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ST. PAUL STREET BRIDGE, ST. CATHARINES

NOTES ON THE DESIGN OF FOUNDATIONS AND SUPERSTRUCTURE OF THE PROPOSED STEEL HIGH LEVEL VIADUCT FOR WHICH CONTRACTS ARE NOW BEING LET.

By H. C. TAYLOR,
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THE substructure is under way and tenders have been called for the superstructure of a steel viaduct 1,236 ft. 3½ inches in length to provide a better means of communication between the business centre of the city of St. Catharines and the section known as the Western Hill. The only steam railway entering the city is the Grand Trunk, and its station and freight sheds are also situated on Western Hill. A deep valley intervenes, through which extends the old Welland Canal.

The need of a high level bridge has been a subject of controversy for a quarter of a century, and several campaigns were started at different times by private enterprise to provide funds for its construction. No definite action was taken by the city itself, however, until shortly after the outbreak of European hostilities, when, in the face of an indefinite period of monetary stringency, a by-law was passed by the ratepayers authorizing its immediate construction.

Of the several possible routes the St. Paul St. extension was finally chosen as being in the best interests of the city. A very slight deviation of the street alignment was necessary, and the structure at the same street level, as proposed, is made to provide for the elimination of 80 ft. of heavy grades with which the present roundabout road to the station is handicapped.

Several designs for the contemplated structure were submitted by Messrs. Sprague and Reppert, consulting civil engineers, Pittsburgh, Pa. Fig. 1 shows the type selected. In the test borings on the site no rock was found nearer the surface than 85 ft. There was also a matter of $40,000 difference between this design and an alternative one of concrete construction. Both factors figured materially in the selection of a steel structure. The cost of the bridge is estimated at $165,000, while the right-of-way has been purchased by the city for $55,000. Against this there are two grants, one from the Dominion Government amounting to $50,000 and one from the Grand Trunk Railway to the amount of $20,000; making a net cost to the city of $150,000. Preliminary work has included, in addition to the above, the cost of removing four stores and three large houses from the site of the north approach to the bridge. A new street will be made, and, when the structure is completed, there will be two

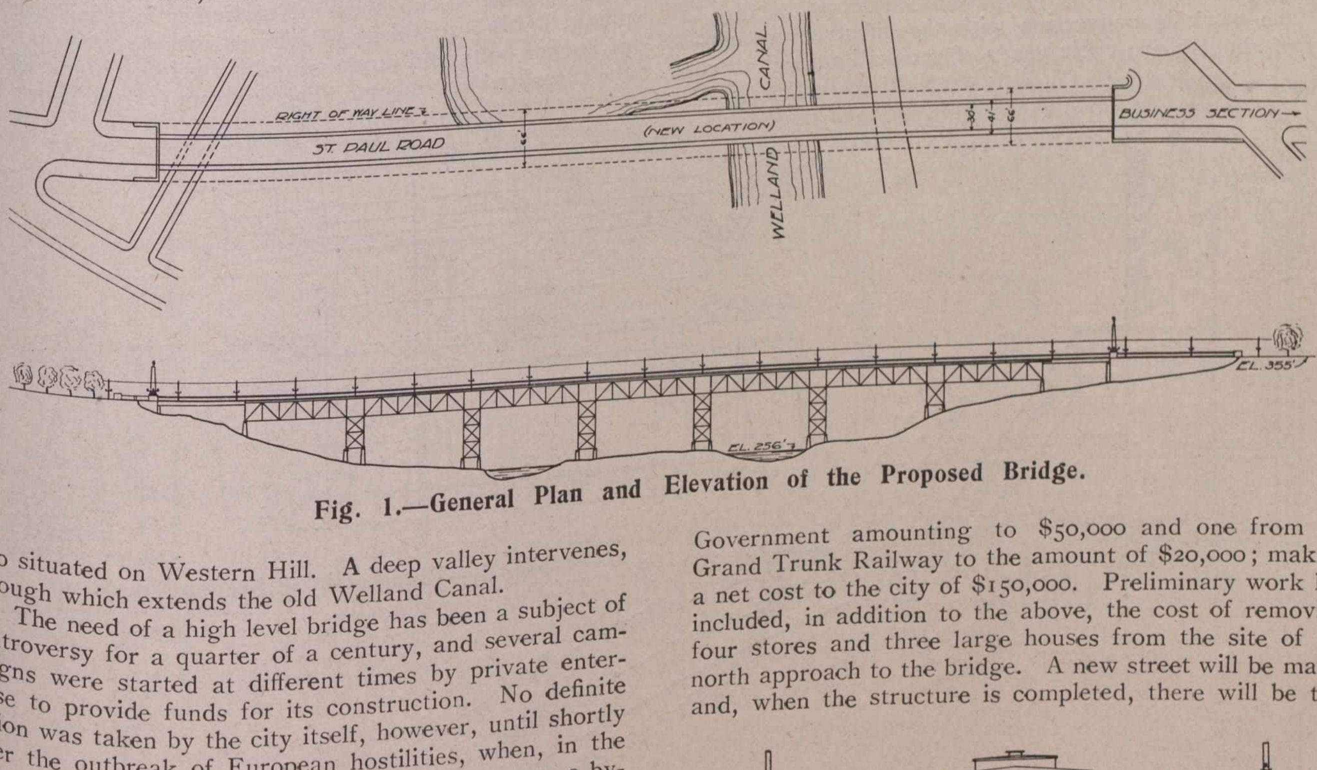

Fig. 1.—General Plan and Elevation of the Proposed Bridge.

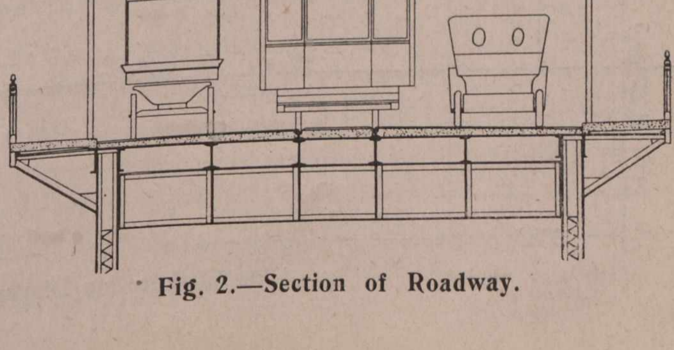

Fig. 2.—Section of Roadway.

streets leading directly to the bridge at the north end, thus allowing for future extension of traffic.

Contracts are being let in three sections. The substructure has already been let by contract to Campbell &

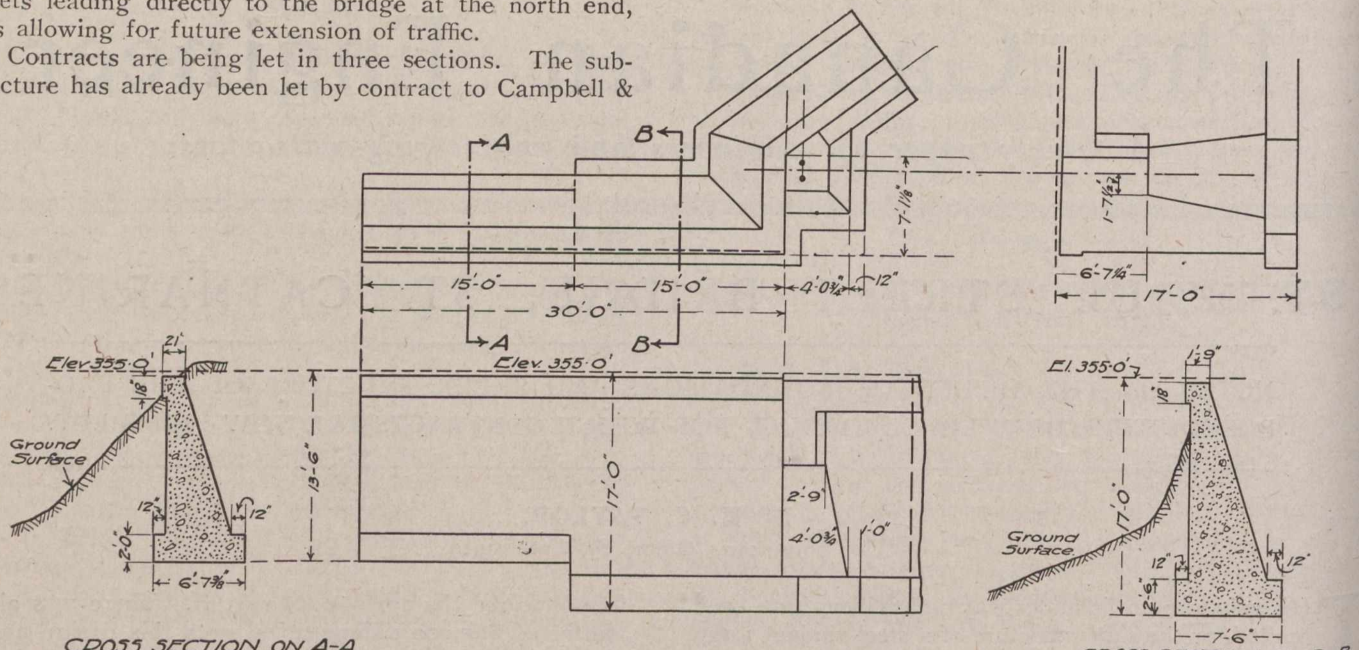

Fig. 3.—Details of Wall Section No. 1.

Lattimore, Toronto. Tenders for the steel superstructure close on December 8th. The contract for paving, which will probably be of creosoted wood block, will be let at a later date.

The work in connection with the substructure consists of about 3,000 cubic yards of excavation, and 1,850 cubic yards of concrete in piers and abutments. There will also be considerable concreting in copings and parapet wall. About 10,240 lineal ft. of timber is being used in piling. Other quantities of interest include 7,250 pounds of anchor bolts and 3,000 pounds of reinforcing steel for the piers and abutments. The contract for this work has

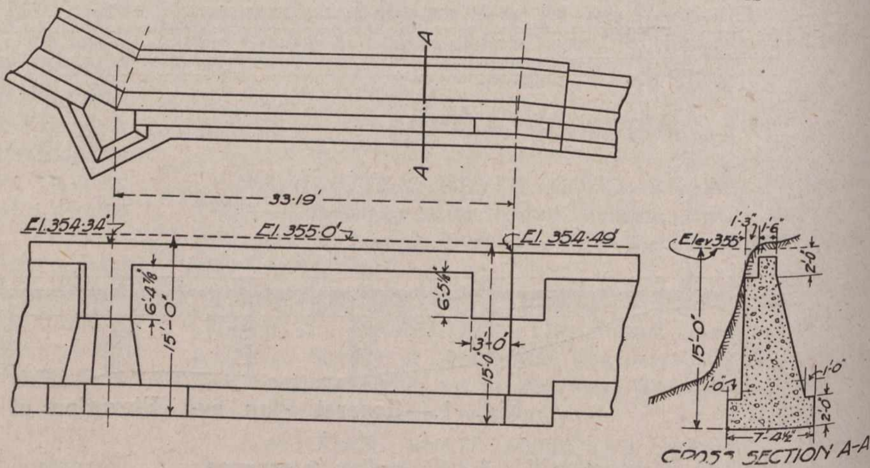

Fig. 4.—Detail of Wall Section No. 3.

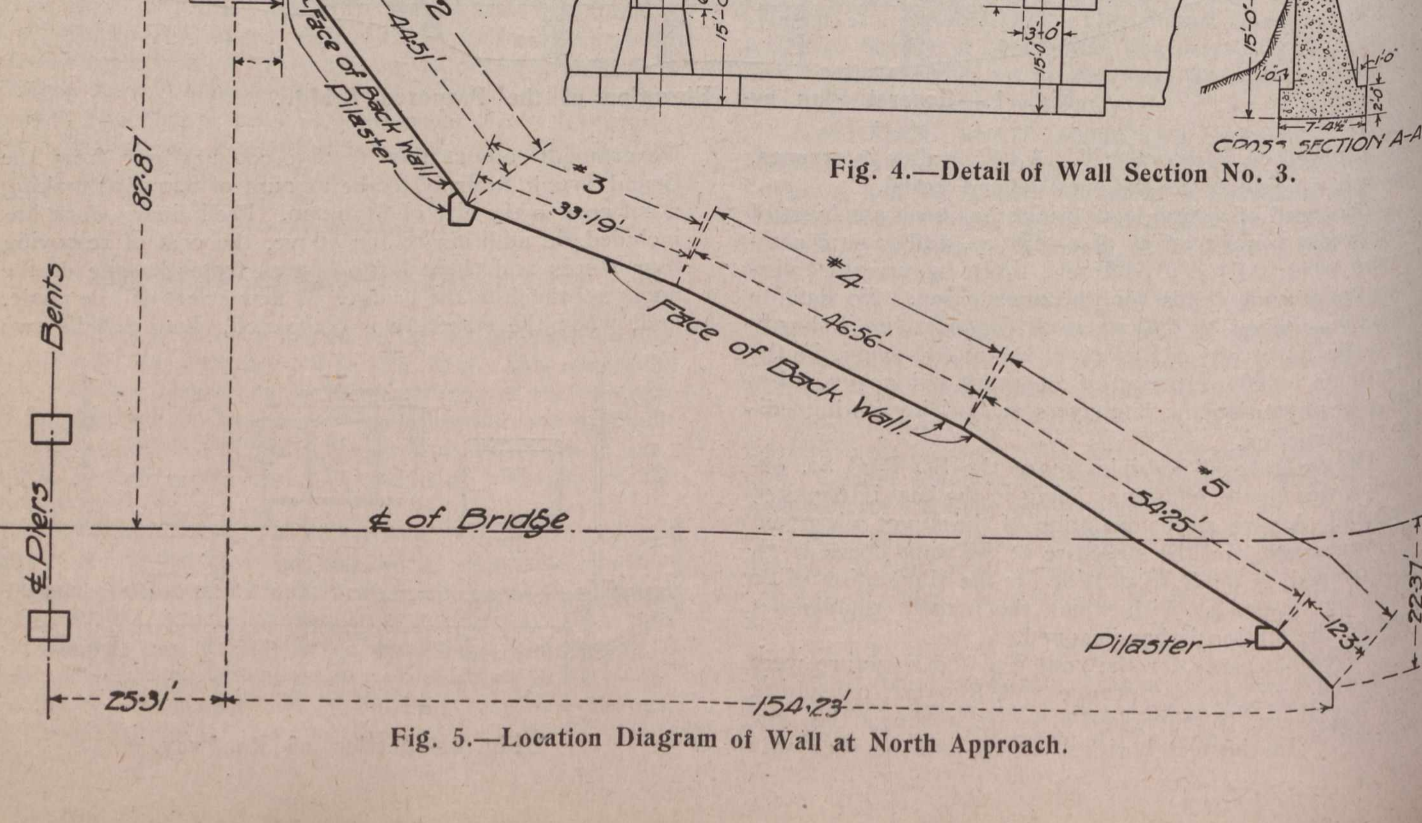

Fig. 5.—Location Diagram of Wall at North Approach.

been let at an amount about $10,000 under the engineer's estimate, the latter being based on normal conditions.

The design of the north abutment possesses some points of considerable interest. As shown in Fig. 5, the wall has been divided into sections with alignments at angles to the centre line of the bridge. Section 1, 30 ft. 46.56 ft. long, the height decreases owing to an elevation of 2 ft. of the base, while the thickness of the base of the retaining wall decreases with the height to 6 ft. 10½ in. Wall section No. 5, which is illustrated in Fig. 6, is 54.25 ft. long with a depression of the base to 15 ft. and a corresponding enlargement of the base to 7 ft. 4½ in. in

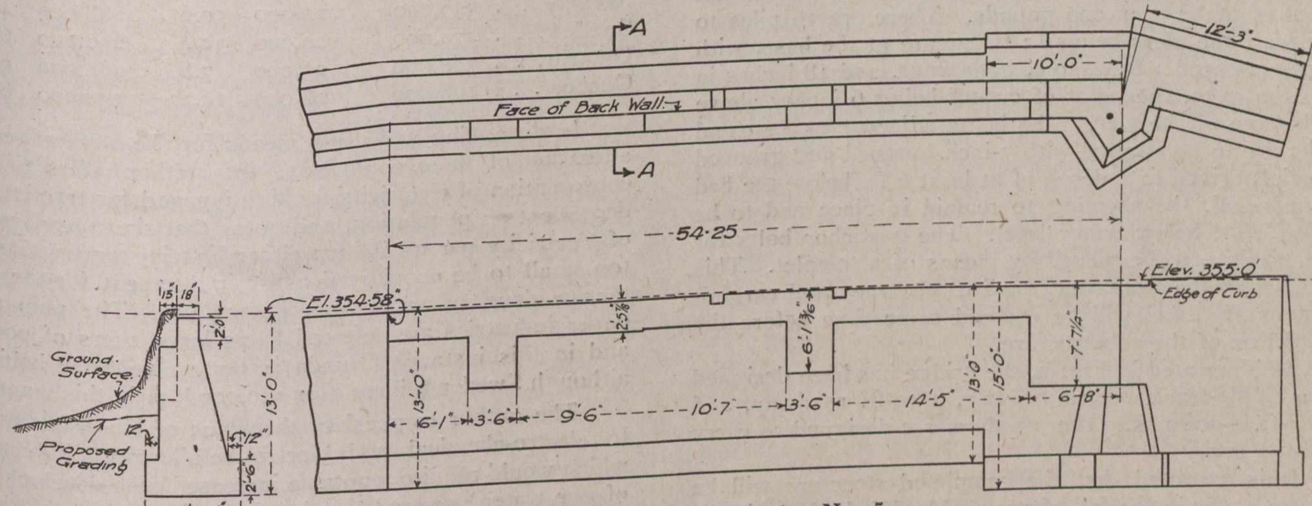

Fig. 6.—Details of Wall Section No. 5.

in length, marking the extreme end of the abutment along Yates St., is shown in detail in Fig. 3. It varies in height from 13½ ft. to 17 ft., and includes a pilaster at the intersection with wall section No. 2. Section No. 3, the details of which are shown in Fig. 4, which is 33.19 ft. in length, is uniform in depth, 15 ft., and its section corresponds to section BB' in dimensions. In section 4, width, as shown in Fig. 5. The centre line of the bridge is crossed by this wall section, and a pilaster, shown in Fig. 6, connects a sub-section 12 ft. 3 in. in length, which forms the extremity of the abutment wall.

The south abutment, 24½ ft. in length, is shown in Fig. 7, which illustrates clearly the general features of its design and the proportioning of the supporting walls.

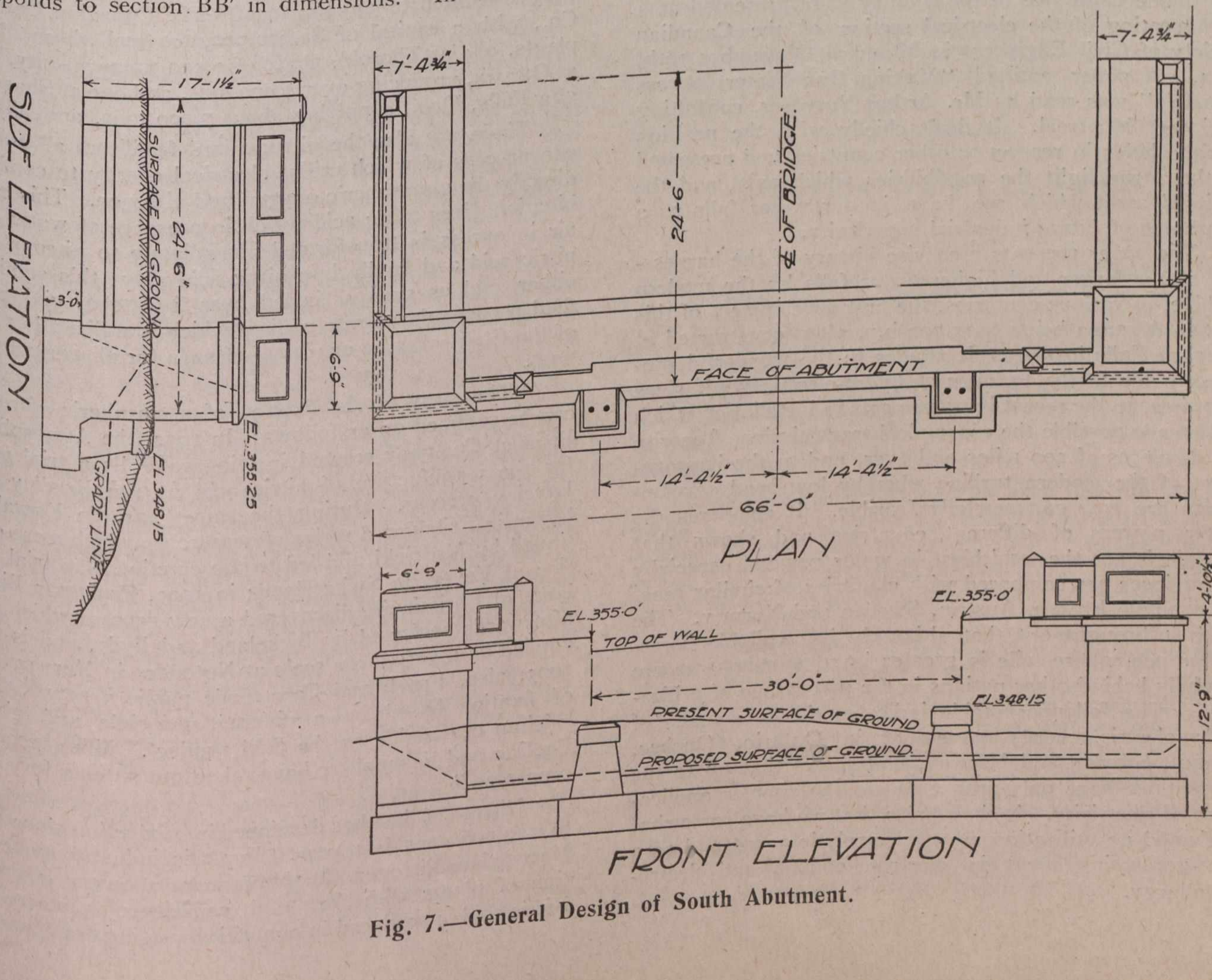

Fig. 7.—General Design of South Abutment.

There will be seven Warren truss spans, with plate girders at the ends extending to the concrete approaches. The steel is supported on 35 concrete piers, two for each of 17 bents, and a single pier at the south end. Five of these piers are reinforced. The 8 bents on the level portion of the valley rest on timber piles driven to a depth of about 40 ft., or to a point where each pile will sustain a load of at least 30,000 pounds. There are 16 piles to each pier, the piers being 12 ft. square at the base, with the piles spaced 3 ft. c. to c. both ways, and 18 inches in from the edge, the point of cut-off being 6 inches above the bottom of the pier. The bents adjacent to the canal banks are to be sheeted with 3-inch tongued and grooved material, driven to a depth of at least 6 ft. below the bed of the canal, the sheeting to remain in place and to be cut off 1 ft. below water level. The 4 anchor bolts for each pier are to be placed by means of a templet. This is a part of the work that requires accuracy and carefulness, as the steel will be ordered some time before the completion of the substructure.

As illustrated in Fig. 2, the bridge has been designed for a single-track electric railway, a 30-ft. roadway, and two 5-ft. sidewalks. The members are designed to carry a 36-ton car.

It is expected that the completed structure will be open to traffic in the fall of 1915. Mr. W. P. Near is the city engineer.

FIELDS FOR THE INDUSTRIAL APPLICATION OF CANADIAN WATER POWERS.

SOME very potent arguments bearing upon Canadian water powers and the rate at which they are being made of service to the country were presented at a meeting of the electrical section of the Canadian Society of Civil Engineers in Montreal, November 16th, 1914. A paper entitled "Making Our Water Powers Valuable" was read by Mr. Arthur Surveyer, consulting engineer, Montreal. It dealt chiefly with the position Canada holds in respect to other countries and presented in their true light the possibilities which exist and the national asset which we have in our water falls as a guarantee of future industrial superiority.

The paper presents a concise history of the harnessing of the larger and higher water falls by the modern turbine, in various countries, the first development of this sort in America being a 15,000 h.p. plant constructed at Niagara Falls in 1893. It alludes to the wonderful progress made in the technics of hydro-electric work since that time, to the recent improvements in installation which have made possible the economical transmission of energy for distances of 200 miles and over, and to the improvement of the modern turbine whereby low head developments are now commercially feasible. It compares the water powers of different countries and shows that Canada is not the wealthiest in water powers, especially if provinces are compared with countries of similar area, for example France, Austria, Sweden and Norway. The truth is brought out that although the available horsepower per square mile is greater in some cases, we are woefully behind other nations in the percentage of utilization. The following table indicates the uses made of hydro-electric energy generated in Ontario, Quebec, France, Sweden and Norway, and shows that up to the present we have only progressed in the simpler applications of electricity. It shows also that we have somewhat neglected its utilization as an electrolytic agent and as a heat-generating agent in electro-chemistry and electrometallurgy.

Countries.	Developed hydro-electric power.	Subdivision of developed power. Electro-chemistry and electro-metallurgy.		Motive power, traction and lighting.	
	h.p.	h.p.	%	h.p.	%
France . . .	592,000	291,000	49.1	301,000	50.9
Norway . .	543,000	275,000	50.6	268,000	49.4
Sweden. . .	370,000	120,000	32.4	250,000	67.6
Ontario. . .	320,000	25,000	7.8	295,000	92.2
Quebec . . .	198,000	28,000	14.1	170,000	85.9

In discussing ways and means for the advantageous alteration of these conditions, the author refers to the consumption of electricity for lighting and for traction as dependent on population, and notes that the consumption of electricity per capita for either lighting or traction is too small to be considered as an inducement for the extensive development of our water falls. The pulp and paper industries are referred to as large users of power and in this instance Canada is not so very far behind, although Sweden utilizes over 120,000 h.p. in this manner.

The author emphasizes the value of closer attention to electro-chemical and electro-metallurgical industries which would require a notable increase in the development of our water powers. He briefly reviews some of these industries that either on account of the abundance of necessary raw materials or because of large neighboring markets, might be likely to prosper in this country.

Electro-chemical Industries.—The manufacture of calcium carbide is the oldest of these industries in Canada. Three plants are in operation at present, absorbing about 14,000 h.p. and producing about 12,000 tons annually, half of which is exported. (The world's production in 1913 amounted to 339,000 tons.) The Canadian Carbide Co., with a capital of $2,000,000, control these three plants, one at Thorold, Ont., of 1,000 tons capacity, one at Ottawa, producing over 4,000 tons, and one at Shawinigan Falls, Que., supplying about 7,000 tons, annually.

There are also the nitrogenized fertilizers all except one process of which utilize electrical energy to combine directly the atmospheric oxygen and nitrogen. This combination gives nitric acid which in presence of water and air in excess is transformed immediately to nitrous and nitric acid and finally into nitric acid only; this azotic is either sold as such or is led over limestone, giving as final product the nitrate of lime which is utilized in place of the Chili saltpetre or nitrate of soda for all agricultural uses.

"The story of the fixation of atmospheric nitrogen can be summed up as follows: In 1902, the Atmospheric Product Company erected in Niagara Falls a trial plant for the manufacture of nitric acid by the Bradley and Lovejoy process. During the same year, de Kowalsky began in Fribourg a series of researches which were continued by Moscicki and led to the erection of a trial station at Vevey, in Switzerland; in 1903, Professor Birkeland, of Christiania, discovered a new process which was afterwards perfected by Birkeland and Eyde, and is now applied on a very large scale at Notodden in Norway. In 1903, also, Frank and Caro made public a new method of fixation based on a different principle and giving calcium cyanamide as the final product. More recently, Pauling and Schonnherr have taken out patents for other processes."

Nitrate of lime has developed in production since 1909 to 110,000 tons last year. For this industry alone the Norwegian Nitrogen Co. have undertaken the construction of plants with the total capacity of 540,000 h.p. Nitric acid is produced in quantities ranging from 200,000 to 250,000 tons per year, United States producing about 70,000 tons. The margin between the selling price of ordinary nitric acid and the cost of synthetic azotic acid is large, according to Mr. Surveyer, and indicates that this industry can afford to pay even more than the nitrate plants for its electrical energy.

Calcium cyanamide requires electrical energy in its production. The world's output in 1913 was 226,000 tons. The Canadian plant of the American Cyanamide Co. at Niagara Falls began operation in 1910 with an output of 10,000 tons. The capacity has since been increased to 24,000 tons per year.

Electro-metallurgy.—In dealing with the industries to which hydro-electric power is applicable under this heading, the writer refers to aluminum, the first metal manufactured in a hydro-electric plant, as belonging to electrochemistry on account of the electrolytic method employed and to electric metallurgy on account of the nature of the product. He traces the growth of its manufacture and the enormous reduction in price per pound which it has experienced. In 1912 the United States produced 18,000 tons of aluminum, France 13,000 tons and Canada 9,000 tons. The actual capacity at present of the plants of the Aluminum Company of America is 90,000 h.p. This company has recently signed a contract with the Cedars Rapids Power Manufacturing Co. for the purchase of 60,000 h.p. to be used at their Massena plant on the St. Lawrence. The Shawinigan plant is the property of the Northern Aluminum Company, and has a capacity of 20,000 h.p.

Nickel, zinc and copper are also referred to as minerals extracted from their ores by smelting in the electric furnace. There is a great field for development of the Canadian industry with respect to them.

The production in the electric furnace of pig iron, ferro-silicon, ferro-titanium, and of steel is lengthily considered. The world's production of pig iron by this method was approximately 25,000 tons in 1912. Extensive experiments have extended over the past several years in Sweden. In Scandinavia there are 20 furnaces absorbing over 36,000 h.p. The world's production of ferro-silicon is over 60,000 tons per year. Two Canadian companies are manufacturing it, the Lake Superior Power Co., at Sault Ste. Marie, with an electric furnace of 250 h.p., and the Electric Metals Co., at Welland, with 4 furnaces totalling 5,000 h.p. Ferro-titanium is worthy of interesting study on account of the large deposits of titanium ore in the province of Quebec.

In the production of electric furnace steel 120 furnaces turned out 175,000 tons in 1912. The electric furnace is also extensively used for melting steel for castings. (Although not mentioned in the paper, it is worthy of note that the Moffat-Irving Steel Works, Limited, Toronto, have a furnace now in operation for the direct production of steel castings or ingots. The furnace is of the 3-phase type, and of 300 kw. This furnace was described in *The Canadian Engineer* for October 23rd, 1913.)

The different industries enumerated by Mr. Surveyer absorb approximately 1,500,000 h.p. Canada's contribution to this enormous utilization of power is just about 3.5% of the total.

Some Foreign Opinions.—After giving a brief survey of the large field which is open and worthy of utmost diligence in study, the paper reverts to some opinions of foreign engineers respecting the future for these industries in Canada. The existing obstacles have been well sifted out, and are, in particular, (1) The severity of winter, causing a low-water period; (2) Absence of adequate means of transportation; (3) Unlikelihood of enlarging Canadian Works around Niagara Falls, owing to movements on foot for conserving the beauty of the water power. While these criticisms are partly correct and while we are in a measure handicapped with economical, educational and physical obstacles to a rapid development of our water powers, it is inspiring to note the extensive studies that are being made by the Department of the Interior, Department of Public Works, Hydro-Electric Power Commission of Ontario, and the Quebec Streams Commission.

With respect to the attracting of foreign capital we quote the following from Mr. Surveyer's paper:—

"It is safe to say to-day, that through the lack of surveys, of discharge measurements and of gauge readings there are very few of our water falls which could be offered to oversea bankers. To convince these men we must be able to lay before their technical advisers, complete plans to enable them to make in their office a rough estimate of the first development costs; we must, moreover, show them discharge measurements and gauge readings covering a sufficient number of years to allow them to calculate with accuracy not only the minimum power available, but also the average power on which they could depend. The electro-chemical and electro-metallurgical industries require energy at such moderate rates that it would be impossible in most cases to bank on the lowest available power only. These industries must have the help of the periodical power to lower the average cost of the energy utilized during the year."

In concluding, the writer refers to the serious handicap which the development of our water powers has experienced owing to the difficulty of obtaining a clear title of ownership, and to the lack of commerciality of some of the clauses contained in government leases. He urges a separate water power policy for each province.

DUSTLESS STREET CLEANING.

Canada's climatic conditions, to a certain extent peculiar to herself, impose handicaps in the care of pavements which are hard to overcome.

The dust on business streets is the admitted cause of immense damage to stocks of merchandise and also is very disagreeable to the individual. This is especially so in early spring and late autumn, when the water sprinkled on the pavements freezes, resulting in accidents to horses and pedestrians.

Water used on pavements at such times is also the cause of serious damage to them, as it soaks into the crevices in the pavement, and freezing, causes the upheaval and disintegration of the pavement. This is especially noticeable along the curbs and street car lines.

Dustless street cleaners, operated on the combined vacuum and sweeper principle, are in use in a number of North American cities. It is claimed that their work is entirely satisfactory, that after cleaning, no sprinkling is necessary, as the dust has been thoroughly removed. The advantages of this system are numerous, including the absence of the dust nuisance, resulting in conservation of both health and property; the saving of water and a large percentage of the cost of sprinkling; the saving of labor in street cleaning, and the avoidance of damage done by water to pavements in frosty weather.

PRINCIPLES COVERING DESIGN OF INBOUND AND OUTBOUND FREIGHT HOUSES.

The economical handling of less-than-carload freight at terminals is a problem that is giving a great deal of concern. The cost of handling a ton of freight a mile by train is approximately known, but it is almost impossible to figure the cost per ton mile for trucking and handling of unclassified freight at the freight house. The cost of terminal handling in all cities is so great compared with the cost of moving a train or a vessel when started on its journey that the latter can be ignored. Freight house design should receive serious consideration. In this connection much of interest and value will be found in the following principles adopted this year by the American Railway Engineering Association and appearing in the recently issued supplement to the 1914 manual.

In outlying districts, where fire hazard is not great and business is not large, and the building laws will permit, frame freight houses having wood floors on joists, studding covered with wood sheathing or metal siding, and wood rafters and sheathing covered with appropriate roofing, are fairly satisfactory and cost less than any other type. Floor for this type should ordinarily be designed to carry 250 lbs. per sq. ft.

With such construction there should be ventilation beneath the floor, but access to the space under the house should be prevented to avoid the accumulation of rubbish and increased fire hazard.

But even where a frame house is to be used, it is better practice to use a fill between concrete foundation walls, eliminating some fire hazard and decreasing maintenance charges.

Where the laws prohibit frame structures and the value of freight stored is considerable and it is necessary to build freight houses of so-called fireproof material, floors should be placed on a fill between foundation walls, and the exterior walls should be of masonry or steel frame covered with metal siding. Roof trusses, framing, etc., can be of wood, covered with appropriate roofing, but to provide better fire protection fireproof construction should be used.

Fire walls of brick or other non-combustible material should be located so as to conform to the requirements of the underwriters. The strictest practice limits the area between fire walls to 5,000 sq. ft. This especially applies to houses with no outside platform. In wide houses, this locates the walls rather close together for economical operation. Fire walls should in no case be more than 200 ft. apart.

Doors in fire walls should be as limited in number as possible, no one door opening should exceed in area 80 sq. ft., and all should be equipped with automatic fire doors.

Where non-fireproof construction is used in inflammable parts, the structure should be covered with fireproof material for a distance of at least 5 ft. on either side of the fire wall. This refers especially to overhanging roofs.

Where but a single house is needed, a width of from 30 to 40 ft. is good practice.

When the amount of freight handled is sufficient to justify it, separate houses for inbound and outbound freight are desirable. When these are provided, the outbound house should be narrow, not more than 30 ft. wide, and the inbound 40 to 70 ft. wide, it being considered expensive operation where a house is in excess of 70 ft. in width.

A platform 8 to 10 ft. wide, along the track side of the house, avoids the necessity of considering the location of doors in spotting cars on the track next to the house, and also eliminates the necessity of keeping an aisle-way inside the house on the track side. It should be at least 8 ft. wide, to give sufficient room for two trucks to pass.

The distance from the centre of the nearest track to the face of the platform or freight house should be not less than 5 ft. 9 in. where tracks are on tangents.

The top of rail should be 4 ft. below the floor or platform level at the track edge, where refrigerator cars are not to be handled in any quantity. With occasional refrigerator cars, the doors can be opened before the cars are set.

Where refrigerator cars are to be handled regularly, the height should not be more than 3 ft. 8 in., this conforming to the recommendations of the M. C. B. Association. The alternative of spacing tracks at least 7 ft. from platforms is usually expensive at important terminals. Many roads are building cars that are lower than the maximum figures given above, and each road in deciding the height of platform above the top of rail should take into consideration the sizes of cars that predominate on its line.

The platform should be protected by an overhanging roof, not greater than the width of the platform, and at least 10 ft. above the platform level.

Where state laws permit, protection over the cars is often used. This should be at least 17 ft. above the top of rail and should preferably extend to within 18 in. of the middle of the car. This will allow walking on the top of cars.

There should also be an overhanging roof or other protection on the team side to protect goods while being unloaded, the overhang to be at least 4 ft. and preferably more, 12 ft. being needed to give protection from a driving rain.

Freight houses without outside platforms would seem desirable in some localities, especially in northern climates, where there is considerable snow and sleet, as these houses can be entirely closed, except for that part of the house where the freight is being received or loaded. At some points where ample track room is not available, the elimination of the outside platform gives better results.

With this type it is necessary to leave more trucking space inside the house longitudinally the full length of the building. With the house congested with freight, it is difficult to keep the aisle-ways from being crowded up so that it is almost impossible to get through with a truck that is loaded with large packages. This causes delay and confusion.

On the street side, the floor of the inbound house should be from 3 to 4 ft. above the street grade, depending on the type of trucks in use. At the outbound house the height should not exceed 3 ft.

To assist trucks, the floor of the inbound house should be sloped toward the street, approximately 1 in in 8 ft., this being for the house proper. An outside platform on the track side should slope approximately 1 in. toward the tracks for draining.

For the outbound house, the floor should slope from the street to the edge of the platform alongside of the car not more than 1 in. in 8 ft.

Several kinds of doors are satisfactory, counterbalance lift (either folding or not), rolling shutters and parallel sliding.

It is advantageous to have as much door opening on the team side as possible. And with all types of doors except the last, all of the house can be opened except for the space occupied by posts.

With the parallel sliding doors, not more than half of the space can be opened up. They are satisfactory on the track side.

Without the outside platform continuous doors should be used, so that an opening can be obtained at any point opposite a car door.

Where an outside platform is provided, a door in each panel is sufficient. Considering the average length of cars and economy in framing, 22 ft. is a good panel length.

It is advantageous to have the floor entirely free from posts; but in houses approaching 50 ft. in width the saving made by using posts becomes considerable and great enough to offset the advantages due to their omission.

On account of light weight merchandise being piled high on trucks, it is desirable to have the edge of the eaves at least 14 ft. above the level of the driveway, where local conditions will permit.

As all freight trucked into the house and cars must pass through the car door, the height of the freight-house door need be little greater than the car door. All doors should be at least 8 ft. high. On the team side a greater height might at times be convenient.

Natural light should preferably be provided in the side walls above the doors. Skylights in the roof are expensive to maintain and ineffective, as is also glass in canopies, or on any plane approaching the horizontal.

Artificial light is needed for operation at night and during the late afternoon in the winter, and, wherever possible, electricity should be used, with wires run according to the specifications of the National Board of Underwriters. One or more lines of lights should be run the full length, inside the house, and one line over outside platforms.

Another circuit should be run along the face of the platform wall, parallel to the track, with outlet boxes not over 40 ft. on centres, with socket arrangement for push plug for use in attaching an extension cord to hang inside the car to provide light for loading on dark days and evenings during the winter season. The need of other outside lights on the train side is questionable.

The type of lights will depend somewhat on the height of the ceiling. All lights should be stationary and operated in circuits from conveniently located panelboards. The circuits should be carefully planned, so as to allow maximum economy in use of lights.

Where water pressure is available there should be provided for fighting fire, standpipes and hose racks not more than 150 ft. apart. By putting them on the fire and end walls they are thought to be more accessible and less liable to be blocked by freight than if located at other points, but by putting them about 40 ft. from the end of each section, fewer hose connections are necessary to cover the entire station. By putting them 100 ft. apart, 50 ft. of hose will be sufficient for each connection, more than this being somewhat inconvenient to handle. As there is no heat in the house, the valve controlling the water supply should be located below the frost line and controlled by a stem, with a hand wheel above the floor. The valve should be located in a pit, so as to be readily accessible for repair or renewal. It should be drained into the pit, and this in turn be connected to the sewer. A 2½-in. standpipe of wrought-iron should be run up to approximately 8 ft. above the floor, and to this should be attached a hose rack, equipped with 50 ft. of 2-in. rubber-lined linen hose.

In houses where electricity is available, there should be over each hose rack a small red light to designate the location of the fire-fighting apparatus, this light to be kept burning at all times.

Chemical extinguishers should be provided in addition to the hose and standpipes. As they are put out of service by freezing, some provision should be made for replacing them or keeping them warm. Tanks containing a solution of calcium chloride are used successfully.

Where a watchman is needed, a watchman's clock system, with a registering clock in the freight office and stations located at various places throughout the freight houses, should be installed.

In outbound houses sufficient scales should be provided so that all the freight can be weighed. From 50 to 80 ft. apart is good practice. In inbound houses where little of the freight is weighed, scales should be placed at least one in each section. The scales should have a minimum capacity of four tons. A successful dial scale expedites the handling of freight. Stalls for checkers should be located at least one in each section. These should be approximately 4 ft. 6 in. by 4 ft. 6 in., with a shelf along the back and drawers beneath. Sometimes they are left entirely open in front, and sometimes are closed up, and heated, depending on local conditions. Some roads make their checkers' stalls portable, so as to allow them to be moved in case of a special congestion of freight at certain points, but this is not ordinarily considered necessary.

In inbound houses a room should be provided to house "over, short and damaged" freight; this to be enclosed so that it can be kept locked.

In large layouts, particularly where there is considerable transfer business, a room should be provided for repairing broken packages, such as crates, boxes, barrels, etc.

In large houses a separate office should be provided for the foreman. If this can be an elevated structure, it will save floor space.

In large houses the general office for the clerks and the private office for the agent should be provided by a second story over the inbound house, and in the second story should also be a space for files and stationery cases, toilets asd locker facilities for clerks. This all should as far as possible be in view from the desks of the agent or chief clerk. The cashier and his clerk should ordinarily be located on the first floor.

Where possible, it is preferable to have the clerks' and agent's offices, the toilet rooms, etc., for the freight handlers and draymen, the room for "over, short and damaged" freight, and the cooperage room for repairing broken packages, etc., all in one section. In the larger terminals provision may be wanted to care for perishable freight, and when it is provided, it should also be located in this section.

The basement should house the heating plant, with room for coal, and is sometimes a good place for toilets for the freight handlers and draymen, and for locker and lunch rooms for the freight handlers.

Where both outbound and inbound houses are arranged in the same layout, a transfer platform is usually included. One of the best designs for covering these platforms is a butterfly shed, with the posts located in the centre of the platform. Where this design is used, the platform should not be less than 12 ft. wide, to provide room for trucks between the posts and the cars.

For loading and unloading agricultural implements and other large, bulky packages, platforms should be built, usually as extensions to the inbound and outbound houses, with ramps on the ends of the platforms. The extension platform should be at least 8 ft. wide, and if possible, 16 ft. wide, especially if covered. A stub end track butting against a platform with a ramp is valuable.

Where no gantry crane is provided in the freight yard, a stiff leg or pillar crane should be provided on the end of the extension platform.

It is not good practice to put downspouts inside the house, and in placing them outside they should be properly protected.

On the team side of all freight houses a fender should be provided to protect the walls from the wagon wheels. A good type is one made up of an 8-in. by 10-in. timber set on brackets, with a spacer or separator to keep the timber approximately 2 in. away from the wall, so that dirt will filter through and not collect on the fender.

In large cities it is frequently advisable to build the inbound houses eight to ten stories high, using the ground floor for handling freight and the balance of the structure for storage, to be leased to shippers. Most of the material stored will not be affected by heat or cold, but provision should be made for cold and warm storage where conditions warrant.

GERMAN SUBMARINES.

The enemy's submarine is comprised of two classes. The Krupp submarine is of the following typical dimensions: Length 120 ft., beam 12 ft., depth 12 ft. 6 in., surface displacement 225 tons, submerged 280 tons. The vessel has an inner and outer hull. The outer hull has the lines of a torpedo boat with high freeboard forward to give seaworthiness. The inner hull is built up of three circular welded sections bolted together. The space between the two skins is divided up into ballast and fuel tanks.

Surface propulsion is effected by two sets of 4-cylinder vertical petrol motors developing 440 h.p. For submerged work two electric motors developing 250 h.p. are used. The conning tower contains all the devices for steering, submerging and working the boat. There are two torpedo tubes in the hull and one mounted on deck aft.

In the Lake type, heavy Diesel engines are used for surface work. These motors are from 200 to 220 h.p., and for under-water work electric motors are used. Special ventilating arrangements are provided. When submerged the vitiated air is drawn off and passed through various filters, oxygenated and cooled. By this means the craft can stay under water for twenty-four hours. The electric accumulator apartments are hermetically sealed to prevent the escape of poisonous gases. Two periscopes are carried, the tubes of which are 16 ft. 6 in. in length. The water ballast tanks can be emptied by means of compressed air in a very short time. The outer hull is fitted with shackles to facilitate salvage operations. A telephone wire is carried to communicate with the outside world, the outer end of the line being attached to a buoy which can be released automatically.

The later submarines of the German navy are said to be over 800 tons in displacement and capable of a speed of 16 knots on the surface, with a corresponding underwater speed of 8 knots. They are fitted with 18-in. torpedo tubes, submarine signalling apparatus, searchlights and small disappearing guns.

The city of Calgary is finding it more economical to shut down one of its incinerators and to operate the other 24 hours a day, on 8-hour shifts.

POLES AND CROSS-TIES IN 1913.

The Forestry Branch, Department of the Interior, has just issued a bulletin, compiled by R. G. Lewis, B.Sc.F., in which are tabled the purchases of poles and cross-ties in the Dominion during 1913. The former relate to 424 pole purchasers consisting of 218 telephone companies, 155 electric light and power concerns, 29 electric railways, 18 steam railways and 4 telegraph companies. For convenience the writer divides them into two main groups: (1) Steam railway, telegraph and telephone companies, and (2) electric railway, power and light concerns. The information relating to cross-ties is collected from the different railway companies of Canada, steam and electric, both jointly and separately. Reports were received from 47 steam railways and 32 electric railways.

In 1913 from a total of 534,592 poles, 49.4 per cent. were white cedar; 27.2 per cent. red cedar; 21.6 per cent. tamarack, while 1 per cent. or less of each of spruce, jack pine, balsam fir and white pine was recorded. Of this amount 469,521 poles were purchased by steam railways, telephone and telegraph companies, and 65,071 by electric railways, power and light companies.

Of the total 340,865 poles, or 63.8 per cent. were 20 to 25 ft. in length; 21.8 per cent. were 26 to 30 ft. in length; 7.1 per cent., 31 to 35 ft.; 4.4 per cent. 36 to 40 ft., and 2.9 per cent. 40 ft. or over. Of poles under 25 ft. in length, over 97 per cent. belong to the two cedar species and eastern tamarack.

As against 534,592 poles purchased in 1913, there were 608,556 poles purchased in 1912.

A total of 19,881,714 cross-ties were purchased in 1913 as against 21,308,571 in 1912. Of these 39.1 per cent. were jack pine; 12.3 per cent. white cedar; 12.2 per cent. Douglas fir; 6.2 per cent. western larch; 6 per cent. hemlock; 5.7 per cent. hard pine; 4.9 per cent. oak; 4.4 per cent. tamarack, and smaller percentages of western hemlock, spruce, chestnut, red cedar, red pine, beech, birch, maple, elm, ash and cherry. Electric railways used 391,233 of these.

The average value of poles of all kinds was $2.22 each, and of cross-ties 43c. each. A total value of $1,188,331 is accorded to poles, and $8,740,849 to cross-ties.

In Canada in 1913 about 10 per cent. of the cross-ties purchased by both classes of railways were given a preservative treatment to retard decay.

PRODUCER GAS PLANTS IN THE UNITED STATES.

The total horse-power of gas-producer power plants in the United States was 160,000 in 1911, of which 80,000 was obtained from bituminous coal, 70,000 from anthracite and 10,000 from lignite. The cost of producer-gas installations is about equal to that of reciprocating steam engines; the cost of maintenance is only about one-half, while the economy has been shown in several cases to be 2 to 3 times as great. The heat losses in typical steam and gas plants are given in the following table:—

	Steam plant.	Gas plant.
Heat lost in ashes	2.00	1.10
" " radiation and cooling	4.60	18.60
Heat lost in smoke	24.60	....
" " radiation and friction	3.30	4.30
Heat lost in exhaust	53.50	23.70
" " jacket water	.....	33.50
" " auxiliaries	7.30	.....
Total losses in entire plant	95.30	81.20
Net efficiency of plant	4.70	18.80

AN EMPIRICAL FORMULA FOR THE DESIGN OF RETAINING WALLS.

Retaining Walls Backed With Earth to the Top of the Wall.

By C. P. Symonds.

WRITERS about these retaining walls give formulæ and rules requiring the weight per foot of the brick-work, and of the earth behind it. Bricks in one district may be light, and those in another may be heavy; though they may both be good, well made, and well burnt; therefore, their weight is a doubtful ele-

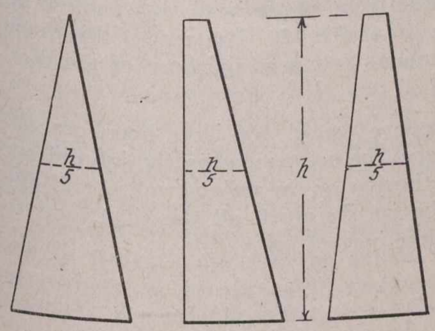

Fig. 1.

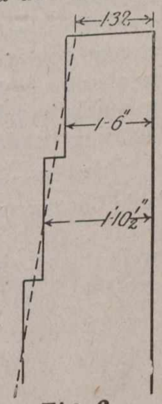

Fig. 2.

ment in calculation. And the earth behind the wall may be wet clay, dry earth, loose sand, or of varying composition, so that its weight is another uncertainty. Again, the backing is almost always heaped up behind the wall soon after it is built, and before the mortar is set.

Therefore engineers in England have, from practical experience, formed a general rule based upon the average thickness compared with the height of the wall. Thus,

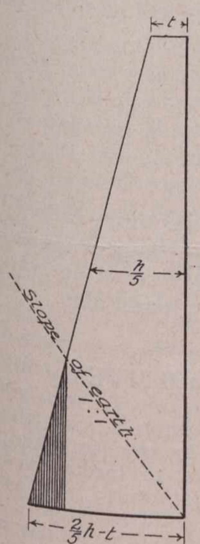

Fig. 3.

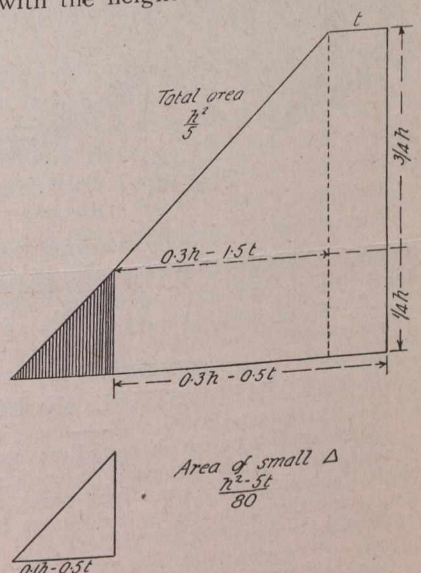

Fig. 4.

in a wall battering ⅛ of the height or 1½ inches in a foot, the average thickness of the wall is to be 1/5 of the height; in such case putting h for the height of the wall the average thickness will be $h/5$, and the area of the cross-section will be $\frac{h^2}{5}$. The section of the wall may be any of the shapes shown in Fig. 1, keeping the average thickness $h/5$.

In the following I have taken the top of the wall as 18 inches and the back of the wall is set off in steps of 4½ inches (Fig. 2). For an average line (dotted) for calculation, the thickness of the wall at the top is taken as 1.32 feet, this being an average line between 1 ft. 6 in. and 1 ft. 10½ in. Then, given h for height and t for thickness, keeping the average thickness of the wall 1/5 of h, the section of the wall will be as in Fig. 3.

Ordinary earth protected from the weather will stand at an angle of 45° or a slope of 1 : 1. It is evident, therefore, that the small shaded triangle is not wanted for supporting the earth, and may be cut off. But, as the height of this triangle varies with every height of the wall, it would complicate the calculations. I therefore take the height of this small triangle as ¼ of the height of the wall, or $\frac{h}{4}$ as a constant quantity, which is a close approximation and greatly simplifies the work. An ex-

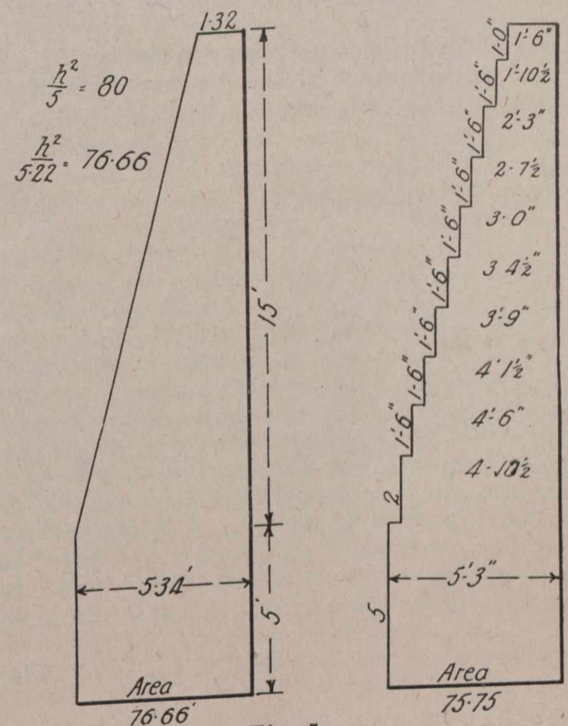

Fig. 5.

aggerated section will then be as in Fig. 4, and after deducting the area of the small triangle, the final area of the wall will be $\frac{3h^2 + ht}{16}$. If the foundation is not good, leave in this small triangle, but if good it may be cut off.

In the two diagrams in Fig. 5, the left-hand one is the calculated theoretical section in feet and decimals. The right-hand one is the same thing adapted to measurements in feet and inches for brickwork. Of the equations in each case, the upper one is $\frac{h^2}{5}$ for the area including the small triangle. The lower one is the area without it. The lowest number denotes the area of the figure in square feet.

Discussion by C. D. Norton.

A few years ago the writer was given the above empirical formula for the design of brick retaining walls, the principles of which are just as applicable to those built of concrete or stone. The author, Mr. Symonds, was chief engineer of the Government Railways in Portugal. Later he had charge of the construction of a large

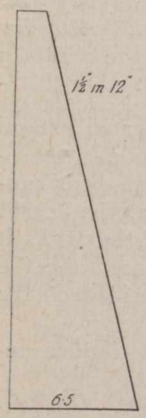

Fig. 6.

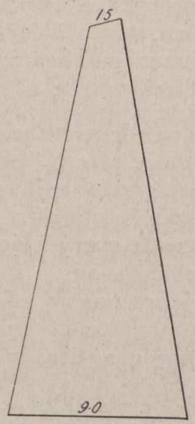

Fig. 7.

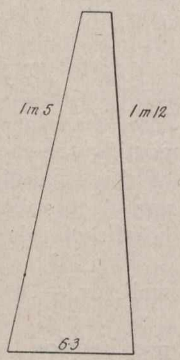

Fig. 8.

part of the South Eastern Railway in England, and was employed on the first tunnel to be built to a predetermined line. These walls were used principally in earth cuttings to avoid the purchase of valuable land, and were not called upon to carry a live load as is the case of an abutment for a bridge. Figs. 6 to 11 show a comparison of various standard types of retaining walls. Those designed by the above formula are the lightest, but it must be taken into consideration that the workmanship was of the best, and in the days that these were built speed was not the important factor that it is to-day.

One thing to which the writer takes exception is the remark about placing the material behind the wall, as given suitable conditions and a fair amount of carelessness, it is possible to wreck any wall except one designed to withstand hydrostatic pressure.

In a retaining wall the cheapest design is that which takes into consideration the placing of the backing in addition to the cost of the masonry. A minimum can only be attained by a due consideration of the material to be placed, and the labor and methods employed. It will be found in nine cases out of ten, that wrong dumping of material is due to mere laziness, either mental on the part of the employer or bodily on the part of the laborer; and it is the duty of the engineer to note these things and, if possible, to remedy them.

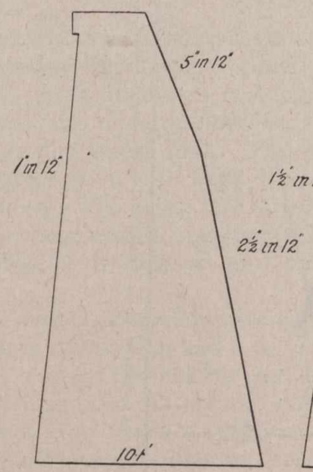

Fig. 9.

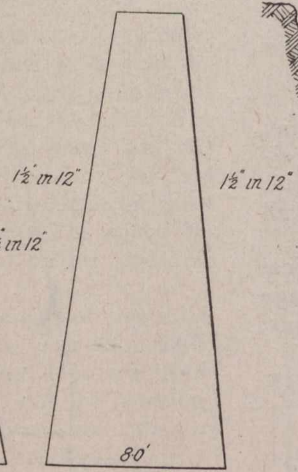

Fig. 10.

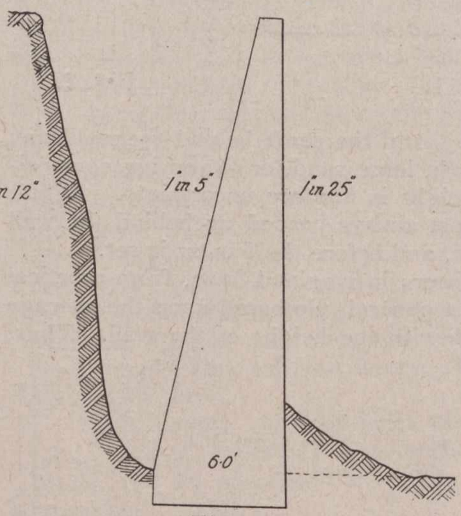

Fig. 11.

It will be noticed that Mr. Symonds does not take frost into account, possibly because in the south of England the mercury seldom falls below 0° F., and then only for a short period; so that the depth to get a good foundation is plenty deep enough to ensure against heaving.

In a small village near Toronto, the authorities received the sum of $500 to build a small retaining wall, which sum was hardly sufficient for one of standard design; so the wall was considerably lightened, and the foundation was sunk only 18 inches below ground level. After the wall was finished it was left for two months to cure, and then the backing was tamped in most carefully. A cross-section is shown in Fig. 11. When finished the amount of pressure against the back of the wall was almost negligible. The front of the wall was banked up to about 4 feet above ground level. The cost of this extra tamping and filling, about $10, was paid out of the road building fund.

The above procedure would not have been practicable but for two things: the contractor on the job did not profess to be an authority on retaining walls, and the writer was able to be on the work all the time, and to see that his orders were carried out.

Figs. 6 to 11 show various walls; the three railway walls are designed to take care of the heavy superimposed load due to fast-moving traffic, although Trautwine considers his capable of taking care of these loads also.

VANADIUM STEEL IN LOCOMOTIVES.

The extent to which vanadium steel is entering into the manufacture of locomotives is indicated by the following table, showing the vanadium parts applied to locomotives built or ordered in the United States from Jan., 1913, to May 15th, 1914:—

Name of part.	No. of engines equipped.	No. of parts applied.
Driving axles	476	1,297
Main rods	377	822
Side rods	284	1,986
Frames	993	2,054
Crank pins	198	612
Piston rods	69	138
Springs (engine and tender)	366	....
Engine truck axles	62	62
Wheels	...	700
Tyres	...	1,150
Cylinders (vanadium cast-iron)	260	540

With the exception of wheels and tires this applies to new power only.

SYSTEM IN ROAD MANAGEMENT.*

By Charles J. Bennett,
Highway Commissioner of Connecticut.

In consideration of a topic of this character, it must be realized that there are certain principles to be applied in organizing or systematizing a highway department, which can be applied generally to the problem wherever a department of this character is to be formed. Further than that we cannot go. The particular methods of accounting, the minutiæ, the forms, types of books, methods of reporting and recording reports are in every instance a peculiar problem to be solved locally and in the manner best fitted to give a solution of the peculiar difficulties which arise on account of position and magnitude of the department geographically or financially.

Having in mind, therefore, that the detailed phases of the problem are local, there will be no endeavor in this paper to outline an ideal system of accounting, reports and records for a highway department, for such a system would apply probably only to that particular department with which the writer is more nearly familiar. There will be, however, an attempt made to show in a general way, what, in the estimation of the writer, are the broad principles which can be applied to systematic management of a highway department, whether it be town, city or state.

In the first place, it is necessary to realize that there are two results to be secured:

(1) The proper and economical spending of a certain amount of money in the way best fitted to serve the general public, and

(2) The presentation of the method of spending this money to the public, so that it may be thoroughly informed as to how its money has been apportioned and what results have been reached. Such a record or report made to the public should be in simple language so that the most uninformed may understand the results desired and the ends achieved.

In connection with the first proposition, *i.e.*, the spending of money to get the best results. The first requisite in organizing a system of this kind is the record or system of bookkeeping which should show at all times the condition of the accounts and keep a check on the expenditures made for specific purposes. Such a system should be simple and familiar to all the employees of the department and should show graphically, at a glance, the amount of the appropriations made for specific purposes and a summary of the definite projects on which this money should be expended with the total weekly or monthly expenditures for the purposes defined. This information should be available to all the employees and should be so plain as to make it possible for a change in the personnel of the office force without a consequent confusion arising from a complicated and abstruse system of accounts.

In connection with this system of bookkeeping and system of reports of work necessary, the orders for the work to be done should be immediately compiled and entered in the books so that the disbursements may be kept up to date. There should be no possibility of verbal orders which would call for expenditures of money without an accompanying written report and order, which should be entered at once in the ledger. This system of accounts should provide also for a periodic statement of the financial condition of the department, which statement or balance should show not only the cash available, but also the actual amount available after all the liabilities, bills and debts of the department were paid.

Having formulated such a system of accounting, a force of employees should be organized in such a manner that the system of accounts may be followed and in such a way also that the general idea of spending the money economically and well be firmly established.

The first idea which should be applied in the organization of a highway department is the military system; that is, the department should be subdivided so that each part might have certain duties with a definite amount of money to spend. Each subdivision should report directly to the superior officer and through this superior officer to the military head. The organization should be such that no orders should be passed around a subordinate, but should rather go through a subordinate. It is quite necessary in dealing with a force of any magnitude that the rank and file should know the purpose of the organization and the wishes of the chief. In other words, the department should be imbued with the spirit and aims of the man at the head, for in this way each man will work, so far as is possible, along the same lines and the results gained will be more nearly uniform and standard.

An effort should be made to build up patriotism in the department, which should work for the betterment of the road system rather than for the personal benefit of the employees or of the political party which is responsible for the appointment of members of the department. A modified civil service system is a good thing, in that it makes the men more sure of their positions than under a political system. Such a civil service should, however, provide for the removal of employees by the head of the department without applying to any outside body, such as a State or Municipal Civil Service Commission. The whole idea of such a department and the organization of the force, should be to secure the right men for the right places and keep them there while they give good service. There is nothing which can disorganize a department so much as the right of an employee to apply to some outside body which has no knowledge of conditions and which can only judge of a man's ability or his right to hold a position, by an examination on his technical knowledge or by a brief hearing. The measure of a man's value is in the results he gains in actual service and knowledge of a man's ability can only be secured by the record of his achievements from day to day.

In the organization of a force, a chart should be prepared showing the connection between employees, showing to whom an employee should report and stating distinctly what his duties shall be. The best results are to be gained by delegating authority to a man and placing confidence in him, having in mind the theory that men are by nature honest and will endeavor to do right and gain good results if given the opportunity. Allowance should be made for honest mistakes and a careful record kept of such mistakes so that a man may realize, when removed, that the reasons for his removal are sound and based on results showing his lack of ability.

In selecting employees to deal with the public, men should be sought who are tactful, intelligent and polite in their intercourse with people. The employee should be instructed that at all times it is necessary for him to be fair and reasonable and to keep his temper. A public employee is a servant of the public and in his dealings with citizens, should realize this fact, but he should also be firm and not afraid to refuse an unreasonable request.

Given, then, a system of accounting in the organization, the members of this organization must bear in mind that if they are kept informed as to the purpose of the

*From paper read before the 4th American Road Congress, November 9 to 14, 1914.

department in which they work, they should on their part, keep their superiors well informed of their own movements, the amount of work done and the character and cost thereof. In other words, a method of reporting work should be established and kept which should give plainly and simply, all the necessary information as to the actual physical operations carried on by the employees. The local situation will govern the extent and frequency of such reports but they should show primarily and in a clear way, the work which the employee is trying to do, the probable cost of the work to be done before it is started, and from time to time the actual cost, including remarks as to the success or failure of any particular experiment. There should not be an endeavor to make complicated reports which should show minutiæ to the point of the ludicrous, for a system of reporting which becomes so complicated that it is not simple of understanding, fails utterly in its purpose.

The recording of reports in connection with the accounting system should be made in such a manner that through these records the outsider, either layman or professional, may secure information as to the comparative cost of certain classes of work, the success or failure of certain types of roads and the financial value of expenditures for certain specific purposes. For instance, it might be possible to demonstrate in a certain instance, by a system of records that a larger first cost of construction would be very much more economical eventually than a small first cost with a corresponding large charge for maintenance in future years. The system of records should, therefore, show the ultimate result from an expenditure, which ultimate result should be gained from records made over a long term.

The above discussion has covered mainly the first principle which was stated, namely, the endeavor to get good work with the money appropriated.

A road department has, however, the duty of presenting its operations to the public eye, not only as results on the roads themselves, but in the success or failure of the department as a financial proposition. This presentation must be made in the form of a periodical report to some superior body, as the mayor of a city or the legislature of a State. The writer finds, in perusing many of the reports made, that there is an entire lack of system in presenting the information, and no effort made to make the report clear. Most reports are made in such a manner that an expert accountant would be needed to find out results gained and even then, these results would be of little value. The spirit shown most in reports is that they claim general excellence for the department and try to justify its continuance. Certainly there are some failures made by roadbuilders which should be reported for the good of the work. Reasons for failure should be stated, whether the failures be financial or physical.

It is quite possible and necessary to make an annual report which is readable and interesting to the layman. The text portion of such a report should be written in plain English without technical terms and with general results stated broadly and succinctly. Tabulation of records should be made as simple as possible and the cost per unit should give not only definite figures, but should state, furthermore, just what details were included in the units of work done. For instance, in one locality maintenance of roads does not include the oiling of the surface, while in other reports this oiling is included which, of course, makes it impossible to compare the two costs, and for this reason, and many others, as stated above, the reports should show definitely what details are included under each heading, and the cost might be analyzed accordingly.

The writer wishes to make clear again that there is no question in his mind that the system should be simple and operative rather than complicated and unwieldly. The simpler the method of bookkeeping, organization, reporting and recording, the more successful will be the results in spending the money economically and well and the more successful will be the opportunity of the official at the head to present his information so that it will be of benefit first, to the general public, and, second, to the profession of which he is a member.

CROSS-SECTIONING.

By J. A. Macdonald.

ONE of the most important problems that confronts the surveyor is the setting of "slope stakes," called cross-sectioning, from which may be determined the amount of earthwork in cut or fill, and which mark the extreme limits of the operations of the construction corps in building railways, highways, sewers, canals, irrigation ditches, etc.

The problem is as follows: Given the required width of finished roadbed or channel, with proper side slopes (depending upon the kind of material) it is required to determine where these side slopes will intersect the natural surface of the ground with reference to the centre line of the survey. The centre line is defined by stake, carefully aligned and levelled, and a profile of it is prepared upon which the grade line is laid down, showing the elevation of the finished roadbed or channel with reference to the natural surface of the ground.

Let us assume the ground to be level transverse to the centre line. Depth of cut at centre, 12 feet; side slopes, 1½ feet horizontal to 1 foot vertical; width of cut at bottom, 20 feet. (See Fig. 1.)

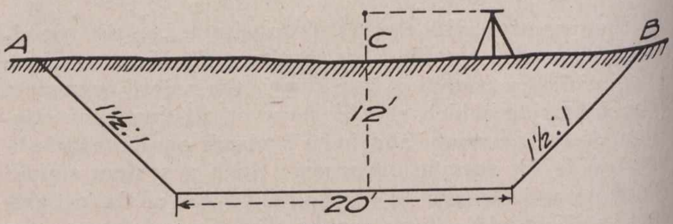

Fig. 1.

Set up the instrument in some convenient position that will command a view of as much ground as possible. Hold the rod at the centre stake and note the reading. Suppose it to be 3.5 feet. If the ground is level, the distance from C to B is evidently 10 + (12 × 1½), or 28 feet, and the rod should again read 3.5 feet when held at B. The point A would be similarly found.

The notes would be kept as shown below:

Sta.	Dis.	Left.	Centre.	Right.	Area.	Cu. Yds.
100	50	+ 12.0 / 28	+ 12.0	+ 12.0 / 28		
101		+ 3.0 / 14.5	+ 6.0	+ 9.2 / 23.80; + 7 / 9		
101	50	+ 2.5 / 13.75	+ 5.0	+ 8.0 / 22		

This example illustrates one of the simplest cases that occur in practice. Let us now take the case of a line located upon the side of a hill, as in Fig. 2.

Depth to grade at centre, 6 feet; width at bottom, 20 feet; side slopes, 1½ to 1. As before, hold the rod upon the ground at C and determine the height of instrument above C. Suppose this to be 5.5 feet. If the ground were level through C it would be necessary to measure to the right 10 + (6 × 1½) = 19 feet to the point D, and the rod should read 5.5 feet. Instead it reads, say 2.8 feet. We know, therefore, that we have not gone out far enough by (5.5 — 2.8) 1½ = 4.05 feet, if the ground were level through the point D, bringing us to the point E where the rod should read 2.8 feet. Suppose it reads 2.3 feet. We must then go out 0.75 foot farther, each move bringing us closer and closer to the point B. This operation may be repeated as often as is considered necessary, but with a little experience in this sort of work the instrument man can direct the rod closely enough to the point B for all practical purposes. We then enter the notes in the second line of the record shown above.

Upon the left of the centre, these operations are reversed. That is to say, we measure out 19 feet and instead of the rod reading 5.5 feet, it reads, say, 8.5 feet. We know then that we are out too far by 4.5 feet. We then move in toward the centre the required distance and read the rod again, noting how much it differs from 8.5 feet, if any, and enter the final results in the notes.

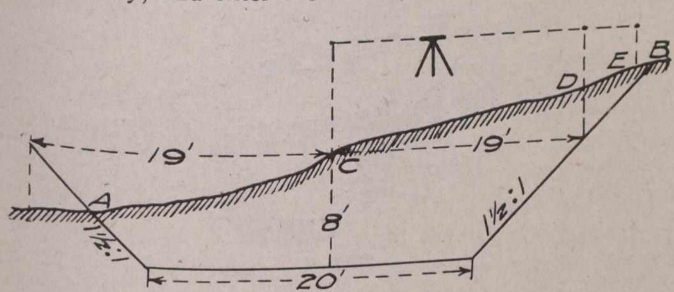

Fig. 2.

A third case is shown in Fig. 3, in which the transverse slope is not uniform. The method of procedure is the same as in the other cases, but the rod should be held at the point where the slope changes in order to find its height above grade. Enter this and the distance out in the third line of the notes.

The transverse section may be very irregular, in which case it may be necessary to take readings at several points in order to calculate the area of the sections with more exactness. At times a section will be cut partly in rock and partly in earth, forming a compound section. Each material will, of course, have its own proper side slope, and the depth and extent of each must be determined by soundings.

In case the section is in fill instead of in cut, the method is the same as in the preceding cases, as will be illustrated in the following examples.

Let us first take a section level transversely. (See Fig. 4.) In this case the finished grade is to be 9 feet above the point C. Hold the rod at C and suppose it reads 3.25 feet. Since the ground is level, we go out to the right and left 9 + (19 × 1½) = 22.5 feet, and set the stakes at A and B, entering the record in the notebook as before, except that the numerator of the fraction will be marked — instead of +.

We will next take the case where the surface of the ground has a transverse slope, as in Fig. 5. Hold the rod at the point C, and suppose it reads 9.25 feet. If the ground were level through C we would have to go out to the right 9 + (6.25 × 1.5) = 18.4 feet to some point D. But there the rod reads, say, 1.5 feet, hence we know we are out too far by 7.75 × 1.5 = 11.63 feet, bringing us back to some point as E, and the rod now reads, say, 3.5 feet, so we move out again 2.0 × 1.5 = 3 feet. We

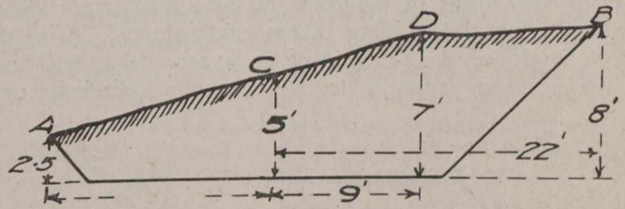

Fig. 3.

move back and forth until we find the point B, where the computed rod reading and the actual reading agree.

Sometimes it will be found that a part of the section is in cut and a part in fill (Fig. 6), but methods outlined will serve in any case.

Cross-sectioning Irregular Sections.—The prismoids have straight lines joining corresponding points in the two cross-sections. The centre line must be straight between two cross-sections. If a ridge or valley is found lying diagonally across the roadbed, a cross-section must be interpolated at the lowest (or highest) point of the profile. Therefore a "break" at any section cannot be said to run out at the other section on the opposite side of the centre. It must run out on the same side of the centre or possibly at the centre. Very frequently complicated cross-sectioning may be avoided by computing the volume, by some special method, of a mound or hollow when the ground is comparatively regular except for the irregularity referred to.

When the natural slope cuts the roadbed there is a necessity for both cut and fill at the same cross-section. When this occurs the cross-sections of both cut and fill are often so nearly triangular that they may be considered as such without great error, and the volumes may be computed separately as triangular prismoids without adopting the more elaborate form of computation so necessary for complicated irregular sections. When the ground is too irregular for this the best plan is to follow

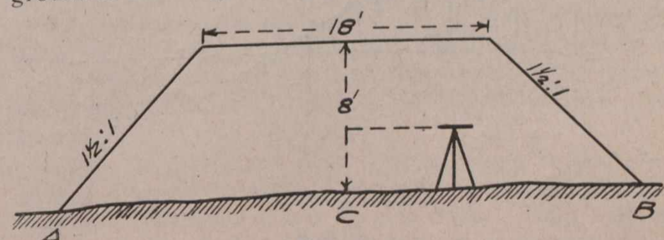

Fig. 4.

the uniform system. In computing the cut, as in Fig. 6, the left side would be as usual; there would be a small centre cut and an ordinate of zero at a short distance to the right of the centre. The area for fill may also be computed by a strict application of the rule.

Compound Sections.—When the cut consists partly of earth and partly of rock, as in Fig. 7, a compound cross-section must be made. If borings have been made so that the contour of the rock surface is accurately known, then the true cross-section may be determined. The rock and earth should be calculated separately, and this will require an accurate knowledge of where the rock "runs out"—a difficult matter when it must be determined by boring. During construction the centre part of the earth cut would be taken out first and the cut widened until a sufficient width of rock surface had been exposed so that the rock cut would have its proper width and side slopes. Then the earth slopes could be cut down at the proper angle. A "berm" of about three feet is usually left on the edges of the rock cut as a margin of safety against a possible sliding of the earth slopes. After the work is done, the amount of excavation that has been made is readily computable, but accurate preliminary esti-

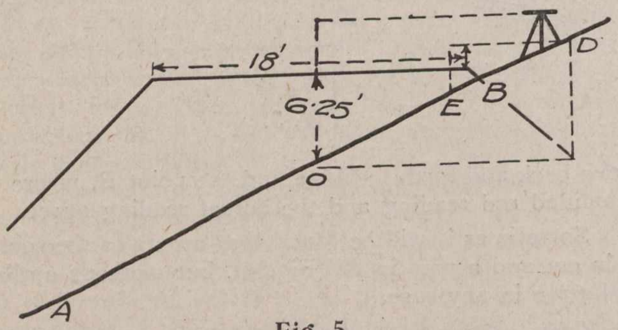

Fig. 5.

mates are difficult. The area of the cross-section of earth in the figure must be determined by a method similar to that developed for borrow-pits.

The distance between the sections longitudinally will depend upon the nature of the ground. On uniformly sloping or level ground they may be taken 100 feet apart. Over uneven ground it may be necessary to take them as closely together as 25 feet, or even less. In the sections themselves, a sufficient number of rod readings should be taken that the area of the sections may be determined with reasonable accuracy.

After the field work is completed, the notes are plotted, usually upon cross-section paper, and the areas determined either with a planimeter, by Simpson's rule, or some other method. These sections then divide the earthwork into a system of prismoids of which the volume

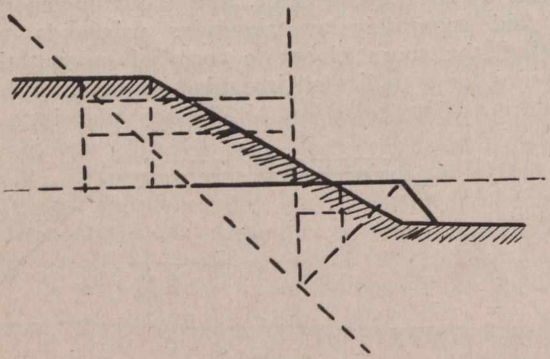

Fig. 6.

must be calculated. The formula for calculating volumes is known as the Prismoidal Formula, and is as follows:

$$\frac{l}{6 \times 27}(A + 4M + B);$$

in which l is the length between consecutive sections; A, one end section; B, the other end section, and M the section midway between the two. The result is given in cubic yards.

The mistake must not be made of assuming that M is a mean between A and B, but a theoretical section must be plotted whose dimensions are a mean between those of A and B. . This often results in quite a complicated problem, and various other formulas have been devised to give sufficiently close results without the labor and time involved in the preceding.

It should be realized at the outset that the accuracy of the result of computations of the volume of any given mass of earthwork has but little relation to the accuracy of the mere numerical work. The process of obtaining the volume consists of two distinct parts. In the first place it is assumed that the volume of the earthwork may be represented by a more or less complicated geometrical form, and then, secondly, the volume of such a geometrical form is computed. A desire for simplicity (or a frank willingness to accept approximate results) will often cause the cross-section men to assume that the volume may be represented by a very simple geometrical form which is really only a very rough approximation to the true volume. In such a case, it is only a waste of time to compute the volume with minute numerical accuracy. One of the first lessons to be learned is that economy of time and effort requires that the accuracy of the numerical work should be kept proportional to the accuracy of the cross-sectioning work, and also that the accuracy of both should be proportional to the use to be made of the results.

Prismoids.—To compute the volume of earthwork, it is necessary to assume that it has some geometric form whose volume is readily determinable. The general method is to consider the volume as consisting of a series

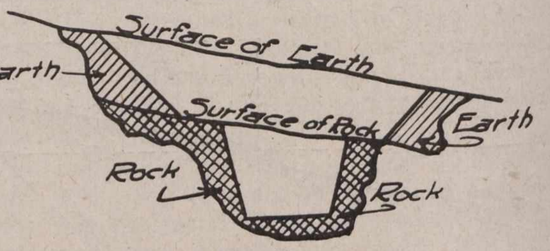

Fig. 7.

of prismoids, which are solids having parallel plane ends and bounded by surfaces which may be formed by lines moving continuously along the edges of the bases. These surfaces may also be considered as the surfaces generated by lines moving along the edges joining the corresponding points of the bases, these edges being the directrices; and the lines being always parallel to either base, which is a plane director. The surfaces thus developed may or may not be planes. The volume of such a prismoid is readily determinable, while its definition is so very general that it may be applied to very rough ground. The "two plane ends" are sections perpendicular to the axis of the road. The roadbed and side slopes (also plane) form three of the side surfaces. The only approximation lies in the degree of accuracy with which the plane (or warped) surfaces coincide with the actual surface of the ground between these two sections. This accuracy will depend (*a*) on the number of points which are taken in each cross-section and the accuracy with which the lines joining these points coincide with the actual cross-section; (*b*) on the skill shown in selecting places for the cross-sections so that the warped surfaces shall coincide as nearly as possible with the surface of the ground. In fairly smooth country, cross-sections every 100 feet, placed at the even stations, are sufficiently accurate, and such a method simplifies the computations greatly; but in rough country cross-sections must be interpolated as the surface demands. Carelessness or lack of judgment in cross-sectioning will introduce errors of such magnitude that all refinements in the computations are utterly wasted.

The process of cross-sectioning consists in determining at any place the intersection by a vertical plane of the prism of earth lying between the roadbed, the side slopes, and the natural surface. The intersection with the roadbed and side slopes gives three straight lines. The intersection with the natural surface is in general an irregular line. On smooth regular ground or when approximate results are acceptable this line is assumed to be straight. According to the irregularity of the ground and the accuracy desired more and more "intermediate points" are taken.

"Setting Up" the Instrument.—In setting up the level to secure horizontal sights, plant the legs firmly in the ground at approximately equal distances apart, so as to make the levelling plate horizontal. The level is, with few exceptions, never placed in line (except when being adjusted under the peg method). It is usually placed in some convenient spot where the greatest number of horizontal sights can be secured. As already stated, the tripod legs must be so placed as to make the plates horizontal. This will save time in bringing the bubble in its proper position. Should it be required to set up the instrument on the side of a hill, place one leg at an altitude and the other two in apparent line with each other, but where the tripod is adjustable the proper method is apparent.

After the instrument is set up and levelled, focus the eye-piece upon the wires and focus the object-glass on the rod by means of the screw placed for that purpose on the top or side of the telescope. Care should be taken not to take a reading until the bubble has been carefully observed and brought in the exact centre of the bubble tube. When this is completed, sight through the telescope and note the rod reading or set the target rod; again look at the bubble and see if it has moved away from its former position; if not, again sight on the rod and see if the first observation was correct. Should the intersection of the cross-hairs fail to coincide with the horizontal and vertical lines of the target or the centre of the rod, the rodman is to incline the rod by the signals of the observer, until it coincides or is in line of collimation.

PURIFYING PAPER AND PULP MILL WASTE WATER.

A means of dealing with any waste waters that offer considerable difficulties in their treatment, especially those coming from paper pulp factories, depends on the use of a mixture of hydrated silica and salts of iron and alumina prepared from ordinary clay by igniting it in a vacuum and treating the residue with such small quantities of sulphuric acid and water that the silica is obtained in a soluble form. The iron always present in common clay greatly assists the clarifying action of the soluble silica on the waste lyes, as does the sulphate of alumina also formed.

The novelty of the invention consists in the ignition of the clay (to destroy its organic matter) in a vacuum, otherwise it is difficult to get the silica in a soluble form, and the soluble silica is the main effective agent, the iron sulphate and aluminum sulphate being of secondary although considerable importance.

The details of the manufacture are as follows:—1,000 lbs. of the ignited clay is treated with a mixture of 400 lbs. of concentrated sulphuric acid and 1,500 lbs. of water in the cold with constant stirring for about one hour. It is claimed that the product will clear one thousand times its weight of waste pulp water sufficiently in from ten to fifteen minutes to permit of its discharge into a river. The sediment is collected and re-ignited for use again.

ENGINEERING SUPERVISION OF ROAD CONSTRUCTION.*

By W. S. Keller,
State Highway Engineer of Alabama.

THIS question confronts every commission that has the building of good roads, and it would appear to the business man that the wisdom of having an engineer supervise the expenditure of large sums of money on highway construction, would not be questioned any more than a railroad company would question the wisdom of employing an engineer to locate and supervise the construction of a railroad.

We may, therefore, for discussion, divide this subject under two general heads:

Is engineering supervision of road construction necessary?

Why is an engineer better fitted to supervise road construction than a practical road builder who is not an engineer?

Engineering supervision of road construction is absolutely necessary and this statement is proven every day, positively and negatively. A layman riding over the roads can tell at a glance a road that has been located and built under the direction of an engineer. When he rides over a road that has been constructed along the old trail, located by the Indians and early settlers, without any regard whatever for grades and very little for drainage, he sees the hand marks of the commissioner, who saves his country the salary of an engineer, and spends it thrice over in useless work and expensive maintenance.

Despite the fact that a majority of commissioners or supervisors have had no training whatever in road building, they will concede to no one that they are not as well qualified to direct road work as any engineer they can employ. They will often admit that an engineer should locate and stake off a road, but they think his duty ends there. It is just as necessary that an engineer supervise construction work as it is that he should locate the road. How many commissioners can tell how much it costs to move a yard of earth or how much it costs to install pipe of various makes—how much per cubic yard their concrete culverts are costing them? You may say we know how much per mile our roads are costing, why should we bother to know the unit cost? Why does a merchant keep the unit cost of his wares? Because he desires to buy from the man who sells the cheapest. So, a county should know if its roads are costing more than they should.

The commissioners of a certain county in Alabama claimed that they were building roads as cheap or cheaper than any contractor could do the work. They had an engineer estimate the cubic yardage of earth moved for a certain period of time and to their surprise it was costing 37½ cents per cubic yard when the average contract price in Alabama for three years had been 23 cents per cubic yard. Authorities should know whether they are getting value received for their money, and an official who overlooks such a vital question, is not true to the trust placed in him by the people.

Many counties are imposed on in the purchase of material and supplies and are actually paying more for such in large quantities than individuals have to pay for the same in small amounts. This is usually attributed to

* Extracts from paper read at the Fourth American Road Congress, Atlanta, Ga., Nov. 9-14, 1914.

either carelessness, politics, or a false idea some of the commissioners have as to their duty. I believe the duty of commissioners, in so far as road building is concerned (and it can equally as well be applied to other public matters) is to purchase with as much care and secure just as low prices as they would if buying for themselves as individuals, regardless of whether the goods purchased come from local or foreign merchants; of course, giving always the preference to local merchants, if their wares are as good and prices as low as those of outsiders. It is not the duty of road authorities to conduct county affairs so as to make money for individuals or to give jobs to political henchmen. If a competent man cannot be found within the borders of a county fit by experience for a position such as foreman, it is right and proper that a competent man should be secured from elsewhere.

The remedy for these ills is, unquestionably, to have some one in charge of road building qualified by education and training and free from political influences, who can be held responsible for results. Very few counties have commissioners or supervisors who devote all of their time and attention to their office, and it is self-evident that an engineer trained in road building will get better results than can any set of men who give only a few days in the year to their public office.

As to the second division of this subject, "Why an engineer is better fitted to supervise the construction of roads than a practical road builder who is not an engineer." First, an engineer is indispensable, even though you have a splendid layman to supervise the work. A large percentage of all roads to be constructed require relocation, profiles made, grades established and if the work is to be contracted, the road must be cross-sectioned and the yardage of excavation and embankment calculated and made to balance as near as possible. Such work a layman cannot do. Who is better fitted to supervise the construction of any job than the man who plans and specifies the work? The road supervisor is usually uneducated and it is practically impossible for him to correctly account for the expenditure of large sums of money and equally as impossible for him to keep cost account of his work.

This condition is usually brought about by a disposition on the part of the board of supervisors or commissioners to economize. Unfortunately, many county commissioners can see only the engineer's salary to be paid twelve times a year and the inevitable result that there will be quite a decrease in the number of days they can legitimately demand pay for laying off and superintending the building or repair of roads in their respective districts. In other words, the engineer is a usurper, taking away the salary of those guardians of the people's right who are so anxious to save money for the people that they save $200 per month engineer's salary and spend $500 per month in doing it. So long as we elect officials because of their popularity rather than fitness, and pay them a mere pittance for their services, we may expect many of them to be incompetent and often dishonest. A foreman in the employ of a certain county was discharged by the commissioner of the district in which he had been working. The commissioner gave as a reason for discharge, that he himself could look after the teams and hands and thereby save the county several dollars a month. The foreman resented his being discharged and took upon himself the investigation of the commissioner's record. He found that on a certain day this commissioner drove seven miles to a small bridge where he then and there made a contract with a party to repair the bridge at a cost of $1.50. A few days later he went back to this bridge to inspect the work he had ordered done. The record of the Commissioners' Court showed that cost of repairing was $1.50 and cost of inspection two days at $3 to $6. He certainly was entitled to pay for at least the time consumed by himself yet it is manifestly wrong for such a condition to exist that cost of supervision is four times that of construction or repair. This would have been a very small matter to an engineer who, while having the bridge repaired, would attend to many other duties.

It is almost impossible to convince many county officials that an engineer can easily save his salary several times over by making certain changes in location and grade and by economically administering the affairs of the county. As a general rule a county gets more in return for money spent for engineering services than for any other single item connected with road construction. A good engineer is a dividend producer for a county. In speaking along this line at the American Road Congress held in Atlantic City in 1912, Col. W. D. Sohier said:

"You will find if you look at any private corporation, that the ordinary engineering expenses for any work of the character of road building, any constructional work, is usually about 10 per cent., and that it is good money well spent."

A highway engineer should have a good technical education and to be successful, he must be practical and he must be a diplomat. He should be sober, honest, energetic and think more about the work he is trying to do than the pay check he will receive at the end of the month. When taking charge of a county's road affairs he should convince the commissioners that he knows more than they do about building roads and then proceed to prove it by doing good work. Unless an engineer can absolutely convince his Board of Commissioners that he knows his business, he had best resign. Trouble is often brought about by the engineer failing to have a thorough understanding as to his duties. This can easily be avoided if, when an engineer makes a contract with a county, he clearly sets forth in this contract what his duties are. If he is to be held responsible, and he should be, for the success of the undertaking, he should have full power to employ and discharge those under him. I think this is well expressed in Rule 2 of Rules and Regulations of the State Highway Department of Alabama, which reads as follows:

The functions of the Commission are judicial and those of the engineer, executive. The engineer will receive and carry out the directions of the Commission and shall, in turn, direct those under him. The engineer shall have full charge of construction work, directing it in all its details. Any orders the Commission wish to give an employee shall be given through the engineer, and the engineer shall have the right to employ, with the consent of the Commission, and to suspend, subject to discharge, without consulting the Commission. All suspensions shall be reported to the Commission for such action as they deem necessary.

The spandrel or face walls of a concrete arch may be carried up at the same time as the arch ring is laid, or may be connected with it later by leaving short lengths of steel projecting radially from the concrete of the arch. Some engineers require that arch centering shall be lowered sufficiently to allow the arch ring to assume its permanent set before parapet walls are placed.

The largest power transmission by means of chains, according to F. L. Morse, is one consisting of two drives, each of 2,500 h.p. capacity, for operating a 5,000 h.p. generator in an Idaho power plant. There are eight chains all told. 21 in. wide, and of 2 in. pitch. The sprockets have 71 and 47 teeth, and are of 45.59 in. and 30.31 in. in diameter, respectively, and each of a face of 92 in. The sprockets are 120 in., centre to centre, and each carries, as stated, four chains, each 21 in. wide.

ICE TROUBLES IN HYDRO-ELECTRIC PLANTS.

IN Canada the designer of a water power development has before him the task of providing a means of eliminating or minimizing the effect of ice upon plant operation and power production. It is an important problem even though there be no direct liability of injury to the plant equipment. Apart from trouble due to ice blocking the water entrances, the presence of it in the river may have such a marked effect upon the power production that it should never be overlooked in the study of a development where ice conditions in winter are liable to obtain.

A good analysis of ice formation, its effect upon the operation of a plant, and suggested methods of overcoming the difficulty, are presented by Mr. M. C. Hendry, chief engineer for the Water Power Branch, Department of the Interior, in his report on Bow River power and storage investigations. His treatment of the subject is given as follows:—

There are three kinds of ice which, owing to their effect upon the operation of water-power plants, are of interest to the engineer. These are: Board or sheet ice, frazil ice and anchor ice.

Sheet Ice.—Sheet ice is that kind of ice which is formed upon the surface of lakes, smooth-flowing rivers, ponds, etc. The process of formation is an interesting one, and begins with the arrival of cold weather. As the season advances, the water on the surface gives up its heat by surface radiation, convection currents are set up, the cold surface water falls and the warmer water below rises; this in turn gives up its heat; by a continuation of this process, the temperature of the whole body of water is gradually lowered until it reaches 39° F.; at that temperature convection ceases, and the water on the surface is cooled down until freezing point, 32° F., is reached. The first indication of the formation of ice is the presence of long needle-shaped crystals on the surface. These rapidly increase in number and size until finally the whole surface is covered. This surface layer becomes more compact, and the ice increases in thickness, as the underlying water gives up its heat by conduction through the ice. The rate of growth diminishes, however, as the thickness of the sheet increases.

When the ice sheet is once formed, radiation to a very great extent ceases. This is due to the fact that the ice is seldom clear, and is generally snow-covered and the heat rays are unable to penetrate under such conditions. If the ice was clear and solid, the heat rays could then penetrate, and the loss of heat from the water below would go on at a much more rapid rate, and consequently the growth of ice would be more rapid.

The pressure of any sheet ice in a river immediately above a power plant has a beneficial effect upon its operation rather than the reverse. The reason for this will be understood after the subject of frazil and anchor ice has been dealt with.

Frazil Ice.—Frazil ice, known also as "slush ice," is perhaps the ice formation which has the most serious effects upon water-power operations. It is always formed in the open channels where the current is too swift or turbulent to allow the formation of sheet ice, and its formation is dependent upon disturbance or agitation, consequently swift turbulent streams are very prolific in its production; it occurs in needles, the fineness of which are due to the amount of agitation. In such places as rapids, and at the foot of falls, these needles are very fine, but they increase in size and thickness where the flow is less rapid and disturbed. Frazil ice is always surface-formed, but the ice crystals rapidly become distributed throughout the whole body of water. This gives rise to the saying that the water is "thick." This condition occurs only during a period of extreme cold, combined with great surface agitation, due to rapids in the river, or wind. The direction of the wind relative to the flow of the river has a varying effect on production of frazil, a wind blowing upstream produces more frazil than one blowing downstream, on account of increased surface agitation.

The conditions that make for the greatest production of frazil ice are a dull, stormy day, with wind upstream. A great amount of frazil may be produced upon a clear, cold night with wind, but on a clear, cold day with wind there is not so great a quantity formed, due to the absorption of heat from the sun's rays at the water surface. Professor H. T. Barnes, in his book on "Ice Formation," says that "a stretch of open water makes a very much greater quantity of ice in the form of frazil crystals than could be produced as a surface sheet, if the water were sufficiently quiet to allow such to grow." It is this production of frazil which gives rise to so much trouble, the steam becoming blocked with the mass. Where an ice sheet exists, conditions are often aggravated, the frazil blocking the waterway underneath, at times causing complete stoppage of flow.

Anchor Ice.—Anchor ice, "ground ice," the German name "Grundeis" and the French-Canadian term "moutonne" are among the many names given to this particular form of ice. As this list of names would indicate, it has attracted very widespread attention, and a number of scientists have published papers in which its formation has been discussed. The name "anchor ice" perhaps best describes it, and is the one by which it is most widely known in this country.

The peculiar feature which gives it this name is the fact that it is formed upon the bottom of the rivers or streams. Many theories as to the reason of the formation of ice upon the bottom have been advanced. That as set forth in a paper by Dr. Farquharson, which he published in 1835 and 1841 is generally accepted as the correct one. He attributes the formation of anchor ice to the radiation of heat from the surface of the stream's bed.

It is remarked that this cooling by radiation, and consequent formation of anchor ice, occurs only in streams whose beds are composed of gravel, stones and boulders, but not in clay or mud-bottomed streams; also that the formation of the ice is greatest on the rocks and stones of dark color.

The formation of anchor ice is most rapid during a clear, cold night (conditions which are favorable to rapid radiation). On a clear, cold day, the sun's rays affect the formation; in fact, it is universally noted that on the appearance of the sun in the morning, the ice becomes loosened from the bottom and rises to the surface. Its appearance when floating has given rise to the French-Canadian term, "moutonne," on account of its resemblance to the backs of white sheep.

It has been noted in connection with anchor ice, that its formation does not occur under cover. A bridge spanning a stream retards radiation and prevents its formation, and it is seldom found where the stream is covered with an ice sheet.

The names frazil and anchor ice are often confused and are frequently used as being interchangeable; the term "anchor ice" being used to designate ice found attached to the bottom, regardless of the method of formation.

Professor Barnes says that "in a shallow, smooth-flowing river, we are more likely to have anchor ice formed in excess, whereas in a deep and turbulent stream we are likely to have more frazil. It is hardly likely, however, that there will be a great difference in the amount of frazil formed in either case; it will probably be that more or less anchor ice will appear in proportion."

The Montreal Flood Commisson in their report deal exhaustively with the question of ice formation. The following is an extract from that report:—

"The terms 'anchor ice' and 'frazil ice' are indifferently applied to the same material, but the first evidently is most applicable to this ice when found in the bottom of the river. In one respect the two are identical; that is, both are exclusively the production of open water. There is no formation of either when or where the surface is covered with ice, and whereas large formations of both take place in the beginning of winter over the vast surface below Lachine Rapids, the further formation of this ice ceases as soon, and whenever the ice-bridge is formed. Frazil, as distinguished from anchor ice, is formed over the whole unfrozen surface above and below Lachine Rapids, between Prescott and the tide-water and wherever there is a surface current or wind agitation to prevent the formation of bordage ice, while anchor or anchored ice, except in the shallowest portions of the current, does not appear in the deeper water until zero weather sets in."

In this report the formation of anchor ice is not ascribed to radiation from the river bottom, but rather to the cooling of its surface through the contact with the frazil-charged water. Proceeding with the description on anchor ice, the report says:—

"On the approach of mild weather, it becomes detached from the bottom, sometimes bringing up with it gravel and stones, and may be seen as a dark-colored mass bursting up all over the surface with considerable force, and with a hissing sound, which rises a foot or more above the surface, but falling back, shows only a few inches floating above it. Out of the portion above the surface, the water quickly drains, and it becomes white as snow."

In respect to the name "anchor ice" being applied to frazil ice, this is due, in the case of water-power developments, to the action of the frazil under certain conditions. Where the head-race of a development is open, allowing the frazil direct access to the intake without having to pass under an ice sheet, it practically becomes anchor ice, because as it comes in contact with the racks and intake structure it adheres to them and rapidly cuts off the water. Under these conditions there is no difference between anchor and frazil ice, once the latter has become attached to the structures. As a matter of fact, it is this action of the frazil which causes the trouble directly to plant operations, as it is generally formed in the greatest quantity. The action of the anchor ice proper is to cut off the flow of water in the stream bed; when the anchor ice is floating, the conditions are improving.

Winter Conditions.—One condition which requires the attention of hydraulic engineers is the effect of ice upon the discharge of the river, for the formation of frazil and anchor ice in the bed of these rivers and streams has a very marked influence upon their discharge. Lying, as they do, at considerable elevations, the temperature obtaining during the winter months is low and, owing to the steep slope of the streams, their flow is turbulent, thus the necessary conditions are present for the formation of frazil ice. The conditions for the formation of anchor ice are also good, for in many places the stream is too swift to allow an ice sheet to be formed. The water is clear and generally shallow, the nights are cloudless and cold; in consequence anchor ice is formed in great quantities.

The formation of frazil and anchor ice in the mountain streams causes their discharge to be very fluctuating, and accentuates the variation in flow during the low-water period.

Winter Conditions as Affecting Plant Operation.—The successful operation of a water plant in winter, on the rivers of Canada, depends in a large measure on the method of providing for or eliminating the ice troubles which are always to be met with.

In the foregoing, the conditions favorable to the formation of the several kinds of ice to be met with have been explained, also the relation of one kind of ice encountered, to another. Of the three principal kinds, sheet or board ice is the least detrimental to operation; in fact if board ice were the only kind to be dealt with, the trouble would be negligible. Where the channels are small, however, and where anchor and frazil have been formed above, great trouble may be experienced, due to the lodging of this frazil and loosened anchor ice, under the sheet, for frazil ice, in the presence of sheet ice, attaches itself to the under side of the latter, and where the channels are small, the whole flow of the stream may become blocked, overflow will then occur and a great proportion of the stream flow be lost.

One of the best methods, however, of avoiding frazil and anchor ice troubles, is by obtaining a pond of sufficient size and depth in the immediate vicinity and above the intake of the plant, which will readily freeze over. The ice sheet obtained will, to a great extent, eliminate any troubles with frazil or anchor ice.

If the entrance to the power plant is a channel restricted in size, the ice sheet will be a hindrance, rather than a benefit, if there is open water above. In such a case it is much better to be without a sheet of ice, and instead make provision for handling the accumulation of frazil and anchor ice in the head works. There have been many attempts made to deal with this problem, but it generally degenerates into a brute force combat. In many plants provision is made for passing masses of frazil ice through the wheels by raising the racks in sections, currents are then induced to pass across the face of the racks, so that the floating ice, etc., may be carried off.

The great trouble with frazil ice is due to its freezing on the racks and the wheels, finally stopping the supply of water. With regard to the racks, this has been usually due, in a large measure, to the fact that the upper ends of the bars composing them have been left protruding above the water for 2 or 3 feet exposed to the very cold air. In such a position these bars become chilled to the bottom, and even when only cooled to two or three one-thousandths of a degree below freezing point, it is sufficient to cause the frazil ice to adhere to the bars and commence the clogging process. This trouble may be eliminated to a great extent by making the upper part of the rack of wood, and keeping the metal bars entirely submerged, thus preventing the conduction of heat from bars to the atmosphere, and the consequent cooling below freezing point. Besides this method of submerging the metal of the racks, schemes have been brought forward for heating them, such as using hollow bars through which steam may be driven. In many plants instead of this, the head works are housed and heated, not only to provide a good working room for the men fighting the ice, but also to prevent the subcooling of the racks. One of the most successful schemes has been that employed by one of the plants in Ottawa. There the tops of the bars are encased with sheeting, steam pipes being also enclosed. By this means ice troubles have been prevented to a great extent. The use of a live steam jet in the wheel case and guide vanes to prevent the freezing or clogging up of the wheel entrance has been quite successful in several plants.

Editorial

FIXED CARBON TEST.

In view of the interesting series of articles on the fixed carbon test which *The Canadian Engineer* was fortunate enough to secure, some months ago, from a number of the leading bituminous experts in the United States and Canada, it is interesting to note that the City of Toronto has raised the limit for fixed carbon from 15% to 18%. For several years the works department of Toronto has insisted on a low limit for fixed carbon, but in the specifications issued for the supply of 1915, the limit is 18%.

After the appearance of the above-mentioned articles, the works department announced its intention of making an exhaustive investigation into the subject, in order to have more data upon which to base their future requirements in regard to this test. Pressure of other work, however, has prevented the department from making the investigation planned; but it was decided to raise the limit anyway, as there was a general feeling in the department that 15% was too low a limit, especially for asphalts refined from Mexican crudes. The department is of the opinion, however, that the fixed carbon test has value, and that some limit should be imposed in this regard by asphalt specifications.

BOW RIVER POWER POSSIBILITIES.

An extremely valuable report, known as Water Resource Paper No. 2, has recently been issued by the Water Power Branch, Department of the Interior, Canada. It covers investigations carried out on the upper waters of the Bow River by Mr. M. C. Hendry, chief engineer in charge of surveys, under the direction of Mr. J. B. Challies, Superintendent of Water Powers. This river was the first of the Rocky Mountain streams to be investigated by the Department as to its power-producing and storage possibilities. The work was commenced in April, 1911, and carried out with the consulting advice of Lieut.-Col. C. H. Mitchell, C.E., one of the board of consulting engineers to the Dominion Government. The present report covers the work for 1911-12-13, the study having been then completed.

The conservation of the waters of the Bow River is vital to the agricultural and industrial prosperity of a very large area of Southern Alberta. The investigation, with usefulness for irrigation and power purposes in mind, has furnished the Water Power Branch with some most valuable data relative to storage possibilities, climatic conditions, industrial development and meteorological phenomena of wide scope, and with all other essentials necessary for a complete knowledge of the area and its characteristics.

These investigations show that it is economically feasible to regulate the flow of the river, and that by means of six power sites, *viz.*, Kananaskis Falls, Horseshoe Falls, Bow Fort, Mission, Ghost and Radnor, to provide over 48,000 continuous 24-hour wheel horsepower, all within 50 miles of Calgary, as against 19,800 wheel horse-power from the natural flow. The study also shows that the utilization of these waters for power purposes above Calgary need not conflict with the consumption of the same water below Calgary for irrigation purposes. On the contrary, the proposed power regulation would be found of distinct advantage to the extension of existing irrigation systems to their ultimate capacities, and also insure in the future the instigation of additional irrigation projects.

The investigation has been similar to others that have been carried out, or are in progress, in Canada, the United States and other countries. The Hydro-Electric Commission of Ontario has made very extensive studies in this respect, on water powers in the province. There is a difference, however, between the two investigations, in that the latter has been carried on with the object of ascertaining what could be done in the way of power production by the Commission, whereas, the investigations of the Water Power Branch have been with the object of supplying information to the public, and procuring information upon which the best administration of the water powers could be based. Other extensive studies have been those of the United States Geological Survey, among which might be mentioned the investigations in states of New York, Maine, Minnesota, and Washington.

THE VENTILATION OF RAILWAY TUNNELS.

The Committee on Roadway of the American Railway Engineering Association has submitted a finding to the effect that the most practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or of diluting and removing, the smoke and combustion gases at the opposite end. As practised in America, this way of procuring ventilation partakes of two methods:

(*a*) To blow a current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine;

(*b*) To blow a current of air against the direction of the tonnage train with velocity and volume sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

PRODUCTION OF STEEL DIRECT FROM ORE.

The conclusions reached in a paper by E. Humbert and A. Hetbeg, before the Iron and Steel Institute, are: That the economic manufacture of steel from ore is quite practicable; that the product, on account of its comparative freedom from hydrogen, nitrogen, and other impurities, is superior, especially in toughness, to steel obtained by present methods; that the electric furnace employed should be of a type permitting violent ebullition of the bath without overflowing; that either charcoal, coke or anthracite may be used as fuel; and that anthracite electrodes will probably be most economical.

Tests were made by the writers, with swedish and Brazilian iron ores in a Héroult electric furnace of 6 tons capacity, using coke as fuel.

ENGINEERS' LIBRARY

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

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BOOK REVIEWS.

Carnegie Pocket Companion. Issued by the Carnegie Steel Company, Pittsburg, Pa. Bound in flexible morocco.

This is the sixteenth edition of the Carnegie Pocket Companion, which has been rewritten and reset throughout. The date of the last edition was 1903. Since that time, the art of bridge and building construction has changed a great deal, while the use of steel has extended into other lines than those covered by the previous edition. In the present publication obsolete forms of construction are eliminated, and the information tabulated is brought up to the present date and present-day practice.

Steel Construction—A Text and Reference Book Covering the Design of Steel Framework for Buildings. By Henry Jackson Burt, C.E. Published by American Technical Society, Chicago, 1914. 381 pages; profusely illustrated; 4½ x 7 inches; flexible binding. Price $2.75. Reviewed by A. E. Davison, B.A.Sc., Hydro-Electric Power Commission of Ontario.

As mentioned in the introduction and largely repeated on page 2 of Part I., "This book is intended to give its students the facts and formulas needed in designing structural steel framework for buildings—accompanied by explanations of the underlying principles. The use of formulas is shown by illustrations of a practical nature, which serve not only to teach the proper application, but to illustrate current practice in this form of construction."

The earlier pages of the book are sufficiently carefully written to permit of anyone, with a reasonable control of mathematics, making practical calculations as outlined, intelligently. Referring to page 38 where "Radius of Gyration" is treated, we find that the information is scarcely as full as an ordinary student might require; that is, actual design practice will not proceed very far until it is necessary to calculate the "Radius of Gyration" for a made-up section such as cannot be taken readily from tables. The text at this point leaves considerable to be determined elsewhere by the student.

On pages 46 to 50, etc., an attempt is made to place the student designer in touch with the urgent need of a thorough understanding between the designer and inspector. In this regard the information on comparative elongation and reduction of area might have been given more attention; for instance, beginners are not generally familiar with the source of empirical data "Elong. 1,400,000/Ult." as indicated on page 50.

Safe units are always a trouble to the student as these may be readily confused with ultimate strengths. We find that in giving data on page 52 the writer, while speaking of "Ultimate Bearing" and "Bearing Values" states "Values below expressed in pounds per square inch taken from the building ordinances from the City of Chicago"; these, of course, are safe load values.

Part II., page 75, etc., deals with practical applications. On this page the matter of "needle" beam with which a new designer soon comes in contact is not mentioned.

On page 94 an attempt is made to give the moment values for a number of different types of beam loading. This tabulation along with those on page 190, etc., save considerable time for the average designer.

In the treating of cast iron columns as on page 232, etc., very little attention is given to the difficulty of lining up a column having a considerable number of splices at floor levels without causing failure at column flanges. Combined stresses with which the ordinary designer has to deal constantly, are briefly treated on page 266, and the matter of the relation of designer to inspector as mentioned above is brought up again on page 370.

Foundations. By Malverd A. Howe, C.E., Professor of Civil Engineering, Rose Polytechnic Institute. Published by John Wiley & Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1914. 110 pp.; 55 illustrations; 6 x 9 in.; cloth. Price $1.25 net.

This is a text book on ordinary foundations, including a brief description of the methods used for difficult foundation work. The fundamental principles upon which proper design is based are stated in an elementary way. Separate treatment is given to the foundation proper and to the footing courses of walls and columns. As stated in the preface, many books do not show a marked line of division between the two.

The work is divided into six chapters, as follows: Supporting capacity of soils; wall footings and column footings; piles and pile foundations; chimneys and towers; bridge piers and abutments; and, methods employed for difficult foundations. The book is concluded with an appendix devoted to formulas and nomenclature. An exceedingly useful addition to each chapter consists of a carefully selected set of references, about twenty to each chapter. These refer chiefly to articles that have appeared in the technical press on the subjects under study.

The book will be found exceedingly useful as a text. Its illustrations refer to actual structures, and, although it contains little descriptive matter in the text itself, the references provide the student with a valuable source of information for the details of any portion to which he may desire to give further study.

Rapid Earthwork Calculation. By C. E. Housden. Published by Longmans, Green & Co., London. First edition, 1914. 31 pp.; illustrated; size 4¾ x 7¼ in.; limp cloth. Price 50c. net.

The author of this book has published several small volumes on earthwork, water supply, drainage, sewerage, etc., that have been found most useful by the practical man in the solution of every-day problems in these branches of engineering. The present work will be found of similar service, as a number of improvements in earthwork calculation are found embodied in it.

In his preface the writer states, "With so many tables already in existence for a similar purpose, new ones may at first sight appear unnecessary and superfluous; actual trial will, however, prove that earthwork quantities can be estimated from them, as within explained, more quickly and with less labor than in any other way."

The tables give the end areas in square feet of bank and cut sections for their side slopes S and S′ to 1 added together, for values of 1, 1½, 2, 2½, 3, 3½, 4, 4½, 5, 6, 7, 8. The text explains how the tables are framed and their application.

Engineering Problems, Part I. By W. M. Wallace, Wh.Sc. Published by the Technical Publishing Co., London. First edition, 1914. 192 pp.; well illustrated; size 5 x 7 in.; cloth. Price 75c. net.

The author gives a collection of rules, relations and data on which are based the more usual calculations in some phases of engineering work. This takes up the opening pages of the text, and is followed by questions and answers illustrating the application of these rules, etc., to practical cases. No method of classification under different branches of engineering has been attempted by the author, and several branches appear to have been entirely ignored. The volume contains, however, some very interesting problems in machine design and in bridge work, while occasionally one encounters an isolated problem, such as earth pressure on a retaining wall, calorific value of petrol, strength of wooden spar, etc. One finds it necessary to state, however, that the subject matter of the book is hardly commensurate with the title chosen for it.

Steam Charts. By F. O. Ellenwood, A.M.Am.Soc.M.E., Professor at Cornell University. Published by John Wiley and Sons, New York; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1914. 91 pp.; illustrated; 7¼ x 10 in.; cloth. Price $1.00. Reviewed by A. S. L. Barnes, Hydro-Electric Power Commission of Ontario.

The title of this book is better chosen than is frequently the case, for it gives a real indication as to what the book is—primarily, a collection of steam charts. These charts have been very carefully prepared and the book as a whole "intended to be of assistance to engineers and students when making calculations involving wet or superheated steam," should fulfil its mission without difficulty. An introduction dealing with "Fundamental Principles" forms a brief explanation of the main theoretical points to be dealt with by the steam engineer. The next section deals with the steam charts themselves and explains how they were prepared and how they should be used.

Following this is a short chapter setting forth how to make barometer corrections. There are corrections to be made for temperature, altitude, gravity and capillarity. Even the expansion and contraction of the scale must be taken into account, if a full length brass scale be used. Next come the charts themselves, of which there are nine. These are plotted to a very convenient scale and are exceptionally clear.

On the ordinates is given the total heat of the steam in B.t.u. per lb., while the abscissæ show the specific volume in cu. ft. per lb. Lines of constant pressure are plotted, as also are those of constant superheat. Lines of constant entropy and of constant quality are shown.

To simplify the using of the charts an index chart is given at the beginning of this section from which the range of the main charts can be readily seen and the correct chart thus easily chosen. In range the complete set of charts are amply sufficient to cover present practice.

The conclusion of the book proper consists of a considerable number of problems involving the use of the various charts and tables given, while the closing pages contain an index.

It is evident that a good deal of care has been spent in the preparation of this book in order to present the information in as useful a form as possible and the author may be congratulated on the result. To quote a couple of the problems will perhaps indicate better than anything else the purpose of the book.

"Find the total heat, volume, entropy, temperature, and heat of the liquid of a pound of steam having an absolute pressure of 180 lbs. per sq. in. and a quality of 98%."

All the items here asked for can be ascertained directly by reference to Plate 1 b.

"The Parsons turbine at the Fiske Street station of the Commonwealth Edison Co., Chicago, has an exhaust opening to the condenser of 252 sq. ft. If the water rate for a back pressure of 1 inch of mercury and a load of 25,000 kw. is 11.65 lbs. per kw. hour, find the velocity, through this opening, assuming the steam has a quality of 80%."

From Plate 6 b the specific volume of exhaust steam under the conditions stated is found and the velocity in ft. per min. is calculated directly by dividing the volume of steam by the area of the exhaust opening.

American Society for Testing Materials, Year-Book, 1914. Edited by Edgar Marburg, Secretary, and published by the Society.

This year the Year-Book includes the standard specifications adopted by the Society for steel, wrought-iron, pig iron, cast iron and finished castings; lime, cement and clay products; preservative coatings; road materials; timber and miscellaneous. Tentative specifications are given for coal drawn steel, quicklime and hydrated lime. Another section of the book is devoted to selected specifications from miscellaneous sources, chiefly American Railway Engineering Association; United States Steel Products Co., and the Association of American Steel Manufacturers. There is a special classification included of standard specifications applicable to locomotives. The volume closes with a valuable index of standard specifications.

Percentage Trigonometry. By John Coleman Fergusson, M.I.C.E. Published by Longmans, Green & Co., London. First edition, 1914. 155 pp.; 60 illustrations; size 6 x 9 in.; cloth. Price $1.25 net.

The author has in print a large volume entitled "Fergusson's Percentage Unit of Angular Measurement," which comes at a comparatively high price. Owing to this the present work has been published with a view to provide at a low figure a book descriptive of the method of using the percentage unit in plane trigonometry. It is written especially for students and navigators. A considerable portion of the book is taken up by a description of how to use Fergusson's Percentage Compass.

The Calculus for Engineers. By E. S. Andrews, B.Sc., and H. B. Heywood, D.Sc. Published by Scott, Greenwood & Son, London. First edition, 1911. 284 pp.; 102 illustrations; size 4½ x 7½ in.; cloth. Price $1.25 postpaid.

This little work is published as Volume 8 of what is known as The Broadway Series of Engineering Handbooks. The importance of a working knowledge of the calculus is no longer a subject for controversy among engineers. The result has been the publication of many text books, more or less modified from standard courses, and prepared in conformity with engineering subjects. In this work, however, the writers endeavor to treat engineering calculus as a subject by itself, and the student will readily appreciate the value of this method when he undertakes to peruse its contents.

The text is supplemented with a number of exercises to test the student's knowledge of the various sections as he goes along. Many examples are specially designed as problems of particular interest to civil, constructional, mechanical, or electrical engineers, as the case may be. Further, the authors have arranged the work in such a way that students may deal systematically with the entire book, or may devote their attention to a shortened course, carefully selected.

Surveying Manual. By Howard Chapin Ives, Professor of Railroad Engineering, Worcester Polytechnic Institute. Published by John Wiley & Cons, New York, London; Canadian selling agents, Renouf Publishing Co., Montreal. First edition, 1914. 296 pp.; size 4¼ x 6¾ in.; illustrated; flexible leather binding.

This manual has been written for first-year students in surveying, with particular adaptation to the needs of mechanical, electrical and chemical engineers, and students in architecture and agriculture. It describes, with illustrations, each instrument, separate chapters being devoted to the chain and tape, the level, the compass, the transit, and another chapter to the aneroid barometer and the planimeter. The practice is very carefully discussed, the subject matter being arranged, in addition to the above chapters, under the following heads: Topographical surveying; railroad curves; computations; plotting; latitude; longitude and azimuth; and large surveys. There is also a chapter descriptive of the U.S. method of laying out public land. A distinctive feature of the manual is that the chapters are divided into sections, each outlining and solving a complete problem. These are replete with sample field notes and carefully explained methods and suggestions.

The information is supplemented by 100 pages of surveying tables, such as are required for ordinary work.

Cast Iron and Steel Pipes: Some Considerations Regarding. By John Sharp, M.I.Mech.E. Published by Longmans, Green & Co., London, Eng. 142 pp., with diagrams; size 6 x 9 ¼ in.; cloth bound, first edition. Price $1.25 net.

Probably in no previous publication has there been presented such scientifically compiled data regarding cast iron and steel pipes. The mathematics in which the book abounds is handsomely presented, and arranged, for the most part, quite logically. In some instances, however, the writer might be accused by many engineers of being biased in his calculations, and in parts the mathematical deductions appear to be derived from doubtful, or at least empirical, presumptions. The various problems are very well treated from a mathematical standpoint, however, and the whole book is well worth reading by engineers, especially as it is being sold at a very low price, considering its excellent typography and fine quality of paper, although readers will possibly be inclined not to accept some of the deductions without personal investigation or the confirmation of past experiences.

Altogether the book is certainly an important one and will probably involve as much discussion and argument in engineering circles as any other book published this year. After discussing the physical and chemical properties of cast iron, wrought iron and steel pipes, and giving figures regarding their strength and elasticity, the author calculates the resistance of pipes to bursting, the thickness and strength of pipes, the flow of water and conditions affecting same, interior and exterior corrosion and influences affecting same, electrolysis, etc. One's impression is that there is an obvious effort to extol the merits of cast iron pipe and to depreciate any value that might be attached to steel pipe. This is carried to an extent that may have an unfortunate influence upon the standing of the book as an independent treatise. Nevertheless, the arguments set forth are of great importance, and it is worth while for every municipal, waterworks and gasworks engineer to read the book and then form his own opinions.

PUBLICATIONS RECEIVED.

Department of Agriculture, Alberta.—Annual report for 1913; 260 pp.; 6 x 9 in.

The Lincoln Highway.—Several pamphlets descriptive of the scenic features associated with the scheme.

Poles and Cross Ties.—Canadian production in 1913, compiled by R. G. Lewis, Forestry Branch, Department of the interior.

Weights and Measures.—Bulletin No. 7, issued by Kansas City Testing Laboratory, containing definitions and tables of equivalents.

Preservation of Ties, Poles and Timbers by Antiseptic Treatment—Reprint of the paper read before the Central Electric Railway Association by W. F. Goltra.

Rubber: Wild, Plantation and Synthetic.—Reprint of an article from the Popular Science Monthly, by Dr. John Waddell, School of Mining, Queen's University.

Pulpwood.—A report on the pulpwood manufactured in Canada in 1913. Also on exports and imports. Compiled by R. G. Lewis for the Forestry Branch, Department of the Interior.

Production of Explosives in United States, 1913.—A 15-page bulletin, compiled by A. H. Fay, United States Bureau of Mines, classifying explosives and listing United States production.

Ventilation of Farm Buildings.—Bulletin No. 78, issued by Department of Agriculture, describing the Rutherford system of ventilation, in operation on all its experimental farms and stations.

Prevention of Accidents from Explosives in Metal Mining.—Circular 19, United States Bureau of Mines, prepared by Ed. Higgins, describing dynamite; method of handling explosives; thawing, and blasting by electricity.

Gold Fields of Nova Scotia.—By W. Malcolm, Geological Survey Branch, Department of Mines, Canada. Issued as memoir No. 20 E., 330 pp.; illustrated; 6 x 9 in. The report includes a summary, general and economic geology, of the various deposits, and statistics of production.

Commission of Conservation, Canada, 1914.—Fifth annual report, containing proceedings of annual meeting, January, 1914, in which is included summary statements of the work done under the several committees of the Commission during the year ending March 31st, 1914. 286 pp.; illustrated; 6 x 9 in.; cloth binding.

Ontario Bureau of Mines, 1914.—23rd annual report containing statistical review, mine production, mining accidents and reports from the Pre-Cambrian rocks north of Lake Huron, the chemical composition of natural gas found in Ontario, and the Kirkland Lake and Swastika gold areas, 340 pp.; 6 x 9 in.; illustrated.

CATALOGUES RECEIVED.

Steam-Jet Air Compressors.—A 4-page leaflet published by Meldrums, Limited, Manchester, England.

Mine Hoist Equipment.—A 32-page bulletin issued by the Canadian General Electric Company, well illustrated.

Exide Batteries.—A 24-page catalogue listing type X batteries for automobiles starting and lighting service.

Portable Volt Meter.—A leaflet issued by the Canadian General Electric Company describing type P-8 portable volt meter.

Steam Railroad Electrifications.—Twenty-four pages issued by Westinghouse Electric and Manufacturing Co., describing various electrifications in the United States.

Steam-Jet Elevators.—A 4-page leaflet describing an improved design for lifting and forcing water, acids, etc. Issued by Meldrums, Limited, Manchester, England.

Ice Harvesting.—A 16-page illustrated booklet describing the basin saw and the bond feeder, important auxiliaries for natural ice plants. Issued by Gifford-Wood Co., Hudson, N.Y.

Modern Electric Railway Apparatus.—A handsomely-illustrated 30-page booklet issued by the Canadian General Electric Co., describing railway power apparatus and installations.

Direct Current Sub-Station Equipment.—A Westinghouse bulletin descriptive of high voltage generators, rotary converters and motor generators, as installed on various notable railway systems.

Portable Railway Plants.—A 68-page illustrated catalogue issued by Robert Hudson, Limited, Gildersome Foundry, Leeds, Eng., describing light locomotives, cars, trucks, switches, turntables, contractor's plant, etc.

Vertical Gas Engines.—Twenty-two pages of interesting information descriptive of Browett-Lindley enclosed, forced lubrication, gas engines of various sizes, speeds and powers. Issued by Browett-Lindley & Co., Manchester, England.

Feed Water Problems.—A 20-page leaflet circulated by Canadian Allis-Chalmers, Limited, Toronto, on reducing boiler room costs by heating and softening the feed water. It describes the Sorge-Cochrane hot process system of water softening.

BACK COPIES WANTED.

Requests have been received for a copy of each of the following issues of *The Canadian Engineer*:—November 30th, 1911; December 7th, 1911; and June 12th, 1913. As our supply of these has been exhausted, we will be glad to extend for one month the subscription of any reader who will supply us with any one of them.

Coast to Coast

Point Grey, B.C.—Plans have been sent to Ottawa for approval for a proposed wharf on the north arm of the Fraser River at Eburne.

Quebec, Que.—The reconstruction of the Dorchester bridge will be completed in a few weeks, according to the J. M. Gignac Co., Limited, contractors.

Toronto, Ont.—The temporary trackage now being laid on Bloor Street West from Dundas Street will be completed within a few weeks. The city has decided to operate this new line as a civic car line.

Sarnia, Ont.—The harbor has been dredged to a depth of 22 ft., and survey work by the engineers of the Department of Public Works, will be continued preliminary to construction work that will likely be completed next season.

Cobalt, Ont.—The lowering of the water in Cobalt Lake has progressed to such an extent that by the end of the month the water line will be over 6 ft. below normal. Practically all work in connection with the outlet has been completed.

Vancouver, B.C.—The completion in this city of a new pier and warehouses by the C.P.R., at a cost of $750,000, is one of the steps that are being taken in anticipation of the business expected with the commercial opening of the Panama Canal.

Toronto, Ont.—A memorial highway, 535 miles in length, extending from Windsor to Montreal, is the subject of considerable discussion. It is estimated to cost $3,000,000. Mr. W. A. McLean, provincial highways engineer, suggests a permanent base 9 ft. in width, and estimates the cost at approximately $8,000 per mile.

Bruce Mines, Ont.—Work may be started in January on a 325 miles extension from Bruce Mines northerly, a contract having been let to the Ontario Northern Construction Co., on a percentage basis. The maximum grade north will be 1 per cent., and south .6 per cent. The heaviest curve will be 6 degrees. It is expected that about 50 miles of the line will be completed early next fall.

Penticton, B.C.—The Kettle Valley Railway has beer linked up between here and Midway and construction work is well advanced towards Princeton, where the line will join the V. V. & E., and use a joint section to Otter Summit, where connection is made with the Nicola branch of the C.P.R. Construction work is now well advanced on the Kettle Valley bridge on the line linking the new Hope Mountain route with the C.P.R. on the north side of the Fraser. Grading has also been completed on the Hope-Coquahalla Summit section of the Hope Mountain route, and it is anticipated that the new line will be ready for traffic to the coast next summer.

Toronto, Ont.—The announcement that the Hydro-Electric Power Commission of Ontario is making a survey of the route of the Ontario West Shore Railway between Kincardine and Goderich, recalls to mind the noted case of the would-be engineer and capitalist, John W. Moyes, who has managed to escape, up to the present, the arm of the law, while a score of municipalities in the counties of Huron and Bruce are paying interest on a multitude of worthless bonds. The engineers of the Commission went out last week to appraise the line and to make an estimate of the material on hand. It is understood that they will report upon the eligibility of the route with a view to incorporating it in the provincial radial scheme. It will be remembered that a little grading had been done before the windup of the ill-fated scheme.

PERSONAL.

H. THOMPSON has been appointed electrical inspector for Belleville, Ont.

CHAS. JOHNSTON has been appointed assistant engineer on the Toronto-Hamilton highway.

G. J. SMITH, of St. Catharines, has been chosen by the Hydro-Electric Power Commission as electrical inspector for that city and district.

J. M. WILSON, formerly assistant resident engineer at Toronto for the Department of Public Works, succeeds Mr. J. G. Sing as resident engineer.

A. W. ELLSON FAWKES, until recently waterworks engineer for the city of Calgary, has opened an office and will carry on a general engineering practice in that city. His address is Burns' Building.

W. E. BRADSHAW, of the Dominion Bridge Co., lectured the Engineering Society of the University of New Brunswick on the design and construction of the new bridge over the Reversible Falls at St. John.

J. G. SING, for many years resident engineer in Toronto for the Department of Public Works, Canada, has resigned, and will continue his practice of consulting engineer. He will also retain his position as consulting engineer to the Toronto Harbor Board.

ARTHUR SURVEYER, Consulting Engineer, Montreal, read a paper before the Electrical Section of the Canadian Society of Civil Engineers on the 19th inst., entitled "Making our Water Powers Valuable." The paper is extracted elsewhere in this issue.

ROBERT W. ANGUS, Professor of Mechanical Engineering in the University of Toronto, and consulting engineer to the city on the Victoria Park water proposal, addressed the Royal Canadian Institute last week. He traced the city's campaign for a better water supply, and described in detail the Victoria Park proposal.

SIR ADAM BECK, chairman of the Hydro-Electric Power Commission of Ontario, gave an illustrated address to the members and friends of the University of Toronto Engineering Society on November 18th. The subject was a general review of the work of the Commission with particular attention to the hydro-electric developments at Wasdell's Falls and Eugenia Falls, Ont. Mr. F. A. Gaby, chief engineer of the Commission, addressed the Society on the technical features of these developments.

GEORGE J. BURY has been appointed vice-president of the C.P.R. to succeed Mr. David McNicoll, resigned. Mr. Bury is a Montreal man, 48 years of age. He joined the C.P.R. as a clerk in 1883, and has since filled the following positions:—Assistant superintendent in charge of division, Chalk River to Cartier and the Soo; superintendent at Fort William; superintendent at Cranbrook, B.C.; assistant general superintendent Lake Superior division; general superintendent of that division; general superintendent of the western division, with headquarters at Winnipeg; vice-president and manager of western lines (1907), and vice-president (1911).

DAVID McNICOLL, who has recently resigned the vice-presidency of the C.P.R., owing to ill-health, will remain on the board of directors of the company. Mr. McNicoll was born in Scotland in 1852. He entered the service of the North British Railway in 1866, and went to the Midland in 1873. He came to Canada shortly after and in 1874 became a chief clerk for the Toronto, Grey and Bruce. He was general passenger agent, 1882-3; from 1883-9 was general passenger agent of the eastern division of the C.P.R., then till 1896 general passenger agent of rail and steamship lines of the C.P.R. Later he became passenger traffic manager, and in 1899-1900 was assistant general manager, becoming vice-president and general manager in 1900. He held this position till 1903, and has since been vice-president and one of the directors of the company. Mr. McNicoll is also president of the St. John Bridge and Railway Company, and a director of the Molsons Bank.

OBITUARY.

Mr. J. S. Ferguson, of the Northern Development Branch of the Ontario Service, died suddenly at North Bay, Ont., last week. Mr. Ferguson was 50 years of age, and for the past three years had been associated with Mr. J. S. Whitson on road construction in Northern Ontario.

The death has been announced of Hon. Wm. Templeman, former minister of mines and of inland revenue for the Dominion Government. Mr. Templeman was also a member of the Royal Conservation Commission in 1909.

CALGARY BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

Mr. William Pearce, M. Can. Soc. C.E., executive assistant, Department of Natural Resources, C.P.R., gave a very interesting address before the members of the Calgary branch of the Canadian Society of Civil Engineers, on Friday evening, the 6th instant. The speaker made a trip around the world about two years ago, and made a special study of irrigation and forestry, in foreign countries. On Friday evening he chose as his subject "Irrigation in Egypt," and, in a very interesting manner, described the various irrigation and other engineering works there. His numerous observations on the habits and manners of the people, the various means of transport, etc., were also very interesting.

The annual meeting of the Branch and the election of officers for the ensuing year will be held on Saturday, December 5th.

COMING MEETINGS.

ANNUAL MEETING, AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The annual meeting of the American Society of Mechanical Engineers will be held in New York, December 1st to 4th, 1914. Secretary, Calvin W. Rice, 29 West 39th Street, New York.

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

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Annual Convention to be held at the King Edward Hotel in Toronto, January 26, 27, and 28, 1915. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

EIGHTH CHICAGO CEMENT SHOW.—To be held in the Coliseum, Chicago, Ill., from February 10th to 17th, 1915. Cement Products Exhibition Co., J. P. Beck, General Manager, 208 La Salle Street, Chicago.

AMERICAN WATERWORKS ASSOCIATION. — The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.