PAGES

MISSING

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Dam That Withstood Unusual Service Test

Gravity Section With Very Wide Apron—Rock and Hard Pan Foundation—Work Carried on Through Heavy Autumn Freshets—Severe Ice Pressure—Water Rose Ten Feet Above Crest by Failure of Dam Above

By A. W. THWING
Ambursen Hydraulic Construction Co. of Canada, Ltd.

EMINENT suitability for the work required of it may be claimed for the new gravity dam at Marysville, N.B., a small manufacturing town three miles from Fredericton, on the Nashwaak River. The drainage area of the Nashwaak River above this point is 650 sq. mi., a very small portion of which is controlled by three timber storage dams.

Description of the Dam

The total length of the dam is about 500 ft., consisting of three waste sluices, 375 ft. of rollway, log sluices and provision for future hydro-electric power-house. The rollway is placed diagonally to the axis of the river, and about 100 ft. of this overflow is controlled by stop-log piers placed on the crest, the purpose of which is to control the current leading to the log sluices. A standard fish ladder is provided at the end of the rollway next to the log sluices. The site of the future head-race leading to the power-house is closed temporarily by means of a wooden crib dam.

Nature of the River Bed

About one-third of the length of the dam is founded on ledge rock and the balance on hard pan, composed of firm, impermeable red clay, containing at least 50% of large boulders. A test-pit, dug 14 ft. below the river, showed no rock bottom at the power-house site, and the hard pan at this end was found to be absolutely dry. The river bed was closely overlaid by very large boulders.

Details of Design

Owing to the nature of the bottom and the comparatively low height of the dam, it was decided to adopt a gravity section having a very wide apron to prevent erosion of the river bed below the dam.

The overlying boulders and gravel were first cleaned off carefully to the firm clay beneath, allowing all large boulders which were firmly embedded in the solid bottom to remain in place. This was done both under the dam itself and under the apron. Below this, along the upstream face of the dam, a cut-off trench of a minimum depth of 5 ft. was excavated into the solid bottom and filled with concrete, in which were placed ¾-in. square bars at 24 in. centres to provide for anchoring the body of the dam to the cut-off. The same size bars were used at the lower end of the spillway bucket and out into the apron. Rods were also placed in the concrete laid between the boulders left in place. This provided a very firm anchorage to the river bed, which was very fortunate in view of the events later described. Where the dam rested on solid rock, every particle of loose material was carefully

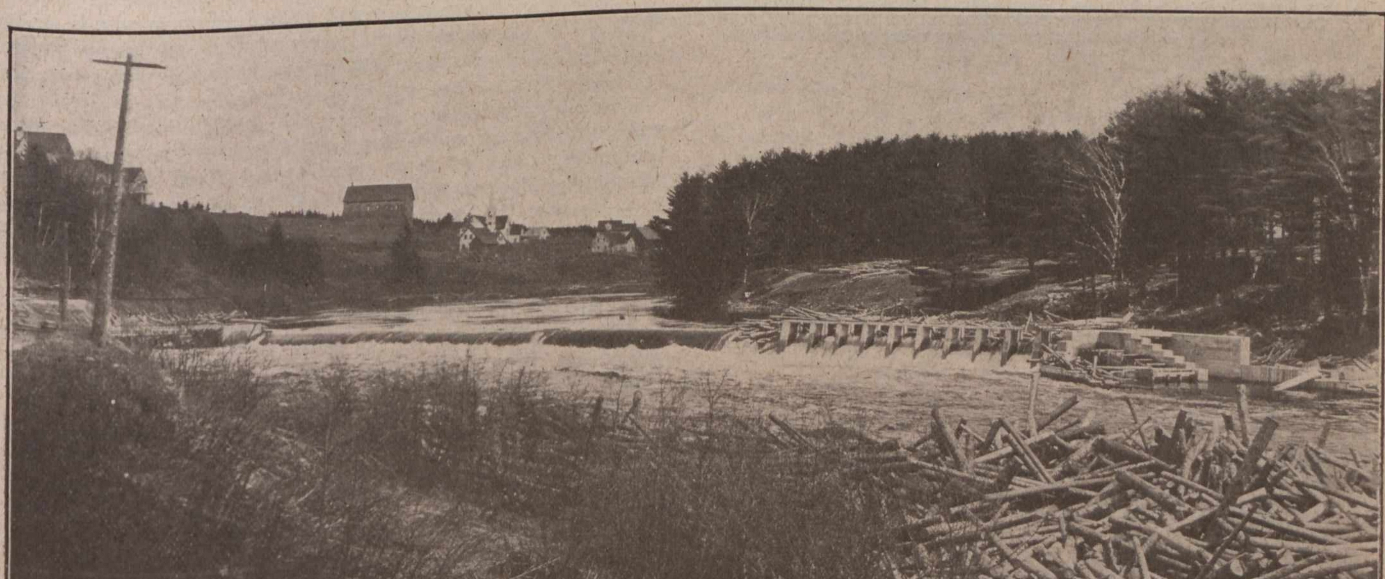


FIG. 1—DAM IN SERVICE SHOWING LOGS PILED UP BY FLOOD OF MAY 9TH, 1920, CAUSED BY FAILURE OF LOG-HOLDING DAM ABOVE

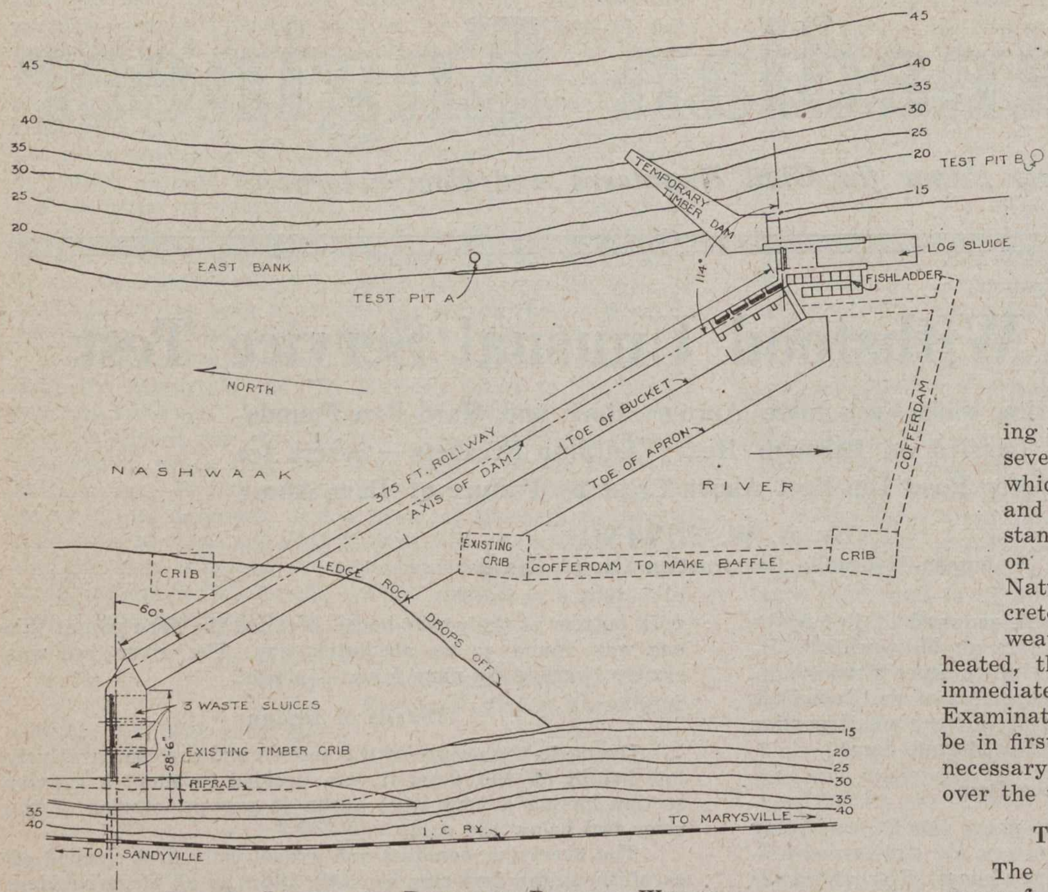


Fig. 2—Layout of Dam and Related Works

Test Pit A carried down to elevation 6.5 showed large boulders in impervious hardpan formation. No indication of rock. Digging discontinued at this elevation. Test Pit B carried down to elevation 3.5 gave results similar to those for Pit A.

removed, providing checks and bonds, in addition to which 1¾-in. diameter dowels were driven 2½ ft. into the river bed and allowed to come 2 ft. up into the concrete, spaced at about 3 ft. centres in each direction.

The construction plant was delivered on the ground and a small force of men put to work in August, 1919, but, owing to legal difficulties, it was impossible to commence actual construction until early in October. This resulted in having to carry the work through during several very severe autumn freshets, which added greatly to the difficulty and expense of the work, but notwithstanding this, the dam was completed on the 22nd of December, 1919. Naturally, a great deal of the concrete work was placed in freezing weather, but all the material was heated, the concrete placed in the work immediately and the forms left in position. Examination this spring shows the work to be in first-class condition, the only repairs necessary being a resurfacing of the floor over the waste sluices.

Test by Climatic Condition

The winter of 1919-20 was the most severe for forty years, and, due to the unusual amount of ice causing steady pressure during the winter and heavy shocks during the spring floods, the stress on the dam was very severe.

In addition to this, on May 9th, 1920, a log-holding dam and piers broke some distance up the river, releasing five to ten million feet of logs, which piled down over the dam, completely blocking all the sluiceways and part of the rollway, so that the water raised 10 ft. above the crest, double the overflow it was designed for. The dam passed through this test without any damage whatever.

This structure was built by the Ambursen Hydraulic Construction Co. of Canada, Ltd., for the Nashwaak Pulp and Paper Co., Ltd., of St. John, N.B. Hon. N. M. Jones, president; Sidney M. Jones, engineer, and Hardy S. Ferguson, consulting engineer.

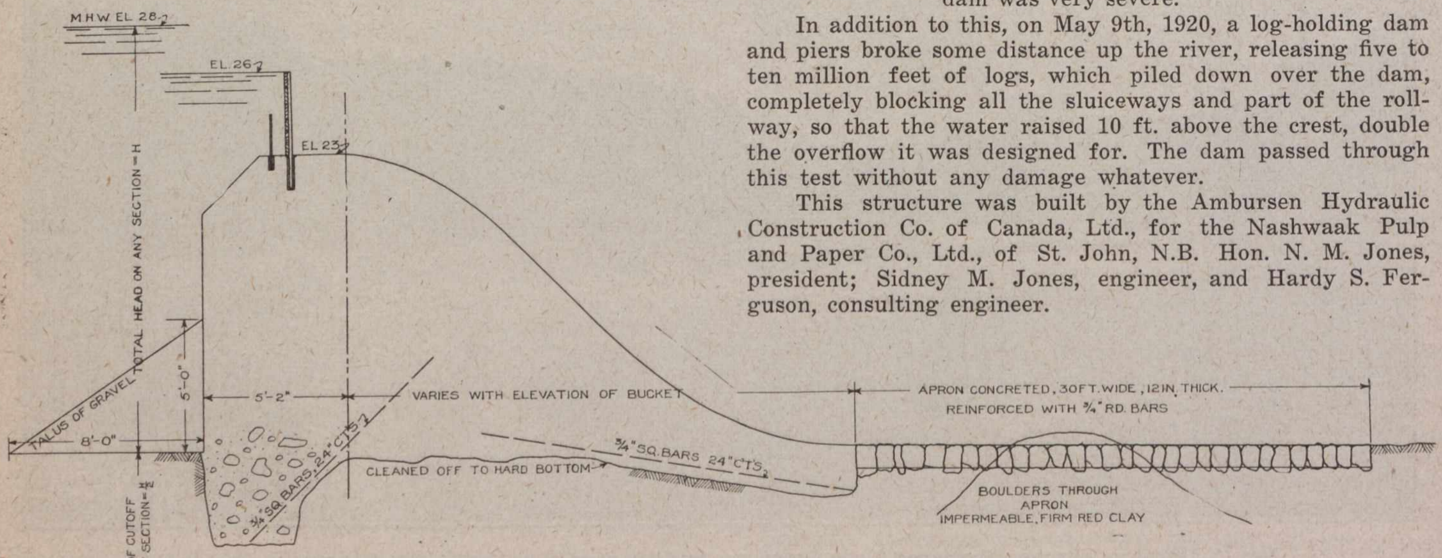


Fig. 3—Section of Dam—Note Very Wide Apron

A subscriber is anxious to obtain copies of our issues for January 23rd, 1919, and April 10th, 1919, for binding purposes. Any reader sending in these copies will have his subscription extended one month.

National ownership of the Edmonton, Dunvegan and British Columbia Railway is a decidedly remote possibility, according to Premier Stewart, of Alberta. Instead of the federal government purchasing the system, as was semi-officially announced by Sir George Foster some months ago, a movement is well under way in the east, it appears, to reorganize the E.D. and B.C. company, and thus bring in sufficient capital to put the road in good shape for traffic and take adequate care of the business at hand.

Having completed the investigation of conditions as far as the present water supply of Moose Jaw is concerned in the rural districts, from the Saskatchewan River to Yellow Grass, the commission appointed by the provincial government in connection with the Saskatchewan River water supply scheme for Moose Jaw, Regina and the intervening country between these cities and the river, is now securing further information from the two cities and the C.P.R., C.N.R. and Grand Trunk Pacific Railways. This will complete the investigation of present water supply conditions and future requirements, and the members of the commission are now in a position to proceed with a design and estimates to conform to these conditions.

The Value and Application of a Traffic Census*

Meaning of Traffic Census—Limitation of Value of Such Census—Application to Construction—Some Purposes of Census—Traffic Census in Ontario—Some American Results—British Results—Traffic Regulation—Definite Data Needed

By W. A. McLEAN
Deputy Minister of Highways, Ontario

ROADS should be built for the traffic they are to carry. This is an axiom of road building which cannot be too strongly emphasized; but which by many road authorities has been met in a hazy, experimental manner, and without proper consideration of probable traffic; and the quality of wearing surface, its width, and the strength of foundation adapted to anticipated traffic. As a result, we find single-track gravel roads where double-track roads, or a concrete pavement should have been built; and conversely, asphaltic pavements are rolling and disrupting in idleness where a good gravel roadway would better have served every purpose.

It follows, then, that adequate information as to traffic is desirable as a rational basis for designing the road or pavement which is to serve any given location; and as a basis for determining whether an expenditure of $1,000, $10,000 or $50,000 for any given work, would be justifiable.

Meaning of Traffic Census

What is a traffic census? On the parallel of a census of population it might mean a complete summation of traffic passing over all the highways of a county within a lengthy period, including the number of vehicles, passengers and amount of freight. Such data would, no doubt, be very useful, but so far as the writer is aware, a census of traffic on such a scale has not been attempted. The term usually signifies an enumeration of the number and kind of vehicles passing a given point on a highway in a limited period of time—a day or a week or a fortnight; and generally omits as unimportant, the night travel. The census may be limited to one highway, or may include a series of highways; and may be at regular or irregular intervals.

Limitations of Value

The value of traffic census has limitations which are at once evident. Thus, the amount of traffic which will pass over many roads after construction, may bear little relation to the traffic over the unimproved road. In such cases, it is the potential traffic of a district which should be considered, rather than existing traffic; but definite data, obtained from actual count, is of use in determining the probable traffic which the improved road will be called upon to carry. Thus on the Toronto-Hamilton highway, traffic amounted to from 300 to 700 vehicles at various points; but with the completion of the concrete pavement, these figures leaped to 2,500, between the hours of 7 a.m., and 7. p.m.

The potential traffic of a district, preceding the construction of a road, is a matter for careful estimate; just as probable traffic for an electric or steam railway may be based on the population and industries served. A somewhat interesting series of charts was published in the report of the Ontario Highway Department for 1915, a net result of which was to show that not less than 80% of the traffic of the province is carried by 20% of the highways; that 80% of the roads are but lightly travelled, and are such as can be adequately built with a single track of gravel or broken stone. Also that few roads serving a purely rural population would be required to carry a maximum of traffic much in excess of an average of 200 vehicles a day.

*Read at Seventh Canadian Good Roads Convention, Winnipeg, June 1-3, 1920.

Traffic in excess of that amount, except adjacent to the largest cities, may usually be attributed to inter-urban influences.

Application to Construction

Knowing the potential traffic of a district, the highway engineer turns to data of the carrying capacity of various types of road and pavement—a matter in which there is room for much diversity of result. For example, limestone gravel has less wearing capacity than a gravel from trap or granite. The foundation, and subsoil have a decided bearing on the case. Roughly, and with scope for such modification, the wearing capacity of various materials as used in Ontario, may be broadly gauged from the following schedule:—

	Single-horse.	Two-horse.	Light Trucks or Passenger Cars.	Motor Trucks.	Total.
Single-track gravel ..	40	15	20	..	75
Double-track gravel ..	50	50	100	5	200
Water-bound macadam (single track)	50	30	40	..	120
Water-bound macadam (double-track)	90	50	100	10	250
Double-track gravel, oiled or tarred	175	75	400	10	660
Double-track macadam, oiled or tarred	200	150	600	10	1,000
Macadam penetration, bituminous	200	300	1,000	50	1,550
Macadam foundation, bitumnions concrete.	200	400	2,300	100	3,000
Bituminous concrete on cement concrete foundation	200	400	4,200	200	5,000
Cement concrete	200	200	4,400	200	5,000

Some Purposes of Census

Among the purposes which traffic census may serve are the following:—

1. To determine the traffic importance of one road as compared with another in the same system, and thus to differentiate between different roads as to community value. This data may be useful in laying out a system, especially with a view to granting government subsidies.

2. To determine the traffic value of the same road before and after improvement. Such information is useful in determining the economic value of highway improvement.

3. To determine the increase of traffic on the same road during a period of say five years, by two different censuses. Such data is useful in anticipating future increase in highway travel.

4. To determine character of traffic, whether farm, local between centres of population, or tourist, and thus to arrive at a fair distribution of cost.

5. To determine respective percentages of horse-drawn, passenger car, and motor truck traffic, and by comparing previous censuses to estimate future changes with a view to adjusting type of construction.

6. To determine total gross tonnage passing over a fixed point for a period of 12 daylight hours, in conjunction with the speed at which this tonnage travels, useful data in determining:—

(a) Amount of wear, including impact and displacement resistance sustained by a certain type of roadway, comparing this with maintenance charge per year; (b) whether such roadway is economically fitted to bear this gross tonnage.

7. To determine the importance of various phases of traffic, and therefrom determine the loadings and speeds which should be permitted; viz., for purposes of traffic regulation.

Traffic Census in Ontario

The first census in Ontario was taken between October 15th and November 15th, 1913, at 20 stations on representative county roads, a large number being now part of the provincial highway system. The count was taken for seven consecutive days from 7 a.m. to 7 p.m., and classification of vehicles was divided into: 1 horse light; 1 horse heavy; 2 horse light; 2 horse heavy; motor runabouts; touring cars; and motor trucks.

Enumerators were provided with a card for each day with columns for each 2-hour period; for each of the above classes of vehicle a space was provided. The method of recording was by making one tick for each vehicle. These ticks were added and checked by the inside staff of the department. The conditions of roads and weather were specified. Owing to the choice of a period when traffic was particularly light, a minimum traffic census was thus obtained.

A second census was taken at the end of July and the beginning of August, 1914, at 210 stations on roads radiating from 21 cities, for seven consecutive days from 7 a.m. to 7 p.m. The classification of vehicles was the same as in the first census, the condition of road and weather being described. Additional information, bearing on local industries and pecularities of traffic, was also secured.

Censuses for certain localities were taken in 1915, on Dundas Street just west of Islington; in 1917, on the Lake Shore Road just east of Mimico; and in 1918, at several points on the Queenston-Grimsby highway and Dundas Street.

Some American Results

In Massachusetts, a traffic count has been made at three year periods since 1909. The actual count is made for 14 hours a day (7 a.m. to 9 p.m.) for seven consecutive days in August, and seven in October. The count is also made at night at a few important points so as to cover the whole 24 hours. The classification is divided into light and heavy horse-drawn vehicles, automobiles and light trucks, and heavy trucks. The following is a table of assumed weights:

Runabouts	1.45 tons
Touring cars	2.23 tons
Trucks	6.25 tons
1 horse, light	0.36 tons
1 horse, heavy	1.12 tons
2 or more horse, light	0.54 tons
2 or more horse, heavy	2.46 tons

The result of the census shows the percentage of each class and the percentage that each class is of the total traffic.

Thus in nine years the total average daily traffic on roads has increased 243%, the total motor traffic has increased 661%, while in six years' time the number of heavy trucks has increased 341%.

In Iowa an interesting census was made in 1917 by the Engineering Experimental Station of Iowa State College from seven to ten days. Scales were set up covering one-half of the width of the road; a huge sign was put across the road, and the driver of every car was halted and interrogated. This census enabled the state to ascertain:—

1. Total number of vehicles.
2. Character of traffic, whether farm, interurban or tourist.
3. Percentages of horse-drawn and motor vehicles.
4. Tonnage of traffic.
5. Width and charatcer of tires.

In ten days in June, 1917, near Ames, Ia., on Ames-DesMoines Road, there passed a total of 1,995 vehicles, of which 647 were farm traffic, 1,227 interurban and 121 tourist. These vehicles carried 1,561 passengers, and weighed 4,919,456 pounds gross. Of the total number of vehicles, 1,752 were motor vehicles and bicycles, and 243 were horse-drawn. The exact basis of farm and interurban traffic was difficult to determine, but it was considered that farm traffic included traffic originating or terminating at the farm, or doing business in passing, e.g., mail. Thus 32% was farm traffic, while 84% was local, i.e., between Ames and DesMoines.

Some American cities favor three enumerators at one station: one man to call out classification, the second to mark down the tick, and the third as relief man. This allows for a continuous count to be made in shifts, one man resting.

British Results

In the United Kingdom methods may be illustrated by a traffic census on the roads radiating from Stirling, Scotland, taken in August and September, 1914, covering sixteen hours a day (6 a.m. to 10 p.m.), for seven consecutive days. An assumed average weight was given to each type of vehicle, and, the width of carriage way being given, the total weight in tons per yard width was ascertained. This assumed weight differs very little from that used in the Massachusetts censuses. The British Road Board Traffic Form is followed, and each traffic enumerator is provided with a small sketch plan to show the exact spot where census is taken.

In London yearly censuses are taken on such thoroughfares as Fleet Street and Putney Bridge for twelve daylight hours on one day, and are chiefly used for determining density of traffic rather than wear to pavement.

Traffic Regulation

Traffic regulation, it has been suggested, is a matter in which traffic data may be of service. "Build the road for the load" is advice commonly heard. As a phrase it has a sound that appeals. That is, they tell us not to limit the load; but to put an unlimited expenditure into the construction and maintenance of the road. If any unlimited load can destroy or injure a road, it is to be taken as evidence that the road, and the man who designed it, were at fault. In British Columbia a case was recently in the courts, in which damages were sought for the destruction of a concrete pavement. A lumberman had put a stick of timber weighing forty tons on a truck, and had broken every slab of concrete pavement over which the load passed. This lumberman, no doubt, held the view that "the road should have been built for the load!"

Truck owners in Ontario have told the speaker of instances in which their vehicles carrying ten or twelve-ton loads, particularly in the early spring, have made ruts four to six inches deep, and ten to twenty miles long, in a single trip over a gravel or macadam road. This information has been imparted by the truck owner cheerfully, and evidently without realization of the thousands of dollars of injury which they have done to make fifty dollars or less. The attitude of the truck owner when considering a trip over the country roads is apt to be merely one of, "can we get through?" Damage to the road in so doing is a matter which has not been brought to his attention. Light traffic is largely a question of durable surface, with sufficient foundation to resist minor, but frequent strains of impact. Heavy truck traffic demands not only a durable surface, but heavy foundation.

The maximum weight of load is an important factor, and one which must be determined before the highway engineer can reasonably be asked to design the roadway. Recent legislation in Ontario has limited the maximum weight to 12 tons, including load and vehicle, with 4½ tons on any wheel, and 650 pounds per inch of tire. During the months of March and April, the load for a motor truck is limited to one-half the carrying capacity of the rated vehicle.

Definite Data Needed

Highway design, as previously stated, is necessarily based on traffic. Traffic data, and information as to the behaviour of various details of design under different ranges of traffic, are, therefore necessary to scientific and rational design. Highway transportation is in a condition of flux, and an immense growth may be anticipated in the next decade. Much data of value in road design is now available, but engineers and road authorities can render this work a valuable service by assisting in the task of accumulating definite results, in order that "trial and error" methods may finally disappear from this important branch of public works.

ROAD MACHINERY*

By Arthur H. Blanchard
Professor of Highway Engineering, University of Michigan

UNDER the general title of "Road Machinery" will be discussed the various machines used in grading operations, and in the construction and maintenance of earth, sand-clay, gravel and broken stone roads. The purchase of an ideal road machinery equipment will be justified, and is usually advisable, if the work is to be extensive in character. As a fundamental economic principle, maximum use should be made of time and labor saving machinery, due espeoially to the high cost and scarcity of common, as well as skilled labor.

General Types of Machinery Employed

Before purchasing a special type of machine, which has been designed with a viewpoint of reducing to a minimum the cost of a certain class of grading or construction, the probable scope of work to be carried on by a department or contractor should be analyzed to determine if the amount of one kind of grading work or construction will warrant the purchase of the special machine, or if, in the long run, such work should not be done with more ordinary types of machines at a slight increase in cost.

Depreciation charges on plant equipment always should be given careful consideration prior to the purchase of machines and accessories as well as in estimating the cost of highway work. The larger types of grading machinery usually must be used for a considerable percentage of the working season, as otherwise such overhead charges as interest on first cost, cost of housing or storage, etc., will be prohibitively high when applied to the cost of a unit of grading on a given piece of work.

If an organization does not include men who are specialists in the manipulation of complicated machinery, or if skilled labor is not economically available, simplicity of machines and ease of manipulation should be given great weight in the selection of equipment. For example, common labor may efficiently perform grading work with scrapers, shovels, wagons, etc., while skilled labor will be required to operate a steam shovel or an elevating or traction grader. Again, graders may be hauled by animals driven by ordinary labor, while, if traction engines are employed, skilled labor must be utilized.

The following paragraphs will be devoted to brief descriptions of the various machines used in grading operations and in the construction and maintenance of roads, to methods of operation, and to comments pertaining to their efficient use.

Carts and Wagons

A one-horse tip-cart is generally built with two wheels, the body of which tips over the axle in discharging its contents. The bodies, without side-boards, have a capacity of about 21 to 24 cubic feet. Two-horse tip-carts are operated on the same principle, but are built on four wheels and hold about 1½ cu. yds. of material. Patent bottom dump-wagons are made in 1, 1½, 2, 2½, and 3 cu. yd. sizes. The bottom of the wagon is made up generally of two leaves, hinged either to the sides or to the ends of the box. The doors are held in place with chains which are wound up on a windlass, operated by the driver. To dump the load, the driver with his foot kicks a release lever and the doors fly open, thus discharging the load. The doors are closed by the driver turning the windlass. While the body of the wagon is generally made of wood, the bottom doors are sometimes made of wood and sometimes of sheet-iron. One of the doors is usually provided with a lip, which overlaps the joint formed by the doors, and thus prevents the material from sifting through.

Plows

The grading plow is so made that a furrow may be turned over to the left or to the right. An ordinary grading plow will make a furrow about 10 ins. wide and from 6 to 10 ins. deep. For breaking up hard-pan, or other stiff material, a rooter plow is employed. A plow of this kind is generally pulled by a steam roller or a tractor.

Drag Scrapers

A drag scraper consists of a pressed steel bowl to which a bail and handles are attached. They have capacities from 3 to 12 cu. ft. This form of scraper wears out rapidly on its cutting edge and on the bottom particularly when working in hard-pan or gravel. A drag scraper is usually drawn by one or two horses. To load, a man grasps the handles and pushes the cutting edge into the loosened earth as the scraper is pulled along. Then the full scraper is dragged along on its bottom to the point of dump, where either the driver or a dump man takes hold of one or both of the handles and lifts the scraper so that it turns upside down about its cutting edge.

Wheel Scrapers

A wheel scraper is similar in shape to a drag scraper, but the bowl is fixed to two wheels fitted with a pole and is usually drawn by two horses. They have capacities of 9 to 18 cu. ft. Scrapers with four wheels are also manufactured. A wheel scraper is operated as follows: as it is pulled through the plowed material in its lowered position, a man grasps the small handles at the rear of the bowl and tilts the bowl so that the cutting edge engages the earth. When the scraper is full, he pulls down on the long lever at the rear, which raises the bowl from the ground.

Buck Scrapers

This type of scraper is also known as a Fresno Grader. It consists of a bowl or scoop resting on runners. It is generally drawn by four horses, and loads and dumps in the same manner as described for wheel and drag scrapers except that it rests on runners while being dragged into position for reloading.

In ordinary grading operations, drag scrapers have been used for lengths of haul up to 200 ft.; wheel scrapers for hauls between 200 to 600 ft.; and for lengths of haul above 600 ft., wagons have been employed.

Road Graders

The 4-wheel machines have blades from 7 to 8 ft. long made up of two parts, a cutting edge and a mold board. By turning large wheels located above the operating platform, the blades may be tilted at any desired vertical or horizontal angle. In using a road grader, a cut is first made at the edge of the ditch using the point of the blade. On the next round the blade is lowered to a flatter angle and the earth is moved along the blade to the centre of the road. By making several rounds with the grader in this manner, the roadbed is crowned up at the centre. To smooth out the roadbed, the surface is first thoroughly harrowed to break up the large lumps and then the grader is drawn along the road with the blades set at right angles to the centre line of the road.

Elevating Graders

The principal parts of the elevating grader are the plow, mold board and the elevating belt. The mold board back of

---

*Read at Seventh Canadian Good Roads Convention, Winnipeg, June 1-3, 1920.

the plow is shaped so as to deliver the furrow of earth to the elevating belt with as little loss as possible. For heavy work, the grader requires 12 horses, 2 drivers and 2 operators on the machine, who operate the various levers controlling the movements of the plow and belt. In many cases a traction engine is used in place of horses. The grader, as it moves along, plows up the earth, which is thrown onto the elevating belt and discharged over its end, either onto the road or into wagons.

Steam Shovels

A portable revolving steam shovel has proved very efficient in highway grading operations. This type of steam shovel has been used for excavating earth, hard-pan and small boulders. It may be used on cuts varying from 6 ins. to many feet. It is generally employed to excavate and load material into wagons.

Road Drags

These machines are used for finishing the surface of subgrades, earth, sand-clay and gravel roads and for the maintenance of the types of roads mentioned. One of the simplest and cheapest forms of road drags is the split-log drag. It is a home-made tool, but is extremely useful in maintaining an earth road, and is to-day preferred by many to the steel drag. A dry red-cedar log is best, although red elm, walnut, box elder, soft maple, and willow make good drags when thoroughly dry. A log should be from 7 to 8 ft. in length and from 10 to 12 ins. in diameter. The log is split as nearly in half as is practicable, and the heaviest and best slab is used for the front log. The logs are braced together. The diagonal brace at the end runs from the middle of the back log to within 1 in. of the bottom of the front log. An iron strip is fixed at the ditch end. It projects ½ in. below the lower edge of the slab at its outermost extremity and is flush with the slab at its other end. If the front log stands plumb on the face, the iron strip may be wedged out, or if the log has a wind in it, this may be taken advantage of in giving the iron strip a pitch. A platform of 1-in. boards is placed over the cross braces on which the driver stands. The boards of the platform are fixed about 1 in. apart to allow any dirt that comes onto the platform to sift through onto the road again. The chain is put through the middle of the log at the ditch end and passed over the top of the log at its other end and fastened to the brace. This allows the dirt to pass underneath the chain as it runs from the ditch along the log to the centre of the road.

A plank-log drag is built in a similar manner to the split-log drag except planks set on edge are used in place of the split-logs, the planks used being 10 to 12 ins. wide and 2 to 4 ins. thick. Lap-plank drags are used for smoothing up a road where only a small amount of material is to be moved.

Various forms of steel road drags are now manufactured, which have about the same over-all dimensions as the split-log drag described above, the logs or planks being replaced by angle irons or steel plates placed on edge. They weigh considerably more than split-log or plank drags, and for this reason are not preferred by some. Steel drags are often equipped with a lever by means of which the blades can be tilted at any desired angle. Some steel drags are made with three parallel blades instead of two and are provided with braces, which, when the drag is turned upside down, serve as runners on which it may be drawn from point to point.

Operation of a Road Drag

In operating a road drag, a team is hitched to the chain so that the drag will be pulled along the road without a load at an angle of about 45 degrees with the centre line, the ditch end always being ahead. If it is desired to make the drag cut deeper, the chain should be lengthened, as it is obvious that the nearer the team is to the drag, the more the tendency to lift it from the ground. The driver generally stands on the drag when working, and by shifting his weight from one end to the other causes the drag to cut into the soil or to drop the soil being carried along by it. To cut he shifts his weight mostly on the front runner towards the ditching end; to cut light he shifts his weight towards the rear runner; to drop the earth carried along into a depression he suddenly shifts his weight to the rear and towards the end of the drag nearest the centre of the road. Some of the steel drags are so heavy that they cannot be operated in this manner, and hence are not so adaptable to the work.

Rollers

Horse, steam and gasoline rollers are employed for the compaction of embankments and roads of earth, sand-clay, gravel and broken stone.

Horse Rollers

A horse roller is generally made with one large roller having a face of about 5 ft. and a diameter of about 5 ft. Any weight desired from 2½ to 5½ tons, varying by 1 ton, can be obtained. Additional weights may be placed in the boxes at either end of the frame and the weight be thus increased by 1 ton. The roller is made of steel or cast iron. An essential feature of a horse-drawn roller is to have it reversible, so that it can be drawn in either direction.

Three-Wheel Rollers

Three-wheel rollers vary in weight from 10 to 20 tons. The majority of rollers of this type are run by steam, although there are a few makes which are run by gasoline engines. Rollers are generally furnished with a high and low speed. The low speed is used in rolling embankment, subgrade, telford, etc., while the high speed is used in finishing the surface or in travelling from point to point.

Scarifiers

These machines consist of a heavy cast-iron block on two or four wheels which hold a series of steel picks. The blocks weight about three tons and the picks can be adjusted in the blocks or the blocks themselves arranged, so that any depth desired up to 5 or 6 ins. can be picked up. The picks are arranged in either a straight line or in two lines which, together, from a V. Most of the scarifiers are so designed that it is not necessary to turn them around. This is accomplished generally by having two sets of picks, one set being used when the machine runs in one direction, and the other when in the opposite direction. Scarifiers of this type are towed by a chain hitched to the roller. The arrangement of the picks and the form of the blocks vary, but all of the machines work on the same principle. Scarifiers are of particular value when used in connection with the resurfacing of roadways of gravel or broken stone.

PROPOSED NEW NAME FOR ACTIVATED SLUDGE

AMONGST those engineers who have to do with the treatment of sewage there is developing a deal of discussion concerning the suitability, or lack of it, of the term "activated sludge." "The Municipal Engineering and Sanitary Record" recently offered a premium for the best suggestion for a substitute name—one that would be more descriptive and less awkward—and the prize was awarded for the name "forced aeration." Whether any new name proposed at this somewhat late date will be generally adopted is doubtful. Terms become fixed and ineradicable in a surprisingly short time.

A bill has been prepared for presentation to the New York State Legislature providing for a bond issue of $15,000,000 that will necessitate a referendum next fall. If successful, this will enable the state to proceed with hydroelectric developments in the Niagara Gorge calculated to generate 165,000 h.p. and relieve industries in the western part of New York State. The program proposed by Conservation Commisioner Pratt provides, among other things, for the restriction of diversion rights, for the limitation of diversion rights at Massena and the Little Sault on the St. Lawrence River, with ultimate developments there.

Education of the Highway Engineer*

Demand for Well-Trained Highway Engineers — Civil, Mechanical, Electrical and Chemical Problems — Strategical Planning — Executive and Administrative Requirements — Recruiting Future Highway Engineers — Highway Engineering Courses — Value of Practical Experience

By BRIG.-GENERAL C. H. MITCHELL, C.B., C.M.G., C.E.
Dean of the Faculty of Applied Science and Engineering, University of Toronto

SUCH prominence has been given to the development of our highways that these are now amongst our most important public utilities. With the greatly increased activity in the construction of highway systems, whether municipal, provincial or national, we find ourselves examining into our preparation and our facilities for the carrying on of these highly necessary and important undertakings. In this preparation we are beginning to realize that provision for adequate engineering, with its many branches, stands much in need of attention from all of us who are concerned in these utilities, and we realize that if we are to proceed along sound lines for highway development we must be assured that a sufficiently large number of trained engineers of the several types required are forthcoming to carry on the work in its various phases. Too much importance cannot be attached to the quality and training of those who are to be intrusted with the engineering of our highways.

Demand for Trained Highway Engineers

As we look forward to the future of highway engineering for the next decade or more, we can see that there will be a very considerable demand from all parts of the country for engineers trained in these various branches, and, when the diversified form of engineering is considered, we realize at once that the field to be supplied is larger than at first appears.

There was a time, not many years ago—and most of us can remember it—when in regard to policy, construction and financial aspect, our highway undertakings were altogether different from those of to-day. In those days it was thought that but a small portion of the work lay within the province of the engineer, and, as a consequence, but few engineers were engaged in highway work. But this has changed. The development of province-wide programs of road-building, the demand for permanent roads of a high class, the employment of materials of road construction as various as the regions in which they are built, the inclusion in every project of numerous interconnected problems of engineering concerned with other public works, and the introduction of motor transport on a scale hitherto unthought of, have all brought about increasing demands for technically-trained men, whether we call them highway engineers or not, who are thoroughly essential not only to the construction of good roads, but to their efficient and economical maintenance.

Wide Experience Necessary

To those actually engaged in the larger construction of highways in our municipal, provincial and national programs, the necessity for wide experience on the part of their engineers must be increasingly apparent, and it is more than ever essential that their particular fitness for the various special branches of engineering should be assured.

The diversity of these various branches or special kinds of engineering which are now included or necessary to the broad subject of road-building is not fully appreciated by the public, nor, indeed, by but a few of those outside of the technical services engaged in the work itself. There was a time when a road or highway was just the roadway itself, so far as the engineering is concerned, and it was treated in this light, and roads were built or grew, and were maintained, if at all, with the employment of the simplest engineering methods or the application of but the most elementary principles of applied science. But nowadays, like all other similar undertakings, the complexity of to-day's requirements and life has laid a much greater burden on those who are charged with the carrying out of the technical side of highway construction.

For instance, we naturally think of highway work as a branch of the broad subject of civil engineering; and so it is. But when one considers at length the various features involved, not only in the actual road-building, but the closely-related problems which accompany it, it is found that, as an engineering question, the so-called specialty embraces many features of other branches of engineering, such as mechanical, chemical, and even electrical, with all of which the well-informed and broadly-trained highway engineer should have no small acquaintance.

Qualifications for a Highway Engineer

It is not sufficient that the civil engineer engaged in highway construction should have a good experience and ability in land survey work, topography, cross-sectioning or mapping, or skill in the location and the balancing and computation of quantities involved in excavations and embankments, or in grades and drainage, or in foundations, or aptitude for the patient and laborious attention to office detail which goes with a well-organized engineering staff. But he must also have a degree of experience in the design and construction, perhaps even to the extent of being an expert in steel and concrete bridges and culverts, in retaining walls and those many concrete structures incidental to roads of all classes. To consider the subject broadly, he must be also a student of meteorology, and understand the climatic conditions and their effects, and he must know something of geology, and even of petrology, where so concerned with the qualities of road metals. If he is concerned with paving and roads and streets in closely-settled areas, he has a highly-specialized field before him in the study of the sources, properties, preparation, construction, behavior and maintenance of all kinds of paving materials, from gravel and stone to wood and asphalt. But that is not all, for he must be prepared at all times, where building such roads and streets, to deal with the continuously occurring problems involved in taking care of water pipes and sewers, of street railway tracks, of railway crossings and their protection and operation, and of the increasingly difficult electric line crossings, whether telegraph, telephone or high-tension electric power lines.

Mechanical, Electrical and Chemical Problems

But the engineer in this work, if he is to be really up to it, must be more than a civil engineer, for, as pointed out, he must have a knowledge of mechanical and electrical and chemical work as well to follow the present-day progress. Not only must he be conversant with the underlying principles of traction, but he must have a practical working knowledge of the mechanical and electrical machinery and equipment used in the processes of manufacture and preparation of materials and in the construction of roads. The varieties of such equipment, with the machinery, for instance, of handling materials in excavation, quarries, sand and gravel pits, and in the preparation of them by crushers and screens or the machinery used in construction, concrete mixers, road rollers, asphalt, tar and similar plants, are in themselves such important factors in road-building as to demand close

*An address given before the Seventh Canadian Good Roads Convention, Winnipeg, June 3rd, 1920.

attention and knowledge on the part of the engineers. But there is the other phase of the mechanical of which the road engineer of to-day must have more than a passing knowledge. He must know the various principles of operation and control of motor transport of all kinds, from the touring motor car to the freight lorry, and their effect upon his roads in all seasons, and with the activities of the manufacturers of to-day he must also keep up with the rapidly-changing types of steam, oil and electric vehicles.

The co-ordination necessary for electrical work in connection with streets and highways has already been indicated as to line crossings, but it is no small matter in congested areas to deal with the complicated problems of electrical conduits in the roadbed, overhead wires, electric lighting arrangements and the vexed questions of electric railways and their maintenance with regard to the roadbed.

So with the chemical side of the work. There must be for the future a larger proportion of these engineers engaged in or with a knowledge of the chemical properties of the various soils and materials of road construction and of the chemical processes involved in securing, preparing and applying in construction the various special constituents of tar, asphalt and other materials.

Strategical Planning

Another feature which, in this new country, is now very properly claiming attention in highway construction, is that concerned with the strategical planning of routes, either municipal or provincial, and the work of general design related to the broad principles of town planning. Much is to be made, and is being made, of this feature, and it is very desirable that the coming engineering generation should make it a part of their work of preparation. In doing this they should not lose sight of the artistic and æsthetic in their work of street arrangement and beautifying, in their boulevards and parkways, and even in the long reaches of rural highways, which are so attractive a feature in the roads of England and France, of which the soldiers in the war have pleasant memories.

Executive and Administrative Duties

But engineering and technical knowledge and experience is not all that the successful highway engineer of to-day and to-morrow will require. That will be only part of his professional equipment. He must be much more than a technical man. The nature of this work requires much of other knowledge and qualifications. He must have administrative ability, he must have vision, judgment and tact, and those most vital qualities which will enable him to deal with and co-operate with other men, whether workmen or employers, foremen or contractors, sales agents or walking delegates, business men, ratepayers or politicians. For, after all, the business of the building and maintaining of highways to-day is largely business, administrative work, with engineering closely mixed with it, and, as we go on in our complex methods of doing things, the business and the engineering will become more interconnected and inseparable.

The highway engineer must, therefore, equally be an administrator, an economist and a co-operator with the business man, the legislator and the ratepayer. It is, perhaps, this part of his work which will make him the more valuable servant of the municipality or the state, but he will acquire that value only in so far as he can efficiently combine his engineering knowledge and experience with his administrative ability.

Recruiting Future Highway Engineers

Now, how are we going to secure these engineers? It will be said, we ask for a super-engineer in this highly-detailed specification of all he must be able to do. But why not? Is not our highway engineering going to be amongst the most important in the development of this country? We must then be prepared to meet the demand, and all those concerned in securing good engineers are equally responsible in the interests of good roads and highways.

The responsibility lies not so much on schools, colleges or universities as upon the municipalities and the governments who are building roads and highways. True, the colleges and universities must give the fundamental education, but it is quite evident that the further or later education must progress in successive stages in the field, on the actual construction, or in the engineering or administrative offices of the highway departments or commissions of the country.

The place of the college or university in this educative process is, however, well defined, and the work they are called upon to do is in a large measure common not only to all classes of engineers destined to be employed on highway work, but common as well to all sections of the country, from coast to coast, where this kind of work is being carried on.

The fundamental principles of applied science in respect to road-building are the same everywhere, and colleges can deal with all of the underlying principles already outlined under the various civil, mechanical and other branches of engineering. It has been said that road-building is an art rather than a science. That may have been true in the earlier days, and even within our own memories, but it cannot apply to-day. The work that has been, and is being carried out in the universities of Europe and America shows conclusively that scientific training is to-day a very large factor in successful road-building. In the work of research the university has a special service to render to the state, and it will be found that, as time goes on and the problems of road-building and maintenance and of road operation and traffic become more complicated, the processes of experiment and research in which the universities can participate will be more than ever valuable to the road-builder.

Highway Engineering Courses

It is not the purpose here to enter into a discussion in detail of the form such college training should assume, or to lay down a special curriculum for highway engineering. All the colleges and provincial universities of Canada are now giving such courses as will supply the coming highway engineer with more or less of the scientific side of his fundamental education. It is desirable, however, that more attention should perhaps be paid to some of those features of the more direct application of principles to road-building and maintenance. In this connection I desire to bespeak a further co-operation between those connected with road-building, either in municipal or government relations, or those engaged in businesses connected with road materials or construction, on the one hand, and the universities on the other, so that there may be some mutual assistance in co-ordination of effort and in research work. The laboratories of the universities should be at the disposal of municipality and government for these purposes, and it is, indeed, the duty of the university to assist the state in every way in this respect.

The universities, however, must recognize what is already pointed out, that the education of the engineer of to-day does not stop at the technical work. They must supply the engineering student as well with some of the economical, financial and broader education which at least will fit him to carry on after he gets out into his life-work.

Value of Practical Experience

When the young graduate leaves his college he must not by any means think himself an engineer, much less a highway engineer. He has much practical experience to get. If he is desirous of following highway work, it is not necessary that he plunge into it as soon as an opportunity offers. There is much advantage to himself and his subsequent employers if he can get some other co-ordinating experience, such as, for instance, on railway work or general municipal work. Railway work is specially fitting for carrying on with highway work, and we are now coming to learn that the engineering work of both is similar and equal in importance, with the advantage lying with highway work for diversity. It is well, too, to keep in mind that, so far as the present is concerned, there are many college gradautes and other young engineers who have had the advantage of war experience on highway work, in road-building and maintenance in France, and in motor transport and traffic operation there as well, under difficult conditions.

But the duty of the state is larger than the university in this respect of education. All that the university can do is to provide the early fundamental scientific education and but a small portion of the special highway engineering training. The municipality and the state must do the rest if they are to secure the right type of useful highway engineers. They must be prepared to take the young university gradaute, or the specially-trained or partially scientifically educated school or college boy and put him into their organizations in such a way that he will learn the other side of the work of the engineering. He must be given every opportunity to learn the practical, administrative and operative portions of the work in successive stages, and only by this means will the state produce for itself a broadly-educated highway engineer.

JOINT COMMITTEE MEETING ON LABOR PROBLEMS

AT a joint meeting of representatives of the international unions of the building trades and members of the standing labor committee of the Association of Canadian Building and Construction Industries, and also representatives from special branches of the industry, held at Hamilton, May 26th, 1920, the following resolutions were unanimously carried with the view of eliminating losses through stoppage of work caused by industrial disputes:—

1. That a National Joint Conference Board of the building and construction industries of Canada be created, to be composed of five representatives elected or selected by the Association of Canadian Building and Construction industries and five members elected or selected by the representatives of the building trades international unions.

2. That this body request the Dominion government to appoint a representative from the labor department to act as chairman and convener of this National Joint Conference Board.

3. The functions of this National Joint Conference Board shall be educational and advisory, with the purpose in view of its ultimate replacement by a permanent National Industrial Council for the building and construction industries.

4. The National Joint Conference Board shall encourage the organization of both the employers and employees into the groups represented by this National Joint Conference Board, and the establishment of industrial councils in the larger centres, such as already exist in Toronto, Hamilton, Ottawa, London and other places.

5. The two parties, members of this National Joint Conference Board, shall each have the power to change their representatives at any time, and no organization other than those already included shall be admitted to membership except by majority consent of the members of both groups.

6. Affiliated organizations and established industrial councils shall be encouraged to refer for settlement to the National Joint Conference Board such disputes as they are unable to adjust locally before a strike or a lockout occurs.

7. The National Joint Conference Board shall undertake to present to the government, on behalf of the building and construction industries, such measures as may be requested by both groups, parties to the Board.

8. The National Joint Conference Board shall advise with the organizations affiliated with it on measures which are considered to be of value in improving the building and construction industries, such as technical education, apprenticeship system, movement of labor, etc.

The executive committee of the American Association of Engineers thas asked its chapters situated in states along the Canadian border to urge upon the President of the United States and the United States Senators representing their respective states the desirability of appointing an engineer to the vacancy on the International Joint Commission, in recognition of the large engineering problems involved in the work of the commission.

VALUE OF THE LOCAL ASSOCIATION IN A NATION-WIDE HIGHWAYS MOVEMENT*

By Wm. Findlay

Business Manager, The Globe, Toronto

TO-DAY Canada stands on the threshold of the greatest highways development in her history, and if existing plans are carried to completion, it is hard to conceive that this country ever again will have to devise a highways project which will be comparatively so novel, so bold, so extensive, or of such cost. I do not mean that present plans for road-building are the greatest which will ever be undertaken by the provinces or by the Dominion. Far from it. The era of road-building upon which we are now entering is going to be permanent. It will, we hope and confidently expect, never be ended. For all the highways never will be built so long as human effort falls short of human ideals.

But I do mean that this country will never again be confronted with any general national road-building program which will involve so great a change from existing conditions, and which will be so much in line with the most advanced thought among good roads advocates, and by the same token, so far in advance of the thought of the general public on the necessity for improved highways.

Perhaps it may be that at this present time my feeling is akin to that of the people of Ontario when, twenty-two or twenty-three years ago, it was suggested that a million dollars of provincial money should be set aside for road-building, the municipalities contributing a proportionate amount. Politicians stood aghast at the size of the project to spend this amount of public money, even though it was to be spread over several years. Before it was thought safe to entrust the proposition to the legislature it was necessary to have a public inquiry, and the wardens and reeves were brought in from the counties and townships—not particularly to ask them what they thought of the scheme, but by the discussion of it to familiarize them with the movement, and to secure their support in their various communities for what was considered a stupendous movement in the direction of better roads.

County and Provincial Control

And what was the great sticking point with these legislators, next after the size of the money vote, they had in mind? The question was whether, in the interest of economical construction, better maintenance and the securing of through routes of travel, the townships could be induced to turn over to the counties a number of their leading roads.

Just at this time that great missionary of better highways whom we have here to-day, and who is now properly at the head of the Dominion Highways Department, Mr. A. W. Campbell, entered upon his official connection with the government of Ontario. He went up and down the province, holding meetings here and meetings there. Little meetings they were, held in the schoolhouse or township hall. I have heard him tell of the half dozen or half hundred progressive farmers who would attend, and of how the gospel of good roads was propagated, and always the subject of his thesis was to get the leading roads under the control of the larger governing bodies. That has been his effort for twenty-five years. It was crowned in Ottawa last year when the Dominion legislation was passed, and the leading roads of all provinces, and connecting the principal centres of the east and west, may now come under a measure of control of the federal government and receive federal aid.

Work of Ontario Good Roads Association

The process of education by discussion started by the inquiry I have spoken of was carried on in another way, and a more widespread way, because many men undertook the work. The Ontario Good Roads Association was an infant two or three years of age at that time. It is a veteran to-

*Paper read at the Seventh Canadian Good Roads Convention, Winnipeg, June 1—3, 1920.

day, not too old to be vigorous, nor too young to be inexperienced. Its members are the very class of men who make public sentiment throughout the counties. They are largely the men who represent the townships and the counties in their municipal affairs. No good roads association in Canada has a better record for progressiveness or continuous active service or for the faculty of translating thought into action than the Ontario Good Roads Association. I speak disinterestedly of this body because I have never been a member of it.

To-day in Ontario we are not discussing whether leading roads should be county roads or township roads, but whether they shall be provincial highways or parts of the federal system. That is the advance that we have made, and I contend that in so far as Ontario is concerned, this advance is due primarily to three causes: First, the educative work of the Provincial Highways Department inaugurated by Mr. Campbell, and so actively and successfully carried on by Mr. McLean; second, the increasing influence on the Ontario Good Roads Association and other more local associations, and the constant effect of the discussions which take place at their conventions; and third, the influence of the automobile, both the car owned by the farmer and the car owned by the city man.

Motor Leagues and Associations

The motor leagues and associations have been great factors in stimulating good roads thought. They have convinced the people of the urban communities that good highways concern not the farmer alone, as was imagined twenty-five years ago. They have paid their good money for highway improvements to their various provincial governments in the form of automobile licenses—millions of dollars— and millions of dollars of it is still in the possession of these provincial governments, and has not yet been spent on good roads, I am sorry to say.

They have gone further, and have convinced the people of the towns and cities that it is a proper thing for them to contribute through their tax bills as well for good roads in the surrounding counties. The motor car owners of the cities have done a great and good work through their associations and leagues.

I do not wish to discriminate as between these two classes of organizations. Each has a field. Each has developed its opportunities. Each is dependent for complete success upon the other. And it is idle in any section of the country where the two classes exist to expect to score 100 per cent. in the development of good roads thought without organization of the men of the rural communities and of the motor car owners in the towns, and then to secure active and harmonious co-operation between the two organizations for specific purposes.

Perhaps your committee asked me to speak on the subject of "The Value of the Local Association in a Nation-wide Highways Movement," not because I have been close to good roads development in Ontario for many years, so much as to enable me to indicate what a local association of good roads enthusiasts of every class and character can do, and in one particular case has done.

Activities in Eastern Ontario

In Eastern Ontario up to three years ago the good roads activity was represented largely by the Ottawa Motor Club and a few purely local good roads associations. Through the efforts of the Ottawa Motor Club and the organization they were able to get together along the route the highway to the St. Lawrence at Prescott had been projected and promised. Other sections in that part of the province were clamoring in a disjointed way for better roads, but their efforts were ineffective, because there was no broad general program in which all could join.

Most of the roads concerned led into the city of Ottawa. The problem, so far as that city was concerned, was insurmountable until the toll gates which confronted the traveller on every leading road near the capital could be taken down and the privately-owned highways could become the property of the people and subject to public control. The question had been on the boards for twelve years, and no progress towards a solution had been made.

Eastern Ontario Good Roads Association

The Eastern Ontario Good Roads Association was formed in the summer of 1918, and to the success of its initial meeting and of all the work it did a great deal of credit is due to the newspapers, daily and weekly, of that part of Ontario. Publicity was the foundation stone of its success. The publishers came at their own expense to a meeting held for that purpose, and pledged their support to the movement, and they gave that support willingly and without stint. It was a movement purely public in its nature, but it embraced the selfish interest of practically every town in which a newspaper was published. The support of the municipalities was sought and secured. They sent their men as delegates to meetings, and they contributed their money.

The policy of the Eastern Ontario Good Roads Association was to urge the erection of all through roads in that part of the province as provincial highways or provincial county roads. The provincial highways along the St. Lawrence and from Prescott to Ottawa had been decided upon, as well as the provincial county road from Morrisburg to Ottawa. To these roads, largely as a result of the activities of the Eastern Ontario Good Roads Association during 1918, there were added as provincial county roads three other highways: one following the lower Ottawa River to the border of the province of Quebec; another traversing the Ottawa Valley northerly to the town of Pembroke; and a third crossing through the Rideau lakes country and the agricultural sections of Leeds and Frontenac to the city of Kingston. The petitions for these roads, prepared and circulated by the Eastern Ontario Good Roads Association, were signed by over seven thousand ratepayers, and adopted by numerous municipal and commercial bodies.

Ottawa Suburban Road Commission

But another, and even a greater accomplishment, was that of bringing the city of Ottawa and the county of Carleton together in the establishment of Suburban Road Commission under the law of Ontario. Ottawa was the last of the larger cities in the province to take advantage of this legislation, although, perhaps, it contained more good roads sentiment to the square yard than any other city. Because of the outside influence which the Eastern Ontario Good Roads Association was able to exert, the city and the county got together and adjusted their difficulties. The Suburban Road Commission was formed, the toll gates came down, and now Ottawa is in a position, as she never was before, to give an entrance to permanent highways connecting with other centres in all directions, and will become, as she has a right to, the highway centre of the eastern portion of Ontario.

The work of the Eastern Ontario Good Roads Association was not confined by any means to the hard roads. A great deal of discussion at its meetings was devoted to the township and county problems. It was a cosmopolitan institution, ready to consider highway problems of every character, and it therefore received the support of all classes of good roads enthusiasts. It believed that the people on every concession were entitled to easy access to the permanent roads.

All big movements in Canada must have their roots widespread if they are to be successful. An association like the Canadian Good Roads Association can be powerful only if back of it there are local good roads associations in every province and in every section of the province. It may be considered that this suggestion contains the thought of selfishness, and that I am advocating the organization of local associations only to take care of local needs or desires. If there were no local needs or desires in this good roads propaganda there would be no propaganda. This is a practical subject. We do not advocate roads for any other purpose than because we want to use them, and most of us will get the greatest use of the road nearest at home.

Co-operation and Co-ordination

The watchword of this convention is "Co-operation and Co-ordination." Co-operate with this national organization by forming your own local organizations, and let it help to co-ordinate the development of the good roads idea all across Canada in a way that only a national organization can do. Develop the good roads sentiment in your locality by a local good roads association. Decide what roads you want to improve. Lay out your program on broad lines, so as to merit as great a following as possible. Then start your educational campaign on general lines, but with the objective of securing the improvement of your particular roads. Get the motor car owners of the town joined up with the people from the townships. Connect up your local association with your provincial association and let the members of all the associations join this Canadian Good Roads Association and co-operate in its work. Let this association be your clearing house. Let it be the body which crystallizes the thought of all the local associations, and secures by co-operation that uniformity of action which a nation-wide movement demands. You will strengthen immeasurably this Canadian Good Roads Association and place it in a position where it can be of even greater service to the cause, and more thoroughly representative of good roads thought of every character and in every portion of Canada. You will help to form and you will be an important part of a closely-knit fabric of good roads ambition and attainment which will extend from one end of Canada to the other. You will prove the "Value of the Local Association in the Nation-wide Highways Movement."

ENGINEERS' FEES

THE Council of the Institution of Civil Engineers of Great Britain has had under consideration certain inquiries from members as to the propriety of increasing fees over pre-war rates. Dealing first with the commission charged for the design and superintendence of the construction of works, the council find themselves in a little difficulty, in that the increased cost which the engineer has to incur under post-war conditions is met by the increased cost of the work on which he charges commission. But this evidently only holds good so long as the work is executed at pre-war speed. The question of fees will depend, therefore, on the cost of the works and the contract time for completion, and it would certainly be proper to stipulate for an extra fee in the event of the work seriously exceeding the contract time owing to unforeseen difficulties with labor or supply of materials. With regard to the fees charged for other classes of work, however, such as enquiries, reports and parliamentary work, the same considerations do not arise, and the council of the institution express the definite opinion that civil engineers are justified in making an advance of 50% on pre-war rates. These decisions will come as a considerable relief to many engineers who have been feeling the full strain of the constant increase of office and living expenses, and at the same time it is plain that the legitimate interests of clients have not been overlooked. It now only remains for the members generally to adopt the higher scales that have been approved by the institution.—The Surveyor.

BOILER INSPECTION

"WHAT are those large iron things?" asked the young lady who was being shown through the railway shops.

"Those are the locomotive boilers," replied the mechanical engineer who was doing the honors.

"And what do they boil a locomotive for?"

"Why, to make the engine tender."

ROAD OILS AND CARPET COATS*

By J. A. Duchastel
City Engineer and Manager, Outremont, Que.

THE road builder is face to face to-day with problems which were of little concern only a few years ago, viz.:

1.—The scarcity and inefficiency of labor;

2.—The high cost and difficulty in securing materials for road construction.

He has, therefore, to apply himself in making the best of a difficult situation, and his duty is to counteract the general tendency of extravagance in road construction, and devise means by which old roads can be restored, improved and maintained until such time when prices come down and labor is more plentiful. Many miles of old macadam or gravel roads can be improved at a small cost, and a surface treatment applied to them, thereby prolonging for years their usefulness and retarding for considerable time the construction in their stead of pavements of a more permanent character.

Saving Due to Improved Roads

Another very important economical question to consider, when the improvements to the roads of a district are planned, is the saving in dollars and cents on the cost of transportation of farm produce and merchandise generally. The Department of Agriculture of the United States, in its County Crop Report for 1918, states that the cost of handling one ton per mile of farm produce in states having improved 25% of their highway mileage, was 10c, while in states where road improvement to the extent of 5% only had been made, the average cost price per ton per mile was 30c. This needs no further comment, as these figures are more eloquent than I can be.

All I might say is that in only one-half the amount of money lost by the lack of maintenance in this country was spent on real maintenance, it would be unnecessary to worry for the future.

The greatest of all problems on road construction to-day, after drainage, is road maintenance, and too little thought is given to this matter.

We are all accustomed to maintain our buildings, our equipment, and ourselves. This has long been drilled into us, but too many people imagine that once a road is down, it is down forever without further care. It is absolutely wrong. The maintenance of a road should start the day it has been completed.

I do not know very much about the conditions in Manitoba, but the situation here as elsewhere warrants a true policy of the strictest economy, and outside of some main trunk roadways in close proximity of Winnipeg, and perhaps one or two other cities, the great bulk of your roads should be improved and treated in the manner I am about to describe.

Bituminous Carpet Coats

In "Good Roads" on March 24th, 1920, in an article entitled "Improved Roads from the County Official's Standpoint" signed by J. Charles Dayton, County Superintendent of Highways of Cayuga Co., N.Y., a quotation from an article written by Col. W. D. Sohier, who is with us to-day, reads as follows:—

"In Massachusetts there are many miles of water-bound macadam from 15 to more than 20 years old, scattered around in all sections, which have never been resurfaced but have been maintained with a bituminous blanket top and constant patching. Others have been satisfactorily maintained by putting a thin mixture of sand and asphalt on top and widening the shoulders with the same material, only 3 or 4 ins. in depth, at the same time diminishing the crown."

*Paper read at Seventh Canadian Good Roads Convention, Winnipeg, June 1st-3rd, 1920.

These excellent methods, adopted by one of the leading states in road-building in the great country to the south of us, should be an inducement for us to follow suit.

Limitations of Surface Treatment

It would be unwise to believe that surface treatment with a bituminous material will banish all evils from roads. We must not expect that a surface treatment is a cure for all ills. While it is admitted that a surface treatment with bituminous material is a ready means of salvaging many types of pavements, on the other hand, it must be remembered that the road to be treated must have a foundation of sufficient strength to sustain the traffic it is called to have that the drainage must be good, and that the road surface be in good condition. No surface coat will last if these conditions are lacking. The surface treatment must be considered as a preservative in the same way as a carpet over a hardwood floor, and the carpet coat has got to be renewed from time to time in the same manner as a carpet over the wooden floor.

Under the title of "Road Oils and Carpet Coats," mention should be made of the dust-laying oils of asphaltic or tar origin. I will say very little on these, as this type of oiling is intended simply to weight down the dust particles and prevent them blowing away. These light oils do not, as a rule, form a protective coat as the heavier ones used in connection with carpet coating. In many cases, far from protecting the surface of the road, these light oils have introduced an element of lubrication in the upper layers of the road surface, with the result that disintegration often sets in faster than it would normally.

A sure indication of wear on a road is the presence of dust. A bituminous carpet coat, if properly laid, will stop the appearance of dust, and will preserve the road both from wear and from the disintegration due to the presence of water. It will render the road practically impervious.

Bituminous Materials Required

The bituminous materials used for a carpet coat should be heavier than those used for dust-laying. They should be asphaltic oils, containing from 60 to 80% of asphalt, or refined tars, containing few or no constituents, distilling at a temperature of 300°F. The idea is to lay over a road a heavy material containing no volatile base or residue, and which will remain on the surface of the road, forming a mat or carpet with the coarse sand or stone chips. Care should be taken to avoid building too thick a carpet, in which case rolling or waving of the surface would shortly appear.

It must be remembered that the tendency of the horses' shoes and steel tires is to cut up a surface of this nature, but if the proper kind of material is used, this defect will be overcome by the ironing action of the rubber tires of automobile traffic.

In determining whether an old macadam or gravel road should receive a surface treatment, the traffic census should be taken, and it is found that if over two hundred automobiles travel over a road in a day, it becomes imperative to treat the road with a bituminous coating. If the road is in good shape, and the coating properly applied, then, the road can carry up to two or three thousand automobiles per day during the summer season.

Before determining whether it is wise to apply a bituminous carpet coat to a macadam or gravel road, it is necessary to investigate the following points:—

1. The nature and volume of the traffic over the road;
2. The thickness of the metal composing the roadway itself;
3. The nature of the sub-soil and its drainage.

If any of these matters require attention, it would be a waste of money to treat the surface without remedying the faults.

Rules for Laying the Carpet

In laying a carpet it is necessary to observe the following rules:—

All dust must be thoroughly removed from the road surface with brooms so as to permit an intimate adhesion between the road carpet and the road surface. For economy's sake it is advisable that a rotary horse sweeper be used. All the small depressions of the roadway in which dust might lodge should again be swept by hand brooms. The road surface should resemble a mosaic after the sweeping is done, and all stones should be exposed over the entire area.

The liquid bitumen should be applied after heating, and in moderate quantities. The quantity applied per sq. yd. will vary from one-fifth to one-third of an Imperial gal., all depending upon the conditions of the road surface. All surplus bitumen will be swept with hand-brooms over the road, so as to avoid the formation of puddles, otherwise the carpet would be of unequal thickness and creeping of the road surface would soon take place.

A couple of hours after the application of the bitumen, the surface should be covered with sufficient coarse sand or screenings to absorb all the bitumen.

No road oiling should be undertaken unless the roadway is absolutely dry, otherwise any dampness at the surface of the roadway might prevent the adhesion of the carpet. Unless perfect adhesion is obtained, the carpet is apt to break away in slabs during the cold weather.

It is important that the heating of the bitumen shall be constantly observed, and the use of thermoneters is recommended. Care should be taken that the flash point of the road oil be not exceeded.

In the case of bleeding of finished surface, an application of coarse sand or screenings should be made without delay.

Experience in City of Outremont

I have had some experience myself in road oiling, and am pleased to state that the results obtained are far beyond my expectations. I find that the roadways that I have treated with road oils have been cheaper to maintain from year to year. They are easier to clean; they are dustless and mudless, and their appearance is most pleasing resembling very much to sheet asphalt surfaces.

I am submitting herewith a few figures, showing the annual cost of repairs to roadways in Outremont for the past ten years, and also the cost of oiling these roadways. It will be noticed that the cost per sq. yd. for repairs has decreased from 1910 to 1919 at the rate of 60%, while wages have increased 140%:—

COST OF STREET REPAIRS, CITY OF OUTREMONT
(Permanent pavements not included)

Year.	Total cost.	Sq. yds.	Cost per sq. yd. Cents.	Average price of labor.
1910	$ 8,866.81	124,945	7.1	$1.50
1911	10,557.79	157,595	6.7	1.75
1912	14,412.84	208,419	6.9	1.75
1913	11,773.45	244,474	4.8	1.75
1914	15,165.20	273,014	5.6	1.75
1915	18,928.88	300,734	6.2	1.75
1916	11,314.83	302,784	3.7	2.00
1917	12,817.86	322,604	4.0	2.50
1918	11,824.74	335,624	3.3	2.75
1919	10,204.00	337,374	3.0	3.00

COST OF STREET OILING

Year.	Total cost.	Sq. yds.	Cost per sq. yd. Cents.	Imp. gall. per sq. yd.	Average price of labor.
1914	$ 787.42	3,000	2.6	...	$1.75
1915	2,624.80	101,930	2.6	.153	1.75
1916	5,037.44	187,675	2.7	.194	1.75
1917	6,351.21	184,540	3.4	.187	2.50
1918	6,202.33	138,690	4.5	.200	2.75
1919	3,648.00	120,860	3.0	.131	3.00

Good progress is being made by the Toronto committee of the Engineering Institute of Canada in its plans for the annual meeting which takes place in Toronto, probably February 1st-3rd, 1921.

BROKEN STONE ROADS*

By Geo. Hogarth
Chief Engineer, Department of Public Highways, Ontario

HIGHWAY development in Canada may be said to begin with the trail or bush road and, depending on the lightness or heaviness of traffic, to advance by well-defined steps to the state of earth road, then a gravel road, then a macadam road and finally, if finances permit and traffic is sufficiently heavy, the road becomes a bituminous or concrete pavement. For all time to come many miles of our highways will remain earth roads. Some roads being more important and leading to railway stations or market centres, will have gravel applied to them as traffic increases, and the need for a better road arises and later when that traffic becomes heavy and approximates 200 to 500 vehicles per day, the need of a stronger road crust will be evident and a macadam surface of broken stone will be laid. Such a stone roadway will carry economically, with ordinary maintenance, a traffic up to 1,000 or 1,500 vehicles per day.

Ordinary Broken Stone Roads

Broken stone roads for ordinary travel may be built at comparatively small expense where rock is situated close to the highway. The installation of a crushing outfit at any convenient point will provide in one season sufficient stone to surface a number of miles of roadway, and by crushing the stone so that all will pass a 1½-in. ring, no rolling will be necessary. In operating such an outfit and building a road the usual procedure is to pass all stone over a screen after crushing and draw into one bin all the dust and chips up to ½-in. The rest of the stone passes into a second bin and is drawn away and spread on the road. The road grade should first be properly drained and slightly rounded up in the centre and a layer of the crushed stone from ten to fifteen feet wide and three to five or six inches thick is placed. After the first layer of stone is in position and spread, a coating of the screenings and dust is distributed on top of the first layer, and the road is left for traffic to consolidate. In this manner a broken stone road for light traffic may be constructed with the minimum of expenditure, and if limestone is used and care exercised in levelling and spreading the stone, a satisfactory result will be obtained.

Construction for Heavy Traffic

Where it is desired to properly construct a one or two-course broken stone road for heavy traffic, more care is required in all the roadbuilding operations. The preparation of the subgrade must be given close attention and the drainage of the roadway properly provided for. Side ditches with good outlets will be required and the bottom of the side ditch should be at least two feet below the crown of the roadway. Many soils are found to be wet and soft and tile drainage under or alongside the stoned portion must be provided to draw away the water and permit the soil to dry out and harden. If the country is rolling, it will be found that tile drainage is absolutely necessary to dry out wet spots on hills, particularly at points from 50 to 200 ft. below the crest of hills, as it is at such points the ground water tends to come to the surface and by creating springs will cause the road to soften and break. By properly ditching and tiling the earth subgrade, it is possible to create at small expense a hard, dry surface upon which to place the foundation course of broken stone. Drainage is essential to roads and the money so spent is returned, because the well-drained road costs less to maintain and lasts longer than one that is poorly drained.

The earth subgrade, after being properly drained and graded, is thoroughly rolled and the base course of stone is uniformly spread upon it. This base course may be ten to twenty feet in width and from four to seven inches in depth, and composed of soarse, stony gravel, field boulders, broken stone or telford. The quality or hardness of the stone used in the foundation course is not important, as the wearing effect of wheels does not come on the base course, so that any stone is usually satisfactory. When the base course is in place a roller should be used to consolidate the stones and render them firm for the top course. The spaces between the stones in the base course may be filled by screenings or coarse gravel and the whole watered and rolled.

On top of the base course a depth of broken stone about four inches in depth is placed. This top layer is composed of stones about two inches in size, and as it is the wearing course of the road the quality, toughness and uniformity of the stone is important. Any good limestone may be used for the wearing course, but the hardness of the stones should be uniform as otherwise the quick wearing of the softer stones will create a rough road in a short time. The top course is thoroughly rolled and is then watered and screenings applied and spread over the stones to fill the voids. Brooms are used to sweep the screenings into all spaces and the surface is watered, broomed and rolled until hard and unyielding under the roller. A light coat of screenings is applied and the road left for a few days to dry out before being opened to traffic.

Maintenance and Repair

The broken stone road is readily constructed, easily maintained and readily repaired. It is a pleasant road to drive over and with proper maintenance is economical. It may be found that after being in use for years a broken stone road has small holes and ruts over its entire length. One method of preventing the road becoming rough is to establish a system of maintenance by patrolmen shortly after the road is built. Under ordinary circumstances one man with a one-horse cart and a small outfit of tools will be able to patrol and keep in repair from three to five miles of road, and he will not need to be continuously employed to do that. The repairs consist in filling the holes and ruts with large stone, covering the stone with screenings and tamping the patch tightly into place with a pounder. An experienced man will patch a road so that the road is smooth and the patches cannot be detected a few days after the work is done. After being under heavy traffic for some time a broken stone road may become rough and pitted, so that resurfacing is necessary. This work is undertaken by first scarifying and loosening the old surface, after which the stones may be levelled off and a new course applied, rolled in and finished the same as when building a new road. It is this ease of repair which makes the broken stone road one of the most economical to maintain and keep in good surface.

Dust Prevention and Drainage

During the summer months a broken stone road may become dry and dusty. To prevent this condition arising, it will be necessary to apply oil or light tar to the surface at the rate of about one-third gallon per square yard, and then spread sand, screenings or pea gravel lightly over the material, the oil or tar to blot up any surplus and stop the material sticking to the wheels of vehicles. An application of a dust preventive in the early spring and a second in mid or late summer will render the road dustless during the months of heavy summer traffic.

Broken stone roads are rounded or crowned slightly in order to shed water. The amount of rise given the centre of the road should be as little as possible consistent with proper drainage. A slope of ¼ to ½ in. per foot will usually be found sufficient and will give on a road 20 feet wide a crown 2½ to 5 ins. higher at the centre than at the sides. A rise of from 3 to 3½ ins. will be found very satisfactory on such a width of road.

On steep grades broken stone roads will be found to give good foothold for horses. In such situations the maintenance cost will be high because of the material washing away. Broken stone roads have, however, been successfully maintained on grades of from 5 to 12%.

*Paper read at the Seventh Canadian Good Roads Convention, Winnipeg, June 1—3, 1920.

Broken stone roads have several advantages, among which may be mentioned, that they do not require rigid or expensive inspection and they can be laid in all but freezing weather. If well built it retains its shape and does not distort or wave or creep, and is an easy riding road for team or motor traffic. The disadvantages of broken stone roads are that if subjected to much traffic in the spring they tend to break up and ravel, while heavy automobile traffic tends to sweep away the dust particles between the large stones leaving a rough surface.

The ravelling of broken stone roads under traffic may be prevented by the application of a hot coat of bitumen. This coat is applied after carefully sweeping the surface and a quantity of from one-quarter to three-quarters of a gallon per square yard is used. Such material may be applied by means of a pressure distributor. It is then covered with a layer of ¾-in. stone, and rolled.

HOUSING AND TOWN PLANNING: A SURVEY*

By H. L. Seymour

Assistant to Dominion Housing and Town Planning Adviser

(Continued from last issue)

IN the past the real estate man, now politely termed a realtor, has been the town planner. He decided the number of lots in a sub-division which as a rule was as many as possible. To this all other planning features were subsidiary. Streets were often merely for the purposes of providing access to lots, because otherwise it was found that it was with difficulty that lots could be sold although sometimes done, and streets were made as narrow as possible without thought of traffic or sewer requirements, of desirble orientation of lots and buildings, of open spaces. Now, that is to say, some real estate town planners forced the surveyor into such procedure so frequently that at last it became a habit to some of us. Of other real estate practitioners, it can be said that we owe them much for their vision in realizing that just as much or rather more money could be obtained by developing areas with regard to other consideration than number of lots. It is true many of these developments were sometimes fantastic in their knotted arrangement of streets and often bore no intelligent relation to surrounding or possible future development. They represented, however, an advance.

The real estate town planner knew costs of land by the acre and then of land by the lot and what it would cost to get it in that state, if he thought it too much he let the surveyor know about it. He also knew or found out what clearing and street grading would cost, and in other instances the cost of houses and approximate costs of street improvements and utilities and was able to figure out the probable returns on his investment before engaging on a large development. All this I feel should become part of the function of the surveyor in these days to come of real housing and town planning. Some of these things the owners of land and clients will want to know in a preliminary way at least even before a topographical survey is authorized. Will land at so much an acre in such a situation justify, say, a housing development, where rents are to be restricted to a certain figure? What are the present and possible transportation facilities? How much an acre do surveys cost? How many families should be housed on an acre? What relation should exist between cost of land, cost of improvements and cost of building? What will be the taxes on land and buildings and for local improvements? What then will be the common rent? etc. Definite figures, of course, cannot be given but the surveyor should be sufficiently acquainted with costs to make a fair approximation. It requires investigations and surveys into local conditions.

*Lecture delivered at the last annual meeting of the Association of Ontario Land Surveyors.

Assuming then that a development is considered a sound one and that a topographical survey is made, contours from 1 to 5 feet intervals, test pits for soil conditions, at least one per acre and of sufficient depth for sewer and water estimating and also for cellar excavations, the plotting of trees to be preserved on the site, are some of the features to be recorded.

After a topographical survey there must be considered the collection of all available data, some of which I have indicated in connection with a housing development as being required even before a topographical survey.

Meteorological Records

We want to know the direction of prevailing winds to determine the best location for factories. Generally, in this part of Canada at least, the prevailing winds are from the west; factories should be consequently located as a rule in the easterly part of any development.

We want to know the climatic conditions to determine on building materials. May I draw your attention to the records issued by the Meteorological Service of Canada and suggest to you an interesting trip of inspection to a meteorological station.

While we yet lack in Canada detailed topographical maps such as have been prepared in other countries, there are various federal, provincial or municipal departments that publish information like that of the Meteorological Service of value to town planners. All such information should be collected and correlated.

Assessment and Taxation

Equitable assessment, equitable methods of taxation are factors also necessary of consideration under a comprehensive planning scheme.

We know that much of the work of assessing that is done cannot be considered as being carried out on any scientific basis. In passing I would just like to mention that there seems to be a field here for surveyors.

The matter of lot valuation in a new development is closely akin to that of assessment. For example, when an area is developed on modern lines, about 25% will be found in roads, 15% in open spaces and parks and 60% in building area or lots. The cost of the whole area will ordinarily be borne by the 60% that is in lots. Some lots depending on their size, the location both vertical and horizontal, should be assigned a higher per foot front or per square foot value than others.

In residential property, where let us say the lots are all about 40 ft. wide by 100 ft. deep (considered a reasonable size for detached houses) values may be determined on the basis of a square foot rate. At Lindenlea, Ottawa, a recent housing development, the average per square foot value was about 13c., varying from about 11c. to 15c., depending on the location, etc., of lots.

Corner lots in residential sections are not so relatively valuable as in business sections. In fact on account of the extra local improvement tax which is a function of the frontage other advantages that may be considered accruing on account of the location are probably offset by the extra local improvement taxes that have to be paid. But in commercial areas corner lots are considered to be more valuable than inside lots. Many assessors now also recognize that the most valuable part of the lot is that nearest to the street line.

In the Town Planning Acts, as passed in six of the provinces but not for Ontario, it is provided that one-half the increment in property values due to the preparation or execution of any town planning scheme shall accrue to the municipality. As an illustration, Mr. LeMay has been good enough to give me the figures in connection with the widening and improving of St. Clair Avenue, Toronto. That improvement carried out a few years ago cost $669,000 affecting some 30,000 lineal feet of frontage.

The abutting and adjoining owners provided $169,000 of this and the remainder—$500,000—was made up out of the general tax, to which the owners mentioned also contributed their small share.

It could be stated that it will cost the abutting owners, the greater portion of which being in ten annual instalments, about $6 per foot front for the improvement. Mr. LeMay advises me that there is not the leas doubt but that all properties have averaged an increase of $100 per foot front on account of the change. Under other provincial acts such improvement, under a town planning scheme, would have returned in a number of annual instalments some $50 to the municipalities. In town planning the principle is recognized, in part at least, that community created values should go to the community and not to the individual.

Aerial Photography

Col. Leckie has referred in a most instructive address to the subject of aerial photography, the results of which are so eagerly awaited by town planners. The numerous features of the urban or rural area can be shown in great detail—in both plan and perspective—detail that might take a great deal of time if otherwise obtained. No town plan would now be complete without provision for an aerodrome or aerodromes. The city of Halifax is reserving areas for two.

Col. Leckie has pointed out that an aerodrome should have an approximate minimum diameter of one-quarter mile, although preferably the diameter should be one-half mile, and obstructing objects near the aerodrome should not exceed in height one-seventh of the distance therefrom.

There is just one matter I would like to impress on Col. Leckie and that is, that the time as well as the date of each photograph as taken should be recorded. By measuring the length of shadows on a photographic plan—and I understand aerial photographs are possible only on bright days—an approximate idea of heights can be obtained. For example, on May 21st, at 4.20 p.m., standard mean time, an aerial photograph is taken at longitude 111 degs. west of Greenwich, latitude 60 degs. north of the equator and a plan is developed and printed.

Scaling from the plan the length of the shadow of a flag pole is found to be about 65 ft. At the time of photographing 4h. 20m. p.m., is the standard mean time (for 105th meridian). For 6 degs. in longitude, subtract 24m. Then 3h. 56m. p.m., is the local mean time. According to the nautical almanac, add 3m. 35s. for the equation of time, and 3h. 59m. 35s. is the apparent time.

From the "Nomogram for Use in Sunlight Engineering," published by the Department of the Interior, Canada,* the length of shadow to height of flag pole taken as 1 is obtained, the sun's declination being obtained from the nautical almanac. This value 1.63, and by dividing the length of shadow, 65 ft., thereby it is found that 40 ft. is the approximate length of the flag pole.

From the nomogram the azimuth of the shadow will be found to be 74 degs., which can be checked against the azimuth as determined from the photograph.

In concluding this survey I would like to indicate the importance now being attached to zoning, especially in the United States, at the present time. Under zoning ordinances or provisions a city or area is divided into factory, business and residential districts, there often being several sub-divisions of these main districts mentioned. The districts are variously restricted as to the height of buildings and the area of lots that may be built upon.

Zoning has been put in force, or is being considered by the following cities in the United States: New York, St. Louis, Los Angeles, Berkeley, Sacramento, Alameda, Fresno, Oakland, Jersey City, Niagara Falls, Cambridge, Philadelphia, Milwaukee, Portland, etc.

In Canada the town planning schemes for Halifax and St. John also include zoning features. It has been found in the United States that while zoning is being enforced without compensation, for the reasons of health, safety and general welfare, it also has a wonderful economic effect in stabilizing land values and reducing the cost of public utilities.

In 1911, a city block in New York, 200 by 800 ft. was assessed for $17,000,000; in 1916 it was assessed for $7,000,000. This depreciation of $10,000,000 is attributed largely to the fact of the intrusion of factories into this heretofore retail area. This cannot happen again as New York city adopted a zoning ordinance in 1916.

In St. Louis it has been estimated that from two to three million dollars might have been saved in the construction of the sewer system if it had been known what the developments in various districts were to be, as they are now known since the Zoning Ordinance of 1918.

In general, zoning effects saving in the construction of public utilities. Streets for expected heavy traffic can be properly paved, while streets in districts calling for lighter traffic need be less expensively paved. Industrial areas can be provided with large water mains for fire protection —larger mains than would be supplied throughout the city generally to serve scattered areas—while probably fewer sewer connections are necessary than in residential districts, which latter on the other hand, can be provided with shallower sewers, than need be provided for business districts with sub-basements.

*Copies of this nomogram and also of the nomogram showing the duration of sunlight can be had upon application to Dr. E. Deville, Surveyor-General, Ottawa. Blueprint giving tables and diagram to illustrate the use of these two nomograms can be had upon application to H. L. Seymour, c/o Office of the Town Planning Adviser to the Dominion Cabinet, Ottawa.

SAD STORIES*

THE man speeded up to see if he could beat the train over the crossing.

He couldn't.

* * * * *

The man struck a match to see if the gasoline tank was empty.

It wasn't.

* * * * *

The man patted a strange bulldog on the head to see if the "critter" was affectionate.

It wasn't.

* * * * *

The man looked down the barrel of his gun to see if it was loaded.

It was.

* * * * *

The man touched an electric wire to see if it was alive.

It was.

*Ontario Safety League, Special Bulletin, No. 54.

WINNIPEG WATER DISTRICT TO CARRY OWN INSURANCE

INSURANCE at present carried under the Workmen's Compensation Act by the Winnipeg Water District will in future be carried by the District itself, according to a recent decision of the District Board. The District payroll for 1920 is estimated at $89,364, and the premium which the District would pay the administration of the Compensation Act amounts to $3,686. The Board, on the recommendation of the commissioners, decided that the District would request the Workmen's Compensation Board for permission to carry its own insurance and run the risk of having to pay yearly a greater amount than the premium. It was stated that in former years the premium has been greater than the amount the District would have lost had it paid the compensations.

It is reported that the Association of Railway Executives of the United States intends to urge the Interstate Commerce Commission to refuse cars and transportation for road-building materials. The reason for this proposed action is given as the necessary diversion of labor and materials to railroad needs. Needless to say it is bringing forth strong protest from those who have highway construction at heart.

SAND AND GRAVEL*

By A. Ledoux
Ontario Bureau of Mines

SAND and gravel belong to the category of unconsolidated clastic rocks. The component fragments vary widely in size, some passing the 200-mesh sieve, others being more than one foot in diameter. Small grains and large fragments may be associated in the same sample. There is no natural limit between sand and gravel; for practical use, we call sand a material made of grains passing the 1¼-in. screen, and gravel a material made of fragments retained on the ¼-in. screen; boulders are fragments larger than 3 ins. in diameter.

Morphological Properties

Size.—The size of the component fragments of a clastic rock affects a certain number of its physical properties, such as specific gravity, absorption and permeability. With regard to size, sands are ordinarily divided into fine, medium and coarse varieties, gravels into fine gravel, pea gravel and coarse gravel.

The classification of a sand or gravel is often made at sight, but more accurately by using sieves. A sieve is defined by the number of holes or meshes per linear inch; for instance, a 100-mesh sieve has 100 holes to the linear inch. A sieve may also be defined by the smallest linear dimension or rating of the hole, a ¼-in. sieve having holes of ¼ in. as their smallest dimension. This last method may be applied to screens with holes larger than one inch. It should be noted that there is a great difference between a 4-mesh sieve and a ¼-in. sieve, depending upon the diameter of the wire. If M represents the number of meshes to the linear inch, D the diameter of the wire in mm., the rating R is expressed in millimeters by the following equation

$$R = (25.4/M) - D.$$

The diameter D is most easily determined by means of a micrometer gauge or by microscopic measurement. The following table gives the number of meshes to the linear inch, the diameter of the wire and the rating, for the series of sieves used in the accompanying metric analyses:—

Sieve Mesh	Diameter of wire Mm.	Rating Inches	Rating Mm.
4	1.651	.185	4.699
8	.813	.093	2.362
10	.889	.065	1.651
20	.437	.0328	.833
28	.318	.0232	.589
48	.234	.0116	.295
80	.1425	.0069	.175
100	.1070	.0058	.147
200	.0530	.0029	.074

In some sands and gravels, the component fragments are of uniform size; in others they vary widely. This can be tested by granular metric analysis. The principle of such an analysis consists in passing a given amount of the material, say 100 to 500 grams, through a series of sieves, and weighing the amount of the sample retained on each of them after sufficient shaking. The results are given in the percentage of the whole *remaining* or *retained* on each sieve. To express the degree of fineness by a single figure, the percentages passing each sieve are added and the total divided by the number of sieves used. The result is called the per cent. of fineness; if the same set of sieves is used this figure may be used for comparing different sands and gravels. The table below gives the results of the granular metric analyses, and shows the difference in the per cent. of fineness between several grades of sand and gravel.

Sieve Mesh	A Fine Sand Ret.	A Fine Sand Pass.	B Medium Sand Ret.	B Medium Sand Pass.	C Coarse Sand Ret.	C Coarse Sand Pass.	D Fine Gravel Ret.	D Fine Gravel Pass	E Coarse Gravel Ret.	E Coarse Gravel Pass.
4	0.0	100.00	0.30	99.70	32.85	67.15	49.80	50.20	80.00	20.00
8	0.0	100.00	3.10	96.90	39.20	60.80	63.85	36.15	83.40	16.60
10	0.0	100.00	6.40	93.60	42.50	57.50	69.50	35.50	84.65	15.35
20	0.0	100.00	16.80	83.20	54.10	45.90	79.10	20.90	87.00	13.00
28	0.0	100.00	25.70	74.30	69.30	30.70	85.55	14.45	89.45	10.55
48	1.25	98.75	60.00	40.00	93.85	6.15	94.45	5.55	98.65	1.35
80	2.00	98.00	93.25	6.75	97.95	2.05	97.55	2.45	99.80	0.20
100	5.70	94.30	98.40	1.60	98.75	1.25	98.55	1.45	100.00	0.00
200	41.50	58.50	99.15	0.85	99.60	0.40	99.30	0.70	100.00	0.00
Total		849.55		496.90		271.90		162.35		77.05
Per cent. of fineness		94.39		55.21		30.21		18.04		8.56

A: Silty sand, very fine, Camp Borden (Simcoe county).
B: Medium sand, Landshore Sand & Gravel Co. (Ontario county).
C: Coarse sand, Markus pit, Pembroke (Renfrew county).
D: Fine gravel, J. Creeper pit, Belleville (Hastings county).
E: Coarse gravel, Bray pit, Port Hope (Durham county).

The results of granular metric analysis may be represented by diagrams, taking as abscissae the ratings of the different sieves and as ordinates the percentage of material remaining on each of them. Joining the different points (Fig. 1) we obtain a graphic representation of the granular metric analysis.

On an ordinate $X = a$, the length measured between the curve and the axis of the abscissae indicates the percentage of material remaining on a sieve of a rating equal to A; the length measured between the curve and the line $y = 100$ represents the percentage of material passing through the same sieve. The area comprised between the curve and the line $y = 100$ is proportional to the fineness of the material; for fine sand this area is large, it is smaller for medium sand, and becomes very small for coarse gravel. This system of geometrical representation (Fig. 2) has been applied to the five granular metric analyses given above. All the curves start from the point 100 on the axis of the ordinates; their general shape is parabolic except near the axis of the ordinate, where there is an inversion on the curves.

The maximum difference between the quantities of material remaining on two alternate sieves such as 4 and 10, 8 and 20, 48 and 100, etc., is a measure of the uniformity of the clastic material. This difference is called the *coefficient of uniformity.* The number of the intermediate sieve in our scale of sieves represents the *grade* of the tested material.

Shape.—The shape of the component fragments is also variable in character. In sands the grains are rounded or angular. If the latter shape is quite common to all the grains, they constitute a sharp sand, much appreciated for building purposes. The difference between a sharp and a rounded sand can be tested under the microscope; it can also be easily ascertained by rolling the grains between the tips of the fingers. For gravels a similar distinction may be established: the component pebbles are spherical, elliptical, flat, disc-like or angular: hence such terms as round gravel and sharp gravel.

Physical Properties

The following physical properties are of interest in the study of sand and gravel: Specific gravity, percentage of voids, permeability, absorption, moisture, percentage of silt, cementing value, bonding power.

*From a report to the Ontario Bureau of Mines.

Specific gravity.—The specific gravity of a sand or gravel may be considered in two different ways. The *apparent* specific gravity of a sand or gravel is the weight of a certain volume of the material, divided by the weight of an equal volume of water. The *real* specific gravity is, on the other hand, the average specific gravity of the fragments composing the material. The real specific gravity is always higher than the apparent specific gravity.

The apparent specific gravity is easily obtained by weighing a known volume of the sand or gravel and dividing the weight of the material by the weight of an equal volume of water. The material should be shaken down as much as possible in order to reduce the volume of voids to the minimum.

Determination of specific gravity.—The real specific gravity of sand may be determined with a glass vessel having a narrow neck with a reference mark. This is filled to the reference mark with water at a standard temperature. A weighed quantity of the sand under examination is poured into the vessel. The pouring should be very slow in order to prevent air bubbles being carried down with the sand. The displaced water is poured from the vessel until the level is the same as before, viz., at the reference mark. This water has been displaced by the sand, and its weight divided into the weight of the sand gives the real specific gravity of the sand. In order to eliminate the air bubbles, the flask containing the sample and water may be placed in an iron cylinder and connected with an air pump to produce a vacuum.

For very coarse gravels a similar method should be applied, the sample having a weight of at least 1,000 grams. The apparatus should be of metal and of a corresponding size.

Weight per cubic foot.—This value is easily obtained from the apparent specific gravity, D_a, and is equal to $62.484 \times D_a$ lbs.

In referring to the weight per cubic foot, the physical condition of the material should be referred to as loose or compact, and the degree of moisture should be stated as wet, moist or dry. Compact sand or gravel may be described as material that has been deposited in a bin from a height or has been shaken down in a vessel.

Percentage of voids.—If D_r is the real specific gravity, and D_a, be apparent specific gravity the percentages of voids (v) may be calculated from the following formula:—

$$v = 100(D_r - D_a) \div D_r.$$

It has been found that in the case of a uniform sand made of equal spherical grains the voids vary between

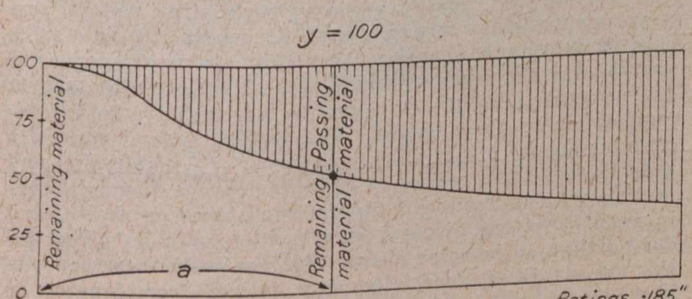


FIG. 1.—GRANULAR METRIC ANALYSIS—SHADED AREA IS PROPORTIONAL TO FINENESS OF MATERIAL

25.95% and 47.64%, depending upon the arrangement of the grains. In the measurement of sands containing grains of different size and of angular shape, the percentage of voids was very often nearly 37%, the average of the two extreme theoretical values. The voids are lower in sands made of grains varying in size than in uniform material; they are also lower in coarse sands than in fine-grained ones.

Diagrams of percentage of voids in functions of the apparent specific gravity, for given values of real specific gravity are straight lines. If the apparent specific gravities are taken as abscissae, and the percentage of voids as ordinates, all the diagrams corresponding to different values of D_r converge at the point $v = 100$ on the axis of the ordinates. The diagram for which $D_r = A$ cuts the axis of the abscissae at a point for which $D_a = A$ (Fig. 3).

The percentage of voids may be directly measured by using a beaker perforated on the side to admit a siphon.

The beaker is filled with water, and the glass tubing acting as a siphon brings the water in the beaker to a constant level. A volume V' of the material to be tested in then poured into the beaker driving a volume V of water out of the beaker through the siphon.

The percentage of voids (v) is given by the following equation:—

$$v = 100(V - V') \div V.$$

Permeability.—While the porosity of a sand or gravel is expressed by the amount of pore space or the percentage

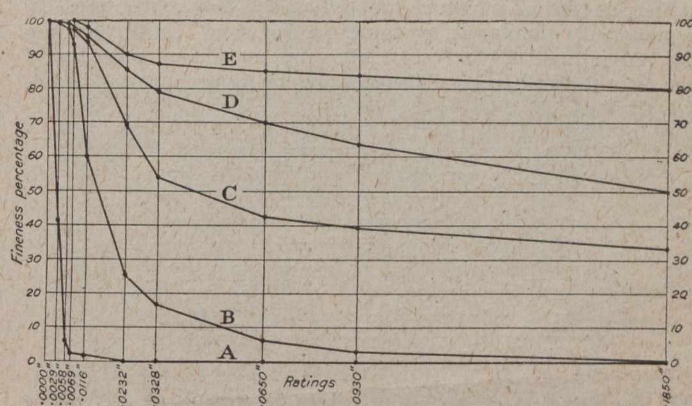


FIG. 2—GRANULAR METRIC ANALYSIS OF FIVE DIFFERENT SANDS AND GRAVELS OF VARIOUS PERCENTAGES OF FINENESS

of voids, the permeability is the quality possessed by certain of these materials to permit an easy passage of liquids or gases. This quality depends partly upon the percentage of voids, but also upon the size of the voids. It is a very important factor in moulding sands and filtering sands. If the pores are small, capillarity and friction prevent or lessen the passage of liquids and gases. Coarse material is therefore more permeable than fine grained. Sands uniform in size are also more permeable than sands of a similar grade, made up of various sizes.

Permeability may be directly measured by filling a tube with a given volume of the material to be tested, and measuring the time necessary for a given quantity of water or air to pass through the material.

Absorption.—On putting a sample of dry gravel or sand into water, a certain amount of water is absorbed by the fragments. The amount depends principally upon the nature of the fragments. The absorption for quartz grains is negligible, but for cleavable minerals such as calcite and feldspar it is larger, and for fragments of porous rocks, such as sandstone, still greater. To measure the percentage of absorption, a sample of the material is placed in water for about one hour; it is then removed and spread on blotting paper and when surface dry, weighed in this state. The sample is then dried over a hot plate to a constant weight. The difference in weight between the surface-dry material and the dried material, multiplied by 100 and divided by the weight of the dried material, gives the percentage of absorption.

Moisture.—The percentage of moisture is obtained by weighing a sample of the material in its natural state—as it comes out of the pit or ready for use—and the sample thoroughly dried. The difference of the two weighings, multiplied by 100, and divided by the weight of the dried sample, represents the percentage of moisture.

Percentage of silt.—This is measured as follows: A weighed sample of the dry material, about 200 grams, is placed in a broad glass tube provided with perforated stoppers and tubes at each end. The tube is placed in the vertical position and a current of water allowed to enter through the bottom and pass away through the top. The tube is shaken from time to time, and the current of water continued till it carries no more silt and is perfectly clear when coming out of the tube. The material is then again dried till the weight is constant. The difference between the weights of the material before and after the experiment, multiplied by 100, and divided by the weight of the sample before the experiment, gives the percentage of silt.

Bonding power.—The bonding power is the property of certain sand grams to adhere more or less to one another. It is an essential quality of a moulding sand, as it permits the sand to retain in all its details the form of the mould. A dry sand made only of quartz grains does not exhibit any bonding power. This quality is principally due to the presence of some cementing material coating the grains. This material is generally clay, though the amount of ferric hydroxide and of moisture also affect the bonding power. It is generally increased by tamping the sand, thus reducing the percentage of voids and allowing more grains to touch one another and to cement together. This property is some-

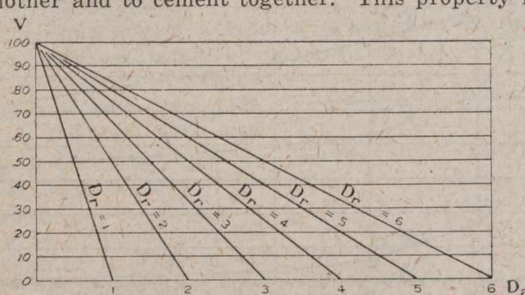


FIG. 3—PERCENTAGE OF VOIDS (V) IN FUNCTION OF APPARENT SPECIFIC GRAVITY (D_a) FOR DIFFERENT VALUES OF REAL SPECIFIC GRAVITY (D_r)

times artificially increased in foundries by adding molasses, clay, linseed oil or "glutrin" to the sand.

The bonding power is measured by moulding the sand into briquettes, and testing their tensile strength in a specially devised testing machine. The ordinary cement testing machine is not suitable, as it is not sufficiently delicate for testing materials of such low tensile strength.

Composition

The composition of sands and gravels may be determined either by a chemical analysis or by mineralogical examination. For most of their uses the chemical composition is of little interest, as there is no simple relation between it and the physical properties of the material. For some purposes, such as for glass-making and in chemical or metallurgical industries, knowledge of the chemical composition is absolutely necessary. A chemical analysis of sand is a long and tedious operation, and little work of this kind has been done on the several varieties of sand.

As in igneous rocks, there is a relation between the chemical and the mineralogical composition of a sand. Analyses of sand may be calculated in terms of a certain number of standard minerals, by a method similar to the one used for the quantitative classification of igneous rock.

The calculated mineralogical composition is called the *norm*, and should not be taken for the mode or actual mineral composition of the examined sample. A large amount of calcite in the norm indicates a sand originating from the decay of limestone. The feldspars are usually present as calculated. Corundum is a very rare constituent of sands, but its presence in the norm may be due to the presence of kaolinite or clay in the sand. Magnetite is very common as small grains in sands. Wollastonite, enstatite and grünerite are the three simplest mineral molecules entering in the composition of micas, amphiboles and pyroxenes; their amount in the norm gives an indication as to the quantity of the complex iron, magnesium and calcium bearing silicates present in the sand.

Quartz is the more common constituent of sands; its percentage in the norm is sometimes much lower than the percentage of silica in the chemical analysis, since a large amount of silica may be combined with oxides to form silicates.

A mineralogical investigation is more easily made; the sand or gravel may be examined with the naked eye, or in greater detail under the microscope. The use of heavy solutions allows a separation by gravity of the fragments, which is very useful when the material is made of two or three minerals of very different specific gravity.

Sands are in general composed principally of quartz, which frequently accounts for more than 70% of the total; the other minerals found in Ontario sands are feldspar, mica, amphibole, pyroxene, calcite, magnetite, garnet, zircon, kaolin and limonite. In coarse sands rock fragments are found just as in gravel. A great number of gravels, principally in the southern part of the province along the Great Lakes, are composed of limestone pebbles with a small proportion of igneous and metamorphic rocks. The limestone accounts very often for more than 75% of the total, but in some cases the gravel is of sandstone or quartzite pebbles.

Slate pebbles should not be present in a good gravel, as the cleavage and softness of slate are a source of weakness either for roadwork or concrete structures. On roads the slate is very soon pulverized to dust, and in concrete beams it may reduce the compressive strength 75%. In the districts of Ontario near the border of the Laurentian granitic belt, the gravels are composed of igneous rocks as the predominant material.

Origin of Sands and Gravels

Sands and gravels are produced by the weathering of other rocks, and may remain in place or be transported by the action of water or wind. As a rule the material remaining in place is the most angular, the transported material being well rounded, although some of its grains may be broken into conchoidal chips. The principal sand and gravel deposits met in southern and eastern Ontario belong to one or other of the following types: (1) Residuary sands and gravels; (2) talus deposits; (3) alluvial deposits; (4) glacial deposits; (5) dune sand.

Residuary Sands and Gravels

These represent the products of weathering of rocks which remained at their original place of formation. At the early stages of the decomposition, the result is a residuary gravel, but later each rock fragment is decomposed into smaller pieces, and so on until each individual mineral grain is liberated. Of course, the products more or less soluble are progressively washed away by percolating waters, and only very resistant minerals such as quartz remain as the final product of the disintegration. The grains are generally angular and the resulting sand sharp. Very often the quartz grains retain a coating of clay-like material due to the decomposition of the silicates. The residuary sand generally contains about 70% of silica, and about 20% of alumina and iron oxides. The residuary deposits may be found in connection with siliceous limestones, sandstones or shales, and in such cases the original stratification may be preserved during the weathering process. But generally these deposits are not stratified, especially when derived from igneous or metamorphic rocks. In southern Ontario some deposits of residuary sands overlie Laurentian granite.

Talus Deposits

During the weathering of rocky hills or cliffs the debris does not remain in place, but rolls down to the bottom of the cliffs where it accumulates and forms a talus deposit. This type of deposit is generally a sharp gravel containing fragments of various size originating from the neighboring rocks. The disintegration of the large fragments leads to the formation of a sand whose grains roll farther down the slope, forming a talus under the natural angle of repose. Such deposits are found in southern Ontario along important ridges such as the Niagara escarpment and the granitic ridge marking the southern border of the Laurentian plateau.

They do not show any stratification and are generally very narrow.

Alluvial Deposits

The most important of these deposits in Ontario are those formed in connection with the history of the Great Lakes. Extending over hundreds of miles, these ancient beaches constitute extensive reserves of sand and gravel. The grains are generally rounded and are composed of different minerals, quartz being the most abundant in the sands. The nature of the gravel pebbles depends upon the constitution of the neighboring rocks. The alluvial deposits always exhibit stratification.

Alluvial deposits are formed not only on the shores of seas or lakes but also in the valleys of rivers; by repeated freshets, the solid particles carried by the water are spread over the soil and increase the alluvial deposit little by little. If the river passes through a lake, the basin if the lake may in time be filled by the silt brought in by the river. A similar process goes on where the river flows into the sea; as the current becomes slower, the solid particles are deposited and so begins the building up of a delta.

Alluvial deposits of sand and gravel are most numerous in southern and eastern Ontario and are generally well suited for building material.

Glacial Deposits

These deposits have been brought into their present position by the action of the ice-sheet which in Pleistocene time covered the greater part of eastern Canada. Most of the material in these deposits consists of fragments of northern rocks. The material is very often a mixture of sand, gravel and clay, and is known as glacial drift. It is sometimes heaped up in small conical hills or drumlins, as well as in moraines of various types: Ground moraine, marginal moraine, and terminal moraine. These deposits rarely furnish pure sand or gravel.

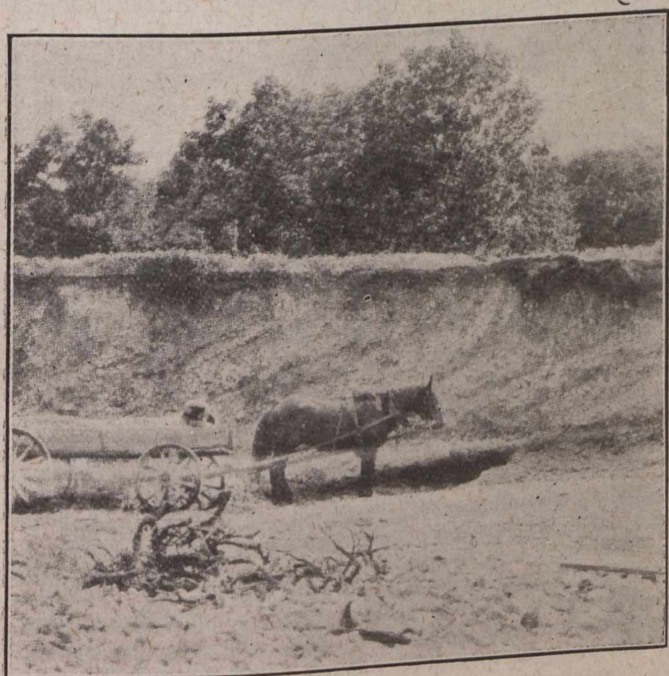


FIG. 4—LAKE ALLUVIAL DEPOSIT OF GRAVEL—NOTE STRATIFICATION

Dune Sands

This sand is carried by the action of wind. The sand resulting from the decomposition of sandstone, granite or other rocks containing quartz may be carried by the wind for long distances. The deposits formed in this way are as a rule unstratified; while the grains are more rounded than in other types of sand. Dunes are generally grouped together in long ridges of hills at right angles to the prevalent direction of the wind.

The most important dune formation in south-eastern Ontario lies on the western coast of Prince Edward county. Enormous reserves of sand have been accumulated there between Wellington and Sandbanks; this aeolian formation is gradually advancing inland.

Uses of Sands and Gravels

The principal uses of sand and gravel may be enumerated under the following headings: Concrete or building sand; concrete gravel; road gravel; moulding sand; glass sand; filtering sand; and locomotive sand.

Concrete or Building Sand

A good concrete or building sand should consist principally of quartz grains free from loam, dust or vegetable matter. The grains should be angular and sharp; the material should pass a ¼-in. mesh, but not more than 15% of the grains should pass the 50-mesh sieve, and not more than 2% should pass the 100-mesh sieve.

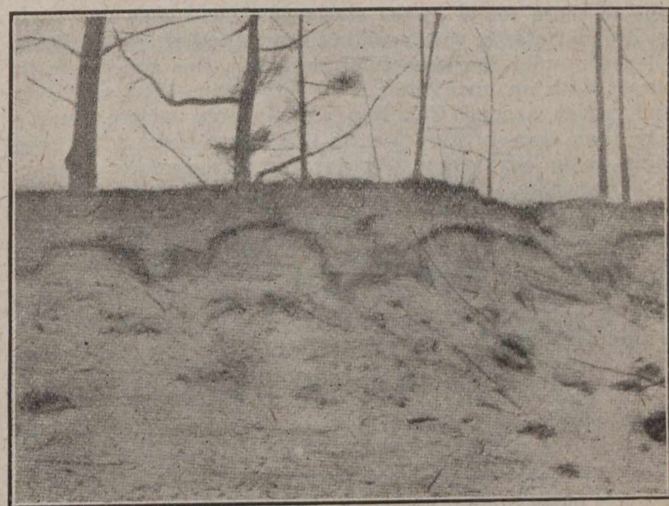


FIG. 5—SURFACE MODIFICATION IN SAND FORMATION BY THE ROOTS OF TREES

The tensile strength of a briquette made by mixing the sand with Portland cement in the ratio 3 of sand to 1 of cement must be similar to the tensile strength of a briquette prepared under the same conditions with standard Ottawa sand.* There are plenty of reserves of good building sand in Ontario, but in the neighborhood of the large towns the deposits are more or less exhausted; builders in Toronto, for instance, are forced to bring considerable quantities of sand from pits located 30 and 40 miles away.

Concrete and Road Gravels

The best gravel for concrete is composed chiefly of very fine pebbles, approaching pea-gravel in size. The material should be retained on a ¼-in. screen and pass completely through a 1½-in. screen. The pebbles should be principally hard limestone, sandstone, or granite; pebbles of shale or other fissile rocks should not be present. The proportion of silt ought also to be a minimum.

Road gravel is coarser than concrete gravel, and is usually the run of the pit. Pebbles larger than two inches in diameter should be discarded or may be used in the foundation of the road, but on the upper part of the roadbed it is advisable to place finer material. The presence of shale and loam in the gravel is objectionable. Such gravel should be carefully avoided, since these materials are quickly crushed to dust by the traffic.

Moulding Sand

The essential qualities of moulding sand are its permeability to gases and vapours, its bonding power by which

*This material occurs as a large deposit of silica sand at Ottawa, Illinois. Owing to the uniformity of size and composition of this sand, it is used as a standard specification sand all over this continent. The grains pass a 20-mesh and are retained on a 30-mesh screen.

the sand holds the form in which it has been moulded, and its infusibility at high temperatures. The most important of these qualities is the bonding power, which depends more or less upon the amount of clay, iron hydroxide and water mixed with the sand, but the relation of the chemical composition of the sand to the bonding power is not as yet well understood. All the methods proposed to get quantitative figures on the bonding are only approximate. A foundry foreman usually determines the bonding power by squeezing a sample in his hand, and noting whether it holds its shape.

For a long period nearly all the moulding sand used in Canada was imported into this country from the United States. There are, however, several important deposits of moulding sand in Ontario, occurring in very similar conditions to those found in the states of New Jersey and New York. In Ontario, the moulding sand appears generally as a deposit under the superficial soil when this soil comes in contact with an underlying sand formation. The moulding sand, which around Hamilton and Toronto seldom exceeds more than two or three feet in thickness, seems to owe its origin to the circulation of water and to the action of vegetable and other organic life. It occurs in very different grades of fineness, the coarsest material being used for large and rough castings, while very fine moulding sand is used for brass and copper castings. As this is a high-priced sand which can be exploited without expensive equipment, there is a possibility of developing a considerable industry in this material for Canada.

Glass, Filtering and Locomotive Sands

Sand for glass manufacture should be as pure as possible, and approach in composition the standard of pure silica. The constituent grains should, therefore, be essentially of white quartz; all other minerals, and especially the ferro-magnesian ones, must be considered as impurities. The presence of iron in the sand imparts to the glass a peculiar green color, and seriously impairs the quality. Various processes have been proposed to neutralize this green-iron coloration through the addition of manganese, nickel oxide or selenium. Certain iron-bearing minerals can be removed from sand by magnetic separation. As a rule a good glass sand should contain more than 99% of silica and less than 0.2% of iron oxide. A small percentage of alumina and alkalies in the form of feldspar grains is valuable in a glass sand, as it reduces the quantity of these materials to be added to the batch.

The shape of the grains is without importance for glass sand. Sometimes this pure sand is obtained directly from the pits. In other cases it is prepared by crushing a more or less disintegrated sandstone, as at the plant of the Oneida Lime & Sand Co., near Hagersville, Ont. The size should be a good medium; the majority of the grains should pass a 30-mesh sieve and remain on a 100-mesh sieve. The coefficient of uniformity ought to be greater than 50, and the grade between 5 and 7. The presence of grains smaller than 0.1 mm. causes the formation of "seed" in the glass.

Filtration sand or gravel must be very clean, and contain only a small amount of silt, loam or other impurities. The fineness of the material depends upon the kind of filtration to be done. For this purpose, washed material is always to be preferred to the ordinary pit material.

Sand for locomotives should consist of hard grains; it is used to prevent the slipping of engines and cars on railway tracks. It must be very clean and well washed material, in order to prevent the stopping of the sand pipe.

Other Uses

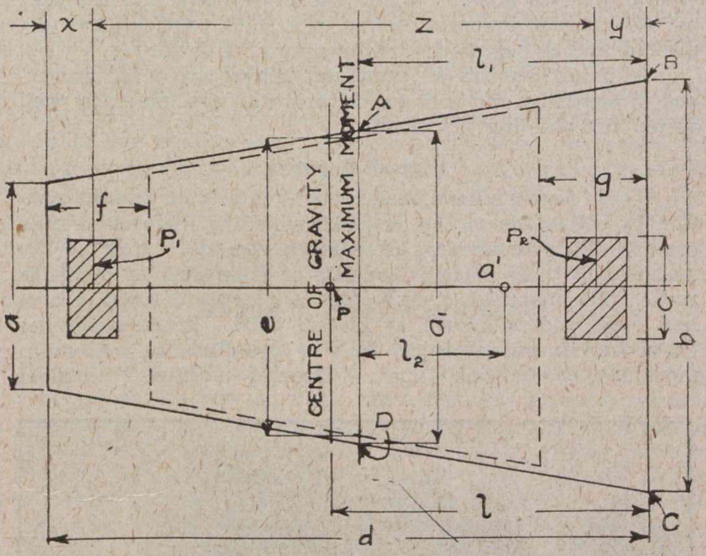
The finer grades of gravel are also used on roofs. Sand is also used as an abrasive for cutting and polishing stones; also as a filler for paper, as filling material for fire-proof safes, for the making of sand paper, and as a raw material in pottery and brick manufacture. The production of white sand-lime brick requires a good, clean, sharp sand, quite free of alkalies.

STANDARD METHOD OF COMPUTING COMBINED FOOTINGS

By N. E. Helff
Wm. Steele & Sons, Ltd., Toronto

Much time and trouble may be saved the designer in reinforced concrete, as well as in any other type of construction, by a clear statement of the various steps to be taken in the design. The method proposed below has been found to possess the merits of directness and ease of application.

It is assumed that the column load P_2 is approximately twice P_1, and that any kind of column, preferably concrete, is used. It is assumed that the stresses and methods of taking care of reinforcing will be governed by the recommendations of the Joint Committee. The footing is assumed as not projecting beyond the columns in the direction "d" far enough



to produce more than 40 lbs. per sq. in. tension in the concrete due to bending if figured by the formula, $f=My/I$.

A=area of footing required,
s=allowable soil pressure per sq. ft.,
F=weight of footing.

To establish the size and plan shape, the following formulas may be used:—

$$l=P_1(y+z)+P_2(y)\div P_1+P_2,$$
$$A=(P_1+P_2+F)\div s,$$
$$a=2A/d\,(3l/d-1),$$
$$b=2A/d[1-(3l/d-1)].$$

Thus all dimensions required are given.

The point of maximum moment, which is at the point of zero shear, is found in the following manner.

Solve for l_1 in $[bl_1-(b-a)l_1^2/2d]s=P_2$, (Hool) which when simplified should give a quadratic equation of the form $ml_1^2+nl_1+q=0$, and solving this for the smaller factor by the formula, $l_1=n\pm(n^2-4mq)^{\frac{1}{2}}/2m$. This will give the distance of the point of maximum moment from the edge b.

The next step is the finding of the centre of gravity a^1 of the trapezoid, $ABCD$, with respect to the side a_1 or $l_2=l_1(a_1+2b)/3(a_1+b)$, after which the maximum moment can be figured in in.-lb. by the following formula:—

$$M=P_2(l_1-y-l_2)\times 12 \quad \text{(Hool)},$$

this giving the moment for band e steel, and depth calculations.

After this the footing must be examined for diagonal tension, punching shear and bond. Transverse reinforcement bands f and g must also be established. The moment for these is calculated by $M=3P_2(b-c)^2/2b\times$ in.-lb.

The Pacific cable board is considering the duplication of its cable from Canada to the Antipodes.

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by

The Monetary Times Printing Co. of Canada, Limited

President and General Manager JAMES J. SALMOND

Assistant General Manager ALBERT E. JENNINGS

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.

Telephone, Main 7404. Cable Address, "Engineer, Toronto."

Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

THE ECONOMIC BASIS OF ENGINEERING

MODERN engineering is very much a matter of dollars and cents. The problem of the technologist is not to determine whether it is humanly possible to do a thing, but whether the doing is commercially worth while. The mountain sections of our railways might conceivably be rebuilt to practically level grades, a 3,000-ft. span might be thrown across the river at Windsor, or freight might be transported from Toronto to Montreal by aeroplane. There is nothing scientifically impossible in these proposals, but there is no immediate likelihood of their being carried out. And the simple reason is that it would not pay.

Of course, what is not now practicable may become so in a few years through patient labor and observation, or perhaps overnight through revolutionary discovery. The unbelievable of to-day becomes the commonplace of to-morrow. A learned gentleman once proved to the satisfaction of himself, if not of the rest of the world, that a steamship could never carry enough coal to propel itself across the Atlantic, and conservatives in engineering may this very moment be taking positions equally absurd. The principle remains, however, that the merits or demerits of a project are weighed in the unemotional balance of commercial practicability.

In other days, investigators were wont to withdraw to a seclusion as profound as their thought, and there, lone-handed and free from the dreaded taint of commercialism, toil long and hard in the effort to usher in a new scientific epoch. Their interest was less in the practical value of results than in the satisfaction of discovery. But times have changed. The lone recluse, with test-tube and toy furnace, has small chance of revolutionizing industry as compared with a vast research laboratory boasting an annual budget of a million dollars and a staff of hundreds of trained investigators systematically and aggressively working toward commercial ends. The commercial spirit is now the major force back of research. Invention and discovery have become the objective of highly-trained corps of workers directed by Napoleons of science.

It has thus come about that the big things now done in the world of engineering are done with an economic motive. Little interest is manifested in results that are merely curious or are simply satisfying demonstrations of the working out of natural law. Such belong to a cloistered age, when the elements of time or cost or practical usefulness were but little considered. Engineering has now become, to quote a modern apostle of engineering economics: "The conscious application of science to the problems of economic production."

FORTHCOMING CONVENTION OF AMERICAN WATER WORKS ASSOCIATION

AS the time for the holding of the Fortieth Annual Convention of the American Water Works Association draws near, interest is steadily growing, and it looks now as though it would eclipse all that have preceded it in point of numbers and interest generally.

Many men who have made a name for themselves in the realm of water works engineering will be there, and a most cordial invitation is extended to all water works men throughout Canada to be present at all or any of the sessions of the convention, and to take part in the entertainment and inspection trips.

The conventions of the American Water Works Association are designed primarily for the improvement of public water supplies through friendly intercourse of experience and knowledge by men who are responsible for the design, construction and operation of water works plants.

An invitation, together with program, has been sent to all water works officials in Canada who are not now represented in the association to attend this convention, which will be held at the Windsor Hotel, Montreal, from the 21st to the 25th of June, 1920.

If any of our readers connected with water works plants in Canada have failed to receive such an invitation and program and will simply drop a line to that effect to Mr. J. M. Diven, secretary, American Water Works Association, 153 West 71st Street, New York, one will be promtply forwarded.

A NOTABLE ENGINEERING CONFERENCE

ONE of the most important meetings that has ever been held in the history of the engineering profession in the United States will take the form of a conference of delegates from the national, local, state and regional engineering organizations at Washington, D.C., on June 3rd to 4th. It is the first attempt to bring about a solidarity in the profession through a federation of the engineering organizations in that country in a comprehensive organization dedicated to the city, state and nation. The gathering together is the direct outcome of the recommendations of the Joint Conference Committee, representing the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Mining and Metallurgical Engineers. To these recommendations the American Society for Testing Materials and the Trustees of the United Engineering Society subsequently subscribed. The call has been issued to about one hundred engineering organizations in the United States, inviting them to send delegates to the conference. More than sixty organizations have already signified their intention to participate, and will be represented by more than 125 delegates, who will represent an aggregate membership of more than 100,000 engineers.

There is much promise in this for the profession the continent over. Whenever engineers get together, join forces and suppress petty institutional rivalries, there is undoubted progress. Recognition of eminent professional status will come with steadfast devotion to statesmanlike policies within and on the borders of the profession.

DISCUSSING GOOD ROADS AT WINNIPEG

SUBSTANTIAL benefit to the country is bound to come from the discussion of the problems of road-making and maintenance at Winnipeg this week. The Seventh Canadian Good Roads Convention contributed much to the returning enthusiasm for solid, practical works of peace. Excepting the supply of power, no public work approaches in importance and urgency the furnishing of adequate primary transportation. The breakdown of the railroads in America has thrown the country violently back upon private and primary means of moving materials and products in order that industry may proceed. This is but another corroboration of the wisdom of those who have been urging the case of the better road, not only at Winnipeg this week, but through many long years, when enthusiasm and support were scant and uncertain.

PERSONALS

CHARLES JOHNS has been appointed to the position of manager of the street railway of St. Thomas, Ont.

J. F. ROCHE, of Montreal, has been appointed resident engineer at the plant now being erected at Bienfait, Sask., by the Lignite Utilization Board.

A. H. SANCTON, late consulting engineer of the McIntyre mine has joined the force of the Kipawa Pulp & Paper Co., with headquarters at South Temiskaming. He will be construction engineer.

PROF. E. G. MATHESON of the University of British Columbia has been appointed president of the provisional Executive Council of the Association of Professional Engineers of the province of British Columbia.

ALBERT R. RAYMER, a graduate of the University of Toronto with the class of '84, has been promoted from the position of assistant chief engineer of the Pittsburgh and Lake Erie Railroad, to that of chief engineer.

CHARLES HERVE JETTE has resigned his position as assistant engineer, Department of Public Works, Canada, and has accepted a position in the engineering department of the St. Maurice Pulp & Paper Co., Three Rivers, Que.

MORRIS KNOWLES, F. W. THOROLD and E. M. PROCTOR constitute a board of engineers charged with making a complete report on the border water situation to the Essex Border Utilities Commission.

ARTHUR L. FORD, of Calgary, has been elected secretary-treasurer of the Calgary branch of the Engineering Institute of Canada, succeeding C. M. Arnold, who has gone to Lethbridge to accept a position on the construction of the Lethbridge Northern irrigation project.

F. J. CROSSLAND, mining engineer of Vancouver, has been commissioned by the Minister of Mines of British Columbia to carry out a thorough inspection of the hematite and limonite ore deposits of the Clinton Mining Division, in the White River region, and to establish as far as is possible in one season's work the tonnage available of this mineral.

E. L. COUSINS, general manager and chief engineer of the Toronto Harbor Commission was entertained at dinner at the Engineers' Club on Monday evening, May 31st, by the heads of departments of the Commission. Mr. Cousins returned from England a few days ago after an extended business trip. He is submitting a complete report to the Commissioners shortly.

ARTHUR SURVEYER was, on May 27th, elected chairman of the Montreal branch of the Engineering Institute of Canada; James H. Hunter was elected vice-chairman and J. L. Busfield secretary-treasurer for the ensuing year. J. T. Farmer, O. O. Lefebvre, George R. McLeod, W. J. Francis, J. Duchastel, S. F. Rutherford and K. B. Thornton were elected members of the new council.

A. R. DECARY, of Quebec, at a meeting of the Corporation of Professional Engineers of the Province of Quebec, held on may 27th, was elected as president of the council for the ensuing year. The other members of the provisional body which during the last year has been organizing the corporation on a sound working basis were also elected. The formally-elected council comprises, in addition to the president, the following: Vice-president, Walter J. Francis; honorary secretary-treasurer, Frederick B. Brown; Councillors for the district west of Three Rivers, Arthur Surveyer, W. F. Tye, Walter J. Francis, K. B. Thornton and Frederick B. Brown; Quebec City and east of Three Rivers, A. R. Decary, A. B. Normandin and J. Gibeau.

OBITUARY

TIMOTHY FOLEY, head of the firm of Foley Bros. & Stewart, railway builders, known from Alaska to Mexico, died recently at St. Paul, Minn., in his 83rd year. Mr. Foley who was widely known in Toronto, built nearly all of the railways in northern Ontario, including the Algoma Central, the Lake Superior branch of the Transcontinental R.R., the Nickel Co.'s line at Sudbury and 600 miles of the Canadian Northern. The Ross-Stratton government offered them the contract to build the Timiskaming and N. O. line in 1902, but they declined. Mr. Foley was president of the First National Bank, and owned ranches, farms and timber limits in Canada and Montana, while the flourishing town of Foley, Minn., is part of the estate. His wealth is estimated at many millions, but nothing will be definitely known for some time in this respect. The Foley boys were interested in the lumber trade and had sawmills at Almonte and Hall, on the Mississippi River 40 years ago. They went west with the C.P.R. builders in the early 80's. Their contracts in Canada which they completed in the early years of the war, were the Ocean Terminals at Halifax, and the nine miles of tunnel through the Rocky Mountains, at Roger's Pass, in Alberta. Mrs. Foley who survives her husband, is advanced in years, and belongs to a widely known Ontario family. She was a niece of the late ex-Premier Alexander Mackenzie.

Herbert Hoover, now president of the American Institute of Mining and Metallurgical Engineers, has applied for membership in the American Association of Engineers. General Leonard Wood is already a member. The engineer is beginning to emerge politically.

The third annual convention of Canadian Chemists was held at Toronto on May 27th and 28th with Professor W. Lash Miller as chairman of the Convention Committee. Meetings were held in the Chemistry and Mining Building of the University of Toronto, interspersed with numerous social diversions and visits to industrial and civic plants.

Sir W. G. Armstrong, Whitworth & Co., Ltd., have taken up the manufacture of water turbines. The present intention of the company is to instal water power plants throughout, manufacturing most of the engineering requirements at their works in Elswick, Glasgow, and Manchester. Probably a great deal of the heavy material will be made at Montreal, where the company already has a works.

Charles Evan Fowler, of New York, with the co-operation of Gustav Lindenthal, associated consulting engineer, is preparing a complete report on the proposed 28-million dollar suspension bridge to cross the Detroit River at Windsor. For the purpose of the report, the assumed span will be about 1,800 ft., there will be two 28-ft. roadways, two 7-ft. sidewalks, two tramway tracks and four steam railway tracks designed for E60 loading.