square inch of this is supported by the reinforcement. From this it follows that the accompanying stress in the concrete is the difference or 870 pounds per square inch. The line for steel has been drawn, it will be noticed, in each case to the ordinate through .0014 as this corresponds to a stress of 42,000 pounds per square inch, substantially equal to the elastic limit of the steel.



In order to find the maximum stress in the concrete occuring either prior to or in coincidence with the elastic limit of the steel, a tangent to the curve parallel to the line for steel was drawn. The point of tangency on the diagrams is denoted in each case by the letter T. Singularly enough, this point corresponds in every case very nearly to the elastic strain of the steel, viz., .0014. The values of the simultaneous stresses are given in the subjoined table. The stress in all cases were scaled from the plot and the tangent was drawn by the usual geometrical method.

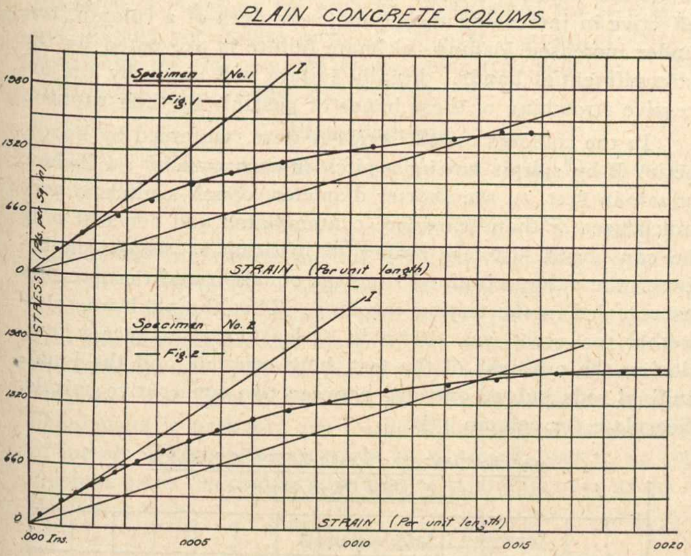
Stresses Corresponding to Point T.

Column.	Stress in Concrete.	Stress in Steel.	Strain.
1 B	890	37,500	.00125
2 A	1,320	42,000	.00140
3 B	1,650	43,500	.00145
2 B	1,050	33,000	.00110
4 A	1,380	37,500	.00125
Average—	1,260	39,000	.00130

As to the manner of the distribution of the total stress between steel and concrete, after the deformation .0014 is passed, little can be said with certainty. The probability is, however, that the curve for steel flattens quite markedly, producing as will be seen from an examination of any of the graphs submitted, stresses in the concrete greater than those in the above table. This is within the realm of probability, since from the table given, it is seen that the average stress up to or coinciding with the elastic limit is only 1,260 pounds per square inch. Now the average ultimate compressive strength of the concrete, it will be remembered, was 1,720 pounds per square inch so that a margin for increase remains. The rising of the stress-strain curve after the elastic limit of the steel has been passed, is thus capable of an explanation, although an exact analysis of these later stresses is quite impossible. The assumption has been made in this discussion, that the elastic limit in compression is the same as that in tension. The error in this assumption is probably very small.

If concrete hardens in air, a shrinkage occurs; if in water, an expansion results. Experiment has shown that a 1:3 plain mortar hardened in air will shrink, in consequence, from 1-20 to 4-20 of one per cent. in its dimensions. Where reinforcement is used, the deformations due to this cause are much less, but notwithstanding their smaller magnitudes they occasion compressive stresses in the reinforcement. A perfect bond between the metal and the concrete is, of course, assumed. Considere cites a case where a 1:3 mortar reinforced with 5½ per cent. of steel sustained a shrinkage of 1-100 of one per cent. in its length. This would occasion an initial compressive stress in the metal of approximately 3,000 pounds per square inch. There can be little doubt that such initial stresses do exist but as to their actual magnitude, little with certainty is known. While their presence in this instance has not been wholly ignored, no attempt to consider their magnitude and effect has been made.

PLAIN CONCRETE COLUMS



As stated above, the features of the stress-strain curve for concrete as obtained by compressometer tests is the variation of its inclination to the axis of strain. This is interpreted as meaning that the material loses rigidity as the stress is increased and that the so-called modulus of elasticity meanwhile grows less. It was thought worth while, in order to get a comparison between working stresses and factors of safety in the two materials, to find for a working stress of 500 pounds per square inch in the concrete, the modulus of elasticity of that material. This was done by finding with a pair of dividers, that point on the diagram where the vertical intercept between the line for steel and the plotted curve, was the graphical equivalent of 500 pounds per square inch. The corresponding strain was noted and from the equation, $E_c = c\ s$, where E_c is the modulus of elasticity for concrete, c the stress, and s the strain, the modulus of elasticity was found. This quotient, of course, will give what might be called the average modulus of elasticity covering a range of stresses from zero up to 500 pounds per square inch. The corresponding stress in the steel was found from the equation $f = E_s S$, E_s being taken as 30,000,000.

The factors of safety given in the following table are based on an utimate crushing strength of concrete equal to 1,720 pounds per square inch, and an ultimate strength in steel of 66,400 pounds per square inch.

Moduli of Elasticity of Concrete Corresponding to a Working Stress of 500 Pounds Per Square Inch.

Column	Ec	Stress in Concrete	Strain	Stress in Steel	Safety Factor-Concrete	Safety Factor-Steel
1 B	1,400,000	500	.00036	10,800	3.4	6.1
2 A	1,900,000	500	.00026	7,800	3.4	8.5
3 B	1,700,000	500	.00029	8,700	3.4	7.6
4 A	1,360,000	500	.00037	11,100	3.4	6.0
Average	1,590,000	500	.00032	9,600	3.4	7.0

The anomaly from the above table is that at such a moderate stress as 500 pounds per square inch in the concrete, the factor of safety should be nearly twice as large in the steel as in the concrete. For this, no very satisfactory remedy seems to offer itself. There certainly could be no valid objection to utilizing stresses, in such steel as here employed, up to 16,000 pounds per square inch. But unless we care to raise the working stress in the concrete above 500 pounds per square inch we must be satisfied with low working stresses in the steel. The stresses manifestly will always be proportional to the moduli of elasticity of the two materials. Evidently the most economical combination would be the somewhat unusual one of high working stresses in the concrete, with low modulus of elasticity. This would tend to an equality in the safety factors of the two materials.

It will also be noted on the diagram that a tangent line has been drawn in each case to the initial direction of the curve. This line represents the initial modulus of the material. The initial modulus of the concrete can now be found by eliminating the value for the steel, according to Talbot's method as previously mentioned. This initial modulus is sometimes employed in theoretic investigations since it corresponds to working values, which are the maximum values with the usual safety factor employed. The following are the values of the initial modulus of concrete for each of the columns tested. There appears to be considerable variation but the average value compared favorably with published determinations.

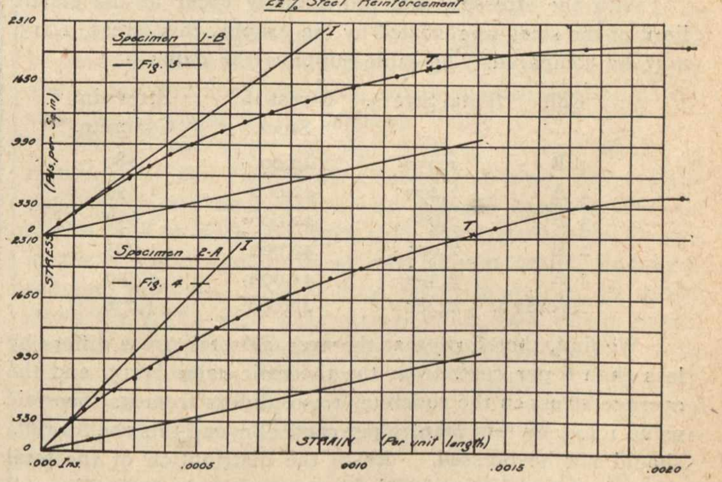
Column.	Ec (Initial Modulus).
1 B	1,710,000
2 A	2,680,000
2 B	3,800,000
3 B	1,840,000
4 A	1,400,000
No. 1	2,630,000
No. 2	2,340,000
Average..	2,350,000

It will be noticed that the points designated T on the graphs correspond fairly well with the strain at the elastic limit of the metal viz., .0014. The modulus of elasticity for the concrete was found for this point also, the method adopted being that previously described. The results are contained in the table below:—

Modulus of Elasticity of Concrete at the Point T.

Column.	Ec.
1 B	710,000
2 A	940,000
3 B	1,100,000
2 B	1,000,000
4 A	1,080,000
Average	966,000

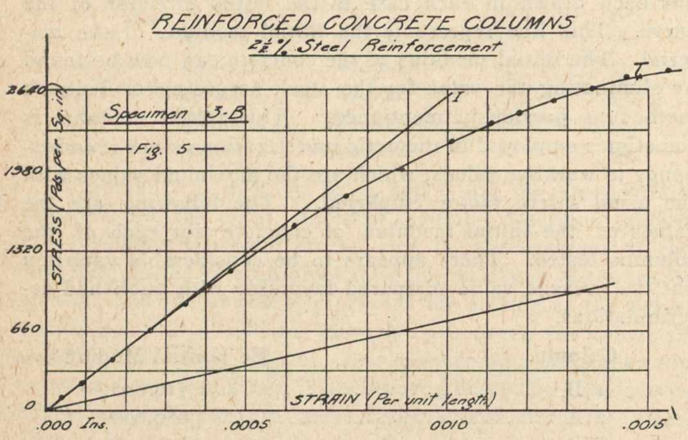
REINFORCED CONCRETE COLUMNS
2½% Steel Reinforcement

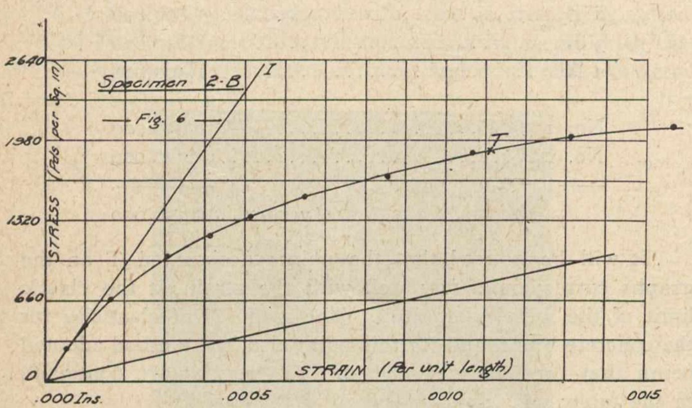


Evidently, for stresses accompanying or approaching the elastic limit of the steel, an approximate value for Ec of 1,000,000 may be taken. This will render n, the ratio $\frac{E_s}{E_c}$ equal to 30 if Es, be taken equal to 30,000,000 as above.

Now where a column is reinforced longitudinally, it can be readily shown that the strength per unit area is given by the equation $c' = c\,[1 + (n - 1)\,p]$.

where c′ is the stress based on total cross-section,
c is the stress in the concrete,
n is the ratio $\frac{Es}{Ec}$ for the stress c and
p is the ratio of metal to concrete.





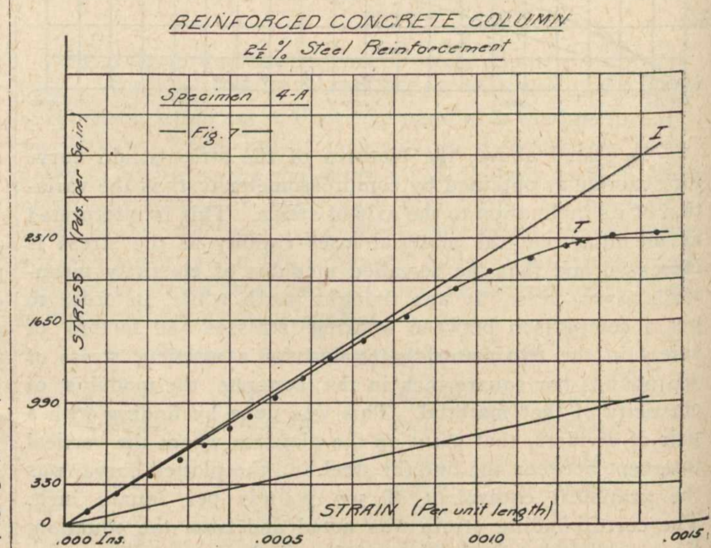
This equation supposes that the two materials deform together and that the concrete adheres perfectly to the steel. The greatest stress in steel to which in fairness, this equation might apply, will be the elastic limit here taken as 42,000 pounds, per square inch, and for this stress, Ec was found to be approximately 1,000,000. The stress in the concrete for such a strain (.0014) will then be 1,400 pounds per square inch. Applying our formula and remembering that p = $\frac{2\frac{1}{2}}{100}$ or 1/40, we have c′ = 1,400 (1 + 29-40) = 2,415 pounds per square inch.

With the stresses, that did actually occur at the elastic limit of the steel, as revealed by the graphs, this stress, 2,415, may be compared. The table supplies the data:—

Col.	Total Stress.	Stress in Steel.	Stress in Concrete.
1 B	1,930	42,000	880
2 A	2,400	42,000	1,350
3 B	2,680	42,000	1,630
2 B	2,055	42,000	1,005
4 A	2,370	42,000	1,320
Average.	2,280	42,000	1,230

We find, therefore, that the average total stress differs by less than 6 per cent. from the theoretic value 2,415, and the average stress in the concrete, 1,230, differs from its theoretic value 1,400, by less than 12 per cent. Beyond this the formula should not be pressed. As to the distribution of the total stress between the steel and the concrete in the region beyond the elastic limit, nothing definite is known. Further, the value of n in such case is assuredly indeterminate and any assumption as to its value must in the nature of things be questionable. Considere succeeded in proving, with Coulomb's theorem as a basis, that the resistance given to sand by hooping is 2.4 times greater than the direct resistance of the longitudinal reinforcing numbers of the same weight when the tensile stress in the former is equal to the compressive stress in the latter. He concluded that the same principle is true of concrete. The assumption was made, however, that the hoops are close together (from 1-4 to 1-10 of the diameter of the spiral). The efficiency of hooping depends on its capacity to resist lateral swelling and as the elastic lateral swelling is small, relative to the longitudinal strain, (Talbot gives Paisson's ratio for concrete as equal to 1-8) the hoops will certainly contribute little to the strength of a column for moderate loads. Such reinforcement is, however, quite effective in increasing the ultimate strength of a column, for, under increased loading, ultimate failure is prevented by the circumferential bands. Finally failure will occur by the excessive stretching of these bands or possibly by their rupture.

In the columns tested, series A were reinforced by hoops, series B by spirals having a pitch in each case of 3½ inches, equal, in fact, to the shorter diameter. Such a pitch is very much greater than Considere contemplated and hence it may be considered scarcely proper to institute a comparison between the values obtained from the equation and the strength as revealed in the testing machine. That the pitch was altogether too great was shown in at least one instance where, during the progress of the test, both concrete and the longitudinal rods bulged outward between two consecutive spirals. See plate for column 1 B.



In accordance with Considere's principle and considering also the presence of the longitudinal rods, the strength of the column will be given by the formula:

$$P' = f\ (As + 2.4\ Ah) + A\ (1 - p)\ c$$

where P′ is the total load on column,
As is area of steel in longitudinals,
Ah is equivalent area of steel in hoops, if converted into longitudinals of same weight,
A is total area of cross-section and
c is compressive stress in concrete.
Now,

$$P' = nc\ (As + 2.4\ Ah) + A\ (1 - p)\ c,$$

$$As = \frac{2\frac{1}{2}}{100} A \text{ and } 2.4\ Ah = .012\ A.$$

When c = 1,400, n = 30.

$$\text{Hence } P' = 1{,}400\ A\ [30\ (.025 + .012) + \frac{39}{40}],$$

$$\text{or } P' = 1{,}400\ A\ (1.11 + .975)$$
$$= 1{,}400\ A \times 2.085.$$

Dividing by A to obtain c′, we have

$$c' = \frac{P'}{A} = 1{,}400 \times 2.085$$
$$= 2{,}926 \text{ pounds per square inch.}$$

If for 1,400, we substitute 1,720.

c′ = 3,590 pounds per square inch.

The propriety of applying this equation in the second instance may be questioned on account of the uncertainty of the stresses produced in the longitudinal reinforcement, and in the hoops. Yet, even in the former case, the result, 2,926 pounds per square inch, is so much greater than the average stress actually reached, that it is doubtful if the hoops contributed anything to the strength of the columns. In other words, the presence of the longitudinal seems to be capable of accounting for the stresses actually obtained.

Two compressometer tests were made on plain concrete columns of the same sectional area, the span between collars being 15 inches. The stress-strain curves are shown in figures No. 1 and No. 2. For the purpose of comparison, a modulus of elasticity for each was determined for stresses of 500 pounds per square inch, and also at a strain of .0014 as was done for the concrete of the reinforced columns. The results are given in the table following:—

Plain Concrete.

No.	Ec at stress 500.	Ec at strain .0014.	Ult. strength.
1	2,630,000	1,060,000	1,542
2	2,200,000	1,100,000	1,744

Apparently the earlier modulus is somewhat larger than in the cases where the columns were reinforced. The later modulus, however, remains practically the same, showing that the hooping in this instance has contributed nothing to the stiffness or rigidity of the concrete which it encloses. We must not lose sight of the fact that the explanation of these phenomena is probably due to the wide spacing of the rings of metal. These tests as might be expected, lead to no conclusions as to the comparative merits of spirals over hoops or vice-versa.

Conclusions.

1. The employment of longitudinal steel reinforcement in concrete columns is not economical except where high working stresses in the concrete accompany a low value of Ec.

2. The hoops and spirals in the cases examined contributed little or nothing to the strength of the column beyond what could be explained by the presence of the longitudinal rods.

3. The hoops and spirals did not increase the rigidity of the concrete which they enclosed. These two phenomena may be explained by the fact that the pitch of the hoops was much greater than is considered good practice.

4. For columns up to 25 diameters, the tendency to fail by buckling under centrally applied loads is probably small.

5. For this particular class of concrete a modulus of elasticity of 1,500,000 for a stress of 500 pounds per square inch seems to be a fair value.

6. The variation in the ultimate strength values of the separate columns would indicate the necessity of employing a fairly high factor of safety in the use of reinforced concrete columns for construction purposes.

The total production of pig iron in Canada in 1907, from both Canadian and imported ores, according to direct returns from nine companies operating sixteen furnaces, was 651,962 short tons valued at $9,125,226, an increase of nearly 9 per cent. in quantity over the amount made in 1906. These figures do not include ferro-products made in electric furnaces. Of the total output of pig iron last year 10,047 tons were made with charcoal as fuel, and 641,915 tons with coke.

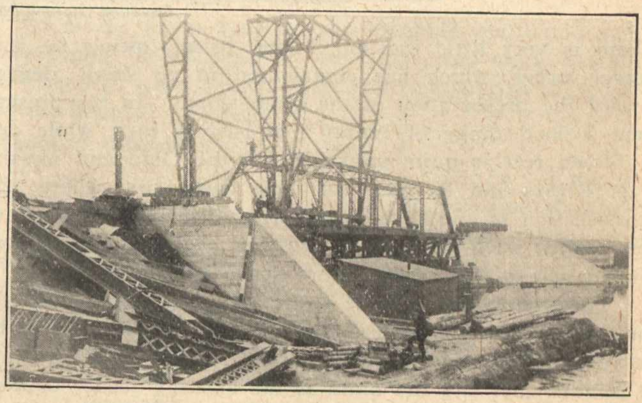
The business in railway rolling stock in Britain is especially heavy just now, one Birmingham firm, for instance, having in hand the supply of 2,000 steel cars, complete with wheels and axles, while another at Glasgow has been successful, in face of severe competition, in securing an order for seventy-one engines for the Indian State Railways, and a third has booked a South American contract for fifty-five locomotives.

Owing to the dust nuisance arising from the increasing traffic of motor-cars, the Kent County Council, (England), recently intimated to the urban authorities that they are willing to pay one-half of the cost of tar painting the main roads, providing the amount does not exceed 1½ cents per cubic yard. The authorities consider the offer altogether inadequate.

MOVABLE DAMS FOR THE BARGE CANAL.

By James Cooke Mills.

The earlier canal-builders of the State of New York encountered many difficulties in the use of fixed dams where the flow was widely fluctuating; consequently the modern device of movable dams has been adopted for the Erie Barge Canal wherever their advantages render this course desirable. Movable dams have come into quite general use in Europe, and more recently the United States Corps of Engineers have employed them on some of the rivers canalized in the South and Central West. A number of these movable dams of various types, in this country and abroad, have been examined by eminent engineers of the barge canal, and after thorough consideration of the subject, and with the approval of the Advisory Board of Consulting Engineers, the State engineers have decided to use the bridge type of dam on the lower Mohawk River.



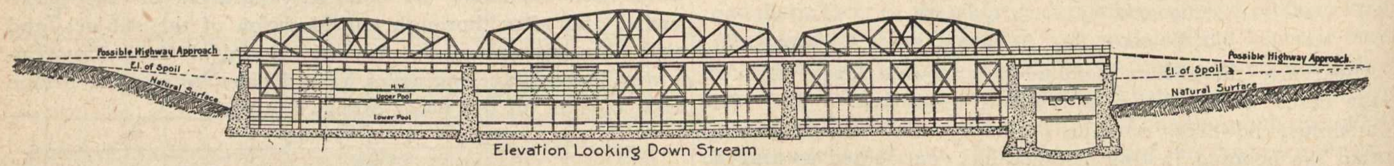
Bridge and Dam Near Little Falls.

The bridge type of movable dam as applied on the Moldau River, in Bohemia, with success, has been adopted on portions of the River Seine, in France. These dams are of great utility in permitting the control of water surfaces to a degree impossible with dams having a fixed crest, and higher levels can be maintained except during floods. The use of a movable dam results in the river being restored to its natural condition during the season when the canal is not in use, and in time of flood the debris and silt is carried down stream instead of forming jams above the dam. The engineers have determined that these movable dams of the bridge type will be much cheaper in construction than fixed dams, and to show the particular type decided on for the barge canal they have made sketches showing the cross-sections, the dam in position, and the dam raised. It is believed that by their use a large amount of money will be saved in maintenance of the completed canal in dredging and in reduced flood damages, which the canalization of the river would cause in the Mohawk Valley.

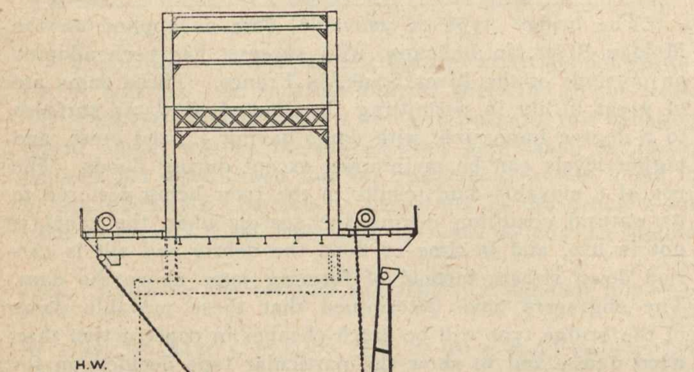
Along the valley of the Mohawk River, which is traversed by the New York Central and West Shore Railways, there are many towns and villages lying at the foot of the hills in such locations that any considerable change in the natural conditions of the stream would endanger valuable property. Should flood levels be raised, as would inevitably occur with fixed dams, much loss would ensue, leading to claims for damages. Such complications with property, which movable dams would largely or entirely avoid, together with the initial cost, were considered by the Advisory Board of sufficient moment for the adoption of this type.

The basin of the Mohawk River and tributaries is of about 3,500 square miles, which, at extreme high-water periods, discharges at the mouth of the stream a volume exceeding 100,000 cubic feet per second. Between Schenectady and Little Falls, a distance of fifty-eight miles, the low-water fall is about 111 feet, or 1.9 feet per mile. The greater portion of the drop, however, is below Schoharie Creek.

From a geological point of view the Mohawk Valley is of unusual interest. The river itself is one of the oldest on the continent, and, in fact, far antedates the glacial period. It is believed that at one time it was an outlet for the vast inland sea which covered much of the northern portion of the United States before the St. Lawrence was carved out to carry the glacious torrents. Throughout the valley there is evidence that an enormous volume of water at one time flowed through it, and at the end of the glacial period there was still a much greater discharge than any since, with the result that the bed of the river is of considerably greater proportionate area than found with later Western and Southern rivers. Because of this large aiea the stream rises very little above its banks in time of flood. Its bed consists largely of gravel, and, except where scoured by some ice gorge, has remained almost unchanged for ages. There is very little erosion of its prism, owing to this gravel lining, which has contributed in no small degree toward the preseivation of the steep slopes. In the present time a flood range of twenty feet is very rare, while one of fifteen feet is quite unusual. On the Ohio and Mississippi Rivers and on many of their tributaries, where the cross-section of the beds is much smaller in proportion to the basins, such ranges are common, while extreme floods often reach to fifty feet or more above low water.



The system of movable dams with Boule gates chosen for the Mohawk comprises nine units, five of which will be between Schenectady and Schoharie Creek, three from there to Mindenville, and the ninth is the existing feeder dam at Rocky Rift, on which a low, movable crest is to be placed. The various locations were determined with reference to



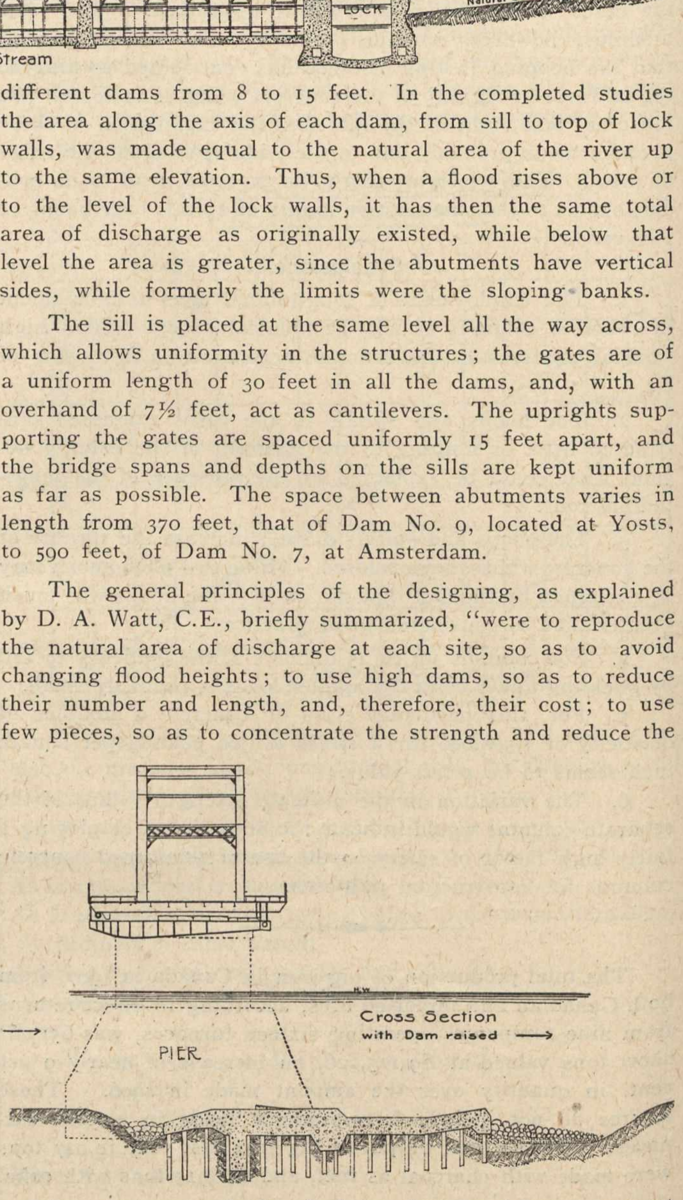
avoiding the flooding of land, the adoption of lifts which would not unduly exceed precedents while allowing the use of a minimum number of dams and the obtaining of as much deep water as possible, so as to reduce the dredging required at the upper ends of the pools.

The river being of a milder character than those on which movable dams have proven successful, it was deemed practicable to use pieces of larger size, which would sustain an unusual head of water As certainty of operation is of prime importance, the bridge and gate type of dam, in which all pieces are suspended and worked from a bridge, seemed under the existing conditions to be the most feasible. In principle the Boule gate is practically a sluice gate, the original of which was a plank, supported at each end, and pulled up or pushed down to regulate the flow. These gates when first used for movable dams were only 3½ feet long and a foot high, supporting a head of 3¼ feet, but have been increased in size to lengths of eight feet and to heights of 17, supporting heads of 14 feet. None of the various other types in use, such as the chanoine wicket, the drum wicket and bear-trap, have yet been employed for normal lifts above these figurs. The last two are simple in principle, but require a head of water for operation, while the needle-dam becomes difficult of operation with as much as 12 feet on the sill, and the openings are long and shallow instead of narrow and deep ones. Their character was not suited to the high lifts and great depths on the sills, which alone could secure an economical canalization of the Mohawk.

For the Mohawk dams a depth of 20 feet on the sill was established as maximum, the range diminishing to 16 feet, while the lifts vary according to the conditions at different dams from 8 to 15 feet. In the completed studies the area along the axis of each dam, from sill to top of lock walls, was made equal to the natural area of the river up to the same elevation. Thus, when a flood rises above or to the level of the lock walls, it has then the same total area of discharge as originally existed, while below that level the area is greater, since the abutments have vertical sides, while formerly the limits were the sloping banks.

The sill is placed at the same level all the way across, which allows uniformity in the structures; the gates are of a uniform length of 30 feet in all the dams, and, with an overhand of 7½ feet, act as cantilevers. The uprights supporting the gates are spaced uniformly 15 feet apart, and the bridge spans and depths on the sills are kept uniform as far as possible. The space between abutments varies in length from 370 feet, that of Dam No. 9, located at Yosts, to 590 feet, of Dam No. 7, at Amsterdam.

The general principles of the designing, as explained by D. A. Watt, C.E., briefly summarized, "were to reproduce the natural area of discharge at each site, so as to avoid changing flood heights; to use high dams, so as to reduce their number and length, and, therefore, their cost; to use few pieces, so as to concentrate the strength and reduce the

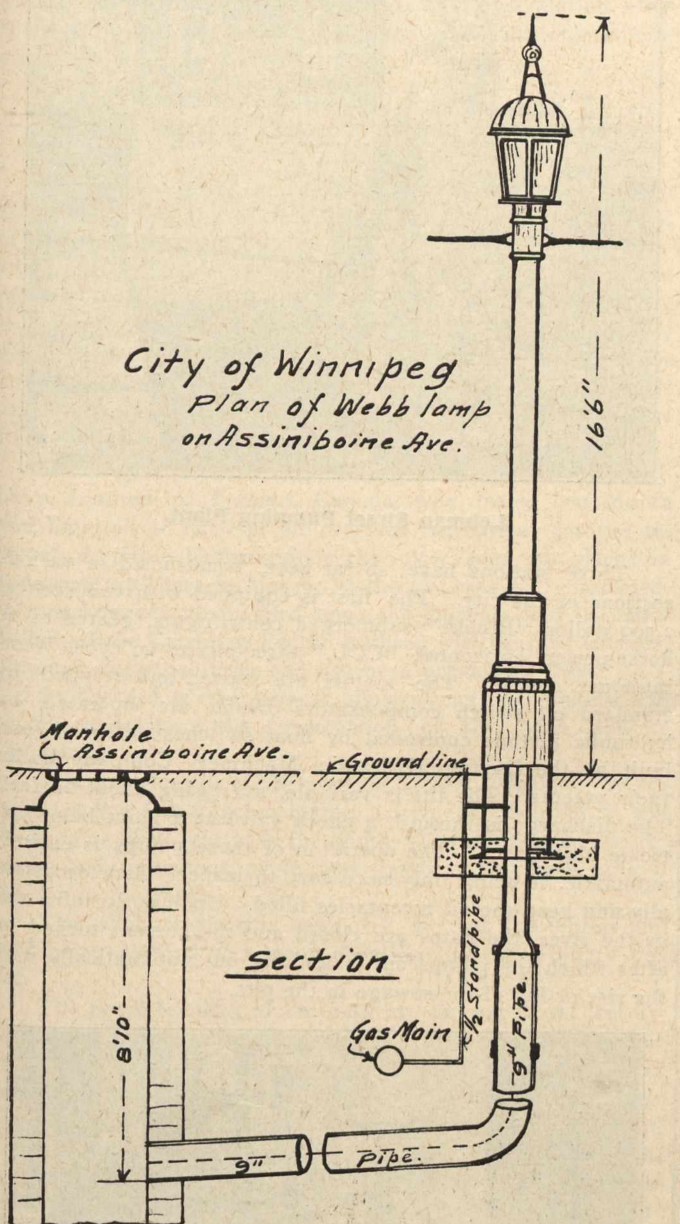


number of pieces to be handled; to place a minimum amount of steel-work permanently under water because of rusting; to make all parts of plain workmanship and similar as far as practicable; and to incorporate only such features as had been successfully adopted elsewhere, or about whose success there appeared to be no reasonable doubt."

In estimating the cost the principal item in each case was the foundation, the cost of the superstructure being a minor portion of the whole. The final estimate gave a cost of about $575 per linear foot in place, including foundations, piers, abutments, bridges, and all other iron work, riprap, and office expenses. "The Boule gate dams on the Elbe, Moldau, and on the Seine have given every satisfaction, as they prove easy to manœuvre, and are certain in their operation, and there appears every reason to believe that the adoption of this type for the Mohawk, although with lifts and depths somewhat in advance of existing practice, will secure a satisfactory canalization."

WINNIPEG'S EXPERIMENT WITH SEWER VENTILATION PLANTS.

The ventilation of sewers has long been a vexed question with sanitary engineers. Sewer gas is constantly forming in the sewers, and escaping at the manholes it becomes a public nuisance. Various methods of preventing the contamination of the air at street level have been suggested such as forcing the gas through beds of charcoal; placing air-tight covers on the manholes and extending the manhole as a shaft taking in air at the ground line, hoping that the admission of fresh air would purify the gas by the time it escapes at the top of the shaft.



The engineering staff of the city of Winnipeg have been experimenting with sewer ventilation lamps, and as to efficiency, the report of both the City Engineer and City Bacteriologist appear favorable. City Engineer H. N. Ruttan, in reporting to the Mayor and Board of Control on April 10th, 1908, says:—

"As instructed, I beg to enclose report on Webb Sewer Ventilation Lamps, with statement as follows:—

"(1) First cost.

"(2) Maintenance and repairs.

"(3) Record of observations.

"(4) Day to Day reports covering first 59 days' observation.

"From the observations, it would appear that the gas and sewer connections were frequently frozen, notwithstanding the comparatively mild winter.

"On 5 and 6 days respectively, there was no ventilation through the lamps; probably due to unfavorable atmospheric conditions. When the lamps were working most effectively, the velocities in the sewers were only 4.22 and 3.60 feet per minute, or supposing that the air came both sides of the lamps, as no doubt was the case, half the velocity, or 2.11 and 1.80 feet per minute.

"In order to make this system of ventilation effective, (supposing the expense of installation and operation to be satisfactory), I should think that lamps would be required, at least one on each 500 feet of sewer.

"There appears to be no doubt that the lamp effectively burns and disinfects what air goes through it.

"This being the case, the gas jet would be as effective if placed in the top of the manhole, allowing the products of combustion to escape at street level, and the cost, as compared with the lamp arrangement, would be trifling.

"The cost of operation would be much reduced, and the effectiveness increased, as the lamp and gas pipes would be protected from frost.

"Also the friction loss in the long sewer connections and lamp posts would be saved.

"For the above reasons, the manhole ventilation would have double the efficiency of the lamps, and might therefore be placed at 1,000 feet intervals, as compared with 500 feet for the lamps."

Record of Observation.

	Lamp on Assiniboine Avenue.	Lamp on Main and Bannatyne.
No. of days observed	59	48
No. of times out	7	2
No. times vent on sewer frozen	10	10
No. times gas pipe frozen	18	14
No. of times no air passing (other cause than freezing)	5	6
Date of maximum efficiency, 4th March, 1908; 7th March, 1908.		
Max. cu, ft. per hour	3,175	4,233
Date of maximum efficiency, 12th March, 1908; 16th March, 1908.		
Min. cu. ft. per hour	52	17
Min. velocity in sewer ft. per min.	0.07	0.015
Max. velocity in sewer ft. per min.	4.22	3.60
Diameter of sewer	4'	5'

First Cost.

Cost of Lamps	$219 15
Freight	32 46
Duty	43 20
Erection	98 35
Teaming	10 00
Superintending and timekeeping	4 00
Stores	46 67
Total for 2 lamps	$453 83

Maintenance and Repairs.

Repair labor	$ 6 00
Teaming	10 00
Frostproof covering	18 00
Thawing out main sewer vent	40 00
Alcohol	2 00
Illuminating gas	8 30
Superintending and timekeeping	1 62
	$85 92

or 82 cents per day per lamp

The City Bacteriologist, Dr. J. H. Leeming, reports to the Civic Health Committee on February 20th, 1908, as follows:—

"I beg to submit herewith the results of the tests which I made in connection with the 'Webb Ventilating Lamps.' I experimented with only one of the lamps, the one which is placed at the corner of Carlton Street and Assiniboine Avenue, and the tests were made on the afternoon of February 3rd.

"Plates containing culture-media of blood-serum, agar and gelatin were exposed to the sewer-air both before and after it had passed through the lamp. In the former case the plates (6 in number), were placed in the pipe leading from the manhole to the lamp. In the latter case the air was conveyed from the top of the lamp by means of a previously sterilized iron pipe, expanded into a funnel at the farther end. This pipe was 12 feet in length in order to allow of sufficient cooling of the air to prevent the spoiling of the culture-media. Six plates were exposed in both cases, and for a period of 1½ hours. As Mr. J. Smith did not have the anomemeter with him at the time of the experiment, I am unable to state how much air passed over the plates, but from readings taken shortly before and after the experiment, I would calculate that about 2,500 feet of air passed over the plates.

"From the plates exposed to the burnt air, i.e., to the air after passing through the lamp, I could not obtain a single growth of bacteria, thus proving that the air was sterile.

"From the plates exposed to the raw sewer air, i.e., the air before passing through the lamp, I obtained a growth of 302 germs. This number, of course, does not include, I should judge, all the germs present in the air, as many more would be swept on by the current of air before they had time to settle on the plates.

"I did not differentiate all these different germs, as that is a task involving considerable time, but I found that among the bacteria were pathogenic organisms, e.g., I obtained a growth of diphtheria of the staphylicoccus pyogenes aurens, and of steptococci.

"I might add that owing to the non-arrival from England of the special thermometers, I was unable to test the temperature of the air issuing from the top of the lamps at the time of the tests. From readings taken since I find the temperature to be 450° F. This is of itself sufficient proof, I judge, that the air must be sterile.

"I might also add that the air (the burnt air), had no foul odor, the only odor perceptible being such a one as is given off by new stove, or furnace pipes, and was due, I think, to the fact that my conducting pipe was new.

"No one now disputes the fact that sewer air contains micro-organisms, such micro-organisms as are present in the surrounding atmosphere. The as yet unsettled point is whether under all conditions sewage will impart to the air its contained micro-organisms. It has been practically definitely proven that, when there is a formation of bubbles in the sewage, the germs, amongst them, of course, pathogenic ones, will be conveyed to the air by the bursting of the bubbles.

"I would like to perform further tests on this matter at different seasons of the year, etc.; but it seems evident to myself that the lamps fulfill admirably the purposes for which they are intended, viz., the prevention of all nuisances arising from sewer manholes."

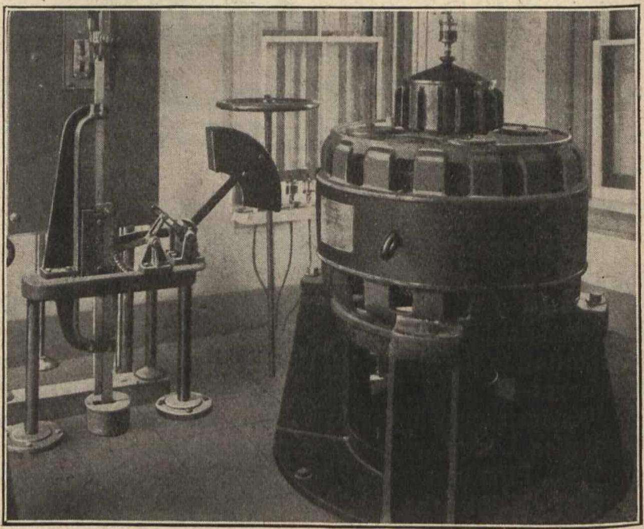
THE SEWAGE PUMPING STATIONS AT DAYTON, OHIO.

The city of Dayton lies in a valley surrounded by hills whose slopes drain very rapidly. At this point, several streams unite to form the Great Miami River. This stream in summer is of insignificant proportions, but in late winter and early spring after a sudden rain or melting snow, it rises in a few hours to the proportions of a great river. To protect the city from inundation, levees are maintained, but a rise in the river cuts off the sewers and it is necessary to close the gates at the outfalls to prevent the river backing up into the streets and houses. At such times it is necessary to raise the sewage and discharge above the flood level. After careful investigation and some costly and unfortunate experiments with steam pumps and pneumatic ejectors, which either required too much attention or were too expensive or uncertain in operation, the city of Dayton decided to install automatic electric pumps and awarded the contracts to the Dayton Hydraulic Machinery Company, builders of the "Brooks" and "Dayton" centrifugal pumps.

When electric motors were decided upon as the driving power, central station power was also accepted as the only satisfactory generating source, since power can be obtained on a moment's notice at any time, night or day. Consequently there is the entire elimination of steam boiler and engine troubles, as these are all cared for by the central station, which is running at all times, whether the water in the river is high or low. Were any other power adopted for the pumps, the maintenance and operating charges would be increased.

Lehman Street Pumping Plant.

Three stations have so far been constructed in various sections of the city. The first is equipped with two vertical 2,500 gallon "Brooks" submerged centrifugals, geared to 20 horse-power, horizontal, "CCL," three-phase, 60 cycle Westinghouse motors. The motors are started and stopped by standard oil switch compensators which are operated by hydraulic pistons controlled by float switches designed and built by the Dayton Hydraulic Machinery Company under their patents. The lift is variable, averaging about 20 feet. The discharge is through a check valve at a point below extreme high water. The operation of these pumps is entirely automatic, it being only necessary to inspect them occasionally and keep the oil receptacles filled. Upon notice of a rise in the river, the gates are closed and the current turned on after which the pumps cut in and cut out automatically with the rise or fall of the sewage in the pits.



Interior of Lehman Street Plant Showing Auto Starter and the Two 40 Horse-power "CCL" Motors.

The second station, at Longworth Street, has three units and the third station, at Lehman Street, two, each consisting of a double suction vertical submerged 4,500 gallon Brooks centrifugal, direct connected to a 40 horse-power, vertical type "CCL" three-phase, 60-cycle, 2,080 volt Westinghouse motor.

The starting apparatus at these last two stations consists of floats which operate the valves on a hydraulic piston, using water under pressure from the city mains. On starting, this piston raises the lever on a Westinghouse auto starter to the starting position at the same time rotating an arm carrying a heavy counterweight which by the time the motors have picked up speed, falls, and by means of a pawl, drops the lever to the running position. On stopping, the reverse motion given the counterweights, moves the lift to the cut-out position. The operation of this apparatus is extremely satisfactory and the motors cut in and cut out automatically with great regularity and smoothness. During a heavy rain when the river was quite high, one pump was sufficient to take care of the flow in the sewers at the Lehman Street station when running three minutes out of each ten, being idle the remaining seven minutes.

A NEW TYPE OF SNOW PLOW.

Snow on railways, and how to remove it quickly, and at the least interruption to traffic is one of the serious problems to be considered by Canadian Railways, for its removal constitutes a large item of the operating expenses of northern railways. Numerous devices have been tried, and several are in use on a number of railways. Light snow falls are readily got rid of by the ordinary push plow, but when deep drifts are encountered they are not what is required, they are expensive and dangerous. Therefore for heavy drifts and deep cuts the Rotary Plow has been the favorite for a number of years.

A new plow manufactured by the Ideal Snow Plow Company, Limited, of Toronto, Canada, was tested last March and bids fair to outrival all previous inventions for the removal of snow. Unfortunately the plow was not placed in operation until late in March, so the test was not completed. It was, however, then tried upon the Durham and Lucknow branch of the Canadian Pacific Railway with marked success, although the machinery had not been previously tried.

By the aid of the several illustrations the reader will readily understand the construction of the plow and its operation.

The total length of the plow is 41 feet 9 inches. Width of the body 9 feet 6 inches inside, extreme width of cut it will make is 11 feet, which is the width at front end, the height of the body is 10 feet inside, and stands 14 feet from rails to the top of the roof.

The whole framing is composed of steel, the siding and roof being covered with wood sheating like an ordinary box car.

The novel features of the plow are the expellers, revolving in semi-circular chambers on each side of the car at the front, they are 9 feet in diameter and 3 feet 6 inches wide and consist of one cast iron centre, or drum 5 feet 4 inches diameter, having four spiral flanges thereon. The flanges are a true helix, having a pitch of about 14 feet, rivetted to the said flanges are four steel plates one half inch thick, both ends being faced off flush with the drum. The expellers are made left and right, and are firmly keyed to a shaft 8 inches in diameter, one to each end.

When in motion they lift the snow, and the spiral blades throw it upwards and outwards. The snow does not enter the chamber, speed of expellers two hundred revolutions per minute, when in deep snow, giving a periphery speed of five thousand six hundred and fifty-five feet per minute.

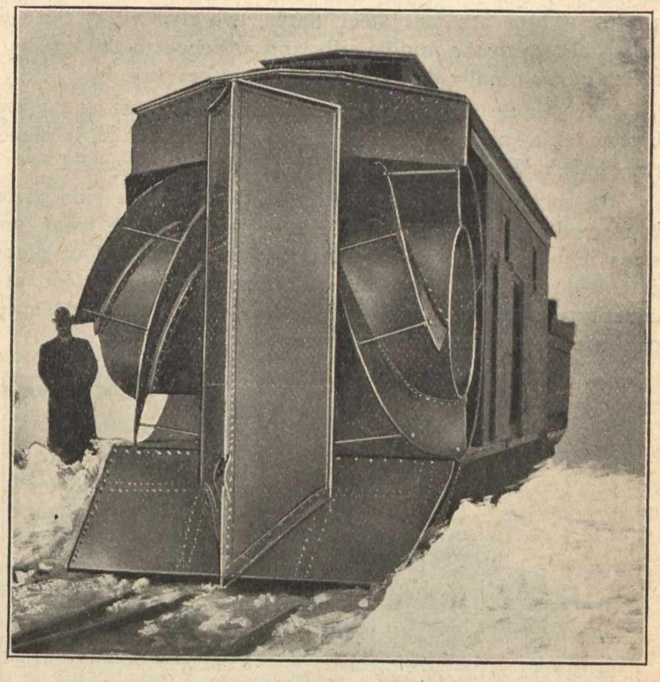
The height from the rail to the centre of the expeller shaft is 8 feet, leaving a space of about 3 feet 6 inches to the bottom of the expeller chamber.

Extending forwards from this chamber is an apron or shovel, having an inclined plane that lifts the snow up into the expellers as the plow is pushed into the drift or bank. It will be noticed that the shovel at the top terminates with a curve, which diverts the snow at that point to an almost vertical direction instead of entering the chamber at the angle of the shovel plane.

Between the two expeller chambers is a third chamber open to the inside of the plow and 4 feet wide, extending forward from the sides of this chamber a plow shear is formed tapering to a thickness of about one inch at the nose. This shear cuts the snow and diverts it to the expellers on each side.

The expeller shaft passes through this middle chamber in which are the shaft pedestal bearings, between said bearings, and firmly keyed to the shaft, is driven gear wheel.

The power used to drive the expellers consists of a pair of heavy built horizontal high speed throttling engines. Cylinder 16-inch diameter, 18-inch stroke, cutting off steam at about 2/3 of the stroke, steam pressure 150 pound per square inch. The engines will develop seven hundred to eight hundred horse-power. The engines exhaust into the boiler smoke box in which a suitable nozzle is provided.



Front View of Plow.

The flooring of the car under the engines consists of oak plank planed level after being laid. The engine beds being planed sit firmly on the floor and are secured in their position by inch and half bolts passing through the oak floor, and the steel framing of the car provided for that purpose, besides this an additional floor of oak is fitted in tight between and all around the engines, making it impossible for any movement to take place between engines and their foundations.

The expellers are driven direct from the engine shaft by two Morse steel belts, each 13 inches wide. The sprocked wheels each have forty-one teeth two inches pitch, face of each wheel 27 inches, all teeth machine cut. This drive is perfectly noiseless and has an efficiency of 98 per cent.

The boiler is of the locomotive type, located at the rear end of the plow, convenient to be stoked from the tender. Provision is made to feed the boiler by a positive feed injector, and an auxiliary duplex steam pump, both drawing the water from the tender, and so connected that either can be put into use immediately. The boiler is also provided with a rocking grate, pop safety valve, glass water gauge, try cocks, blow off, and all the modern appliances suitable to insure safety. It is also firmly braced to the car framing.

The flooring of the car under the boiler is 5/16 steel checker plate with an opening at the back end of the ash pit, to dispose of the ashes. The floor of the ashpit is of concrete 3 inches thick, laid on the steel plate.

The framing of the plow body or car is built of steel plates, channels and angles, total length 41 feet and 9 inches. Width of body 10 feet. Height from bottom of side sill to the top plate 11 feet.

The bottom framing of the car consists of four 12-inch steel channel stringers with sundry transverse beams rivetted to the stringers.

The body bolsters are made up of channels and plates securely rivetted to the stringers. The back end sill is also of 12-inch channel mitred to the side sills and firmly connected to them, and also the centre sills by standard angle connections. Two 12-inch channels are also rivetted to the end sill and body bolster between which the draft-gear is fixed.

Longitudinally with and between the four channel stringers is six oak stringers, 4½ x 6 inches, bolted to the transverse beams to which the flooring is secured.

The side framing is constructed of steel angles vertical and diagonally placed, which together with the top plate and side stringers constitute a steel truss, the whole is rivetted together by ¾-inch steel rivets.

The roof car lines are steel angles rivetted to the top angles and are crowned 6 inches at the centre.

The front portion of the plow is composed of steel plates and angles firmly rivetted to the floor stringers and top chord angles. There are four steel plates, two rivetted to the side sills and two to the middle sills and attached to the top by a series of diagonally disposed steel angle bracing.

The middle plates are spaced 48 inches apart at top and bottom, this space constitutes the chamber in which is placed the shaft pedestals, also the driving chain and wheel.

On each side of these plates and between the side plates is formed the semi-circular chamber open at the front and sides in which the two expellers revolve. These four plates extend down below the sills, and forward about 4 feet, and constitute a part of the shovel, and to which the steel angles of the expeller chambers are rivetted.

View Showing Location of Boiler.

At the front of the car and rivetted to the middle plates and the shovel is the vertical plow shear, composed of two steel plates, having a steel bar rivetted between the plates at the nose; diaphrams are rivetted between the plates to stiffen the same, when operating in hard snow.

A lookout box is provided in the front end of the car and means will be provided so that communication can be maintained between the engineers of the plow and the locomotive pushing the plow.

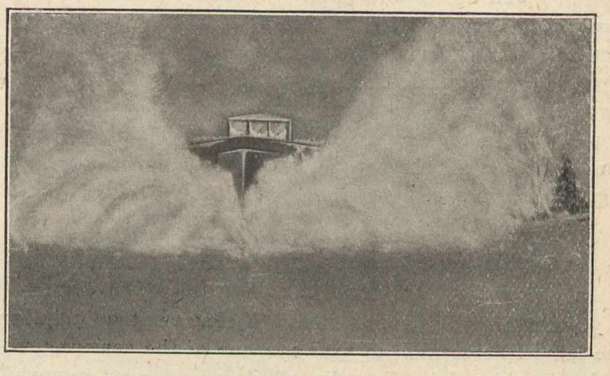
The trucks are 24 feet apart, wheels 5 feet centre, the front truck being a standard for a 50-ton car, and the hind truck a standard for 30-ton car.

Total weight of the plow is sixty tons, and was built by the Hunter Bridge and Boiler Company, of Kincardine, Ont. The engines were built by the Doty Engine Company, of Goderich, Ont.

In further reference to the trial of the plow we append some extracts from the report of the engineer who conducted the trial.

The plow arrived at Orangeville on the 18th of March, at which place a tender belonging to the C.P.R. was attached, and left again for Proton, later on the plow was taken to Proton Junction and was pushed into the snow on the Durham and Lucknow branch of the C.P.R., but the engine was to light, therefore little progress was made. Next day an additional engine was attached; with the two engines better progress was made, but owing to the solid condition of the snow the plow could not penetrate the mass unless the two engines drove the plow into it at a speed of 6 to 8 miles per hour, but when the plow was entered the expellers rapidly threw out the snow.

This process of bunting in was repeated and with good success for some time, when through the accidental slipping of one eccentric of the expeller engines, work was stopped for that day. On Monday afternoon, after the arrival of Mr. Stewart, of the C.P.R. staff, the plow was put into the snow drifts, again doing splendid work, the heavy engine driving



Plow Throwing the Snow.

the plow into the snow at about eight miles per hour, the plow entering 10 to 12 feet at a jump, the expellers lifting tons of snow. Again the plow would be withdrawn to take another run at the mass. By this mode of operation a large deep drift was cleared out in about two hours, the expellers throwing some portions to a distance of 50 to 60 feet. After getting through the heavy drift the plow cleaned up a portion of the road varying in depth up to five feet at a good steady run. Some distance further on another drift was attacked with similar vigor, but after a few rushes the plow struck the compact snow with such force that the sudden check of the plow caused the water in the boiler to rush through the steam pipes into the cylinders, which wrecked one of the expeller engines, the bed being cracked near the shaft bearings. Work had to be abandoned to make the necessary repairs.

With further reference to the snow banks, attacked and removed, the same had been accumulating since the 14th of January, 1908, and become so compact that blocks weighing 50 pounds thrown out by the expellers could not be broken by an ordinary shovel. In fact some portions were almost ice.

It looked like an impossible task to get through when first struck, but the plow by perseverance did get through what was considered the hardest portion of the drifts.

Cut Partly Opened.

The plow body demonstrated its ample strength to withstand the hard usage snow plows are subjected too, and has ample load on the front truck to keep it on the rails, but should the plow leave the track through a broken rail or otherwise, the front truck cannot slew around, therefore the wheels would run on the ties until the plow was stopped.

The inventor of this device is E. Bowman, Esq., Elmwood, Ont. The whole work was designed and built under the supervision of the company's engineer, Wm. H. Law, M.E., Toronto, Ont. The secretary of the company is E. D. Weber, Esq., 521 Dovercourt Road, Toronto, Canada.

TRANSPORTATION.

M. J. Butler, Deputy Minister Railways and Canals.

The subject matter before us is one that is of the utmost importance, one that has already engaged the attention of a Royal Commission. I do not propose dealing with any of the features found in that report, it will well repay careful study.

Upon the successful solution of the problem of transportation, hinges, in large measure, the price of the food we eat, the clothes we wear, the buildings that house us, the fuel that keeps us comfortable these winter days, and the thousand and one things that go to make up the wants and luxuries that constitute modern life.

Physical Features.

It is not an easy thing to condense within reasonable limits the characteristics of such a country as Canada, covering more than one half the North American Continent, and reaching from Latitude 42° N. to the Pole; a country whose coast line on the Atlantic measures 10,000 miles, and whose western shore upon the Pacific is of almost equal length; a country where corn, tobacco, peaches, grapes are staples, and all vegetation ceases in the barrenness of the sub-Artics. If we examine the eastern section we find the greatest forest on the globe—alas, all too speedily being destroyed by careless cutting, and fire. If we examine the central region, we find the great prairie country, and the mixed forest and prairie, the future home of prosperous millions, and teeming with wheat fields. Further to the West the Pacific Province, British Columbia, with its "Sea of Mountains," compared with which the mountains of Europe are of limited extent. If for a moment we disregard British Columbia in the general description, it may be described as a country of broad lakes and flowing rivers; where the abundant streams and the regularity of the rains preclude drought, and secure the widest area of vegetable growth. It is a land of grass and forest, containing by far the largest portion of fresh water on the globe, and which we share in common with the United States—along our southern boundary. The general slope of the country from the foot-hills of the Rocky Mountains to the sea is so gentle, that with the single abrupt falls at Niagara and the rapids at a few other points, the rivers flow with an even, gentle current.

Navigation.

Having thus briefly described the area and physical characteristics of our country, I venture to as shortly as possible, enumerate the water transportation routes and the size and description of each of the canals. The rapids at the Sault Ste. Marie are overcome by three canals, two on the United States' side and one on the Canadian side. The Canadian canal is a single lift of 18 feet, is 5,967 feet long; the width of the lock is 60 feet; depth of water 20 feet 3 inches; length of lock 900 feet; the breadth of canal at the water surface is 150 feet. The old American canal is 1⅛ miles long; 80 feet width of lock; depth of water 16 feet; length of locks 515 feet. The new American canal is 1 7-10 miles long; width of lock 100 feet; depth of water 21 feet; length of lock 800 feet. No tolls are charged by either Government for the use of these canals, the tonnage is very great, and the growth of traffic such that it is doubling about every five years. The gross tonnage for the year 1906 was 51,754,331 tons, and the aggregate value of the property reached the enormous total of $537,463,454, of which the Canadian canal proportion was 6,574,039 tons or 13 per cent.

Welland Canal.

The Falls of Niagara are overcome by the Welland Canal, running from Port Colborne on Lake Erie, to Port Dalhousie on Lake Ontario, a distance of 26¾ miles, with 25 lift locks and one guard lock; 14 feet depth of water on the lock sill, and the locks are 270 x 45 feet. The total fall or lockage is 326¾ feet. At Port Colborne there is, in process of erection, a modern fireproof elevator, planned for 2,000,000 bushels capacity, although the portion now being built will have a storage capacity of 800,000 bushels, in order to test the requirements at that port. If it should be found that the greater storage capacity is required, the additional bin can be built in one season.

Williamsburg.

The Galops, Rapide Plat and Farran's Point are collectively known as the Williamsburg Canals.

Galops Canal.

This canal enables vessels to overcome the rapids at Point aux Iroquois, Point Cardinal and the Galops. The length of the canal is 7⅓ miles; number of locks 3; one being a guard lock. The dimensions of the locks are two of 270 x 45 feet; one of 800 x 45 feet; total rise or fall 15½ feet; depth of water on sill 14 feet, and breadth of canal at water line 144 feet. From the head of the Rapide Plat Canal to Iroquois, at the foot of the Galops, the St. Lawrence River is navigable 4½ miles.

The Rapide Plat Canal.

Length of canal 3⅔ miles; number of locks 2; dimensions of locks 270 x 45 feet; total fall 11½ feet; depth of water on sill 14 feet; breadth of canal at surface of water 152 feet. The old lift lock 200 x 45 feet with 9 feet depth of water on sill is also available. From the head of Farran's Point to the foot of the Rapide Plat there is a stretch of navigable river 10½ miles. Descending vessels run the rapids safely.

Farran's Point.

Length of canal, 1 mile; number of locks, one new lock 800 x 45 feet; old lock, 200 x 45 feet; total fall 3½ feet; depth of water on sill 14 feet new lock; old one 9 feet; breadth of canal at water surface 154 feet. From the head of the Cornwall Canal to the foot of the Farran's Point Canal the distance is five miles; and the lock is large enough to allow ascending vessels with full tows to pass. Descending vessels run the rapids with safety.

Cornwall Canal.

Length of canal 11 miles; number of locks 6; total fall 48 feet; size of locks 270 x 45 feet; depth of water on sills 14 feet; breadth of canal at water surface 164 feet. The old lift locks, 200 x 45 feet, with 9 feet of water on sill are available from the head of the Soulanges Canal to the foot of the Cornwall Canal, a distance of 32¾ miles. Crossing Lake St. Francis the navigation is for 14 feet draught of vessels. The Cornwall Canal extends past the Long Sault Rapids and the town of Cornwall to Dixon's Landing. Excursion steamers run the rapids, and the thrill experienced in taking them for the first time will long be remembered.

Soulanges Canal.

The canal extends from Cascades Point to Coteau Landing, overcoming the Cascades, Cedars and Coteau Rapids; and is 14 miles long. Five locks in all, one a guard lock.

The dimensions of the locks are 280 x 45; total fall 84 feet; depth of water on sills 15 feet; and the breadth of canal at water surface 164 feet. From the head of the Lachine Canal to the foot of the Soulanges, across Lake St. Louis, is a distance of 16 miles, navigable for vessels with 14 feet draught.

Lachine Canal.

The canal extends from the City of Montreal to the town of Lachine, overcoming the St. Louis Rapids, or better known as the Lachine, the first of the series which bars the ascent of the River St. Lawrence from the sea, distant some 986 miles from Belle Isle Straits.

The canal consists of one channel with two systems of locks, the old and the new, with the lock entrances at each end. The length of the canal is 8½ miles; number of locks 5; dimensions of locks 270 x 45 feet; total fall 45 feet; depth of water on sills, two of 18 feet, three of 14 feet; average width 150 feet. The old locks are 200 x 45 feet, with 9 feet of water on the sills.

The River St. Lawrence, with the system of canals, the Lakes Ontario, Erie, St. Clair, Huron and Superior, with connecting rivers and canals, afford a continuous water communication from the Straits of Belle Isle to Port Arthur, a distance of 2,200 miles. From the Straits of Belle Isle to Montreal the distance is 986 miles. From Quebec to Montreal the distance is 160 miles. Formerly vessels drawing over 10 or 12 feet could not pass above Quebec, but owing to the energy and enterprise of the people of Montreal, and of the Government of Canada, a magnificent channel has been dredged, lighted and buoyed, having a minimum width of 400 feet on straight portion and in curves for 500 to 750 feet and depth of 30 feet; thereby placing Montreal at the head of the ocean navigation.

The difference in level to be overcome from the sea to Lake Superior is about 600 feet; the aggregate length of canal is 73 miles; the total lockage overcome 551 feet, and the number of locks through which a vessel must pass from Montreal to Lake Superior is 48.

Other canals serving local and useful functions in the progress and development of the country are: St. Peters, Cape Breton, having a tidal lock connecting St. Peters Bay, on the southern side of Cape Breton, with the Bras d'Or Lakes.

The Ottawa River Canals connecting the City of Ottawa with Montreal. The Rideau system of canals connecting the City of Ottawa with Kingston, at the foot of Lake Ontario; and Richelieu and Lake Champlain, which connects the St. Lawrence system with the Hudson River and New York.

The Trent Canal system, which comprises a series of lakes and rivers extending from Trenton, on the Bay of Quinte, to the Georgian Bay; 106 miles are now open, but as it is wholly in the interior and has not yet been opened through to either outlet, is of local value only.

The canal traffic through the Sault Ste. Marie lock is very large, fully two-thirds of the capacity of the work. It must be confessed, however, that the St. Lawrence system has proven to be a disappointment; the shipping interest of the country has not availed itself of the possibilities of the 14 feet navigation. No doubt there are a number of reasons which have been determining factors; one is the lack of boats designed for the route in question. The largest type of steamer, with a capacity of 10,000 tons, can enter Port Colborne on Lake Erie, but no further; neither have storage facilities been provided at that port, although there is under consideration an elevator, modern in every respect, planned on a scale for 2,000,000 bushels storage of grain. It will be ready for next season's crop, with a storage capacity of 850,000 bushels. When the requirements of the port can be ascertained, should it be found that a larger storage is needed, the additional room will be provided in time for the crop of 1910.

To transport cargoes through the Welland Canal and thence across Lake Ontario and the St. Lawrence route, requires as strong a class of steamer as the upper lakes. Consequently, it has been suggested that the Welland Canal should be enlarged to ship size to provide 21 feet on the sill and thus allow the large ships to pass across Lake Ontario and down the St. Lawrence as far as Kingston or Prescott, where large storage elevators and store houses should be built. Prescott is practically at the head of canal navigation on the St. Lawrence, distant only 118 miles from Montreal; has good rail facilities—the Grand Trunk and Canadian Pacific, and by ferry with the New York Central system. All incoming ships are reported at Belle Isle or sooner; the consignor well knows what cargo he needs, and can notify Prescott just what quantities and qualities are to be sent to Montreal for the particular boat. There is ample time in which to load up canal barges; and for a powerful tug to tow them to Montreal and be ready immediately on arrival of the ship. A system of rapid transfer elevators would have to be provided, and no expensive and elaborate storage elevators would be required in Montreal, where ground is so valuable. Of course, the type of barge and tug suitable for such service will have to be built on such lines as are needed for the exact service. It is easily practicable to provide 2,000 ton barges; and three or four would not be too great a tow for the right kind of a tug. It would never be necessary or desirable to attempt to carry the ship canals down the St. Lawrence to Montreal.

Another route which is enthusiastically advocated is that of the Georgian Bay Ship Canal, whereby it is proposed to canalize the French River between the Georgian Bay and Lake Nipissing; and the Ottawa River and certain tributaries from Lake Nipissing, to Montreal. This route is much shorter than the St. Lawrence route, and is worthy of the most exhaustive study particularly from the view point of the navigator and ship owner. The chief factor requiring authoritative determination is the average speed possible in the proposed water way, by the larger type of steamers; the question of distance, relatively, is of minor importance, unless it also shortens the time of transit. It is a dream of some enthusiasts that the time may come when a ship will load cargo at Port Arthur, and without breaking bulk, land in Liverpool. I am afraid it will always remain a dream; the type of steamer required for the Atlantic Ocean is so vastly different; the scantling, depth, beam, etc., are all on an entirely different scale, and the cost of transfer or cargo is so trifling, that it is hardly practicable to work out a type of boat suitable for the different services. Assuredly, none of the existing steamers on the great lakes could be adapted to the ocean service. It will be a costly canal to construct, and due consideration is required in order, that from the start no mistake be made. It may be when **all** the factors are considered that the solutions of the problem of how best to secure to Canadian ports the products of the Canadian West is to be solved by its aid.

We have in the Dominion of Canada shown our faith in water transportation, by spending $91,734,718 in building our present canal system, and have a fixed burden of some $1,730,000 per year for the upkeep and improvements of the services. The total of the goods transported last year through the canals reached 51,751,080 tons, freight paid estimated at $36,666,839.06, and at the average rate per ton per mile was 84-100 of a mill barely 1-9 of what rail transportation would have cost; although it must be borne in mind that the canals are free of tolls and that no direct return is earned upon the capital invested, as is always required on railways.

Railways.

The splendid map which has been prepared by Mr. White, Geographer to the Department of the Interior, shows clearly the rail routes throughout the Dominion. By following the several distinctive colours the "Sphere of Influence" or tributary territory to each of the railway systems of the country may be clearly understood, and I will not weary you with a full description of the characteristic features of each. Railways are available at all times and seasons, and are consequently of greater importance than waterways, which can only be used for a part of the year—say from May to December—first seven months at the most. Again, all classes of freight are handled by railways, whereas necessarily only the coarser bulk freights seek water routes. I desire to draw your attention to the railway statistics of Canada for the year 1907, wherein will be found a most interesting amount of valuable information published for the first time in the history of Canada.

We have at present 172 railways, aggregating 22,452 miles, in operation; the total capital equalling $1,171,937,808, towards the cost of which aid has been granted by the Dominion of Canada to the amount of $181,298,412.91; loans to the amount of $15,576,533.33, and lands to the extent of 31,762,954 acres; by Provincial Governments, $28,189,695.80; loans to the extent of $6,633,435; by municipalities, $12,102,634.72; loans, $2,404,498.62, and subscriptions to shares, $2,839,500. Land grants have also been made to the extent of 20,000,000 acres.

The cost of the Government system of railways amounting to $90,052,237, and of the Temiskaming and Northern Ontario Railway, built and owned by the Province of Ontario at a cost of about $10,000,000, is not included in the above mentioned sums. In addition to the above, guaranteed bonds by the Dominion and the several Provinces, to a large amount, have been given as aid toward the construction of our railway systems. For comparison, the capitalization of various railways in the world is given:—

United States	$ 67,936 per mile
United Kingdom	273,437 "
New South Wales	63,063 "
Victoria	63,113 "
India	56,796 "
Canada	56,995 "
Intercolonial	57,112 "
Prince Edward Island	27,965 "

The business done during the year 1907 reached a total of 63,866,135 tons, of which the products of agriculture afforded 17 per cent.; animals 4 per cent.; mines 33 per cent.; forests 18 per cent.; manufactures 14 per cent., and merchandise and miscellaneous 14 per cent.; compared with whole United States, the percentages of which are as follows: Agriculture 9.03 per cent.; animals 2.54 per cent.; mines 53.59 per cent.; forests 11.24 per cent.; manufactures 13.6 per cent.; merchandise 4.32 per cent.; and miscellaneous 5.68 per cent.

The passenger business done on our railways—32,137,319; however, it must be recognized that the mere number of passengers or tons of freight is no measure of the business handled unless the distance hauled is also included. It, therefore, becomes of interest to learn that our passengers hauled 1 mile reached the total of 2,049,549,813; and tons 1 mile 11,687,711,830, that the average passenger travels 64 miles, and that the average haul on freight is 183 miles; 124,012 persons are directly employed in railway service, the compensation amounting to $58,719,493. Taking into consideration the average family dependent upon each wage-earner and those employed in other lines of industry, such as car and locomotive works, bridge works, etc., it is no exaggeration to say that one out of every six in the community are dependent upon railway transportation for his or her living, either directly or indirectly. The average receipts per passenger per mile on the railways of Canada is two cents, and the average receipts per ton per mile hauled is about ¾ of a cent.; so much for what has been accomplished by a population of, at present, 6½ millions, occupying only a small fraction of the area of our country. When it is remembered that barely 1⅓ per cent. of the land is improved farm lands, that 1½ per cent. in addition is in occupancy but unimproved, or that, in all, less than 3 per cent. is in the use of our people, what may we look forward to when say 25 per cent. is in use, or when 50 per cent., the possible fertile useful portion, is likewise in use.

The world's principal market for the products of agriculture is London, England, and in all probability the Atlantic seaboard will remain the outlet for the principal products of this country; hence our efforts must be directed towards reaching that end with the least possible expenditure. Fortunately for our country in so doing we are following the lines of least resistance, generally. In the early days of the settlement of this country, the transportation question compelled the early settlers to stick close to the seashore and the banks of the navigable rivers, following up the St. Lawrence valley and its navigable tributaries, and along the shores of the great lakes. The main lines of our railways systems are therefore compelled to parallel our water routes.

The National Transcontinental Railway, commonly known as the Grand Trunk Pacific, however, opens up the hinterland of Ontario and Quebec, and will give access to an area of some 18,000,000 acres of land, besides giving access to a virgin forest and untold incalculable mineral wealth. Who would be bold enough to say how many Cobalts will be found along the mineralized belt of Huronian rocks, which extends almost parallel with the main line from Lake Abbitibi eastward. I tramped over the entire district between Temiskaming Lake and North Bay some eighteen years ago, and while my note-books show frequent reference to possible mineral wealth I was not fortunate enough to locate a Cobalt.

Hudson Bay Route.

Quite recently a couple of pamphlets have been issued from the Department of the Interior; one dealing with the possible wealth of our North land, and I am quite sure that any person who studies the conclusions therein set forth will have a clearer conception of the enormous possibilities of that area. The second one, prepared by Mr. J. A. J. McKenna summarizes in an admirable manner the available information as to the possibilities of navigation on Hudson Bay. I regret to say that the data to warrant any conclusions of value are lacking, and the information, while of some value, is not the kind that will convince financiers of the economic value of the proposed route. The problems that must be solved are:—

1st. Will any regular commercial line of steamers carry cargo from Hudson's Bay to Liverpool at the same rate as from Montreal?

2nd. Will insurance companies cover ships and cargo at a rate not exceeding that on the St. Lawrence route?

3rd. Can any merchant afford to carry any considerable amount of merchandise, grain or other products, over from the month of October, the usual date of closing, until the following August or July (in case it should be found possible for navigation to start in July.) It must close about October 15th. Hence the route must be one that does its entire business in three months, and the goods which furnish the traffic must be the product of the preceding year; at any rate, to a very great extent, I am of the opinion that another solution is necessary, and that every effort must be made to get the crop as close to the world's market as possible, in order that any rise in price can be taken advantage of. Hence, the nearer the storage point is to the seaboard, the better. Midland, on the south-east shore of the Georgian Bay is an obviously well located site, and can be quickly and safely reached with 20 foot navigation from Port Arthur or Fort William. This port will be connected with Montreal, St. John and Halifax by low grade many tracked railways so that the cheapest possible rail haul can be secured. The lines of railway between the prairies and the head of lake navigation at Fort William will be double tracked, four tracked or six tracked, as the business warrants; and 20 foot, safe navigation affords very low cost across the lake to Midland. The Grand Trunk Pacific Railway with 4-10 of one per cent. grades and built and equipped in a first class manner throughout is bound to open up a new basis for rail haul. This direct line through the centre of the wheat belt to the seaboard will no doubt be of immense value to the country.

Providence has seen fit to locate our greatest prairies upwards of 1,000 miles from the seaboard; hence, for all time the burden of transportation must be a charge against our farm products from that land. So, in turn, the natural and topographic resources of our eastern territory are such as to compel all manufacturing to be carried on a long distance from the consumer, thus helping the transportation companies by supplying return loads for the trains. It, therefore, behooves us to study closely the conditions requisite for economic operation of railways.

In 1825, Thomas Tredgold, civil engineer, wrote "A Practical Treatise on Railroads and Carriages," and for his motto quoted an extract from the Quarterly Review, reading as follows:

"Our present modes of conveyance, excellent as they are, both require and admit of great improvement." The text still remains true; by way of digression it may be of interest to look back to the inception of railways, and note briefly the point of view of that day.

Before dismissing the subject of locomotive engines, it ought to be remarked, that they must always be objectionable on a railroad for general use, where it is attempted to give them a considerable degree of speed; for many passing places there cannot be; hence, the velocity of the greater part of the carriages on a line of road must be limited by a slow travelling one. This would not only be a source of inconvenience, but one of danger, from carriages striking against one another. A steamboat has sea room; a mail has the width of the road, but a steam carriage cannot deviate from its track to avoid an accident. We therefore must now turn our attention to fixed enquiries; and examine if they afford any better reason to hope for the application of steam power with advantage and safety."

After a careful discussion of the proper height and width of carriages he concludes: "All these circumstances demand the serious attention of the engineer who has to conduct a railway where the carriages are to proceed at the rate of ten miles an hour.

"We speak of this as a rapid motion, and the more we consider the subject the more reason we find to consider it so, and we see no material advantage in a greater speed, unless it were on a railway for messengers and letters only, where the small carriage to contain the messenger and letters may be impelled by a man, seated in it so that he could work in a manner similar to a man rowing. On a railway adapted for such a light carriage, with its load suspended below its axles, a great speed might be obtained, when habit has rendered it supportable; and perhaps it may in a few rare instances be worthy of trial, when the quick transmission of intelligence or dispatches is of importance; and being successful in these instances, it might be adapted for the conveying of mails; but that any general system of conveying passengers would answer, to go at a velocity exceeding ten miles an hour or thereabouts is extremely improbable."

The economies of railway location were not appreciated by the engineers until a much later period, and although Professor George L. Vose, in his "Manual for Railroad Engineers," published in 1878, directed attention to the questions of grade and curve resistance, it was not until some years later that the great work of A. M. Wellington was published. The first edition of the "Economic Theory of Railways" failed to meet with anything like the consideration its merits deserved, but the second edition, revised and enlarged, avoided some of the errors of the first, and embodied for all time the fundamental principles which govern the questions involved in railway economies. Mr. Wellington was a man of the highest genius, and gave his life to his work. Appreciation came slowly during his lifetime, but to-day the entire engineering and railroad world acknowledges the great debt it owes to his labors.

Railway Earnings.

The receipts per ton mile by the railways of this country must yield on the average about 7-10ths of a cent, and about two cents per passenger mile. It would seem to be theoretically possible to materially reduce the average rate on a railway built to the highest standard, with easy curvature and easy gradients. Calculations have been made by various persons about as follows:

The average cost of running a train one mile is $1.25, the operating costs are about two thirds of the gross receipts; hence we should earn at least $1.90 per train mile. As a typical example of this kind of calculation; the distance from Brandon to Quebec, via the Grand Trunk Pacific, with 4-10 of 1 per cent. grades, the maximum curvature of four degrees, is about 1,500 miles; using a locomotive that will haul a train of 2,000 tons pay load, all of which falls within the limits of present practice, the necessary earnings of such a train for such a single trip would be $2,850, or $1.42½ per ton, or say 4¼ cents per bushel of wheat. Elevator and handling charges at each end would bring the cost up to about five cents. The lowest existing rate, via the Canadian Pacific Railway, to Lake Superior and thence by steamer to Midland and rail to Montreal, is 22.8 cents, or by all water from Lake Superior 14.8 with elevator charges 15.55 from Fort William to Montreal 8½c. to 7c.; water rate 1½c. to 2c.; rail 5c. from Midland to Montreal.

As the railways are not earning any more than seems reasonably necessary to meet their obligations, something must be wrong in the solution, and other factors must be taken into consideration. What are they?

The first that seems to call for consideration is the fact that agricultural products cannot support a railway, that barely 15 per cent. of the traffic is derived from this source—and that it is generally a car-load lot matter, rating among the lowest in class—viz., 8th to 10th.

Second. There is on all railways a lot of empty engine mileage due to switching, making up trains, pushing, etc., which must be paid for.

Third. That quite one-third of the car mileage is hauled empty, due to preponderance of freight in one direction.

Fourth. That cars are not loaded to anything near their capacity; the average being barely one-half of the rated capacity, due in part to bulky freight, and other causes.

Fifth. That railways, in order to be profitable, must have a fair proportion of high class freight able to bear the charges.

Sixth. The earning power of a railway is affected by the freight and passenger density of the business.

	U.S.	Canada.
Average freight ton miles per mile of railway	861,396	530,564
Average passenger miles per mile of railway	109,949	91,286

Seventh. It can be shown that an average speed of ten miles per hour is the most economical one for freight trains, and that therefore they should average at least 100 miles per day, with all freight trains. Some fast freights greatly exceed the economical rate, but on the average I doubt if one half the distance named is made.

Eighth. It is apparent that many factors have to be considered in arriving at the cost of any particular service, and I must confess I have not seen a satisfactory solution, however I venture to submit a tentative theoretical possibility. Assume gross earnings of $2.50 per train mile as not unreasonable, that the distance is as above 1,500 miles, and that the train load will consist of 2,000 tons of pay freight that the entire train has to return empty. We then find 3,000 train miles at $2.50 = $7,500 for the round trip or $3.75 per ton—or about 11¼ cents per bushel. If we add ¾ of a cent for elevator and storage charges the price of hauling a bushel of wheat from Brandon and placing it on board ship at Quebec will be 12c.

Quebec is practically 24 hours closer to Europe than Montreal, having regard to the up and down trip and the hours of navigation. Such a result, if practicable, would mean a great deal to the West.

Rate Making.

Probably no more abstruse subject in the whole range of economics can be found than is embraced in rate making. The tariffs and classification seem to be needlessly confusing and the principles governing are by no means clear. Volumes have been written on the subject; however, if we consider the subject of municipal taxation, a somewhat analogous one to that of rate making, we find that taxes are charged on the basis of the ability of the individual to pay. So also in rate making the phrase has been coined of "charging what the traffic will bear," and when rightly considered it is the proper measure the cost of transportation should be based upon—the value of the goods. The valuable products must help carry the less valuable. It is obvious that a car load of hats, sewing machines, or other high class products, involves greater risk, more attention and care than a car of coal or lumber. If the coal and lumber are to be hauled a long distance, the price would be prohibitive unless carried at a low rate. Reasonable rates should be granted and fairness should be shown to all shippers; but what is a fair and reasonable rate must ever be a difficult question to answer. The railway, like any other business, has something for sale; that something in its case is transportation. It must earn enough to pay its wages, its supplies, and a reasonable interest on the capital invested; otherwise, like any other business, it must go into bankruptcy; but unlike most other lines of business it must continue to run as long as it is a railway. Unreasonable treatment or legislation by the public will hinder railway development. We in Canada have placed upon our Statute Books the most advanced piece of railway legislation so far enacted anywhere; by it a Railway Commission is created and vested with large powers. The Commission has been at work for about four years, and has given splendid results. It has demonstrated already that the railways can be controlled, that the public interest can be protected, without impairing the capital invested, and that many of the problems which trouble our neighbors to the south of us can be much more readily and surely solved than by the enacting of legislation along extreme lines, which, practically result in destroying the earning power of the property affected.

The car famine last year resulted in a lot of friction between shippers and the railways, so far indeed has the feeling gone that it has been suggested that Canadian cars should be kept within the boundaries of Canada. I am afraid the suggestion is made without a full knowledge of the conditions. On the Intercolonial Railway the only market for pulp-wood, sawn board, and nearly all other descriptions of lumber, other than deals, is in the United States, the same is true of a large proportion of the trade in Ontario and Quebec, any such action would ruin those engaged in the business. Once a car crosses in United States territory the jurisdiction of Canadian laws is lost, hence it would be necessary to trans-ship at the boundary. I need not enlarge upon what would be the result, however, conditions have changed; at present in the United States, March 1908, 350,000 cars are idle, I am unable to give the number in like condition in Canada, but it is a large one.

I am of the opinion that much of the hostile talk, and threatened legislation aimed at remedying abuses in railway working in Canada, is due to our American cousins, for a couple of years the popular magazines have been conducting a vigorous campaign against corporate abuses of every description, rousing public opinion to a fever heat, with the result, that State has been vying with State, to see which could go the farthest in hostile and rigorous legislation, but with the recent check to prosperity a halt has been called. I do not think the conditions or abuses have been as bad in this country, and the result is that the railway companies are endeavouring to obey the law more closely than elsewhere.

THE BUYING OF COAL.

Many and varied are the methods employed to-day in the buying of coal. They are discussed in a lucid manner in a recent paper by Mr. E. G. Bailey, chief of the Coal Department, Arthur D. Little's Laboratory, Boston. From this paper the following extract is taken:—

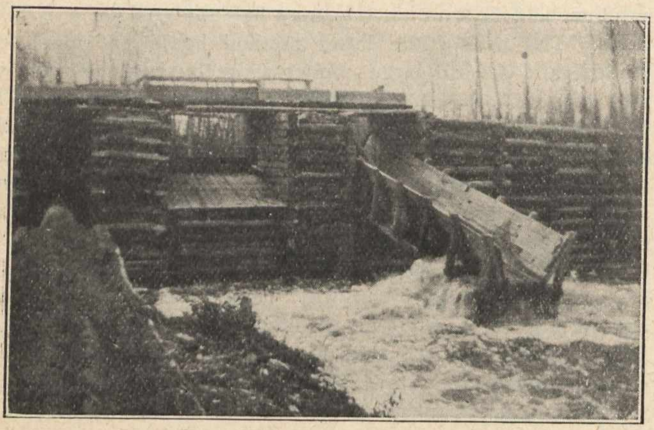
"Some people buy coal simply because the price is the cheapest they have had quoted to them. Another man buys coal upon its past reputation. He thinks 'that coal has always given good results: it gave Mr. So-and-So good results, and I will keep on buying it.' Another takes the recommendation of his engineer or fireman, and no matter what the price, he says: 'That coal is worth the money, and I will take it.' Another man buys his coal upon the basis of the highest number of heat units per dollar. Another will make evaporative tests, and buy the coal giving the highest evaporation per dollar. Of course, the latter result is what every one wants in a steam plant, but in such cases the purchaser is frequently misled, because he figures the price of his coal f.o.b., the car or vessel, and does not consider that a coal which may evaporate eight pounds of water to a pound of coal costs a good deal more to handle enough to supply him for a year than if the coal evaporated 10½ pounds of water to a pound of coal. He has to pay more for labor for having the coal brought into his boiler-room; he has more ashes, and all the way through there are numerous small expenses which, if considered in the first place, might show that coal to be more expensive at the end of the year than the other coal would have been. In any case you cannot depend entirely upon the price and quality, whether you take it from heat units or evaporation. There are certain practical things that must be considered, such as delivery and the question of spontaneous combustion. There are numerous things upon which you cannot put a definite money value, and each person must use his own judgment to a certain extent after all. He must determine the coal to buy, either from a trial or from past use of that particular coal. There are variations in the conditions in the mines as impurities, sulphur balls; and also the preparation of the coal, so that what you received from a mine last year does not prove that you will receive the same the coming year. One cannot drop the matter as soon as he has made his contract. He must follow the thing up to be sure that he is getting the value contracted for. He may determine this by inspection, and if the coal is from the same mine and of the same character, one can tell a great deal about the coal as to impurities, one of the largest factors in the question. He may make evaporative tests from time to time, and in that way determine whether the coal is giving the results previously obtained from it. He may analyze the coal, determine the percentage of ash, sulphur, and heat units. He may buy the coal on a B.T.U. basis. The use of the latter method has been much extended, and several large concerns are buying their coal in that manner. It has good points as well as faults. The fault lies mostly in having to pay a higher price for the coal. The coal dealer is not sure his coal is going to run uniformly throughout the year, even from the same mine. He is going to have his profit, and he, therefore puts up the price from ten to twenty-five cents to offset the chances of that coal being bad. If he can afford to take the risk at twenty-five cents a ton why cannot the buyer? There are certain cases where it is advisable to buy coal on a B.T.U. basis, but the coal man is not yet ready to do a general business on that basis. One reason why the coal man advances the price in order to offset any difference in quality is because he is not familiar with his own coal. He has probably had a few analyses from it, but he is not sure they are the average. Another reason is that by past experience the sampling of coal delivered has been done in such a way that fair average results have not been obtained. Sometimes the coal man is cheated and sometimes the buyer. A fair sample of the coal is a very difficult thing to obtain by a person who does not know all the chances for obtaining erroneous results, and that has knocked the confidence out of both the coal seller and buyer; but a proper average sample of coal can be obtained. There is a large concern which burns about a thousand tons of coal a day, and receives a coal which runs fairly uniform. From the results of their sample it seldom varies more than one-half of one per cent. in quality. They have learned that a few shovelfuls, or a handful here and there, does not represent the average of a carload. You must take a considerable quantity, from 500 to 2,000 pounds. That should be taken miscellaneously, and all of it broken up and thoroughly mixed, so that a piece of slate left in your sample or thrown away will make practically no difference. A small sample may have a piece of slate in it that will be five per cent. of the total. This is often found in samples taken, so you can readily see where the discrepancy comes in.

"The method of determining the quality of coal by evaporative tests is what may be considered the really practical method, but there are certain difficulties even there. The boiler efficiency varies with so many things that it is practically impossible to maintain the same boiler conditions throughout two consecutive tests. The fireman has a great deal to do with it: the load on your boiler, the draft, the cleanliness of the heating surface; all these things are very irregular. The method of determining heat units in a laboratory is a very practical one. A small amount of coal is taken, which is a representative sample if properly taken, and is burned in an atmosphere of oxygen in a steel bomb, which is submerged in water. A very delicate thermometer gives the temperature of this water before the coal is burned, and by means of an electric spark the coal is ignited and entirely burned, and every bit of the heat developed is absorbed by the water, and the thermometer rises accordingly. From this rise in temperature the B.T.U. are determined. The result is practical, as a B.T.U. is the heat required to raise the temperature of one pound of water one degree Farhenheit. It obviates all the errors which come in a practical boiler test."

HYDRO-ELECTRIC PLANT OF THE LISKEARD LIGHT, HEAT AND POWER CO., LIMITED.

D. Sinclair, B.A., Sc.*

The town of New Liskeard is situated at the head of Lake Temiscaming in the District of Nipissing, and is destined to become an important centre in New Ontario. It is on the line of the Temiscaming and Northern Ontario Railway, which is being constructed and operated by the Ontario Government, and running northerly from North Bay to its junction with the Grand Trunk Pacific, a distance of approximately two hundred and fifty miles. New Liskeard is one hundred and thirteen miles north of North Bay, and three hundred and thirty-eight miles north of Toronto. From its natural location it is bound to be of more or less importance,



Dam Showing Timber Slide and Spill-Way.

having a vast area of good agricultural land lying to the north-east and west, and having immediately to the south the famous Cobalt District, and to the north Larder Lake District, which is attracting considerable attention at the present time. In addition to the agricultural and mining possibilities, the country is covered with valuable timber, such as pine, spruce, tamarac and cedar.

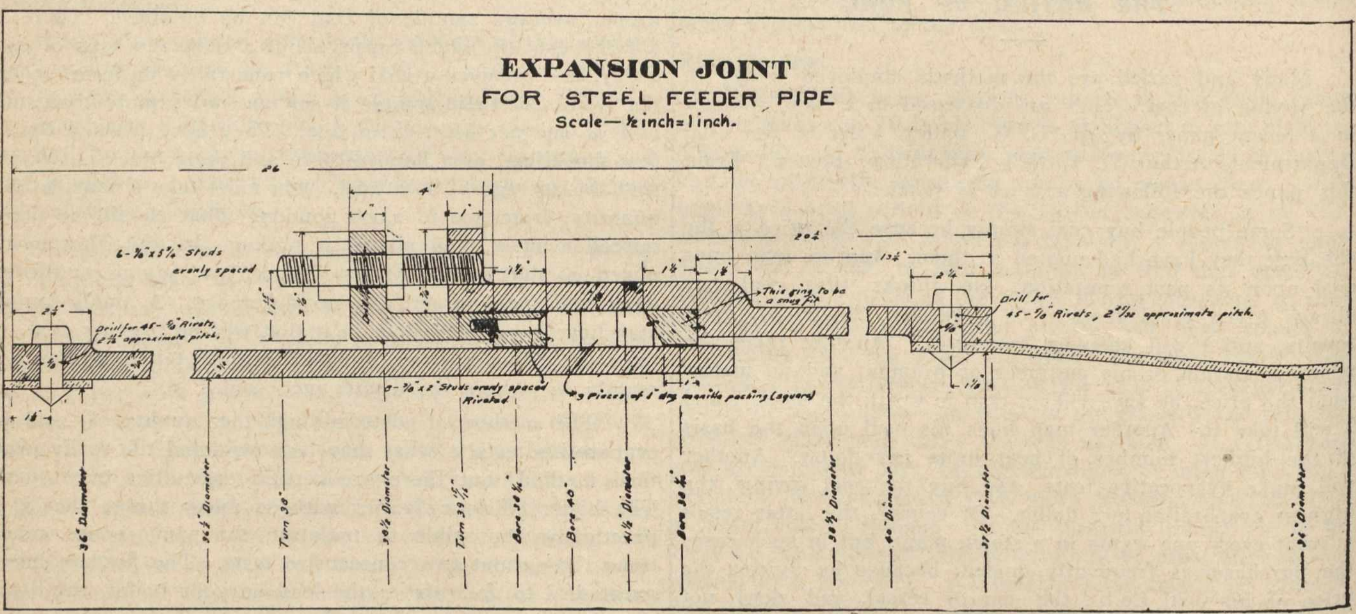
The company has the franchise for supplying light, heat and power to the town of New Liskeard. During the summer of 1906 a steam plant was installed and this supplied light to the town till November, 1907, when the water-power, known as Chester's Falls, was set in operation, and since then the steam plant has not been used, but will be kept as an auxiliary in case of necessity. The steam plant consists of a 200 horse-power Robb-Armstrong engine belted to a 120 k.w., 3-phase, 60-cycle 2,200 volt Westinghouse generator, running at 900 R.P.M., and having an exciter belted to the generator shaft.

In September, 1906, we were instructed by K. Farah, Esq., of the Liskeard Power Company, to report on the water-power, locally known as Chester's Falls, with the result that development work was commenced on the same during October of the same year, and was completed during the latter end of October, 1907. Since then the lighting system of the town has been supplied by electric energy from this power and at the beginning of the present year the waterworks system of the town has been put into operation and the pumps being electrically driven receive energy from the above power also. The pumping plant consists of two Worthington turbine pumps, each direct-connected to a 100 horse-power induction motor.

The Hydro-Electric-Power plant is at Chester's Falls on the south branch of the Wahbe River, and is situated on the south half of Lot 4, Concession 3, in the Township of Dymond, being three miles west of the town of New Liskeard.

The power development consists of a dam, a steel pipe line, a power house containing one hydraulic unit direct connected to the generator, and a 3-phase transmission line.

The dam is of timber crib construction filled with rock and gravel. All the timber was taken from the lot on which the power is located, and the rock was quarried within one hundred and fifty yards of the site of the dam. It is 24 feet high in the centre and varies in width from 24 feet to 16 feet. The total length of the dam at the crest is about 200 feet, 136 feet of this being of timber crib work, and the remaining part being of earth embankment with sheet piling. There is one sluice-way 12 ft. wide and 7 ft. deep with stop logs to take care of the flood discharge. There is also a timber slide of V shape, 2 ft. inside at the bottom, and 3 ft. deep, the sides having a slope of one horizontal, and two vertical. The head gates are in another sluice 6 ft. wide, the bottom of the pipe being 13 ft. from the top of the dam. In the centre of the structure there is a drain 4 ft. x 3½ ft., having a head gate, and which was used during construction to take care of the water, and can be used in case of repairs to the dam. The main part of the dam is on a rock bottom of a slaty nature,



and the sills were made so as to fit the rock bottom, after all loose rock and debris of all kind were removed.

On either side of the stream the excavation went down to rock bottom if found within 5 ft. of the natural surface. If rock was not found at this depth the sills were embedded in the clay, and the cribs filled with stone and gravel. The dam has four longitudinal sills with cross ties every 8 ft. approximately. The sills were 12 x 12-inch, and were fitted to the rock bottom, and anchored to it with 1¼-inch bolts extending into the rock at least 2½ ft., and were secured by fox wedges and then cement grout. These bolts were spaced 4 ft. centres and passed through the sills and the adjacent timbers, and had an iron washer and a wedge-shaped key.

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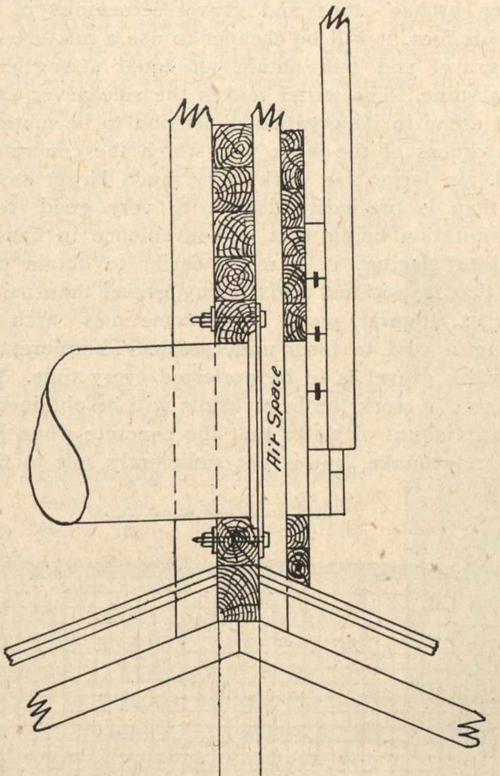
*Sinclair and Smith, Consulting Engineers, New Liskeard, Ontario.

The up stream face of the dam and the sides of the sluices had the timbers squared on three sides. The timbers were dove-tailed and securely spiked with ⅝-inch iron spikes passing through two timbers and half the thickness of the next. The wall timbers were not less than 10 x 10-inch, and the cross ties were at least 8 x 8-inch, and were either pine or cedar.

The up-stream face of the dam, the sides of the sluices and also the decks and aprons of the same have two layers of 2-inch planking, dressed on the edges and put on so as to break joint. At the face of the dam they were driven to rock bottom and were well secured with 5-inch spikes. A few inches of cement grout were put along the up-stream side of the planking, so as to fill any openings caused by unevenness of the rock bottom.



SECTIONAL ELEVATION

The face of the dam was then puddled with clay, first moistened to a sticky state and then well rammed into place extending up the face of the dam to a height of about 10 feet.

In building the embankments at each side the ground was first ploughed and cleared of all rubbish, then along the centre line a 3 ft. trench was dug and in this 2-inch sheet piling was driven. On each side of the sheet piling it was well puddled and tamped into place. The top of the embankment is 8 ft. wide.

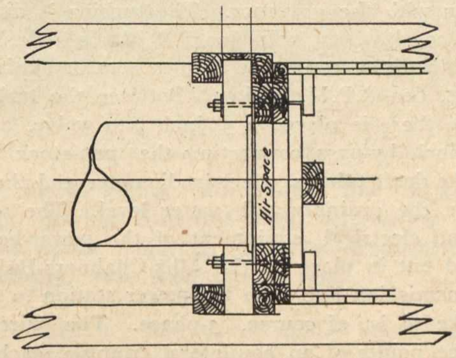
The head gates are of timber construction with the usual hoisting gear used under similar conditions. It consists of a rack and pinion operated by means of a lever. By examining the sketch of these it will be seen that the pipe has a cast iron flange, and is bolted to the timbers, which are practically stop-logs. It will be seen that there are two systems of stop-logs, caulked with oakum, so as to make them perfectly water-tight and between these two walls is left a 6-inch air space of a width equal to the diameter of the pipe and extending to the crest of the dam. The gate proper does not come into contact with the flange of the pipe, but is on the up-stream face of the upper wall. The object of this air space is to admit air into the pipe in case the head gate is closed and the pipe drained for possible repairs. The pipe is laid to a down grade from the dam to the power-house and thus no other air vents are required. The head gates are housed over to prevent sticks and rubbish from getting into the pipe through the air space. There are two racks, the coarse one being made of iron bars 1¾-inch by ¼-inch spaced 1½-inch centres; but this was found to be a little too coarse as there was such an amount of limbs and rubbish in the reservoir site. To overcome this difficulty a galvanized iron screen of ½-inch mesh was used along with the coarser one, and it has given good satisfaction.

The country through which the pipe line runs is comparatively rough, and, as it was thickly wooded at the time of the survey, considerable difficulty was experienced in obtaining the best location for it.

The length of the pipe line is 2,136 feet, and is practically straight, and is laid to a down grade, which varies from 1.5 to 10 per cent., the changes in grade being taken care of by gradual curves in the pipe and not by a single join. The pipe has an inside diameter of 36 inches, excepting the last 6 ft. next to turbine, which is reduced to 33 inches. It is all made of ¼-inch steel plate and the longitudinal and transverse joints are single riveted for the first 1,400 feet, where the pressure is under 30 pounds per square inch, the remaining 700 ft. being double riveted in the longitudinal joints; the rivets, of course, being staggered.

The pipe line was supplied and erected on foundations prepared for the purchasers by the William Hamilton Manufacturing Company, of Peterborough, Ont. It was sh'pped from the shops in lengths of 30 feet, 9 lengths being placed on each car. The field riveting was all done by hand. There are three man-holes in the pipe line, the first being 880 feet from the head gates, the next 1,550 feet from the head gates and the last one about 25 feet from the flange of the value just next the turbine. Provision is made in the line for expansion and contraction by placing two expansion joints in the line, one being 895 feet from the head gates and the other about 45 feet from the lower end of the pipe line. Each joint has a play of about 10 inches, and was set to correspond with the temperature at that time. These joints have given good satisfaction and no leakage of any account has come from either of them.

The pipe line crossed the stream at one point, and is supported by four timber stringers on which are timber saddles spaced about 6 feet centres, these stringers being supported on each side of the stream by timber cribwork filled with stones to prevent their being carried away by floods. Where the pipe passes through clay cuts it is embedded in the same



SECTIONAL PLAN

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and where the foundation is not on natural rock the pipe is supported by means of timber sills let down on the solid rock bottom in most places. Where the pipe line is above the natural grade a crib work of timber was built under the pipe line and filled up with clay. Where the pipe crosses the stream it is boxed in and filled with saw-dust, the space between the edge of the boxes and the pipe being about one foot. Except at this point the pipe line is covered over with clay through its entire length, and in no place is this covering less than one foot. Where the pipe was not completely under ground longitudinal timbers were placed on both sides of it at a distance of one foot from the edge of the pipe. The space between these timbers and the pipe was then filled with clay, the timbers were built high enough to allow a covering of one foot over the top. Although, we have very severe weather here this method of protecting the pipe from frost has given good satisfaction.

The pipe was anchored on both sides of the stream, but this was the only point where anchorage was required, except at a point about 25 ft. from the lower end of the line, where it is anchored to a concrete pier, and the main purpose of this anchorage is to relieve the turbine of all thrust.

The power-house is a log building with cottage roof, sheeted on the inside, both walls and ceiling, with V joint Georgia pine. The floor is concrete, as are also the foundations for the turbine and generator and governor. The tail race has walls and bottom of concrete to a point immediately outside the wall of the building. The total length of the tail race is about 200 feet and varies in depth from 10 feet at the power-house to zero at the point where it strikes the stream. It has a width of 6 feet at the bottom and is timbered on both sides so as to keep the banks from caving in.

The hydraulic equipment of the power-house consists of a 360 horse-power single horizontal turbine in spiral scroll case with quarter-turn-discharge and is direct connected to the generator. The turbine is of special Swiss design and was supplied by the Allis-Chalmers-Bullock Company, of Montreal, who are manufactures of hydraulic machinery of Escher, Wyss and Company, of Zurich, Switzerland. The total head from the level of tail water to crest of dam is about 105 feet, but the turbine is designed to operate under a head of 100 feet, the 5 feet being deducted to allow for friction in the pipe line. The turbine was computed from the following data:—

Head	100 feet
Discharge	40 cubic feet per second
Power	360 B.H.P.
Speed	600 R.P.M.

Efficiency.

Full gate	79 per cent.
¾ gate	81 per cent.
½ gate	77 per cent.

The turbine is governed by a self-contained oil governor, being a Standard Allis-Chalmers-Bullock Company's latest design. There is also a pressure regulator which operates in connection with the governor. The turbine is direct connected to a 250 k.w. 25 volt, 600 R.P.M. 60-cycle, 3-phase generator, and direct connected to a generator shaft is an 8 k.w. 120 volt, 600 R.P.M. exciter. Between the turbine and the pipe line there is placed a 33-inch gate valve, and there is also a 6-inch by-pass connecting the pen-stock with the turbine. The draft tube is 3 feet in diameter and the floor is 8 feet above the ordinary tail water level. The complete hydraulic and electrical equipment of the power-house was installed and put in place by the Allis-Chalmers-Bullock Co.

The transmission line from the power station to the town of New Liskeard is, of course, 3-phase. The wires being located at the points of an equilateral triangle, each side of which is 27 inches. The poles are 30 feet long and are of cedar being spaced 110 feet apart. No step-up or step-down transformers are used. The generating voltage is 2,500 volts, while that in the town is 2,200 volts, and the size of the wires was calculated for a drop of 10 per cent. The wires are of number 00 copper.

The plant has been in continuous operation for the past four months and is giving good satisfaction.

SELECTION OF MATERIALS FOR CONCRETE.

The importance of careful discrimination in the selection of materials for the making of concrete is forcibly shown by Mr. Leonard C. Wason, president of the Aberthaw Construction Company, Boston, in a recent paper. He asserts that "in the selection of sand care should be used to avoid that which is fine and not sharp. The difference in strength due to these qualities alone in some tests of the writer's on sand that was used in foundations amounted to a loss of 52 per cent. from standard sand. Dirt should also be avoided. There has been some controversy as to how much can be permitted, but the writer believes that the ordinary test, which is performed on the work of throwing a handful into a glass of water, is sufficiently reliable for all cases. When the water is badly muddied and remains clouded for a considerable time the sand should be washed or rejected.

"There is little difference obtained in results of broken stone or gravel. By actual test the writer has found that a broken stone having a rough surface with angular fractures will give an increase in strength over a rough bank gravel of about 15 per cent. in most cases. In some, however, the gravel has given the greatest strength. If the stone has a glossy surface, such as is found with some trap rocks, the gravel will always give the greatest strength. In the first instance if the specifications required "one-three-six" broken stone concrete, and there is a difference in cost between broken stone and gravel screenings of two cents per cubic foot, it will be cheaper to use a mixture of 1:2½:5 with gravel and still obtain an equal strength with the broken stone. The writer makes the rule never to allow the size of stone in its greatest dimension to be more than half the thickness of the work into which the concrete is to be placed. In large size work, very much larger stone can be used than is ordinarily done with very good results, the only limitation being that of convenience in handling. In regard to placing, it is much easier to obtain dense concrete, that is, without voids, using gravel than using broken stone, as angular pieces will sometimes arch together, allowing a void to form underneath. Therefore, for water-tight work gravel is to be preferred every time. For nearly all classes of work the best results will be obtained by using such an amount of water that the concrete when placed will just barely quake, but is not sufficiently soft to flow."

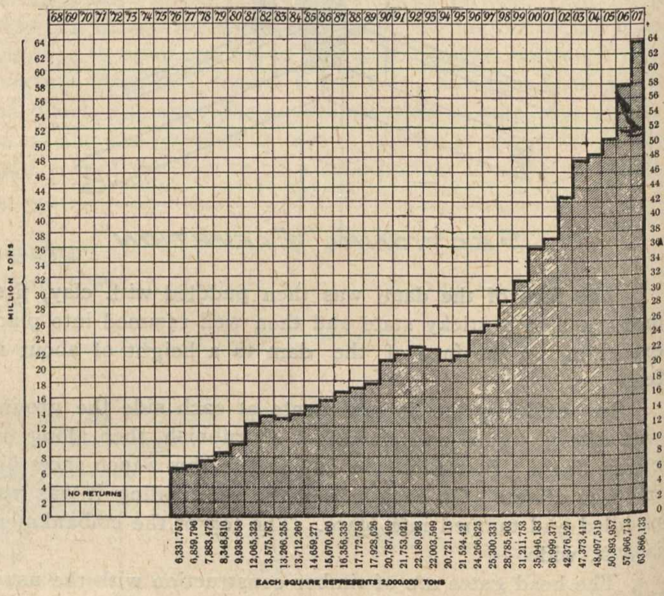


Diagram Showing the Yearly Increase in Volume of Railway Traffic in Canada Since 1876.

WILLOWS AS A SNOW FENCE.

Between Fargo and Valley City there will be planted 100,000 golden Russian willows for a snow fence by the Northern Pacific this summer. The willows are said to be a good substitute for a snow fence and less susceptible to damage by fire.

The opening of a branch in Vancouver by H. W. Petrie, Limited, of Toronto, early in the year, has proved very satisfactory. The result has been a decided addition to the connection of this well-known Canadian machinery emporium. The Western manager is Mr. Emil Hallman, who has been for years a valuable employee of the Toronto establishment, and he is showing in the rosy West the same qualities of thoroughness and industry that his friends say he showed here.

GAS ENGINE PLANT OF THE MILWAUKEE NORTHERN RAILWAY.

A feature of the equipment of the Milwaukee Northern Railway which has attracted especial attention from the engineering public and users of power is the fact that the motive power of the road is furnished by gas-engine-driven electric generating units of a size heretofore unknown for purely traction service.

The railway, which was opened for traffic in October, 1907, runs at present from Milwaukee to Port Washington, thirty miles, but when completed it will have 112 miles of track. The power house, a view of which is here shown, is situated at Port Washington. The generating units are three in number, each of 1,000 kw. capacity, two of which are now installed; the third will be set up shortly. Each unit consists of a twin tandem horizontal double-acting Allis-Chalmers gas engine, direct connected to a 405 volt, 25 cycle Allis-Chalmers alternator. Although the rating of each unit is given as 1,000 kw., both engines and generators were designed with large overload capacities, the engine being capable of developing upwards of 2,000 horse-power, and the generator having a corresponding capacity. Each engine has four cylinders, 32 in. in diameter by 42 in. stroke, and operates at 107 revolutions per minute.

Valves and Valve Gearing.

The valve gear is of the standard Allis-Chalmers cut-off type, and the engine operates with constant compression, thus tending to ensure smooth running under the highly variable loads to which it is subjected. The inlet gear is extremely simple, consisting of a main inlet valve of the single beat poppet type, eccentric operated, thus ensuring long life and quiet running. The mixture of the air and gas is thoroughly effected before entering the cylinder by means of a patented annular mixing chamber located under the main inlet bonnet; the design and operation of this device is such that, at the instant of closing of the main inlet valve, there is practically no explosive mixture left outside the cylinder. The gas valve is of the double beat poppet type controlled by a variable lift rolling lever operated by a single link connection to the main inlet gear, the lift of the valve, and consequently the amount of gas admitted and the time of admission being regulated by the governor. The exhaust gear is of the single beat poppet valve type, eccentric operated, and is in this respect a duplicate of the main inlet gear. A distinctive feature of the Allis-Chalmers gas engine is the location of this exhaust bonnet with its valve at the bottom of the cylinder, where all the dirt is removed by the action of the exhaust gases, and the provision of a substantial jack to lower the entire exhaust mechanism out of place to allow inspection and regrinding of the valve, which also serves to swing the valve chamber, with the valve and its entire operating mechanism complete, out to one side, where it can be reached by the crane hoist. The removal of one pin, either in the inlet or exhaust mechanism, is all that is necessary to allow the removal of either the inlet or exhaust bonnets, with their valves and entire operating mechanism, without disturbing any adjustment whatever.

Ignition System.

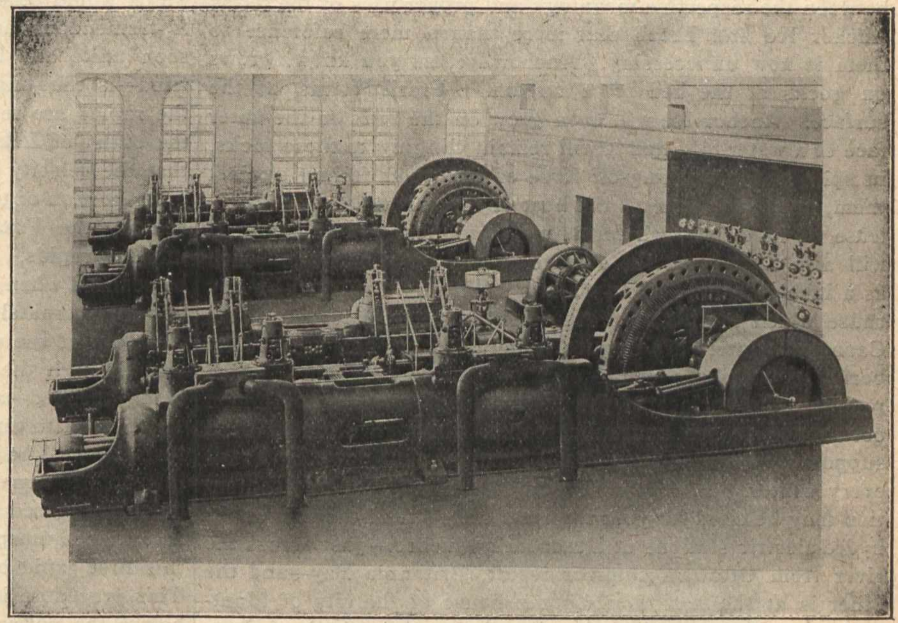
The igniters are electrically controlled, and so arranged that the time of ignition may be regulated by a single hand wheel. Direct current at 60 volts is used in the ignition system. Duplicate igniters are provided at each end of the cylinder to ensure prompt firing of low heat value gases, and also to avoid the danger of shut down due to short circuit. The entire ignition system, from the motor generator set which furnishes the current to the electrically operated igniters, is the most solidly built apparatus ever furnished for this purpose.

Air Starting System.

The air starting device consists of a small poppet inlet air valve at each end of each cylinder, with a main distributing valve operated by the layshaft. Air is admitted to each cylinder in turn at what would be the working stroke As the high compression carried prevents the engine from stopping on the dead centre, this arrangement ensures the prompt starting of even a tandem engine without the use of a barring gear. The Port Washington engines being twin tandem, will, of course, start from any position.

Distinctive Features of Engines.

As Allis-Chalmers Company has been in touch for a generation with the requirements of the central station world, particularly in the street railway field, and the largest steam engine units ever built for this service are the product of its shops, it is but natural that the same qualities of rigidity, massive construction and simplicity of design which has characterized its work in other fields should also be distinguishing features of these gas engine units. The engines are, in fact, exceptionally heavy and rigid, the weight being concentrated in the frame cylinders and tie pieces in the direct line of the stresses to which an engine of this type is subjected. The engine frame illustrates the difference between American and European practice in gas engine design. This frame is designed for a side crank in place of the double throw crank, which is the standard practice abroad. The stresses transmitted to the frame in a side crank gas engine are very great, but, even in the largest sized gas engines they are no greater than Allis-Chalmers Company has, for many years, successfully provided for in its steam engine practice. This is contrary to popular belief, but the stresses cared for in the engines operating the New York Subway, for example, are as great as any that the gas engines is ordinarily called upon to sustain.



Allis-Chalmers 4-cycle, double-acting twin-tandem Gas Engines, each of 2,000 H.P. capacity, driving Allis-Chalmers Alternating Current Generators in the power house of the Milwaukee-Northern Railway, Port Washington, Wis.

The jaw, which is subjected to a peculiarly severe stress, is made in a form to ensure maximum strength of the casting and is further strengthened by two steel tie bolts carried above the shaft, which are made of sufficient size to carry their proportion of the load without appreciable elongation.

The distinctive features of the engine—the features which appeal most strongly to those who have seen these units in service, are the extreme simplicity of design, the solidity of the construction and quiet operation.

ICE TROUBLES IN HYDRAULIC POWER WORK, AND METHODS OF OVERCOMING THEM.*

By John Murphy.

Electrical Engineer, Department of Railways and Canals, and Board of Railway Commissioners for Canada.

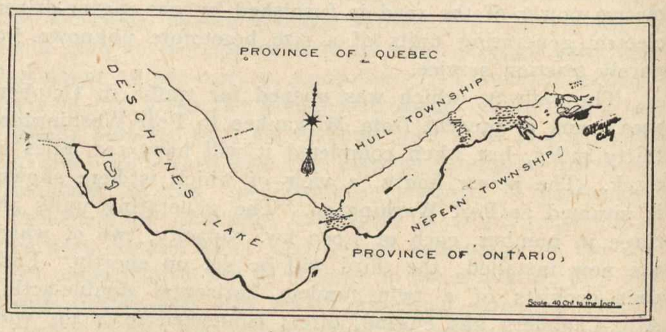
Ice Troubles in Hydraulic Power Work and Methods of Overcoming Them, are subjects of some interest to all Canadians, and they are subjects of special interest to those of us who have been or are connected with the development or operation of one of our great national assets—our Water Power.

It is well-known that industries and services dependent upon water power for their operation are frequently interrupted by ice. These interruptions are usually accredited,—wrongfully, however—to Anchor Ice. It is also generally believed that water powers will never be immune from Ice Troubles; but, with this belief I do not agree. With your kind indulgence I will explain why I am in entire disagreement with this popular belief. The ice that is most troublesome at hydraulic power plants is called Frazil.

Dr. Barnes, our esteemed friend and teacher—these terms are usually synonymous—has drawn such a clear distinction between the respective meanings and proper uses of the terms Anchor Ice and Frazil that more than a mere reference to them is now unnecessary. Anchor Ice, as you know, grows on rocks at the bed of a stream. Frazil forms at the surface. Anchor Ice will even grow on the rock on the outer face of a water-fall, and it will remain clinging to these rocks, in spite of the washing-off force of the water falling against them, until such time as the heat of the sun makes the ice release its hold. Frazil forms most prolifically in rapids. It will also form upon the surface of any body of water—such as a lake or canal—if the water's surface is disturbed by any cause which retards or prevents sheet ice from forming. As Canadian winters are frequently heralded by, and are usually borne in upon, the wings of a cold north-west wind, which roughen the surface of the waters, it is not an uncommon occurrence to see hydraulic plants, although situated at a supposedly immune-from-Frazil location, shut down by Frazil every winter. Two notable examples in proof of this contention may be cited for your information. One of those is at the hydro-electric stations at Deschenes, Quebec,—just across the river from Ottawa's summer resort, Britannia Bay—and the other is at the waterworks pump house of the city of Montreal. It may be recalled that Frazil shut down both of these works entirely last December, although one has a stretch of 25 miles of smooth lake and river above it, and the other many miles of quiet canal. The terms "smooth lake" and "quiet canal," are only applicable when the wind is not blowing. Frazil then is likely to form upon the surface of any body of water when the latter is not protected from the action of the cold air by a layer of sheet or surface ice, or by some artificial covering. Frazil forms, of course, most prolifically in rapids which remain open all winter. After surface ice is properly formed Frazil is only made in the rapids and it does not enter the power plants because it clings to the surface ice. If the surface ice is removed by a temporary spell of mild weather Frazil will, of course, form again upon the return of cold weather as it does in the early winter.

The city of Ottawa is famous because it is "the capital of a country greater in extent than the United States of America." The Ottawa District has also become famous, amongst the engineering profession, as a manufacturing centre—i.e., as a Frazil manufacturing centre. Why it has achieved this latter reputation may be learned by a short study of that portion of the Ottawa River from which most of the energy used in the district is obtained.

There are many hydraulic power plants here, and they are nearly all situated around the Chaudiere Falls at Ottawa and Hull, within a very short distance of the point where the first "run of stone" for a grist mill was erected in the early part of the last century. As may be seen these power plants are below three sets of rapids. There are also a few power plants at Deschenes—just at the Deschenes Rapids The latter plants—although having no rapids or water-falls above them for some 25 miles, as was mentioned above—are placed hors de combat every winter by Frazil.



View of the Ottawa River.

When winter is setting in, in this district, it is usually preceded by a cold north-west wind. The wind lashes and furrows Lake Deschenes and prevents the sheet or solid ice, which would otherwise soon cover its surface, from forming. A tremendous amount of Frazil—the spicules which would soon unite and become sheet ice but for the action of the wind—is thus manufactured in Lake Deschenes itself before the rapids are reached at all. The sides and the bottom of the outlet of Lake Deschenes are so very rough in character that the velocity of flow at the surface is greater than at any other portion of the stream. On account of this great surface velocity the Frazil from the surface of the lake is drained into the rapids. . . . The roughness of these rapids may be realized when I say that huge saw logs and sticks of timber are alternately entirely submerged and then thrown almost clear out of the water into the air, again and again, on their way through the rapids. The water in the rapids is always being kneaded—as a baker kneads dough—from top to bottom and bottom to top. New water surfaces are being continually turned up. The temperature of the whole river at this point, instead of remaining warmer at the bottom, is thus very quickly reduced to the ice-making temperature, and, under favorable atmospheric conditions, the Ottawa River even at this first rapid becomes a stream of Frazil instead of water. This procedure is then enacted again in the two other rapids before the power plants at Ottawa and Hull are reached. It is, therefore, not surprising that these plants have to encounter ice troubles.

From the foregoing it may be inferred that the destruction of rapids by the erection of dams is one method of preventing Frazil formation.

Frazil attacks are never experienced when the sun is shining. At any and every other hour of the day and night frazil may be expected—under favorable conditions.

Frazil has the peculiar tendency of clinging to everything with which it comes in contact. It has on several occasions within my own observation temporarily choked up the total flow of the Ottawa River itself, by blockading the rapids.

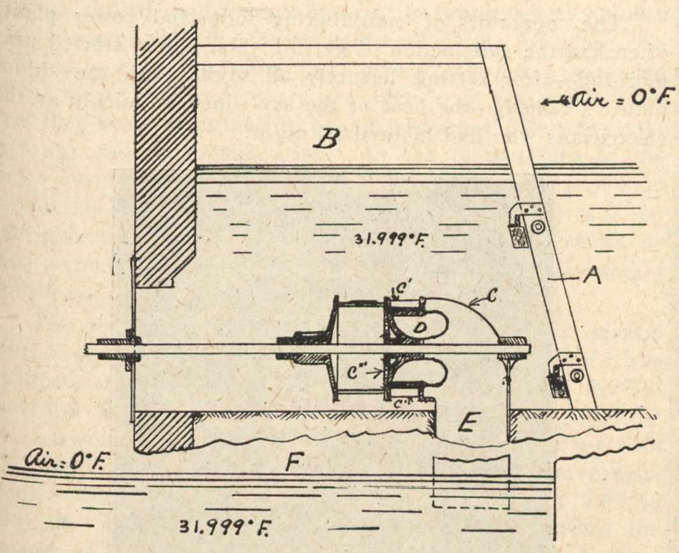
It is this tendency of Frazil to cling to other objects, coupled with its ability to grow and form itself into immense mushy masses, that makes it cause so much trouble at power plants. Instead of flowing quietly through the power plant, as water does, Frazil clings to the edges of every opening and soon closes them altogether. Large rectangular sluice openings, 6 feet long by three feet wide, have been blocked by Frazil so completely in a few hours that water could not flow through these sluices any more than through the closed gates.

One of the earliest attempts to cope with the Frazil difficulty, which came to my notice, was the hanging of cedar boughs from a stout rope stretched across the surface of a channel. This was done by grist millers many years ago, and the cedar bough barrier floating low in the water soon became covered with Frazil and served as a starting point for the formation of surface ice. As these barriers soon formed dams, and then were sometimes torn from their moorings by the

*Address presented to the Applied Science Undergraduates Society of McGill University, at Montreal, February 26th, 1908.

force of the flowing water, and the whole mass was carried into the racks at the power plants, this practice was not universally adopted. It was harder to remove the cedar boughs from the racks than the Frazil.

A view of a water-power plant may assist in obtaining a better understanding of the troubles caused to it by Frazil.



(Power Plant Unprotected From the Air).

A—is a view of one bar of the rack, or screen, which prevents floating debris from being carried into the penstock or wheel-pit. The rack bars are set at a slight angle for cleaning or raking purposes. The distance between these rack bars varies from 1 to 3 inches according to the sizes of the openings in the wheels which they are to protect.

B—is the penstock in which the complete water-wheel outfit is set up.

C—is the wheel case in which the water-wheel or turbine D runs.

c'c'—are the chutes between which the water passes as it enters the wheel.

C″—is a cylinder gate by means of which the wheel is started, stopped and controlled by varying the length of the opening between the chutes and the wheel, and thus controlling the amount of water passing through the wheel. The gate has rods attached to it—not shown—which pass out into the generator room.

D—is the turbine or "runner" as it is called. It is keyed solidly to the shaft, which projects into the generating room (if this happens to be a hydro-electric station). A coupling unites this shaft to the generator shaft, or, a pulley mounted upon this shaft will drive machinery of any character.

E—is the draft tube through which the water flows or falls into the tail-race, and, being air-tight it enables the turbine to operate under the total head of water-fall even though the turbine is not situated at the exact bottom of the fall.

F—is the tail-race which is simply a channel for the purpose of carrying off the water after it has done its work of driving the machinery.

A power plant of this character suffers from Frazil in the following manner:—

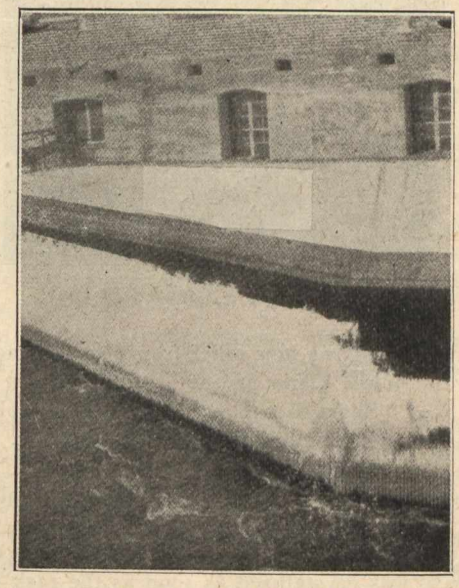
(1) The openings in the rack get clogged, and as the supply of water to the penstock is reduced, the output or capacity of the plant is lessened. When rack clogging once begins a complete shut-down is usually inevitable within a very short period of time. Some institutions, believing a shut-down unpreventable in any other way, entirely remove the rack just before winter sets in. Their water wheels run the risk of being destroyed by floating debris, but this risk is, in their opinion, preferable to the certainty of rack clogging. Hand and mechanical rakes are used for the purpose of cleaning the racks. This raking work simply consists in scraping the Frazil from the bars; when it is scraped off the current carries it into the penstock. If a side sluice exists near the end of the rack much of the floating Frazil may be passed over it.

Some idea of the amount of work required to keep a rack open during an attack of Frazil may be gathered from the statement that the combined efforts of two motor-driven rakes and a gang of willing, able-bodied hand-rakers, placed so close together that they elbow each other, are often unable to keep a rack half open.

(2) When the rack is kept open by raking the next difficulty that is encountered is the sticking or freezing of the water-wheel's controlling gate. The Frazil clings to the chutes and to the exposed part of the gate and it cements the gate so firmly to the parts of the case which surround it that the gate cannot be moved. The wheel in this condition becomes uncontrollable. The automatic governors, although powerful machines, often operating at a pressure of 200 lbs. per square inch, and applied to the gates by means of cylinders 5 to 8 inches in diameter, are not capable of loosening frozen gates from their icy grip.

When two metals are to be soldered together they are brought to a definite temperature and then a third material—the flux, as it is called,—is added and fusion occurs. Frazil will not unite with metal, it will not freeze to it, so long as the latter's temperature is kept above the freezing point. What happens to the water—in the form of Frazil—that makes its tentacles grip metal, at the freezing point, so firmly, and makes it glide past, like water from the back of a duck, or water over a greased surface, when the metal's temperature is above the freezing point? Your kind assistance is needed in connection with this point.

It is a common occurrence to see steel pinions having large factors of safety, so far as mechanical strength is concerned when doing their ordinary work, smashed to pieces while an effort is being made to loosen frozen gates.



(Ice-Covered Rack).

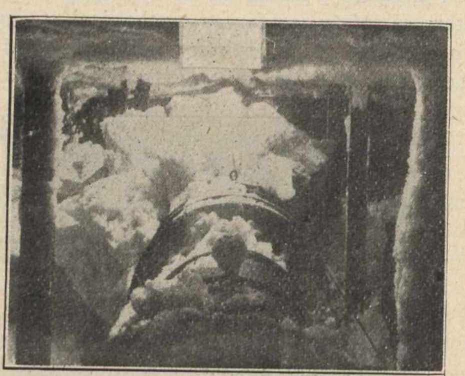
The freezing of the controlling gates of a water-power plant is a very serious matter; it might be compared to the condition of a runaway locomotive but for the fact that the locomotive cannot do nearly so much damage as the power plant. The energy of the locomotive is reckoned in hundreds of horse-power while the power plant's capacity is usually measured in thousands. The fire may be drawn, or, it will soon die out under the boiler of a runaway locomotive, but a river is not likely to stop its flow within the same time-limit. If the load which is being carried by a power plant goes off while the controlling gates are frozen to the wheel case disastrous electrical and mechanical breakdowns are almost sure to follow. One not intimately acquainted with those conditions can scarcely imagine the serious plight in which a power plant and its attendants are placed when the controlling gates become frozen tight.

(3) The third difficulty to which Frazil subjects a power plant is the clogging up of the chutes. The effect of ice closing up the chutes is just the same as closing the gate and a complete shut-down is often thus effected.

Part of this picture may convey some idea of the manner in which Frazil will plaster up a rack and prevent water from entering the wheel pits. All the mills and power-houses in the district were stopped by Frazil on this occasion, and, as the water in the head races arose when they were stopped, this accounts for the height to which the Frazil ascended this rack. Frazil covered every portion of this rack to such an extent that not a drop of water could pass through it. When this picture was taken, the plants were all again in operation and the water in the forebay was at its usual height. The sun had relieved this plant. This rack faces the south. Rocks facing the north freeze up more quickly, and they also thaw out several hours later next day, yet this valuable point is usually given no consideration by designers of power plants. Your attention is directed to the manner in which the water had cleaned this rack although the temperature of the air when the picture was taken was still much below the freezing point.

It is the practice at hydraulic plants other than hydro-electric stations, to let the sun thaw the plants out, next day, after Frazil shuts them down. No effort is ever made to start them up again during the same night that Frazil shuts them down.

With the operators of water electric light and power services, however, other practices must of necessity obtain. Their work of attempted relief is immediately begun whether the hour of affliction happens to be 5, 10 or 11 in the evening, or 1, 3, 5, or 6 in the morning. (The members of the medical profession are not alone in having their night's rest disturbed).



(Penstock Being Cleared of Ice).

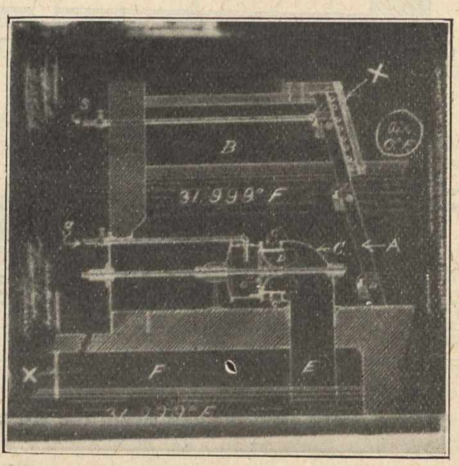
This picture shows how relief from Frazil attacks was afforded to the power plants in the Ottawa District before the winter of 1905. Since then I am pleased to be able to say, a simpler and speedier method has come into use.

When the water wheel gates become frozen the chutes clogged up, the penstocks filled, and, the racks blocked with Frazil, it was formerly necessary for workmen to remove these icy accumulations by hand (or wait for next day's sun). As the Frazil was crystallized as soon as the rack clogged up and it came into contact with the cold air, it was necessary to break it up with bars and axes before it could be taken out of the penstock. More than half the accumulation of Frazil from this penstock had been removed when this picture was taken. After the ice was removed one of the following courses had then to be adopted to loosen up the gates which were still frozen to the wheel cases:—(1) Either liberal doses of brine had to be applied to the gates, or, (2) a fire of oily waste and kindling wood had to be built around the wheel case for the purpose of actually melting the ice and freeing the gates. Steam was used for melting the ice when it was available.

This ice-cleaning-out and ice-melting process usually occupied from three to five hours, the length of time depending upon the amount of ice to be removed, and the difficulty of getting down and up the head gates or the stop logs—the latter, when down, generally froze in position also and another difficulty was thus placed in the way of quickly re-starting the plant.

It may here be mentioned that absolute continuity of supply is a necessity in connection with electric light and power services. A shut down of one minute's duration is an unpardonable occurrence. Keeping this point in mind kindly consider the effect of a five-hour shut-down! These came along, however, almost as regularly as winter during some 20 years of my experience. Frazil troubles caused and constituted 85 per cent. of all the shut-downs during this whole period.

The operators of neighboring industrial power plants often had the satisfaction of getting their works started next morning—after resting leisurely all night—with the aid of nature's remedy—the heat of the sun—just as quickly as the electricians who had labored all night.



(Unprotected Rack Again).

It has long been generally recognized that the rising sun brings with itself almost immediate relief to a plant tied up with Frazil. This was the first lesson in regard to ice troubles that came to my attention. It was well-known that before any appreciable rise in water temperature occurred in the early morning, practically at sunrise, water wheels that had been hopelessly tied up for hours immediately started running again.

The second lesson that I learned was in regard to the effect of cold air upon the vulnerable parts of water-power apparatus.

From a point of vantage which I happened to occupy for a number of years, I noted the operation of a great number of plants, and I became convinced that water-wheels protected by wooden racks were, during Frazil attacks, usually able to run later into the night than those protected by iron racks. This conviction—theory, some called it—was confirmed as time rolled on; it was often supported by actual occurrences. In addition to these observations, I frequently encouragingly joined the beaten rakers—for brief periods at a time, I must admit, because raking ice in a blizzard is harder work than playing football—and one's greatest ice-raking efforts are rarely rewarded by a cheer of "well tried." An expression more often heard is:—"What's the use?" With rake in hand I found that Frazil could be removed from wooden racks very much as plastic mud can be scraped from one's boots; but that it requires much more physical effort to detach Frazil from a metal rack because it actually crystallizes on the latter. Why these different conditions obtain will, I think, be better appreciated by another glance at this picture. As may be noted, a large area of iron rack projects into the air. When Frazil is being formed the temperature of the air is frequently down to 0° F., and it is often much lower. When Frazil is being formed Doctor Barnes has shown that the water's temperature only goes a thousandth of a degree, or two, below the freezing point. A note of these temperatures has been made upon this drawing, so that they will be better impressed upon your memory. (Assuming that the air is at 0° F. and the water is at 32° F.). Is not this an ideal ice manufacturing arrangement? Here is water just at the freezing point—a thousandth of a degree below it—just ready to crystallize. Here is a cooling device—metal bars in the winter wind—with an unlimited amount of energy behind it, lowering the temperature of the iron rack and of the water, and ice surrounding the rack. (Artificial ice-making plants are equipped in this very manner). Wood is such a poor heat conductor that it has practically no effect on the water, and, consequently, Frazil does not crystallize upon a wooden rack—although it will clog up the latter very quickly if it is not kept passing through.

The tail-races of some power plants are also exposed to the action of cold air, as shown; the heavy metal draft tubes become chilled, and, by conduction the water wheel's whose case becomes chilled. These neglected plants are more susceptible to Frazil troubles than others which are protected from the air. These points are such very reasonable ones that they are now agreed to by all who have given the subject any serious consideration. As the temperature of the water never falls very low, and as water has such poor heat conducting qualities—about 120 times less than iron—is it not advisable to keep the hydraulic outfit completely covered by this warm (comparatively speaking), water blanket rather than leave it exposed to the action of the cold air?

The foregoing statements present to you my mental attitude in relation to the ice question at the time when I was fortunate enough to pick up a paper entitled:—"Ice Formation and Precise Temperature Measurements," written by Dr. Barnes. The reading of Dr. Barnes' work filled me with a desire to carry out some experiments, and, these experiments—although carried out in the face of much adverse criticism and some ridicule—were successful beyond the dreams of hope or imagination. They may be summed up with the statement that a set of water-wheels in the condition of that illustrated in Fig. 4, (Ottawa Electric Railway), can by the simple opening of a steam valve and the application of a little heat to the wheel case, be cleared of Frazil in a few minutes. (It formerly took a greater number of hours, as I pointed out above). By the earlier application of a little heat to the wheel case Frazil will not accumulate in it at all, and the plant can be kept in continuous uninterrupted operation?

In Dr. Barnes' work, to which reference has been made, he emphasized a point with which I was familiar, i.e., that river water remains just at the freezing point all winter. He went further than this, however, for he made what I might call a more molecular analysis of my view-point. He showed that water temperature variations from the freezing-point frequently occurred, almost every day and night, and that they were measurable—in thousandths of one degree!

Dr. Barnes discovered that the water's temperature was sometimes 32.001° F., and, sometimes 31.999° F. He noticed that a change of a couple of thousandths of a degree, from one side to the other of the freezing point, was—to use his language; "accompanied by tremendous physical effects." Frazil in immense quantities was manufactured if the change in water temperature was towards the negative side of the freezing-point; and anchor ice was compelled to loosen its grip on the bed of the stream if the water became warmed to the extent of a thousandth of a degree on the positive side of the freezing-point.

The beneficial effects of preventing the cold air from chilling the metal hydraulic equipment had long been apparent to me, and the action of the heat of the sun in relieving frozen-up plants before any appreciable, or (as we thought), measurable, rise in water temperature occurred, was also well-known for many years. No one, however, at least to my knowledge, had ever conceived what delicate or almost infinitely minute water temperature changes actually take place in our wintry streams until Dr. Barnes made this matter so beautifully clear. The light thus shed upon my study of the Ice Question by the publication of Dr. Barnes' work opened up the following line of thought:—Energy measured in millions of horse-power may be necessary to change the water used in a power plant from the solid to the liquid state without changing its temperature; hundreds of thousands of horse-power may be required to raise the temperature of all this water one degree; but, the hydraulic power plant operator has nothing to do with either of these problems. His problem is to prevent the temperature of his apparatus from being lowered to the freezing-point—his duty is to keep this temperature 1-10,000 of a degree on the positive side of the freezing point and Frazil will have no inclination to stick to it.

This is a picture of a Frazil combatting scheme which has given more beneficial results than one not personally conversant with the details of its operation can readily believe.

First of all, the action of the cold air is carefully excluded from every part of the plant. (This, in my opinion, is a point of vital importance). Secondly, heat is applied to these parts of the plant at which Frazil is likely to accumulate, i.e., at the rack and at the controlling gate.

This rack never blocked up while it was thus equipped. This wheel has never choked up and this gate has never been frozen to its case with Frazil since 1905. Some 30 wheels are now rigged up in this manner. The governors in the first station so equipped, consisting of three units, made up of three water wheels per unit, have not only controlled the variations in load which occurred on the light and power system supplied from this station, but they have also on innumerable occasions, taken care of the variations in loan on a calcium carbide plant, on a cement plant, and on a street railway plant while the controlling gates of the three latter plants were all frozen stiff for days and nights together. The generators in all these stations were operated in parallel and they all, with the exception of the one in question, were time and again either shut down altogether or else had to operate with a constant load upon them, because their controlling gates were frozen and could not be moved.

The heating arrangement here shown may not be considered an economical one. Although steam is blown into the open dome, and much of it must escape down the draft tube, yet more than one ton of coal was never consumed in 24 hours in order to keep a plant with an output of 3,000 horse-power in continuous operation at times when Frazil shut down all other wheels within ten miles of it.

To supply 3,000 horse-power from a steam plant requires about 6 tons of coal per hour! By comparison with this the ice combatting plant shows great economy.

Some such arrangement has to be improvised for plants already in operation, and this scheme has worked so successfully that others like it are being installed.

A point that may interest you is the fact that this winter is the first winter that the Ottawa Elecric Railway Company, whose water wheels filled with Frazil were just shown, have made use of a small steam plant for fighting Frazil. This winter is the first winter since this power-plant was built that they did not have to break and chop the ice out of their wheels by hand!

An ideal economical arrangement and one which may be incorporated in and provided for at new plants is along the lines illustrated in the next picture.

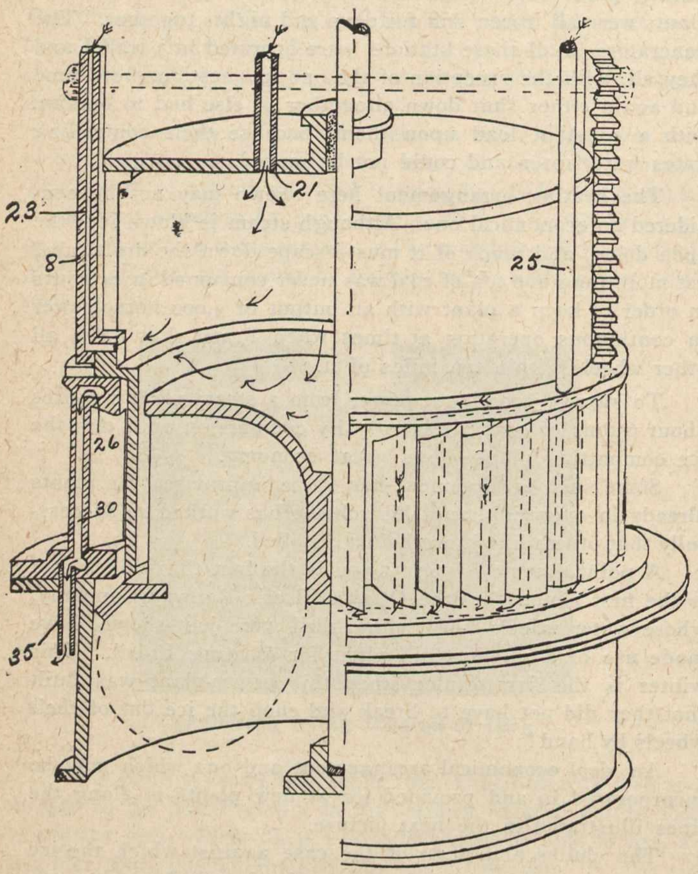
The chutes and parts of the case against which the ice and water are shown cored out (in the foundry) so that any heat bearing fluid may be kept in constant circulation through them when Frazil is expected.

Besides this work, which I have attempted to briefly describe, a number of experiments were also made in electrical rack heating, and these were carried far enough to show that this method is practicable in regard to the questions of efficiency and efficacy. 1-50 of 1 h.-p. hr. of electrical energy broke the bond between solid ice and a piece of iron rack which could only otherwise be removed by the very vigorous use of an axe. Many engineers of mature experience who at first viewed this whole work with much skepticism are now enthusiastic in regard to its feasibility.

Apart altogether from the Frazil troubles which I have dealt with, there are some other ice-troubles which I will merely mention in passing.

First of all there is the annual diminution of water supply in our streams that occurs towards the latter part of every continued cold winter. This is primarily caused by the cessation of surface drainage. In winter time the atmospheric precipitation takes place in the form of snow, instead of rain, and consequently many of the sources of our rivers are dried up. Then there is also the difficulty of securing a flow of water into many power-plants on account of the accumulation of deep surface ice, to which Frazil has become attached to such an extent that it completely blocks the channels. This condition coupled with the diminution of the normal rate of flow in a river is often of greater moment than the temporary stoppages of the plants by Frazil. These troubles can only be removed by the building of dams and thus creating immense storage reservoirs from which an equable steady flow may be obtained all the year round—the spring floods and the fall and winter drouths will then be unheard of.

Many of you will, I presume, become hydraulic engineers; I trust that you will all attain eminence in whatever branch of engineering, or other work, you find your calling. When making estimates as hydraulic engineers of the amount of water-power available on a stream always let your clients know how little power is available, during periods of minimum flow, so that provision for these emergencies may be made. They are entitled to this information just as well as to know how much power may be obtained during the period of normal and maximum flow. I have in mind one case where only from 15 to 20 per cent. of the hydraulic machinery actually installed can be made use of during three months of every year.



(New Wheel Cored For Hot Air, Water, Steam, etc.).

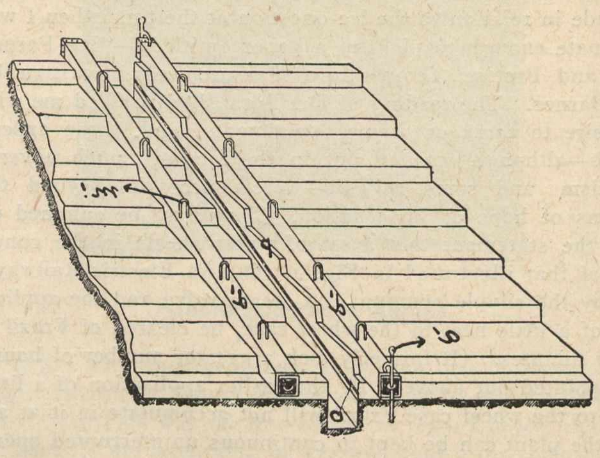
In conclusion I beg to say that the study of the ice question—which was incidental to my regular duties—has been to me a source of much satisfaction. The pleasure which I experienced in keeping a power-plant in operation in the face of Frazil difficulties is akin to the joy experienced when a victory is won in the last minute of a one-sided game in which the play and the score have been overwhelmingly against one's team. The satisfaction of feeling one is on the right path and having the tenacity to pursue that path to its conclusion always brings reward—it frequently brings unexpected rewards. One of these latter has come to me. I find myself addressing the Undergraduates Society of McGill University—one of the greatest institutions in this world. I often eagerly wished, as a youth, for an opportunity to take advantage of the training which it is your good fortune to be receiving. I never dreamt that I would be so honored as to be asked to address your Society—a Society which has the benefit of hearing many persons eminent in various branches of Science. For this great honor I beg to thank you and to assure you that it has been a great pleasure to come and meet you.

The Board of Control and Faculty of the Michigan College of Mines announce Class Day Address to Graduates of 1908 by Charles Richard Van Hise, Ph.D., LL.D., president University of Wisconsin at the College Gymnasium, May 1st. 1908.

THE ENGINEER'S LIBRARY

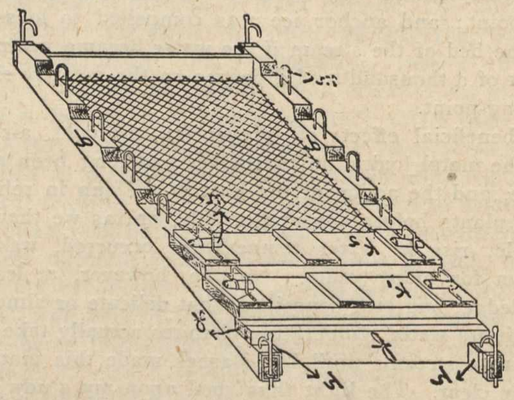
REINFORCED CONCRETE SEA DEFENCES—SLOPE DEFENCE WORK IN HOLLAND.*

Reinforced concrete has been used in many cases in Europe for the defence of earth slopes from the encroachment of the sea, but in the majority of cases has not met with complete success. The method described below, devised by M. de Muralt, of the Dutch Corps des Ponts et Chausees, has been highly successful for a large amount of work in Holland.



Showing Trench and Forms for Sloping Reinforced Concrete Beams.

The usual difficulty with slope protection is that the facings have been destroyed by the thrust of the soil beneath them produced by extremes of temperature. M. de Muralt has overcome this by making the facing of independent units, as far as their support is concerned, but that present an unbroken face to the water. His method consists of forming slabs of reinforced concrete directly on the slope to be protected, each slab having the size of a standard sheet of expanded metal (8 ft. x 6 ft.), which he has found to be the most suitable reinforcement for this work. The surface of the slab resembles a flight of low steps, the thickness varying from 3 to 5 inches.

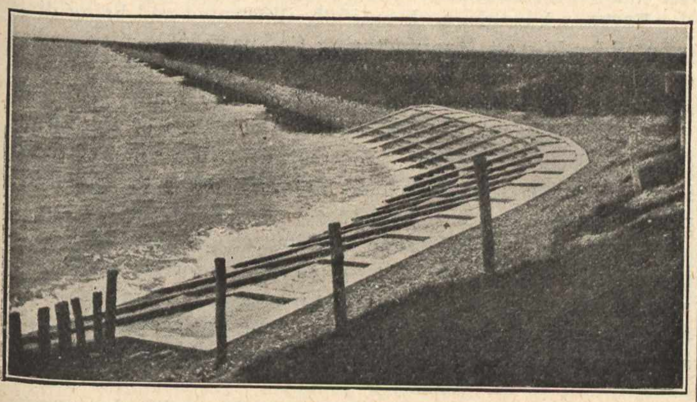


Concreted and Covered by Boards Showing Two Lowest Steps.

Between adjacent slabs at sides and end is left a space of 6 inches. When the slabs have set hard trenches are dug in these spaces to a depth of about 7 inches below the bottom of slab. Reinforcing rods are layed in these trenches, and a T beam formed, of which the trench is the stem, and the head extends several inches over the slabs on each side. Near the top surface of the head is laid a strip of expanded metal. In addition to the beams between the slabs a beam of greater depth is formed at the foot of the slope and also at the top.

*Abstract from Concrete and Constructional Engineering.

This construction results in a series of slabs independent of each other, but held in place by the framework of beams so that any one slab may sink slightly or the framework may rise slightly without danger of cracking and destruction of the concrete.



Fore Shore Defence Work at Half Tide.

Special forms have been designed so that work may be done at low tide and covered at high tide without injury to the fresh concrete.

Since 1906 more than 95,000 square yards of slope facing have been executed in Holland on this principle.

J. M. O.

BOOK REVIEWS.

Books reviewed in these columns may be secured from Vannevar & Co., 438 Yonge Street, Toronto, Ont.

Analysis of Elastic Arches.—By Joseph W. Bolet. Published by the Engineering News Publishing Company, 220 Broadway, New York. Size, 6 x 9, pp. 320. Price, $3 net.

This work is an exposition of a new system of treating stresses in arches. The application of the elastic theory to the analysis of these stresses is limited, since its use in the solution of problems involves much labor. This book, however, makes the application more clear, and simplifies to a considerable extent a treatment of a problem involving much labor and considerable careful study. The first six chapters of this work present the application of the elastic theory to all types of arches; the second part of the work gives the Algebraic analysis of the elastic theory, the theorem of least work, and the deflection theory as developed by Rankine, Maxwell, Mohr, Winkler, and others. This section of the work analyzes the principles applied in the first part. The deductions of the various forms of analysis are given for the purpose of facilitating self-instruction. This part of the work should be found helpful. To the average engineer no special preliminary study of the subject should be found necessary in following and understanding it. A large number of examples carefully worked out help to simplify the more difficult sections, and aid to a large extent in their study and application. The elastic theory as applied to masonry arches in its general form has been demonstrated by analyzing the stresses in the masonry arch over the Syra Valley, Plauen, Saxony. An appendix is devoted to the Algebraic deductions and expressions of the elastic theory as applied to arches and to the displacement theory. Taking everything into consideration, this treatment of a complex subject is one of the best we have seen, and, although much study of the subject will be found necessary, it has been treated in such a manner as to overcome in many cases difficult application of the theory as well as a considerable saving of time in its study.

Earthwork Diagrams.—By R. A. Erskine Murray, A.M. Inst. C.E., and Y. D. Kirton, A.M. Can. Soc. C.E. Published by Crosley, Lockwood and Son, 7 Stationers' Hall Court, London E.C. Size, 26 x 36. Price, $1.50.

This is a diagram to be used in the determination of the quantities in cuts or fills by a graphic method. The diagram is prepared for roadbeds from 9 to 32 feet in width, and for slopes of 1½ to 1, 1 to 1, and ¼ to 1, and for fills and cuts up to 40 feet. For aiding in the rapid calculation of estimate quantities we have not seen anything quite so good. Easy to understand, accurate, within the usual limitation of tables, and rapid in application it is a diagram that is a great value to engineers estimating for excavation work.

Experimental Electrical Engineering and Manual for Electrical Testing.—By V. Karapetoff. Published by John Wiley & Sons, New York City. Size, 8vo. XXXIV. x 790 pages, 539 figures. Price, $6 net.

The book is a comprehensive laboratory manual, primarily intended for the use of students in the electrical engineering laboratory, but is also suitable as a text book for class instruction, especially in the parts describing the performance of the various types of electrical apparatus. The experiments described cover practically the whole scope of electrical engineering from a laboratory point of view, and their practical import and application are carefully explained with the necessary theory of measurements. It differs somewhat from the ordinary laboratory testing manual in that considerable space is devoted to the description of the performance of different types of apparatus. The chapters on magnetic measurements and testing of iron contains a thorough treatment of this subject, with practical experiments.

Three chapters are devoted to Illuminating Engineering. The various types of photometers being described and experiments suggested for the practical tests of room illumination.

The chapters on direct and alternating current generators forms a valuable section, giving their operating features, methods for commercial tests and separation of losses, considerable room being devoted to commercial tests and to the predetermination of the performance of alternators and syneteronous motors. The induction motor is especially treated, giving in full the theory of the circle diagram and instructions for constructing it from the results of test. A complete chapter is devoted to the harmonic analysis of alternating current wave form. Other chapters treat of storage batteries. The use of boosters-electric heating and welding, switchboards, elevator tests, controllers, telephony, etc. A notable feature of the book are numerous diagrams explaining the performance of transmission lines, storage batteries and alternating current apparatus. Great care has been used in selecting the material, the treatment is accurate and practical, and is presented in clear and forceful manner. The instructions and directions for performance of the experiments are explicit and in good form for laboratory use. It is well illustrated with sample curves, data sheets, sketches, and numerical examples from modern practice. The make up of the book is excellent, and forms a valuable testing manual and text book for the engineering student, both junior and senior.

F. A. G.

Moving Loads on Railway Underbridges.—Including diagrams of bending moments and shearing forces and tables of equivalent uniform live loads. By Harry Bamford, A.M. Inst. C.E., Lecturer on Engineering Drawing and Design, Glasgow University. Publishers: Whittaker and Company, London and New York. Size 6¼ x 8¾; pp. 78; 80 figures in the text. Price, $1.25.

In this little book the author presents a concise analysis by analytical and graphical methods of the shearing forces and bending moments produced in beam and deck girder bridges due to wheel loads, with ready means of determining the maximum in each case for a range of spans up to 150 feet. Since by "underbridges" is meant bridges carrying railways over highways, it seems to be taken for granted that all such bridges are of the continuously-loaded type, although in this country through girder spans with floor beams are quite as common as the former for crossings over roads. The studies presented appeared in part in Engineering somewhat over a year ago, and were subsequently incorporated in the present volume with a discussion of the diagrams of shearing forces and bending moments due to fixed and moving loads. While there is essentially nothing in it which has not been published before or which is not familiar to every American bridge engineer, the subject is attractively presented for the student, and those wishing to obtain a clear understanding of the theory of stresses due to moving loads would do well to consult Mr. Bamford's book.

C. R. Y.

The Steam Turbine.—By Robert M. Neilson. Longmans, Green & Company, London, Eng.; 600 pages, 46 plates, and 387 text illustrations. Price, $4.

This is the fourth edition of this book, and a greater portion of the previous edition has been re-written, and much additional matter has been added.

The author's aim throughout has been to render the subject intelligible to the average British or American engineer who has had a fair, but not necessarily a very extensive, scientific training. The formulæ employed have generally been arranged to be suitable for any system of units; but, where clearness or effect could be gained by fixing the units, the usual British system has been adopted.

The first two chapters are largely an introduction, giving notes and definitions without a knowledge of which the reader could not appreciate the subject matter of the book and a history of the steam turbine covering in outline the chief inventions and improvements from 1577 to the present.

Chapter III. deals briefly with the conversion of the heat energy of steam into kinetic energy.

Chapter IV. classifies and compares steam turbines.

Chapter V. losses and efficiency.

Chapter VI. vane speeds and efficiency.

Chapters VII. to XIII. deal with different types and classes, giving in some detail descriptions of the more modern and successful steam turbines.

Chapter XV. deals with the design of machines suitable for the driving of electric generators.

Chapter XVI. gives the results of tests on steam consumption of various turbines.

Chapter XVII. deals with the design and equipment of steam turbine power stations.

While the last chapter devotes some fifty pages to ship propulsion by steam turbines.

The book is a valuable contribution to the literature on steam turbines, clear, concise, and does not devote any space to valueless introductions.

PUBLICATIONS RECEIVED.

American Mining Congress.—The report of the tenth annual sesion held in Joplin, Mo., November, 1907. Several of the papers discuss the education side of the Mining Engineer. James F. Callbreath, Jr., secretary, Denver, Col.

Department of Public Works.—Report of the Commission of Public Works for Saskatchewan, being the first report of the department since the province was organized.

Portland Cement Mortars.—Bulletin No. 331 of the United States Geological Survey, Technological Branch. This report gives the results of tests made with cements and sand, gravel and screened stone mortars.

Health Officer's Report.—The report of the Provincial Department of Public Health, Nova Scotia. The report contains a chapter of great value on the ventilation of building.

Ellsworth Dam.—The booklet describes more by pictures than by words the rapid progress made by the Ambursen Hydraulic Construction Company, of Boston, Mass., in the construction of the Ellsworth dam, the height of rollway of which was 65 feet, the length of dam 500 feet.

Highway Improvement.—The twelfth annual report of Department of Highways for Ontario. A. W. Campbell, Commissioner. The report contains a Manuel of Roadmaking, and may be obtained from Hon. J. O. Reaume, Toronto, Ont.

Steel Sheeting.—George W. Jackson, Inc., of Chicago and New York, have issued an interesting catalogue descriptive of steel sheeting and showing work under construction where interlocking steel sheeting has been employed. A large number of views show the many uses of steel sheeting, and many forms of construction made possible by its use. Size, 10 x 7, page 70.

CATALOGUES.

Oil Gas.—Mansfield & Sons, of Derby Square, James St., Liverpool, Eng., are distributing catalogues describing their oil gas apparatus, the advantages of this system of lighting and comparative costs.

Tarva.—A catalogue beautifully illustrated and being distributed by Barrett Manufacturing Company, New York, describes and pictures the effect of Tarva, a new treatment for preventing the formation of dust of country roads.

Direct Current Motors.—Bulletin No. 100 of Canadian Crocker-Wheeler Company, Montreal, describes some of their latest belt type direct current motors from 5 to 45 horsepower.

Lorries.—Broom & Wade, Limited, High Wycombe. A well illustrated catalogue descriptive of their lorries, which are suitable for carrying a load of 3 to 4 tons, and are also capable of drawing a trailer carrying 2 tons on level ground, in addition to the load up. As regards the general mechanical design, this is an extremely strong lorry, and capable of standing very rough usage. In comparison with the steam traction engine, there is no doubt that the motor lorry illustrated is far less complicated.

Rock Drills.—A complete catalogue by the Ingersoll-Sergeant Company, of Montreal, Canada, descriptive of their machines, their construction and workings. Also air compressors. The catalogue gives weights and principal dimensions.

Concrete-Steel Dams.—The Ambursen Hydraulic Construction Company, of Montreal, Canada, tell in this booklet of the concrete-steel gravity dam, as to design, construction, tightness, life and stability. Size, 8 x 10.

Induction Motors.—Bulletin No. 301, Allis-Chalmers-Bullock, Montreal, contains many illustrations and brief description of their poly-phase induction motors.

Locomotive Cranes.—The Brown Hoisting Machinery Company, Cleveland, Ohio, are distributing an interesting booklet descriptive of the "Brown Hoist" Locomotive Cranes. The book contains many illustrations, showing the great variety of uses hoists of this class may be put to. It also contains diagrams showing the principal dimensions of their cranes and the distances at which they work.

THE WHEELER CONDENSER & ENGINEERING COMPANY.

Carteret, N. J., has made arrangements with Charles S. Lewis & Company, Granite Building, 4th and Market Streets, St. Louis, Mo., to handle "Wheeler" apparatus in the State of Missouri. This includes the wellknown "Wheeler" Surface, Jet and Barometric Condensers, Feed Water Heaters, Re-Heaters and Receivers, Vertical Engines, Centrifugal Pumps, Rotating Dry Vacuum Pumps, and Vacuum Pans and Multiple Effects. This also includes the "Edwards" Pump, which contains no suction valves, the pump is as effective in removing air as a dry vacuum pump having mechanically operated admission valves. This pump is widely applied for other vacuum work, as well as with condensers. It is built in various combinations, single, duplex, and triplex, for steam and electric drive, etc.

A most interesting illustrated lecture upon the construction and collapse of the Quebec Bridge was given by Mr. Walter J. Francis, C.E., before a large gathering at the Royal Arcanum, in Montreal, last week. His acquaintance with the bridge, having been gained to a very considerable extent while employed in investigation work for the Quebec Bridge Commission, which reported upon the cause of the collapse, Mr. Francis was enabled to be unusually realistic and instructive. Lantern slides, of which there was a large number, chronicling the progress of the bridge, furnished the theme, and were exceedingly interesting. Mr. Francis embraced in his remarks an explanation of some of the engineering problems involved in the design and construction of the bridge. He was warmly applauded and thanked at the close of the lecture.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS.

Ontario.

BRANTFORD.—Tenders will be called for until May 21st, 1908, for furnishing and laying 5,450 feet sewer pipe. T. Harry Jones, city engineer. (Advertised in the Canadian Engineer.)

GUELPH.—Tenders will be received until May 18th, 1908, for high duty pumping engine, water tower and foundation and 3,000 feet cast-iron pipe. Davis & Johnson, Berlin, engineers; J. J. Hackney, manager of Waterworks. (Advertised in the Canadian Engineer.)

OTTAWA.—The time for receiving tenders for the British Columbia Fishery Cruiser will be extended from the first of May until the first of June next. F. Gourdeau, Deputy Minister of Marine and Fisheries.

OTTAWA.—Tenders, addressed to the undersigned and endorsed "Tender for Dredging," will be received until Friday, May 15th, 1908, at 4.30 p.m., for dredging required (at various places) in the Province of Ontario. Fred. Gelinas, Secretary Department of Public Works. (Advertised in the Canadian Engineer.)

NIAGARA FALLS.—Tenders addressed to the Commissioners of the Queen Victoria Niagara Falls Park, Niagara Falls, Ontario, will be received up to the fifth day of May next for paving about one-fourth of a mile of the park driveway near Table Rock. James Wilson, acting superintendent.

SIMCOE.—The town of Simcoe have for sale two steam Waterous fire engines, capacity 250 gallons per minute. Reason for selling, new system of waterworks. W. C. McCall, town clerk.

PORT ARTHUR.—The city has decided to increase the storage at the Union Lake dam by building an additional eight feet on top at an estimated cost of $10,000. Tenders are being called for.

Manitoba.

VIRDEN.—Tenders will be received up to 10th day of May 1908, for the building of such telephone lines and the installation of such telephones as will be required in the telephone system in the rural municipality of Wallace. James F. C. Menlove, Secretary-Treasurer.

Saskatchewan.

MEDICINE HAT.—Tenders will be received at the office of the city engineer up to 17k May 18th, 1908, for the drilling of an 8-inch gas well to a depth of 1,100 feet more or less. W. P. Morrison, city engineer.

MOOSE JAW.—Tenders will be called for until May 11th, 1908, for 500 k.w. Turbo-Alternator, etc., for the town of Moose Jaw. John D. Simpson, city clerk. (Advertised in the Canadian Engineer.)

PRINCE ALBERT.—The trustees of High School District No. 3, Prince Albert invite competitive plans for a high school building, cost not to exceed $75,000, to be submitted by 11th May, 1908. C O. Davidson, secretary-treasurer, Prince Albert, Sask.

SASKATOON.—Tender for heating Post Office, Saskatoon, Sask., will be received until Friday, May 8th, 1908, for the construction of a heating system for the new public building here. Mr. Neil Stewart, clerk of works, Saskatoon, Sask.

Alberta.

EDMONTON.—The contract for grading the Grand Trunk Pacific Railway from the Macleod River for a distance of one hundred miles west will be let on May 15th, and for the grading of the next eighty miles to the west, on June 22nd. Tenders will be received for this grading up to date of the letting of the contract and a large number of contractors are now looking over the line preparatory to tendering on the work. This 180 miles added to 120 mile division to the Macleod River now being graded will take the line through the Yellowhead Pass in the Rocky Mountains.

VICTORIA.—Tenders will be received up to Monday, the 18th of May, 1908, for supplying to the Victoria Waterworks seventy tons of pig lead. Wm. W. Northcott, purchasing agent.

British Columbia.

VANCOUVER.—The date for receiving tenders for the bridge over False Creek, Vancouver, has been extended until May 16th, 1908. Waddell and Harrington, consulting engineers, Kansas City, Mo. (Advertised in the Canadian Engineer.)

CONTRACTS AWARDED.

New Brunswick.

FREDERICTON.—Work will shortly be commenced upon the contract which the Willard Kitchen Company, of this city has been awarded for building thirty-two miles of the Grand Trunk Pacific between the Tobique River and Grand Falls. Mr. Kitchen estimates roughly the contract price for constructing the thirty-two miles will be about $3,000,000. There will be a tunnnel one thousand feet long. The company will also do the ballasting and will erect the telegraph line and place the ties and rails in position. The building of practically the entire piece of road will be done by the sub-contractors, Johnson Bros., of Winnipeg, and Ryan & McDonald, of Montreal, have the heaviest contracts on the line. Johnston Bros. will build one and a half miles which will likely cost $200,000, while Ryan & McDonald will build two miles which will cost about $260,000. The contract calls for the completion of the work by September, 1910.

Quebec.

MONTREAL.—The Water Committee have decided to purchase from the John McDougall Caledonian Ironworks Company, a 12-million gallon Worthington pump, to cost $29,465. According to the specifications, the pump must be delivered within nine months. The cost is less than half that of a pump with a reciprocating engine, the new pump being fitted with a turbine by the Bellis-Morcom firm, of Manchester, England.

Ontario.

GODERICH.—The successful tenderer for the construction of the two sedimentation tanks at Goderich, Ont., was Mr. Peter Nicholson, Moncton, Ont., whose tender was for something under $9,000. Mr. J. Grant MacGregor, C.E., is the town engineer.

GUELPH.—The Water Commissioners are letting a $25,000 contract for tile pipe, in connection with the water supply scheme to an American firm. Canadian companies object to Americans getting the contract. The Mimico Company have a tender for $500 under the American Company's figures.

PALMERSTON.—The municipality proposes installing a system of waterworks, and Messrs. James Peat & Sons, of Petrolea, Ont., have been awarded the contract for the drilling of an eight-inch water wheel, to a depth of 600 feet, if necessary.

Saskatchewan.

EDMONTON.—The city council have definitely decided to sell the street railway now under construction if a suitable offer can be secured. Two bodies of English capitalists have intimated to the mayor that they will make an offer.

Alberta.

EDMONTON.—The contract for building 70 miles of wire fence around the Battle River Buffalo Reserve was let to the

Ideal Fence Co., of Winnipeg, and John Breckenridge, contractor of Calgary. The estimated cost was $70,000, and the contract price was well within the estimate. The Ideal Fence Company is the western end of the McGregor Bannell Fence Company, of Walkerville, Ont. The new fence will be a 15-stand woven wire fence, 7½ feet high, the top strand being barbed wire. Tamarack and jack pine fence posts will be used.

MACLEOD.—Messrs. Janz and McDonnell, the railway contractors, who have secured the contract for the cutoff between this place and Lethbridge are preparing for work. Much of the work will be sublet.

British Columbia.

PRINCE RUPERT.—The sub-contract for the first mile of the G.T.P. from Prince Rupert has been awarded to Contractor Ross, who has a year to finish the work.

VICTORIA.—It has been announced that the successful tenderer for the new main building that the fair mangement will erect at the Exhibition Grounds, was the firm of J. D. McDonald and Son of this city, late of Grand Forks. The contract price is given out at $11,875, and the contract calls for the completion of the structure by July 30th. The successful tenderer was the lowest of twelve, the number of those who put in tenders for the erection of the building.

RAILWAYS—STEAM AND ELECTRIC.

Ontario.

GODERICH.—V. M. Roberts has been appointed chief engineer, and with a staff of draughtsmen, rodmen, and chainmen starts to-day the preliminary surveys of the West Shore electric road, which is to be built from Goderich to Kincardine, a distance of thirty miles. It is expected this line will take two years in construction. It is the intention of the Company to extend their line when built to Goderich south along the lake shore to Sarnia, a distance of sixty miles, opening up one of the most fertile districts of Ontario.

LEAMINGTON.—The Windsor Essex and Lake Shore Railway (electric) inaugurated regular service from Windsor to Leamington. The litigation between the road and the Bell Telephone Company has been settled by the railway paying the Telephone Company $900 toward the cost of moving the latter's wires.

MIDLAND.—The Grand Trunk Pacific Railway Company is about to erect what is said to be the largest grain elevator in the world at Fort William, which will be operated in conjunction with the one now under construction here in connection with their transcontinental system. There is a rumor floating about that the Grand Trunk will very shortly move their round house equipment to Tiffin where it will be very much enlarged and a repair shop added.

NORTH BAY.—The T. and N. O. Railway offices moved from the Ferguson Block into the handsome new building built for railway office purposes in the east end of the town. This office building has been under construction by O'Boyle Bros. for nearly a year, is a handsome structure of cut limestone; the partitions and floors are of concrete. The finishing is of oak with tiled roof.

Manitoba.

NAPINKA.—Considerable new work will be undertaken by the C.P.R. in this district towards providing a sufficient water supply for their locomotives.

PORTAGE LA PRAIRIE.—The Grand Trunk Pacific has started laying steel on the line into Winnipeg and expects to reach that city shortly. Last winter steel was laid from this city to the bridge over the Assiniboine, a distance of four miles. The work has been taken up from there. The superstructure is being placed on the bridge and every preparation is being made to rush the work through to completion. The resident engineer here states that the twenty miles separating the end of steel from Saskatoon is also being railed, and by the middle of May trains will be running from Winnipeg to west of Saskatoon.

Alberta.

CALGARY.—P. A. G. Rodrique, of Calgary, made an application to the City Council at a meeting recently for permission to construct a street railway system according to a set of plans submitted. He would take electric power from the city. The matter will be dealt with by a special committee of council. He would have all construction and equipment work done in Calgary and import material only.

British Columbia.

PRINCETON.—The Great Northern Railway has let con tracts for cutting the right of way between Princeton and Hedley, B.C., and some of the contractors have begun work.

VICTORIA.—One hundred and twenty-five thousand dollars will be spent this summer in improving and modernizing the seventy-eight miles of roadbed of the E. and N. Railway between here and Nanaimo, and this work will start at once and be rushed to completion as fast as possible. This is the important announcement that was made recently by one of the prominent officials of the E. and N. Railway.

SEWERAGE AND WATERWORKS.

Ontario.

LONDON.—The Water Commissioners have decided on a plan of extension which will be submitted to the council in order to be embodied in a by-law. The scheme is to take in the Kilworth, White and Cronyn Springs, with high pressure and a filtration plant where the latter is needed. The sum asked for by the Commissioners for this purpose is $560,000.

Manitoba.

PORTAGE LA PRAIRIE.—At a public meeting held here recently the proposition to expend $50,000 on an auxiliary waterworks system was endorsed.

British Columbia.

NEW WESTMINSTER.—At a special meeting of the city council held recently for the purpose of meeting the officials of the B.C.E.R., Mr. J. Buntzen, the managing director, assured the city that he was perfectly in accord with them on the necessity of building a new dam at Coquitlam Lake, and that the matter would be laid before the directors in England. Realizing that something would have to be done he considered it would be better for the company to proceed with a new dam rather than waste any money on temporary repairs to the present structure.

NEW BUILDINGS.

TORONTO.—Building permits to the value of $140,000 were issued to the city architect from April 15th to April 20th. They included forty-four dwellings.

Saskatchewan.

TANTALLON.—A large brick yard will be in operation here by the fall if the plant can be secured and put up by that time. A. R. Fleming, a Regina contractor, has a homestead adjoining village property and he has found that the clay will make the best of brick. It is his intention to have a $10,000 plant put in at the earliest date.

MOOSE JAW.—At a recent city council meeting it was decided to have a petition circulated asking for the submission of a new fire hall by-law. The former sum voted being inadequate to include the purchase of a new site, and the further equipment found necessary this year, a by-law for $35,000 is now asked for.

MISCELLANEOUS.

Quebec.

MONTREAL.—The Montreal Street Railway are preparing to haul stone from the Outremont Quarry to the city. It is expected by this means the city will secure stone for macadamizing streets much cheaper than formerly. The estimated cost of the stone crushed, and delivered to any part of the city is $1.40 per ton.

MONTREAL.—At a meeting of the Road Committee held recently some of the specifications for the work that the department will undertake during the coming season were taken into consideration, chief of these being an estimated necessary expenditure of $545,000 for new sidewalks, one half this cost being collectable from the proprietors after the work has been done. The amount was finally cut down to $390,000, application for which will be made to the Finance Committee to be spent in the different wards.

Ontario.

TORONTO.—Civic Works Committee have decided to recommend to the City Council that they submit a by-law providing for the expenditure of $700,000 on a seawall from Bathurst Street to the Humber to the ratepayers on Saturday, June 27th.

TORONTO.—Referring to the transmission lines Hon. Adam Beck says: "The high voltage transmission contemplated from Hamilton will have an estimated capacity of 30,000 horse-power, but with the 10,000 applied for by the city the line can be built and power delivered at the price quoted. The estimated cost of the whole system of transmission lines to serve the Western municipalities as well as Toronto is $3,500,000."

Manitoba.

WINNIPEG.—Difference of opinion exists here as to whether or not the various money by-laws it is proposed to submit to the ratepayers on May 7th can be voted on.

Alberta.

HARDISTY.—The C.P.R. bridge over the Battle River will soon be ready for steel, after which construction on the line to Saskatoon will be commenced.

British Columbia.

NEW WESTMINSTER.—Two new industries are likely to be started near this city soon, a pulp mill and a pottery and tile works. The pulp mill will be established in connection with the British Columbia box factory, if the present plans of Finch Page are carried out. Mr. Ewen Martin has discovered a large deposit of clay on his property in Burnaby, and the samples which have been analyzed have been pronounced excellent for pottery and tile pipe. Mr. Martin is now making arrangements for the starting of a manufacturing plant of tile pipe and brick.

VICTORIA.—As soon as possible this city will commence paving Wharf Street and Belleville Street. Instead of the customary block paving the city will probably adopt vitrified brick. The city has not heretofore used this class of pavement but owing to the heavier traffic on Wharf Street, which serves the main portion of the wholesale district, it is felt that a more substantial kind of pavement should be put in. The city is now calling for tenders for $1,000,000 blocks and as soon as these are ready and such water pipes as are necessary have been laid, the work will proceed.

PERSONAL.

MR. PAUL OGILVIE, who was resident engineer of the C.P.R. at Kenora, has been transferred to Vancouver, where he will take a similar position with the company.

DR. F. W. KING, of the Canadian section of the International Waterways Committee, has gone to Washington to endeavor to secure legislation to prevent the proposed diversion of the waters of the St. Mary's River in South Alberta into the Milk River, Montana.

PATENTS.

Below will be found a list of patents recently granted to Canadian inventors in Canada and United States, which is furnished by Messrs. Fetherstonhaugh & Company, barristers and solicitors, Toronto, Ottawa, Winnipeg, and Montreal:—

Canadian Patents.—W. Bernerd, Smith's Falls, Ont., angle cock for air brake systems.

United States Patents.—J. T. Bertrand, Isle Verte, Quebec, marine concrete construction; G. F. Brindley, Niagara Falls, Ont., fusing maerials; F. Duffy, Kingston, Ont., steam-trap; R. C. McClure, Lethbridge, Ont., continuous rail joint; F. F. Miller, Napanee, Ont., internal combustion engine; J. Phillips, Midland, Ont., lock; J. F. D. Withrow, Ottawa, Ont., apparatus for mixing concrete.

SOCIETY NOTES.

Engineers' Club.

At the regular meeting on April 23rd a thorough and general discussion of one of Toronto's pressing problems, that of securing pure water, was indulged in by the members of the Engineers' Club at their regular meeting last night. The discussion moved chiefly about the proposed filtration plan of the municipality. It was pointed out that filtration would not absolutely guarantee the purity of the water from disease germs, and one member of the club questioned whether the process of filtration could be made rapid enough to supply a city of the size of Toronto with a continual supply of water. That the devotion of more attention to the treating of sewage was the proper solution of the problem was the general opinion.

City Engineer Rust gave the members a concise review of the development of the city's waterworks system. Dealing with the question of water impurity, he said he thought the agitation about the presence of disease germs in the water had unnecessarily alarmed the public.

"Too much has been said about impure water being the cause of the typhoid in the city," declared Mr. Rust. "I have found that during the summer months, when the water is purest, there is more of the disease than during the spring when the water is at its worst. Health officers often blame the water because they don't want to take the trouble to investigate for other causes. Toronto's death rate from typhoid was smaller than that of any of twenty-five large American cities."

Mr. J. Aird Murray, commenting on the civic filtration proposal, seriously questioned if the plan would prove workable owing to the rapidity of operation which would be required. He advocated thorough sewage treatment, and said that at comparatively little expense all house taps could be provided with a filtration device that would be as effective as the undertaking contemplated by the city.

American Society of Mechanical Engineers.

The semi-annual meeting of the American Society of Mechanical Engineers will be held in Detroit, Michigan, June 23-26. Among the papers to be presented at this session are "A Method of Cleaning Gas Conduits," by W. D. Mount; "A Method of Checking Conical Pistons for Stress," by Prof. George H. Shepard; "Clutches," with special referance to automobile clutches, by H. Souther; "Horse-power, Friction Losses, and Efficiencies of Gas and Oil Engines," by Prof. L. S. Marks; "Some Pitot Tube Studies," by Prof. W. D. Gregory; "The Thermal Properties of Superheated Steam,"," by Prof. R. C. H. Heck; "A Journal Friction Measuring Machine," by Henry Hess; "A By-Product Coke Oven," by W. H. Blauvelt; "Tests of Some High Speed Steam Engines," by F. W. Dean. There will be a symposium upon machinery for conveying materials, with papers by several authorities. The Society for the Promotion of Engineering Education, and the Society of Automobile Engineers will also hold their annual meeting in Detroit at this time, which will enable members of each Society to participate in the sessions of the other.

MARKET CONDITIONS.

Toronto, April 30th, 1908.

No alteration in prices of iron and hardware is to be noted, and no additional activity in these lines is reported. There seems to be a lull, to be succeeded, in the general belief, by much briskness after the full opening of navigation. Metal quotations in the main unchanged.

Dealers in cement, lime, sand, and bricks report a moderate enquiry, with the possibilities of increase with warm weather. There is no new feature in lumber. The labor situation is calmer than usual; many men are earnestly looking for work and not so pliant to the labor unions.

The following are wholesale prices for Toronto, where not otherwise explained, although for broken quantities higher prices are quoted:

American Bessemer Sheet Steel.—Fourteen-gauge, $2.45; 17, 18, and 20-gauge, $2.60; 22 and 24-gauge, $2.65; 26-gauge, $2.80; 28-gauge, $3.

Antimony.—Quiet, but inquiries are coming in more freely; we quote 10 to 11 cents.

Bar Iron.—$2 base, from stock to the wholesale dealer.

Beams and Channels.—Outside enquiry is not remarkable, but local builders are more in evidence; prices continue to be $2.50 to $2.75, according to size and quantity; angles, 1¼ by 3-16 and larger, $2.55; tees, $2.80 to $3 per 100 pounds. Extra for smaller sizes.

Boiler Heads.—25c. per 100 pounds advance on boiler plate.

Boiler Plates.—¼-inch and heavier, $2.50. Supply probably adequate and quotations still firm.

Boiler Tubes.—Lap-welded steel, 1¼-in., 10c.; 1½-in., 9c. per foot; 2-in., $9.10; 2¼-in., $10.85; 2½-in., $12; 3-in., $13.50; 3½-in., $16.75; 4-in., $21 per 100 ft.

Building Paper.—Plain, 32c. per roll; tarred, 40c. per roll. Demand up to average for the season.

Bricks.—Common structural, $9 to $10 per thousand, wholesale; small lots, $12; there is a good demand. Red and buff pressed are worth $18 at works.

Cement.—Price of Canadian makes to the dealer in 1,000 barrel lots and up is $1.75, in cotton bags, on car, Toronto. The dealers' price to the contractor up to car-load lots without package price, are general at $1.80 per barrel in cotton bags and $2 in wood, weight in each case 350 pounds. Most builders are booked for year's supply.

Detonator Caps, 75c. to $1 per 100; case lots, 75c. per 100; broken quantities, $1.

Dynamite, per pound, 21 to 25c., as to quantity.

Felt Paper—Roofing Tarred.—Market steady at $2 per 100 pounds. In moderate request.

Fire Bricks.—English and Scotch, $32.50 to $35; American, $25 to $35 per 1,000. Demand, moderate.

Fuses—Electric Blasting.—Double strength, per 100, 4 feet, $4.50; 6 feet, $5; 8 feet, $5.50; 10 feet, $6. Single strength, 4 feet, $3.50; 6 feet, $4; 8 feet, $4.50; 10 feet, $5 Bennett's double tape fuse, $6 per 1,000 feet.

Galvanized Sheets—Apollo Gauge.—Sheets 6 or 8 feet long, 30 or 36 inches wide; 10-gauge, $3.25; 12-14-gauge, $3.35; 16, 18, 20, $3.50; 22-24, $3.70; 26, $3.95; 28, $4.40; 29 or 10¾, $4.70 per 100 pounds. Stocks very low.

Ingot Copper.—The expected advance did not come; matters are much as before. Local price continues at 14 to 14½c.

Iron Pipe.—Black, ¼-inch, $2; ⅜-inch, $2.25; ½-inch, $2.72; ¾-inch, $3.68; 1-inch, $5.28; 1¼-inch, $7.20; 1½-inch, $8.64; 2-inch, $11.50; 2½-inch, $18.40; 3-inch, $24.15; 3½-inch, $30.40; 4-inch, $34.55; 4½-inch, $38; 5-inch, $43.50; 6-inch, $56. Galvanized, ¼-inch, $2.85; ⅜-inch, $3.05; ½-inch, $3.57; ¾-inch, $4.83; 1-inch, $6.93; 1¼-inch, $9.45; 1½-inch, $11.34; 2-inch, $15.12.

Lead.—Holding its own at $4.25. Easier in England.

Lime.—In plentiful supply and moderate movement. Price for large lots at kilns outside city 21c. per 100 lbs. f.o.b. cars; Toronto retail price 35c. per 100 lbs. f.o.b. car.

Lumber.—The following are quotations for lumber suitable for making forms for concrete, per 1,000 feet f.o.b., shipping points; hemlock, 2-inch plank, $16; 2 x 4 scantling, $12; spruce, good mill culls, 2-inch, $14. For dressing one or two sides the prices will be about $1.25 in advance of quoted prices, and for dressing and matching about $1.75.

Nails.—Wire, $2.55 base; cut, $2.70; spikes, $3.15.

Pitch.—Fair demand at 75c. per 100 lbs.

Pig Iron.—Market is steady; Summerlee quotes: No. 1, $25.50; No. 3, in car load lots, $22 to $23 here; Glengarnock, $25.50; Clarence, $20; No. 1 Cleveland, $20 to $22, Old Country market firm.

Steel Rails.—80-lb., $35 to $38 per ton. The following are prices per gross ton; Montreal, 12-lb. $45, 16-lb. $44, 25 and 30-lb. $43.

Sheet Steel.—In moderate supply; 10-gauge, $2.65; 12-gauge, $2.70.

Tar.—Market unsettled, $3.50 per barrel, the ruling price.

Sand.—Prices of washed sand, 50c. per cubic yard, (2 cubic yards to a load), on dock, Toronto. Delivery made f.o.b. works at any point in city at from 90c. to $1.10 for large quantities. Quotations at outside points depend on interview or correspondence.

Tank Plate.—3-16-in., $2.65.

Tin.—Irregular abroad, but higher on the whole; price here 33 to 34c.

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Montreal, April 30th, 1908.

The markets of the United States show very little change this week. The associated interests are holding prices on the level of some time past, although, no doubt, some of the independent makers are accepting orders for moderate sized lots, for prompt shipment, at a considerable reduction. Almost all the iron now being made is going into actual consumption. Indications for an increased business are not good. The railway companies still refrain from making large purchases, and as this trade constitutes fully 35 per cent. of the whole, the effect is very seriously felt. If crop reports show up well during the next two or three months, there is a general feeling that the railway companies will come into the market for a heavy tonnage for the various classes of iron and steel which they use.

Prices remain steady in the English market. Shipments from Middlesboro have been very heavy during the past month, a considerable tonnage coming to Canada. The result is that stocks are further depleted and makers are statistically in a good position. There is some uneasiness because of the reported intention of the shipbuilding interests to close down their works owing to difficulty with their workmen. If a lock-out takes place, it will materially reduce the quantity of iron and steel consumed, and the situation of makers will become very precarious and prices may be forced to a lower level.

Locally, business is fairly active, and there is a better feeling, although the amount of iron actually going into consumption is not large and is being taken care of, to a considerable extent, by Canadian furnaces. These interests are offering metal at prices which make it difficult for foreign brands to compete. It is expected, however, that there will be a considerable tonnage of English and Scotch iron received here during the next week on account of orders placed two or three months ago, and such metal will be promptly distributed upon arrival here.

Antimony.—The market holds steady and sales are being made at 9½ to 10c. per lb.

Bar Iron and Steel.—Prices continue unchanged and business is only fair. Bar iron, $1.90 per 100 lbs.; best refined horseshoe iron, $2.15; forged iron, $2.05; mild steel, $2.05; sleigh shoe steel, $2.05 for 1 x ⅜-base; tire steel, $2.05 for 1 x ⅜-base; toe calk steel, $2.50; machine steel, iron finish, $2.15.

Boiler Tubes.—The market holds steady, demand being fair, prices are as follows:—2-inch tubes, 8 to 8¼c.; 2½-inch, 11c.; 3-inch, 12 to 12¼c.; 3½-inch, 15 to 15¼c.; 4-inch, 19¼ to 19½c.

Building Paper.—Tar paper, 7, 10, or 16 ounce, $2 per 100 pounds; felt paper, $2.75 per 100 pounds; tar sheathing, No. 1, 60c. per roll of 400 square feet No. 2, 40c.; dry sheathing, No. 1, 50c. per roll of 400 square feet, No. 2, 32c.

Cement—Canadian and American.—Canadian cement, $1.70 to $1.75 per barrel, in cotton bags, and $1.95 and $2.05 in wood, weights in both cases 350 pounds.

There are four bags of 87½ pounds each, net, to a barrel, and 10 cents must be added to the above prices for each bag. Bags in good condition are purchased at 10 cents each. Where paper bags are wanted instead of cotton, the charge is 2½ cents for each, or 10 cents per barrel weight. American cement, standard brands, f.o.b. mills, 85c. per 350 pounds; bags extra, 10c. each, and returnable in good condition at 7½c. each.

Cement—English and European.—English cement is steady at $1.85 to $1.90 per barrel in jute sacks of 82½ pounds each (including price of sacks) and $2.20 to $2.30 in wood, per 350 pounds, gross. Belgian cement is quoted at $1.75 to $1.85 per barrel in bags, and $2.05 to $2.20 per barrel, in wood.

Copper.—The market is steady at 14 to 14½c. per pound. Demand continues limited.

Iron.—The steamships are now arriving at Montreal with iron from Great Britain, and as a result the spread between the prices quoted for spot business and business to arrive has disappeared, the latter prices now prevailing. The following are quotations for pig-iron now arriving;—No 1 Summerlee, on cars, Montreal, $20.50 to $21 per ton; No. 2 selected Summerlee, $20 to $20.50; No. 3, soft, $19.50 to $20; Cleveland, $18.50, and No. 3 Clarence, $18; No. 1 Carron, $22 to $22.50; Carron special, $20.25 to $20.75; Carron, soft, $20 to $20.50.

Lead.—Trail lead is unchanged, at $3.90 to $4.00 per 100 lbs., ex-store.

Nails.—Demand for nails is moderate, but prices are steady at $2.30 per keg for cut, and $2.25 for wire, base prices.

Pipe—Cast Iron.—Trade dull and prices steady at $36 for 8-inch pipe and larger; $37 for 6-inch pipe, $38 for 5-inch, and $39 for 4-inch at the foundry. Gas pipe is quoted at about $1 more than the above.

Pipe.—Wrought.—The market is not very active, and the tone of prices is about steady after the recent decline. The list continues unchanged, but the discounts have been largely increased, being now as follows:—¼-inch, $5.50, with 63 per cent. off for black, and 48 per cent. of for galvanized; ⅜-inch, $5.50, with 59 per cent. off for black and 44 per cent. off for galvanized. The discount on the following is 68 per cent. off for black and 58 per cent. off for galvanized; ½-inch, $8.50; 1-inch, $16.50; 1¼-inch, $22.50; 1½-inch, $27; 2-inch, $36; and 3-inch, $75.50; 3½-inch, $95; 4-inch, $108.

Spikes.—Railway spikes are in fair demand, $2.60 per 100 pounds, base of 5½ x 9-16. Ship spikes are steady at $3.15 per 100 pounds, base of ⅝ x 10 inch and ⅝ x 12 inch.

Steel Shafting.—Prices are steady at the list, less 25 per cent. Demand is on the dull side.

Steel Plates.—Demand is good, and the market steady. Quotations are: $2.55 for 3-16, $2.40 for ⅛, and $2.30 for ¼ and thicker, in smaller lots.

Tar and Pitch.—Coal tar, $4 per barrel of 40 gallons, weighing 575 to 600 pounds; coal tar pitch, No. 1, 75c. per 100 pounds, No. 2, 65c. per 100 pounds; pine tar, $4.35 to $4.50 per barrel of about 280 pounds; pine pitch, $4.25 per barrel of 180 to 200 pounds.

Tin.—The market is steady at 33½ to 34c. per pound.

Tool Steel.—Demand is light, but the market is firm. Base prices are as follows: Jessop's best unannealed, 14½c. per pound, annealed being 15½c.; second grade, 8c., and high-speed, "Ark," 60c., and "Novo," 65c.; "Conqueror," 55 to 60c.; Sanderson Bros. and Newbould's "Saben," high-speed, 60c.; extra cast tool steel, 14c., and "Colorado" cast tool steel, 8c., base prices. Sanderson's "Rex A" is quoted at 75c. and upward; Self-Hardening, 45c.; Extra, 15c.; Superior, 12c.; and Crucible, 8c.; "Edgar Allan's Air-Hardening," 55 to 65c. per pound.

Zinc.—The market is unchanged, at 5¼ to 5½c. per pound.

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Winnipeg, April 28th, 1908.

There is little change in prices. Wholesalers report a good demand, chiefly for railroad construction purposes for the West. Locally, agents have received orders for large quantities of steel, principally for bridge work, the Manitoba Iron Works of this city having secured the steel work on the Dominion Government examining warehouse; and the contract in connection with the joint terminus of the Grand Trunk and C.N.R., which will require a considerable amount of steel work, will be let in the near future. There has been active demand for house building requisites. The demand for nails is improving and prices are holding steady, while beams and channels are also in good request. Building paper is being purchased in large quantities for immediate shipment. Now that navigation has opened it will be coming forward and a slight reduction is expected during the coming month. Lumber continues round prices quoted, with large supplies, and prices firm for better grades. On the whole the demand is favorable compared with last year, as the season is yet in its infancy.

Bar Iron.—$2.50 to $2.60.

Beams and Channels.—$4 to $4.50 per 100 up to 15-inch.

Building Paper.—4½ to 7c. per pound. No. 1 tarred, 84c. per roll; plain, 60c.; No. 2 tarred, 62½c.; plain, 56c.

Bricks.—From $11 to $12 per 1,000, three grades.

Cement.—$3.25 to $3.50 per barrel.

Dynamite.—$11 to $13 per case.

Roofing Paper.—60 to 67½c. per roll.

Nails.—$4 to $4.25 per 100. Wire base, $2.85; cut base, $3.20.

Tool Steel.—15 to 20c. per pound.

Lumber.—No. 1 pine, spruce, tamarac, British Columbia fir and cedar—2 x 4, 2 x 6, 2 x 8, 8 to 16 feet, $27.25, 2 x 20 up to 32 feet, $38.

Timber.—Rough, 8 x to 14 x 16 up to 32 feet, $34; 6 x 20, 8 x 20 up to 32 feet, $38; dressed, $37.50 to $48.25.

Boards.—Common pine, 8 in. to 12 in. wide, $38 to $45; siding, No. 2 white pine, 6 in., $55; cull red or white pine or spruce, 6 in., $24; No. 1 clear cedar, 6 in., 8 to 16 ft., $60; Nos. 1 and 2 British Columbia spruce, 6 in., $55; No. 3, $45.

Flooring.—No. 2 red pine, 4 in., $43; No. 3 red, 4 in., $38; No. 4 red and white pine or spruce, 4 in., $28; ceiling, No. 2 white pine, 4, 5, and 6 in., $55; No. 3 red pine, $38.

Lath.—No. 1 red and white pine mixed, $5.50; No. 2, $4.75.

Shingles.—No. 1 British Columbia cedar, $4.25; No. 2, $3.75; band sawn, $6.

ANNUAL MEETINGS.

May 5th.—Lake Erie and Detroit River Railway Company, Walkerville; Montreal City and District Savings Bank.

May 7th.—Detroit River Tunnel Company, Detroit.

May 9th.—Argentine Mining and Smelting Company, Limited, New York.

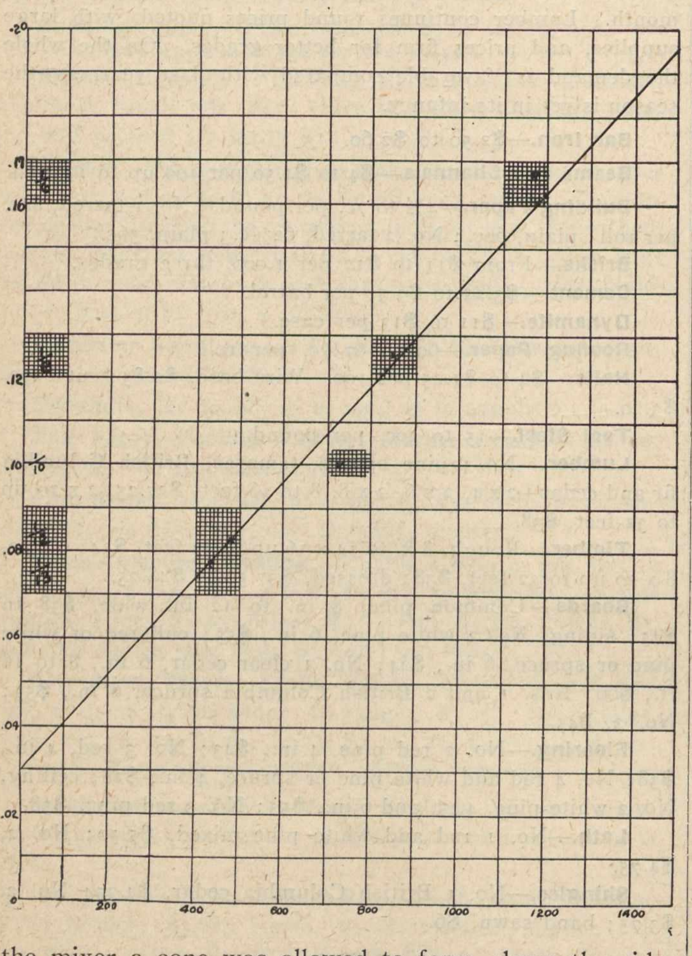
RELATIONS BETWEEN AMOUNT OF CEMENT AND STRENGTH OF CONCRETE.

In a recent paper on "Proportions Used and Methods of Mixing Concrete," Mr. Leonard C. Mason, President of the Aberthaw Construction Co., Boston, Mass., presents from actual tests some interesting facts regarding the effect of the amount of cement upon the strength of concrete. His statement is as follows:—

"The necessity of thorough mixing has been universally known for many years. The loss of strength from poor mixing is not, perhaps, so well known in figures. There were some private tests made at the Watertown Arsenal about eight years ago, in which the writer was interested, which throw some light upon improper mixing. On a large job a certain type of mixer was disapproved of by the supervising engineer, who insisted upon a comparative test of machine and hand-mixed concrete. All concrete was made with proportions of one part of cement, three of sand, and five of broken stone, ranging from 2½ inches to ½-inch, and was moulded into one foot cubes. A full size batch was first made with machine without any previous dry mixing of the aggregates. As the material was dumped from the mixer a cone was allowed to form, down the sides of which quite a quantity of stone rolled, separating from the mortar and accumulating around the base of the cone. A second batch was made, the cement and sand being thoroughly dry-mixed before adding the stone, and then thoroughly mixed together when in the mixer. No cone was allowed to form. A third batch was mixed by hand, being turned five times, the engineer with a hoe throwing into the mass stones which became accidentally separated from it. In filling the moulds the engineer insisted that from the first batch stone be shovelled up from around the base of the cone. The rest of the batch which remained properly mixed was filled into other moulds, four cubes and two beams being made from each batch. The first cube averaged only 2⅓ pounds, or about 2 per cent. lighter than the other three cubes, due to lack of mortar. Nevertheless, it gave a result 28 per cent. below that of the average of the other three, the figures being 3.081 pounds per square inch as against 4.263 pounds per square inch, the average of the other three. Age of all specimens was ninety days. The average of the four cubes which were dry-mixed before mixing in the machine was 4.123 pounds. The hand-mixed specimens averaged 3.187 pounds.

It will be seen that there is an advantage in machine-mixed concrete over that made by hand of 25¼ per cent., and that that which was not dry mixed before putting into the machine gave 3⅓ per cent. greater strength than that which was. The machine used in this case was the portable Gravity Concrete Mixer. It is safe to assume that these specimens were more carefully made than under ordinary commercial conditions, which they tried to reproduce, and the marked weakness of the specimen which lacked but a small amount of mortar is very significant. The weakness is doubtless due to the voids in the material, reducing the cross-sectional area. Ten years ago another series of experiments was conducted by the writer at the Watertown Arsenal, giving the relative merits of machine and hand-mixed concrete and the strength of various mixtures.

Diagram showing the relation between amount of cement used and the strength of the concrete:—



$$\text{Ordinates} = \frac{\text{Volume of cement.}}{\text{Volume of concrete.}}$$

Abscissa = Ultimate strength in lbs. per sq. in.

$y = mx + b$, $y = .00011x + .03$, or $x = 9091y + 273$.

These were specimens, one foot square and varying from six to fourteen feet in length. They were all made in mid-winter in an open lumber shed, and remained in the open air until tested, which accounts for the low ultimate strength. The modulus of elasticity of the hand-mixed specimens, with proportions of 1:3:6 and average age of forty-three days at a stress of 700 pounds per square inch was 2,500,000; the machine mixed, 2,870,000, an increase of 12½ per cent. of the modulus. The ultimate strength of the hand-mixed was 921 pounds; the machine-mixed, 1,111 pounds, an increase in the ultimate strength of 17 per cent., due to machine mixing.

The hand-mixed specimens in this case were somewhat better than commercial conditions, because, in order to fill the moulds, the concrete was handled several times more than would be necessary in placing ordinary work. Each handling was equivalent to a mixing. It will be seen, therefore, that there is a marked improvement in strength due to machine mixing, and, as the machine is positive, we can be assured of obtaining this concrete uniform, whereas with hand work it is likely to be anything but uniform, while a little carelessness makes a big difference in the final strength.

A series of specimens were made, one foot square, six feet long, machine mixed, identical in every way except the amount of cement used. There were two specimens, each 1:3:6, 1:4:8, 1:5:10, 1:6:12, 1:7:13. The results of each pair were averaged, and are shown in the accompanying diagram. While these tests are not extensive enough to be conclusive, they indicate that the strength is directly proportional to the amount of cement used. Be careful to note the difference between the ratio of **parts** of cement to **parts** of stone and the ratio of **volume** of cement to **volume** of concrete."

DOMINION LAND SURVEYORS.

The increased cost of living has led to an amendment of the scale of fees to Dominion land surveyors. The ordinary surveyors will receive $8 a day instead of $6.50, while those in charge of surveys on block outlines are increased from $7.50 to $10. Inspectors of surveys, whose employment is continuous, will receive $9 a day when in the field, and $5 a day when engaged in office work.