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Volume 27. Toronto, July 30, 1914

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

DEEP WATER TERMINALS AT HALIFAX

REINFORCED CONCRETE PIER CONSTRUCTION BY DOMINION GOVERNMENT FOR THE INTERCOLONIAL RAILWAY—DETAILS OF PILE CASTING AND DRIVING—OUTLINE OF ULTIMATE DEVELOPMENT.

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To such an unexpected extent has the volume of freight passing through the port of Halifax increased of recent years, that the Government Railways' Managing Board has been forced to map out a comprehensive plan of extension by which it is hoped to care for the constantly increasing traffic on the Intercolonial Railway.

Fig. 1.—View of Pier No. 2 While Under Construction

The city has two terminal points, one known locally as "Deep Water" and the other as Richmond. The Deep Water terminal is centrally located in the city proper, while the other piers are located at Richmond at the north-eastern extremity of the city. The proposed extension and improvements will be constructed chiefly at Deep Water. Fig. 2, showing the old as well as the contemplated development, gives an idea of the vast improvements to be made at this shipping centre. The plan of improvements includes four piers sufficiently large to accommodate steamers over 700 feet in length, considerably increasing in this respect the capacity of the terminal. One of these piers, No. 2, has been completed. New piers 3, 4 and 5, shown dotted, are as yet in prospect.

The old piers were all of a much smaller size. Old pier No. 2 was practically rebuilt 15 years ago, having a second story added 6 years ago. This was found inadequate for general purposes, as its south side was too short for long steamers and the basin in the north side was too narrow. Old pier No. 3, recently rebuilt, is still in good shape and will probably be included in the completed scheme.

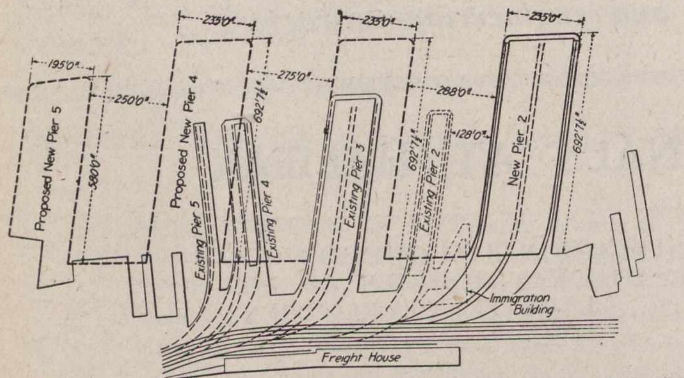

Fig. 2.—General Plan of Development—Existing Piers Shown Dotted.

When these terminals were finally decided upon, Mr. John Kennedy, Hon.M.Can.Soc.C.E., consulting engineer, Montreal, was retained upon the work, and it was under his direction that the contemplated plan was developed and is now being carried out. Mr. A. F. Dyer, C.E., is the resident engineer who is supervising the work, and his assistant is J. Shepherd Lee, C.E.

These improvements make provision for four new piers, pier 2 being 800 ft. by 235 ft., with freight and passenger shed. Pier 3 is for freight purposes only, having the same dimensions as No. 2, and being of similar construction. Pier 4 will also be 800 ft. by 235 ft. with accommodations similar to No. 2. Pier 5 will be 650 ft. by 190 ft. and will be used for smaller steamboat and sailing vessels, as well as for transatlantic steamships. The basin width between piers 2 and 3 will be 280 ft., between Nos. 3 and 4, 275 ft., and between Nos. 4 and 5, 250 ft. These basins will be dredged to a minimum depth of 34 ft. below mean low tide.

Fig. 4.—View of Pile Casting Yard.

Pier 2 is the first to be constructed and is now complete, the Nova Scotia Construction Company having had the contract at $914,600. This pier is located between the old Immigration Building and the Cunard pier, the latter interfering to a great extent, and now being completely removed.

It was decided, owing to congested yard space, to build a new bulkhead further out in the location indicated. The cribwork of this new bulkhead is to be built in blocks reaching up to about 2 ft. above low water. Above this point the cribwork is to be continuous. The facing of this cribwork is to be of squared timber and made mud-tight. The top of the bulkhead will be finished off with a coping of squared creosoted pine timbers. All timbers over 3 ft. above low water are to be creosoted, the proportions being 12 lbs. of creosote per cubic foot of timber, except for planking, in which case the amount will be increased to 18 lbs.

To strengthen the immigration building wharf where the facing is exposed, sheet piling of squared timber has to be driven along the face and for a distance of 30 ft. beyond the corner. For a further distance of 25 ft. the foundation and cribbing will be protected by round piling. Most of this square sheet piling is to be creosoted, and is to be driven 39 ft.

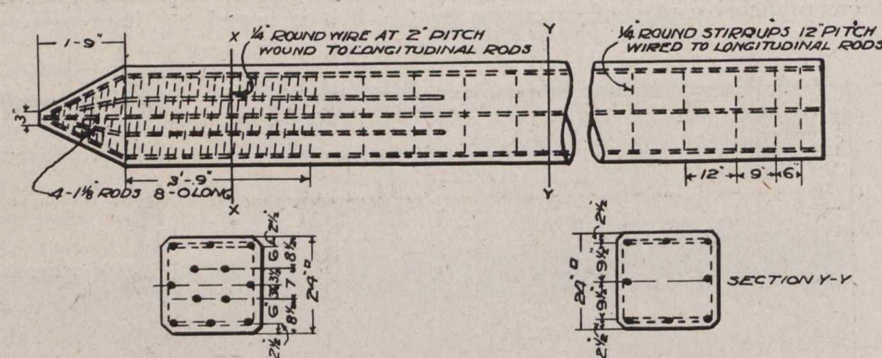

Fig. 3.—Details of Reinforcement of Concrete Piles.

On account of the great depth of water and unevenness of the bottom, there was some difficulty at first as to the mode of construction. The bottom is formed of a substructure of rock, the stratum running nearly perpendicular and presenting a very rough and uneven surface. The rock is covered by a bed of gravel and hardpan varying from 4 ft. to 12 ft. in thickness. This is in turn superimposed by a layer of mud 5 ft. to 25 ft. thick. At the outer end the rock depth is 67 ft., and in shore 44 ft.

Owing to the enormous weight which the supporting piles would be required to carry and owing also to the activity of teredos and limnoria at this point, the use of wooden piles did not meet with favorable consideration, and reinforced concrete piling was adopted instead. The piles are of the construction and size denoted in Fig. 3.

For piles over 70 ft. long the longitudinal reinforcing rods are 1¼-in. rounds; between 60 and 70 ft., 1⅛-in. rounds; and under 60 ft., 1-in. rounds. Four extra 1⅛-in. longitudinal rods extend up for a short distance from the pointed end. Except near the point of the pile, where the rods are wound with ¼-in. round wire at a 2-in. pitch, the rods have ¼-in. wire stirrups, at a 12-in. spacing. The largest of the piles weigh about 25 tons. The concrete is composed of 1 of cement to 4½ of aggregate, the latter being composed of about 1½ of sand to 3 of broken stone. The cement used was specially selected to resist frost and salt water action, the former causing spalling of the concrete between tide levels and the latter setting up a chemical action with the constituents of the cement causing disintegration. The selected brand has an extremely low percentage of alumina, the specifications calling for a maximum of 6.3%. Used in the proportions mentioned above and carefully graded, a dense and impermeable concrete is produced. To further protect it against frost action between high and low tide levels, the pile is sheathed over a space of 8 ft.

Each pile was made with one filling of the mold, and the concrete thoroughly rammed into place, more particularly at the water line. Fig. 4 gives a view of the pile fabricating yard, which is 600 x 800 ft. in dimensions.

terior column, while three singly driven intermediate piles carry the floor.

In order to handle these 1,800 extremely heavy piles and to drive them through the hard-pan to solid rock a special pile driver was constructed by the Bucyrus Company, of South Milwaukee, Wis., under the direction of Mr. W. L. Scott, chief engineer of Mussens, Limited, Montreal, who was retained by the contractors in the matter of designing a suitable machine. It is of massive construction, the machinery on account of the weight of the piles being very heavy. The gearing is all of cast steel with cut teeth, and the drums steel castings bronze bushed. The hull is of wood, 108 ft. long, 45 ft. wide and 12 ft. deep at the bow. In order to support the leader carriage tracks, solid timber bulkheads run fore and aft. These, in addition to several transverse trusses, provide a hull of extremely rigid construction.

To facilitate the driving of brace piles without changing the position of the driver, the leads are designed so

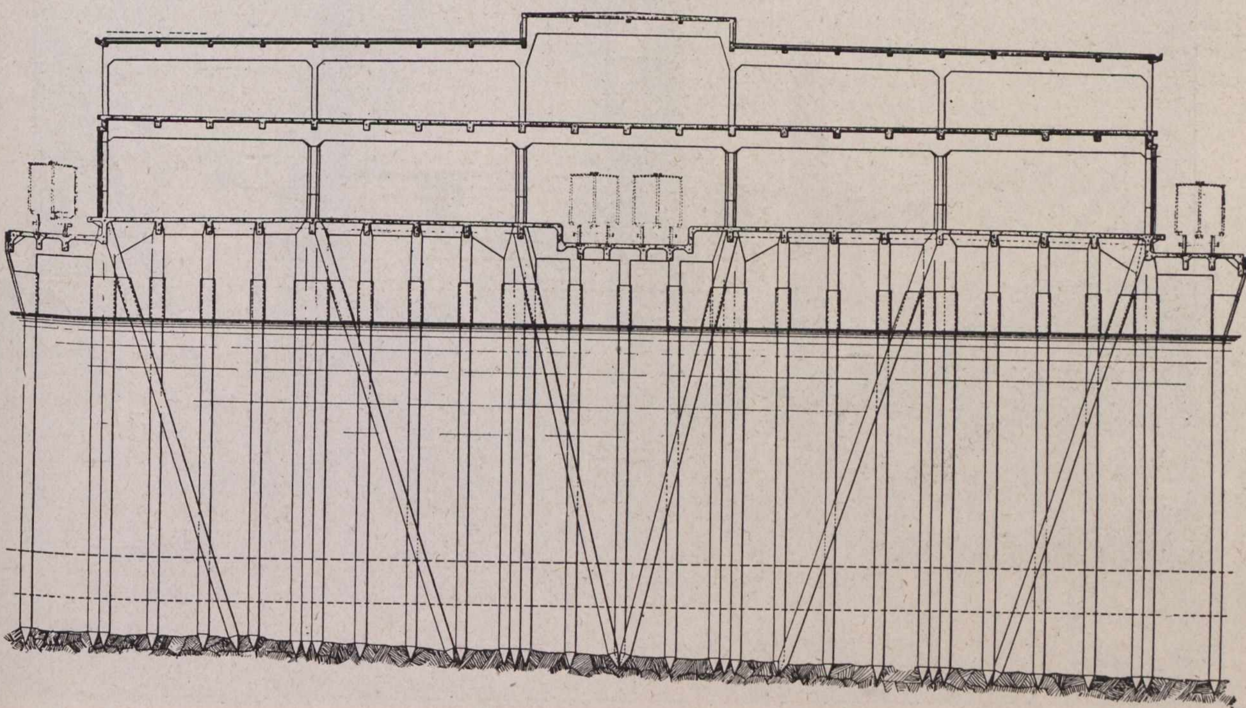

Fig. 5.—Transverse Half-Section of Pier, Showing Arrangement of Brace Piles.

The piles, which are 24 in. square, were set in the molds for 7 days at least and were not lifted for 6 weeks or driven in less than 8 weeks. The estimated maximum load to which each pile will be subjected when in use is between 85 and 86 tons, and in order to safely sustain this weight, they are all being driven through the hard-pan to solid rock, steam hammer and water jet being used for the purpose. A floating weight of 180,000 lbs. which, at low tide, will apply itself to the pile under test, is one of the means suggested for testing the bearing power.

The average height of the structure, from solid rock to the level of the tracks on the pier, is 75 ft. Extreme low-water level is 15 ft. 8 in. below track level. Because of the fact that such a difference exists between the distances above and below water through which the piles were to extend the pier was stiffened by reinforced concrete brace piles driven as shown in Fig. 3. This system of bracing is novel and, according to several authorities, this is its first application. As shown in the diagram, three vertical piles and one brace pile support each in-

as to have a transverse motion of 8 ft. across the face of the hull, and a fore-and-aft motion of 7 ft., and a transverse sloping position to an angle of at least 20°, sufficient in all to encompass the driving of a whole cluster of piles without moving the pile driver hull from the position to which it is fixed by the spuds.

The drums and machinery for hoisting the piles and the hammer and for operating the stern spud are driven by a double-cylinder 12 x 16-in. engine. All this machinery is mounted on a heavy structural-steel carriage, so arranged as to be moved fore and aft. This carriage is in turn mounted on rollers which travel fore and aft on a suitable track. The whole is moved by means of a rack-and-pinion drive from the main engine, the rack being rigidly bolted to the deck. The front of the carriage is provided with two transverse heavy structural-steel girders, one just above the deck level and the other some 30 ft. higher, running across the leads. These two transverse girders are shown in Fig. 6. The upper girder carries a trunnion bearing which supports the weight of the leads.

The lower carries a specially designed crosshead, attached to the leads in such a way that they are held vertically in any position.

The trunnion bearing on the upper girder and the crosshead on the lower girder, are both connected to independent screw shafts driven by 8 x 8-in. double-cylinder engines. When both screws are in gear with the engines, the leaders can be moved transversely across the leader carriage and battered to any angle. In order to batter the leaders it is only necessary to drive the upper or the lower screw alone. The advantage of this screw design is to make the mechanism fool-proof, as no false motion on the part of the operator can turn the leaders over. The forward spuds hold the driver in position when in action. Each spud is provided with an independent spud-handling engine, which raises the spud or "pins up" the driver as is the practice on a modern dipper dredge.

3 feet beyond the end of the piles, the hammer is fitted with a special cap. The leads are provided with a special hammer track, by means of which the hammer when hoisted can be switched in out of the way of a swinging pile. An automatic dog locking device is also provided at the top of the leaders to carry the weight of the hammer while the pile is being placed in position, and also an intermediate stop to hold the hammer when the driver is not in use. The main engine, drums and machinery weigh approximately 33 tons, the leaders 40 tons, the leader carriage 40 tons and the steam hammer 15 tons. The machine was originally intended to drive one pile an hour but it has been found that it can, with ease, handle 20 to 25 in a 10-hour working day.

The character of the material through which the pile is being driven controls the capacity considerably, as it takes from 25 to 30 blows of the hammer to drive the pile

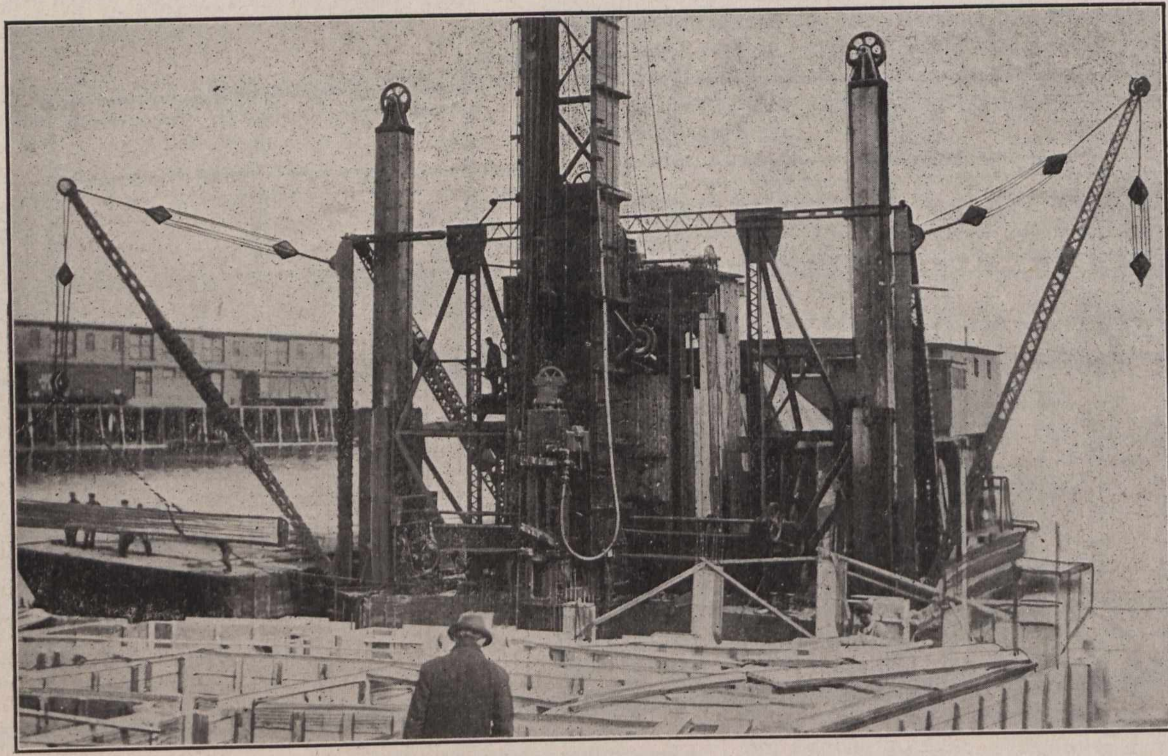

Fig. 6.—General View of Pile Driver and Top of Form Work.

The spud machinery is placed well aft on the deck and is connected to the spuds by wire ropes leading over the top and bottom of each spud. The levers controlling the movements of the spud engines, are so arranged that the engineer from his position in the traveling leader carriage has full control.

The steam hammer which was designed and built by the Union Iron Works, of Hoboken, N.J., is without question the largest double acting steam pile driving hammer ever constructed. The combined weight of the hammer with follower and follower guide is approximately 28,000 pounds. The diameter of the cylinder is 14 in., stroke 36 in., and the weight of ram alone is 4,000 pounds. With a mean effective steam pressure in cylinder of 80 pounds per square inch, the hammer is rated to develop 3,916,000 foot pounds per minute, when the hammer is striking 80 blows per minute. With a penetration of pile of one inch for each blow, the average force of the blow would be 588,000 pounds. This assumes that the steam follows the piston during the entire stroke. In order to take care of reinforcing bars, which project

one inch into the hard-pan which is encountered. In actual practice, however, it has only been necessary to drive about 15 piles a day.

Figs. 7 and 8 show the driver with the leads canted and brace pile being driven.

The piles were delivered to the driver loaded on scows. Two derricks were provided for lifting them and swinging them in front of the leads. These derricks were placed one on either side of the driver on the deck and outside of the forward spud guides. The swinging of the derrick was accomplished by manipulating the forward spuds. The pile cable being made fast to the staple projecting from the pile head, the order to hoist was given, and as the derrick fall was lowered the pile was gradually hoisted into a vertical position, the derrick straps being disengaged as they slackened off. The leaders are then moved until the pile, hanging in them, was centered in exact position. Then the pile was lowered, its own weight being sufficient to penetrate the soft mud overlying the hard-pan. When the thickness of the mud was equal to about a third of the length of the pile it was found that the pile would stand where placed without any bracing; as a rule, however, the pile was braced while the hammer was being adjusted on its head.

Separate cushions were used between the concrete of the pile and the ram of the hammer. On top of the pile was placed a 3-in. spruce plank. On this rested a cast-steel follower about 4 ft. high consisting of a hollow cylinder or post with top and bottom flanges. The bottom flange was flat, and in it were eight holes through which the projecting rods of the pile reinforcement passed and were protected. The top flange had cast on its upper side a rectangular depression in which was placed a hard-wood block about 15 in. thick, bound round with a steel band. This block received the direct blows of the hammer and had to be frequently renewed; sometimes it would last for two piles only, while at other times it would stand the hammering of twenty. Usually the cause of failure was the breaking of the steel bands, but on one occasion the block was found to be on fire and badly charred owing to the heat generated by the force of the blows.

Where the thickness of hardpan was small the pile would often come to a stop after 200 or 300 strokes, while at other places nearly 1,800 blows would be required. The rate of penetration through the hardpan was small, the advance in the last strip being in many cases not more than ¼ in. per blow.

Only two out of 1,550 piles had their heads smashed in driving, and these were among the first dozen driven, the cause being a continuation of the hammering after the pile had reached rock. No harm was done, however, by a few blows after the penetration had stopped. In order to find out what was happening to the point of the piles some of them were pulled out after having been driven to refusal. In only one case was there any damage done to the point, and this damage is believed to have been caused by a projecting rock spalling off a small amount of the concrete.

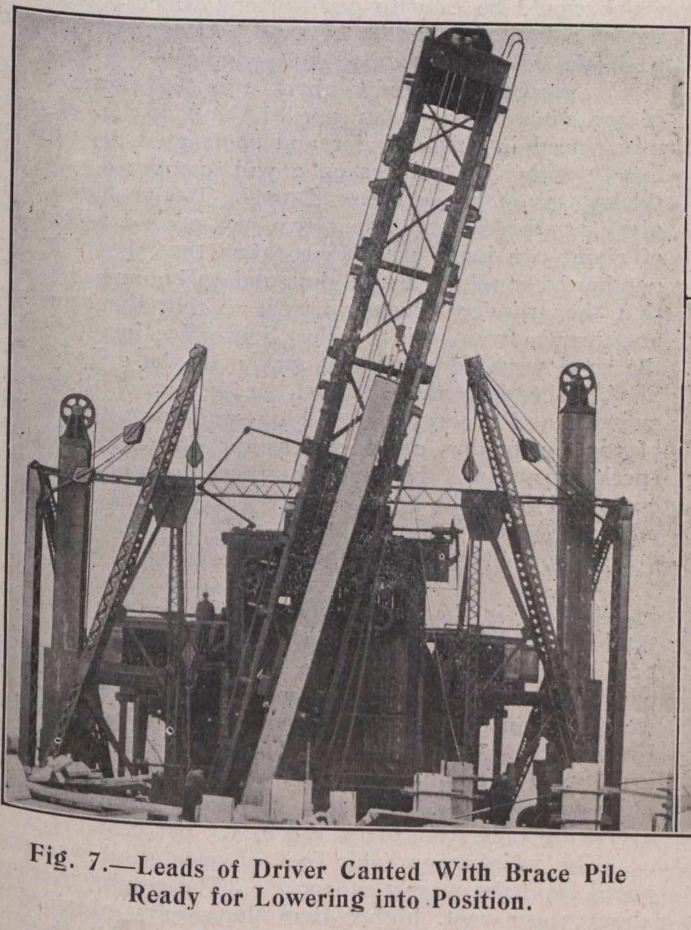

Fig. 7.—Leads of Driver Canted With Brace Pile Ready for Lowering into Position.

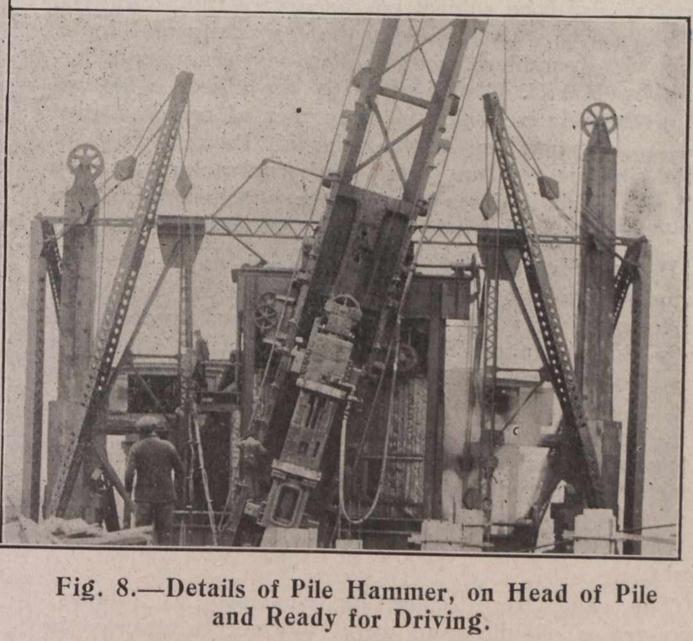

Fig. 8.—Details of Pile Hammer, on Head of Pile and Ready for Driving.

The bearing power of the piles was tested after driving by one of them being subjected for 3 hours to a load of 120 tons. This caused no settlement whatever.

It is the intention to have two railway tracks extending the length of the pier through the centre of the shed, and two outside, one on each side. The flooring is raised to the car deck level above the tracks to facilitate and expedite the handling of freight. There are two roadway ramps at the Water Street end, one on each side, for the accommodation of dray traffic.

Superstructure on Pier.—The shed will consist of fire-proof material having reinforced concrete walls and floors. It is necessarily of substantial construction as upwards of 3,000 immigrants and their effects will be housed in the building when two large well-filled steamships reach port at the same time. The building is a two-story structure. The ground floor is a plain floor for freight purposes, covering the whole area of the building with a series of railway, steamship and custom offices and storerooms at the shore end and in each side of the two central freight tracks. Along each wall, outside of which are the exterior tracks above referred to, there is a series of overlapping doors of sheeted steel frame construction. These can be slid along to form an opening at any desired place in the full length of the building. The upper story of the building is for passenger purposes exclusively. It is divided into three main sections, baggage rooms on the north and south extending the full length, with the exception of a distance of about 100 ft. at each end, and passenger rooms and offices along the whole length of the central part of the shed and across the whole width of each end. The outer wall of each baggage room will have alternate doors and windows at 36 door centres, so that it may receive passengers and baggage from any part of either two short or one long steamer up to the full length of the pier.

The adoption of the plans for the Deep Water terminal improvements means a general shifting of the railway yard arrangements. Other equally extensive changes will likely be necessitated to bring about a completely harmonious arrangement.

MORTAR-MAKING QUALITIES OF SAND.

THE importance of careful discrimination in the selection of ingredients of mortar is a consideration to which attention has been called frequently in these columns. The term "mortar," as defined by the American Railway Engineering Association, is a mixture of fine aggregate (sand or crushed stone screenings), cement or lime, and water, used to bind together the materials in concrete, stone, or brick masonry, or to form a covering for the same. Owing to varying geological conditions, sand, for instance, is one ingredient which may be expected to vary widely in character, and in practice it is found to fully comply with such expectations. In concrete construction the cement is nowadays subjected to careful inspection. The specification requires the sand to be "clean and sharp," although such wide latitude as has heretofore been allowed in its inspection is giving way to closer investigation and scrutiny. This is owing to failures that have been caused by deficiency in both durability and strength, that may be laid only to the inferior quality of sand used.

There is a growing demand for more information concerning the general characteristics of sands, as well as for reliable data on the mortar-making qualities of typical sands. The subject has been very fully discussed in a bulletin recently issued by the University of Illinois, containing a complete account of an investigation undertaken by Mr. C. C. Wiley, with the object of determining the relative value of a number of representative sands in common use in the cities of Illinois. It is of special interest to engineers and contractors, as the methods which it describes and the conclusions arrived at will be found distinctly useful for general guidance.

Description of Tests.—Each sand was tested for cleanness, gradation of size of grains (sieve analysis), specific gravity, voids, and weight. The approximate mineralogical composition and comparative sharpness were also determined. Tests for tensile strength were made on mortars made of each of the sands. In making all of these tests especial care was taken to eliminate the personal factor from the results. There were 576 briquettes prepared and tested, 18 for each specimen of sand. The mixture contained Portland cement, and the various sands mixed in the proportions of 1:3 by weight.

The sands were tested for cleanness as follows: 1,000 grams of the sand were thoroughly agitated in about one gallon of water. The mixture was then allowed to settle for about one minute, experience showing that this allowed sufficient time for the finest sand to settle. The dirty water was then siphoned off, care being taken that none of the sand was carried over with the water. This washing process was repeated until the water showed no discoloration. The sand was then transferred to a pan and as much water as possible drawn off by jarring the sand until the water flushed to the surface, and then removing the water with a pipette. The sand was then re-dried over steam coil and weighed. The loss in weight due to the washing was taken as the amount of suspended matter.

The following standard sieves were used: Nos. 5, 8, 10, 16, 20, 30, 40, 60, 74, 100, 150, and 200. The washed sand was then placed on the top sieve and the whole shaken for forty minutes on an agitator driven by power at 100 r.p.m. After shaking, the sand retained on each sieve was weighed and from these weights the percentage passing each sieve was calculated. In making these calculations the amount of suspended matter, as determined by the cleanness test, was included with the material passing the finest sieve.

The specific gravity of the sands was determined by means of a Schumann flask, consisting of a bulb or bottle into the neck of which a graduated stem fits with a ground joint. The bulb was filled with water and the height of the column of water in the stem read from the graduations. Fifty grams of sand were used and results checked by an additional 50 grams.

The large variation in the percentage of voids in sands as determined by different observers is doubtless due to errors of observation, particularly to a failure to compact all sands to the same extent. For the present series of tests some method of operation was desired which would compact all sands alike, and hence yield reliable results; and, further, a method was desired which would be easy to perform and which could make use of a limited quantity of sand. After a number of trials the following method was adopted:—

A graduated cylinder about 2 in. in diameter and of 500 c.c. capacity was used. About 20 c.c. of sand was placed in this cylinder and compacted by striking lightly with the cylinder on a pad composed of eight thicknesses of heavy cotton flannel. Twelve blows were given at the rate of about two per second with a fall of about one inch, care being taken that the blow was not hard enough to cause the sand to bounce, and also that the cylinder struck squarely so that the sand was not thrown from side to side. Successive increments of the sand were added in this way until the cylinder was filled. The difference between the weight of the empty cylinder and the cylinder full of sand gave the weight of 500 c.c. of dry, compacted sand. Then, knowing the specific gravity of the sand, the percentage of voids was computed from the equation

$$V = 100 \frac{S - W}{S}$$

in which V is the voids expressed in per cents. of the total volume, W is the weight of the sand, and S is the product of the volume of the sand, its specific gravity, and the weight of a unit volume of water; i.e., S is the weight of an equal volume of sand containing no voids. In the present case S equals 500 multiplied by the specific gravity. The results obtained by the above method were quite uniform, the maximum variations from the mean averaging only from about 0.8 to 1.5 per cent.

The weight per cubic foot of each sand was computed from the weight of 500 c.c. The results averaged about 3 per cent. higher than the results obtained by other observers on similar sands, due evidently to a difference in the method of compacting the sands.

Mineralogical compositions and sharpness were determined by microscopical examinations.

Conclusions.—Following is a brief discussion of the series of tests and the conclusions arrived at:—

The mineralogical composition of a sand is the fundamental factor in its mortar-making qualities, since not only its durability, and hence the durability of the mortar, but the size and gradation of the grains, the nature of the grain surfaces, the strength of the grains themselves, and all the other factors which affect the strength of the mortar are more or less directly dependent on the nature of the component materials of the sand.

The specific gravity of a sand affords but little information relative to its mortar-making qualities, its principal value being as a factor in certain computations. Quartz has a specific gravity of about 2.65; and the nearer the specific gravity of a sand approaches this value the greater is the content of silicious material. A higher value indicates considerable quantities of materials other than quartz, which are likely to be hard and durable; while a lower value usually indicates the presence of soft, unsatisfactory material, or of considerable quantities of clay and loam or other foreign matter.

Angularity or irregularity of the sand grains appears to exert no effect on the tensile strength of the mortar. In compression, the sharp sands may show a slight advantage due to the interlocking of the angular grains; but evidently such action is insignificant as compared with the resistance to displacement of the grains afforded by the bond between them, due to the adhesion of the cement to their surfaces, hence the strongest mortars are invariably those in which the cement most readily adheres to the sand grains. Crystalline rocks when freshly fractured generally show surfaces of great smoothness to which the cement does not adhere well; but when these grains have been worn down the surfaces become roughened and the cement adheres much more readily. This is particularly true of quartz, as is evidenced by the fact that rounded silicious sands usually form mortars of greater strength than similar sharp sands. With sands composed of rocks which naturally show a rough, granular fracture this advantage of round grains is lost, but in any case mortars made of round-grained sands will compact more readily than those of sharp sands; hence such mortars in place are likely to be more compact and dense, which conduces to greater strength. The usual requirements of specifications that sands for mortar and concrete shall be sharp is not only useless, but may even be detrimental, and should, therefore, be omitted. Further, since the condition of the grain surfaces does materially affect the strength of the mortar, the specifications should fully cover this point.

The percentage of voids in dry sand is a function of its compactness and the gradation of sizes in the sand grains, hence the effect of the voids on the strength of the mortar is included with that of the gradation of the sizes of the grains. The percentage of voids is valuable in determining the amount of cement necessary to give the densest mortar.

It has been demonstrated, both by experiment and practice, that coarse sands will yield denser mortars than fine sands, and that the maximum density is obtained when the various sizes of grains are present in the proper proportions. Just what the proper proportions are, or in other words, what the ideal form of the sieve analysis curve is, has not as yet been determined. Experiments with materials for concrete indicate that for a mixture of cement, sand, and stone the sieve analysis curve should approximate a parabola, and by analogy it would seem that the same should be true of a mixture of cement and sand as well. Assuming that the parabola is the ideal line for the mixture, and remembering that the cement is very fine, it follows that the ideal line for the sand considered alone must lie below the parabola, and that it would be different for each proportion of cement used. But since the cement is very fine and forms a relatively large proportion in most mortars, the consequent variation in the ideal gradation for the sand considered alone will not be great; and hence it may be said that for the common proportions of cement and sand (1:1 to 1:4) the flatter the sieve analysis curve of the sand the denser will be the mortar made from it.

It has also been demonstrated that, other things being equal, the denser a mortar the greater is its strength; and hence the size and gradation of the grains is indirectly a factor in the strength of the mortar. Unfortunately, the fact that "other things must be equal," has been frequently overlooked with disappointing and sometimes disastrous results. It is only when the various sands are identical in mineralogical composition, condition of the grain surfaces, cleanness, etc., that the size and gradation of the grains becomes the controlling factor in the strength of the mortar and even then it is only relative. Thus, if two sands are exactly alike in all respects except size and gradation of the grains, the better-graded sand will yield the mortar of both greater density and greater strength; but this strength may be decidedly less than that of a mortar from a third sand which may be less perfectly graded than either of the two given sands, but is superior in other characteristics. Consequently, we may have two sands which have identical sieve analyses and yield mortars of the same density, and yet these mortars may differ greatly in strength; or, two sands which differ greatly in their sieve analyses may form mortars of the same strength, although different in density.

Where strength is of the first importance in a mortar the only criterion is a direct test for strength; but after the absolute strength of the mortar from any one sand is determined, the sieve analysis may indicate whether the strength can be somewhat increased by improving the gradation of the sand. In general, this improvement must be accomplished by judicious screening rather than by the addition of other material, since usually the added material will not be of the same general character as the given sand. Where a dense or impervious mortar is required, the size and gradation of the grains is of more importance; and if strength is secondary, may control the choice of the sand. In this case the sieve analysis curves may be of considerable assistance in selecting the proper sand, or in indicating whether the desired results can be obtained either by combining several sands or by screening. In no case, however, should the direct test for strength be omitted, for a certain amount of strength is always required, and a good result for the sieve analysis is not sufficient evidence that the mortar will have sufficient strength.

The maximum size of grain permissible depends on the work for which the mortar is intended. For concrete the maximum size is now taken at ¼ inch, but certain kinds of masonry, etc., require a much smaller maximum size. The maximum size of grain fixes the limits of sieve analysis, and consequently two sands may differ greatly in average fineness, and yet each one may be more perfectly graded, and hence more suitable for some particular work than the other.

Foreign material in a sand may affect the strength of the mortar by retarding or preventing the hardening of the cement, by preventing the adhesion of the cement to the sand grains, and if present in sufficient quantities by simple "dilution" of the cement. Organic matter is the most common source of trouble, but inert clay and loam may prove deleterious under certain conditions. Experiments indicate that finely divided inert clay or loam may be present in an average sand to the extent of 10 to 15 per cent. without appreciably affecting the strength of the mortar, provided the clay or loam does not adhere to the grains, while a very small quantity may seriously impair the strength of the mortar if it forms a coating around the sand grains.

The tensile strength of the natural sand mortars varied from 140 to 464 lbs. per sq. in. at the age of 90 days. By comparing the tensile strengths with the sieve analysis curves, it is seen that the coarser sands give the mortars of greater strength, and it will be noted that several of the sands show almost identical curves but that their tensile strengths are quite different, while still others, giving practically the same strength, differ greatly in their sieve analysis curves. An examination of the sands themselves shows that this variation is due to some of the other characteristics of the sands. Only five of the natural sands gave a tensile strength greater than the Ottawa standard sand; and it will be noted that all of these are bank sands with rounded grains, comparatively well graded and containing considerable material other than quartz. The river sands showed less variation in strength than the bank sands, but this is to be expected since they differ less in composition, grading, and cleanness. It may, therefore, be expected that river sands will form mortars of only moderate strength, and that there is likely to be little variation between different sands; and that bank sands will furnish the mortars of greatest strength, but that the strength from different sands will vary through a wide range.

In an experimental investigation there is often a question as to how many individual results are necessary for the accurate determination of the result. It will be found that in any extended series of observed values of a single quantity one value is considerably less than the average, another considerably greater than the average, while the remaining values fill in the interval between these extremes more or less completely. If the values are platted as ordinates in the order of their magnitude with uniform horizontal spacing, the resulting curve will be found to have the form of an ogee or reversed curve, and the average value will lie at the point of reversal of the ogee. If the values are too few in number, the curve will be discontinuous, and the average value cannot be said to be accurately determined. As the number of values is increased the curve will become smoother and more complete; and it is only when the typical ogee form is distinctly and continuously outlined that the average value of the results can be considered as accurately determined.

The selection of the proper proportions for a mortar is essentially a problem in economics, whether the result to be attained is a mortar or concrete of maximum strength, or one of the greatest density and imperviousness, or simply one of sufficient strength for the purpose in hand. The object in any case is to obtain the desired result with the minimum cost. If this fact is kept in mind, it will become clear that it may really be true economy to spend what appears to be a considerable amount of time and money in investigating the available sands and determining the best combinations. Obviously, the saving to be effected varies with the magnitude of the work, and hence the bigger the job the more important it is that the materials be properly selected. If such investigations were generally made it would certainly result in reducing the careless and extravagant use of cement, the most costly material entering into mortar or concrete.

OIL IN JAPAN.

Alberta is not experiencing the entire universal supply of oil-boom excitements. It is reported that the Japan Petroleum Company recently completed a well at Kurokawa, Akita district, which proved to be a gusher, yielding 400,000 gallons a day. The news caused extraordinary excitement on the Tokyo Stock Exchange, and the company's shares rose from 86 to 200 yen in a very short time; and would have gone further, but the Exchange officials ordered dealings suspended.

According to the "Journal of Commerce" of Montreal, the statistics of the exports of iron and steel for the year 1913 show that Germany heads the list, with exports of 6,497,000 metric tons in 1913, against 6,042,000 tons in 1912. Great Britain comes second, with 5,050,919 gross tons, against 4,933,112 tons in 1912. The United States exported 2,760,133 gross tons, against 2,947,597 tons in 1912.

A NOTABLE SUBMARINE GAS SUPPLY.*

THE town of Christiansund, Norway, extends over the mainland and three islands, and, until recently, the question of lighting either by gas or electricity had not resulted in any practical scheme, owing to the unusual difficulties presented. It was optional for the municipality to either build their own works or place the work in the hands of a contractor. They preferred the latter, and the work of erecting gasworks and of further providing the main portion of the town, namely, Kirkelandet, with electricity, was given on the 17th of July, 1907, to Mr. Ferd. G. Juell and Engineer Karl F. B. Pihl. The concession was granted for twenty-five years, but the municipality reserved to themselves the

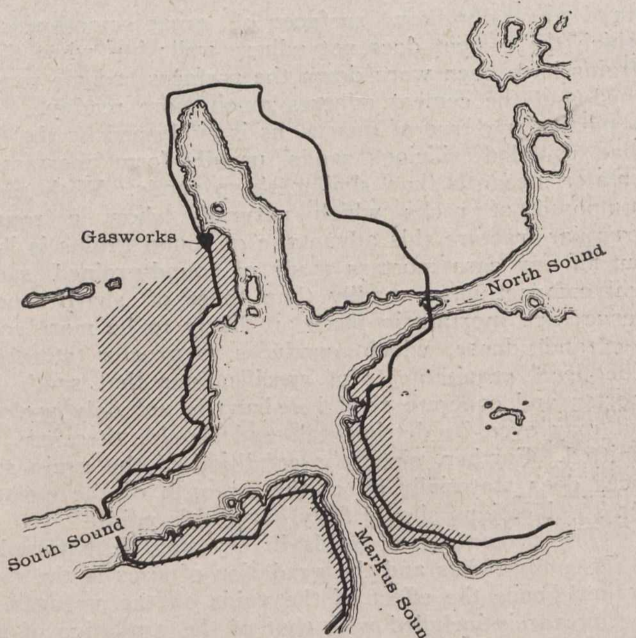

Fig. 1.—Plan of Gas Mains in Christiansund.

right to take over the works after ten years, under certain conditions. It was feared that to supply the remaining portion of the town with electricity would be too expensive, in view of the small demand, and it was, therefore, optional to the concessionnaires to supply

Fig. 2.—Section of the South Sound.

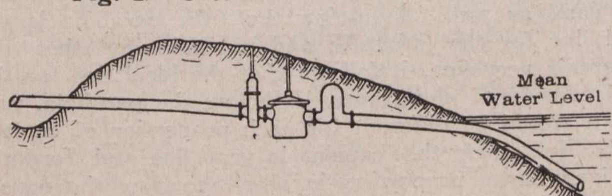

Fig. 3.—Position of Drip-well on Either Side of the South Sound.

those parts with gas. Should, however, they decide that this could not be done owing to the broad and deep Sound, then those parts were to be supplied with electricity.

* Translated from "Teknisk Ukoblad" by "The Gas World."

Preference was given to gas, owing to the advantages which it offered to the inhabitants, in so far as it could be used for lighting, cooking and heating, whereas electricity could practically only be used for lighting, and it was decided to go in for a submarine and long-

Fig. 4.—Sinking Gas Mains.

distance gas main, in spite of the difficulties offered by the Sound.

The main, which is 2½ miles long (half of which distance is without branch mains), is the only one of its kind in Norway, and, furthermore, it is surmised that there are no other submarine gas mains laid at so great a depth. As shown in Fig. 1, the gasworks is situated at Kirkelandet, from which one main goes round the Overvaagen, *via* Gromatlandet, through the North Sound to Nordlandet, and another main is laid from the gasworks through the South Sound to Inlandet. The main crossing the North Sound also supplies the small island situated in this Sound, and, as the depth of this Sound is only 24 feet, no difficulties were encountered during laying. The laying of the main in the South Sound, however, was a more formidable undertaking.

Fig. 2 shows a section of the South Sound. The submarine portion of the main in this sound is over 200 yards long, and its greatest depth below the level of the water is 86 feet. The depth of the Sound would, therefore, involve a maximum external pressure of 86 feet head of water, or 37 lbs. per square inch. In the case of a water main, a small leakage under these conditions would not be serious, or even with a sufficiently high-pressure gas main, but the supply of gas is designed for low pressure, only 15 to 25-tenths, and, therefore, it was necessary, above all, that the joints of the main should be absolutely tight. Furthermore, the difficulty of pumping any drip-well placed at such a depth enhanced the necessity not only of providing securely against leakage of water into the main from without, but also of obviating condensation within. The engineer, Mr. Pihl, appears to have worked on the lines of prevention.

In order to encourage condensation of gas in the main before or after its passage through the Sound, the pipes were laid above ground for a certain distance. Drip-wells were then placed on either side as shown in Fig. 3. Valves also are installed, and the main proceeds to dip under the water without any further provision, either for catching liquid or pumping it out. Four years of practical experience have proved that this bold scheme has been successful.

The submarine gas main consists of weldless Mannesmann steel tubes of 4 inches diameter, in lengths of 33 feet. They are protected against the action of sea water by means of galvanizing. They are also coated inside and out with rust-preventing mixture, and covered outside with strips of hessian soaked in a special tar preparation. The ends are threaded and the tubes connected by means of couplings with tightening cones, which type of joint has already proved satisfactory in a main at Vardo. The tubes were easily jointed up as per Fig. 5. They were bent on land to suit the shape of the banks, the remainder being allowed to adapt itself to the formation of the bottom of the Sound. The main was completely erected on a small island, inspected and tested to the requisite pressure, and was then brought by tugs into position, where it was sunk by divers, as shown in Fig. 4. During laying, a small tug was stationed at the entrance to the Sound to tow incoming steamers into port by another route. The sinking of the main was done quickly and safely, and not a single joint was damaged.

Both submarine mains have now been in use for four years without interruption, and no accident has happened to them, except directly after laying, when an anchor, which was dropped without permission, got into contact with the main in the North Sound.

All four parts of the town are supplied with gas by these long-distance and submarine mains.

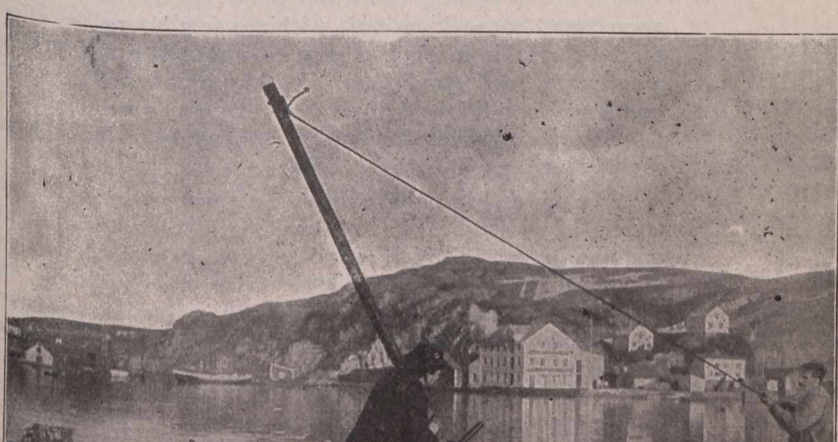

Fig. 5.—Screwing up the Joints of the Pipes.

FLOOD PREVENTION.*

By Maj. J. C. Oakes, M.Am.Soc.C.E.,
Corps of Engineers, U.S.A.

FLOODS are caused by excessive rainfall, quick melting of a thick blanket of snow, or a combination of the two, quick run-off, and channels inadequate to take care of the resulting flow of water. The run-off may be hastened by frozen ground, or a ground saturated by previous rainfall so that all of the precipitation escapes rapidly. The natural channel capacities may be, and usually are, reduced by artificial obstructions which prevent free and easy run-off.

Flood prevention measures must reduce precipitation, retard run-off, or increase capacity of the channels. I think that it is generally agreed that it is beyond the possibility of human ingenuity to control precipitation. The only method that has been seriously advanced is by forestation, and even for that method I am not aware that its advocates claim that forests decrease precipitation. It is certain that for all practical purposes the control of precipitation by forests or other means is at present impossible.

Flood prevention must deal, therefore, with the other causes of floods.

Run-off may be retarded by the retention of precipitation on or in the ground, or by the use of reservoirs. Several means of holding the precipitation where it falls have been proposed, such as deep plowing, contour plowing, and forestation. The term deep plowing is self-descriptive and the method is advocated not only for the purpose of retarding run-off, but also as a means of improving the yield of agricultural land. If all cultivated land could be plowed deep and the material well broken up, a considerable amount of precipitation would be retained by the soil. However, as can be readily seen, as a means of flood prevention, it is hardly within the control of the government. Furthermore, with a serious storm it is very doubtful if more than a very small portion could be held in the soil, even if plowed deep. Again, a large part of the country is uncultivated and covered by forests, hillsides and towns. This method, therefore, is very limited in its application and apparently impossible of control.

Contour plowing is a term applied to the method of plowing which creates ridges following the contours of the land and forms, as it were, terraces in such a manner that water will be held where it falls. This method, or perhaps a modification of it by the use of small dikes, is used extensively in foreign countries, such as Japan and the Philippines, where there is an excess of rain in one season to be followed later by a season of drouth. Under such climatic conditions, holding the water on the lands becomes necessary, else no crop can be raised.

In the eastern and middle western states these measures are not necessary for agricultural purposes, and while, if used extensively, they would retard run-off to some extent, they are impossible of control.

Both of these methods, therefore, seem to have advantages within certain limits, and would seem desirable, but they are not feasible means.

This brings us to forestation. This subject was treated at some length in the report of the National Waterways Commission, and the following is quoted from their report:

It is generally admitted that forests exercise such reservoir characteristics and under favorable conditions to a sufficient extent to improve the regularity of stream flow. There is, however, a decided limit to the quantity of water which a forest cover can absorb. The capacity for absorption varies greatly under different conditions, depending upon the depth and character of the forest litter, as well as of the soil underneath, whether pervious or impervious, also upon the condition of the ground, whether frozen or not, upon the steepness of the slope, and numerous other factors. Where the forest litter is destroyed by forest fires, or is removed to prevent them, the absorptive capacity is thereby reduced.

Various experiments have been made to ascertain the amount of water which different kinds of forest litter could absorb and hold. The results show that in general an amount equal to a precipitation of 0.16 of an inch can ordinarily be retained, while under favorable conditions the absorption of an amount equal to 0.24 of an inch or even more is possible. The soil beneath the humus may also be capable of some absorption. As soon as the saturation point is reached, additional rainfall must necessarily run off on the surface just as if the ground were deforested. This explains why forests are powerless to prevent floods, although, to the extent that they do absorb the precipitation, they may mitigate them.

Effects of Forests Upon Floods.—Floods are caused primarily by a heavy and prolonged precipitation, amounting oftentimes to several inches within twenty-four hours. During the heavy rains which caused the disastrous floods in the Passaic Valley in October, 1903, 14 inches fell, according to records taken at New York and Newark. The worst floods usually occur in the spring when these heavy rains fall upon a considerable accumulation of snow, which melts rapidly and augments the amount of water already precipitated. At this time the ground is more apt to be frozen or saturated and its capacity for absorption to that extent impaired.

Forests retard the melting of snow in the spring and by allowing the water from this source to be absorbed, exercise a beneficial influence upon stream flow, but should heavy spring rains fall upon the snow thus preserved and cause it to melt within a few hours the effect of the forest is in such a case to aggravate rather than ameliorate flood conditions. It thus appears that under one set of conditions forests may exercise a beneficial influence upon stream flow and floods, while under another their influence will be harmful.

Assuming that the above is a fair statement of the effects of forest on stream flow, it will be noted that an amount of precipitation equal to 0.16 of an inch can ordinarily be retained, while under favorable conditions the absorption of an amount equal to 0.24 is possible. Applying the factor of 0.16 of an inch to the State of Ohio, and to the storms which created the flood of March and April, 1913, if the whole State of Ohio could be reforested and could retain 0.16 of an inch of rainfall, only 2⅔ per cent. of the total rainfall would have been retained by the storage effect of this forest. The present forest area of Ohio is about 9,000 square miles, or a little less than one-quarter of the State of Ohio. If we could imagine an additional 10,000 square miles of present cultivated land back into forest, this additional forest under the most favorable hypothesis would retain only two-thirds of 1 per cent. of the rainfall of such a storm as that of March 23-27, 1913.

*Address delivered before the Indiana Sanitary and Water Supply Association, Indianapolis, Ind., February 26, 1914.

This subject was very thoroughly discussed in the Transactions of the American Society of Civil Engineers in connection with an article by Brigadier-General H. M. Chittenden, Corps of Engineers, U.S. Army, on the subject of "Forests and Reservoirs in Their Relation to Streamflow, With Particular Reference to Navigable Rivers." As illustrating the bad influence that forests may have upon run-off, he states:

In the first place, forests break the wind, prevent the formation of drifts and distribute the snow in an even blanket over the ground. * * *

The water from the first melting of the snow blanket does not sink into the ground, but into itself. The forest shade thus holds the snow, which gradually becomes saturated from its own melting until the heat and warm rains of late spring and early summer arrive. * * *

The result is that when the final melting begins, the whole body of snow disappears very rapidly, rushing from every direction into the streams, swelling them to their limit and often causing disastrous freshets. * * *

The delay in melting caused by the forest shade has simply operated to concentrate it into a shorter period and increase the intensity of the resulting freshet.

I believe that all of us will agree that the above statements are correct under certain conditions, and that by retarding the melting of the snow, forests have, on occasions, contributed to disastrous floods. Furthermore, even if it could be proven that forests exert on the whole a very beneficial effect, it is impracticable to convert fine agricultural land into forests. This country is certain to be more thickly settled than at present, greater crops will be needed for the support of the people and all tillable land will be ultimately used for the cultivation of crops until timber becomes so scarce that its value will pay the farmer to set aside a portion of his farm for its cultivation. Another objection to this method is that the formation of a humus sufficient to have its maximum effect in absorbing rainfall requires a long period, probably at least a century.

For these reasons it seems to me inexpedient to advocate reforestation as a means of prevention of floods.

The last mentioned and most feasible method of retarding run-off, is by the use of reservoirs. We have heard much on this subject within the last few years, and it has become a popular remedy for the prevention of floods.

If a certain amount of water flows downstream creating damage during its flow, it is apparent to anyone that if that water can be held in a reservoir and allowed to escape slowly, no damage would occur. Therefore, without understanding the immensity of the problem the ordinary man thinks he sees a remedy for floods and proceeds to become an advocate of what has come to be known as the reservoir method of flood prevention.

I desire to dwell on this subject at some length, for the purpose of showing that the problem is not as simple as stated above. There are without doubt many localities that may be protected by a reservoir or reservoirs. For instance, in the study of flood protection for the city of Columbus, O., the engineers were able to show that there were available sites immediately upstream from that city, which could be converted into holding reservoirs sufficient to take care of a flood similar to that of March and April, 1913. If such reservoirs had been in operation and had been controlled properly, releasing only sufficient water to fill the channel and not overflow the banks, no serious damage would have occurred in Columbus. It is also reported that the consulting engineers for the city of Dayton have shown that not only that town, but several others in the immediate vicinity, may be protected in like manner. The Pittsburgh Flood Commission has studied the subject in connection with flood protection for their city, and they have evolved a plan which appears to be ample to provide against future disastrous floods at Pittsburgh, if, however, the control of the reservoirs is possible to obtain results in accordance with the plans.

When one comes, however, to consider the prevention of floods in a river system like that of the Mississippi, the problem becomes exceedingly difficult. In the first place, reservoir sites are not generally found close to the points where the damage will occur, and this is particularly true of the Mississippi.

Col. C. McD. Townsend, Corps of Engineers, U.S. Army, president of the Mississippi River Commission, in an address before the Drainage Congress in the spring of 1913, stated:

To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Ill., having an area of 7,000 square miles, slightly less than that of the State of New Jersey, and a depth of about 15 feet, assuming that the reservoir was empty when the river attained a bank-full stage. Cairo is the logical location for a reservoir to regulate the discharge of the Lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and Upper Mississippi. But if the reservoirs be transferred from the mouths of the tributaries to the headwaters, their capacities must be largely increased.

It is not to be supposed that the people of Illinois and Missouri would be willing to have a portion of their territory as large as the State of New Jersey turned into a reservoir.

In this connection it should also be remembered that at the headwaters of the Mississippi there is the largest artificial system of reservoirs in the world, with a capacity of 93,000,000,000 cubic feet. These reservoirs have been successful in slightly increasing the low-water discharge of the Mississippi River above St. Paul, and also in reducing floods in that portion of the river; but a hundred miles farther downstream it is impossible to detect their influence during either high or low water.

The Ohio River has a very large flood discharge. At Louisville, for instance, the maximum discharge is 790,000 c. f. s. At the mouth of the Ohio the estimated maximum discharge amounts to 1,500,000 c. f. s. Let us see what effect the system of reservoirs proposed for the protection of Pittsburgh would have had at Louisville during the flood of March-April, 1913. The Pittsburgh Flood Commission proposed the construction and operation of seventeen reservoirs whose total capacity is approximately 59,500,000,000 cubic feet. The amount of water flowing past Louisville during the day of maximum height was approximately 67,392,000,000 cubic feet. The proposed reservoir system, therefore, would have been more than filled by one day's flow at Louisville. If we assume that the dangerous flood height at Louisville is 54 feet, then, to have kept the river below that height during that flood, a storage capacity of 7,300 square mile feet, equal to 200,000,000,000 cubic feet, would have been required, or over three times the capacity of the proposed Pittsburgh system.

If there had been a reservoir just above Louisville, with a capacity of 7,300 square mile feet, and if such reservoir had been empty when the flood stage of the Ohio River occurred, the Ohio River at Louisville could have been kept below the flood stage. But anyone can see that it would not be feasible to construct a reservoir of such capacity between Pittsburgh and Louisville because of the great value of the land, towns, improvements, etc., that would be submerged.

Another illustration may be taken from the Wabash River. To have kept the Wabash within its banks at Mt. Carmel between the date of March 25th and April 21st, would have required a storage capacity of 260,000,000,000 cubic feet, amounting to 9,300 square mile feet. This would have required a reservoir or reservoirs having an area of 930 square miles with water at average depth of 10 feet. It is apparent to anyone who knows the territory along the Wabash River that it would be impossible to find any such reservoir site in the vicinity of Mt. Carmel, and even if found, the cost of such site would be prohibitive.

It is evident, therefore, that on the large rivers like the Mississippi and the Ohio, there will be few reservoir sites close to the main streams that can be used to control floods and that sites must be found on the tributaries and generally at their headwaters. This complicates the problem and makes large numbers of reservoirs of immense capacity.

If reservoirs are to be located on the headwaters of the tributaries, then sufficient capacity must be provided on each of the tributaries to allow for its maximum flood. This capacity will be many times the capacity estimated from the discharge of the main stream, because floods are generally caused by the flow from a number of tributaries, but seldom from the flow of all the tributaries at their maximum stage. Thus each individual tributary must be treated and reservoirs must be so operated that they will be empty when needed and when full they must be emptied slowly so as to prevent the piling up of water in the main stream.

A marked defect of this system is the possibility that one storm may follow another so closely that at the time of the second the reservoirs will be full and not available for storage purposes.

Besides the points mentioned above, there enters the question of costs. Reservoir sites are, in general, extremely costly. The Pittsburgh Food Commission estimated the cost of its proposed system at $21,000,000, but a Board of Engineers, U.S. Army, in reviewing the report found that land and property damage were underestimated by $13,000,000, so, if their other estimates were correct, the cost would be $34,000,000. If a complete system were practicable for the Ohio River, some idea of its probable magnitude may be gained from the fact that the area of the basin of the Ohio Valley is 204,320 square miles, while the drainage area of the rivers above Pittsburgh just referred to is but 18,920 square miles, or 9 per cent. of the whole. Assuming that the cost per square mile would be the same as that for the Pittsburgh system, the total cost of providing reservoirs for the Ohio River would be $378,000,000. It is probable, however, that these costs would be greater, for the territory in question above Pittsburgh is not nearly as valuable as in such States as Ohio, Indiana, and Illinois.

The advocates of reservoirs for flood prevention recognize the enormous cost of this method of protection for a large river like the Ohio, and to offset this very pertinent objection they claim that the water stored in reservoirs may be used to produce power which may be sold to the public, thereby reducing the cost of flood prevention, and may also be used to increase the low-water flow of streams thereby improving navigation.

It is true that reservoirs may be used for flood prevention and the water held therein used for power, or for increasing the low-water flow of a stream, but the full capacity of a reservoir may *not* be used for all three of these purposes at the same time. Reservoirs to be used for flood prevention must retain the water during the possibility of floods, but the instant that possibility passes the water must be allowed to escape as rapidly as possible without doing damage, in order that they may be empty at the time of the next possible flood. The use of reservoirs for increasing the flow of streams at low-water stages is just the reverse of this. They must be kept full as long as possible and the water only allowed to escape when it is absolutely necessary to increase the low-water flow. The use of reservoirs for power, on the other hand, requires a constant flow with a constant head to obtain the best results, and the more nearly these conditions are met the more efficient is the plant and the greater income obtainable from a given expenditure.

A little thought on this subject will convince a reasonable man that the three uses of reservoirs proposed by their advocates are incompatible one with the other, and in my opinion if an endeavor were made to use the same reservoirs for these three purposes it would not be long before the power interests would obtain control, and it would be practically impossible for a government agent to empty a reservoir in anticipation of a flood when the power interests desired the reservoir to be kept full in order to provide uniform power for their plant.

In any case, it will be seen from the above that to prevent floods by the use of reservoirs will require a certain definite capacity; that if these reservoirs are to be used for any other purpose their capacity must be vastly increased, thereby increasing the costs of the system. Before the feasibility of protection by reservoirs in any particular case can be affirmed, available information must be supplemented by extensive, reliable data as to run-off, flood heights and discharges, available sites and costs.

The capacity of streams may be increased by the use of levees, dredging, or auxiliary channels.

With reference to the levee as a means of flood protection, it has been used for many hundreds of years. It is a means available for the immediate protection of sites or areas of varying size. Large areas of the Mississippi basin are protected by levees, as well as many towns on that and other rivers. New Orleans and Cairo are so protected. With this method the solution is simple, and the only important questions are to determine the size of the levees and the cost. An area may be made secure against any flood of similar height to those we have had in the past, or that may be expected in the future. The method is simple and direct and is the only method extensively used for protection in cases of large river systems. The levee system on the Mississippi has been in process of construction many years, and while it is true that breaks occur which cause vast damage, it is due to the fact that such levees have not been constructed to the height necessary for protection against the greatest floods. Where a community felt itself too poor to provide against the highest floods they have built their levees as high as their funds would allow, with the expectation and knowledge that when a higher flood came the levees would be topped.

Dredging may be used for increasing the capacity of channels where the increase required is very moderate, but a radical increase in the capacity of a large stream may not be accomplished by this method without the expenditure of enormous sums of money. A point often forgotten is that dredged material must be placed outside of the river channel if the dredging is to do any permanent good. This requires the purchase of lands upon which such material may be deposited, and increases the cost of actual dredging very materially.

No instance is known where a radical increase by dredging of the flood-carrying capacity of a river channel has been attempted on any large stream. The low-water channels in streams like the Mississippi oftentimes are dredged to facilitate navigation, but it is believed that the limited application of this method should be apparent.

Auxiliary channels have been suggested, both paralleling long stretches of streams and also to form cut-offs. The cost of providing additional channels for a stream like the Ohio or the Mississippi, of sufficient capacity to carry off the flood waters, is absolutely prohibitive. For the protection of a particular locality short auxiliary channels or cut-offs may be used, but these have the disadvantage that while they may benefit the locality in question by facilitating the run-off past that particular locality they pile the water up more rapidly below, thereby creating more damage at other points, as they necessarily cause steeper slopes, higher velocities, and greater erosion.

The method of prevention of floods have been discussed at some length, and it must be realized that the subject is one of great extent and the problem in the case of large streams very difficult of solution.

We now come to the question of the prevention of damage by floods.

Many towns have grown up on the flood planes of the streams, occupying areas that have been overflowed from the beginning; people have entered the bottom lands and erected their structures with the knowledge that those lands were formed by silt deposited by flood waters; railroads have constructed earthen embankments across these bottoms, leaving only very narrow openings with wholly inadequate capacity for passing floods; city and county officials have built bridges with abutments projecting into the stream, with many piers of insufficient height, thus reducing the discharge area materially; individuals have dumped materials over the banks to increase the area of their property for business purposes. These structures and encroachments have reduced the capacity of the streams, have formed partial dams which raise the water above previous levels and then by the breaking of an embankment or the washing out of a bridge the water held back has rushed downstream under increased head and velocity, destroying everything in its path. Aside from the damage done by the inundation of property, which, while serious, is not destructive, almost all of the damage at the points visited is caused by increased velocities of current due to the backing up of the water, by embankments, bridges, and other structures, the subsequent breaking of these partial dams and the rush of the released waters under increased heads and velocities.

The measures to be taken to prevent such damage are: wherever possible, to remove structures from the flood planes and river bottoms, or to elevate such structures above possible high water; to protect by levees valuable property which it is impossible to remove; to prevent the construction of heavy earthen embankments across flood planes by railroads or counties; to increase the capacity of channels by removing encroachments thereon in the shape of bridges, buildings, etc., and to remove all artificial and natural filling or deposits.

Fire has recently completely destroyed the Oceanic dock at Portland, Ore., and has entailed a damage loss of $150,000. The dock was owned by Balfour, Guthrie and Company. The fire was the third destructive waterfront blaze this spring, all along one section of the Portland waterfront.

SUBURBAN, INTERURBAN AND RURAL ROADS.

Some valuable suggestions as to the classification of public highways and the proper division of expenditures for their construction and maintenance appears in the 1914 report of the Public Roads and Highways Commission of Ontario. In discussing the subject of supporting areas for cities, the report emphasizes the value to the latter of general rural development brought about by better roads.

Urban centres with good roads are especially benefited by the main roads in their immediate vicinity. It may in a general way be assumed that each city has a special interest in an area immediately surrounding it, sufficient to provide a food supply for the city, and the population within such area.

Attention is called in this report to one or two preliminary points. It is well known that cities are not, even in the matter of home-grown products, supported altogether by their immediate neighborhoods.

It would seem, however, that the most potent influence in preventing such a condition has been the heretofore inadequate means of local transportation in marketing. Improvement in these facilities would induce the abandoning, by nearby farmers, of low-priced crops, which have heretofore carried the bonus of cheap marketing, for high-priced crops upon which marketing charges will decrease as the farmer is brought closer to his market.

Then again, some districts are specially adapted to the production of certain products, such as fruits, and they should, therefore, be properly expected to specialize in the production of these commodities. This factor has its effect in altering any general calculations that may be made for cities and their supporting area as a whole.

Still another point arises with the calculation of a large supporting area. A number of towns of various sizes are found within the area. In this instance, therefore, a special calculation has to be made and the results tabulated. In the case of the smaller cities, however, this difficulty is not incurred.

In all, calculations have been made for the twenty-one largest centres in Ontario. The results appear in the table given on the next page.

The results given are based upon calculations in which both the general items of food entering into the dietary of the average family, and the yield of these items in the various districts respectively, for which estimates are presented, have been taken into account. The "average family" was taken consisting of five members. There was then worked out the acreage required to supply the various food items appearing. The total area required for the support of fifty people for one year was thus found to be 109.14 acres. It is to be noted that this acreage provides only the amounts of each kind of food grown locally and consumed by the unit of fifty people in one year and no account is taken whatever of other foods, such as imported fruits, etc., which are consumed in addition. The 109.14 acres thus represents the area required to provide home-grown products only. It is to be further noted that this acreage represents only the net area required, and this whole area of land would need to be cultivated to provide the required amount of food. In the case of each area for which a calculation was made, therefore, account was taken of the proportion between cultivated or producing land and total acreage.

It will be noted that when the circles designating the supporting areas are placed upon a map, certain of these, if carried through, would intersect; the conclusion being that the supporting areas of various cities are found to overlap each other. It therefore becomes necessary to make allowances in these cases. The smaller city is favored in that the amount of overlapping, when taken from the larger area, makes but a slight difference in its total, whereas the same amount taken from the smaller area would make a very appreciable difference. Furthermore, the areas where overlapping takes place lie, with one exception, closer to the smaller than to the larger urban centre.

Name of City	Population	Total supporting area. (Sq. miles.)	Radius of circle or part of circle of total supporting area. (Miles.)	Radius of area of immediate support. (Miles.)
Toronto, city only (Census 1911)	376,538	1676.8	....	32.7
City, 1913 (Assessment figures)	445,575	2591.9	....	35.3
With country (census)	458,432	2225.4	37.6	....
With country, 1913 (Assessment)	533,411	2591.9	40.6	....
With country and towns, 1913 (Assessment)	573,728	2905.9	43.0	....
Ottawa	87,062	621.25	19.8	16.8
Hamilton	81,969	730.84	15.9	11.8
London	46,300	326.18	10.1	8.3
Brantford	21,132	161.82	7.2	5.5
Kingston	18,874	126.77	8.9	7.8
Peterborough	18,360	148.49	6.9	5.6
Windsor	17,829	119.98	9.6	7.7
Berlin	15,196	104.28	5.8	4.8
Guelph	15,175	97.95	5.6	4.8
St. Thomas	14,054	79.98	5.1	4.4
Stratford	12,946	75.71	4.9	4.3
Owen Sound	12,558	99.67	5.9	5.1
St. Catharines	12,484	101.76	8.0	6.4
Chatham	10,770	60.35	4.4	3.8
Galt	10,299	68.04	4.6	4.0
Sarnia	9,947	80.21	7.8	6.7
Belleville	9,876	63.88	6.3	5.4
Brockville	9,374	73.21	6.8	5.8
Woodstock	9,320	53.69	4.2	3.7
Niagara Falls	9,248	69.56	6.6	5.1

Road Classification.—It has been pointed out that while municipal responsibility should be encouraged, there is a point at which, in order to obtain results, the influence of a central authority must bear directly upon road administration. A consideration of the classification of roads will assist in determining the point at which the forces of a central administration should be applied.

Roads should be built to meet the needs of traffic. For example, there are roads which, lightly traveled, by an initial expenditure of $1,000 a mile, will remain in good condition for ten years; on the other hand, there are other roads which, because of heavy traffic, demand an outlay of $1,000 per mile annually for maintenance alone. For this reason, roads admit of classification according to traffic for purposes of construction and maintenance, revenue and administration. They must be constructed and maintained adequately; revenue must, in equity, be derived from those who are benefited and organization must be commensurate with the work.

Cities and Suburban Roads.—The opinion is frequently advanced in the cities that the provision and support of good reads should fall upon the farmer, inasmuch as he must use them to market his products. The farmer, however, is fully justified in maintaining that the cities are equally interested in the roads over which their food supplies reach them. In point of fact, the city and country are necessary to each other, with the advantage somewhat on the farmer's side; for, while he could manage without the city, the city could not exist without him.

About each city there exists, as stated, a belt of rural territory which is knit to it in the closest fashion. Much of the city's food is grown in this belt; more would be if the means of communication were better. Sundry industries, due to the presence of the city, are prosecuted in this area. The residents for some miles out are valuable customers of the city's shops. In every way the city stands to gain by the equipping of this belt with a system of roads able to carry a heavy traffic with speed and economy. The speed of the motor bus and motor truck would extend the city's influence—that is, the area from which it could draw food and direct trade. Opportunities would be afforded for a specially beneficial development, the rapid moving of workers out into the countryside after their daily task is over. It is understood that in Belgium one-third of the industrial workers live outside of the towns, cultivating small holdings of land, under conditions of health which surpass those of residents in the crowded streets. From the standpoint of the city's food supply alone, the improvement of the roads is of great importance to the town dwellers.

Economically speaking, distances are measured by time, and if men trespass too much on the early morning hours in order to reach distant markets, nature makes her claim on them later on. If the constant, regular supply to city markets is limited to points, say, two hours therefrom, it would mean leaving the farm at 6 a.m. in order to be on the market stand at 8 a.m. It is easy to realize, therefore, that by cheap motors and good roads the supply area can be greatly enlarged, as compared with the present districts surrounding most cities, in which supplies are sent into town by horse-drawn vehicles on indifferent roads. Further, the widening of the belt means enhancing the profits per acre, to the advantage of the farmer.

Again, the countryside has suffered for several decades from certain inevitable developments. Forty years ago a considerable amount of industrial work was carried on in nearly every small town, in nearly every village, and, indeed, in many rural communities too small to aspire to the name and style of village. This caused a wholesome diversity of industry, increased the interest of country life, and was in most respects a beneficial social influence. The march of progress has swept that state of things away. The tendency of the age is toward centralization. Those small industries, which meant much to the small towns, have been absorbed into those operating in larger centres. The countryside must specialize in farming. Why, then, should cities—to a certain extent built up by rural districts, which have lost taxable property to those cities—not be prepared to contribute to the road system by which both benefit?

Interurban Roads.—In dealing with interurban roads it is necessary to glance at one aspect of the problem created by the motor. The greatest asset of some European countries is their scenery; it attracts tourists, and the money they spend is of great importance to the community. Bearing in mind that the tendency to reach summer resorts by motor is increasing, it is not difficult to realize that, with a system of main arteries penetrating country regions in the United States and Canada, a more important tourist traffic would be developed. This traffic is of little benefit to the people of the intervening districts traversed; it throngs the roads, and there is a tendency to over-rapid driving, with its accompanying nuisances, of which the dust evil is but one. However, the traffic is of great value to the summer resort region, which would be the goal of most of these hurrying wayfarers, and the interests of such regions must be considered as well as those of the more strictly farming districts.

Along the interurban roads many persons will pass who do not live in the municipalities in which they are situated. This is perfectly natural; from time immemorial the King's highway has been for the use of the traveler, regardless of his residence. It is necessary, of course, to see that the burdens of constructing and maintaining such a road are equitably adjusted, so as not to impose an undue proportion of them on the people of the locality. Indeed, if measures of this sort are not taken, the situation will work itself out, and disadvantageously to all concerned; for the motorists will search out and appropriate to their use the best stretches, and there will be motor routes which at once will give dissatisfaction to the motorists and inflict a sense of injury upon the farmers and ratepayers along them.

At the same time, a road which constitutes an artery of this sort is not exclusively an affair for the traveller from a distance. It is a series of links—market roads necessary for the needs of local people, and it will be the strictly local road for those who dwell along it. In short, it discharges functions at once local, provincial, and in some cases even national, and in consequence it demands assistance from more than local administrations.

Rural Roads.—It can hardly be doubted that there is impending a revolution in farm operations. Two centuries ago or less the European farmer used the pack-horse to take his products to market. A revolution in methods occurred, and he came to employ wagons, which were hauled along roads much better than the tracks his ancestors had known. The self-propelled vehicle has come to stay, and the successful solution of the problem of good roads in some part depends upon a recognition of that fact. Indeed, the motor, to no small extent, creates the problem, for it has proved so destructive to main highways which resisted the wear and tear of horse-drawn vehicles that means must be devised to guard against a deterioration which now proceeds with a rapidity formerly unknown. Opportunities as well as difficulties are created by this new method of transportation. It prevents some, at least, of the features essential to profitable use by farmers; it conveys loads of a size so moderate that a single farm can furnish one or more than one, yet so large as to out-class the old horse-drawn wagon; it requires, not specialized tracks, like railway, but a common highway, albeit improved to a standard within the reach of the community; it is free from the difficulties of traffic adjustment which have made the conduct of railways a business by itself, and a peculiarly difficult business. In short, it is an individualistic method of transportation, and this commends itself to farming, the most independent and individualistic occupation in the world. Already there are cheap motor cars and trucks to be obtained; the farmer of to-day can procure one of these with as little straining of his resources as his grandfather could a top buggy; and it is but reasonable to expect a further lowering of the price. In this beneficent revolution, good roads must play a necessary and important part.

Increasing attention must be given, not only to the important market roads, but also to the township roads, those gravel or earth highways which pass the doors of the great mass of farmers and afford them access to the country or market roads, which lead to the centres where they sell their products and make their purchases. In Ontario these township roads are estimated at 85 per cent. of the whole of the highways.

It is proposed that township councils should provide for and control the roads of local travel, with the proviso that to encourage better methods and organization the province will grant a subsidy of 20 per cent. of their annual expenditures for a limited period of years. Such aid should not, however, be given to townships until the county has assumed a system of market roads; otherwise, as alternative plans, they might seriously interfere with the installation of a proper system of such county roads. It is felt that provision for a system of good market roads in each county is of first importance and that aid to townships should not be in any way allowed to take the place of such roads. As to the division of cost for rural market roads, it is suggested that 60 per cent. of both construction and maintenance expenses be paid by the county, and 40 per cent. by the province.

Future Development and Maintenance.—In the present circumstances, the general condition of rural roads being so indifferent, interurban and market routes have a tendency to shift, as one stretch of road is improved or another allowed to deteriorate, so that the volume of traffic borne by a particular route is not an absolute proof that under a proper organization of the road system it would not be a main traveled road. A road census would show what amount of travel is furnished to-day by a given district, and the channels which it now takes; but considerations such as the density of population, the productivity of the land, railway construction, possible or probable developments, the distribution of road-making material, and so forth, would have to be taken into account.

One such consideration is the possibility of future urban growth which will lead to the places concerned sending out and attracting to themselves a greatly increased volume of traffic; should this occur, the place so developing would need additional market and interurban routes, striking out from it at varying angles, and in some cases cutting diagonally across the present rectangular road-patterns. It is suggested that tentative plans for such diagonal roads be drawn up with regard to certain prominent centres, and some arrangement—such as the prohibition of the erection of buildings in their track—be made to ensure the possibility of their being constructed at the lowest possible cost, if need should arise in the future.

It is the opinion of the Ontario Highways Commissioners that if due care is taken in studying the situation, the county roads, those taking care of the heavy non-local traffic, need not greatly exceed fifteen per cent. of the whole. Thus they view the problem in Ontario as that of bringing 42,500 miles of township roads to a reasonably fair standard, and of fitting 7,500 miles of county roads to bear the severe demands made upon them.

The first principle in connection with road expenditure is that money secured by bond issues should only be put into permanent roads. The future should not be called upon to pay for the present, unless the present creates something that will be useful to the future. The maintenance of permanent roads is made necessary through the wear and tear of the present generation, hence that burden should be met by the users. As bond issues must eventually be redeemed, and as the roads will wear out and call for renewal from time to time, the bonds should not run for a longer period than the natural life of the road with proper maintenance. It is believed, therefore, that the bond should preferably be redeemed within twenty years, and should not exceed thirty years.

Maintenance would become increasingly heavy as stretch after stretch of standard roadway came into existence; from the moment a permanent road is constructed, a properly organized system of repair and upkeep must be applied to it if the first expense is not to be wasted and the project to issue in disappointment.

An intelligent system of records and cost-keeping is a basic requirement in an undertaking such as road construction and maintenance, for the guidance of those in charge of the work, as well as for the information of the public who supply the funds. Economy of expenditure, and public confidence and support, will be greatly aided by adequate records of work done with a corresponding and lucid statement of expenditure.

A NEW EXPLOSIVE.

TITANITE, a new explosive, which has been invented recently in Vienna, and for which many advantages are claimed, is an ammonium-nitrate and turmeric powder compound. The turmeric root is nitrated by boiling in water to extract coloring substances, drying, grinding, treating with a mixture of sulphuric and nitric acids, washing and drying the product of the reaction. Carbonized turmeric powder may be similarly nitrated. Ammonium-nitrate explosives usually contain carbonaceous material and carbonized turmeric powder and carbonized sandalwood are recommended as excellent for this purpose, the sandalwood hastening the speed of combustion. As a formula for an explosive compounded along these lines, the following is suggested: Ammonium nitrate, 88 per cent.; carbonized turmeric powder, 1.05 per cent.; carbonized sandalwood, 0.95 per cent.; nitrated turmeric powder, 10 per cent.

It has been found, however, that the carbonized material is unnecessary when the nitrated turmeric powder is used, and a simpler formula offered is: 80 to 90 parts of ammonium nitrate and 20 to 10 parts of the nitrated turmeric powder, carefully dried, intimately mixed and finely ground.

The addition of trinitrotoluene and gelatin, the latter consisting of collodion cotton and dinitrotoluene, results in an explosive of greater strength. A formula for such a compound would be: Ammonium nitrate, 82 parts; nitrated turmeric powder, 4 parts; trinitrotoluene, 10 parts; gelatin, 4 parts (the latter to consist of 0.17 part of collodion cotton and 3.83 parts of dinitrotoluene.)

It is claimed that these explosives are stable when stored, the hygroscopic quality of the ammonium nitrate being overcome; that they are entirely safe, being insensitive to blows, shocks and fire, and exploding only from an initial explosion as by a powerful detonator; that they are powerful in their effect, and that they yield only a small amount of noxious gas. As a matter of fact, according to the Engineering and Mining Journal, these claims have been pretty well borne out by trial at one of the largest mines in America. The difficulty in the way of the general introduction of the explosive, which is called titanite, seems to be that ammonium nitrate cannot now be obtained quite cheap enough to enable the titanite to compete in price with the other high explosives in common use.

The great dry dock in Japan at the Maidzura naval station on the western coast, has been completed after 8 years' work. It will accommodate warships up to 35,000 tons displacement.

MODERN METHODS OF STADIA SURVEYING.

By J. A. Macdonald, Ottawa, Ont.

ONE of the reasons why the stadia is growing rapidly into more general use is that fewer men are required for a stadia party than for an ordinary transit party. This particular advantage of the stadia over the transit and chain for the traversing of lakes has caused the Topographical Surveys Branch of the Department of the Interior at Ottawa to adopt the stadia almost exclusively for lake traverses. In the Lands Survey Branch the stadia is used almost entirely, also for all lake traverses necessary to be made in the subdivision of townships. This article embodies the best methods to adopt for surveying by means of the stadia rather than the chain and transit or compass. By reference to Fig. 1 it will be seen that the rays of light proceed from a point so distant that in the stadia the rays may be considered parallel, and these are refracted and converged to a point in the axis of the lens called the focus, or the principal focus, at a certain distance, depending upon the radii of curvature of the surfaces of the lens. The image is formed at the distance, F, in front of the object glass owing to the image of the cross-hairs being projected beyond the objective to the extent of the focal length of the latter. The rays converge at that point, and the measurement must be taken from it. Therefore, in order to obtain accurate results a constant must be added to the reading from that point, which constant is equal to the focal length of the objective, plus the distance from the objective to the centre of the instrument. The focal length is shown by the dotted line, f, while the distance from the objective to the centre of the instrument is shown by the dotted line c. The rod-reading gives the distance only from the point, F, to the rod, so that to get the total distance from the point over which the instrument is set the values of c and f must be added. The distance, then, is the rod-reading (assuming it reads 1 in a 100) of the rod plus $(f + c)$ in all cases. Each instrument has an individuality of its own, and must be adjusted by actual trial at a mean distance. The difference of focal length for an 11-inch transit telescope of 30 magnifying power at a change in distance from 100 to 300 feet would be but 0.0027-ft., so that it is possible to read all lengths of sights with an almost perfect degree of exactness.

Traversing with the Stadia.—In a combination of hydrographic and topographic work, such as the traversing of lakes and other bodies of water, the party usually consists of surveyor, transit-man, two rodmen, and canoe. The traverses of a lake or other body of water is usually made from one or more instrument-stations at or near the shore, the rodman following the bank and giving side-shots at suitable distances apart. For rivers and lakes there is an advantage in keeping one rodman on each side and surveying both sides at the same time, the rodmen following the shore in opposite directions till they meet at the far side. The survey will, however, generally be made on one side only, the front rodman travelling away from the surveyor, while the rear rodman travels towards the surveyor. The rear rodman having reached the surveyor and the front rodman the next instrument station, the surveyor moves his instrument to the next station, while the rodmen are waiting in their places. Upon the arrival of the surveyor the front rodman shows him his new station and the instrument is set up. The rear rodman places his rod upon the last station for orienting the transit, and the survey proceeds as before. It is well to remember that when the sun is shining and the distance is great, a rod cannot be read unless the sun is shining upon its face, and so only one of the rods can be used for measuring side-shots, according to the direction of the sun. The rodman who is not giving side-shots along the shore can be engaged taking soundings from the boat, while he also gives side-shots to stations on islands.

When no astronomical observation is taken, the instrument is oriented by means of the compass, or rather by the magnetic needle, reading the azimuth of magnetic North deduced from previous readings or from astronomical observations taken from a magnetic map.

It is highly important for the rodman to understand the significance of holding the rod vertical; to ascertain if it is hidden; and how to select a new instrument station. The face of the rod should be turned slightly towards the sun when by so doing the sun can be made to shine on the graduations. A system of signals should be arranged with the rodmen for directing them to stop, or to start again, or to indicate that the rod is hidden. Some signals can be made with the arms, or a flag may be necessary at great distances. Before the rodman leaves the instrument it is well to indicate to him as nearly as possible where the next station is to be. It is more important that the surveyor himself act as front rodman, or at least be with him at instrument points or stations, and leave the transit-man at the instrument. It is also well to read the three wires for both the front and rear instrumental stations as a precaution against errors.

When the instrument is but a few feet above the water it is not necessary to record vertical angles along the shore; when, however, the inclination exceeds 1°-30′, the vertical angle should be recorded and the proper correction applied to the distance read between instrument stations always, and frequently on side-shots if the vertical angle is large.

Reading the Rod.—For reading distances, set the lower wire on an even chain or foot-division on the rod, count the number of feet, tenths and hundredths to the upper wire and estimate the fraction. Distances read by means of the whole interval are twice as accurate as with the half-intervals. The length of courses between stations should always be measured with the whole interval when the distance is less than 1,300 feet, or 20 chains; the readings with the half-interval will necessarily have to be made at distances greater than 20 chains, as the limit of any 13-foot rod is but 1,300 feet with the whole-interval reading, and 2,600 feet reading with the half-interval. When the sum of the readings of the half-intervals equals the reading of the whole interval, the check is significant. The constant of each instrument is anywhere between one and two feet, and this sum must be added to the reading.

As an example of instrument No. X., for which the wire interval factors are: Upper interval 197.19, lower interval 211.53, whole interval 102.18; a reading of 200 ft. with the upper interval corresponds to 197 ft., to which has to be added the constant. With the whole interval, a reading of 1,000 ft. corresponds to 10.22 + .02 (constant). A reading of 2,000 ft. with the lower interval corresponds to 21.15, to which the constant .02 must be added. The correction to the reading is, therefore, + 115 + 2, or + 117; that is to say, the reading both of the rod and the constant is 117 greater than the actual distance.

These directions are tabulated and used for plotting when extreme accuracy is demanded. Usually they may be overlooked. In inclined sights the reductions of distance may be quickly reduced by means of the slide-rule.

When the difference between the starting and closing corners differs more than 5 % from the distance in an original survey, if any, the error should be located by retracing with the stadia.

For Soundings.—For obtaining contour lines on lakes, or shore lines 5 ft. deep, 10 ft. deep, etc., procure a quarter-inch hemp rope, attach a 2 or 3-lb. lead to the end and mark every 10-ft. with a strip of red and every 5-ft. with a strip of blue bunting. Always tie the loose end of the rope to the boat before leaving the shore. Soundings can be made in shallow water with the rod, though this method of taking soundings is not recommended. After completing the survey of a lake enter in the notes the nature of the water, whether fresh or alkaline, the sources of supply, the outlet, and such other

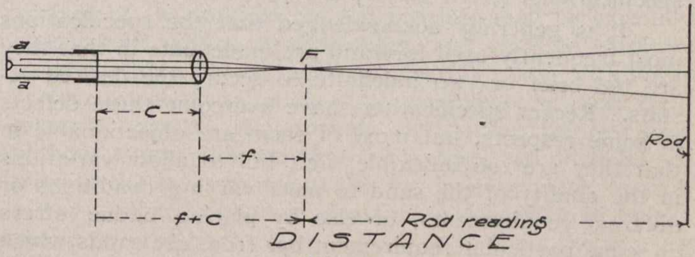

Fig. 1.

data as may be of interest. A determination of the magnetic meridian should be made if the weather permits making an astronomical observation, but this will not always be necessary.

Plotting the Survey.—A rough sketch of the survey should be made or plotted on the right-hand page of the field book before leaving the locality, or as the work proceeds. Two field books may be used consecutively, one being left in the office or camp while the other is in use on the survey. Make the plot, first, at least, in pencil, preferably on paper ruled to a scale of 10 chains to the inch. Commence plotting carefully the instrumental stations and work in pencil the north and south points of each station.

Plot the side-shots by means of the protractor. Then enter on the plan the soundings taken, and all other information that has been collected.

The Field Book.—The left-hand page of the field book is for the notes; the right-hand page for a sketch of the survey. Two stations are designated by numbers; the side-shots by letters. In the first column of the left-hand page enter the letter of the side-shot or the number of station sighted upon. The second column is for the distance read or estimated; the third column for the bearing; the fourth column for the vertical angle, and the remainder of the page for remarks.

Stat. No. or side-shots.	Distance.	Bearing.	Vert. angle.	Remarks.
(1)	...	....	....	Inst. set Comp. north.
(a)	150	307.00	6.40	Top of bank.
(b)	350	115.30	82.45	Foot of bank.
(c)	457	31.25	....	....
(d)	1423	224.51	....	Creek, 10 feet wide, 2 feet deep.
(2)	1343	122.26	85.50	Marshy shore. Water—
Stat. 2—				
(e)	918	46.40	....	....
(f)	987	238.12	....	....
(g)	1423	224.51	....	....

At each instrument-station enter in the notes the nature of the shore, the rise of the ground from the water's edge, the depth of the water as determined from soundings in the boat by one of the rodmen, the estimated distance to the foot or top of the slope when the lake lies in a valley, and such other data as may be considered useful.

SAND SPECIFICATIONS.

In connection with the conclusions arrived at by the Engineering Experiment Station of the University of Illinois, following the extensive tests to ascertain the mortar-making qualities of various sands, the specifications, given below, are proposed:—

It is generally acknowledged that the specifications most frequently used for sand are inadequate in that they are too brief or two indefinite to secure the desired results. Recent specifications have overcome these defects in some respects, but most of them are objectionable in that they are too inflexible, i.e., fail to allow variations in the quality of the sand to meet varying conditions or different requirements, or else by placing undue stress on some particular requirement bar from use sands which would prove entirely satisfactory. The following specifications have been prepared with the idea of giving this necessary flexibility and at the same time making them sufficiently rigid. It is not intended, however, that these specifications should be used indiscriminately for all purposes, but rather that they should serve simply as a guide in preparing the specifications for any particular piece of work. In preparing these specifications both the specifications proposed by the national engineering societies and the results of the test described in the bulletin have been taken as guides.

Definition of Sand and Screenings. — The term "sand" shall be understood to mean natural sand which will pass, when dry, a screen having ¼-in. clear openings. Similar material which is the product of artificial crushing shall be known as "screenings," and shall conform to the specifications for sand.

Suggested Classification of Sands.—Sands shall be classified as No. 1, No. 2, No. 3, plastering sand, and grout sand, the several grades being suitable for the following classes of work:—

No. 1 sand is that required in reinforced concrete and in other work requiring a mortar of maximum strength and density.

No. 2 sand is that required in work not demanding maximum strength or density, but still requiring a mortar of high quality.

No. 3 sand is that required where high strength or density is not a controlling factor.

Plastering sand is that for use in ordinary plastering over masonry, concrete, and wood or metal lath. Either No. 3 sand or plastering sand is of high enough quality for use in lime mortars. The latter sand should be used where the thickness of the mortar joint is such as to require grains of small size.

Grout sand is that for use in pavement fillers and other work requiring a thin, smooth, free-running grout.

Specifications for No. 1 Sand.

Composition.—No. 1 sand shall consist of grains from hard, tough, durable rocks, and be free from soft, decayed, or friable material.

Cleanness.—The sand must be free from lumps of clay, loam, or other foreign material. It shall not contain more than 2 per cent. by weight of finely divided clay, loam, or other suspended matter when tested by washing in such a manner as to remove all such material without removing any of the finest sand; provided, that if the strength of the mortar made from the sand is greater than 110 per cent. of the strength of a similar mortar made with standard Ottawa sand, the amount of suspended matter may reach 3 per cent. This suspended matter must not form a coating around the grains to such an extent that such coating is not entirely broken up and removed from the grains by sprinkling with water or in the mixing of the mortar or concrete. The sand shall be free from oily or greasy matter in any form and must contain no organic silt.

Roughness.—The grains shall have rough, unpolished surfaces to which the cement paste will readily adhere.

Size of Grains.—The grains shall be well graded in size from the finest to the coarsest. For the greatest density not more than 8 per cent. by weight, including the suspended matter, shall pass the No. 100 sieve, and not more than 60 per cent. the No. 16 sieve. If maximum density is not essential and the mortar yields the required strength, these quantities may be increased to 12 per cent. and 75 per cent., respectively.

Voids. — The voids in the dry sand, when well shaken, shall not exceed 33 per cent. of the total volume of the sand.

Tensile Strength.—Mortar, in the proportions of 1:3 by weight, when tested at an age of 28 days, shall develop a tensile strength at least equal to the strength of a similar mortar made of the same cement and standard Ottawa sand tested at the same age.

Specifications for No. 2 Sand.

General Requirements.—No. 2 sand shall meet the requirements for No. 1 sand in all respects except as follows:—

Cleanness.—The suspended matter shall not exceed 6 per cent. by weight when tested in the same manner as described for No. 1 sand.

Size of Grains.—Not more than 15 per cent. by weight, including the suspended matter, shall pass the No. 100 sieve, and not more than 80 per cent. the No. 16 sieve.

Voids.—The voids shall not exceed 35 per cent. of the total volume.

Tensile Strength.—The tensile strength shall equal at least 80 per cent. of that of the standard Ottawa sand mortar when tested as described for No. 1 sand.

Specifications for No. 3 Sand.

No. 3 sand shall meet the requirements of No. 2 sand, except that the suspended matter may reach 8 per cent. and the tensile strength be as low as 65 per cent. of that of the standard Ottawa sand mortar.

Plastering sand shall meet the requirements for No. 3 sand in all respects, except that for the finishing coat it shall be of the requisite fineness to give the desired finish.

Grout sand shall meet the requirements for No. 3 sand except as follows:—

It shall all pass a No. 16 sieve. The voids shall not exceed 38 per cent. of the total volume. The tensile strength shall be at least 40 per cent. of that of the standard Ottawa sand mortar.

The firm previously known as the Canadian Contractors, Limited, of Winnipeg, has recently changed its name to "Joseph Macdonald and Company, Limited."

SPECIFICATIONS FOR DRAIN TILE.

Among the committee reports that were presented at the recent convention in Atlantic City of the American Society for Testing Materials, that of Committee No. C-6, on standard tests and specifications for drain tile, contained something more definite and valuable than has heretofore been published. The following considerations, relating to strength tests, quality and recommended practice in design and construction are extracted therefrom:

Proposed Specifications for Strength Tests.—1. The specimens shall be unbroken, full-size tile. They shall be carefully selected so as to represent fairly the quality of the tile.

2. A standard test shall comprise five individual tests. The result for each specimen and the average of the five shall be given in the report of the test.

3. The materials of the tile shells shall, at the time of testing, be in a thoroughly wet condition, such as may be obtained by covering with sacks kept wet for 8 hours.

4. No test specimen shall be exposed to water or air temperatures lower than 40° F. from the beginning of artificial wetting until tested. Frozen tile shall be completely thawed before artificial wetting begins.

5. Each specimen shall, if practicable, be weighed on a reliable scales just prior to testing.

6. The load shall be applied by any machine or hand method which will apply the load continuously, or in uniform increments not exceeding 0.05 of the total load necessary to break the tile. The tile shall not be allowed to stand any considerable time under load. All solid parts of the bearing frames or bearing blocks shall be so rigid that the distribution of the load shall not be appreciably affected by the deflection of any part. All bearings and the test specimens shall be so accurately centered as to insure in every direction a symmetrical distribution of the loading on each side of the centre of the tile.

7. The inspector, in specifying test requirements for drain tile, shall prescribe in advance one of the three following kinds of bearings: sand bearings; hydraulic bearings; three-point bearings.

8. The test results shall be reported in terms of the ordinary supporting strength. This term shall be defined to mean the supporting strength of a tile when the load is applied with such a distribution as to produce a maximum bending moment of $0.20 \frac{RW}{12}$, where W = the ordinary supporting strength, and R = radius of middle line of tile shell, in inches. The ordinary supporting strength shall be obtained by multiplying the test breaking loads, by the following factors: For sand bearings, 1.00; for hydraulic bearings, 1.25; for three-point bearings, 1.50.

The ordinary supporting strength shall be reported in pounds per linear foot.

9. The modulus of rupture shall be calculated from the maximum bending moment prescribed in Section 8 by the formula

$$p = \frac{6M}{t^2}$$

where p = modulus of rupture in pounds per square inch, M = maximum bending moment in shell in inch-pounds per inch of length, calculated as prescribed in Section 8, and t = thickness of tile shell in inches.

Five-eighths of the weight of the tile per lineal foot for sand bearings, or three-fourths for hydraulic or three-point bearings, shall be added to W in computing the maximum bending moment, when such addition exceeds 5 per cent. of W.

10. Where sand bearings are used, each specimen shall be accurately marked in quarters, with pencil or crayon lines, prior to the test. Specimens shall be carefully bedded, above and below, in sand, for one-fourth the circumference of the pipe, measured on the middle line of the pipe shell. The depth of bedding above and below the pipe at the thinnest points shall at each place be equal to one-fourth the diameter of the pipe, measured between the middle lines of the pipe walls.

The sand used shall be clean sand which will pass a No. 4 screen.

The top bearing frame shall not be allowed to come in contact with the pipe or with the test load. The upper surface of the sand in the top bearing shall be carefully struck level with a straight edge, and shall be carefully covered with a heavy, rigid, top bearing plate, with lower surface a true plane, made of heavy timbers or other rigid material, capable of uniformly distributing the test load without appreciable bending. The test load shall be applied at the exact centre of this top bearing plate, in such a way—either by the use of a spherical bearing or by the use of two rollers at right angles—as to leave the bearing free to move in both directions. In case the test is made without the use of a machine, and by piling on weight, the weight may be piled directly on a platform resting on the top bearing plate, provided, however, that the weight is piled in such a way as to insure uniform distribution of the load over the top surface of the sand.

The frames of the top and bottom bearings shall be composed of timbers so heavy as to avoid appreciable bending by the side pressure of the sand. The frames shall be dressed on their interior surfaces. No frame shall come in contact with the pipe during the test. A strip of soft cloth may be attached to the inside of the upper frame on each side along the lower edge to prevent the escape of sand between the frame and the tile.

11. Where hydraulic bearings are used, each specimen shall be accurately marked in halves, with pencil or crayon lines, prior to the test.

A hydraulic bearing shall be composed of a wooden platen to which is attached, as hereinafter described, a section of rubber hose. The hose shall lie against the tile, and the pressure shall be applied to the hose through the platen.

The platen shall be built of yellow pine, and shall be at least 4 by 4 in. in section, and its least length shall be the length of the pipe plus 8 in. One-inch quarter rounds with their convex surfaces facing shall be firmly attached to each edge of one side. The straight portion of this face shall extend at least the length of the pipe, and the platen beyond this length may be cut to the arc of a circle.

Between the quarter rounds shall be laid a piece of 2½-in. hose, which shall be closed in a water-tight manner at each end by clamps. The hose shall contain a volume of water not less than one-half nor more than two-thirds its capacity, when completely distended. This hose may be attached to the platen at either end in any satisfactory manner which will not induce wrinkling when under test pressure.

The test load shall be applied at the exact centre of the top bearing, in such a way as to leave the bearing free to move in the vertical plane of the axis of the pipe.

It is recommended that stops be screwed to the platen symmetrical with the point of application of the load, and at a distance apart not greater than the length of the tile plus ½ in. This will help centre the load coming upon the pipe.

12. Where three-point bearings are used, each specimen shall be accurately marked in halves, with pencil or crayon lines, prior to the test.

The lower bearings shall consist of two wooden strips having a corner rounded to a radius of approximately ½ in. They shall be straight and shall be securely fastened to a rigid block in a position such that the bearing lines of a cylinder of 24-in. diameter laid along the rounded edge of the strips shall be 2 in. apart.

The upper bearing shall be a wooden block, straight and true from end to end.

The test load shall be applied through the upper bearing block in such a way as to leave the bearing free to move in a vertical plane passing between the lower bearings.

In testing a tile which is "out of straight," the lines of the bearings chosen shall be from those that appear to give most favorable conditions for fair bearings.

Proposed Specifications for Quality.—1. Specimens to be tested shall be selected by the inspector from the tile to be used on the work; these specimens to be selected at the factory, shipping destination, or at the trench location. The tile shall be measured, sounded and examined by inspection. Five specimens of each materially different class noted shall be selected for a test. If, in the judgment of the inspector, it is necessary either before or after the testing of the specimens, additional specimens may be selected, but in no case shall these additional specimens exceed 1 ft. in length for each 100 linear feet of tile to be laid. These additional specimens shall be furnished by the contractor free of charge at the point of selection, provided that, in case the specimens tested meet the specifications, not more than 1 per cent. shall be required to be furnished free.

2. Each tile shall be of a cylinderical section, the size being designated by the interior diameter. The average diameter shall not be more than 3 per cent. less than the specified diameter. The maximum and minimum diameters of the same tile or average diameters of adjoining tile shall not differ more than 80 per cent. of the thickness of the wall.

3. The minimum length of the tile shall not be less than 12 in. In tile 12 in. or above in diameter, up to 30 in. in diameter, the length shall not be less than the diameter. Tile above 30 in. in diameter need not have a greater length than 30 in.

4. Tile designed to be straight shall not vary from a straight line more than 3 per cent. of its length.

5. Tile shall be reasonably smooth on the inside, and free from cracks and checks extending into the body of the tile in such a manner as to appreciably decrease the strength.

Tile stood on end and tapped with a light hammer when dry shall give a clear ring.

Tile shall be free from chips or broken pieces which will decrease its strength or admit earth into the drain. The end shall be regular and smooth and admit of the making of a close joint when properly turned and pressed together.

6. In a standard test, if one or more specimens fall more than 25 per cent. below the required strength as specified, the class of tile represented by the failing specimens shall be rejected, and other specimens tested to complete the standard test.

7. *(a) Class No. 1B.*—No. 1B tile are intended to be suitable for supporting the load in the worst material in a trench having a grade line 5 ft. deep. They shall have minimum average ordinary supporting strengths calculated as prescribed in Section 8 of the proposed Standard Specifications for Strength Tests of Drain Tile, in accordance with the following table:

Required Average Ordinary Supporting Strength for Class No. 1B Tile.

Diameter of tile, in.	Lb. per linear foot.
10	600
12	700
14	800
16	900
18	1,000
20	1,100
22	1,100
24	1,200

(b) Class No. 1A.—No. 1A tile shall be made of good materials by the most approved method, and are intended to be suitable for supporting the load in the worst material in a trench having a grade line 7 ft. deep.

The inner surface of the tile shall be free from defects. The outer surface shall be free from broken blisters, lumps or flakes which are thicker than 20 per cent. of the thickness of the tile, or whose diameter is greater than 15 per cent. of the inner diameter of the tile, and such defects as are allowed shall not be of such nature as to appreciably weaken the tile when laid in the ditch.

The tile shall have minimum average ordinary supporting strengths (calculated as prescribed in Section 8 of the proposed Standard Specifications for Strength Tests of Drain Tile) in accordance with the following table:

Required Average Ordinary Supporting Strength for Class No. 1A Tile.

Diameter of tile, in.	Lb. per linear foot.
12	900
14	1,000
16	1,200
18	1,300
20	1,400
22	1,550
24	1,700
26	1,800
28	1,900
30	2,000
32	2,050
34	2,150
36	2,250

(c) Class No. 1 Extra A.—No. 1 Extra A tile shall be extra good, and are intended to be suitable for supporting the load in the worst material in a trench having a grade line 10 ft. deep. They shall be either vitrified, salt-glazed, clay tile, or thoroughly seasoned concrete tile, made of the best materials, by the most approved method.

The inner surface of the tile shall be free from defects. The outer surface shall be free from broken blisters, lumps or flakes which are thicker than 16 per cent. of the thickness of the tile, or whose diameter is greater than 12 per cent. of the inner diameter of the tile, and such defects as are allowed shall not appreciably weaken the tile when laid in the ditch.

The tile shall have minimum average ordinary supporting strengths (calculated as prescribed in Section 8 of the proposed Standard Specifications for Strength Tests of Drain Tile) in accordance with the following table:

Required Average Ordinary Supporting Strength for Class No. 1 Extra A Tile.

Diameter of tile, in.	Lb. per linear foot.
12	1,000
14	1,200
16	1,500
18	1,700
20	2,100
22	2,300
24	2,500
26	2,600
28	2,800
30	3,000
32	3,200
34	3,300
36	3,500

8. Tile not meeting the above specifications shall be rejected.

Proposed Recommended Practice in Design and Construction of Tile Drains.—The selection of a class of tile suited to a particular case requires a knowledge of the pressures to which the tile will be subjected. This in turn depends upon the character of the soil and the manner of laying the tile as well as upon the depth and width of ditch. The following is recommended as good practice in design and construction:

Methods of Tile Laying.—1. Three grades of work are recognized, namely, Ordinary, First Class, and Concrete-Cradle. Generally the engineer will specify the grade of work required, but in some cases it may be advisable to allow the contractor a choice between using a superior method of laying, or a stronger tile.

2. In Ordinary tile laying the contractor shall shape the bottom of the ditch approximately to fit the lowest one-quarter of the outside circumference of the tile, taking pains to secure an extra firm bearing near the outer edges of the bearing area.

In hard material he shall bed the tile in a thin layer of granular earth where, in the judgment of the engineer, it is necessary to secure a good bearing.

After the tile is bedded truly to line and grade, the contractor shall carefully place the earth around and over the tile by hand to the depth of at least 1 ft. over the tile, using shovels or other suitable tools to work the earth filling down the sides, and underneath the tile so far as practicable.

Whenever the ordinary supporting strength of the tile, as determined by actual tests, and calculated as prescribed in Section 8 of the proposed Standard Specifications for Strength Tests of Drain Tile, is 50 per cent. or more in excess of the strength specified, the bottom of the ditch need not be shaped to fit more than the lower one-eighth of the outside circumference of the tile.

3. In First-Class tile laying in hard material, the contractor shall shape the bottom of the ditch approximately to fit the lowest one-quarter of the circumference of the tile, taking pains to secure an extra firm bearing near the outer edges of the bearing area. Upon the concave surface so prepared the contractor shall spread a layer, 1 to 2 in. thick, of pulverized soil, or sand free from pebbles larger than ¼ in. diameter, and shall firmly bed each tile truly to line and grade thereon.

Where the bottom of the ditch is so wet and soft as to enable the thorough bedding of the lowest one-quarter circumference of the tile without the use of the layer of pulverized earth or sand, and still is firm enough to afford good, safe support to the tile and its load of ditch filling, the engineer may authorize the omission of the layer of granular material, but such authorization shall not excuse imperfect bedding.

The space between the tile and the bottom and sides of the ditch shall be filled with selected earth, thoroughly tamped as fast as placed, up to the level of the top of the tile. The side filling shall be carried up as rapidly on one side of the tile as on the other.

The tile shall then be covered by hand with earth to a depth of at least 1 ft. above the top of the tile.

No tile laying shall be considered as First-Class unless the laying and tamping of each tile are watched and directed by an inspector kept constantly on the work for that purpose.

4. Two grades of Concrete-Cradle tile laying shall be recognized, one for solid material and the other for yielding material.

(a) Solid Material.—Solid material shall be defined as that which is as solid as average, firm, clay sub-soil. Concrete-Cradles, Solid Soils, shall be made as follows:

The contractor shall shape the bottom of the ditch to fit approximately the lowest one-fourth of the circumference of the tile. Upon the concave surface so prepared there shall be spread at least 2 in. of soft concrete, stiff enough to sustain the weight of the tile, and the tile shall be firmly bedded truly to line and grade thereon.

The space between the tile and the bottom and sides of the ditch shall then be thoroughly tamped or spaded full of soft concrete, up to a level one-quarter of the diameter of the tile above the mid-height. The thickness of the concrete at any point shall not be less than 2 in.

Each joint shall be promptly cleaned on the inside of the tile, as soon as the concrete is in place for that joint.

The concrete used in this method of strengthening tile shall be made of 1 part Portland cement and 8 parts of gravel, or 1 Portland cement, 5 parts sand, and 8 parts broken stone. No pebbles or stone shall exceed in size 1 in. less than the thickness of the concrete.

(b) Yielding Materials.—Yielding materials shall be defined as including all materials not solid, as defined above.

Concrete-cradles for yielding material shall be designed by the engineer to carry safely to the soil foundations both the vertical load on the tile from the ditch filling and a side thrust at the mid-height of the tile, such as would exist if the tile were cracked at the top, bottom and each side. The thickness of the concrete at the lowest part of the bottom of the tile shall be at least one-eighth, and on each side at the mid-height at least one-fifth the internal diameter of the tile, and the side concrete shall extend about one-quarter of the diameter above the mid-height of the tile. Each joint shall be promptly cleaned on the inside of the tile as soon as the concrete is in place for that joint.

The concrete used in this method of strengthening pipe shall be made of 1 part of standard Portland cement and 5 parts of good, coarse, clean gravel, or 1 part of standard Portland cement, 3 parts clean, coarse sand, and 5 parts broken stone. No pebbles or stone shall exceed 2½ in. in greatest diameter, nor exceed 1 in. less than the thickness of the concrete.

5. Tile in the trench shall not be subjected to freezing weather during construction without a sufficient depth of cover to prevent cracking.

6. In Table I. are given the approximate values in pounds per linear foot of the ordinary maximum loads on drain tile and sewer pipe from common ditch-filling materials, as determined by tests[1] at Ames, Iowa, and Bos-

[1] For both the tests and the data of actual drains and sewers, see the Report of Committee C-6 on the Investigations on Drain Tile, American Society for Testing Materials, published as Bulletin No. 36, Iowa Engineering Experiment Station.

ton, Mass., and by study of the detailed data of about 90 actual tile drains and pipe sewers, part sound and part cracked.

It is recommended that for clay and all common material except sand and loam, the values under clay be used, and for sand and loam, the values under sand.

Strength of Tile Required.—6. It is recommended that where tile are to be laid according to the description for the Ordinary method, a factor of safety of 1½, applied to the average strength, shall be used when the results of the tests are reported in terms of the ordinary supporting strength, calculated as prescribed in Section 8 of the proposed Standard Specifications for Strength Tests of Drain Tile, and loads estimated according to Table I.

7. Where the tile are to be laid in accordance with the method denominated First-Class, in consideration of the increased support furnished by the improved foundations, the nominal factor of safety to be employed shall be 1¼, applied to the average strength, and with loads estimated according to Table I.

8. In this case it is intended that the concrete-cradles shall furnish the strength necessary to carry the load from the ditch filling. It is recommended, however, that only Class No. 1 A or Class No. 1 Extra A tile shall be used in this case.

Table I.—Maximum Loads on Drain Tile and Sewer Pipe from Ordinary Ditch-Filling Materials—Ordinary Sand, 120 lb. per Cu. Ft.; Thoroughly Wet Clay, 120 lb. per Cu. Ft.

Loads in Pounds per Linear Foot.

Height of fill above top of tile, ft.	Breadth of Ditch a Little Below Top of Tile 1 ft.		2 ft.		3 ft.		4 ft.		5 ft.	
	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.
2	180	190	410	420	650	660	890	900	1,110	1,130
4	270	300	710	750	1,170	1,220	1,640	1,690	2,100	2,150
6	310	360	910	1,000	1,590	1,680	2,270	2,400	2,970	3,100
8	340	400	1,070	1,190	1,910	2,070	2,820	3,000	3,720	3,930
10	350	420	1,180	1,330	2,180	2,400	3,260	3,510	4,380	4,680
12	360	440	1,250	1,440	2,400	2,670	3,650	3,990	4,980	5,340
14	360	440	1,310	1,530	2,570	2,890	3,990	4,380	5,490	5,940
16	360	450	1,350	1,600	2,710	3,090	4,260	4,740	5,940	6,480
18	360	450	1,380	1,650	2,820	3,250	4,490	5,050	6,330	6,930
20	360	450	1,400	1,690	2,910	3,390	4,700	5,340	6,660	7,410
22	360	450	1,420	1,720	2,980	3,510	4,880	5,570	6,960	7,800
24	360	450	1,430	1,740	3,050	3,600	5,010	5,780	7,230	8,160
26	360	450	1,440	1,760	3,090	3,680	5,150	5,970	7,460	8,490
28	360	450	1,440	1,780	3,120	3,750	5,240	6,120	7,670	8,760
30	360	450	1,440	1,790	3,150	3,800	5,340	6,280	7,830	9,030
Infinity	360	450	1,450	1,820	3,270	4,090	5,820	7,280	9,090	11,370

PROPOSED STANDARD ROAD TERMS.

By the Committee on Standard Tests for Road Materials, appointed by the American Society for Testing Materials, the following terms applicable to materials for roads and pavements were submitted at the recent convention of the society as proposed standard definitions:

Asphalts.—Solid or semi-solid native bitumens, solid or semi-solid bitumens obtained by refining petroleum, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt upon the application of heat and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.

Asphaltenes.—The components of the bitumen in petroleum, petroleum products, malthas, asphalt cements and solid native bitumens, which are soluble in carbon disulphide but insoluble in paraffin naphthas.

Blown Petroleums.—Semi-solid or solid products produced primarily by the action of air upon originally fluid native bitumens which are heated during the blowing process.

Carbenes.—The components of the bitumen in petroleums, petroleum products, malthas, asphalt cements and solid native bitumens, which are soluble in carbon disulphide but insoluble in carbon tetrachloride.

Cut-back Products.—Petroleum or tar residuums which have been fluxed with distillates.

Tars.—Bitumens which yield pitches upon fractional distillation and which are produced as distillates by the destructive distillation of bitumens, pyrobitumens or organic materials.

Coal Tar.—The mixture of hydrocarbon distillates, mostly unsaturated ring compounds, produced in the destructive distillation of coal.

Coke-oven Tar.—Coal tar produced in by-product coke ovens in the manufacture of coke from bituminous coal.

Dehydrated Tars.—Tars from which all water has been removed.

Gas-house Coal Tar.—Coal tar produced in gas-house retorts in the manufacture of illuminating gas from bituminous coal.

Oil-gas Tars.—Tars produced by cracking oil vapors at high temperatures in the manufacture of oil gas.

Pitches.—Solid residues produced in the evaporation or distillation of bitumens, the term being usually applied to residues obtained from tars.

Refined Tar.—Tar freed from water by evaporation or distillation which is continued until the residue is of desired consistency; or a product produced by fluxing tar residuum with tar distillate.

Water-gas Tars.—Tars produced by cracking oil vapors at high temperatures in the manufacture of carburetted water-gas.

Editorial

JOHN GALBRAITH, ENGINEERING EDUCATIONALIST.

With engineering in Canada will always be prominently associated the name of John Galbraith, who gave the fullness of his life to the building up of an institution devoted to the teaching of the scientific principles which, when inculcated, formed the basis of many engineering careers. The loss which engineering has sustained at his death will never be fully realized. So brightly has shone the personality of the Dean through so many years that it will continue to shine.

Nearly forty years of a whole-hearted application of one of the most observing, resourceful and judicious intellects, to the problems before it, have left an impress that nothing can obliterate. His tremendous ability, his remarkable alertness to the difficulties of others and to the cause to which he had devoted his life, his unceasing vigilance and prompt yet cool and masterful disciplinary powers, his keen sympathies for the student and his work, for his staff and its worries, for the country and its needs, raised him high above his fellow men, yet nestled him into their hearts.

The encomiums which are being so abundantly and so deservedly accorded him, come with double aptitude, in the light of the fact that death found him in the harness, to the last, never lingering, never slipping, and always in the hearts of his School men, always with them in his heart.

ETHICS IN COMPETITIVE DESIGN.

Competitive designing may be a good thing, providing the rules of the game are observed. Its goodness is altogether contingent, however, upon close adherence to the conditions by which the competition is governed. Otherwise it is apt to come within the category of "skin games."

Recently the council of a western city took a flier into the sport and launched a competition, which is very slow at righting itself to the general satisfaction of all concerned. For even the judges should observe the rules with exactness.

The city employs an engineer. (It may be that our readers will remember a reference in these columns last year to a city engineer, taken suddenly ill, being indiscreet enough to be hustled to the hospital without first bending his knee and asking permission—thereby almost forfeiting his job. It is the same city engineer, and the same city. The incident was commented upon to show the absolute lack of fairness which the city council displayed in dealing with the case.)

Competitive designs were received this spring for a piece of engineering work of interest to engineers and architects. The conditions of the competition, with which we are especially concerned, stipulated that the competitors were required to submit fully detailed drawings to enable the city engineer to check over the design, as regards strength and stability, as well as specifications, quantities, prices, etc.; that designs were required to conform in line and grade with location plans supplied by the city engineer, and that, should any of the conditions be ignored, the plans, being disqualified, would not receive consideration.

Some 29 designs were submitted by 23 engineers and architects. They were referred to the city engineer. The city engineer also prepared a design, which, it is stated, was not presented at the same time as the others. Later he prepared a second design.

The special committee of the city council took his design No. 2 into competition with the others and recommended it.

The other competitors thereupon held a meeting and protested against the recommendation on the grounds that, (1) the city engineer acted in a triple capacity, viz., as compiler of the regulations governing the competition, as technical expert in judging the designs, and as a competitor; (2) the city engineer's design was contrary to his own regulations, and did not conform to the lines and grades as laid down by himself. Therefore it was not eligible for competition. Having spent considerable time, labor and money on the competition, the competitors (21 of whom had signed the protest) hoped that the council would take a stand which would allow it to be closed with satisfaction to all and honor to the council.

The city has a branch of the Canadian Society of Civil Engineers, who protested against the procedure; so did the Provincial Architectural Institute.

The city council adopted the design No. 2 submitted by the city engineer.

In view of the disturbance which resulted from the proceedings, the city engineer, in a letter to the mayor, stated that the modification of design No. 1, which was embodied in design No. 2, had been conceived and prepared before examining the individual plans submitted by the various competitors. He explained that the choice of design was not made by him or upon his recommendation but by the committee; and that he was not present when the decision was reached. He made it clear that since his own designs were in competition with the other twenty-three, he would prefer to be relieved of all responsibility for advising the city council in the matter.

It is stated, further, by one of the aldermen, that no one knew of the design No. 2 until a day or two before the committee met to go over the plans. According to the city engineer's letter to the mayor, his report dealing with the engineering features of the various plans had been prepared prior to this. The sub-committee to go over the plans and city engineer's report was not appointed until six weeks after the competition had been closed. It is very evident that as the city grows older its council is not improving in the matter of fairness. But there is an engineer connected with the unfairness, whose case should be clearer than the circumstances indicate. We have been hoping that our information is inaccurate, but supplementary advices from other sources strongly bear it out. Is it a case of absolute devotion to his employers, in right or wrong, with an equally absolute disregard for engineering ethics?

JOHN GALBRAITH

DR. JOHN GALBRAITH, Professor of Engineering and Dean of the Faculty of Applied Science and Engineering, University of Toronto, died at Go Home, among the islands of Georgian Bay, on July 22nd, 1914. It was known by an intimate few that his health had been seriously impaired, but death came with appalling and unexpected suddenness, even to the members of his family close to him at the time.

His early career, until the founding of the School of Practical Science in 1878, is briefly told. Born in Montreal, September 5, 1846, and coming with his parents a few years later to reside in Ontario, his early and high school education was received in Port Hope. At the age of 17 he entered the University of Toronto. Here, despite his modest and retiring nature, his desire for a liberal education, and for the uplifting of others as well as of himself, created a pronounced interest in undergraduate activities. The annals of the University record him as a participant in the foundation of several of the earlier organizations, including the first National Science Club.

> Dr. Galbraith was one of the greatest men of his age, for he has been instrumental in producing the men who are now so strong a factor in the development of our Dominion.
>
> I shall always cherish his memory with sincere affection.
>
> H. G. TYRRELL, '86,
> Consulting Engineer.
>
> Evanston, Ill., July 24th, 1914.

His graduation with the degree of B.A. was marked by a singular appreciation of his ability, in the award to him of a double scholarship in mathematics and general proficiency. He acquired the gold medal in the former, and in 1868 his unparalleled qualifications earned for him the Prince of Wales' prize. Characteristic of the genius and of his insatiable desire for knowledge, the education which had been accompanied by these distinctions was regarded by him as very ungratifying. Though young in years, he had a remarkable conception of the future of the country and of its inevitable development. His explorations into the forest-covered confines of Upper Canada had revealed to him the dependency of this development upon the training in applied science of young men. Throughout the years which followed his convictions were augmented by the primitiveness of many of the methods then in vogue in engineering work. During his connection with the building of the Midland, the Intercolonial and the Canadian Pacific railways his resourcefulness and comprehensive grasp of fundamentals earned for him the prophecy of his chiefs, that in the open field of civil engineering his would be a most notable career. But the yearning for the application of science to the problems of engineering triumphed over the call of the wild. In 1875 he returned to the University of Toronto for the degree of M.A. and strongly voiced his convictions, now a part of himself, that the direst need in education at that time was the need of a technical training for young men, to enable them to become engineers. His persistent and potent arguments resulted in the Legislative Assembly of 1877 sanctioning the establishment of a School of Practical Science in Toronto. His scheme of organization included an arrangement whereby the students of the proposed institution were to enjoy full advantage of the instruction given by the teaching staff of University College in all the departments of science which would be embraced in the work of the School. John Galbraith assumed the full personal responsibility of instruction in Engineering Thus opened the gateway through which have passed a multitude of technically trained engineers—one of the outstanding and epoch-making events in the history of the Dominion of Canada.

> Dean Galbraith was the greatest practical engineering educator of his time and, through his graduates, he has influenced all parts of the engineering world. I count it a great privilege to have studied under him, and the friendship which has since continued makes me mourn his loss most keenly.
>
> LOUIS L. BROWN, '95,
> Vice-President The Foundation Co.
>
> New York, July 25th, 1914.

> Dean Galbraith possessed, I believe, more of the Christian virtues than any other man I have known. He was of a most kindly disposition and was considerate, almost to a fault, of the feelings of all with whom he came in contact.
>
> For over twenty years he has been my most intimate friend, and in this long period I cannot recall his ever having spoken uncharitably of anybody, although he occasionally expressed righteous anger at manifest wrong doings. He practiced to the fullest extent the Golden Rule, "Do unto others as you would have others do to you."
>
> He was extremely happy and content in his home life and had practically no outside interests, other than those connected with the University and the School of Science.
>
> R. F. STUPART,
> Meteorological Service.
>
> Toronto, July 25th, 1914.

The progress of the School of Practical Science through the intervening years, until 1906, and its development since, as the Faculty of Applied Science and Engineering of the University of Toronto, is as well and truly written over, and under, the surface of this country as it is in the archives of Parliament or the University. Better! It bespeaks, as writings cannot do, the long-drawn strife and indefatigable devotion of the force behind the institution. The history of the institution is the biography of the man. Its success has been to his sacrifice. The story of the battle of a life-time will never be told in full. The conscientious engineer carried his self-unrevealing troubles under seal to his grave.

The arduousness of the academic work which he had set himself to do, took him, during the summer months of each year, into the field of engineering to acquire first-hand knowledge of its progress and its requirements. Always on the alert, years went by with no cessation of engineering activity. His extensive knowledge of the geographical and geological nature of the country was acquired by canoe and trail, years before the faces of other white men had penetrated into the Indian's domain. The various tribes committed their dialects to his mastering, his friendships among the red men were many, and more than one tribe has hailed him as the "Chief of all the Whites." His foot trod over the mineral fields between civilization and Hudson Bay a score of years before the intrusion of the pick, and the northern waterways familiarly bore his canoe when geographical map there was none. He saw it all as a field for the engineer, and as the horizon receded, he saw to it that his purposeful labors, with their attending trials and responsibilities, expanded accordingly. The sun set with his shoulder still to the wheel.

> He has left his mark in Canada through his great influence. He was beloved and revered by every student who studied under him and few men will be more widely mourned.
>
> T. R. DEACON, '91,
> Mayor.
>
> Winnipeg, Man., July 27th, 1914.

A noted writer has already said of him: "In a world where men are crowding and pushful, it is gratifying to see, now and then, a man who is quiet and retiring brought out whether or no, and placed in front, where his attainments entitle him to be." In 1907, he was appointed a member of the Royal Commission to investigate and report upon the collapse of the Quebec Bridge. In 1909 he was elected president of the Canadian Society of Civil Engineers, for which he had long acted as councillor and in the establishment of which, in 1887, he was one of the founders. Back in 1902 the University of Toronto conferred upon him the honorary degree of LL.D., and in the following year Queen's University, Kingston, likewise paid tribute to his ability. For many years he had been an associate member of the Institution of Civil Engineers of Great Britain.

> For 32 years I had the great good fortune of the acquaintance, advice, instruction and friendship of Dean John Galbraith.
>
> The late James Ross, a thorough judge of men, said in 1883, that Galbraith was an exceptionally capable engineer and teacher, and that any boy who was fortunate enough to graduate under his instruction would need no further collegiate training in Europe or America.
>
> The advice given me by Dean Galbraith has been repeated to many young men, as I have felt sure that it would benefit them as it has benefited me.
>
> There is no man living whom I respect, admire and love as much as I did Dean Galbraith.
>
> T. KENNARD THOMSON, '86,
> Consulting Engineer.
>
> New York, July 25th, 1914.

In his earlier manhood, Dr. Galbraith was a military as well as a civilian engineer. He was present at the mustering of the garrisons near Montreal in the sixties, upon the occasion of a visit from the then Prince of Wales, later King Edward VII. The story has been told of the call for volunteers during the Fenian raids. At that time he was an assistant on the railway survey party. When news of the call reached the party in the forest, the chief, desirous of enlisting, designed to leave the work in charge of John Galbraith. His assistant, however, advanced his own sense of duty at such a time of need, arguing that the better surveyor should stay and the better fighter should go. The acknowledgment of the respective qualifications was somewhat unbalanced and the latter accomplishment required vindication. This was adjusted out behind the tent. Galbraith went.

To the graduates of the institution known familiarly as "The School," the record of his death has come with appalling suddenness. He was dearly loved by all; by some as the Dean, by others as the Principal, by many others by the more familiar and genuinely brotherly appellation of "Johnny." The age of 67 found him with his energies ebbing, spent in the pursuit of his life-work, to a greater degree than any but his closest friends surmised. After a strenuous year, full of characteristic endeavor to bring his institution to that degree of efficiency that has always been his ideal, he had repaired with his family, only a few weeks ago to Go Home, a quiet and beautiful spot established by himself more than twenty years ago on the shores of Georgian Bay. His lowered

> For a long while I have known him—33 years—and in all that time, first as a pupil and afterwards as one of the many who had the good fortune to possess his friendship, I grew to respect more and more and admire those rare qualities of heart and mind which so endeared him to all who knew him well.
>
> His personality was extremely attractive. He appealed to all sorts and conditions of people, to young and old, to the plain workman as well as to the educated college man.
>
> He had all the qualities of a truly great leader. He had wonderful tact and intuition and was very, very kindly. His modesty and genial good nature, keen sense of humor, and charity for human weaknesses, gained him friends everywhere, and yet when necessary, he could be very strong, but he ruled through love and not through force.
>
> He possessed the faculty to a remarkable degree of imparting knowledge to others, and of stimulating a desire for thoroughness. I have met none who were his equal in this respect. There was something in him which unconsciously brought out the best in his pupils. I do not remember that he ever lectured his class on conduct or ethics; but his influence somehow stimulated the best that was in us. He was not only a great teacher of Applied Science—he was an upbuilder of character—he made Men as well as Engineers.
>
> His loss to Canada and to the University is very great. To his wife and family and to his many devoted friends, it is irreparable; but he had lived to see the fruition of his life's work, and it gave him much joy in his later years to see the bountiful return which his early strenuous and loyal work had produced. The influence of his life will long survive him. The world is better for John Galbraith having lived.
>
> EUGENE W. STERN, '84,
> Consulting Engineer.
>
> New York City, July 24th, 1914.

vitality failed, however, to respond, as usual, to the recuperative environments.

Dean Galbraith was not a seeker of renown. His world-wide reputation is of the kind that will wear through ages, gathering as it has done from without the horizon of his sphere of labor. He merely sought to do his part, faithful to himself, loyal to his profession, a friend of every student, and every man a student like himself. With the close of his career the continent loses the person of one of its greatest educators, but one who had accomplished so much in the upbuilding of the engineering profession that the personalty behind it all will go down through the ages an archetype of the life of the engineer as it should be lived to do the most good to mankind.

LETTERS TO THE EDITOR.

Concrete Arches.

Sir,—I note with considerable interest, in your issue of June 11th, 1914, the five conclusions drawn from the paper on concrete arches in Proceedings of the American Society of Civil Engineers for Vol. 39, page 1193.

The writer of your article has not referred to the discussion which followed in subsequent numbers of Proceedings. Some recognition of the same should be made, for, in the writer's opinion at least, these discussions, made by the most eminent engineers of the country, are of great value.

As I am at present away from Toronto and have not these numbers of Proceedings with me, I am unable to give names or figures, but the following general discussions are, I believe correct:—

*(1) and (2) are generally confirmed.

(3) This statement is questioned by a large number of engineers. In the first place, there will not be very much more concrete in a fixed rib than in a three-hinged rib, if both are properly designed, and the cost of forms will be very nearly the same. Consequently, the saving in using a three-hinged rib will be only in material, and the estimate should be so prepared. On the other hand, the cost of the hinges is very considerable, and will usually offset, or even outweigh, the saving in concrete.

Secondly—The fixed ring is without doubt more rigid and stable than the hinged ring.

Thirdly—The greater reliability which is attributed to the hinged ring is largely a matter of facility and certainty of design. A fixed ring is susceptible of a very rigid and accurate design, and can be carried to a scientifically fine point. Of course, the labor of designing a fixed arch is somewhat greater than of a hinged arch.

The value of a hinged arch ring is its greater adaptability to small motions of the abutments. But in the general condition of rigid, immovable abutments the fixed ring is generally considered not only better design, but more economical.

Permit me to refer your readers to the last chapter in David A. Molitor's "Kinetic Theory of Structures," which the writer holds in high esteem.

(4) The rib of I-section is not in general favor, since any small settlement which may occur before forms are removed tends to crack off the flanges. (For want of a better word I employ the term flanges, which will at least be understood.)

In addition to this, the extra amount of formwork which is necessitated by this form of arch ring will reduce, or even eliminate, the economy of concrete material.

(5) The value attributed to the form of pier mentioned in the article is also somewhat questioned, chiefly on account of the agitation and obstruction of the current of the stream. This difficulty can, no doubt, be overcome by carrying a solid pier to above high water.

These remarks can be amplified and verified by an examination of the numbers of Proceedings in which these discussions are published. I trust they will be of some interest to your readers.

Ernst G. Kaufmann, C.E.
Schomberg, Ont., July 21st, 1914.

*See *The Canadian Engineer*, June 11th, 1914, page 872.

Improved Roofing Materials.

Sir,—We have read with interest a paper by W. E. King, C.E., published in your July 16th issue under the title of "Economical Design of Industrial Works," and we note therein a paragraph referring to the roof.

We would like to inform your readers that we have had a series of experiments with two styles of roof, which have proven very efficient and permanent. A great many industrial establishments in Montreal and elsewhere in Canada have been covered with a thin slab of fine cinder concrete, ordinary cement mortar, and finished with felt or asphalt material.

The idea of construction is to attach to the roof small shapes for purlins at 5-ft. centres, and to these purlins attach ¾-in. or 1-in. channels at 12-in. centres and transverse, and to these channels apply a 24-gauge expanded metal lathing. To this lathing apply a fine cinder concrete, and when the slab is dry finish the exposed side with a roofing compound and plaster inside with ordinary cement mortar. This makes a permanent roof, and by the use of the two different compounds condensation is reduced to a minimum.

Another very superior style of fireproof and permanent roof is procured by the use of ferro-dovetail plates. The idea is to attach purlins from 4 to 6 ft. centres, and to these purlins attach the plates in the same manner as you would attach corrugated sheets. When these sheets are affixed, cover with cinder or fine stone concrete, applied to a thickness of 1 in. above the plates, and then apply your roofing compound. The underneath side of the plates can then be plastered with ordinary lime mortar, cement mortar or gunite.

The Pedlar People, Limited,
Per W. E. Ramsay.
Montreal, July 17th, 1914.

Two books have been published dealing with the proceedings of the Fifth National Conservation Congress, held in Washington, D.C., last November. One of them treats of Water Power subjects exclusively, and is an important contribution to constructive literature in this subject. The other book contains the Forestry reports and addresses, which were conceded to be the most valuable ever presented at a similar meeting in this country. The books may be had through N. C. McLoud, Treasurer and Recording Secretary of the Congress, 1201 Swetland Building, Cleveland, Ohio.

ENGINEERS' LIBRARY

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

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CONTENTS.

BOOK REVIEWS.

Insulation and Design of Electrical Windings.—By A. P. M. Fleming and R. Johnson. Published by Longmans, Green and Co., London. Canadian Selling Agents, Renouf Publishing Co., Montreal; 224 pp.; 102 diagrams; size 6 x 9 ins.; cloth. Price, $2.25. (Reviewed by Prof. H. W. Price, Department of Electrical Engineering, University of Toronto.)

Relatively there are very few books on insulation which attempt to treat the subject generally. The authors of this volume have offered a valuable addition to this literature, and in it have included a large collection of data in tabular and curved forms on mechanical and electrical properties of insulation for rotating and static electrical machinery. It is difficult to predict with exactness the service to be expected of insulation, because in so many situations it is subjected not only to fairly definitely-known electrical stress and frequency, but also to variable and imperfectly-known punishment or fatigue from mechanical strain in construction and operation, dirt and moisture, overheating, high frequency, etc. Therefore trial and error is largely depended upon for advice. The authors have made many tests to find individual effects of these variables in operating life of insulations, and their results are interesting as an aid toward good judgment in design.

The first three chapters are devoted to an account of physical characteristics of gaseous, liquid and solid dielectrics, the nature and extent of electrical stresses to be met in practical work and properties of many insulating materials when subjected to electrical stress, fatigue from continued over-stress or abnormal frequency, effects of oil and moisture on both electrical and mechanical characteristics, properties when dried out in various ways after abuse, etc. The authors have evidently made many investigations themselves, have also collected data from other sources, and with many curves, tables and discussion, offer a good assembly of information.

A large section is devoted to "design of insulation and windings," insulation tests, etc. Various windings for motors, generators, and transformers are discussed from the insulation point of view, and many sketches are offered showing actual materials and thickness provided for specified service. This information is extensive and valuable, but in view of titles of book and chapter one wonders why no attempt is made to explain how the authors would proceed with their data to choose insulation other than by copy-cut-try methods, which their preface states they desire to make less necessary.

The last two chapters concern drying and handling of windings in factory and in service, and causes of failures in service. Such matters as drying of transformer oil, which have been fully dealt with by others, are given little space. Here, as in several other places in the book, the authors have wisely preferred definite references to their selections from literature now available on the point in question.

Sanitary Engineering.—By Francis Wood, M.I.C.E., F.G.S. Published by Chas. Griffin and Co., Exeter St., Strand, London; 306 pp.; 181 illustrations; size 5½ x 7½ ins.; cloth. Price $2,25 net.

This is the third edition of a practical manual of town drainage, sewerage and refuse disposal. It contains a number of additions covering improvements and alterations, which have developed in the design and construction of sewers, particularly in the application of concrete; also in the ventilation of sewers or oxygenation of the sewage, and other subjects which have been given great attention since the publication of the first edition 13 years ago.

The book contains 20 chapters, the first three of which are of an elementary nature and deal lightly with hydraulics together with formulæ for the velocity of flow in pipes, etc. Following, 12 pages are devoted to a technical consideration of earth pressure and retaining walls. Chapter V. is on power, and a few facts are given concerning water-power, steam, electricity and compressed air. In the reviewer's opinion, the six pages devoted to the subject of power might well have been omitted as the subject matter is so elementary as to be entirely lacking in practical information respecting the subjects mentioned. Mere definitions of horsepower, ohm, ampere, volt, etc., seem quite out of place in a book written specially for the sanitary engineer.

The subject of house drainage has been well and thoroughly treated, both from the standpoint of the urban and rural dwelling. Chapter VII. has to do with land drainage, evaporation, rainfall, etc. The subject of sewers and sewerage systems are taken up in a capable and comprehensive manner in some 70 pages, under the headings of Sewers, Separate System, Sewage Pumping, Sewer Ventilation, Drainage Areas, Manholes, etc. A chapter of 20 pages is devoted to trade refuse and river disposal. The titles of the remaining chapters are Sewage Disposal, Bacterial Treatment, Sludge Disposal, Construction Materials and Cleansing of Sewers, Refuse Disposal, Chimneys and Foundations. The book is well indexed, the illustrations are particularly clear and the whole subject is treated in such a way as to render the book a valuable one to sanitary engineers, architects, inspectors, contractors and students.

Metallurgy of Copper.—By H. O. Hofman, E.M., Met.E., Ph.D., Professor of Metallurgy, Massachusetts Institute of Technology. Published by McGraw-Hill Book Co., New York City; 556 pp.; 548 illustrations; 130 tables; size 6 x 9 ins.; cloth. Price, $5 net. (Reviewed by Geo. A. Guess, Metallurgical Engineer, Toronto.)

To write the metallurgy of copper is unquestionably a difficult undertaking. Progress in the art is so rapid, each year seeing new developments, that a book can hardly be written before new metallurgical features are in successful use.

Dr. Hofman in his "Metallurgy of Copper" has, however, given us a book that is up-to-date, and which covers the field as no other book does. The work is essentially a compilation of the published literature on the metallurgy of copper, supplemented by data obtained from several of the larger American smelters and refineries. The work is clear, concise and free from padding. It is difficult to find anything but praise for the book. If inclined to be critical one might object to descriptions and cuts of roasting furnaces hopelessly antiquated, or of descriptions of smelting operations which recall the days when an air of mystery surrounded the metallurgist. Such a description is given in the smelting in of a reverberatory furnace bottom. Under leaching methods considerable attention is paid to wet processes for treating copper mattes, a practice which is extinct in America. It is to be hoped that, in view of the rapid development of wet methods of ore treatment, the author will rewrite in a year or two his chapter on the leaching of copper ores. The book quite correctly does not deal with any form of wet concentration or flotation. It is written for the profession and the advanced student of metallurgy.

The work is purely descriptive. The author refrains from criticizing furnace or plant design. He states without comment, conditions as they exist, as to equipment of plant, and scheme of operations. He reviews the evidence and leaves the case with his readers.

Practical Iron Founding.—By Jas. G. Horner, A.M.I., Mech. E. Published by Whittaker & Co., London and New York. 409 pages; 285 illustrations; size, 5 x 7 ins.; cloth. Price, $1.25 net.

The principles and practice of iron founding are depicted in this work for the special guidance of the student and of the practical man, relating particularly to the two branches of machine molding and the melting of iron. This is the fourth edition of Mr. Horner's treatment of the subject, and it has been thoroughly revised and enlarged to conform with the great changes which the industry has experienced since the first edition was published. In it the portion devoted to machine molding has been entirely rewritten and new chapters prepared with additional examples of molds introduced. The volume has outgrown the stage of elementary treatise and its value has increased accordingly.

Its scope may be briefly summed up by an enumeration of the subjects of the 16 chapters. They are as follows: Principles; Sands and their Preparation; Iron-Melting and Testing; Cupolas, Blast, and Ladles; The Shops, and their Equipment; Molding-boxes and Tools; Shrinkage, Curving, Fractures; Faults; Principles of Green Sand Molding; Examples of Green Sand Molding; Dry Sand Molding; Cores; Loam Work; The Elements of Machine Molding; Examples of Molding Machines; Machine-molded Gears; Miscellaneous Economics; Weights of Castings.

Foundry workers will find in this new edition a wealth of material quite up-to-date and in keeping with the present stage of iron founding.

Electrical Practice in Collieries.—By Daniel Burns, M. Inst. M.E., Professor of Mining and Geology, Royal Technical College, Glasgow. Published by Chas. Griffin & Company, Limited, London. 353 pages; 207 illustrations; size, 5 x 7 ins.; cloth. Price, $2.00 net.

In this work the three previous editions have been carefully revised and brought abreast with the latest developments of the industry, as well as the alterations of the laws of Great Britain pertaining thereto. Its publication is justified by the increasing of electric power in mines, particularly in the improvements with respect to coal-working machinery.

The book as a manual of information will be found useful, particularly in the author's native country, by colliery managers, under-managers, and students going up for certificates as such. The purely scientific aspects of the subject are ignored with the exception of a portion of the opening chapter, which has to do with elementary details of electric currents and units of measurement. The chapters following discuss the dynamo, the electric motor, and the applications of electricity to lighting, pumping, haulage and coal-cutting, while the closing chapter of over 50 pages deals with miscellaneous electrically-operated appliances of service in mining operations. Several chapters are concluded by arithmetical examples for the benefit of those students who may peruse the volume.

As a work generally descriptive of the application of electrical power with a minimum of technical discussion this book will be found of considerable assistance to those for whom it was especially written.

Elementary Principles of Illumination and Artificial Lighting.—By Arthur Blok, published by Scott, Greenwood and Son, London, Eng. Illustrated; size, 5 x 7 ins.; cloth. Price, $2. (Reviewed by H. W. Price, Associate Professor of Electrical Engineering, University of Toronto.)

For a small book, the treatment given principles of illumination and lighting is really good. The author has not only explained how to attack many practical problems, but has presented here and there actual cases with the solution completely carried out as he would advise.

Chapters I. and II. cover general principles, selective radiation, effect of light color on color of body illuminated, color matching, etc. The meaning of and methods of using in calculations the units of light and intensity are well explained. Only flame standards of candle power are mentioned in detail. One wonders why electric incandescent secondary standards and their proper use are given seven lines only, when a thousand of them are in use in industrial photometry for every flame standard in service.

Chapter III. gives illustrated description of various commercial photometers, followed by four pages of excellent advice on the use of them in field work. Chapters IV., V., VI., devote 60 pages to all sorts of calculations on lighting and illumination. Explanation of each method is followed by examples from practice completely solved as the authors would recommend. Numerous diagrams and tables are arranged to assist the reader. Chapter VII. is devoted to typical distribution curves from gas and electric light sources, and the science of converting these as efficiently as possible to any other form desired by reflectors, globes and shades. Chapters VIII. and IX. are specially upon problems of indoor and outdoor illumination. Examples are included showing how to value actual requirements of practice. The last chapter deals specially with the properties of illuminants.

The book is pocket size, yet it has a complete contents, list of tables, five useful appendices, a list of symbols employed, a reference list of 20 equations used, a cross index, and a list of other authors referred to in the text. Our opinion is that this small book is most useful to any requiring assistance in work on illumination.

Motorcycles, Side Cars and Cycle Cars.—By Victor W. Page, M.E. Published by the Norman W. Henley Publishing Company, 132 Nassau Street, New York. 550 pages; 339 illustrations; size, 5 x 7 ins.; cloth. Price, $1.50.

This book is a comprehensive, non-technical treatise, defining all forms of the lighter self-propelled vehicles, principles of operation, construction and practical operation of components in the leading machines. It contains detailed advice on management, maintenance, and repair of all representative types.

Undoubtedly the growth of the motorcycle industry has created a field for a book of this nature. The motorcyclist has heretofore been obliged to acquire his knowledge by much research and reading because the books on motorcycling have been in the nature of elementary pamphlets rather than works of any pretensions. He will find in the work at present under discussion some very useful material, easily understood and up-to-date.

Memorials of Henry Forbes Julian.—By Hester Julian. Published by Chas. Griffin & Company, Limited, London. 310 pages; illustrated; size, 6 x 9 in.; cloth. Price, $1.50 net.

These memorials of Henry Forbes Julian, a member of the Institution of Mining and Metallurgy of Great Britain, joint author of "Cyaniding Coal and Silver Ores," and who perished in the Titanic disaster of April, 1912, have been written and edited by his wife, the author of a number of widely-known biographical works. In the course of his profession as a mining engineer the subject of these memorials was called upon to travel in many countries, and his prominence in the metallurgical industry resulted in a widespread reputation and recognition. He was one of the pioneers of metallurgical work in South Africa, as well as having taken an active part in the development of mining in Germany, Mexico and the United States. The text affords ample indications of his scientific acquirements, his patient industry and adaptability to varied circumstances.

Clean Water and How to Get It.—By Allen Hazen, consulting engineer, New York. Published by John Wiley & Sons, Inc., New York; Canadian Selling agents, Renouf Publishing Company, Montreal. 196 pages; illustrated; size, 5 x 7 ins.; cloth. Price, $1.50, postpaid.

This is the second edition of Mr. Hazen's book dealing with matters of general policy, pressure, fire service, sale of water, and the financial management of waterworks. The volume describes a number of plants and their methods of operation, to illustrate the principles involved. The second edition contains chapters upon the disinfection of water and the "red water" trouble, as well as a general bringing up to date the treatment of the subject in general. The problems of water supply from large and small lakes, from rivers, and of ground water are concisely dealt with in separate chapters. Chap. 6 is devoted to a discussion of the action of water on iron pipes and the effect thereof upon the quality of the supply, together with an outline of the recognized methods for the elimination of trouble in connection with the same.

The development of water purification in America is historically dealt with in a very concise yet comprehensive chapter. The questions of tastes, odors, coagulation and filters are clearly explained. Chap. 9 deals to some length with the nature of purification methods, classifying the processes into mechanical separation, coagulation, chemical purification, disinfecting processes, biological processes, aeration, and boiling. Chap. 10 deals entirely with disinfection, Chap. 11 with the application of the methods of water purification, arranged according to the matters to be removed by the treatment; Chap. 12 with storage of filtered water; Chap. 13 on the required sizes of filters and other parts of waterworks; Chap. 14 as to the pressure under which water is to be delivered; Chap. 15 on the use of measurement of water; Chap. 16 on the financial aspects of the water supply problem; Chap. 17, the laying out and construction of works, and Chap. 18, on the financial management of publicly-owned water supply systems.

The book is very carefully indexed and will be found useful by engineers and waterworks superintendents.

A Glossary of Road Terms.—By H. Percy Boulnois, M. Inst. C.E., city engineer of Liverpool, etc. Published by St. Bride's Press, Limited, London, England. 71 pages; size, 5 x 7 ins. Price, 50 cents net.

The convenient manner in which this glossary has been prepared will receive an enthusiastic welcome from highway engineers. The author's attempt to standardize the nomenclature of road terms appeared last year in the columns of The Surveyor, London, and has resulted in a number of valuable suggestions and criticisms which the author has subsequently incorporated in his work. The glossary follows closely the road terms of the Engineering Standards Committee, the author taking this step advisedly and refraining from technical and geological terms of various rock materials in use.

Oil Fuel: Its Supply, Consumption and Application.—By Edward Butler, M.I.M.E. Published by Chas. Griffin & Company, Limited, London, Eng. 328 pages; 150 illustrations; size, 5 x 7 ins.; cloth. Price, $2.00 net.

This is a third and considerably enlarged edition, and comprises an exhaustively and systematically classified record of the development and progress made in the application of oil fuel for marine and naval purposes, locomotives, road vehicles, lighting, domestic, metallurgical, and other purposes. The relative advantages of steam, compressed air and mechanical action as an atomizing addition for liquid fuel-burners is treated carefully in thirty pages, which include the results of a number of tests. The technical composition of fuel oils, their thermodynamic properties and a history of combustion methods are each treated to some length, while the origin, production and sources of supply of liquid fuel are dealt with in an interesting and authoritative manner. The production of petroleum in the chief oil-producing countries covering a period of a number of years is also given.

The book will be found of distinct value to engineers and manufacturers who encounter various problems connected with the combustion of oil fuel.

Report of a Plan of Sewerage—City of Cincinnati.—By Harrison P. Eddy, Consulting Engineer; H. M. Waite, Chief Engineer, Department of Public Works, and H. S. Morse, Engineer-in-Charge. 730 pages; plates, maps, diagrams, and tables; size, 6 x 9 ins.; cloth.

This is one of the most complete reports on the sewerage of a city that has ever been published. The general report, of 32 pages, outlines the matter treated and the conclusions reached. The treatment of the development of the sewerage system, an account of the detailed underground survey of the existing system; a topographical survey for future plans; data on rainfall and runoff, the planning of relief sewers, of intercepting sewers and creek mains, and the disposal and treatment of sewage are subjects that are very fully discussed. Although the greater part of it is of purely local interest, there are many theories of general application and matters of similar interest to municipal and sanitary engineers.

PUBLICATIONS RECEIVED.

Annual Report of the City Engineer of the city of Halifax, N.S., for the civic year, 1912-1913.

Labor Organization in Canada.—Third Annual Report for the year 1913, issued by the Department of Labor at Ottawa.

McGill University Calendar, 1914-1915, containing full information regarding all departments and faculties, details of courses, etc.

Proceedings of the Union of Nova Scotia Municipalities at the eighth annual convention, held at Bridgewater, N.S., on August 27th, 28th and 29th, 1913.

Monthly Bulletin of the Canadian Mining Institute.—Edited by H. Mortimer Lamb, Secretary. This bulletin represents the proceedings of the Institute for the month.

28th Semi-Annual Report of the Sewage and Water Board of New Orleans.—This mid-year report consists of brief financial statements and synopsis covering the previous six months.

Notes on Radium-Bearing Minerals.—A 26-page handbook, listed as Prospectors' Handbook No. 1, issued by the Geological Survey Branch, Department of Mines, Ottawa. Compiled by Wegatt Malcolm.

Summary Report of the Geological Survey, Department of Mines, for the calendar year 1912. A 544-page summary of the operations of the Geological Survey for 1912, including the reports of the various officials on the work accomplished by them.

Progress Reports of Experiments on Dust Prevention and Road Preservation, 1913.—Bulletin No. 105, issued by the United States Department of Agriculture, Washington, covering experiments made at Chevy Chase, Md., with supplementary reports.

Year Book, 1913.—Issued by the Swedish Chamber of Commerce in London. The contents include the first annual report of the council, transactions of the year, and various lists, statements and reports; in addition several plans, maps, and full-page illustrations.

Flumes and Fluming.—By Eugene S. Bruce, expert lumberman. Issued as Bulletin No. 87 by the United States Department of Agriculture, Washington. This bulletin discusses the use of flumes in lumbering operations and tells how to build them. Of special value to lumbermen and log-drivers.

Permissible Electric Lamps for Mines.—Written by H. H. Clark, and issued, as Technical Paper No. 75, by the Bureau of Mines, Department of Mines, Washington. This paper deals with safety as a feature of miners' electric lamps, permissible tests, and specifications suggested by the Bureau of Mines for portable electric lamps.

Serpentine and Associated Rocks of Southern Quebec.—Compiled by John A. Dresser. A preliminary report, dealing, primarily, with the economic resources of Southern Quebec, with some attention given also to the petrography and structural geology of the district. Issued as Memoir No. 22 by the Geological Survey Branch, Department of Mines, Ottawa.

Precise Levelling.—By F. B. Reid, D.L.S., and issued by the Dominion Observatory, Department of the Interior, Ottawa. This publication is a continuation of two that have already been issued—Appendix No. 5 to the Chief Astronomer's report for 1910, and the 1913 publication on precise levelling. The present publication is arranged in the same general form, with the results of the levelling set forth in three tables.

Ohio State Board of Health—27th Annual Report, 1912.—Voluminous report, comprising 880 pages. Size, 6 x 9 ins.; bound in cloth. It contains the minutes of board meetings and complete discussions of the subjects taken up. Reports on proposed new water supplies and purification plants for various cities are included. Another section is devoted to reports upon communicable diseases, and another to hygienic laboratories.

Brass-Furnace Practice in the United States.—Compiled by H. W. Gillett, and issued as Bulletin No. 73 by the Bureau of Mines, Department of the Interior, Washington. The bulletin deals with the object and results of an extensive investigation conducted to ascertain the melting and fuel losses on present brass-melting losses, and to indicate, as far as possible, methods by which such losses might be reduced.

Portions of Portland Canal and Skeena Mining Divisions, Skeena River, B.C.—By R. G. McConnell. Memoir No. 32, issued by the Geological Survey Branch, Department of Mines, Ottawa. This memoir includes reports on four neighboring areas, all portions of the Skeena mining district. The main report deals with Portland Canal mining division; the others describe the results of preliminary work in the Salmon River valley, portions of Nass valley, and on observatory inlet.

Tests of Bond between Concrete and Steel.—Compiled by Duff A. Adams, and issued as Bulletin No. 71 by the Engineering Experimental Station, University of Illinois. The tests reported in this bulletin were made in the Laboratory of Applied Mechanics, and formed a part of the investigations of reinforced concrete and other structural materials which were conducted by the Experimental Station. The tests cover the experiments which were designed with special reference to a study of bond between concrete and steel during the period of 1909-1912.

The Tractive Resistance of a 28-Ton Electric Car.—By Harold H. Dunn, and issued as Bulletin No. 74 by the Engineering Experimental Station, University of Illinois. The first part of the bulletin describes the purpose, methods and final results of tests conducted by the Engineering Department to determine the resistance offered to the motion of a 28-ton electric car running on a straight, level track, in still air at uniform speed; and to asertain the relation existing between the resistance and the speed of the car. In the three appendices details are given concerning the apparatus, the methods of calculation, the test data, and the intermediate results.

CATALOGUES RECEIVED.

Merritt Sewage Disposal Apparatus.—A 16-page, illustrated booklet descriptive of the various features of Merritt sewage apparatus. Issued by the Merritt Hydraulics Company, Philadelphia, Pa.

C-E Flow Meters for Measuring Steam, Water, and Air.—Bulletin No. 46501, containing 52 pages descriptive of flow meters manufactured by the Canadian General Electric Company, Limited, of Toronto.

Electric Cable-making Machinery.—A fine, cloth-bound, 84-page catalog descriptive of electric cable-making machinery and accessories. Issued by W. S. Glover & Company, Limited, Manchester, Eng.

Lighting of Business Streets.—A small folder illustrating the adaptability of G. E. ornamental luminous arc lamps for the attractive lighting of business streets. Issued by the Canadian General Electric Company, Toronto.

Small Motors.—A well-written 20-page booklet issued by the Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa., descriptive of the construction, application, and utility of electric ventilating outfits.

Heavy-Duty Corliss Engines.—Bulletin No. 1529, 20 pages, containing a brief description of the more important features of the Corliss engine designed for heavy duty. Issued by Canadian Allis-Chalmers, Limited, Toronto.

Priestman Sewage Pumping Equipment. — A 16-page booklet issued by the Merritt Hydraulics Company, Philadelphia, consisting of a complete description of the Priestman method of sewage pumping, its advantage, cost of operation, etc.

Heat-Treating Furnaces.—A handsomely-illustrated and well-designed 40-page booklet issued by Tate, Jones & Company, Inc., Pittsburg, Pa. This booklet is descriptive of heat-treating furnaces for annealing, hardening and tempering of steel, and all heat-treating operations.

Steel Chain Belt.—Catalogue No. 54, illustrated, 32 pages, descriptive of Chabelco chain belt, manufactured by Chain Belt Company, Milwaukee, Wis. A few pages are devoted to chilled steel sprocket wheels and the application of the two to conveyer systems, paving-mixers, etc.

Tiffin Motor Trucks.—An attractive 24-page booklet issued by the Tiffin Wagon Company, Tiffin, Ohio. This booklet is fully illustrated with fine half-tones, and gives a very complete and comprehensive description of the design, construction, and utility of Tiffin motor trucks.

Recent Developments in Machine Stoking.—A 40-page, illustrated booklet issued by Ed. Bennis & Company, Limited, London, Eng. This booklet gives a complete description of modern machine stoking by the Bennis method. The text is freely illustrated with interesting photographs.

Flushtank Siphons and Water Regulators.—A 16-page, 6 x 9-in. booklet, by Merritt Hydraulics Company, Philadelphia, dealing with water flushing and control, and containing details of construction and operation of the Morse and Merritt flush-tanks, automatic and semi-automatic.

Bermudez Road Asphalt.—A 16-page booklet descriptive of some roads made from Bermudez asphalt and the wide adaptability of the latter. Many illustrations are given of some of the 12,000,000 sq. yds. of these roads in the United States. Specifications for bituminous road-binder are included. Published by the Barber Asphalt Paving Company, Philadelphia.

Gurley Scientific Instruments.—1914 Catalog, 6 x 9 ins., of W. & L. E. Gurley, Troy, N.Y., for civil, hydraulic and mining engineers' and land surveyors' instruments, including transits, levels, compasses, current meters, and all supplies for field and engineering office work. The catalog, which comprises 224 pages, is very carefully and handsomely illustrated, many of the descriptions of instruments being accompanied by full-page plates.

The Exhaust Steam-Heating Encyclopedia.—The Harrison Safety Boiler Works, New York, have issued their new 207-page edition of the Exhaust Steam-Heating Encyclopedia. This unique and beautifully-designed volume contains a complete compilation of facts and statistics concerning the improved Cochrane Steam Stack and Cut-out Valve Heater and Receiver, and its application in connection with commercial systems of exhaust steam and hot water heating. In addition, there is much other information and tables useful to heating and ventilating engineers and contractors. Canadian Allis-Chalmers are the Canadian agents.

Coast to Coast

Deseronto, Ont.—A flow of natural gas has been struck at Deseronto at a depth of 60 feet; and it is stated gives promise of heavy pressure.

Regina, Sask.—It is now expected that the street railway deficit at Regina will amount this year to only half of the estimated amount, which was $100,000.

Ottawa, Ont.—On July 20, the government steamer "Minto" sailed for Hudson Strait and Hudson Bay, to install 12 lighthouses for the protection of navigation.

Owen Sound, Ont.—As an endeavor to solve its paving problem, the council of Owen Sound has authorized the construction of a block of tarred road, as an experiment; and if this proves satisfactory, more of this road will be built.

Leamington, Ont.—It is expected that before fall, the harbor at Leamington, planned by the Canadian Government, will be ready for the use of vessels drawing not more than 26 feet. Soundings are now being made by engineers; and a breakwater will be built 300 feet out in the lake west of the present dock, which will provide a commodious and safe haven during bad weather.

St. Catharines, Ont.—In addition to the question of a water supply which is now being confronted by the town of St. Catharines, there is the question of the effect of the raising of the river level upon the sewerage system of the town. An endeavor is being made at present to solve both problems and to reach an agreement with the Department of Railways and Canals for the defraying of new expenditures that will be involved.

Sault Ste. Marie, Ont.—Such progress has been made in connection with the construction of the third lock at Sault Ste. Marie that it is expected by lock officials that it will be in use by September 1. Water has been turned into the approach at both ends; and only minor touches remain to be given to the entrance channels. The depth of the new lock will be 25 feet. A year later, it is planned to have a new fourth lock ready for traffic.

Montreal, Que.—Due to the fact that more small buildings are being erected and a correspondingly smaller number of large structures are being undertaken this year in Montreal, figures obtained from the office of the city building inspector show that for 1914, from January to June 30, the estimated value of new buildings was $8,521,910; while for the same period of 1913 the value of buildings erected was $9,942,286, or in other words a decrease for the current year of $1,400,000.

Weyburn, Sask.—The laying of steel on the new Weyburn-Lethbridge branch of the C.P.R. has been completed as far as the Alberta boundary line. This work has progressed steadily all summer at the rate of 3 miles per day, leaving only some 80 miles of its 410 miles in length to be completed. A passenger service is already being run from Weyburn to Shaunavon, which it is expected to extend to Covenlock on September 1, this latter point being practically situated on the boundary line between Saskatchewan and Alberta. In addition to the construction work on the Weyburn-Lethbridge line, the C.P.R. is also double-tracking the main line between Regina and Broadview. This work will be completed by September 1, giving a double track run practically all the way across Saskatchewan.

Montreal, Que.—The plans which are to be prepared, and have almost been completed by the architects of the Montreal Harbor Board, provide for a new extension to the No. 1 elevator which will be an almost exact duplicate of the addition which was completed last winter and put into operation this spring. The original elevator had a million bushels capacity, its first extension increasing this by one and a half millions, and the new extension to add a similar amount, so that the two additions will be three times the capacity of the original elevator. This new extension will cost about $750,000, and will be completed for use, it is hoped, by next September. Little beside the elevator itself will be required in the construction. It will be of the same type as the extension at the east side of the original No. 1, with huge concrete tanks to hold the grain, while the machinery in the original elevator will be sufficient to handle the grain in the whole series of bins. When this addition is completed, the Montreal Harbor Board will directly own no less than 7,000,000 bushels of elevator capacity, which will give the Montreal port an elevator equipment of well over 9,000,000 bushels, including the Harbor Commission's 7,000,000, and the Grand Trunk elevators with a capacity of 2,160,000 bushels.

Victoria, B.C.—The first section of tunnel in connection with the northwest sewer construction at Victoria has been completed. The south tunnel from No. 1 shaft, near the outfall, was pierced to meet the drift in from the open cut at McLoughlin point, the connection being made without the slightest difficulty. It will be some time, however, before the tunnel northwards under Smith Street hill will meet the tunnel work being commenced at the outfall point. Preparations are being made for driving tunnel Y, the intention being to drift in from an opening at Sea terrace as well as from the ends. Work in the open trench is also in progress at Hereward road. At the Sunnyside tunnel, where the engineers are working in from Selkirk water, about 270 feet have been completed. This tunnel will be 1,800 feet long. It is the intention to have as much of the open excavation done as possible before the rains of winter. Sewer work is also in progress in the King's road ravine, and at Oxford Street. At the latter place, the collapse of the brick surface drain proved an expensive item; but the worst of the work has been repaired. It is proposed to insert steel ties at each side of the brick work, and brace the sewer, filling in with concrete, in place of the bricks, the base where further danger threatens. It is believed that by that means it will be possible to save a considerable amount of money, and also to secure a drain which will last the lifetime of the paving.

PERSONAL.

A. M. NANTON, who succeeded Sir William Whyte on the directorate of the Canadian Pacific Railway has been elected to the vice-presidency held by Sir William on the Winnipeg Electric Railway Board.

T. R. PERKINS, assistant manager of Toronto branch of the Pedlar People, Limited, has been appointed Western manager, beginning August 1st. He will make Winnipeg his headquarters.

THOS. TURNBULL has been appointed assistant chief engineer of the Canadian Northern Railway, with headquarters in Winnipeg. For the past four years Mr. Turnbull was with the C.P.R. in the West, and with the Hudson Bay Railway, previous to which he was connected with the C.N.R. in Ontario.

A. F. HATCH, formerly president of the Canada Steel Good Company, of Hamilton, Ont., has been appointed general manager and treasurer of the Hamilton branch of the Steel Goods Company, of New Britain, Conn., the latter company having absorbed the former. Operations will be commenced without delay on the erection in Hamilton of an extensive new plant.

ARCH. CURRIE, C.E., city engineer of Ottawa, has tendered his resignation owing to ill-health. Mr. Currie assumed his duties in July, 1913, going to Ottawa from Westmount, Que., where he had been city engineer for two years. Previous to that Mr. Currie had been engaged in municipal work in Great Britain, and in railway work for 12 years in China and 10 years in South Africa. In January last Mr. Currie suffered a severe illness, and since that time, despite his many efforts to attend to civic duties, he has not succeeded in regaining his health.

OBITUARY.

The death occurred on July 19th of Mr. W. N. Allan, a third-year student in mining engineering, University of Toronto, at an age of 26. Mr. Allan was at the time resident in Oakville, Ont., being in the employ of the Ontario Public Roads and Highways Commission, making a survey of the Lake Shore Road between Toronto and Hamilton. Upon noticing a canoe overturn, throwing its occupants into the lake, Mr. Allan swam to their rescue, but death, due to heart failure, intervened. High tribute is being paid to his heroic action, and his untimely death has occasioned much sorrow among his class mates and many others who knew him. Deceased was a native of British Columbia.

COMING MEETINGS.

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

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

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

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

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

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

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

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