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THE DEVELOPMENT OF SEWAGE DISPOSAL PRACTICE

HISTORICAL REVIEW OF THE SCIENTIFIC DISPOSAL OF WASTE — VARIOUS AGENCIES IN USE — PAPER READ BEFORE THE ONTARIO MUNICIPAL ASSOCIATION, TORONTO, AUGUST, 29TH

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It is a fundamental biological law that no living organism can long exist in the midst of its own wastes. This law is as applicable to the municipal organism as to the individual. Methods for the disposal of human wastes are as old as mankind itself, but the problem of sewage disposal which confronts us today originated only sixty or seventy years ago. Before this time the disposal of waste was largely an individual duty and not until the adoption of the water-carriage system did it become a civic responsibility. At the beginning of the water-carriage system, the method of disposal was by discharging the contents of the sewers into the nearest watercourse. This same method is too frequently used to this day. As long as the volume of water receiving the sewage was large compared with the amount of sewage no great attention was paid to the desirability or otherwise of this means of disposal. Before the germ theory of disease, and even much later, the discharge of sewage in bodies of water used for water supply has been tolerated and the use of unpurified water from such sources has caused enormous loss of life from typhoid. With rapid growth of population the waters receiving sewage have become not only unsafe for water supply but have become, in many cases, so grossly polluted as to be unfit for boating, bathing or fishing. Many otherwise attractive streams and lakes have become open sewers, offensive both to sight and smell. In other cases, as with certain sea coast towns, extensive shell-fish industries have been threatened by the pollution of harbor water.

In Europe the problem became acute much earlier than in America, on account of the smallness of the streams and the density of population. Local nuisances, due to fouling of the streams, became so pronounced that means had to be taken very soon after the introduction of the water-carriage system to prevent further fouling of the streams receiving sewage. The condition of the Thames at London became so intolerable that a government commission was appointed in 1868 to investigate methods of sewage disposal with the end in view of restoring the river in England to some degree of its former purity. This commission, called the Rivers Pollution Commission, after investigation, reported that the best means of disposal was land irrigation, and for many years this opinion was of powerful effect in shaping sewage projects in Europe, and in England land irrigation had official sanction almost exclusively until 1908.

In America the problem was first attacked in Massachusetts, and the Massachusetts Board of Health started experiments in 1888 on the purification of water and sewage which are being continued to the present day. In respect to sewage the immediate result of their first experiment was the adoption in Massachusetts of sand or gravel beds for sewage treatment. The most important results, however, were the establishment of the scientific basis upon which sewage purification depends and the stimulation given to other investigations of the sewage question.

The Massachusetts experiments proved that sewage purification is largely a matter of oxidation through bacterial agencies. Bacteria and other micro-organisms in soil, water or artificial devices, if given an abundance of oxygen, oxidize complex, putrescible, organic compounds to simple, non-putrescible, inorganic substances. As long as oxygen is present the organic compounds in sewage give comparatively little offence, but as soon as this oxygen is exhausted the unoxidized organic matters decompose, giving rise to foul, ill-smelling compounds and gases. From this it will be seen that the whole problem in a nutshell is to supply sufficient oxygen to the sewage. In fact, the sewers of a city may be likened to the veins of a human body, the sewage to the impure blood in the veins and the means of purification to the lungs where the impurities are oxidized by the inhaled air.

Sewage Defined and Classified.—Sewage itself has been defined as the water supply of a city after use. It contains the wastes of man and of man's activities. In composition it is mainly water and the proportion of solid matter to water is about 1 to 999. Aside from the solid matter it carries innumerable forms of microscopic life, and often contains bacteria dangerous to health. The solid matter and the harmful bacteria bring about the sewage problem, the solid matter by offensive decomposition and the bacteria by producing disease. The solid matter can be divided into two kinds, organic and inorganic; the organic solids being those subject to purification. For practical purposes, another classification is made of the solids into floating, suspended and dissolved solids. Floating solids consist of garbage, rags, paper, sticks, etc. The suspended solids are smaller particles carried in suspension by the sewage; and the dissolved solids are those in solution. The suspended solids are divided into settling and non-settling solids, the settling solids being those which will settle out when subjected to quiescent sedimentation, and the non-settling those which will not. The aim of proper sewage disposal is to prevent nuisances from the decomposition of these solids and to also prevent injurious effects to health from the disease bacteria.

Natural Purification of Sewage.—When sewage is discharged into a body of water, the forces of nature immediately begin its purification; bacteria and oxygen oxidise its organic constituents adverse conditions of temperature and food supply destroy large numbers of harmful bacteria and thus, under some conditions, disposal by dilution is both practical and scientific. It is estimated by various authorities that the amount of water in a stream receiving sewage must flow at a rate of 3 to 6 cu. ft. per second for each inhabitant contributing to the sewers. In lakes, the extent to which disposal by dilution can be used, depends entirely upon local circumstances, in respect to location of outlets, currents, location of water supply inlets, etc. Where disposal by dilution can be used it is important to prevent deposits of solids and to keep the oxygen content of the diluting water from becoming exhausted.

Screens to Collect Floating and Suspended Solids.—Under some conditions, where disposal by dilution can be practised, it is necessary to remove the floating solids. In this case screening is usually resorted to. Screening is also used previous to further treatment to protect pumps and prevent scum-forming materials from entering tanks. There are many types of screens, the most common, probably, is the bar screen. This screen consists of iron bars, spaced at regular intervals and inclined vertically to the sewage flow. The spacing of the bars varies from one-half to several inches. Sometimes two or more sets of screens are used, the spacing of the bars in the second set being less than that in the first. The material collecting on the bars is removed and destroyed. Of late years, especially in Europe, mechanical screens of fine mesh have been used and with more or less satisfactory results. Fine mesh screens not only remove the floating matter but also a portion of the more finely divided suspended solids, and in some cases they have been used in place of sedimentation tanks.

In America the best known mechanical screen is a cylindrical framework of steel, about 6 feet in diameter and 12 feet long, upon which wire-cloth of 40 meshes to the linear inch is fastened in removable segments. The wire-cloth is protected by a copper screen of larger mesh and heavier wire. This screen is revolved slowly and the wire-cloth is washed by the jets of water. The sewage enters at one end of the cylinder and, passing through the cloth, leaves behind the floating and some of the suspended solids. The screenings are carried by a worm to the outlet end of the screen where they can be collected and disposed of. For burning, the screenings can be dried in a centrifugal dryer and mixed with coal. This type of screen removes 15 to 20% of the undissolved solids contained in a sewage. It is a somewhat expensive operation and is unnecessary where tanks are used.

Settling Tanks.—Tanks with and without the aid of chemicals have been used for many years for the settling out of sewage solids. Plain settling tanks are those receiving sewage untreated by chemicals and from which the deposited solids or sludge are removed before very much decomposition has taken place. Usually they are built rectangular in plan with sloping floors for sludge drainage. In the design of sewers, it is the aim of the engineer to keep the cross-section small enough to prevent low velocities of flow, thereby preventing deposition; on the other hand, in the design of settling tanks it is essential to obtain as low a velocity as possible in order to increase the amount of sedimentation. The length of time that sewage stays in a tank is much less important than the velocity with which it flows through, provided the period of retention is not so great as to cause undesirable decomposition. A very efficient type of tank is that designed by Mr. Watson for Birmingham, England. This is a cylindrical tank with a conical bottom, the sewage enters above the bottom at the centre of the tank and, flowing upward, slowly passes out through wires arranged around the top of the tank. The solids settle out into the conical part and can be removed by the hydraulic head without interrupting the operation of the tank.

Tanks for chemical precipitation are of various shapes but are most frequently rectangular in plan and the addition of chemicals take place just before the sewage enters the tank. The chemicals commonly used are lime and copperas; these, when mixed, form a flaky precipitate which carries down the particles of suspended solids. In some cities where trade wastes from iron manufacture enter the sewage the amount of iron in the sewage is sufficient to give a good precipitate when lime alone is added. The tanks can be cleaned by draining off the supernatent tanks to the level of the sludge and the sludge removed by sludge pumps. The sludge in chemical precipitation tanks is very heavy and rather difficult to handle. Chemical precipitation has the advantage over plain sedimentation that it removes some of the non-settling solids as well as the settling. It is, however, more expensive.

The Function of the Septic Tank.—The so-called septic tank is an attempt to utilize the decomposing action of bacteria in reducing the amount of organic solids to be dealt with. The septic tank is similar in design to the plain settling tank, but it is operated with very infrequent removal of the sludge. The period of retention of the sewage in the septic tank is usually much longer than in the settling tank. After the sewage has been retained a short time the oxygen originally present is exhausted and the putrefactive bacteria which work best in the absence of oxygen, begin to break down the organic matter. The organic solids are decomposed into liquids and gases thereby becoming somewhat less in quantity. At one time it was thought that this action would prevent the forming of any sludge, but while there is some reduction in the quantity of sludge, it is much less than was formerly thought. Besides, when a tank of sewage is undergoing rapid decomposition bubbles of gas bring quantities of sludge to the surface, often forming a scum on the top of the tank as well as on the bottom. The effluents from septic tanks are often more offensive than those from plain settling tanks, due to products of putrefaction.

Within the past few years a two-story tank has been derived which attempts to combine the advantages of plain sedimentation of the settling solids with the sludge digestion by the septic process. Tanks of this type have been devised by Mr. Imhoff, of Essen, Germany, and are known as Imhoff tanks. These tanks are coming into general use both in America and abroad. The Imhoff tank is divided into two stories by a false bottom; the upper part serving as the sedimentation chamber and the lower part for the storage and digestion of the sludge. The false bottom is arranged into slits in such a way as to allow the settled solids to pass into the digestion chamber and yet not allow the gases or sludge to pass through into the sedimentation chamber. By this means the liquid passing through the tank remains practically unchanged by any septic action which takes place in the deposited solids. This type of tank is usually twenty to thirty feet deep and the decomposition of solids under head produces a sludge full of gas bubbles under pressure. When the sludge is withdrawn the gas expands and the resulting sludge is very porous and easily drained and dried.

Another development in tank treatment is the tank originated by Dr. Trans at Hampton, England. This tank not only removes settling solids, but a portion of the finely divided non-settling solids. This is accomplished by hanging plates in the sewage flow and on these surfaces aggregate the small particles of solids until a settling mass is formed which sinks into the sludge tanks. Like the Imhoff tank, the Trans tank has a separate compartment for sludge digestion, but unlike it, allows a portion of the flow to pass through this digestion chamber.

The Disposal of Sludge.—Whatever method of tank treatment is used, some means must be found to dispose of the sludge produced. Even the best sludge contains considerable amounts of putrescible organic matter and this organic matter, together with the high per cent. of water, renders the sludge problem somewhat difficult to solve. Part of the sludge treatment really takes place in the tanks due to the action of the bacteria in breaking down the organic compounds, but the removal of the water or drying of the sludge must take place outside. The sludge from deep tanks, where the sludge is drawn off under pressure, contains less water than that from shallow tanks, or that from tanks which have the supernatent water removed before cleaning. The best sludge will run as low as 75% moisture, but even then it is too wet to handle easily. Methods used for sludge drying are filter pressing, draining on sand beds and drying in centrifugal machines. Strictly speaking, these methods do not finally dispose of the sludge, but the dried sludge can be used for filling in low land or for fertilizer. Without drying, sludge can be disposed of by trenching the land and filling the trenches with wet sludge and eventually plowing the sludge underneath the soil. At Columbus, Ohio, the sludge is run into the river during the winter when the flow is sufficient to dilute the sludge without nuisance.

Although there are undoubtedly valuable fertilizer constituents in sewage sludge, the great difficulty in realizing this value is due to the high per cent. of water in even the dried material. To have value as a fertilizer it must not contain over 15% of water, and about the best that sludge-drying methods to date have been able to accomplish is 50% moisture. Probably the next few years will show developments in successful sludge utilization.

For the removal of dissolved organic solids, the earliest method is that of land irrigation. This method simply controls the flow of sewage over an area of land, this land being utilized for farming. Land irrigation given satisfactory effluents requires large areas of land, gives rise to nuisance from odors and flies, and on the whole is more costly than the modern methods. The sewage farms in Berlin cover about 43,000 acres, and those which are being abandoned gradually in Birmingham, England, 28,000. The financial aid realized from the sale of crops is not as great as might be expected and this method is generally going out of use.

A step in advance is the intermittent sand filter, as developed by the Massachusetts Board of Health. This filter consists essentially of a graded bed of sand or gravel, four or five feet in depth, well underdrained by lines of tile laid with open joints. Sewage applied evenly to the surface at regular intervals percolates through the bed and runs off in the drains. Bacteria and other micro-organisms form a jelly-like covering on the surfaces of the sand grains and in conjunction with the air present oxidize the impurities. It is necessary to operate this type of filter intermittently in order to admit the air required for oxidation. Although excellent results are obtained with intermittent filtration, the same objection holds as with land irrigation. For large plants this type is very seldom adopted now-a-days, although for small quantities and where high degree of purification is required, it is extremely useful.

The Contact Bed and Sprinkling Filter.—The experiments of the Massachusetts Board of Health with sewage filtration through coarse gravel, led to further investigation on a practical scale in England and two forms of filters of coarse material were developed, the contact bed and the sprinkling filter.

The contact bed consists of a tank filled with broken stone to a depth of 4 or 5 feet, the bottom being underdrained and devices for the control of the sewage flow provided. The method of operation is to fill the bed with sewage, allow it to stand full for a short period, then drain until empty; this process being constantly repeated. While standing full some of the solid matter is deposited upon the surfaces of the stone, and while draining the air admitted, aided by the bacterial films developed on the stone, oxidizes the organic matter. It is necessary to pass the sewage through two or more beds of this type successively to get a well-oxidized and stable affluent. The use of coarse material allows much larger quantities to be treated than with sand filtration, although in time the voids become filled with solids and the material has to be renewed. The affluent from contact beds is usually non-putrescible and inoffensive, but is not as good as that from a sand filter. Contact beds, however, can be operated at a rate of 500,000 gallons per acre per day, while the best a sand bed can do is 100,000 gallons. The cost of operation is also much less

A sprinkling filter is essentially a bed of broken stone 5 to 8 feet in depth, placed over a concrete floor. The floor is covered with an under-drainage system for the rapid removal of the affluents and for ventilation. The sewage is applied to the surface of the filter in the form of a fine spray through a series of sprinkler nozzles, spaced symmetrically over the bed, these nozzles being fed by a system of distribution pipes connected with some sort of dosing apparatus. In passing through the air the sewage absorbs oxygen, and as in the other methods described, the bacteria growing on the filter stones, use their oxygen to oxidize the organic matter. On account of the continuous application of sewage and the constant supply of oxygen, the rate of filtration with a sprinkling filter is very high, running from one to three million gallons per acre per day. Usually final settling basins are provided for after treatment with this type of filter.

These basins are needed to collect the solids which wash out from the filter at periodic intervals. Unlike the contact bed, the sprinkling filter does not require to have the filtering media renewed on account of the clogging because at certain times of the year the clogging solids are washed out naturally and the media becomes absolutely clear. If fresh sewage is applied to sprinkling filter very little nuisance arises from odor; with both sprinkling filter and contact bed previous tank treatment is usually adopted, the best type of tank being that which delivers the freshest sewage with the largest amount of settling solids removed.

None of the processes of sewage purification destroy completely the bacteria present in the sewage. Well-operated land irrigation areas and intermittent filters give the best grade of effluent but, as we have stated, are being largely superseded to-day by the more rapid methods. Under some circumstances it is desirable to obtain an effluent reasonably free from possible disease germs. In this case practical sterilization can be accomplished by the use of chemicals; hydrochlorite of lime or bleaching powder being most commonly used. This chemical, when dissolved in water, liberates active oxygen which is extremely efficient as a germicide. About 99% of the bacteria in sewage effluents can be killed by adding 75 pounds of strong bleacher per million gallons. Raw sewage can also be largely freed from bacteria by larger quantities of the bleach. Other methods have been proposed by sterilization, such as the use of ozone and of chlorine gas. The use of the former in sewage work is probably prohibited on account of its cost. There seems to be a good field for chlorine gas and several types of machines are devised for using liquid chlorine from cylinders.

STEEL WHEELS FOR MOTOR TRUCKS.

One of the most interesting developments in the steel casting business recently has been the increase in the use of steel wheels for motor trucks. Automobile engineers have turned their attention to steel because the high quality of wood required for truck wheels is being rapidly exhausted. Also, wood wheels cause a good deal of trouble by variation of size, and cannot be used successfully in very dry climates.

While the cast-steel wheel overcomes all of the above objections, it has the disadvantage of excessive weight, the development of cracks, and it is not as resilient as wood. The proper design of truck wheels of very thin section is helping to overcome this to a great extent, and a few steel casting concerns are building up a large business on cast-steel wheels.

The annual purchases of British electrical goods, exclusive of machinery, by Australia have risen within five years from £350,000 to £858,000; in the case of India, from £223,000 to £330,000; South Africa, from £99,000 to £307,000; New Zealand, £78,000 to £153,000; and Canada, £49.000 to £278,000; while the demand on behalf of countries outside the empire is hardly less remarkable, as exemplified by Japan, which last year purchased British electrical goods, exclusive of machinery, to £375,000, against £126,000 in 1908; Egypt, £395,000, compared with £23,000 in the former period; the Argentine, £268,000, contrasted with £148,000; and Brazil, £167,000, against £86,000. The United States last year bought British goods of this class to no less than £169,000, against only £9,000 five years ago.

TYPICAL SPECIFICATIONS FOR STEEL HIGHWAY BRIDGES.

THE Office of Public Roads of the United States Department of Agriculture has just issued a set of typical specifications for the fabrication and erection of steel bridges for highways. The bulletin, compiled under the direction of L. W. Page, is offered as a suitable guide for highway officials in fixing requirements to which bridge structure should be made to conform with a view to eliminating the prevalence of poorly constructed bridges, indicative of a lack of information on the part of highway officials concerning proper specifications for this class of work.

Two classes of bridges are considered under these specifications—those which carry suburban or interurban electric cars and those which carry highway traffic only. The former are designated as class A and the latter as class B bridges.

Types of Bridges.—It is recommended that the type of bridge employed be selected as follows:—

For spans up to 30 feet—rolled beams.

For spans from 30 to 40 feet—plate girders or rolled beams.

For spans from 40 to 80 feet—riveted low trusses or plate girders.

For spans from 80 to 200 feet—riveted high trusses.

For spans over 200 feet—pin-connected high trusses.

All parts of the superstructure except the floor shall be of rolled steel.

In computing the stresses the length of span for the trusses or girders shall be taken as the distance from centre to centre of the end bearings; and for the floor beams, from centre to centre of the trusses.

Width of Roadway.—For Class A bridges the clear distance between the centre line of the car tracks and the nearest truss shall be not less than 7 feet, and on one side the clear distance betwen the centre line of the car track and the truss shall be at least 12 feet. The width from centre to centre of trusses shall in no case be less than one-eighteenth of the span.

The clear head room for a width of 6 feet on each side of the centre line of the bridge shall be not less than 15 feet.

The ratio of depth of span shall be not less than the following: For rolled beams, 1/20; for plate girders, 1/12; for trusses, 1/10.

Loads.—The assumed dead load shall be not less than the total weight of the completed structure. The following unit weights shall be used in computing the dead loads:

Steel	490	pds. per cu. ft.
Concrete	150	" "
Brick	150	" "
Macadam	130	" "
Asphalt	135	" "
Sand or earth	100	" "
Stone	160	" "
Timber:		
Creosoted	5	pds. per ft. b.m.
Oak, untreated	4½	" "
Pine, untreated	4	" "

Class A.—For the floor and its supports and for the trusses of spans less than 50 feet in length the live load shall be assumed as follows:

On each car track a concentrated load of 24 tons evenly divided between two axles, spaced 10 feet centre to centre with wheels spaced 5 feet centre to centre on axles, shall be assumed to occupy a width of 6 feet on each side of the centre line; on the remaining floor surface, exclusive of sidewalks, a uniform load of 125 pounds per square foot and on sidewalks a uniform load of 100 pounds per square foot.

For the trusses of spans between 50 feet and 100 feet in length, a uniform load of 1,800 pounds per linear foot for each car track (assumed to occupy a width of 12 feet) and 100 pounds per square foot of remaining floor surface including sidewalks, shall be assumed. For the trusses of spans greater than 100 feet in length, the live load per linear foot for each car track and per square foot of remaining floor surface may be reduced, respectively, 50 pounds and 2 pounds for each additional 10 feet of span, provided that in no case shall these loads be reduced below 1,200 pounds and 80 pounds, respectively.

All class A bridges shall be assumed as also subject to the loading specified for class B bridges.

Class B.—For the floor and its supports and for the trusses of spans less than 50 feet in length, the live load shall be assumed as follows:

On any part of the floor surface a concentrated load of 15 tons on two axles spaced 8 feet centre to centre, with wheels spaced 6 feet centre to centre on axles two-thirds of the load on one axle, shall be assumed to occupy a space 16 feet in the direction of traffic by 12 feet at right angles to that direction. On the remaining floor surface, exclusive of sidewalks, a uniform load of 125 pounds per square foot and on sidewalks a uniform load of 100 pounds per square foot, shall be assumed.

For the trusses of spans between 50 feet and 100 feet in length a uniformly distributed load of 100 pounds per square foot of floor surface shall be assumed. For the trusses of spans greater than 100 feet in length the uniform load per square foot may be reduced 2 pounds for each additional 10 feet of span, provided that in no case shall the assumed live load be less than 80 pounds per square foot of floor surface.

Distribution of Stresses Due to Concentrated Loads.—In considering the concentrated load under Class A, each wheel load shall be assumed distributed over an area of floor surface 5 feet square. In considering the concentrated load under class B, each wheel load shall be assumed distributed as follows: For reinforced concrete floors, protected by a wearing surface, 3 feet in the direction of traffic by 5 feet at right angles to that direction; for wood floors at least 3 inches thick the distribution in the direction of traffic shall be neglected in designing the joists and the distribution at right angles to the direction of traffic shall be taken as 4 feet.

The top lateral bracing in deck bridges and the bottom lateral bracing in through bridges shall be designed to resist a lateral wind load of 300 pounds per linear foot, and one-half of this shall be treated as a moving load.

The bottom lateral bracing in deck bridges and the top lateral bracing in through bridges shall be designed to resist a lateral wind load of 150 pounds per linear foot.

Provision shall be made for stresses due to a change in temperature of 150°F.

For class A bridges provision shall be made for a longitudinal force equal to 20 per cent. of the weight of the heaviest electric train which could reasonably be expected to come upon the bridge.

Impact and Centrifugal Force.—The maximum live-load stress in each member shall be increased to provide for impact by an amount to be determined from the formula $I = \frac{100\,S}{L + 300}$, where

I = impact or dynamic increment due to the effect of moving loads;

S = computed live-load stress; and

L = loaded length of bridge in feet which produces maximum live-load stress in the member under consideration.

When curved tracks occur on class A bridges, the centrifugal force produced by two cars coupled together moving at 50 miles an hour shall be considered as an additional live load in designing the lateral bracing.

Proportions and Unit Stresses.—All members shall be so designed that the stresses coming upon them may be accurately computed, and shall be so proportioned that the sum of the maximum stresses produced by the loads herein specified shall not exceed the following amounts in pounds per square inch.

Axial tension on net section—16,000; axial compression on gross section—$16{,}000 - 70\frac{l}{r}$, where l is the length of the member in inches and r is the least radius of gyration of its cross section in inches.

For class A bridges no compression members shall have an unsupported length exceeding 100 times its least radius of gyration for main members, or 120 times its least radius of gyration for laterals. For class B bridges no compression member shall have an unsupported length exceeding 120 times its least radius of gyration for main members, or 140 times its least radius of gyration for laterals.

Bending stresses on extreme fibres of rolled floor beams, joists, and girders, 12,500; on extreme fibres of built-up girders, 16,000; and on extreme fibres of pins, 20,000.

Shearing—	
Pins and shop-driven rivets	10,000
Field-driven rivets	7,500
Plate-girder webs (gross section)	9,000
Bearing—	
Shop-driven rivets	20,000
Pins and field-driven rivets	15,000
Wall plates on concrete masonry (1:2½:5)	500
Wall plates on stone masonry (ashlar)	500
Wall plates on stone masonry (rubble)	400
Expansion rollers (per lineal inch)	500d

where d is the diameter of the roller in inches.

Alternate Stresses.—Members subject to alternate tensile and compressive stresses shall be proportioned to resist each kind of stress, and each stress shall be considered as increased by an amount equal to eight-tenths of the smaller stress in determining the sectional area. The connections shall be proportioned for the arithmetical sum of the stresses.

Combined Stresses.—Members subject to a combination of direct and bending stresses shall be designed so that the greatest unit fibre stress shall not exceed the allowable unit stress for the timber.

Counters.—Wherever the live and dead load stresses are opposite in character, only two-thirds of the dead-load stress shall be considered effective in counteracting the live-load stress.

For class A bridges counters shall be so provided and proportioned that an increase of 25 per cent. in the specified live load would not increase the unit stress in any member more than 25 per cent.

Net Section at Rivets.—In proportioning tension members the diameter of the rivet holes shall be taken ⅛ inch larger than the nominal diameter of the rivets.

Proportioning Plate Girders.—The flanges of plate girders shall be assumed to take all the bending moment, and the web shall be assumed to take all the shear. The compression and tension flanges shall have the same gross section.

The Floor System.—All floor beams shall be rolled or riveted steel girders and shall be rigidly connected to the trusses or side girders. They shall, when practicable, be placed at right angles to the direction of traffic.

All joists shall be rolled or riveted steel girders and shall be rigidly fastened to the floor beams. When wood floors are used, the joists shall be riveted to the webs of floor beams by means of connection angles. The spacing of joists centre to centre shall be not greater than 3 feet.

Wood floors shall be constructed of first-quality timber of the kind specified by the engineer in writing or indicated on his drawings. For oak floors the minimum thickness of plank used shall be 2½ inches, and for pine the minimum thickness shall be 3 inches. In no case shall the thickness of the floor plank be less than one-twelfth of the distance, centre to centre, between joists. All plank shall be laid with the heart side down at right angles to the direction of traffic. Spaces approximately ¼ inch shall be left between adjacent planks.

Wood floors shall be provided with a wheel guard on each side of the roadway. Wheel guards shall be constructed of timbers having a cross section of not less than 6 inches by 4 inches, spliced with 6-inch lap joints, and shall be securely bolted to the joists at intervals not to exceed 5 feet.

Adequate provision shall be made for draining all parts of the floor, and the water drained off shall go clear of all metal work.

Details of Design and Construction.—The minimum thickness of metal used in any part of the structure, except that used for fillers and other minor parts, shall be 5/16 inch. For class B bridges, however, this specification may be modified by the engineer in writing to permit the use of standard channels and I-beams having web thicknesses of less than 5/16 inch, provided that the modification is made as a supplementary clause to these specifications before the contract is awarded or is indicated on the engineer's general drawings.

Truss spans shall be given a camber by making the horizontal projection of the top chord longer than the bottom chord by 3/16 inch for each 10 feet of span.

All connections shall be designed to develop the full strength of the connecting members and shall be of the character indicated on the engineer's drawings or by the engineer in writing.

Angles subject to tensile stress shall be connected by both legs, otherwise only the section of the leg actually connected will be considered effective.

The neutral axes of connecting members shall meet in a point.

Rivets and Rivet Spacing.—Rivets shall be either ⅞ inch, ¾ inch, or ⅝ inch in diameter, except when used in minor parts.

The maximum pitch in the line of stress shall not exceed 6 inches or 16 times the thickness of the thinnest outside plate. The minimum pitch shall not be less than 3 inches for ⅞-inch rivets, 2½ inches for ¾-inch rivets, and 2 inches for ⅝-inch rivets. For plate girders the rivet spacing in the vertical legs of the flange angles shall be determined from the formula, $p = \frac{rh}{s}$, where p is the pitch in inches, r the permissible stress in one rivet in pounds, h the distance between lines of rivets in inches, and s the maximum shear in pounds at the section under consideration. In no case, however, shall the pitch exceed 4 inches.

The minimum distances from centre or rivet holes to the nearest edge shall be not less than 1½ inches, 1¼ inches, and 1 inch for ⅞-inch rivets, ¾-inch rivets, and ⅝-inch rivets, respectively. The maximum distance from any edge to the centre of rivet holes shall not exceed 8 times the thickness of the thinnest outside plate or 6 inches.

Unless otherwise specified in the engineer's drawings or by the engineer in writing, ⅝-inch rivets shall be used for all flanges less than 2½ inches wide, ¾-inch rivets for flanges between 2½ and 3½ inches, and ⅞-inch rivets for all flanges over 3½ inches wide.

At the ends of built compression members the pitch of rivets in the line of stress shall not exceed 4 diameters for a distance equal to twice the maximum width of the member.

The grip of rivets shall, in general, be not greater than 4 diameters. When it is necessary to make the grip greater than 4 diameters, the allowable unit shearing strength shall be decreased 1 per cent. for each 1/16 inch of additional grip.

Pin Connections.—All pins shall be sufficiently long to furnish full bearing upon the turned body of the pin for all connecting parts. All pins shall be secured by chambered nuts and the screw ends shall be sufficiently long to admit of burring the threads after the nuts are set.

No pin shall have a diameter less than three-fourths the width of the widest eyebar attached to it.

The several members attaching to a pin shall be so placed as to produce as little bending movement as practicable upon the pin; and they shall be held in place by means of filling rings.

All pin holes shall be so bored that when the pin is in place it shall be perpendicular to the axial plane of the truss, and each connecting member shall bear uniformly upon the pin. The diameter of the hole shall not be more than 1/32 inch greater than that of the pin.

Pin holes shall be sufficiently reinforced to distribute the stresses properly over the full cross section of the members. Where "pin plates" are used, they shall contain a sufficient number of rivets to transmit their proportion of the bearing pressure, and at least one plate on each side shall extend not less than 6 inches beyond the edge of the nearest batten plate.

Riveted tension members having pin connections shall have a cross sectional area through each pin hole 25 per cent. in excess of the net sectional area of the members. The sectional area of the metal between the pin hole and the end of the member shall not be less than 75 per cent. of the sectional area through the pin hole.

Batten Plates and Lattice Bars.—The open sides of compression members shall be stayed by batten plates at the ends and by diagonal lattice bars at intermediate points. Batten plates shall be used at intermediate points when, for any reason, the latticing is interrupted.

Batten plates shall have a thickness of not less than ¼-inch nor one forty-fifth the distance between the lines of rivets connecting them to the flanges. They shall have a width parallel to the axis of the member not less than the maximum width of the member.

Lattice bars shall have thickness not less than 5/16-inch nor less than one forty-fifth their unsupported length. They shall be inclined to the axis of the member at an angle not less than 60° for single latticing nor less than 45° for double latticing. Double latticing shall be riveted at the intersection points.

The width of lattice bars shall not be less than 2 inches nor less than on-sixth the width of the member of which they form a part.

Abutting ends in compression members shall be planed true to the angle of the joint and shall be sufficiently spliced on four sides to hold the connecting parts accurately in place. All joints in tension members shall be fully spliced.

Where splice plates are separated from the parts which they connect by intervening plates or fillers, the number of rivets on each side of the joint shall be increased by 33⅓ per cent. of the number theoretically required for each intervening plate.

The thickness of eyebars shall not be less than ⅝-inch nor less than one-seventh the width of the bar. Heads of eyebars shall be formed by upsetting and forging, and never by welding. The heads shall be so proportioned as to develop the full strength of the bar.

Eyebars shall be perfectly straight at the time they are bored, and all bars which work together as one member shall be piled, clamped together, and bored in one operation.

The eyebars composing a member shall be so arranged that their surfaces are not in contact. The inclination of individual eyebars to the axis of the member which they compose shall not be greater than 1 inch in 16 feet.

No rod shall be used which has a cross sectional area less than ¾ square inch.

All roads having screw ends shall be upset, previous to threading so that the net sectional area at the root of the threads shall be greater by at least 17 per cent. than the net sectional area of the rod.

Compression members shall be so designed that any part of segment of a member will be proportionately as strong as the member taken as a whole.

No web shall have a thickness less than one-thirtieth the distance between the lines of rivets connecting it to the flanges, and no cover plate shall have a thickness less than one-fortieth the distance between rivet lines.

Flanges of built members which have no cover plates shall have a thickness not less than one-twelfth the width of the outstanding leg.

Lateral System.—All lateral and portal bracing shall be made of shapes capable of resisting both compression and tension, and shall have riveted connections to the chords.

Laterals shall be as nearly in the plane of the axes of the chords as practicable. When eccentricity is unavoidable, however, provision shall be made for the maximum bending stresses which would be produced in the connections with the member fully loaded.

Portals for through bridges shall be as deep as the specified head room and depth of truss will permit. They shall consist of top and bottom struts and stiff intermediate bracing. All portals shall be provided with curved knee or corner braces.

Intermediate top struts in through bridges shall have a depth not less than that of the top chord, and, if the engineer so requires, they shall be provided with curved knee or corner braces.

End struts shall be provided at the ends of all bottom chords.

All deck bridges shall be provided at each panel point with sway bracing made of shapes capable of resisting both tension and compression. The sway bracing shall extend the full depth of the trusses, and at the end of the trusses ample provision shall be made for transferring all wind loads to the piers or abutments.

A substantial hand railing not less than 3½ feet high and of appropriate design shall be constructed on the outside of footwalks, or, when footwalks are omitted, at the outside of the roadway.

Expansion and Contraction.—Provision shall be made for all bridge structures to change in length owing to temperature changes at least ⅛-inch for each 10 feet of span, and joints shall be provided at such points in the floor and pavement as may be indicated on the drawings furnished or approved by the engineer.

For all beam and girder bridges expansion bearings shall be designed for motion to take place by sliding. For all truss bridges the expansion bearings shall preferably be provided with rollers or rockers, though for spans less than 80 feet in length the engineer may, in his discretion, permit the use of sliding bearings. All rollers or rockers shall have a diameter of at least 3 inches. In all cases the bearings shall be so designed that motion can take place in a longitudinal direction only, and shall be so placed at the time the bridge is erected that the shoe or bolster will occupy a central position on the bearing at the atmospheric temperatures specified by the engineer in writing.

Shoes or bolsters shall be so designed as to distribute the load over the entire bearing, and shall be securely stayed against lateral or upward motion by anchor bolts. Fixed bearings shall be rigidly anchored to the masonry.

Bedplates shall be designed to distribute the load over an area sufficiently great to keep the pressure upon the masonry within the hereinbefore specified limits. All bed and bearing plates on masonry shall be set on sheet lead not less than ¼-inch thick and the same size as the plate.

DESIGN FOR THE FOUNDATION OF 150-TON SHEAR-LEGS.

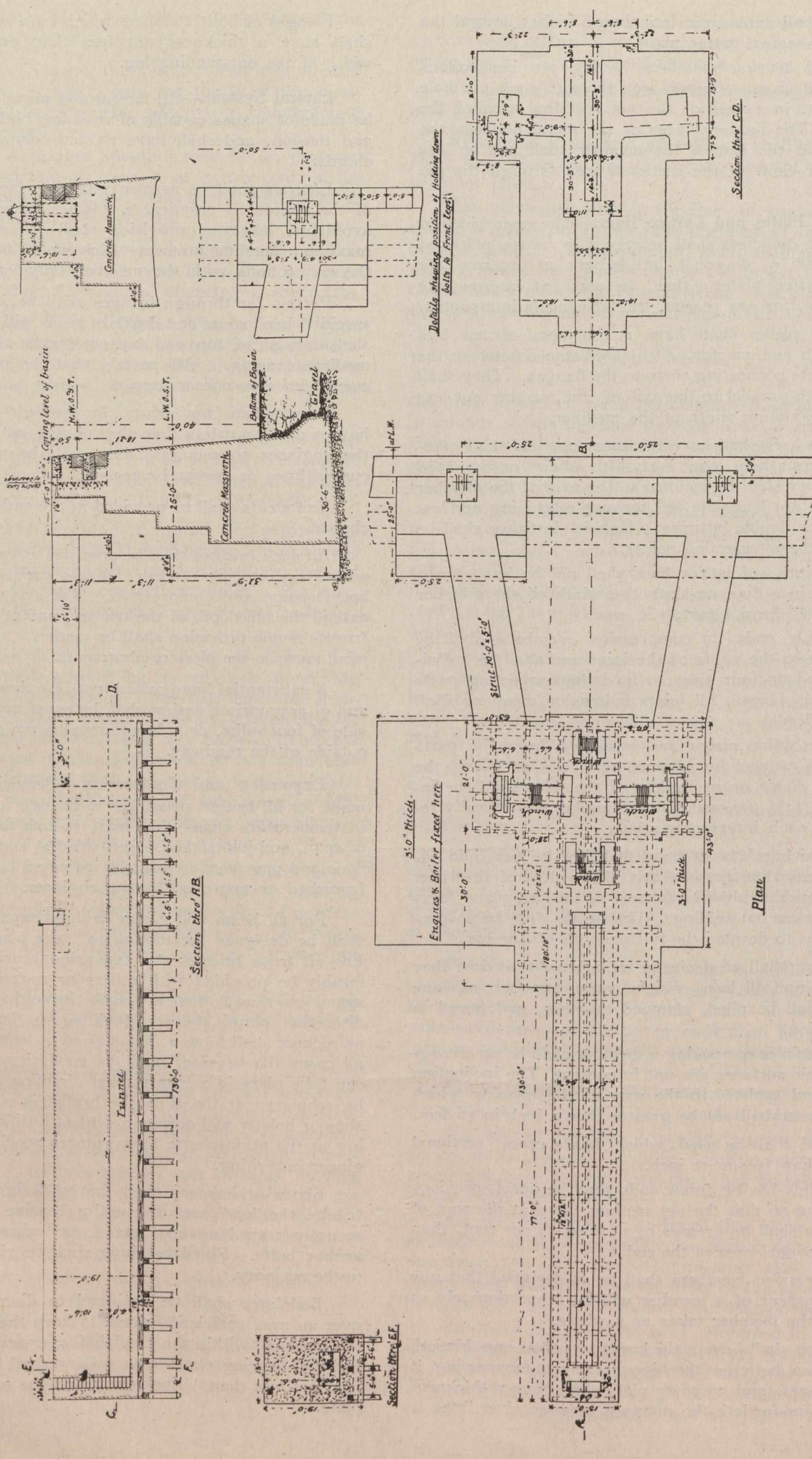

Fig. 1.—Foundation Details for 150-Ton Shears.

DESIGN FOR THE FOUNDATION OF 150-TON SHEAR-LEGS.

By Leonard Goodday, C.E., M.E.
Late of the British Admiralty.

A FEW years ago the writer was associated with the construction of some new docks and basin accommodation in England. The work included the design and erection of shear-legs for the support of hoisting tackle, a most essential factor in dock yards where heavy weights are to be hoisted over the side of a wharf or lowered to the deck of a vessel. Guns and heavy machinery are easily and comparatively quickly handled by this means, and this manner of hoist is also frequently used in "stepping" masts.

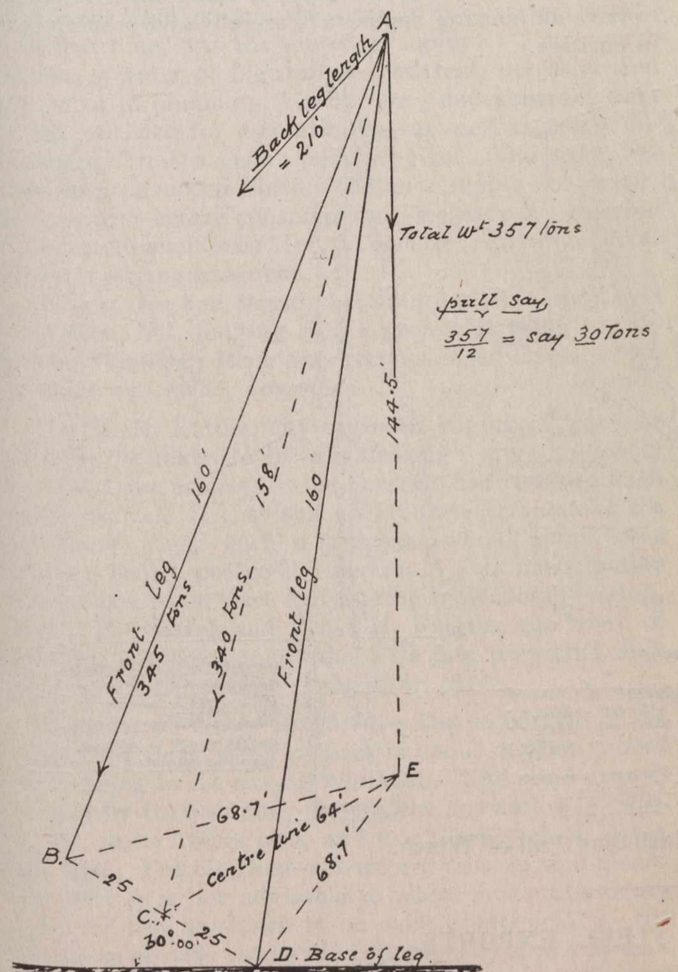

Fig. 2.—Isometric Sketch Showing Deduced Dimensions of Shear-legs.

The two front legs are necessarily close to the edge of the wharf; in the instance under consideration the distance therefrom being five feet. This necessitates a very solid wall and foundation, well tied in to counteract the outward thrusts from the toe of each front leg, while the rear leg is in compression. These foundations are connected to the concrete pit foundations for the back leg screw and thrust block gear by two counterforts, as shown on the plan in Fig. 1. The longitudinal and cross-sections illustrate the piling necessary in this particular case on account of the foundations resting upon "made" ground. The piles were carried down to gravel, as were also the foundations for the counterforts and basin wall, as will be seen in the drawing. Generally the back leg foundations are carried down in concrete unless the solid bed is of too great a depth, in which case footings, proportioned in size to the weight to be supported, would be used. Piling is not used unless absolutely necessary.

In the design the first step consists in fixing the maximum height required. This estimate is based upon the largest weight, the highest lift anticipated, the depth of load, and length of blocks, including tackle. The height, as shown in the diagram, of the case under consideration is 144 feet 6 inches, measured from the ground.

The necessary width between the footings for the front legs and the greatest overhang from the vertical are next deduced. These are found to be 50 feet and 64 feet respectively.

Referring to the isometrical sketch of Fig. 2: $\sqrt{CE^2 + CD^2} = \sqrt{64^2 + 25^2} = 68.7$ feet $= DE$; and $\sqrt{DE^2 + AE^2} = \sqrt{68.7^2 + 144\frac{1}{2}^2} = 160$ feet $= DA$, which is the length of front leg from point D to point A. $\sqrt{CE^2 + AE^2} = \sqrt{64^2 + 144\frac{1}{2}^2} = 158$ feet $= CA$. (See Fig. 2).

The weight of one front leg is arrived at by computing the volume from the dimensions given and the weight at 20.5 lbs. per sq. ft.

Weight of front leg	=	51,520 lbs.
Weight of four ribs	=	9,280 lbs.
Weight of blocks	=	13,120 lbs.
		73,920 lbs. or 33 tons, approximately, (2,240 lbs.).

Allowing for the weight of end blocks, etc., the estimate for each front leg may be considered 40 tons.

The weight of the back leg will be found by proportion to be 52 tons, its length being 210 feet.

The load increased by 50% over load is considered as a test weight = 150 + 75	=	225 tons
Tackle - - - - - - - - -	=	10 tons
Half the weight of the front legs (considered twice) - - - - - - - -	=	40 tons
Half the weight of the back leg - -	=	26 tons

making a total approximating 300 tons.

In considering the blocks themselves the double "purchase" must be taken into account, the test weight being $\frac{225}{12} = 19 \times 2$ = 38 tons

Friction, etc. (reckoned at 50%) = 19 tons

making a total of 57 tons, double "purchase," and a grand total of 357 tons, as the weight. The pull would therefore approximate 30 tons, or 1/12 of this.

Resolving the load when overhanging 64 feet, the tension on the back leg reaches 350 tons, and on the front legs 680 tons thrust, or 340 on each, if both were on the centre line (for calculation only), and 345 tons on each when splayed 50 feet apart at base.

Taking the pull into account, a block of concrete of sufficient weight to resist the tension of the back leg at its foot when the weight is at its greatest overhang, 64 feet, must be of the following depth:

$$\frac{189 \text{ tons, vertical pull, } \times \text{ 16 cu. ft. per ton of concrete}}{32 \text{ feet, length, } \times \text{ 13 feet width}}$$

$= 7.3$ feet. Therefore, the dimensions of the block might be 32′ 0″ × 13′ 0″ × 7′ 6″ depth.

This gives 3,024 cubic feet of concrete required. In the actual case the chosen depth of the block was 10′ 6″, affording an excess volume of 1,344 cubic feet.

The front leg thrust equals 315 tons; 285 tons vertically and 140 tons horizontally. The sectional area of the top block of the counterfort, about 11′ 3″ below the coping, as shown in the diagram, is about 400 sq. ft. (dimensions 16 × 25). This gives, therefore, 0.35 tons per sq. ft. as the force tending to cause the block to slide. As 1 ton per sq. ft. is safe against this shearing, the factor of safety is sufficient.

Referring again to the diagrams of Fig. 1, one shows the shear-legs run in until the weight hangs over the centre of the track. The stresses at intervals from Fig. 1, 1a to 7, as the thrust block is run backward on the screw, are given. In this case the pull from the winches is taken into account, thereby increasing these stresses. At the points 1a to 7 are shown the resultant vertical stresses, 26 tons, or one-half the weight of the back leg being deducted when the leg is in tension, and added when in compression. This gives the lines *BC* and *CD* when in compression and tension respectively, *C* being the neutral point.

The diagram thus supplies the following data: The block 37′ 0″ in length represents the amount of concrete affected, which also must shear before failing. The pyramid is really a trial block giving a factor of safety of 3.

There are 1,200 cubic yards of concrete in each counterfort wall of the actual case to which this design applied. This includes the basin wall between it and its face. The concrete for the back leg foundations and the two connecting struts amounts to 1,180 cubic yards.

The plan in Fig. 1 also shows the position of boiler, engines and steam winches. They are equipped with centre tunnels, as shown, to provide access to bolts and plates in their foundation beds, it being most important to have all hoisting apparatus carefully and properly fixed in position.

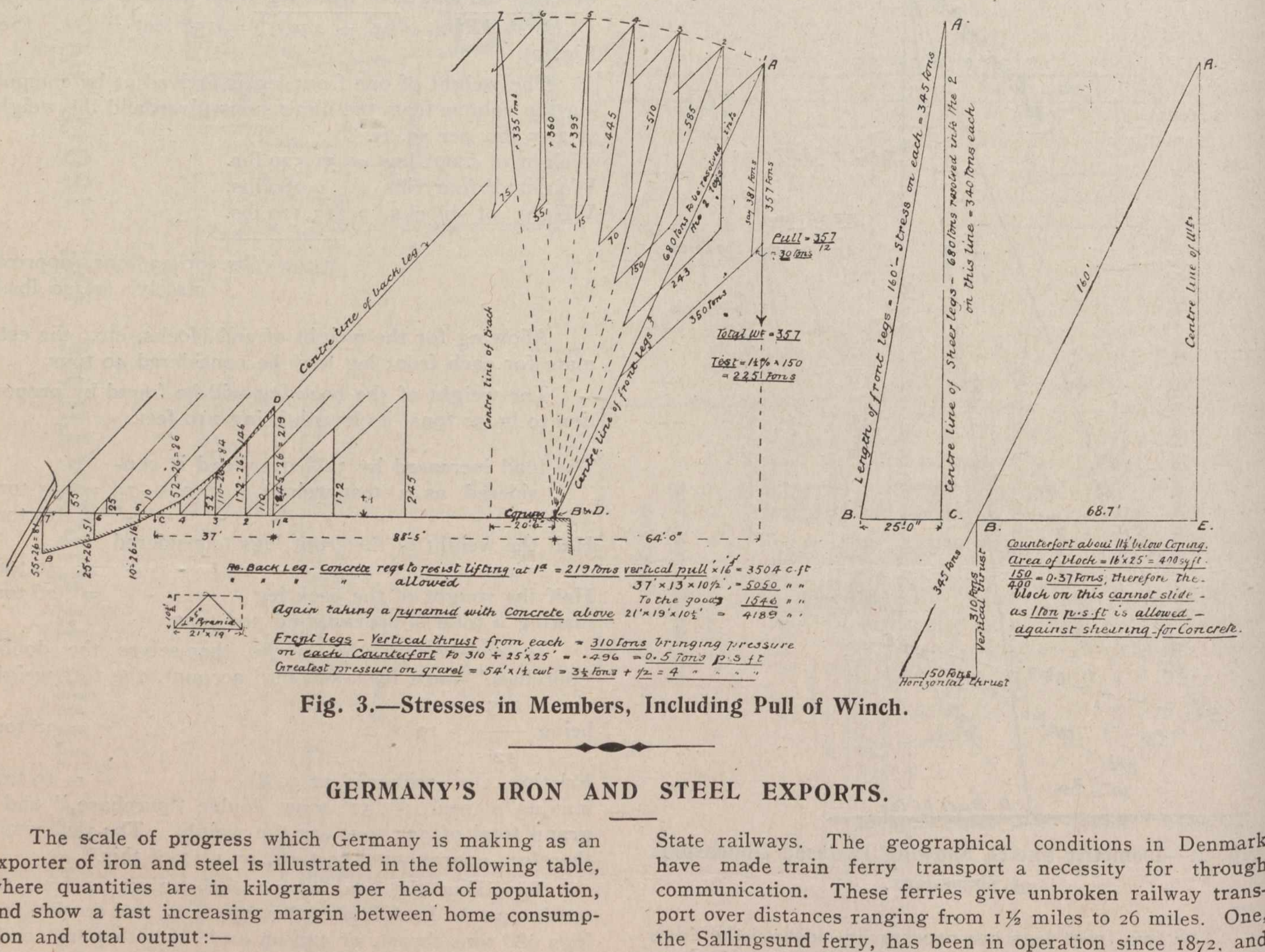

Fig. 3.—Stresses in Members, Including Pull of Winch.

GERMANY'S IRON AND STEEL EXPORTS.

The scale of progress which Germany is making as an exporter of iron and steel is illustrated in the following table, where quantities are in kilograms per head of population, and show a fast increasing margin between home consumption and total output:—

January to May.	Output of blast furnaces.	Home consumption.
1907	85.87	60.64
1908	81.77	52.83
1909	81.69	51.50
1910	92.95	56.28
1911	98.60	59.71
1912	107.83	62.88
1913	119.13	68.08

The most notable example of existing train ferries in Europe are those which have been established by the Danish State railways. The geographical conditions in Denmark have made train ferry transport a necessity for through communication. These ferries give unbroken railway transport over distances ranging from 1½ miles to 26 miles. One, the Sallingsund ferry, has been in operation since 1872, and that across the Storabelt, at a point where the arm of the sea is 16 miles wide between Korsoer and Nyborg since 1883. There is a train ferry between Copenhagen and Malmoe, a distance of 19 miles. The longest of the ferries, that which crosses the Baltic between Warnemunde and Gjedser, carries trains for 26 miles over waters where heavy seas are not infrequent. Some of the Danish ferries provide uninterrupted railway communication only between the separated parts of Denmark; others, of which that from Gjedser to Warnemunde is the most important, provide through railway connection with the railway systems of Europe, with all the accompanying advantages of unbroken goods and mail transport and sleeping-car accommodation for passengers.

A WATER SUPPLY FOR WINNIPEG

A REPORT CONCERNING SHOAL LAKE AS A SOURCE OF SUPPLY FOR THE GREATER WINNIPEG WATER DISTRICT—BY AN OFFICIAL BOARD OF CONSULTING ENGINEERS.

WINNIPEG'S chief problem is that of water supply, and municipal authorities have for years been studying the question of a sufficient supply of safe and desirable water for domestic and industrial use. A year ago *The Canadian Engineer* (issue of Sept. 19th, 1912) published, in part, a report presented by Prof. C. S. Slichter, of Madison, Wis. Shoal Lake was recommended by him in preference to the other possible sources, viz., Winnipeg River, the Poplar Springs, the Crystal Springs, and the artesian well system which, up to that time, was the source of supply. This source provided a water of high mineral content, corrosive and destructive to plumbing, boilers, etc., and generally considered too hard for domestic use, as well as being unsatisfactory from a health point of view. The report referred to pronounced Shoal Lake as a supply not requiring treatment before consumption. Readers are referred to the article mentioned for a concise résumé of Prof. Slichter's recommendations.

This source had already been suggested in 1907 by a commission, but, judging such a project as being too expensive, Winnipeg River was recommended instead. No procedure was made, however.

Mr. H. N. Ruttan, city engineer, suggested last year that steps be taken to have a thorough investigation of the Shoal Lake project, as the question had resolved itself largely into one of cost and an accurate estimate of the expenditure which such a proposal would entail, was necessary before proceeding further. This investigation has been carried on since early spring by Rudolph Hering, Frederic P. Stearns and James H. Fuertes, the board of consulting engineers, and who have just presented their report, which we publish herewith in part:

Quantity of Water Required.—The population of the Greater Winnipeg water district is about 225,000, about 200,000 being in the city of Winnipeg. The rapid growth is shown by the fact that the present population is twice that of seven years ago, and five times that of fifteen years ago. The city and district are now so well established that it is not advisable to adopt a hand-to-mouth policy if it can be shown to be more economical in the long run to provide works of large capacity at the present time. The population of Winnipeg and the amount of water supplied in each year beginning in 1902, is given in Table I.

Year.	Population as shown by assessment records.	Water supplied per day* Imperial gallons.	Imperial gals. per inhabitant.
1902	48,411	1,550,000	32
1903	56,741	1,860,000	33
1904	67,262	2,340,000	35
1905	79,975	3,280,000	41
1906	101,057	3,500,000	35
1907	111,729	4,580,000	41
1908	118,252	4,880,000	41
1909	122,390	5,820,000	48
1910	132,720	5,930,000	45
1911	151,958	6,510,000	43
1912	166,553	7,750,000	47

*The table does not include the small quantity of water pumped at the high pressure fire station for other than fire purposes.

This table shows that the amount of water used per inhabitant is increasing, which is a result to be expected with the increase in the facilities for using water and one which accords with the experience of other cities. The increase is likely to continue until it reaches about double the present amount now used per inhabitant, if the present meter system of selling water is continued, as we believe it should be, or a much larger quantity provided the water is not metered to the consumers.

We believe that 85 gallons per inhabitant is a proper quantity to adopt for estimating the future needs of the district as an average for the year, but in some months the rate will average as high as 100 gallons per inhabitant. Therefore an aqueduct to provide for a considerable time in the future should, in our opinion, be designed with a capacity of 100 gallons per inhabitant, and even with this provision a large reservoir should be built near the city, in the future, to provide for a still higher rate of water consumption during short periods.

The consumption of water at the present time is somewhat restricted by the limited capacity of the sources of supply and will undoubtedly increase to a considerable extent when a new supply with a better water is furnished. For the next ten years, however, the consumption is likely to be less than 85 gallons per inhabitant.

As already indicated, we have found that the best structure for conveying water for the greater part of the way from Shoal Lake to Winnipeg is a concrete aqueduct laid with a continuous down grade, and as such a structure can be built of large capacity for a moderate additional cost, we have designed this structure to carry 85,000,000 gallons in 24 hours, sufficient, on the basis assumed, for a supply throughout the year for 850,000 inhabitants.

This may seem to be an unnecessarily large provision for future years, but it must be born in mind that the additional cost of making such a structure of liberal size is comparatively small while the cost of duplicating such an aqueduct would be large.

We adopted the capacity of 85,000,000 gallons daily after giving due consideration to the many demands for money for public works in a growing city like Winnipeg; otherwise we should have recommended a larger aqueduct, say one having a capacity of 100,000,000 gallons in 24 hours.

From the point near Transcona where the concrete aqueduct ends, to the existing McPhillips Street reservoirs, a pipe is recommended; and a single pipe line of the sizes which now seem desirable will convey by gravity 25,000,000 gallons of water in 24 hours, or nearly three times the quantity of water now used. When necessary, the flow through this pipe can be increased by pumping, or a second pipe can be laid.

Assuming a continuous growth for the Greater Winnipeg Water District, based upon the past growth of the district and the rate at which other somewhat similarly situated cities have grown, the 85,000,000-gallon aqueduct would have sufficient capacity for supplying the district until 1944. Assuming further the introduction of water from Shoal Lake at the earliest practicable date, the aqueduct would supply the requirements of the district for about 25 years after its completion, and the 25,000,000-gallon pipe line would supply by gravity the quantity of water required for two or three years; but, as already stated, the capacity of the pipe line can be increased by pumping.

Quantity of Water Available from Shoal Lake.—Shoal Lake has a drainage area of about 360 square miles and a water surface of 107 square miles, and is at the same level as the Lake of the Woods, with which it connects at Ash Rapids. No direct measurements of the quantity of water which this lake will furnish have been made, but the probable quantity of water may be inferred from the amount of rainfall in this vicinity and the size of the drainage area and of the lake surface.

Shoal Lake, if separated from the Lake of the Woods, would derive its supply from the rainfall upon the surface of the lake and upon the land included in its drainage area. The rain which falls upon the surface of Shoal Lake is offset in part by the evaporation from the lake, but under all ordinary conditions there is probably a considerable supply to the lake from the excess of the rain over the evaporation. A part of the rain which falls upon the land surrounding the lake is lost by evaporation from the surface of the ground, but such evaporation is not as great as from the lake surface, so that there is a larger yield of water per square mile from the land surfaces.

Shoal Lake is so large that in case the supply to it in any year were unusually small, water stored in it in previous years could be used to make up the deficiency. For example, the quantity of water in a single foot of Shoal Lake is equivalent to about 8.5 months' supply for 850,000 people, at the per capita rate of water consumption before stated.

Quality of Water in Shoal Lake.—Physical and chemical examinations of water taken from Shoal Lake show that it is practically free from contamination, that it is clear and practically without color and that it is free from odor and has an agreeable taste. It is very soft in comparison with the water at present supplied to Winnipeg, and was, at the time we examined the water, of excellent quality for a domestic water supply. The chemical analyses show that it is well suited for boiler and general manufacturing purposes.

Microscopic examinations of the water show, as is the case with the water of all lakes and reservoirs, that the water contains a variety of minute animal and vegetable organisms which can be discerned with the microscope and some of them with the naked eye. The total number of organisms per cubic centimeter has ranged from 249 to 1,776, and averaged 833, which is no more than the amount usually found in small lakes and the better class of reservoirs used for water supplies.

So far as the examinations have been carried, the water has had no disagreeable taste or odor at any time, but it is sometimes the case that these minute organisms increase greatly in numbers and give the water a pondy or even a disagreeable taste. This is not as likely to be the case in large lakes as in small ponds and artificial reservoirs. Many cities take water from the Great Lakes, from Lake Superior to Lake Ontario, and there has been no complaint from bad taste or odors from such waters, although they are not free from microscopic organisms.

There are many other reservoir supplies which contain a much larger number of organisms than has been shown by the recent examinations of Shoal Lake water, and which are nevertheless used without serious complaint on the part of the water takers.

We cannot, in the absence of definite knowledge as to the history of Shoal Lake water, affirm that growths will not occur to cause at times unpleasant tastes and odors, but the results of recent observations and all of the conditions indicate that troubles from bad tastes and odors should be infrequent, and not very serious, if they occur at all.

Having made such an extended reference to these organisms, we wish to state positively that they have no relation whatever to disease germs and there is no evidence that they render the water unwholesome.

Should is ever become desirable to filter the water, either completely, or to the more limited extent required to remove the microscopic and larger organisms, this can be provided for at the site of the proposed reservoir east of Transcona, where an opportunity is also presented for the aeration of the water should this be found advantageous.

Description of Proposed Works.—The main features of the work for immediate construction are:

1. A dyke and channel for the diversion of the Falcon River into Snowshoe Bay.

2. A concrete masonry aqueduct, having a continuous down grade for 84.73 miles from an intake at Indian Bay to a point just south of the Grand Trunk Pacific Railroad, about one mile east of Transcona, the aqueduct having a capacity of 85,000,000 gallons of water daily.

3. A pipe 5 feet in diameter, extending from the end of the masonry of the concrete aqueduct, most of the way through streets to Victoria Park on the west side of the Red River in Winnipeg, this pipe to be of steel except under the Red River, where cast-iron pipe laid in a tunnel is recommended.

4. A 48-inch cast-iron pipe through the streets of Winnipeg from Victoria Park to the McPhillips Street reservoirs. The pipe line will, as stated, have a capacity of 25,000,000 gallons daily.

Estimates of Cost.—Detailed estimates of the probable cost of construction, excluding land acquisition, installations of branch pipes to adjoining communities along the line, water damages, interest charges, etc., are summarized in the report as follows:

85 miles of construction railway	$1,020,000
Clearing	55,000
Ditching	90,000
Telephone line	25,000
12,000 lin. ft. 4-foot cast iron pipe from McPhillips Street reservoirs to Victoria Park at $23.17	278,000
900 lin. ft. tunnel under Red River, including the shafts and the 5-foot cast-iron pipe laid in shafts and tunnel, at $144.44	130,000
43,200 lin. ft. 5-foot steel pipe, extending from the easterly shaft of the Red River tunnel to the junction with the concrete aqueduct about one mile east of Transcona, at $20.74	896,000
447,300 lin. ft. concrete aqueduct, extending from the end of the stel pipe to Indian Bay, with all appurtenances, at $19.51	8,729,000
Falcon River diversion	121,000
	$11,344,000
Add for administration, engineering and contingencies, 15 per cent.	1,701,600
Total estimated cost	$13,045,600

The annual cost of maintenance of the aqueduct and the expense connected with its operation is estimated at $40,000.

Conclusions.—"Briefly summarized the conclusions and recommendations are as follows:

"1. Shoal Lake, without help from the main Lake of the Woods, can be depended upon to furnish, even in the driest years, a large part, if not all, of the water needed for Winnipeg until the population shall have reached about 850,000, and with the help of the Lake of the Woods can furnish a practically inexhaustible supply.

"2. The water of Shoal Lake was, when we examined it, of excellent quality for domestic and manufacturing purposes, being soft, practically free from contamination, without noticeable color, free from odors and of an agreeable taste. The results of recent examinations of the Shoal Lake water, and all of the local conditions, indicate that the occurrence of bad tastes and odors in the water, from growths therein, should be infrequent, and may never occur at all.

"Should such troubles occur in the future the opportunity to correct them by suitable treatment may be availed of when necessary without interrupting the supply of water to the city or making expensive changes in the works as built.

"3. The best point to take the water is from near the west end of Indian Bay, an arm of Shoal Lake, as the depth of the water and the configurations of the bottom and shores in this neighborhood are favorable.

"4. In order to avoid the dark colored water discharged by Falcon River, and cut off the shallow flowage at the extreme westerly end of Indian Bay, we propose the construction of a dyke across the end of the bay and a canal leading therefrom to Snowshoe Bay, through which to divert the undesirable waters.

"5. We find that the best way to get Shoal Lake water to Winnipeg is to bring it down first through a concrete aqueduct 84.75 miles in length, laid with a continuous down grade to a point about a mile east of Transcona, and then in a 5-foot steel pipe to the Red River. A 5-foot cast-iron pipe, in tunnel, is to convey the water under the river, and thence a 4-foot cast-iron pipe, laid in the city streets, will deliver it to the reservoirs at McPhillips Street. The total length of the aqueduct is 95.35 miles.

"6. We recommend that the concrete portion of the aqueduct be given a capacity of 85,000,000 imperial gallons per day, but that the pipe line portion be given the smaller sizes above stated, capable of discharging 25,000,000 gallons per day by gravity into the McPhillips Street reservoirs.

"7. We recommend taking the water out of Shoal Lake by gravity rather than pumping it over the summit in pipe lines.

"8. We estimate that the total cost to the Greater Winnipeg Water District of building the intake, Falcon River Diversion Works, concrete aqueduct and steel and cast-iron pipe lines, including crossings of streams and rivers, waste weirs, and other appurtenant works, will be $13,045,600.

"This estimate does not include the cost of acquiring land, or of branch pipes to the different communities; neither does it include any allowance for water damages, and for interest charges.

"9. We recommend as a part of the plan, but not for immediate construction, that a new storage reservoir, holding about 250,000,000 gallons, and estimated to cost between $300,000 and $400,000, be built at a point about a mile east of Transcona, and that a main pumping station be there established to force the water to the city through the 5-foot steel pipe, and through branches to be laid to the different sections of the city and district requiring the water. This reservoir and pumping station should be completed and ready for use before the demands for water shall have reached the capacity of the pipe line."

It remains to state that the report has been adopted by the administration and work will proceed without further delay, Winnipeg thus hoping to have, at the end of the five years which it will take to install, a healthful and plentiful water supply.

THE POWER PLANT OF THE CALCUTTA ELECTRIC SUPPLY COMPANY.

There is probably no local undertaking which has contributed more to the comfort and well-being of the residents, in a climate like that of Calcutta, than the supply of electricity for lighting and power purposes. The supply was first started in Calcutta in 1899 from a small non-condensing station. The advantages of electricity were quickly realized, and extensions have been found necessary from time to time. Although branch power stations have been erected at Alipore, Ultadanga, and Howrah, the demand has increased so regularly that it was found necessary to go further afield for a suitable site, one essential being that there should be an ample supply of water for condensing purposes.

The site now used is situated on the banks of the Hooghly at Cossipore, about two miles north of Calcutta, and it is large enough to allow for any further extensions that may be necessary. The distance of the generating station from its main area of supply made a high-tension scheme necessary, the generating being done at a pressure of 6,600 volts, supplying power to various substations in the city.

In the main building there are three 4,000 b.h.p. Oerlikon turbine-driven alternating generators, one mixed pressure turbo of 1,000 b.h.p., and one motor convertor of 600 b.h.p. In the wing are being erected four interpole direct current generators by Crompton and Company, driven by Bellis and Morcom engines of 600 b.h.p. The turbines, of the impulse type, are particularly remarkable for the simplicity of the governing arrangements by which the speed is kept absolutely constant automatically, and can be raised or lowered from the switchboard. The bearings are also self-oiled under a pressure of 60 lbs. of oil, and are so arranged that any interference with the oiling arrangements will immediately bring the machine to rest without damage. The mixed pressure turbine can be used to work from the exhaust steam from the Bellis and Morcom engines, or live steam from the boilers, or a mixture of both, as required.

The switchboard arrangement is a unique piece of work, being fitted with the very latest pattern switches and recording instruments.

In the boiler-house there are five water-tube Stirling boilers, each of the rapid evaporative capacity of 25,000 lbs. of water per hour, at a working steam pressure of 175 lbs. per square inch, with a grate area of 105 square feet and 5,856 square feet of heating surface. They are fitted with the automatic underfeed system of mechanical stokers. In this method of firing the green coal is fed from below and distributed from the centre over the sides of the fire-grates into ash trays which are dumped periodically. Unscreened slack coal of a low grade is being burnt quite smokelessly, even though the chimney is only 100 feet high. When completed the station will have some 18 of these machines installed, capable of burning 300 to 350 tons of coal each 24 hours. Forced draught is used, and there are installed Green's Economizers of 750 tubes in six blocks, three on each side, being in series, with a total heating surface of 7,200 square feet.

DISTRIBUTION OF EXPENDITURES ON COLEMAN TOWNSHIP ROADS FOR SEASONS 1909, 1910, 1911, 1912.

THE following table is an indication of the development of roads in the Cobalt-Haileybury region of the province. The records of expenditures for highway improvement made by the township of Coleman are quite complete as indicated by the data, which we have obtained from the report for 1912 of the township engineer.

Name.	1909.	1910.	1911.	1912.	Total.
Timiskaming Road:					
(a) Overhead Bridge to Giroux Lake Corners	$ 8,328.96	$ 2,592.70	$ 3,136.68	$ 987.80	$ 14,956.14
(b) Giroux Lake Corners to Drummond Siding	(no record)	800.00	nil	2,041.03	2,841.03
(c) Drummond Siding to Timiskaming Mine	4,944.07	1,397.67	4,531.92	8,240.18	19,113.84
Nipissing Road	5,393.27	1,563.12	2,405.74	800.00	10,162.13
Kerr Lake Majestic Road	4,145.03	1,357.00	1,003.25	1,062.60	7,567.88
Cobalt Central Road	2,500.55	1,199.15	nil	1,610.97	5,310.67
King Edward Road	2,252.26	3,005.03	nil	nil	5,257.29
Kerr Lake Road	500.00	2,353.14	nil	1,174.44	4,027.58
Ophir Road	1,365.13	1,866.51	1,475.11	nil	4,706.75
Foster-Savage Road	204.10	2,342.25	625.91	nil	3,172.26
Haileybury Road, Coleman	nil	872.38	3,473.16	nil	4,615.54
"104" Road	nil	2,457.88	51.82	nil	2,509.70
Coleman Firstbrook Road	1,904.22	933.13	891.56	4,091.07	7,819.98
Latchford Road	nil	1,548.80	18,413.24	5,425.98	25,388.02
McKinley-Darragh Road	nil	1,133.04	1,000.00	837.67	2,970.71
Cobalt Town	nil	(no record)	5,161.59	8,555.07	13,716.66
Portage Bay Road	nil	nil	nil	1,290.88	1,290.88
Gillies Depot Road	nil	nil	nil	883.62	883.62
West Cobalt Ditch	nil	nil	110.38	64.03	174.41
Cart Lake Road	nil	nil	nil	887.62	887.62
Waterworks Extension	nil	nil	nil	3,378.96	3,378.96
Short Street	nil	nil	nil	134.12	134.12
Giroux Lake School Grounds	nil	nil	nil	129.32	129.32
Cobalt Athletic Grounds	nil	nil	150.00	352.34	502.34
Tool account	nil	(no record)	1,240.84	1,864.45	3,105.29
General maintenance	nil	316.08	654.24	2,991.85	3,962.17
Sidewalks	nil	(no record)	521.98	958.94	1,480.92
Giroux Lake walks	nil	nil	nil	1,593.02	1,593.02
Haileybury Road in Bucke	nil	nil	613.43	14,141.24	14,754.67
Cemetery Road	nil	nil	436.08	nil	436.08
Street on Silver Queen	nil	nil	165.37	nil	165.37
Streets in "104"	nil	598.04	nil	nil	598.04
Total	$31,537.59	$26,335.92	$47,062.30	$63,497.20	$168,433.01

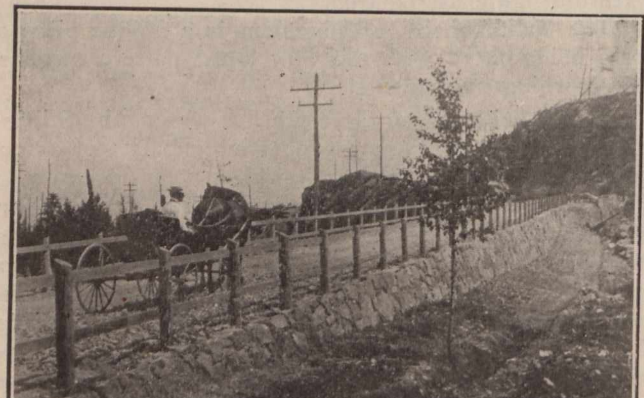

Fig. 1.—Cobalt-Haileybury Road, Showing Permanent Wall Construction.

Fig. 2.—Section of Roadway Typical of Difficulties in the Construction of Northern Roads.

In his report of work accomplished during 1912, Mr. H. T. Routley, until recently township engineer, outlines in a very interesting way the methods of construction, and data relating to them, of some important roadways in the township. An interesting feature of the report is the exceedingly small requirements for maintenance and repair of the main roads in comparison with conditions pertaining to the cheaper earth roads. The divergence in cost is explained by the fact that all main roads during the past three years were laid with water-bound trap-rock macadam. The rainy season of 1912 is stated to have forcibly demonstrated the fact that where a road is being

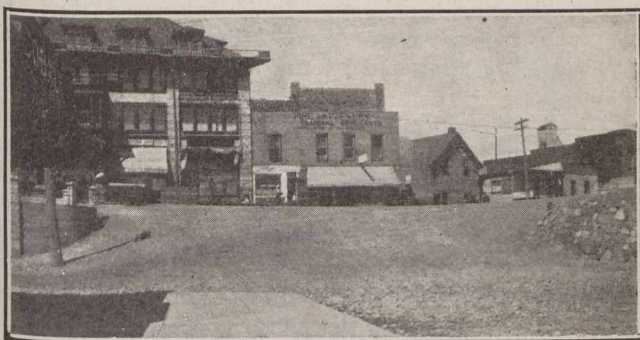

Fig. 3.—The "Square," Cobalt, Showing Rocmac Pavement.

constructed for continuous traffic, the best soon asserts itself to be the cheapest. During the greater part of this period it was impossible to keep the unsurfaced earth roads in Coleman township, and throughout the district generally, in good condition, while the main roads, which were properly surfaced when constructed, were in excellent shape throughout the entire unfavorable season.

A few of the difficulties encountered in the construction of these roads is best described by illustrations as

Fig. 4.—Cobalt-Latchford Road.

shown herewith. Fig. 1 illustrates a piece of permanent wall construction on the Cobalt-Haileybury Road. During the year about 2,000 feet of retaining walls from 5 to 10 feet in height were constructed for this purpose.

With the exception of a very small piece of work the construction of these roads and other development work has been done directly on the day-work system. The plan followed was that of engaging carefully picked men and retaining them season after season.

PROGRESS IN THE INVESTIGATION OF THE WATER POWERS OF BRITISH COLUMBIA.

THE fourth annual report of the Commission of Conservation contains the report of its consulting engineer, Mr. Arthur V. White, respecting the work that was accomplished up to the close of 1912, in the Commission's investigation of the water-power resources of British Columbia. As stated some little time ago in *The Canadian Engineer*, Mr. White and his men are at present engaged in a continuation of the undertaking.

According to the report no other province of Canada is confronted with the problem of adjusting so complex a water situation as exists in British Columbia. In the early "fifties," water rights and privileges for mining operations began to be taken up, and, subsequently, other rights and privileges were granted for irrigation in connection with the development of large agricultural areas. All of these rights are now represented by upwards of 5,000 water records, issued under various terms and conditions. In addition, there are others, given later, for water-powers. The applications for waters for all purposes are on the increase. The whole situation is a difficult one, and, until adjudication upon conflicting interests can be had, patience and consideration will be required on the part of the record-holders, and caution, wisdom and courage on the part of the administration. These problems are now being dealt with by the Provincial Government.

The co-operation which the Commission is receiving from the province is worthy of much commendation. Through the Minister of the Department of Lands a great deal was gained by the co-operation of forces, the province advancing $3,450 to cover its portion of the co-operative work. In connection with this Mr. White states that in the United States, much water investigation work is carried on co-operatively between the Federal and State authorities. For example, during the fiscal year 1912, the Water Resources Branch of the United States Geological Survey received for such co-operative work, from the state authorities of California, $25,500; from Minnesota, $16,000; from New York and Oregon, each over $13,000; from Idaho, $12,500, and from Washington, $4,400; while a number of other states contributed lesser sums. All the contributing states thus gave a total of nearly $114,000, and this co-operation has proved of mutual benefit.

It might add a little to the clearness of the report to state that the authorities which exercise jurisdiction over water-powers in British Columbia, are first, the Water-power Branch of the Department of the Interior, which has jurisdiction over the Railway Belt; and second, the Department of Lands of British Columbia which has a Waters Branch dealing with irrigation, and also a separate Lands Department dealing with water-powers.

Railway Belt Water-Powers.—In the report of the third annual meeting of the Commission, it is stated that in initiating the water-power investigation in British Columbia it was decided to begin systematically to cover the territorial area of the province. The area south of the Railway Belt, together with the Railway Belt itself, contains the bulk of the population of the province; it also comprises the water-power possibilities of more immediate economic importance, and, consequently, the investigation was commenced in these districts. A large part of the province south of the Railway Belt, in 1911, was examined by the engineers of the Commission.

Through the courtesy of the Water-power Branch of the Department of the Interior, the hydrographer of the Railway Belt has, during 1912, carried forward an investigation in his territory, and the principal field data respecting the water-powers in this area have been assembled. Most of these data have been reduced to a form readily adaptable for inclusion in the proposed water-power report.

The Kamloops hydrographic office has had a heavy task with its own irrigation and other work, and notwithstanding this, extra effort was made by its staff to further the early collection of water-power information that had been requested. They have secured hydroghaphic data, including measurements of stream flow, for some of the large rivers, such as the Fraser, the North Thompson, the South Thompson, the Columbia, and the Adams.

Columbia River Survey.—The Department of Public Works, Canada, in 1912, commenced an instrumental survey of the Columbia River around the "Big Bend." Through the courtesy of the Department, it was arranged that the Commission of Conservation might attach a man to this survey party, that he might make water-power investigations of the tributaries of the Columbia, using the main survey party as a base for operations. Meantime, however, a new water-power organization had been effected in the Lands Branch at Victoria, which has commenced instrumental surveys of the Pend 'Oreille and Kootenay Rivers, and the results will later be available for our report upon the water-powers of Western Canada.

Further Co-operation.—The Forests Branch of British Columbia has just organized an extensive, systematic survey of the forests of the province, and the chief forester, has arranged to have the skilled men engaged upon this special survey, report specifically upon water-powers observed.

The Surveyor-General of the province has instructed British Columbia land surveyors, who are executing the provincial land surveys, to send in information relating to water-powers. It is to be supplied upon special forms, returnable to the Surveyor-General, when the surveyors are handing in their survey reports.

In the Waters Branch, British Columbia, there is now being compiled a complete, brief tabular synopsis of all records and water reservations issued in the province. These water records, as above intimated, constitute really the underlying basis of the water situation and, in many cases, they conflict with the possible development of power on streams to which they appertain. This tabulation will be available for our proposed report, and will constitute a valuable basic record.

The electric energy inspection branch of the Department of the Attorney-General of British Columbia, is also co-operating to secure some desirable information relating to the hydro-electric power companies now operating in the province.

During 1912, a firm of engineers were conducting a railway survey and taking levels down the North Thompson. It was not possible to send a party into this territory, but through the kindness of one of the members of the firm, data was obtained respecting tributaries of the North Thompson.

The Commission has likewise been fortunate in obtaining a co-operation of engineers engaged upon stream gauging in the United States. The water-power investigations that are being conducted throughout the Western States will afford a considerable body of data. The State of Washington, for example, purposes investigating the rivers in that portion of the state adjoining British Columbia, and the results will be available for the report of the Commission. They will be valuable since they are derived from territory corresponding in physical characteristics to portions of British Columbia.

During 1912 the engineers of the Commission covered a very considerable amount of territory embracing the tributaries of the Fraser River, as far north as the Grand Trunk Pacific Railway. In all about 3,300 miles were travelled by the Caribou party. Work was also carried on along the mainland coast, northwards from Powell River, an examination being made of all streams entering the various inlets. It is estimated that the coast party covered about 3,000 miles, much of which distance was necessitated by the trips in and out of the long inlets.

The season, during which it is profitable to carry on reconnaissance water-power investigations in British Columbia is comparatively short, and it is almost impossible for observers to avoid over-estimating the power possibilities of streams observed during high stages. Engineers doing similar work in the United States experience the same difficulty, and have therefore been endeavoring to do the work, as much as possible, when the streams are approaching their lower stages of flow.

In his report Mr. White strongly recommended a careful survey of the water-powers on Vancouver Island. Some of the streams are important, notably Campbell River. A territory so well confined and relatively of such limited extend should not be subjected to the class of reconnaissance investigation that would be justified for larger areas. Vancouver Island presents an excellent opportunity to make an investigation of its rivers in a manner to yield data of higher standard and thus leave the work more complete, and an example of what might be striven for in other parts of the country.

In the United States there is an increasing tendency to do preliminary work of investigation of power rivers in a more detailed manner; the streams are profiled, and possible dam sites, and storage reservoirs, are contoured. This results—without undue increased cost—in the production of permanent survey records of enhanced value.

In the northern portion of the state of Washington much greater outlay is now being made for water-power investigation and surveys, and it is especially desirable to make corresponding investigations in this country, especially upon waters which flow across the boundary.

The work which is underway during the present season is an investigation of the territory tributary of the Grand Trunk Pacific and the Pacific and Great-Eastern Railways, along with the balance of the west coast, Vancouver Island, and a part of the province lying well to the northward of the Grand Trunk Pacific Railway.

THIRD AMERICAN ROAD CONGRESS, DETROIT.

It now seems assured that the heads of every State highway department, from Maine to California, will personally take part in the Third American Road Congress, in session at Detroit during the week of September 29th, and as a result of this unusual interest, the demand for exhibit space by manufacturers has been unprecedented. All available space has been reserved by nearly one hundred manufacturers, who will display their products, including every kind of road-making machinery, engineering instruments, concrete machinery, bridges, culverts, concrete, wood block, asphalt, tar, and oil preparations.

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CONTENTS OF THIS ISSUE.

GEOLOGY IN ENGINEERING WORK.

Engineers and contractors are in the habit of considering a knowledge of geology as having little or no bearing upon their work and, therefore, an unnecessary part of their equipment. Consequently, they are not as well versed in the science as they should be, and few have stopped to estimate how closely it is allied to their own work.

Of course, the mining engineer familiarizes himself with enough geology to give him a working knowledge of the earth's formation and of the characteristics of rocks. This is practical geology that is very necessary to him As some one has put it, "The geologist, purely studious, points out what he has deduced about the construction of the earth; but the engineer makes the mine pay."

For civil engineers the science of geology holds much of importance. The value of a knowledge of it has been brought home to a few by geological contingencies that have arisen in their work and asserted claims for respect. Millions are involved in engineering enterprises, the design and construction of which are greatly influenced by the geology of the country. The Panama Canal and the Catskill Viaduct are instances. In tunnelling, railroading, foundations, water supply, in fact, in nearly all of the applications of civil engineering the science of geology touches. Not exempt is the structural engineer, who finds good value in a knowledge of petrology, whereby he may select building stone free from iron to injure its appearance on exposure, or feldspar that will not disintegrate rapidly under the action of weather.

Here, perhaps, lies the reason why the science has not received more attention from the engineer. In his training the study of geology is derived almost entirely from books, and later he experiences difficulty in recognizing the ordinary formations he encounters, and is unable to foretell with any reasonable assurance what a proposed cutting may contain.

It is geology of such practical value as this which appeals to the engineer and a knowledge of which should be fostered.

The world-renowned Twelfth International Geological Congress came to Canada and its last excursion is nearing its destination. With the close of this month its members will have dispersed, and the Congress will be known as the greatest.

But the event did not receive the attention of the engineers that it should have received. The reason has already been defined. But geology should not be overlooked. Conditions of earth and rock strata in connection with excavation work, qualities of sand and stone used in concrete, the condition of river beds, etc., demand attention. The startling revelations of the excavator emphasizes the diversified tendencies which prehistoric glacial volcanic action has left to be contended with. A little of the indefiniteness of excavation might be dispensed with by a greater practical knowledge of geology and the same applies to many branches of the civil engineer's work.

CLAY IN CONCRETE.

Although the effect of clay on the strength of concrete is not definitely known, its presence is presumed by most engineers to be an element of weakness. While the sand and gravel used in concrete work often contain as much as 5 or 10 per cent. clay, yet many specifications require a minimum of 2 per cent. Such specifications make it necessary to clean the sand, and as the expense of cleaning is great, it is a question of whether it might not be more economical to use more concrete with a high per cent. of clay, than to remove the clay in order to save concrete. The lack of reliable data along this line suggests the value of more systematic experiments to determine the effect of clay in sand and gravel upon the strength of concrete and mortar.

A few years ago the results appeared of a series of tests performed by Messrs. Richey and Prater in the laboratories of the University of Illinois. They had used cubes containing respectively 0, 6 and 12 per cent. of clay, each series of which were seasoned for 1, 4 and 12 weeks respectively before crushing.

In general, the results of the tests indicated that up to 5 or 6 per cent. the weakening influence of clay is not great. Beyond 5 or 6 per cent. the injurious effect increases more rapidly than the amount of clay. Tests on mortar agreed more closely than those on concrete and indicated that clay up to 5 or 6 per cent. is not only not injurious but is even beneficial to the strength of mortar.

The results with natural cement were less erratic than those with Portland, but this was probably due to differences in conditions rather than to the difference in the kind of cement employed. In the natural cement tests not only was the proportion of cement greater, but the mixtures were wetter than in those with Portland. It is probable that the latter is the more important factor, and the suggestion was made by these men that in future experiments more uniform results would probably be obtained by using moderately wet mixtures rather than dry ones.

The tamping of concrete has much to do with its strength, and in considering the effect of clay in the mixture, it may be well to note that a difference may be observed in the action of different mixtures under the tamping iron. The ease of tamping was greater in the experiments mentioned for the 4 or 6 per cent. clay mixtures than for either the clean or 10 or 12 per cent. Tamping the clean material more nearly approaches the case of tamping marbles, not because the voids are not filled but because the adjacent surfaces are clean and the friction is thus reduced so that it becomes difficult to compact the mass. In the 10 or 12 per cent. mixtures clay was present in excess of the amount required to prevent the slipping of the aggregate under the tamper, and as a result some of the clay was forced toward the surface and clung to the tamper so that tamping became a difficult, as well as a disagreeable task.

From their results the experimenters concluded that since the strength of concrete is not much impaired by even 6 per cent. clay, and since the cost of cleaning sand and gravel to contain only a small per cent. is comparatively great, it is probably more economical to use a little more concrete in the work for the sake of avoiding the trouble and expense of removing all the clay contained in the materials available. In other words, the tests indicated to them that it was unwise to specify for any concrete work a minimum of less than 4 or possibly 5 per cent. clay in the sand and gravel used, when any considerable expense would be incurred to obtain cleaner material.

"COAL RESOURCES OF THE WORLD."

One of the outstanding features of the Twelfth International Geological Congress was the presentation of the monograph on the world's coal resources. It comprises three large volumes and an atlas, specially prepared, and closely related to "Iron Ore Resources of the World," which was published under the auspices of the Eleventh Congress.

The coal resources of the world, as compiled from the reports received from a total of sixty-four countries, amounted to 7,397,533,000,000 tons. Of this total, nearly 4,000,000,000,000 tons are bituminous, nearly 3,000,000,000,000 brown coals of various grades and nearly 500,000,000,000 anthracite. Of the anthracite, Asia with the great Chinese fields has by far the largest supply of any of the great continental divisions, furnishing 407,637,000,000 tons. In bituminous, America leads by a wide margin with 271,080,000,000,000 tons, and is also first in the various grades of brown coals. The world's production for the year 1910 was about 1,145 million tons. Making due allowances for loss in mining and for areas that cannot be economically worked, it will be many hundred years before the exhaustion of the supply may be looked for, though considering individual countries the end is in sight in more than one case.

A TUNNEL UNDER THE ENGLISH CHANNEL.

The question of constructing a tunnel between England and the main land is again engaging the attention of the British Government. The question has a fair amount of history connected with it, as in early days the project was favored by both the French and English Governments. As far back as 1874, the British Foreign Office expressly approved of the idea, but a few years later the military and strategic aspects came to the front, and the general conclusion was reached that the project was not likely to promote, but might seriously hamper, the best interests of the country when considered from a military point of view. Since that time the scheme has been resolutely opposed by every government in office, and it is only during the past few years that it has been gaining favor, and the interest in it reviving.

Expert engineers have expressed the opinion that unbroken rail communication between England and France may be successfully carried out by a bridge, a tunnel, or a train ferry. It has been estimated that $10,000,000 would establish an efficient ferry service whereas a tunnel could not be constructed for less than $40,000,000 and the cost of a bridge would be likely to reach $100,000,000. It is the tunnel, however, that is being most dwelt upon.

EDITORIAL COMMENT.

Owen Sound has received a report from the Hydro-Electric Power Commission to the effect that Eugenia Falls, on the Beaver River, will furnish 1,400 h.p., or with the use of storage basin, 4,000 h.p.

IRRIGATION IN OREGON.*

By John H. Lewis,
Irrigation Engineer, State of Oregon.

IN the state of Oregon, we have but recently passed from the pioneer stage of irrigation development into the more complicated stage of expensive works, shortage in water, and numerous controversies. With only seven people to the square mile (over 500 to the square mile in one county) it is apparent that there is yet much room for development. We expect in the near future to reach that stage of irrigation development where the ordinary summer flow of our streams will be augmented many fold through the release of stored water, as is the case in a number of the older irrigation states.

This transition from the pioneer period of unregulated diversions to that of strict public control of all diversions is not easy of accomplishment. The entire thought and life of the water user must be adjusted to the new order. He must abandon the indefinite miner's inch and think of water in second feet and acre feet. He must respect public and private rights to water and suffer the penalty for violating law. Until the new water user, the courts, and public generally, understand the reasons for each feature of the new system, and appreciate the general benefits to be derived from a strict enforcement of its provisions, it will be difficult for the administrative officials to attain the best results.

The Need of Irrigation.—Irrigation is necessary in Eastern and Southern Oregon, but until recently has not been considered necessary in the northwestern, or more densely populated section of the state. The annual precipitation is unevenly distributed, as illustrated by the government record at Glenora, 135 inches; Portland, 45 inches; Government Camp, 90 inches; The Dalles, 15 inches, and Umatilla, 8 inches; each point being approximately 50 miles west of the one preceding.

In the extensive and fertile Willamette Valley only three inches out of the 45 inches of annual precipitation falls during the summer months, while about 20 inches fall during the winter months. Already several irrigation projects are being constructed with a view to supplement this summer deficiency.

Throughout much of central Oregon, which ranges in elevation from three to four thousand feet above sea level, the precipitation varies from about eight to fifteen inches. This district, which has long been famous as being the largest area in the United States without any railway transportation, is now being rapidly settled, due in part to the active railway construction now under way, to the reduction from five to three years' residence required for homestead entry, to the increase from 160 to 320 acres allowed to each entryman, on non-irrigable land, and primarily to the fact that the precipitation in this vast empire is believed to be ample for dry farming purposes.

With only 686,129 acres of land irrigated out of a total of 61,200,000 acres, and with about 4,000,000 acres susceptible of irrigation, the public has become aroused to the importance of irrigation development in Oregon. It is apparent that from six to ten times the population can be supported on irrigated lands in comparison with an equal dry farming area. As the land to be irrigated is well scattered throughout the dry farming and grazing districts, it is also apparent that the value of such lands will be somewhat enhanced through the irrigation of adjoining tracts.

The courts are becoming educated to the value of water and are now less willing than formerly to grant extravagant claims in water adjudications. If twice the amount of water necessary to produce crops is allowed, it is readily apparent that the ultimate area to be irrigated will be reduced approximately one-half. For this reason the public is vitally concerned as to the duty of water. Public funds have accordingly been appropriated for the making of accurate stream measurements extending over a long series of years, for the making of topographic surveys and river profiles, and for determining the quality of the public waters. There is thus a general awakening among all classes as to the importance of irrigation.

Value of Water.—The value of dry farming land ranges from about $5 to $30 per acre. Irrigated, this land would sell from $40 to $100 or more per acre. Improved irrigated land has been known to sell at from $500 to $1,000 per acre and over. Water has, therefore, considerable value, and water rights and titles are now receiving careful consideration. In some sections one cubic foot per second of water, flowing continuously during the irrigation season, is estimated to be worth approximately $10,000.

The cost of irrigation works has increased from $5 per acre in 1900 to an average of $15 in 1910, according to the government census, and systems are now planned or are under construction estimated to cost $40 to $100 per acre. The amount of water and record evidence of water titles are, therefore, important matters, which are now given serious consideration by the investor, the water user, and the public.

Water Laws.—In 1909, Oregon adopted a water law which is similar in many respects to that now in force in the province of British Columbia. It has in general been found satisfactory to both the water user and the prospective investor, and is not burdensome to the public, as the fees, collected and paid into the State Treasury, have gone far towards meeting the appropriations for its maintenance.

The law deals primarily with (1) the adjudication and recording of rights to water which were initiated prior to its adoption; (2) the granting of new rights, after proper application and record, and (3) the protection of all recorded rights, as well as of the public interest in unappropriated waters. Its administration is in the hands of the state engineer and the superintendents of the two water divisions into which the state has been divided, each of whom has special duties to perform. All important grants or decisions are made by these officers sitting as a board.

This law declares all water within the state to be the property of the public and makes beneficial use the basis of rights to its use. In the water right certificate, which is record evidence of title, this basis is qualified by a definite statement as to (1) the priority; (2) the purpose; (3) the period, and (4) the place of use of water; also by (5) the maximum rate of flow or quantity of water. Such certificate gives also the name and address of the owner of the right, and the stream from which the water is diverted.

Owing to the peculiarities of climate and soil, and to the necessity for diverting water for irrigation and other uses, the strict common law doctrine of riparian rights established by early court decisions has been so modified in recent cases that only the faintest shadow of this conflicting doctrine remains to cloud the horizon of the in-

* Read at the recent convention of the Western Canada Irrigation Association, Lethbridge, Alta., August 5, 6 and 7, 1913.

vestor in water projects. In some of our states the common law doctrine still prevails in modified form and is a serious handicap to the adoption of modern administrative water codes. The Canadian provinces should be congratulated upon the freedom with which they can adopt laws suited to their conditions, without a long period of turmoil and expensive litigation by those who wish for some personal or financial benefit, to have streams flow undiminished to the ocean.

Administrative Problems.—Although our water code has been in effect four years, we are just reaching the point where its practical operation can be observed by the irrigator. All rights to water on a number of streams have been adjudicated and recorded, and water masters mave been in charge of distribution. These water masters are appointed by the Water Board, but are paid by the county court. They are thus not as responsive to orders of the superintendents and the board as if paid directly by such board, and subject to dismissal for cause. Another difficulty has been the requirement of law that water masters should be residents of the district from which they are appointed. This prevents the promotion of experienced men to the more complicated districts.

In defining water rights in Oregon, the Water Board has generally specified a particular rate of flow for a definite irrigation season. Where the amount of water thus decreed was too small to furnish an adequate irrigation head, rotation was authorized. In this way each man could at any time ascertain whether or not his neighbor was taking more than his share. In case of rotation among a group of neighbors, the total quantity of water used by any one should not exceed the sum of that allotted to each. Self-interest will cause each man in such rotation group to see that he gets the total quantity of water his full share of the time. Such a decree is almost self-executing, as the average water user is honest, and will not take more than he is entitled to, if he knows the water supply is now sufficient for all. In Wyoming, where they have had long experience in distributing water, it is the exception rather than the rule to call out the water master to administer such decrees.

For old rights, one cubic foot per second is usually allowed for 50 to 80 acres, depending upon local conditions. All new grants for irrigation purposes have been restricted to the rate of one cubic foot per second to 80 acres. The average irrigation season or time between the last killing frost in the spring and first in the fall, has been carefully estimated from official records, at 120 days. The above rate of flow will deliver during such a period three acre feet of water on each acre of land. This in general is sufficient for alfalfa, the ordinary crop requiring the greatest amount of water.

Much difficulty is encountered in defining and protecting rights on flood water streams. On such the floods run off early in the spring, leaving the stream practically dry during the summer months. Rather than build expensive reservoirs, the pioneer settlers flooded their lands by means of ditches or temporary diversion dams, thus storing water in the soil itself. In most cases but one crop of wild hay, yielding about one ton to the acre, is produced, but under favorable conditions one to two cuttings of alfalfa have been produced.

In such cases, a larger rate of flow is allowed and the total quantity of water for the irrigation season limited to 2.5 to 4 acre-feet per acre. The volume limitation in certain cases has been further qualified by defining the amount in acre feet which can be diverted within any period of, say, thirty days. Such a decree is difficult to enforce. No reliable and inexpensive instrument has yet been devised for automatically recording acre feet. The water master must be employed whether a controversy exists or not, and no water user will know whether or not he is getting the amount of water decreed him, unless he keep an independent record throughout the entire season.

Many water masters will thus have to be employed as each ditch will have to be measured one or more times each day. If the water master is not present when water is being run, his records will be incomplete.

Under such system it will be difficult to convict one of stealing water. It will also be difficult to convince each water user that he has received his full share of water. Such system of defining water in acre feet is more suited to large canal systems where numerous ditch riders are necessary to distribute the water, and where but little additional expense would be entailed in keeping accurate ditch records of the volume of water used each day.

Irrigation by Pumping.—Gravity irrigation under large ditch systems did not become a complete success until the common carrier canal was abolished, and water was made by law appurtenant to the land. Those planning to pump water have not forgotten the early experiences of the water user under such canals where the charge for water, after the expiration of the original short time contract, was increased by the company in accordance with the settler's ability to pay. It is believed that pumping for irrigation purposes will not reach its fullest development until both the power and the water are made appurtenant to the land benefited, either through the district or state ownership and distribution of power.

This question is of particular interest to Oregon for the reason that we have a considerable area which cannot be economically supplied by gravity canals, but which may be irrigated by pumping from adjoining streams, or from underground sources.

Along Snake River, in eastern Oregon, a pumping plant was recently installed for the irrigation of 6,000 acres where the maximum lift was over 100 feet. An irrigation district has been formed for the irrigation of 20,000 acres adjoining the above project where the lift will be 200 to 300 feet, and the land about 2,300 feet above sea level.

In central Oregon there are great interior basins, each containing several hundred thousand acres of level land, where the rain fall does not exceed the evaporation. In most of these basins a limited supply of water is found from 20 to 40 feet below the surface. With a permanent supply of cheap power this water could be pumped for at least partial irrigation of these districts.

Public Interest.—It is the duty of the state engineer to refer to the state water board any application wherein the proposed use conflicts with determined rights, or is a menace to the safety or the welfare of the public. This board can direct the refusal of such application after full hearing, if public interest demands. This feature of the law has recently been upheld by our Supreme Court and marks a distinct advance in water legislation.

In Oregon, we have a number of large irrigation projects which can be developed at reasonable cost. Unfortunately the early settlement in these districts has occurred along the streams and there is a strong natural tendency to complicate and delay the construction of the larger projects through the construction of power plants in the stream channels, or the building of railway lines through available storage basins. If the entire stream basin were owned by an individual, he would compel the power plants to locate a few miles distant on some tributary of the stream where the water could be used for irrigation after passing through the power wheels, although such construction would be perhaps a little more expensive. He would also compel the railroads to locate their lines around and above feasible power and reservoir sites, in order that the large projects which must eventually be built will not be unnecessarily encumbered, and their construction correspondingly delayed.

The state is endeavoring to look somewhat to the future in these matters as indicated by the above authority granted to its administrative officers for the protection of the public interest.

Public Investigations.—Recently a further step in this direction was taken by our legislature. The sum of $50,000 was appropriated for the making of detailed plans and estimates of cost of a number of these projects, and authorizes co-operation with the United States. The government has allotted an equal amount from the reclamation fund and the investigations are now being carried on jointly. The necessary land and water rights are withdrawn so as to prevent further complications, and it is the intent to assign such plans, and rights to the people forming themselves as a district for the construction of the project, or to private capital, who will undertake to carry out the public plans on terms satisfactory to the people. Failing in this, the legislature has submitted a constitutional amendment for vote of the people in 1914 authorizing the issuance of bonds equal to two per cent. of the assessed valuation of the state for the construction of irrigation and power projects, and for developing the cut over timber and other lands of the state.

In other words, the state is now authorized to make water filings, and to gather all necessary information relative to these large irrigation and power projects, which may be necessary in promoting their construction by either private or public funds. It has also taken the first step looking towards construction with public funds if such action is found necessary.

Speaking for the West generally, water is of more value than land. It is highly important that the people be aroused to the value of public water surveys, and the necessity of securing more complete information as to the duty of water.

NEW SLIDING CAISSON FOR H.M. DOCKYARD, PORTSMOUTH.

Last month Messrs. Swan, Hunter & Wigham Richardson, Limited, launched from their new shipyard at Southwick-on-Wear a large sliding gate or caisson for one of the Admiralty new graving docks at Portsmouth. The caisson was launched on its side owing to the great draft of water required when in an upright position. It was then towed to the shipyard, where it was set upright by adding ballast, and then made ready for the voyage to Portsmouth. The caisson is an interesting steel structure about one hundred feet wide at the top and about fifty feet deep. At the side of the entrance to the graving dock a chamber is built of masonry, and into this the caisson is hauled, when the entrance to the graving dock is to be opened. This chamber is covered by a moveable camber deck fitted with apparatus for lifting or lowering it. The camber deck was shipped in pieces to Portsmouth, and where it will be erected and placed in position.

ECONOMICS OF CENTRAL STATION HEATING.*

By Byron T. Gifford.

THERE are three important branches of central station heating: (*a*)the production of heat units; (*b*) the distribution of this product; and (*c*) making the service attractive to the consumer.

The first of these, the generation of heat, may be handled by three distinct methods: by direct firing, or "straight fuel burning" plants; by an electric generating plant with heating as a by-product; and by a combination of a by-product plant and a heating plant.

Owing to many causes the heating plants of the future will be of the last type. In an arrangement of this kind, electricity, for instance, can be produced much more cheaply than is possible in the most economical electric plant, and there are a number of ways of disposing of this by-product: It may be sold to an existing electric plant at a wholesale rate; a market may be made for it by creating industries requiring a fairly large amount of electricity at a comparatively low price. The author has in mind the case of an industry which has supplied to it 400 kw.-hr. of electricity 20 hours per day, 365 days per year, at less than 1 cent per kw.-hr. The net income to the heating company from this by-product is more than sufficient to meet the payments of the bond interest, taxes and insurance of the entire property. This additional income, amounting approximately to $11,000, is being handled with an increased operating cost of $2,200, as compared with the operation of the plant the year previous when no electric current was generated. With a simple or a twin Corliss engine a kilowatt of electricity can be generated under conditions which exist in the average central heating plant with 45 lb. of steam. Assume, for example, a heating plant serving 200,000 sq. ft. of steam radiation. This load gives an average demand on the boilers of about 40,000 lb. per hour, which, if sent through a simple or twin Corliss engine, will develop 880 kw.-hr. of electricity. Assume that this electricity is sold to some consumer for 1 cent per kw.; at this price 1 cent would be realized for every 45 lb., or 22 cents for every 1,000 lb. of steam delivered to the heating mains before it had left the station. The history of central station heating has proved that a rate averaging 60 cents per 1,000 lb. for steam is reasonable and can be procured from any heating consumer. This would mean 82 cents per 1,000 lb. for the steam generated, which is a good return on the investment.

Heating plants in America at present vary in size from a connected load of 10,000 sq. ft. of radiation to a connected load of 1,750,000 sq. ft. of radiation. These plants are built in towns of upward of 1,000 people.

There are few electric generating plants that can put a kilowatt-hour of electricity on their switchboard below a cost of ½ cent per kw.-hr., and there are also few electric plants that can generate and distribute to the primary side of their transformers for a cost of 1 cent per kw.-hr., especially when the overhead and fixed charges are considered. Heating plants, with electricity as a by-product can do this, and this fact alone will make a place for central heating plants. Some of the larger operating

* Abstract of paper read before the Chicago Section of the American Society of Mechanical Engineers, April 9, 1913.

companies are doing this at the present time and others are building properties to operate along this plan.

Regarding the second point, distribution, in waterworks or in gas properties the losses from distribution consist of leaks and pressure drops due to friction which is caused by insufficient pipe capacities. In central heating there are these two losses to contend with, and in addition the loss from radiation, called "line loss" by central heating engineers. Leaks are a decided detriment to heating pipe line, and the loss from this source is probably more serious than was at first supposed. Assume, for example, a hole ¾ in. in diameter in a pipe line containing steam at 5 lb. pressure. With an evaporation of 7 lb. of water per lb. of coal, this leak will cost 23 tons of coal per month. A leak of this size is equally as detrimental in a hot-water heating system. The loss from friction affects, of course, the initial pressure to be carried on the heating mains, and consequently affects the back pressure to be carried on the engines.

As to the detriment of too high a friction loss, in a 3-in. steam line 1,000 ft. long, carrying 1,000 lb. of steam per hour, the friction loss will be equal under average conditions approximately to 1,460 B.t.u. per hour. This same load carried 1,000 ft. in a 3½-in. line will show a friction loss equal approximately to 500 B.t.u. and a 4-in. line under the same conditions will lose only 240 B.t.u. from friction.

The radiation loss from central heating is even more important than friction loss, from the B.t.u. standpoint. There is a number of styles of underground insulation in use to-day, which lose anywhere from 0.03 lb. to 0.38 lb. of steam per sq. ft. of underground surface per hour.

In order to determine the most economical line to install it is necessary to combine the friction and radiation losses. Take, for example, a demand of 1,000 lb. of steam per hour which must be carried 1,000 ft. A 3-in., 3½-in., 4-in. or 4½-in. pipe will do this work, but the most economical size must be determined. The loss from friction would be 1,460 B.t.u. per hour on the 3-in. line; 500 B.t.u. on the 3½-in. line; 250 B.t.u. on the 4-in. line and 130 B.t.u. on the 4½-in. line.

Assume a radiation loss of 0.05 lb. of steam per sq. ft. of underground surface per hour; the radiation loss from the 3-in. line will be approximately 45,000 B.t.u. per hour; 3½-in. line approximately 52,000 B.t.u.; 4-in. line approximately 58,000 B.t.u.; 4½-in. line approximately 65,000 B.t.u. Combining these two losses, it is seen that the 3-in. line is the most economical to install, provided it does not affect the heating station conditions by causing excessive back pressure on the engine.

Experience has shown that a 3-in. line carrying this load the given distance will have a drop in pressure of about 7 lb., and as it is necessary to have 1 lb. pressure at the end of the line, it means that the back pressure at the station would be approximately 8 lb. If this pressure is excessive it would be necessary to run a 3½-in. line, which would give a back pressure of less than 5 lb. The difference in cost between a 3-in. and a 3½-in. line is comparatively small. The cost of material is somewhat less for a 3-in. line; the cost of labor is approximately the same.

To show the value in dollars and cents of efficiency in underground insulation, a piece of line insulated with a construction that will lose 0.05 lb. of steam per sq. ft. of underground surface per hour may be compared with a line insulated with a construction that will lose 0.14 lb. per sq. ft. per hour. Both constructions are found in everyday practice. For this purpose an 8-in. line 1,000 ft. long will be considered. Such a pipe has 2.25 sq. ft. of surface per lineal foot. In the first case the line loss will amount to 112 lb. of steam per hour; in the second case to 215 ft. Assuming a generation cost of 30 cents per 1,000 lb., in a season's operation (from October 1 to June 1, or 5,832 hours) a line loss in the first case will equal $195 per year and in the second case $550 per year.

The money saved, therefore, will be the difference between these two figures, or $355 per year. This is 10 per cent. on $3,550, an amount which can be spent to install the more efficient construction. Since the difference between these line losses is 0.09 lb. of steam per sq. ft. of underground surface per hour, and since the example assumed consisted of 1,000 ft. of 8-in. line, which is 2,250 sq. ft. of surface, it is seen that for every 0.01 lb. of steam saved on this 8-in. line, approximately $400, or 20 cents per sq. ft. of underground surface, can be spent.

Another interesting example is the comparison of two insulations on an entire underground heating installation. This installation consists of approximately 800 ft. of 12-in. pipe line, 1,200 ft. of 10-in. pipe line, 3,600 ft. of 8-in. pipe line, 4,200 ft. of 6-in. pipe line, and 7,300 ft. of 4-in. line and surface. The number of square feet of underground surface in this system is equal approximately to 30,000 sq. ft. Comparing two insulations, one with 0.04 loss and one with 0.09 loss (difference 0.05) by the following formula which the author has derived, the more efficient insulation in this case will be worth $30,000 more than the less efficient:

$$N \times S \times L \times C$$

where N = the difference between the two insulations in hundredths of a pound of steam lost per hour

S = the number of square feet of surface per lineal foot of pipe

L = the length of pipe

C = a constant based upon the cost of steam per thousand pounds and the number or hours in the heating season.

Where the steam costs 30 cents per 1,000 lb. and the heating season is 5,900 hours, the value of C is 21 cents.

Regarding the third point, making the service attractive to the consumer, it is not necessary, perhaps, to wrap it up in a good looking package, but it is necessary to have it attractive in price and quality. That this class of service is attractive is shown by the fact that central heating plants, with few exceptions, have had no trouble holding their consumers. It is this one fact, as much as anything else, that has put many heating plants into trouble. They have been tempted to serve a larger territory or more consumers than their plants could economically handle, and they have been tempted also to extend their service without due regard to the economics of the proposition.

As to the best method of selling the heating service, experience has shown that the meter basis is the most equitable. The rate will depend upon local conditions. A number of companies are selling steam on the meter basis, with a sliding scale rate; others have devised a maximum demand or readiness to serve rate, both of which work out admirably in practice. The quality of the service is always sufficiently attractive to obtain a large percentage of the possible consumers.

CONCRETE DAM CONSTRUCTION NEAR TRENTON, ONTARIO.

A NEW concrete dam, recently completed on the Trent River, near Trenton, Ont., has some features that may be of interest both in the matter of design and difficulties encountered during its construction. Work was commenced in September of 1912, and the structure was completed early in July of this year, covering a total period of about 10 months. Owing to the mildness of the winter of 1912-13 in that locality the Trent River did not decline to its usual minimum flow for this period, and was, in fact, at flood stage several times during the winter months. This naturally caused difficulty which was unexpected, the most acute being in the last closure of the dam.

The new structure replaces an old wooden dam that had furnished power for running a paper-box mill at the site. One of the construction problems was that of maintaining sufficient head during the construction of the new dam to keep the mill in continuous operation. This feature was successfully carried out, although it increased the cost of construction somewhat on account of the required extra height of coffer-dams required. The extra outlay was fully justified, however, as otherwise the prospective loss that the mill would have sustained, had it been obliged either to close down operations or to install steam machinery and equipment for the power, would have amounted to many times the sum.

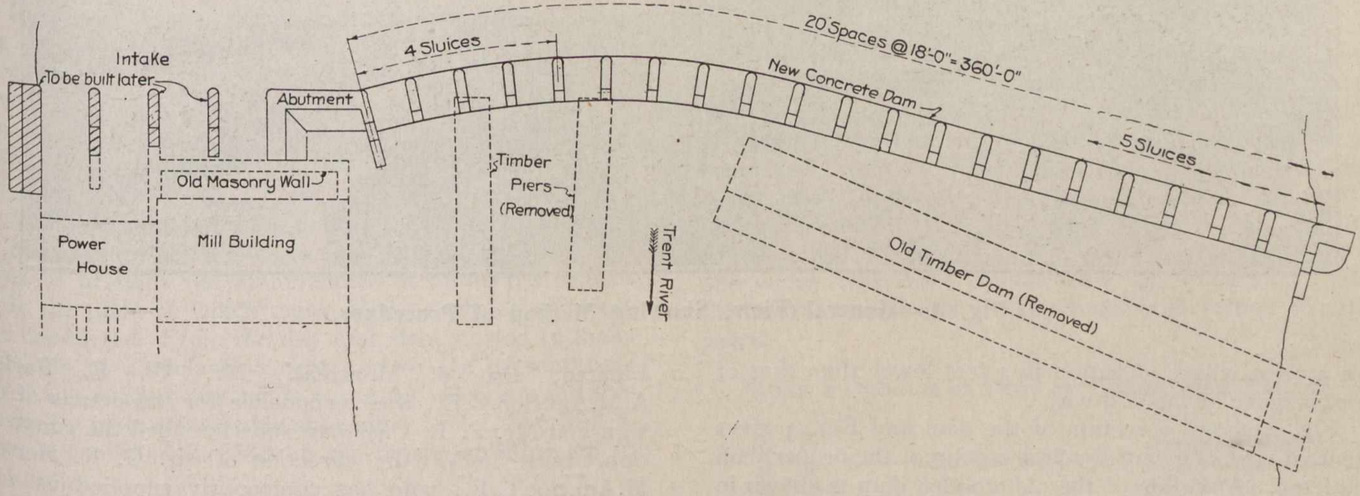

Fig. 1.—Plan of Concrete Dam Across Trent River.

The accompanying drawings and illustrations are self-explanatory and need little description of details. The total length of the dam over all as constructed is 425 feet. There are twenty piers, each of which are 3 feet 6 inches and placed 18 feet between the centres. These piers are reinforced with corrugated steel bars which are also extended into the main still-way section. The design is such that stop-logs can be used between the piers to regulate the head as required.

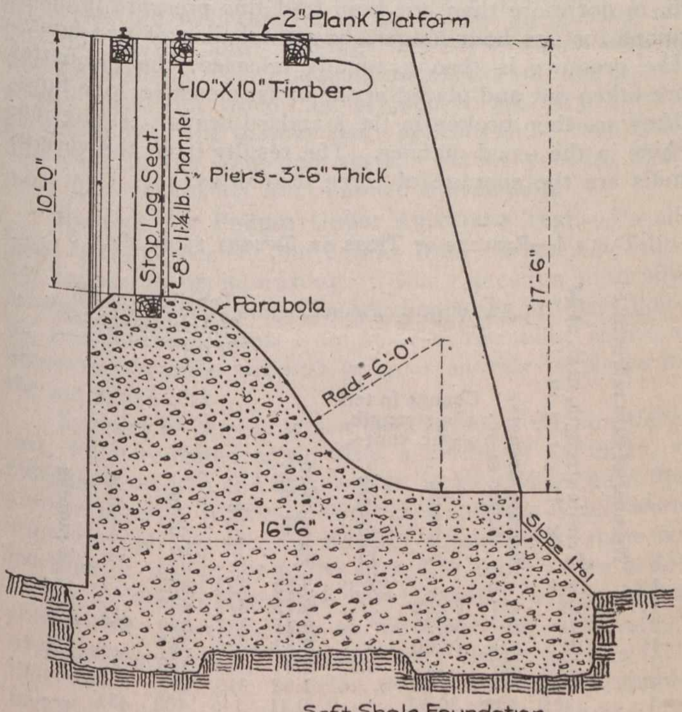

Fig. 2.—Section of Trent River Dam.

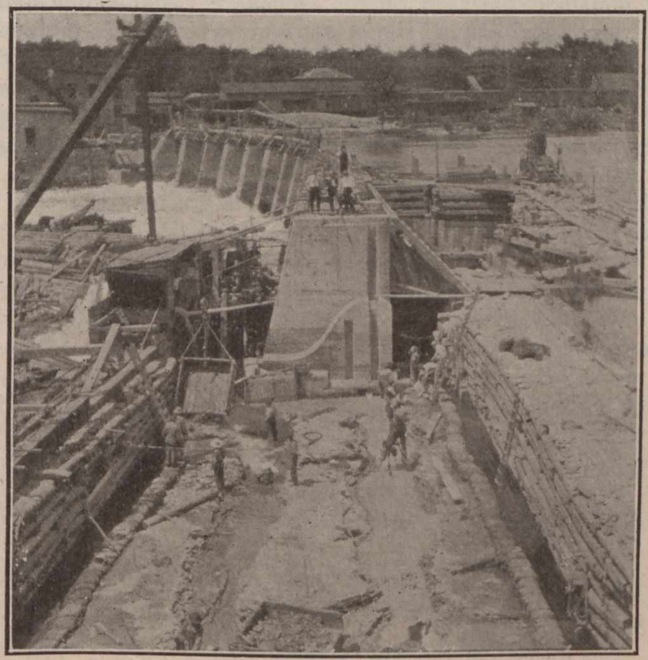

Fig. 3.—Showing Cofferdam After Pumping.

Fig. 1 shows the general layout of the new dam and its position relative to the old structure.

In order to give a greater latitude for operations and to increase the amount of water which may be safely carried over at plug stages there are four openings in the section of the dam adjacent to the mill and five at the opposite end, as the drawing illustrates. These openings have a crest whose elevation is 3 feet lower than that of the remainder of the still-way.

Fig. 2 shows a section of the dam and Fig. 3 gives a general view showing the first section of the proper dam completed. A section of the old wooden dam is shown in the foreground with 2 feet of flash boards in place, in order to maintain the operating head at the mill wheels.

Fig. 4 is a view looking west from the top of the eastern bank of the river and shows clearly inner cofferdam unwatered and excavation for the foundations of the dam in procedure.

The dam was designed and constructed for Miller Bros., Limited, of Montreal, by Walker & Company, Limited, also of Montreal. Mr. W. F. Farley, A.M.Am.Soc.C.E., was responsible for the details of design and Mr. F. E. Cushman superintended the construction, both under the direction of Mr. G. R. Heckle, M.Am.Soc.C.E., who has courteously supplied us with the information and illustrations forming this article.

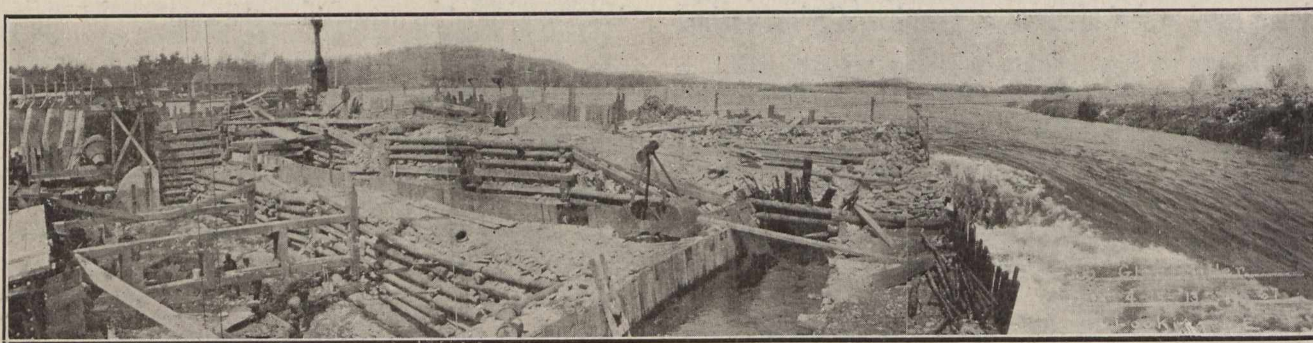

Fig. 4.—General View, Showing Method of Procedure.

THE EFFICIENCY OF THE AUTOCLAVE TESTS FOR CEMENT.

A greater part of the volume of the consideration which has been given throughout the past year to the application of Portland cement, has dealt with the so-called Autoclave or high pressure steam test as specified for construction work on the Delaware Lackawanna and Western Railway. The attention which this method has received from engineers, cement manufacturers and various technical and scientific associations crystallized into a most important discussion at the convention of the American Society of Testing Materials at its meeting in Atlantic City last June. A paper entitled "The Results Obtained with the Autoclave Tests for Cement," was presented by Mr. H. J. Force, chemist and engineer of tests for the above company and the lengthy discussion which followed his outline of the latest results obtained in the laboratories of the road has added somewhat to the information on the subject although no basic conclusions were arrived at, but rather a clear intimation displayed that no results yet obtained have been sufficiently authoritative as to demonstrate its value. And although the discussion of the test has not been allowed to become dormant, the consideration given it has not disclosed many opinions favoring it, other than the few expressed at that time.

The paper was considered one of the most interesting of the meeting, the discussion following it was unusually thorough.

As described by Mr. Force the autoclave test is made as follows:—

Three neat briquettes are made up, using water which gives a normal consistency on the Vicat needle of from 7 to 10 mm. The briquettes are kept in the damp closet for twenty-four hours, at the expiration of which time they are removed from the molds and placed in the autoclave. Sufficient water is added to partly or wholly cover the briquettes, and the instrument closed. The burners are of sufficient size to raise the pressure to 295 lb. in not more than one hour and this pressure is maintained for one hour longer, or a total time of two hours. The pressure is then gradually released, the briquettes are taken out and placed in the moist closet for one hour. They are then broken in the standard cement testing machine in the usual manner. The results from the various mills are the average of three briquettes.

TABLE 1—RESULTS OF TESTS ON CEMENT FROM MILL 3

Number of cars represented	Tensile strength, neat, at 24 hr., lb. per sq. in.	Autoclave test				Tensile strength of 1:3 briquettes, lb. per sq. in.			
		Tensile strength, lb. per sq. in.	Change in tensile strength, per cent		Expansion, per cent				
			Increase	Decrease		7 days	28 days	3 months	6 months
1.....	318	40	....	87.39	5.58	332	382	...	...
1.....	297	487	64.00	....	0.75	372	447	...	...
2.....	330	597	80.90	....	0.25	347	390	448	422
1.....	375	472	26.00	....	0.53	295	387	...	...
3.....	392	387	....	1.27	0.41	326	350	432	482
1.....	300	305	1.66	....	1.02	315	397	...	...
1.....	405	528	30.37	....	0.31	346	408	431	...
2.....	392	513	30.89	....	0.10	352	457	450	...
5.....	335	205	....	28.80	1.28	357	...	...	...
Av'ge	349	393	38.96	39.15	1.13	338	402	440	452

A 1 x 6-in. expansion bar is made up with the briquettes and at the end of twenty-four hours is measured and placed in the autoclave. The bar is removed with the briquettes at the end of the two-hour test. The final measurement is made after the bar has remained in the moist closet for one hour.

The tables show the results of all tests on the cements from Mills 1 to 5 respectively. (Two of the tables, showing tests of cements from Mills 1 and 2, are omitted here. All samples, representing 344 cars of cement, passed the autoclave test.) For purposes of comparison, there are shown in Table 4 the averages of the results of all tests from each mill.

Results of Tests.—Each shipment from Mill 2 showed a large increase in tensile strength in the autoclave test and with one or two exceptions the expansions were all very low. The chemical composition of the cement from this mill is about normal. The tensile strengths for the sands on the 7 and 28-day and the 3 and 6-month tests were all excellent.

Mill 1 shows, perhaps, the most uniform results of any of the five mills. This is the first mill in the United States to attempt the manufacture of autoclave cement and is the plant at which many of the early experiments were conducted. From the day that they started to make shipments of autoclave cement up to the present time there has not been one single cause for rejection and this is indeed a most remarkable showing. Mill 1, like Mill 2, shows a continual increase in the tensile strength up to six months.

Mills 4 and 5 also show a wide variation, some of the shipments passing the test, others failing; some showing little expansion, others showing considerable expansion. The results of the 7 and 28-day and the 3 and 6-month tests are lower in this case than in either Mill 1 or 2.

The method of making briquettes used in the laboratory of the Lackawanna Railroad is one of tamping. About 9 per cent. of water is usually used and the briquettes are well tamped in the molds by placing an iron die thereon and striking it several times with a wooden mallet. This gives higher results on the 7 and 28-day tests, but when the briquettes are very firmly packed in with the thumbs there appears to be very little difference in the long-time tests, except possibly that more uniform results are obtained by tamping.

Reasons for Failure Under Autoclave Test.—To all large users of cement the figures from the various mills are certain to be interesting. The question naturally arises as to why a cement which passes the ordinary boiling test in many cases, from some of the mills, shows a decrease in tensile strength or goes entirely to pieces in the autoclave test.

Samples of cement which have failed in the autoclave test, when re-tested again after a period of 30 days, 2 months, 6 months and over a year, in most cases pass the autoclave test. In one or two cases samples which were approximately 15 months old still continued to show no increase in tensile strength; in a few other cases a decrease in tensile strength was shown, while others showed an increase, due to the seasoning process, of over 100 per cent. This points very clearly to the fact that these particular samples were not properly manufactured, for with certain mills any cement which has not passed the autoclave on the first test has in practically every case passed the test after the cement is held for a period of time.

Fine Grinding.—Further investigation as to why some of these cements fail to pass this test after a period of time shows that the raw material was more coarsely ground than in other samples which did pass the test after seasoning. The grinding of the raw material and the proper burning play a most important part in the quality of Portland cement; and the author believes that the failure of cement to pass the autoclave test is due very largely to the coarser granules which do not become hydrated when the cement is set up and that the failure of these granules to become fully hydrated is due to their chemical composition. That is, the granules are composed largely of dicalcium silicate ($2CaO\ SiO_2$), with a smaller proportion of tricalcium silicate ($3CaO\ SiO_2$). Granules of this composition fail to properly hydrate in the period of twenty-four hours and consequently, when brought in contact with the heat and pressure, together with moisture, slaking of the dicalcium silicate is quickly brought about, with the result that a large percentage of expansion occurs, together with a proportionate decrease in tensile strength. On the other hand, if the proportion of tricalcium silicate is largely in excess of the dicalcium silicate, then we may expect a more stable product and one which will show considerably less expansion under the autoclave test and remain constant in volume in after years.

TABLE 2—RESULTS OF TESTS ON CEMENT FROM MILL 4

Number of cars represented	Tensile strength, neat, at 24 hr., lb. per sq. in.	Autoclave test: Tensile strength, lb. per sq. in.	Autoclave test: Change in tensile strength, per cent: Increase	Autoclave test: Change in tensile strength, per cent: Decrease	Autoclave test: Expansion, per cent	Tensile strength of 1:3 briquettes, lb. per sq. in.: 7 days	28 days	3 months	6 months
6.....	275	508	84.72	....	0.20	406	493	535	414
5.....	402	232	....	42.29	2.77	373	461	478	469
4.....	332	297	....	10.54	1.20	401	471	462	482
2.....	435	555	27.58	....	0.50	331	359	475	476
3.....	473	192	....	59.40	1.87	370	418	483	483
9.....	370	146	....	60.53	3.68	342	399	470	428
4.....	410	525	28.05	....	0.31	373	440	408	452
2.....	350	345	....	1.42	0.25	307	412	406	425
3.....	427	367	....	14.00	0.70	328	352	424	...
1.....	420	27	....	93.57	Soft	408	402	...	...
1.....	364	270	....	26.00	1.97	327	435	...	...
1.....	307	475	54.72	....	...	410	505	...	...
2.....	385	602	56.40	....	...	348	452	544	...
9.....	392	9	....	99.24	Soft	413	443	483	...
2.....	369	64	....	80.00	3.10	355	390	454	...
3.....	378	257	....	31.50	1.92	413	461	470	...
1.....	296	459	16.00	....	0.39	390	473	...	...
1.....	237	630	87.00	....	0.20	416	492	...	...
2.....	429	495	15.40	....	0.80	238	433	...	...
3.....	396	447	13.01	....	1.07	390	453	...	...
Av'ge	372	345	42.54	47.13	1.31	367	437	468	453

In order to produce a large excess of tricalcium silicate two things are necessary—the raw material must be more finely ground and the cement must be burned at a higher temperature. Most of the cement in Mill 2, as well as in Mill 1, shows very little expansion and a comparatively low loss on ignition. It is also known that in both Mills 1 and 2 the raw material was very finely ground. In some of the other mills—for example, Nos. 3 and 4—while the burning was good, the raw materials were not so finely ground; in Mill 5 there was not only fairly coarse grinding of the raw material but there was also a much higher loss on ignition. From the report of Mill 5 it is evident that the cement from this mill could not be as constant in volume as that from Mills 1 and 2.

In order to manufacture a cement which will pass the autoclave test it is necsssary to grind the raw material very much finer than is customary and to have the clinker well burned. The manufacturer, however, can greatly increase the output of his mill by grinding his raw material coarser and burning his clinker not quite so hard. This produces a cement which contains a very large percentage of dicalcium silicate, which may not be constant in volume, and which would more than likely fail to pass the autoclave boiling test. This cement would probably require seasoning in order to make it pass the regular boiling test.

Future Tests.—Briquettes for tensile strength from the various mills have been made up on most of the samples shown to one year. It is to be expected that the results on cement for longtime tests will be equally as high, if not higher, than on the standard-specification cements. On the long-time tests for expansion very little difference or variation has been noted to date. A number of expansion bars have been kept under observation and measured at frequent intervals. It is believed that some time must elapse before any difference will be noted in these bars.

A large number of cylinders and cubes have been made up for compression tests. The results to date indicate that higher compressive strengths are being obtained, as a rule, on autoclave cement. A large number of 2-in. cubes of the various brands have been made up for compression tests, to be made during a period of from one to five years. The number tested to date is not sufficient to draw any definite conclusions, except as stated above, that in many cases the autoclave cements show higher strength in compression. The results obtained on autoclave cements are more uniform than on other cements.

Discussion of the Paper.—Dr. A. S. Cushman, director of the Institute of Industrial Research, Washington, in presenting his discussion gives some historical data in connection with the autoclave test. It appears that the high-pressure steam test on Portland cement was first recommended in Germany in 1881 by Dr. Erdmenger. His test was fully investigated by some of the leading German authorities on cement and was rejected by them as inadequate and misleading. The International Association of Testing Materials is also mentioned by Dr. Cushman as having reported against the test because it had been found to lead to erratic and inconsistent resource. He likewise refers to a number of researches on the subject, tending to condemn the test as irrational and one not to be used as a method of judging behaviours in construction work of a given brand of Portland cement. He cited tests which go to show that the autoclave process is not able to distinguish between the strength developing qualities of cement up to six months under normal exposure to out-of-door conditions.

In conclusion Dr. Cushman says:—"A careful examination and analysis of all the data obtained in various laboratories and the experience of the Institute of Industrial Research, gained during a systematic investigation of the autoclave test, show that it yields erratic results and is not to be depended upon for determining a quality or condition of any brand of cement either for immediate or future results in service. The conclusion which must be reached as the result of these investigations is that the test is not dependable as a method of distinguishing cement which will give successful results from the cement which may be expected to fail under service conditions."

Table 3—Results of Tests on Cement from Mill 5

Number of cars represented	Tensile strength, neat, at 24 hr., lb. per sq. in.	Autoclave test: Tensile strength, lb. per sq. in.	Autoclave test: Change in tensile strength, per cent: Increase	Autoclave test: Change in tensile strength, per cent: Decrease	Autoclave test: Expansion, per cent	Tensile strength of 1:3 briquettes, lb. per sq. in.: 7 days	28 days	3 months	6 months
2....	347	504	45.24	....	0.60	385	466	553	491
3....	310	562	81.29	....	0.60	306	362	457	467
6....	242	388	60.33	....	0.75	251	315	407	425
6 ..	365	392	7.39	....	1.00	345	355	431	452
5....	347	83	....	76.36	4.83	248	287	312	450
18....	233	260	11.50	....	0.91	290	358	416	430
3....	292	472	61.22	....	0.63	312	320	395	396
4....	343	267	....	29.82	2.50	309	380	442	486
4....	275	135	....	60.00	0.40	281	370	407	430
6....	195	410	110.00	....	0.86	328	385	430	446
7....	270	62	....	96.55	2.82	248	355	395	...
4....	268	350	30.70	....	1.20	273	373	472	...
6....	288	80	....	76.60	3.12	305	352	417	...
5....	250	337	53.00	....	0.48	273	346	440	...
7....	193	235	23.68	....	1.50	312	402	483	...
4....	340	435	28.00	....	0.48	339	398	438	...
39....	272	Soft	Soft	....	Soft	352	415	550	...
8....	285	142	....	50.00	1.70	309	372	472	...
1...	370	565	53.00	....	0.23	347	477	...	...
6....	340	Soft	....	Soft	Soft	372	433	504	...
19....	378	Soft	....	Soft	Soft	301	371	532	...
8....	371	Soft	....	Soft	Soft	317	382	509	...
30....	365	25	....	90.41	3.44	328	345	453	...
6....	360	10	....	97.00	4.00	308	363	468	...
16....	275	Soft	....	Soft	Soft	388	438	410	...
6....	352	Soft	....	Soft	Soft	307	435	456	...
6....	385	432	25.90	....	0.52	332	441	524	...
1....	387	532	37.20	....	0.43	355	334	...	...
4....	342	500	46.15	....	0.30	382	424	...	...
6....	372	94	....	80.00	5.40	430	490	430	...
4....	299	70	....	76.60	5.00	413	445	484	...
1....	358	143	....	44.57	3.23	332	390	...	...
2....	261	462	80.00	....	0.52	258	380	...	...
5....	261	374	33.00	....	0.70	233	412	...	...
6....	216	75	....	65.30	No Bar	217	457	...	...
1....	309	494	59.80	....	0.06	...	...	...	...
3....	282	410	45.30	....	0.81	311	395	...	...
2....	387	403	11.10	....	0.68	327	390	...	...
2....	216	440	137.00	....	0.48	361	410	...	...
3....	293	430	47.30	....	0.54	368	466	...	..
1....	308	432	40.26	....	0.36	310	426	...	...
4....	407	325	....	25.23	2.24	370	385	...	...
Av'ge	310	314	49.06	66.80	1.52	320	392	453	447

Mr. Rudolph J. Wig, Assistant Engineer of the United States Bureau of Standards, stated in his discussion that his criticism was based upon tests made by that Bureau over a period of nine months. He drew the following conclusions from these tests:—

1. Of the 48 brands tested, 88 per cent. passed the autoclave requirement upon some tests; 52 per cent. passed upon all tests; and 6 brands failed upon all tests.

2. There is no difference in linear expansion between set cements of types 2 and 3 (unsound and sound, respectively, under autoclave test) which are exposed in the atmosphere for 6 months.

3. Nor is there any difference in linear expansion in these cements when exposed to fresh water for 6 months.

4. The linear expansion of different cements varies from 0.135 to 4.2 per cent. of the original length when exposed to steam at pressures between 180 and 300 lbs. per square inch. The Type 3 cements had an expansion below 0.2 per cent., and the Type 2 cements had an expansion above 2 per cent.

5. The linear expansion of set cements exposed to steam increased slightly as the steam pressure was increased. (Samples tested show an average increase of 0.02 of 1 per cent. for pressures ranging from 100 to 275 lbs. per square inch.)

6. Set cements shows very little change in volume upon storage in air or water after being subjected to high-pressure steam.

7. Samples of apparently sound cements and concretes have been taken from structures 1 year or more old, and found to disintegrate upon being subjected to high-pressure steam. Samples of concrete of poor quality have been taken from structures 1 year or more old and found to show no physical change upon being subjected to high-pressure steam, while other samples of concrete of apparent poor quality entirely disintegrated.

8. The expansion of a 1:1 or 1:2 cement sand mortar made with Type 2 cement exposed to high-pressure steam, shows more than 50 per cent. of the expansion of the same cement neat exposed to high-pressure steam.

9. Of cements which are normally unsound in the ordinary atmospheric steam or autoclave steam test, if the finer size particles are removed, they will be found more sound if tested in the same manner as the original cement, and in many cases entirely sound. While fineness is not essential to soundness, it is the coarser particles of a normally unsound cement which cause the expansive action.

10. A cement originally unsound in the autoclave test will usually become sound in 2 to 6 months.

11. If the cement hydrated and formed into a test piece while it is unsound, it will not become sound upon aging for several months, even though the test piece is stored in water.

12. The maximum tensile strength of sound cement exposed to steam appears to be attained at a pressure not exceeding 150 lbs. per square inch.

13. The compressive strength of concretes made from the three types of cement—No. 1 cement failing to pass the standard atmospheric steam test; No. 2 cement passing the standard steam test, but not passing the autoclave test; No. 3 cement passing both the standard steam test and the autoclave test—show a tendency for Type 1 cements to develop the least strength and Type 3 cements the greatest strength, although the range of values is not very great, and these results should be considered somewhat tentative.

Sufficient data has not been advanced to justify a conclusion as to the merits of the proposed autoclave test of cement, or to warrant its adoption into a specification; but further investigation should be made and due consideration given to a hot test of greater severity than the present standard steam test.

Mr. L. R. Ferguson, Assistant Secretary of the Association of American Portland Cement Manufacturers, and Mr. Henry S. Spackman, consulting engineer, both of Philadelphia, Pa., also took an important part in the discussion, their remarks indicating that those cements which failed under the autoclave show a higher strength in 6 months than those which passed the test. In other words, the very paper advocating the new test has internal evidence which indicates that the increase in strength in the autoclave has no relation to the strength in a structure. Moreover, the results obtained by the experimenters are exactly what were to be expected, for the Germans, after an experience with the high-pressure steam test, concluded many years ago that it was of no value.

While, therefore, those participating in the discussion did not entirely condemn the test, and indicated that they would pursue their studies farther in order to determine its value, those who have been disturbed by recent agitation as to the adequacy of the present specifications may rest assured that the autoclave method has so far failed to demonstrate its value. There is nothing to prove that a cement bought under autoclave specifications is superior to one passing the standard specifications but failing under the autoclave test.

TABLE 4—AVERAGE OF RESULTS OF TESTS FROM MILLS 1 TO 5

Mill No.	Tensile strength, neat, at 24 hr., lb. per sq. in.	Autoclave test: Tensile strength, lb. per sq. in.	Autoclave test: Change in tensile strength, per cent: Increase	Autoclave test: Change in tensile strength, per cent: Decrease	Autoclave test: Expansion, per cent	Tensile strength of 1:3 briquettes, lb. per sq. in.: 7 days	28 days	3 months	6 months
1.....	416	687	57.71	....	0.13	393	450	475	463
2.....	407	631	54.53	....	0.27	380	447	486	463
3.....	372	345	42.54	47.13	1.31	367	437	468	453
4.....	349	393	38.96	39.15	1.13	338	402	440	452
5.....	310	314	49.06	66.80	1.52	320	392	453	447

ALUMINIUM INDUSTRY IN INDIA.

The working of aluminium in India is making rapid headway, and promises to become one of the most important industries of the country. The most important potential use of aluminium in India is in making vessels for carrying water to the native houses from the village taps or hydrants or from wells and rivers. On account of caste rules or prejudices, natives of different castes living in the same neighborhood must often go long distances apart in order to secure water not defiled or monopolized by other castes or outcastes, and as a rule not only the poverty of most of the people, but also their religious prejudices prevent the connection of their houses with central taps. When the natives are extremely poor they use earthenware vessels, but as their means increase they adopt the use of metal ware for carrying their water. In a prosperous community the vessels are commonly of copper or brass, but the advantages of aluminium for this purpose are becoming recognized, as it is not only much lighter to carry, but also much cheaper. An aluminium vessel of carrying capacity equal to one of brass or copper would be much cheaper, even if the same prices per pound were charged for the metal. Many metal dealers are now specializing in aluminium goods, and it is said that their profits are very large. Generally speaking, they can allow themselves a much wider margin of profit than is obtainable for brass or copper ware. Another important and rapidly extending use for aluminium in India is in manufacturing cooking utensils, especially kettles, gridirons, saucepans, stew pans, frying pans, etc.

Lockwood, Greene & Company, architects and engineers for industrial plants, with headquarters in Boston, have incorporated a Canadian company, and are opening an office in Montreal.

A COAL TESTING PLANT FOR THE SASKATCHEWAN GOVERNMENT.

A plant is about to be erected by the Saskatchewan government at Estevan for the purpose of developing and testing the lignite coal of that district. The plant will be in charge of Mr. S. M. Darling. The following short account of what he has accomplished with North Dakota lignite is especially interesting to us in view of the fact that the lignites of Southern Saskatchewan and of North Dakota are of the same cretaceous character.

The chemical composition of these lignites precludes their being successfully briquetted in their natural condition. To market the lignite commercially in a large way it must be destructively distilled, carbonized or partially carbonized, and the resulting gas, oil or tar, ammoniacal liquor and carbon residue utilized separately.

Analysis of a large number of samples of North Dakota lignite averaged on a dry basis; volatile matter 40.67, fixed carbon 53.33, ash (practically no sulphur) 6.00.

On carbonization, the products in round numbers are:—

1. Gas, per ton of lignite .... 10,000 cubic feet.
2. Oil or tar per ton .... 20 gallons.
3. Ammoniacal liquor .... 35 gallons.
4. Carbon residue .... 1,200 pounds.

The yields of gas and oil depends largely upon the temperature and rate of carbonization. With a high temperature and quick carbonization the yields of gas will be high and of oil low; while with a lower temperature, and longer time in which to carbonize, there will be less gas and more oil.

The gas has a heating value of 450 British thermal units per cubic foot. It contains a good percentage of illuminants, but has about fifteen per cent. of carbon dioxide, which almost entirely destroys the illuminating power. This carbon dioxide can be removed by passing the gas through lime, but the process is too expensive for commercial application. The gas can be used as an illuminant by burning it in a mantle, but it is serviceable principally for fuel and power.

There is more gas in one ton of lignite than is required to carbonize the next ton. In practice only sufficient gas is removed to supply the requisite fuel to carry on the process. The remaining portion of the volatile is left to add heating value to the carbon residue.

There is therefore no charge for fuel in the process.

On distillation the oil yields:—

Light oils, benzine, toluene, etc.	11.5 per cent.
Carbolic, oils, some naphthaline	11.5 per cent.
Creosote oils	36.1 per cent.
Anthracene, some paraffine	18.4 per cent.
Pitch, hard	22.4 per cent.

This oil or its distillates can be put to many uses—fuel oil, creosoting oil, leather preservative, waterproofing, pitch, etc. Upon exhaustive distillation it yields aniline dyes, carbolic acid, and in varying proportions all the other coal tar products.

The ammoniacal liquor yields some acetate of lime, or if desired, acetic acid, and about 15 pounds of sulphate of ammonia per ton of lignite. There is a growing market for all of these materials, particularly the sulphate, as fertilizer.

The lignite crumbles on carbonization, which renders possible a continuous carbonizing process, obviating the laborious charging and drawing of retorts, as practised in coal gas plants.

The cretaceous lignites retain largely their original woody structure, and hence do not break up so finely during carbonization. After removing by means of screens the small percentage of fines after carbonization, there remains practically lump charcoal of one-half to two inches in size. This can be used in gas producers, under boilers, and for domestic purposes. This lump charcoal is of about the same analysis as anthracite and has about the same heating value, but is not so dense in structure and therefore has somewhat more bulk per ton than the anthracite.

The fines have to be briquetted, or still further pulverized and burned as powdered fuel, a practice which is rapidly gaining favor.

Actual briquetting and burning tests of this fuel in carload lots demonstrate that satisfactory briquettes can be made with not to exceed 2 per cent. of starch and 6 per cent. of coal tar or lignite pitch as binder.

The briquettes burn with a short flame, no odor, no smoke and no clinker. They can be used wherever anthracite or bituminous coal is burned. They retain their structure in the fire until completely burned. They do not disintegrate or lose value in the weather, and can therefore be shipped any distance without loss.

The lignite coke is an ideal gas producer fuel. A satisfactory gas producer generating gas for power purposes from fuels containing a large amount of volatile, as does the raw lignite, is not available. But with the volatile removed, this lignite coke, transformed into producer gas and used in a gas engine to generate electricity, effects an enormous saving over the present method of producing electricity by means of boilers and steam engines. The gas producer requires only about one-fourth the fuel necessary with boiler and engine to produce an equal amount of horse-power. This producer gas also is an exceptionally good fuel for burning brick, tile, etc.

The matter of a large central power plant at the mines to generate electricity for transmission over a wide radius is essentially one of the quantity of current that can be sold, distance that it must be transmitted and evenness of load. If the current must be transmitted a long distance to a large centre of population there must be intermediate towns at which substantial quantities can be sold. This is simply a question of population. Of course, with cheap power available manufactories and people to use it will come rapidly. But, while the time is near when such a central power plant will be the logical thing, heed must be given also to the large demand for solid fuel, for gas producers, boilers and domestic purposes. Any large installation, therefore, would have as products not only electrical current, but coke, briquettes, fuel oil and other by-products resulting from the carbonizing process.

To defray the cost of carbonizing and briquetting there is the revenue from the by-products, and it is known that the income from this source will at least meet that charge. But aside from this, there is to be derived from this carbonizing process the enormous benefit afforded by the possibility of mining and shipping lignite the year round because the product is put into a condition which prevents deterioration no matter how long the fuel is stored or how far it is shipped.

The Lancashire Dynamo and Motor Company of Canada, Limited, have moved to new premises at 107 Duke Street, Toronto.

A French process of "electrocuting" timber is declared to give perfect seasoning in a single night. With lead plate electrodes on each side the timber is placed in a solution containing 10 per cent. of borax, 5 per cent. of resin and a little soda, and application of the current expels the sap and fills the wood cells with the borax and the resin.

EXPERIMENTAL MINE EXPLOSIONS.

Coal dust explosion tests in an experimental mine are dealt with in Bulletin No. 56 of the United States Bureau of Mines for the purpose of placing before mining men an account of the objects sought in the establishment of the experimental mine of the bureau. A description is given of the arrangement and equipment, and a detailed account of the first series of explosion tests, with explanatory notes concerning recording apparatus, etc.

Particularly interesting is the information which the bulletin contains concerning the mine and its operation. The requirements considered in connection with the selection of the mine site were:—

It should be in a coal bed, the dust of which was inflammable; the mine should be naturally dry and self-draining; its openings should be drifts to avoid complications of shaft-wrecking; the mine should be practically free of explosive gas; a supply of natural gas should be available, so that tests with gas could be made if desirable; a good boiler-feed water supply should be available; and mine should be near a railroad, but at some distance from dwellings.

These requirements were met in the selection of the site at Bruceton, thirteen miles from Pittsburg. Development was begun in December, 1910. The mine at the time the first tests were made, which were considered to be preliminary tests, consisted of two main parallel entries a little over 700 feet long, nine feet wide, with a forty-one foot pillar between them. The entries were connected with cut-throughs every 200 feet. A diagonal heading 198 feet long connected the air-course at a point 117 feet from its mouth to a third opening. Ventilation was furnished by a small fan at the top of an air-shaft, which is offset six feet from the air course fifty-five feet from the opening.

The main entry was lined with reinforced concrete for the first 169 feet, and a strongly reinforced concrete portal constructed at the main opening. Five rows of shelves, three inches wide, were installed on each side of the main entry. The explosions in the first series were originated by blown-out shots of black powder from a cannon at the face of the entry or a pipe embedded in the coal. The shock wave from the shot would blow up the coal dust from a bench in front of the shot into a cloud and ignite it. Beyond this point the coal dust previously placed on shelves in like manner would be thrown into a cloud in advance of the flame and in turn be ignited.

At various points along the main entry instrument stations had been constructed in the coal rib, which were separated from the explosion gallery by heavy steel plates. Four types of instruments were used in recording the results of the explosions. Pressure manometers were used to give a record on a revolving smoked paper of the variation in pressure at the particular point. Pressure circuit breakers, installed in the stations, were connected to recording apparatus in an outside observatory by means of wires passing through a pipe embedded in concrete in a groove in the coal rib. When the circuit breakers were acted upon by a certain pressure the circuits were broken, the time of the breaks being recorded on a moving paper strip in the recording instrument at the surface. This permitted the determination of the velocities of the pressure wave between different stations. In like manner the velocity of the flame is obtained by a series of flame circuit breakers installed in the various stations. In addition, maximum pressure gauges measured, by the compression of copper cylinders, the maximum pressure exerted at various points.

The first series consisted of fifteen tests. Several of these were given before large numbers of spectators, that of December 30th, 1911, before about 500 persons. A large part of the value of this series was the educational work performed in convincing many persons who still doubted the explosibility of coal dust, that violent explosions could occur without the assistance of inflammable gas in the air. Apart from this result the tests were chiefly valuable in trying out the mine conditions and the various pieces of recording apparatus. Practically all of the tests were made for the purpose of obtaining information with respect to the phenomena accompanying the explosions. For this reason there was little opportunity for studying preventatives. The Taffenel barrier, with a load of shale dust, was not tried in the direct path of the explosion, but was installed a number of times in the air-course parallel to the main entry. The results were inconclusive as to its value.

Each of the explosions is described in detail in the bulletin as to origin of explosion, character of igniting shot, quality and quantity of coal dust used, nature of preventative, outside manifestations of the explosion, inside observations after the explosion, length of flame, and character of records obtained. Analyses of coal dust after the explosion, soot, coked dust, and mine air before and after the explosions are included in the description of the tests.

CHANGE OF NAME FOR NOVA SCOTIA FIRM.

The William P. McNeil and Company, Limited, of New Glasgow, N.S., have announced a change of name to that of the Maritime Bridge Company, Limited. The executive and directorate of the new firm is as follows:—Executive—Walter McNeil, president; Kenower W. Bash, vice-president and manager; Robert C. Grant, secretary. Directors—Francis C. McMath, president Canadian Bridge Company, Limited; Phelps Johnson, president Dominion Bridge Company, Limited; G. H. Duggan, general manager Dominion Bridge Company, Limited.

The old company was incorporated in 1908, although it existed for some time previous to that, in which time it has built up a considerable business. A good market for the products of the company was developed and in the spring of 1912 it was deemed advisable to place the plant and business in the most advantageous position possible for the handling of its requirements. This resulted in the joint purchase by the Canadian Bridge Company, Limited, of Walkerville and the Dominion Bridge Company, of the control of the organization.

In the fall of last year the plant was thoroughly overhauled and extensions made. Better facilities for fabrication work were introduced by more efficient routing of material, etc. The growth of the business in the eastern provinces and the development of the plant under the impetus of the changes made has been very marked.

DURABILITY OF TIES.

The average life of untreated ties as reported by the steam roads is as follows: Cedar, 9 years; tamarack, 8 years; hemlock, 7 years; Douglas fir, 7 years; jack pine, 6 years; spruce, 6 years. As recent statistics bear evidence, cedar is the species pincipally used, because of its durability, but the supply of cedar is rapidly becoming exhausted. Unless preservative treatment of ties is introduced, the short-lived species will have to be used untreated, which, on account of the necessary frequent renewal, will increase the cost of mileage maintenance. If treated ties were used, which would cost 30 cents extra per tie for creosoting and equipping with tie-plates, the inferior species, which are very plentiful and cheap in Canada, could be used with economy. With such a treatment, these woods would last at least fifteen years, and if protected from wear would probably last much longer, and would effect a very considerable saving.

COAST TO COAST.

Fort William, Ont.—The city of Fort William will take over their end of the electric street railway this coming fall. Heretofore the city of Port Arthur controlled the street railway under a joint board, made up of representatives from both cities. Formal steps have already been made in connection with the operation and interchange service between the two cities.

Toronto, Ont.—Superintendent Bennett, of the Colonization Roads Department, has arrived at the Parliament Buildings after an inspection of the districts recently visited by forest fires. The damage to bridges, he said, was very slight. In the Sudbury district a $25,000 colonization road nine miles in length was completed last week. The colonization road work had not been seriously delayed by the fires, and the extent of territory benefited this season was likely to make a new record.

Ottawa, Ont.—A great improvement has been made to the Richmond Road between the city limits and Westboro. Employees of the Bytown and Ottawa Road Company have covered the road with tarvia. As it is now almost a dustless road, it is certainly a great improvement, and one that is much appreciated by those residents living along the way. For some time the residents of Westboro and all along the Richmond Road have been urging the road corporation to take action in the matter, and at one time they suggested that the road through the village should be treated at the expense of private parties. It is understood that the road company intends to cover the road with tarvia for several miles west of Westboro. This will also meet with the approval of farmers in that locality.

Victoria, B.C.—The city officials are paying about $8,000 a month to the Esquimalt Waterworks Company for the purchase of water from Goldstream, judged on the basis of last month. It is intimated by a prominent city official that the yearly cost will run to $80,000. It is frequently stated that the city is making a profit by buying water at half its retail cost, to sell again to consumers, the observation being based on the fact that the Esquimalt Company is selling five million gallons of water per day at six cents a thousand gallons. However, of that amount at least 30 per cent. never is retailed to consumers, the loss in the mains, evaporation at the reservoir, water for city services, and the amount lost in other ways absorbing the difference. Besides, the city has to maintain a distributing service for its consumers. Those in touch with the matter expect that the profit and loss account on this purchase will not show a large margin for the city when the whole information is tabulated for the consideration of the council.

Toronto, Ont.—Sir William Mackenzie, president of the Canadian Northern Railway, has secured the money necessary for the fulfilment of the Canadian Northern Railway Pacific Coast terminal plans, and they are to be proceeded with without delay. In a recent interview Sir William stated that, of the capital he had secured in London—an issue of $2,000,000 of 4½ per cent. terminal bonds, and an issue of $7,500,000 of five per cent. five-year notes—a large portion would be immediately used for western terminal development and the remainder for the building of an extension of the Canadian Northern Railway lines in Western Canada. Included in the Canadian Northern Railway Pacific Coast plans are large yards and shops to be erected at Port Mann; terminal stations, etc., at Victoria and New Westminster, and at the city of Vancouver a project which involves an expenditure of $10,000,000, and which will take five years to carry out. In consideration of the conveyance to the railway by the citizens of Vancouver of what is known as False Creek, the Canadian Northern Railway are building the main Pacific terminals thereon, including a big passenger depot at a cost of $1,500,000; the erection of a modern hotel, and the absolute reclamation of False Creek. The plans further called for making the railway's own entrance into Vancouver by way of a tunnel from New Westminster, the construction of which will cost in the neighborhood of $4,000,000.

Ottawa, Ont.—The Commission of Conservation, under the chairmanship of Hon. Clifford Sifton, has issued an exhaustive and carefully prepared report on the general question as to the giving of power rights on the St. Lawrence River to private corporations, with special reference to the application pending before the United States Congress from the Long Sault Development Company for rights to dam the St. Lawrence at the Long Sault Rapids, near Cornwall. The enormous importance of the power franchises, involving the whole industrial development of Eastern Ontario, Western Quebec and the bordering American States, is fully pointed out in the preface to the report, and the logical conclusion is reached from a study of all the conditions that the plain duty of the Federal Government is to maintain public ownership and control of all the power rights on the river absolutely unimpaired. The Commission strongly urges that public interests in power development on the St. Lawrence should be conserved for all time, and that the persistent efforts of the merger company to secure monopoly rights should be firmly resisted.

Toronto, Ont.—It is rumored in the city that the farmers in the County of York are concluding that the good roads provided by the Commission do not meet the requirements of vehicular traffic. Not only is it stated that the good roads so far supplied are not so constructed as to stand the wear and tear of traffic, but macadam roads are being declared a failure. There are many who have reached a conviction that the only solution of the good roads problem is to construct asphalt pavements, the same as in the city. Such is the condition of public sentiment upon the results shown by the Commission that a reorganization of the good roads movement in the near future is likely to be demanded.

Toronto, Ont.—The Toronto Board of Trade is preparing for an active year in civic improvement and the general development of Ontario and Canada, and will in October resume the publication of The Board of Trade News, the official publication of the organization, which is not issued during the months of August and September. The members and officials of the organization are naturally proud of the things accomplished in the past, and point with pride to the creation of the Board of Railway Commissioners, the Harbor Commission, the work on the new Welland Canal, the agreement for a railroad viaduct on the water front, and the initiation of the movement for good roads with an appropriation to date of $600,000. The scope of the future work of the Board of Trade may be understood from the appointment of special committees to give attention to the subjects named, viz., harbor and Welland Canal, railway and transportation, legislation and education, good roads, civic and social service, Ontario development, express rates and parcel post, viaduct, publicity, Federal square, foreign trade, membership and conference committee of one hundred. The organization was incorporated in 1845, and now has a membership of 2,800.

Toronto, Ont.—Toronto will have the finest freight terminals in the world before this time next year. The Canadian Pacific Railway has just completed plans for additional buildings to be erected at the corner of King and Simcoe Streets, on the old Government House site, and the Grand Trunk Railway also is planning the erection of more buildings at the corner of Wellington and Simcoe Streets. City Architect Price and the division engineers of the Canadian Pacific Railway declare that the Toronto freight terminals will be the most modern anywhere. The large new building which the Canadian Pacific Railway will erect at King and Simcoe Streets will cost over half a million dollars. It will be used by the freight department and the Dominion Express Company, which will leave the Union Station altogether. Following is a partial list of the works the Canadian Pacific will carry out in connection with its new freight terminals: Solid brick and steel warehouse, fronting on King Street, 500 by 75 feet, to be used by the freight department and the Dominion Express Company, cost $500,000. Freight house for inbound freight, 900 by 50 feet; freight house for outbound freight, 900 by 50 feet; covered transfer platform, 900 by 50 feet; offices on Simcoe Street connecting both freight houses, size 40 by 185 feet. All buildings will be of solid brick and steel construction, and the total cost of erecting them is estimated at $1,200,000. This does not include the cost of track-work, paving, real estate, legal and other general expenses. The real estate alone cost over $2,000,000; a retaining wall to support the south side of Front Street will cost $49,000; it will cost $43,000 to pave roadways, and the track-work, grading and incidentals will cost $132,000. There will be fifteen railway tracks in connection with the Canadian Pacific Railway terminals and three granite-block-paved team roads with alternate tracks.

Victoria, B.C.—Costing $4,000,000, and unquestionably to be the largest shipbuilding drydock and ship-repairing plant in Canada, the scheme of the Amalgamated Engineering Company for North Vancouver has been approved by Hon. R. Rogers, Minister of Public Works. Work will be started as soon as the necessary formalities are arranged with the Government. The plant will be situated in D. L. 265, and will include a floating drydock, a shipbuilding plant and ship-repairing works of the most modern type. The immense basin will give a depth of thirty feet at low tide. The floating dock will have a lifting capacity of 20,000 tons, which will provide a wide margin over the present requirements of shipping in Burrard Inlet. A second dock will be built to the west of the basin capable of accommodating smaller vessels. Building berths will also be erected. Four in number, two will be 750 feet long and 100 feet wide, and two will be 350 feet long and 75 feet wide. Shops will be constructed in connection with the works and with the railway facilities of the North Shore. Electric cranes and the latest machinery will be the features of these. Construction of the plant will require three years. When in full working order it is expected to give employment to an average of 2,000 men. Plans are now being hurried forward, and, when ready, will be forwarded to the Dominion Government so that the necessary Order-in-Council may be passed. Mr. C. J. V. Spratt, of Victoria, is managing-director of the company, which includes Col. Sir Henry Pellatt, Col. Sir John M. Gibson, Lieutenant-Governor of Ontario; Mr. D. B. Hanna, and Mr. E. J. Palmerm, of the Victoria Lumber and Manufacturing Company, Chemainus. Also, there is an advisory board of directors—men of high standing in Great Britain. The site, which was purchased from the Lonsdale estate, covers an area of eighty acres—which is quite sufficient for the establishment of a great and flourishing industry. The original idea was to invest $2,500,000 in the scheme, but after further consideration it was felt that a more comprehensive plant was needed, and enlargement was accordingly effected. The company acquired the property on especially favorable terms on the understanding that they would complete the construction in a given time, and that they would give employment to a certain number of men within a specified period.

Montreal, Que.—An appropriation of $1,500 to cover the expenses of a specially qualified man to report on the whole plan of municipal ferry-boats running to St. Helen's Island is recommended to Council by the Controllers. They favor municipal ferries rather than a renewal of the present contract, which expires on May 1st, 1915. There may be some opposition to this recommendation as there is standing in abeyance just now a scheme for another report of a somewhat similar character. The Council approved of the idea of having a report from two engineers, appointed by the city and Harbor Board, respectively, on the suitability of the Island for an exhibition and the possibilities in the way of developing sufficient means of access. The city has appointed a man but the Harbor Board has not as yet. The report now desired by the Board of Control is to be on the kind of boats required, their probable cost, best places for docks, and probable cost of the whole scheme.

Montreal, Que.—The corporation of Montreal is employing 10,000 men, outside of the permanent staff. More than half of these are engaged in laying concrete and asphalt pavements and sidewalks. The weekly payroll is more than $100,000. The work commenced early in the spring and will be continued until the snow comes. The demand for unskilled labor has long since far exceeded the native supply, and the importation of foreign hands is steadily increasing. The Italians and other Southern Europeans who do this kind of work were formerly of a nomadic character, but employment has been so steady and there is so much in sight that they are becoming permanent residents. This season a large number of Russians have been added to the labor population of the city and suburbs.

New Westminster, B.C.—Mr. F. J. McKenzie, M.P.P. for Delta, took a seventy miles trip over Langley and Surrey Roads recently, and found that the work was being speeded by both government and municipal employees in order to put as much of the road improvement through as possible before the rainy season begins September usually sees the end of the season, but there is no question that the roads on the south side of the Fraser will be in much better condition for traffic this winter than they were last. A great amount of road grading has been done, which is now being ballasted, and a start has been made with rocking the road between Murrayville and Langley Prairie. This is the beginning of rock work in Langley Prairie, and in future rocking will supplant gravel in that municipality. The route taken by Mr. McKenzie was through Port Mann, Port Kells, Jericho, Clayton and Colebrook, and returning by the Scott Road and the hill there, about which so much complaint has been made, is now in good condition.

Vancouver, B.C.—The greatly improved roads of North Vancouver are beginning to exert a great attraction for Vancouver automobilists. Most striking testimony of this is the fact that fines imposed on motor car owners and drivers by the North Vancouver district police courts are far greater than they were two years ago. The latest move in the good roads project across the Inlet was the application by the Vancouver Automobile Club recently to the District Council asking that the remaining two miles of Keith Road to Deep Cove be surfaced by the municipality. Mr. Ford, the secretary, in his communication, showed the advantages in increase of trade an increase in automobile traffic would entail. It was said that the cost of the work would be proportionately trifling. The Council replied that it had the matter under consideration for some time, but that finances did not permit the letting of the contract. When the revenues increased, it would be possible to take up the project again. In the meantime the letter was referred to the Board of Works. Automobilists from Vancouver have opportunities for three splendid tours in North Vancouver. By far the best, and the one most frequently travelled is the Capilano Road. The Lynn Valley Road has been macadamized, and presents a good surface for automobiling from the North Vancouver Ferries entrance to the Rice Lake intake. The Dundarave Road contains less hills, and furnishes a beautiful view. Part of this thoroughfare runs through West Vancouver, where the "boulevard" is the pride of the residents. All three routes run through pleasant stretches of woods and near wonderful stretches of water. The West Vancouver highway will, it is expected, some time be a business street throughout the greater part of its length. In the three municipalities the greatest expenditure is for this road.

Montreal, Que.—In a report to the Harbor Commission, F. N. Cowie, engineer of the Commission, reports a serious state of affairs in regard to the pumping station for sewage being erected near the Place Royale. The site selected adjoins the Sailors' Institute and the Birmingham Building. It was necessary for the contractor to go down a considerable distance for the foundations. For fourteen feet good soil was found, but below that clay and quicksand, very wet, has been met with. Mr. Cowie advises the Harbor Commission to assume no responsibility whatever for the work, as the city of Montreal made the selection, the station being needed for the diversion of sewage from the Elgin basin. The work is being done at the joint expense of City and Harbor Commission. Mr. Cowie declares that the Birmingham Building will have to be taken down, as the walls are in a state of collapse, and the walls of the Sailors' Institute are none too safe. The excavation, states Mr. Cowie, is in a deplorable condition. The timbering has collapsed and the lower portion of the ground is caving in. The depth of the excavation is held responsible by Mr. Cowie for the condition of the Birmingham Building and the Sailors' Institute.

Prince Albert, Sask.—An exhaustive report on the power situation by F. A. Creighton, power manager, which has been in the hands of the aldermen for some time, was read at the last meeting of the city council, at which P. H. Mitchell, the consulting engineer, was present, and made a number of explanations on various points. The estimated cost of completion of the scheme on the basis of a 4,000 horse-power capacity is $1,700,000, and of this sum $771,111 was spent up to June 30th. One of the most important points in the report was in regard to the flow of water at La Colle Falls during the dry season of the year. According to a gauging taken last year, the only one available, that flow is only 1,500 second feet during January, February and March, and with such a flow only 3,360 horse-power could be generated. Mr. Mitchell emphasized the handicap they had from the lack of sufficient and reliable data on those gaugings, and it was decided to petition the Dominion Government to make arrangements twice a week from November till May.

PERSONAL

M. B. WATSON, B.A.Sc., has been appointed Assistant Engineer to the Ontario Highway Commissioners.

GEO. H. POWER, of Chipman and Power, Consulting Civil Engineers, is returning this week to take charge of the Winnipeg office, after spending several months in Toronto.

J. H. BILLINGS, B.A.Sc., has accepted a position in the Department of Mechanical Engineering of the University of Missouri, Columbia, Mo., as instructor in thermodynamics.

GEO. CONDON has accepted an appointment from the National Steel Car Company, Ltd., of Hamilton, Ont., to represent them in Montreal. The new offices are in the Shaughnessy Building.

V. A. E. GOAD, B.A.Sc., has gone to Montreal where he will take permanent charge of the Montreal interests of the Chas. E. Goad Company. Mr. Goad has been associated with the main office in Toronto for the past three years.

ISHAM RANDOLPH, C.E., of Chicago, announces that he has removed his offices to Suite 1807 Commercial National Bank Building, north-east corner of Adams and Clark Streets, where he will continue his practice as consulting engineer.

F. D. MANNING has been appointed Canadian sales manager for the Continental Car Equipment Company, Inc., of New York City and Louisville, Ky., manufacturers of dump cars. Mr. Manning will have his offices in the C.P.R. Building, Toronto.

WM. C. WILLARD has been appointed Assistant Professor of Railway Engineering at McGill University, succeeding Professor Smart, resigned. Mr. Willard is a graduate of Lehigh University, an associate member of the American Society of Civil Engineers and a member of the American Railway Engineering Association. He leaves the position of Assistant Civil Engineer, Panama-Pacific International Exposition, San Francisco, California, to come to Montreal. Among other positions of importance held by Mr. Willard are those of Instructor in Civil Engineering and Director of the Summer School of Surveying, University of California; Assistant Engineer, construction department, Southern Pacific Railway; Professor of Railway and Highway Engineering, State College of Washington, and Assistant City Engineer, Oakland, California.

COMING MEETINGS.

THE ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Sixth General Annual Assembly will be held at Calgary, Alberta, September 15th and 16th. President, J. H. G. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.—Tenth Annual Meeting will be held at Cleveland, Ohio, September 17th and 18th. Secretary, W. P. Blair, 824 Engineers' Building, Cleveland, Ohio.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Third Annual Meeting in Regina, September 18th, 19th and 20th. General Secretary, Major Lorne Drum, Ottawa; Local Secretary, R. H. Murray, C.E., Regina.

ILLUMINATING ENGINEERING SOCIETY.—Annual Convention to be held at Pittsburg, Pa., September 22nd to the 26th. Secretary, I. D. Israel, 29 West 39th Street, New York City.

AMERICAN ROAD CONGRESS.—Annual Session will be held in Detroit, Michigan, from September 29th to October 4th. Secretary, J. E. Pennybacker, Colorado Building, Washington, D.C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—Twentieth Annual Meeting to be held in Wilmington, Del., October 7th to 10th. Secretary, A. Prescott Folwell, 15 Union Square, New York.

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

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

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.