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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

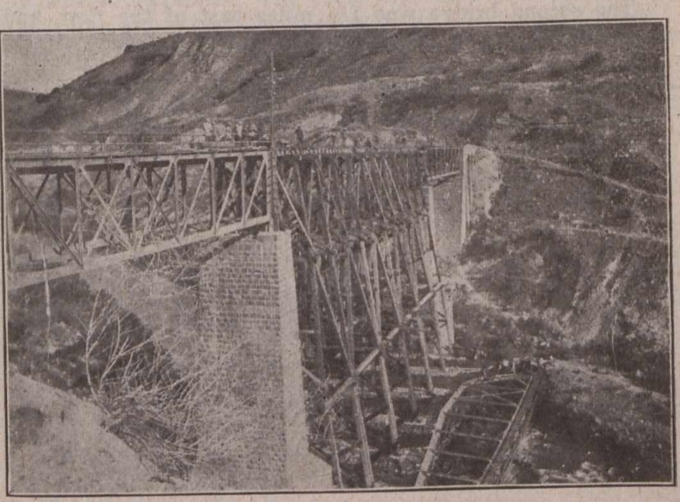
Three Bridges in Palestine Built by Canadians

At Request of British War Office, Company of 254 Picked Volunteers from Corps of Canadian Railway Troops Joined Egyptian Expeditionary Force October 1st, 1918, and Replaced Railway Bridges Destroyed by Turks

By MAJOR A. P. LINTON, O.B.E.
Bridge Engineer, Department of Highways, Province of Saskatchewan

IN August, 1918, the War Office asked Brig.-Gen. (now Maj.-Gen.) J. W. Stewart, C.B., C.M.G., G.O.C. of the corps of Canadian Railway Troops, to select a Canadian bridging company from units under his command in France for service with the Egyptian Expeditionary Force. The writer was selected for the command, and the other officers were Capt. E. P. Muntz and Lieuts. M. Helyer, M.C., Price, Johnstone and Sanderson.

The corps of Canadian Railway Troops consisted at the time of thirteen battalions, the C.O.R.C.C. and several companies engaged on special work. Each C.O. of the various C.R.T. units was asked to send volunteers, picked for their experience in bridge work, to the mobilization centre chosen. Some 320 were men sent, and from these were chosen the 248 other ranks called for in the establishment. The men chosen were of a splendid type; every essential trade was well represented. Most of the men had worked for years on bridge construction on the various Canadian transcontinental railways. The N.C.O.'s were nearly all bridge foremen of wide experience, and were chosen from volunteer N.C.O.'s who were all required to revert. The ones chosen were given acting rank, with promise of confirmation if they "made good."



YARMUK BRIDGE NO. 1—NOTE DESTROYED TRUSS IN RIVER BED

Such distinctly Canadian equipment as the army does not stock was taken along. This included cross-cut saws of American pattern, peavies, dollies, two hoisting engines and iron parts for two pile drivers. Transport consisted of one Ford car, two three-ton lorries, two motor cycles, one horse and cart and one saddle-horse.

Mobilization was completed in two weeks and the company entrained for Marseilles, where three weeks were spent waiting for a boat. An uneventful trip of nine days across the Mediterranean landed the company at Kantara, on the Suez Canal, on the last day of September, 1918. Only one day was spent there, and a night on the train took the company to Ludd, advanced H.Q., Railway Services, Egyptian Expeditionary Force. There orders were received and work assigned the company. The orders were, briefly:—

YARMUK BRIDGE NO. 2

"The Turks have blown up two bridges near Semakh. See them. Tell us what material is required, and get the line through."

It took two days for the company to reach Semakh, and it at once proceeded to the work, some three miles east. The company was accompanied by two companies of the Indian army, who stayed with it and relieved it of all duties in connection with guarding the camp. Machine guns were posted on each of two high hills overlooking the camp, and no trouble was caused by the hostile Arabs.

The first bridge crossed the Yarmuk river about two miles from where it enters the Jordan, of which it is the principal tributary, and the camp was about five miles from the sea of Galilee. The crossing consisted of a 50-metre bowstring truss with a 30-metre lattice girder at either end, all on stone piers and abutments. The middle 50-metre truss had been destroyed by the charge and had fallen clear of the east pier. The west end had fallen about half way down the pier and had there remained fixed. It was evident the steel was beyond repair, and it was decided to scrap it and trestle across the break.

At that time there was a 14-mile break in the railway between Ludd and the Yarmuk river, and all material reaching us had to be carried in lorries across the gap. It was impossible to take any heavy material with the company, so it landed with only the lightest of its equipment: Some blocks and tackle, a few jacks and some gun-cotton. It was estimated that two weeks would be required to link up the railway, so that much time was available to clear away the obstructing truss. This was done according to plan sent, but only by strenuous effort. Two men were nearly killed by the snapping of a cable.

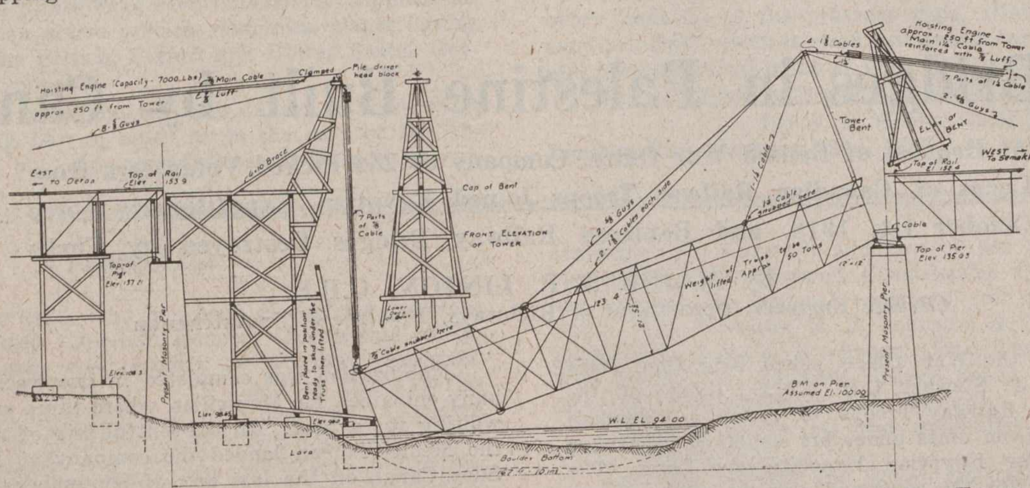


Diagram Showing Arrangement for Lifting Undamaged Portion of Steel Truss, Yarmuk Bridge No. 2

After the destroyed span had been rolled to one side, material began to arrive and the pedestals for the trestle were started. Cofferdams were made of sand bags. These merely quieted the water enough to allow the concrete to set. Gravel was brought from the shores of the sea of Galilee, and a very good concrete resulted. Each bent was supported on three concrete pedestals, which were tied together by two rows of railway rails, three rails to each row.

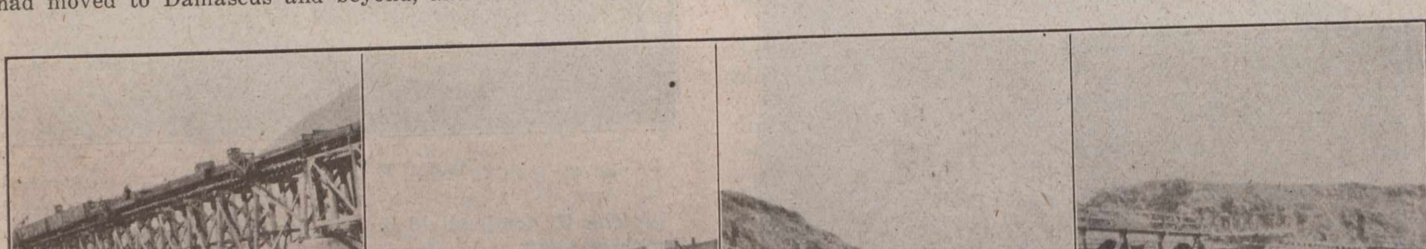
The altitude of the camp was about 690 ft. below sea level, and about this time malaria, which is so prevalent in the Jordan valley, began to show its effects, and the men began to go to hospital in batches. None were sent until their temperature reached 105°, but some days 30 men went. In the first two months, 108% of the total strength of the company entered hospital, so, naturally, the working strength was almost totally depleted. At one time only one officer, one N.C.O. and six working men were left.

The work was of the utmost importance. Desert corps had moved to Damascus and beyond, and this railway was their main source of supply. Ammunition and rations had to get through, and although supplies were brought up to Semakh by train and portaged across the break by 300 camels, the delays were costly and the amounts transported necessarily small.

A Royal Engineer officer and 24 other ranks were attached to the company. They did good work, but would not work off the ground, so their usefulness was limited. They framed all timber for the first bridge. Three hundred of the Egyptian labor corps, under a white officer, were attached to the company. They did all lifting and carrying and the manual work in connection with the concrete work. This labor corps was largely responsible for the success of the British arms on this work. Stupid and slow as they were, when properly handled, they did enormous amounts of work. One native officer and 22 Egyptian army sappers were also attached, and proved very good craftsmen. It was to the Canadians alone, however, that the erection of the trestle depended, and progress was slow during a period of six weeks until enough men returned from hospital to make a showing.

The first bridge consisted of five double bents, 28 ft., centre to centre, each bent resting on the three concrete pedestals, as already mentioned. At the top of the first deck were placed A-frames to subdivide the span, and the third deck consisted of bents placed 14 ft., centre to centre, the limit of span allowed by the stringers. Rapid progress was made when the men returned, and the first bridge was completed early in December. Rail was 85 ft. above water.

The second bridge was 1½ miles east of the first, and was identical with it. The centre truss had the three panels



Yarmuk Bridge No. 1 Yarmuk Bridge No. 1 Yarmuk Bridge No. 2 Yarmuk Bridge No. 2

A Few Views of the Reconstruction of the Two Yarmuk Bridges to the east badly shattered, and this end of the truss had crashed to the river bed. The west end still rested on the rocker shoe, which was its original support.

It was decided to salve what was left of the truss, to lift it back into position, and to fill in the remaining space with a timber trestle. The new end post and new end diagonal members were strengthened by adding extra steel to give the increased section required. Some difficulty was experienced in getting tackle strong enough to make the lift, but finally the navy loaned the proper material.

Truss Lifted Into Place

At the east end a straight pull was taken from a temporary and stationary derrick built on the completed trestle, and at the west end a lifting pull was made by fixing a stiff leg on the top chord of the truss and pulling back from it. The two hoisting engines, one at either end, provided the pull. After the tackle was placed, the bridge was lifted into place in a few hours.

At this crossing considerable strengthening had to be done to the east lattice girder truss, which was also badly shattered. This was done by building two trestle bents underneath to relieve the truss of most of its load. This bridge was completed quickly and without a hitch.

The third and last work was at Hama, about 200 miles north of Damascus, on the Alieppo line. Hama is situated in a very fertile valley on the Orantes river, from which it is irrigated. Immense wheels, some of them 60 ft. in diameter, lift the water to flumes, generally built of arched masonry, and it is distributed over the land from off-shoots. The wheels are built entirely of wood and their creaking can be heard for miles.

Used Mahogany Worth $60,000

Lieut. Helyer and 20 sappers were sent in advance to clear away the destroyed truss, which was of 30-metre span. The Royal Engineers had estimated that this would take two weeks, but on the second day he wired that the site was clear.

The bridge was replaced by putting in a pier, which consisted of a double bent on piles, and using an army standard type of trussed girder. These were shipped in units of 20 ft., and one 40 and one 60-ft. were used.

The C.O. finally went to hospital with malaria, and Capt. Muntz completed the bridge in record time.

All material for the three bridges was handled and placed by overhead travellers. The cable was salved from an old Turkish line, and a traveller was made by the company blacksmiths from any material available. The lumber used came from India, and was a species of mahogany, and over $60,000 worth was used in the first two bridges.

Upon completion of the third bridge, all lines of military importance were once more in commission, and the company was taken down country by train. After a short stay at Kantara, it sailed for Marseilles, en route to England.

In a recent issue of *The Canadian Engineer* the recent annual meeting of the Engineering Institute of Canada was referred to as the thirty-third annual meeting of that society. That was an error, as the meeting was the thirty-fourth.

Successful flotation of a bond issue of $800,000 for the purpose of consolidating the liabilities of the Taylor Engineering Co., in liquidation, will result, it is expected, in prompt payment of the claims of some 300 or more creditors of that concern.

At a recent meeting of the Niagara District Hydro-Radial Union, Manager Yates, of the St. Catharines Hydro-Electric System, quoted F. A. Gaby, chief engineer of the Hydro-Electric Power Commission of Ontario, as having stated that when the present Chippawa-Queenston canal has been completed, the Commission will proceed to increase the production of the Queenston plant to 1,000,000 h.p., additional water to be procured under a new treaty with the United States government. Mr. Yates also quoted Mr. Gaby as having stated that the first 125,000 h.p. at Queenston would be ready for distribution in the fall of 1921, and a further 125,000 h.p. by the following spring.

SOME EXPERIENCES IN FOUNDATION FAILURES

By Reginald B. Evans
Engineer, Toronto Parks Department

When a young engineer has to decide on safe foundations for a railway, road or bridge, too much care cannot be taken, not only for the safety of others but for his own reputation.

The construction of the Toronto-Sudbury branch of the C.P.R., through several different geological formations, gave ample opportunity for the engineers to study foundations.

The Foundations for This Bridge Were in Solid Clay, But When a Pier Settled It Was Found That the Entire Bank Was Sliding Toward the Creek

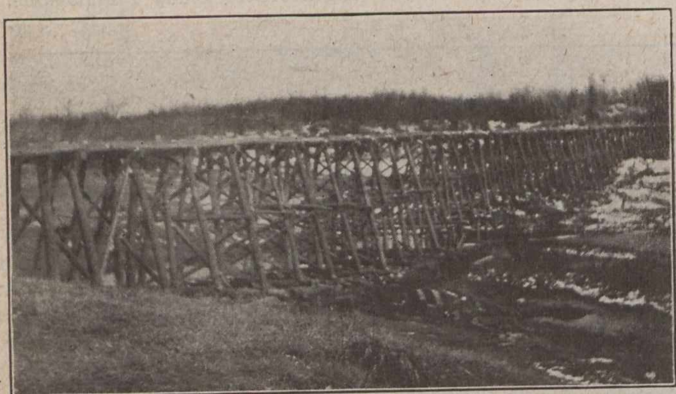
The northern part of this road was built through the granite country, where swamps lying between the rock ridges had to be crossed either on pile bridges or crossways, or by laying a temporary track and filling by means of gravel trains. On all occasions soundings were taken with iron pipe, and the depth to solid rock, or the character of the bottom, determined as closely as possible.

The first large swamp north of Parry Sound was about 900 ft. long, and although covered with evergreens and some

Building the C.P.R. Through a Swamp

birch, it was found very wet and considered unsafe for a track. Soundings were taken, and it was found to be from 12 to 15 ft. deep, with an uneven rocky bottom. It was decided to wait until winter, when the swamp would be frozen hard enough to support horses; then six rows of large logs were cut and laid lengthways with the line, at about 7 ft. apart, and across them sticks 40 ft. long were laid close together, requiring about 1,000 pieces for the 900 ft. The ties and rails were then laid and a gravel train was operated until the timbers and gravel sank into the swamp. This method could not have been used had not the timber been near by.

On another swamp the track was laid right on the surface, and an engine, which had stood on the rails for some time, settled on the right until it lay over on its side. To save time a temporary track was laid past the "wreck" and another engine put in use. On reaching this same spot in the swamp, it settled and lay over on its side.



Due to Insufficient Bracing, This Trestle Was Blown Down Before it was Completed

Care must always be used in taking soundings in a swamp to find the slope of the rock bottom in relation to the road, as when the rock slopes to one side and a fill is put on the swamp, it may slide down the rock and be lost. Several instances of this kind were experienced, the fill having slid down the rock during the night, leaving the rails and ties bolted together and 10 or 15 ft. above the dump, suspended in the air. This necessitated disconnecting the rails and letting the track down before another train load of gravel could be put on.

At another point, foundations for a bridge over a river were excavated in solid clay to a good depth, and concrete

On the C.P.R., North of Parry Sound, During Construction, Showing Foundation Difficulties

piers built up some 25 ft. to the bridge seat. Shortly after heavy trains were operated, one of these piers commenced to settle towards the creek. Soundings were taken, and it was found that the whole bank was sliding down the sloping rock. The only remedy was to excavate to the solid rock, blast out a few holes and set a new concrete foundation.

A temporary round-timber trestle, about 1,500 ft. long and about 20 ft. high, was constructed over the valley of a stream, and although the pile foundations under each bent were solid, there was a strong wind the first night after the bents had been raised, and as sufficient braces had not been put on each bent when it was raised, the whole trestle was found flat the next morning; it cost about $1,000 to re-hoist it.

"Safety First" in Foundations

Difficulty was experienced with one large trestle, some 90 ft. high, over a rock ravine. The foundations had to be blasted out of the side hill and then built up with broken stone, leaving a bench approximately 30 ft. long and 4 or 5 ft. wide, on which to lay mud sills to support each bent. There was a tendency to build up the benches without first blasting a good niche in the rock, thus reducing the cost, but no "safety first" rule was considered, as there was nothing to prevent the pile of loose rock used for a foundation from sliding down the hill unless a good niche had been blasted out.

Other foundations from which the writer has learned lessons were for large ore docks on Lake Superior, where soundings were taken and piles driven to solid rock. In some cases the rock was evidently broken, as two or more piles would have to be joined together and driven to a depth of 80 ft.

The nature of the ground should be carefully studied for some depth to make sure of the stability of the soil. In West Virginia, along the rivers where most of the railways run, the soil is a clay gumbo, getting very wet in some seasons of the year and causing large land slides. These can often be avoided by careful draining with weeping tiles, by piling and by avoiding making new cuts in side hills, thus changing the natural slope of the ground.

Conditions at Toronto Island

At Toronto Island, where nothing but pure sand is found, and that under water, a more stable foundation can be depended on than in most dry land. Piles are generally driven there by first putting down a 2-in. iron pipe, through which a stream of water is forced, thus boring a hole into which the pile is placed before the drop-hammer is used. The first concrete arch built in Toronto was across one of the lagoons on the Island. Twenty-six piles were driven about 3 ft. apart, both ways, to a depth of 20 ft. under each abutment. The span is 60 ft. clear, and the thickness of the arch at centre is 11 ins. This bridge has been in use a little over ten years and no settlement has been noticed.

The pier of a railway bridge was noticed one morning after a spring freshet, entirely undermined for a depth of 3 ft., although it had stood for a quarter of a century. The river bed was a coarse, hard gravel, too hard for piling, and a heavy rain had caused an eddy around the pier such as may often occur from logs, brush or ice jams. A cofferdam had to be built and excavation made to a good foundation.

Orders amounting to approximately $3,000,000 have been awarded to the Eastern Car Co., a subsidiary of the Nova Scotia Steel and Coal Co., Ltd., by the Canadian National Railways.

The city council of Windsor, Ont., has joined hands with Ford City and Walkerville in a request that will be forwarded to the Ontario legislature for the appointment of a harbor commission to control the waterfront on the Canadian side of the Detroit river.

At a general meeting of the shareholders of the Grand Trunk Railway held last week in London, Eng., it was decided to accept the offer of the Dominion government to take over the railway, guarantee a fixed income upon certain of the company's stock and purchase the remainder by arbitration. Pending the award of the arbitrators, the G.T.R. will be operated as a part of the Canadian National Railway system, and the board of directors of the G.T.R. will be supplanted temporarily by a board of five men, two of whom will be representatives of the C.N.R., two representatives of the G.T.R. shareholders, and a chairman to be chosen by these four.

BITUMINOUS ROADS*

By Bruce Aldrich
District Engineer, The Asphalt Association

In recent years the tremendous increase of automobile and and truck traffic has caused the engineers in charge of county and small town roads and streets much worry. Roads which stood up well under horse drawn traffic, rapidly disintegrated and became a burden to the ratepayers on account of enormous maintenance costs.

Engineers and others soon began to look for some means to arrest the disintegration of their roads and to bring down the maintenance charges. Bituminous roads of various types were brought out with varying success depending on the materials and the manner in which they were constructed. Light bituminous materials were tried with the idea of overcoming the dust nuisance and preventing disintegration of the surfaces.

Surface treatment should be applied as soon as the road surface has hardened or set to a point where sweeping will remove all dust and the surface present a hard mosaic appearance.

In new construction it is frequently advisable to apply the bituminous materials before opening the road to traffic. After application the road should be kept closed for about 36 hours, in order that the bitumen may penetrate the surface before it is disturbed and also to allow any excess of volatile constituents to evaporate.

Application of Light Materials

To obtain the best results in the application of light bituminous materials, a distributor, either horse drawn or motor driven, is used and the material applied at the rate of from ¼ to ½ gallon to the square yard under a pressure of about 20 pounds. Where a very light material is used, a sprinkling wagon such as is used for watering streets, will apply the material satisfactorily.

Many engineers believe in giving two applications of light materials the same year, one in the early spring and another in the fall, followed by an application of heavier materials the next spring; after making this last application, very coarse sand or ⅜ to ⅝-inch chips are spread, which, after being ironed into the surface by traffic, gives the surface the appearance of a bituminous concrete road. In making this last application it is necessary that no pools of bituminous material be left on the road or that a greater amount of stone or sand be used in these places with the idea of drying up the excess of bitumen (the excess of bitumen should be swept off the road) as these conditions are the cause for the surface "pushing" under traffic.

A sixteen foot road treated in this manner will stand up under a thousand automobiles per day while an untreated waterbound macadam road would fail in a short time under the same number.

Care should be taken that roads are dry before the application of bituminous materials as they will not adhere to the surface unless so applied, the surface flaking off under traffic if applied while the road is damp.

Before applying bituminous materials to old macadam surfaces or retreating roads which have had one or more applications, care must be taken in repairing holes or ruts. These must be thoroughly cleaned, all loose stone removed and new material tamped in, first well painting the bottom of the holes with the material which is to be applied to the surface or with a mixture of sand and stone and a cold patch material.

Bituminous Macadam

Bituminous macadam pavements are another type of construction which have been used most extensively since the advent of motor traffic. Bituminous macadam is a type of highway having a wearing course of macadam coated with asphalt or tar by the penetration method and usually laid on a stone foundation, though often on concrete or on old macadam surfaces.

In the construction of bituminous macadam roads, too much care cannot be taken in the preparation of the foundation, as defects in workmanship very rapidly show in the surface of these pavements.

Construction of Foundation

The stone for the foundation should be clean and hard, all passing a three-inch screen with about 85 per cent. retained on a one-inch-screen and having a French coefficient of wear of not less than 8. In placing the stone for the foundation, it is customary to spread it by hand, but mechanical spreaders are often used successfully. When spreading stone by hand, the stone should be dumped along the road sufficiently far apart in order that all the stone be shovelled ahead, as the practice of dumping stone where it is required and merely levelling it out results in segregation of the finer material and prevents proper penetration of the binding material; also the stone in the centre of the piles receives a greater compaction than that which has been spread around it, causing an uneven foundation, which unevenness will be duplicated in the wearing surface after the road has been subjected to traffic. After the foundation course has been uniformly laid, screenings should be spread to fill the "voids" in order to provide maximum stability. The foundation is then rolled with a three-wheel roller weighing from ten to fourteen tons.

Where conditions permit, traffic may be turned over the foundation in order to assist in its consolidation.

After the base has been consolidated, the stone for the wearing course is spread, generally to a depth of three or four inches. This is rolled, but only sufficiently to compact the stone to the contour of the road and bring out any irregularities which may develop, as an excessive amount of rolling at this time is likely to break up the stone and fill the voids with small fragments, thereby preventing the penetration of the binding medium.

Application of Bituminous Materials

The application of the bituminous material should be made as soon as possible after the initial rolling of the wearing course. This is usually applied by a distributor, using a pressure of about 35 pounds, though where a distributor is not available, it is done by means of hand pouring cans. This latter method is not likely to produce the best results unless the maximum-sized stone is used, the material heated to its maximum permissable temperature, and the work done in warm weather.

To obtain the best results, the bituminous material should be heated to from 300 to 350 degrees F., when an asphalt binder is used, or to not over 300 degrees F., when tar is used. The first application is usually of a little less than 1½ Imperial gallons to the square yard.

Immediately after the application of the binding materials, ¾ to 1-inch clean stone should be spread at about 35 to 40 pounds to the square yard.

The road is then rolled after which it is swept in order to remove any excess of ¾-inch stone or fine material.

The seal coat is then applied at the rate of not more than one-half gallon to the square yard, care being taken that no excess remains on the surface, as this has a tendency to make the surface "bleed" and 'roll."

Coarse sand or ⅜ to ⅝-inch chips is then spread uniformly over the seal coat at approximately ten to twelve pounds to the square yard. Rolling is then continued until the surface is smooth and uniform.

In the construction of many of the earlier bituminous macadam roads by the penetration method, it would appear that "waving" or "corrugation" of the surface was caused by the use of excessive amounts of binding materials, the use of too soft a material or inferior construction of foundations. The use of an asphalt binder from 75 to 100 penetration at 77 degrees F., and a tar with a melting point of 115 degrees F., is considered good practice. While these surfaces were, and are, constructed for light traffic they have in many instances stood up under traffic conditions which would ap-

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*Read before the Toronto branch, Engineering Institute of Canada, February 19th, 1920.

pear to warrant the use of a more scientifically built and expensive pavement.

The Post Road from New York to Boston, Mass., through Massachusetts, as well as the Providence-Narragansett Pier (Shore Road) road, have a number of sections constructed of asphalt macadam which have been down for five years, and are giving splendid service, without maintenance to date.

Bituminous Concrete

This type of pavements is one that has gained popularity in recent years, by reason of its simplicity of construction, long life, cheapness and ease with which it is repaired.

The American Society of Civil Engineers defines a bituminous concrete pavement as follows:—

"A bituminous concrete pavement is one having a wearing course composed of stone, gravel, sand or slag, or a combination thereof, and bitumious material incorporated by mixing methods."

The binding materials used in the construction of bituminous concrete pavements are asphalts, water-gas tars and coal tars. The original bitumious concrete pavements were laid in England using tar as the binding medium. In the early seventies and eighties, various types of bituminous concrete pavements were laid in the United States with varying results. In 1904 bituminous concrete was adopted as standard by a number of state highway boards and cities. Since then marked progress has been made in the development of the many kinds of bituminous concrete pavements, and since 1910, the majority of the larger cities and highway boards have adopted some form or other of bituminous concrete as a standard type of construction. Each year brought out new types and methods of construction, but to-day the bituminous concrete pavement has passed the experimental stage and is now recognized by road builders as one of the most economical types of construction, both in first and annual maintenance costs.

Bitulithic and Warrenite

Under the heading of Bituminous Concrete are a large number of different pavements which have been used and have given excellent results. Among those more commonly used are the "Bitulithic," "Warrenite," "Amiesite," "Topeka," "Filbertine," "Bitoslag," and what is termed, the "Open Mix Specification." The principal differences in the specifications is the character of the mineral aggregate and the class of bituminous material entering into the composition of the wearing surface. I shall not attempt to go into the details of the various specifications of the different types except in a general way, in an endeavor to bring out the more important difference.

"Bitulithic" specifications require an aggregate composed of broken stone, all passing the 1½-in. screen and retained in a 10-mesh screen. To this is added a certain amount of limestone dust and asphalt cement of the proper consistency which will, when mixed, give maximum density and a minimum percentage of voids.

"Warrenite" is another type of bituminous concrete, closely resembling the "bitulithic," and largely used on highway construction. Its composition is a modification of the "bitulithic" mixture.

The "Filbertine" and the "Washington" mixture very closely resemble one another. Both are composed of a mixture of approximately ⅔ stone and ⅓ sand, 5% of limestone dust, and from 6 to 8% of bitumen. The "Washington" mixture uses a stone graded from 1¼ inches down to ¼-inch, while the "Filbertine" uses from ¾-inch down to ¼-inch. A considerable amount of this type of bituminous concrete was laid in Washington during the years 1910 and 1914, and has given excellent results.

Topeka Mixture and Bitoslag

The "Topeka" mixture is one of the most popular types of bituminous concrete, more closely resembling sheet asphalt than any of the others. A lesser percentage and smaller size stone is used in this mixture than in the other types of bituminous concrete.

The specifications for this mixture are as follows:—

Bitumen—7 to 10%.
Pass 200 mesh screen from 5 to 11%.
Pass 40 mesh screen from 18 to 30%.
Pass 10 mesh screen from 25 to 35%.
Pass ¼ mesh screen from 8 to 22%.
Pass ½ mesh screen less than 10%.

These requirements cover the size of the stone, sand and limestone entering into the finished mixture. This type of pavement is laid largely on highways and residential streets and is particularly popular because of the excellent foothold it affords for horses.

"Bitoslag" is a mixture very similar to the "Topeka," except that crushed slag is used instead of stone, the slag entering the mixture, all passing a ¼-inch screen.

"Open Mix" and "Amiesite"

There are many variations of the "Open Mix Specifications," but no matter what type, it can readily be seen by comparing specifications, that the main differences are in the size and grading of the mineral aggregate, and the amount of bitument used. One specification for the "Open Mix" is as follows:—

"The stone to be 'run of the crusher' passing a one-inch and retained on a ⅛-inch screen. One cubic yard to be mixed with from 18 to 20 gallons of bitumen."

"Amiesite" is another type of bituminous concrete, but differs from the others in that it is mixed at a factory and shipped by rail, if necessary, to the site of the work and laid cold. The specifications for this mixture are as follows:—

88 to 92% pass a 2-inch and retained on ¼-inch screen.
4 to 6% of filler.
½ to 1% of lime.
½ to 1% of liquified.
4 to 6% of asphalt.

A considerable amount of "Amiesite" has been laid in New Jersey and Pennsylvania, and was laid in the following manner:—

"The first course consisting of the 2-inch material, was laid on the prepared foundation, and just sufficiently rolled to bring it out to the proper contour of the street. The second course consisting of the smaller-sized stone was then spread. The pavement was then thoroughly rolled, after which stone chips were spread and the pavement again rolled. In some instances a seal coat is applied before spreading the stone chips."

Crushed trap rock, hard limestone and slag have been the most successful materials used in bituminous concrete mixtures, though gravel, shells and other rock have also given good results. The majority of engineers, however, prefer a hard limestone, believing that bituminous materials adhere better to crushed limestone than other materials.

Most Suitable Penetration

All types of asphalts and tars have been used in the construction of bituminous concrete. It has been found that a penetration of from 50 to 60 at 77 degrees F. is the most suitable for the more heavily travelled streets or roads, and from 60 to 70 for the lighter.

Bituminous concrete mixtures are used for both rssurfacing and new construction, the wearing surface varying from 2 to 3 inches.

In new construction, bituminous concrete is laid on either cement concrete or broken stone foundation. A cement concrete foundation six inches thick, composed of a 1:3:6 mixture is recommended for very heavy traffic; broken stone for suburban, or lighter traffic; a Telford foundation is recommended in low flat country where drainage is poor.

In resurfacing the macadam roads, bituminous concrete has proven very satisfactory. For worn-out brick and concrete streets, it is the most satisfactory remedy.

The method generally used for resurfacing old brick or concrete surfaces, is to first thoroughly clean the surface of the old pavement, then fill all holes or depressions with bituminous or cement concrete, bringing the surface to an even grade. A two or three-inch wearing surface is then laid.

Some engineers give the old surface a coat of bituminous paint before laying the new wearing surface. The paint coat should be applied with great care as an excess will soften the mixture and cause it to "roll" or "push" under traffic.

Resurfacing of this type can be done at about half the cost of the original pavements, the results being, in most cases, very satisfactory.

The principles in the construction of "Topeka," which will be taken up here, are applicable to nearly all forms of bituminous concrete.

Mixing

There are a number of different types of asphalt plants with which various kinds of mineral aggregate may be economically heated and mixed with bituminous materials. Among these are the stationary, railroad and portable road plants. There are also a number of types of cement concrete mixers fitted with heating attachments which are largely used in preparing the "open mix" specification mixture.

In a modern plant, when mixing bituminous concrete, the mineral aggregate consisting of the properly graded sand and stone is heated to a temperature which will thoroughly dry them prior to placing them in the mixer. In the newer asphalt plants the aggregate is carried by bucket elevators to rotary dryers, where it is dried, all moisture and dust being removed. The aggregate is then raised from the dryer to the storage bins by conveyors. When ready to be mixed, the required amount of the aggregate is drawn from the storage bins, carefully weighed (preferably by an automatic weighing device) and deposited in the revolving mixer, in which is placed at the same time from 7 to 10% (by weight) of asphaltic cement. The exact quantity depends upon the grading and weight of the sand and stone to be used After the mineral aggregate is thoroughly coated with hot asphalt, it usually taking about one minute to thoroughly mix a batch, it is dumped or dropped into waiting wagons or trucks and hauled to the prepared foundation. The surface mixture should be brought to the road or street at a temperature between 275 degrees F. and 350 degrees F. If necessary to retain temperature in transit from plant to street, canvas covers should be provided for the trucks or wagons in which the mixture is hauled. In no case should it be laid on a wet or damp surface, or when the air temperature is below 35 degrees F. as it will cool so rapidly that proper compression will not be obtained when rolled.

Construction on Street

It should be uniformly spread by means of hot iron rakes in such manner that after having received its final compression by rolling, the finished pavement conforming to the proper grade and crown will have a thickness of not less than two inches. It is important in the spreading of the wearing surface to see that the mixture is completely loosened up and spread evenly with rakes before the use of the roller is permitted. Waviness in a surface is often caused by insufficient raking of the hot material; no lumps should remain. No workman should be allowed to walk or place his foot in the hot mixture for the purpose of reaching out to correct some defect; depressions thus made will be filled by the raker, causing more material at these points than elsewhere, resulting in unequal compression. Extreme care should be taken in spreading the mixture. The rolling and compression of bituminous concrete surfaces require a skillful workman, but the best man can not secure the proper results if the surface mixture has not been properly spread by the rakers. Initial compression is best effected by a roller weighing about two and one-half tons and final compression by a roller weighing at least eight tons. The amount of transverse rolling should be equal to the longitudinal rolling. All material that cannot be compressed by the roller should be well tamped with hot iron tampers. Smoothing irons should never be used unless handled by experienced men, as they often burn the surface, causing it to disintegrate.

Immediately after the wearing surface has been compacted, and while the surface is clean and dry, the seal coat of about one-quarter gallon to the square yard of hot asphalt, is spread uniformly over the surface. On this is spread clean dry stone chips from ¼ to ½ in. in size; The surface is again thoroughly rolled and the street opened to traffic. In using the finer mixture, the seal coat is often left off and the wearing surface swept with a small amount of portland cement.

The most important factors in securing the best results in bituminous concrete pavements are as follows:—

Use of the best materials available.

The proper grading of the mineral aggregate.

Using the proper consistency of the asphalt cement and determining the right amount of bitumen in order that the mixture is not too lean nor too rich.

Proper and thorough mixing at the plant.

Care in raking and rolling.

In the opinion of the writer, a bituminous concrete pavement, if properly constructed, is one of the best of modern surfaces, it being not only smooth and resilient, but having the stability to withstand modern traffic.

Sheet Asphalt

Sheet asphalt is one of the oldest of modern pavements, the original pavements of this type being laid in Europe of rock asphalt principally obtained from the Seyssel and Val de Travers deposits during the early sixties. In about 1870 the first rock asphalt pavements were laid on the American continent, but owing to the cost of importing the rock asphalt and the invention of modern asphalt pavement which could be laid much cheaper, this was eventually abandoned as a street paving material, though large quantities are still used for sidewalks and flooring.

The first asphalt pavement laid in America was put down by Prof. E. J. de Smedt, in Newark, N.J., in 1870. Shortly after this, sheet asphalt pavements were laid in New York and Philadelphia. Washington, D.C., then adopted the use of sheet asphalt as a standard paving material in 1877, and was soon followed by many others cities. In the earliest pavements, "Trinidad" lake and land asphalts were used; later "Bermudez," "Cuban," "California" and "Mexican" came into favor as they were developed. The first four being termed "natural," the others "oil" asphalts, resulting from the distillation of asphaltic base oils.

The sheet asphalt pavement is one having a wearing course composed of a carefully graded sand, limestone dust or portland cement, and asphalt cement, mechanically combined. This is usually called "topping." This mixture is almost always laid on an intermediate course called "binder" of which there are two kinds, "open" and "close." The former consists of stone usually from 1½ to ¼ ins. in size, coated with asphalt cement; the latter, which is largely used to-day, is composed of stone similar to that used in the "open" binder and sand usually in proportions of 75% stone, 25% sand. This, when mixed with asphalt cement, produces a bituminous concrete which is more impervious and offers greater resistence to displacement than the "open" binder.

Typical Sand Gradings

The foundation for sheet asphalt pavements is usually of portland cement concrete, though it is often laid over brick, granite block, broken stone and old cobble pavements. In laying sheet asphalt on this last type of pavement, large quantities of binder are used on account of the irregularity of the cobble surface, thereby materially increasing its cost.

Sand for the topping should be irregular in shape, clean, hard grained and fairly sharp. A smooth round sand, no matter how well graded, will produce "mushy" mixture.

The following are typical sand gradings for light and heavy traffic:—

Sand grading.	Heavy traffic.	Light traffic.
Pass 200 mesh	0	0
Pass 100 mesh	17	10
Pass 80 mesh	17	10
Pass 50 mesh	30	30
Pass 40 mesh	13	15
Pass 30 mesh	10	15
Pass 20 mesh	8	10
Pass 10 mesh	5	10
Pass 8 mesh	..	..

These are, of course, arbitrary standards and to be used as guides in using local materials.

Fillers are used in the topping for the purpose of toughening and filling the voids, thus producing a dense impervious surface when compacted. For these, finely powdered limestone dust or portland cement is used, the requirements being that it shall pass a 30 mesh sieve and at least 66% pass a 200 mesh sieve.

A light traffic mixture should, on analysis, never show less than 10% passing the 200 mesh sieve; and a heavy traffic mixture, not less than 13%.

Conditions Affecting Consistency

The consistency of the asphalt cement used is governed largely by climatic and traffic conditions. The following table will serve as a guide in selecting the proper penetration for asphalt cement to be used under different traffic and climatic conditions:—

	Temperature		
Traffic.	Low.	Moderate.	High
Light	50-60	50-60	40-50
Moderate ..	50-60	50-60	40-50
Heavy	40-50	40-50	35-40

The percentage of asphalt cement used carries from 9.5 to 12.5%.

Heavy traffic mixtures usually carry less bitumen than those used on streets of light traffic.

Both the binder and the topping of the sheet asphalt pavement are prepared at a paving plant similar to those used in the manufacture of bituminous concrete, from which they are carried directly to the site of work and laid and compacted while hot. They should be delivered on the work at such temperatures that they may be readily spread and the loads should never be dumped in place but should be shovelled from piles. Each pile should be shovelled from the bottom and the mix deposited upon the road preferably by turning the shovel completely over. It is then spread by means of hot rakes to such a thickness as, after compaction, will produce the specified thickness for that particular course. The rakers should not stand on the hot mix more than absolutely necessary.

Rolling

Each course should be compacted by rolling while hot, and as soon as possible after spreading and raking. If allowed to cool or set up before rolling, satisfactory compaction cannot be obtained. Initial compaction is sometimes secured by the use of a three to five-ton tandem roller and final compaction with a heavier roller, usually seven to eight tons in weight. To prevent the mix from adhering to the wheels of the roller, they should be mopped with kerosene and water during the rolling operation. Rolling should commence longitudinally at one side and each trip of the roller should overlap the preceding one until the centre line of the pavement is reached, when the operation is repeated, starting at the other side; the roller should proceed slowly and alternate trips should be of slightly different length to prevent wave deformation of the surface. The second rolling is made diagonally across the centre line and later followed by cross rolling, if the pavement is of sufficient width to permit. Places which cannot be reached by a roller should be compacted and finished with hot tampers and in the case of topping, with smoothers. Smoothing irons, however, should be used only when absolutely necessary as without great care burning or blistering the surface may result.

Rolling should be conducted as continuously as possible to avoid unnecessary formation of joints. When the operation is temporarily discontinued, as at the end of a day's work, the last load may be rolled to a feather edge, in which case when the work is resumed, the mix should be cut back so as to produce a slightly beveled edge for the full thickness of the course. The old material which has been cut away should be removed from the work and new mix laid against the fresh cut. A better method of forming joints consists of rolling into the mix a stout rope which is stretched across the pavement close to the finished edge. This rope is allowed to remain in place until work is resumed when it is removed together with all surplus material on the far side, and fresh mix then laid against the joint thus formed. The edge of a joint should be painted with hot asphalt cement, though this practise is apt to lead to the formation of an undesirable fat streak across the pavement if the paint is applied in excessive quantities. Joints may be satisfactorily finished on the surface with a hot smoothing iron carefully used.

The total thickness of a sheet asphalt pavement is usually made three inches. Sometimes this thickness is proportioned as one inch of binder and two inches of topping, but better practice calls for one and one-half inches of each. The binder serves to true up unavoidable inequalities in the foundation, prevent slipping or shoving of the topping and increase the stability of the pavement for any given total thickness. It is very important that the binder be well compacted and all binder that shows lack of bond or which may become broken up before it is covered with topping, should be removed and replaced with good material. No more should be laid at any one time than can be covered by the day's run of paving plant on topping. As soon as possible, after the binder is laid and preferably while still warm, it should be covered with topping in order to effect the most thorough bond between the two. The binder should be kept clean and as free from traffic as possible under working conditions. Before laying, the foundation should be dry. The topping provides a smooth, impervious durable wearing course which, during compaction, knits firmly into the surface of the binder. After final compaction, it is usually finished off with a sweeping of portland cement.

Life of Sheet Asphalt

Properly constructed sheet asphalt pavements wear slowly under traffic, and their life is from fifteen to twenty years, and with proper maintenance, even longer. They can be easily repaired and where care is taken in making these repairs, no trace of the patches can be found after having been under traffic a short while.

The average cost of the maintenance of sheet asphalt pavements is approximately $.03 per square yard after the guarantee period, which is usually five years, expires.

In the construction of all types of bituminous roads and pavements, sufficient "crown" should be given to ensure the removal of water as rapidly as possible. On flat grades about .30 is the proper crown for a twenty-foot pavement. This, of course, decreases as the grade of the pavement increases.

A reorganization of the water service in the city of Coaticook, Que., has been authorized by the lieutenant-governor-in-council. A charter has been issued to a new company, which will take over the present enterprise, plant and business of the Coaticook Water Co. and operate same under the new firm name of the City Water Co. The authorized capital stock of the new corporation will be $149,000.

Following is the program of the Montreal branch of the Engineering Institute of Canada for the remainder of this season: March 4th, "Industrial Relations," by J. S. Cameron; March 11th, "Steam Turbines; Manufacture and Testing," by G. E. Newell; March 18th, "The Utilization of Lignite," by R. de L. French; March 25th, "Replanning Montreal and District," by James Ewing; April 8th, "St. Maurice River Regulation: The Gouin Dam," by L. Lefebvre; April 15th, "Naval Gunnery," by Lord Congleton; April 22nd, "Cotton Rope for Power Transmission," by J. Melville Allison; April 29th, "The Engineering Features of Tramway Operation," by D. E. Blair.

SOME ADVANTAGES OF PERMANENT HIGHWAY CONSTRUCTION*

By H. S. Van Scoyoc

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GOOD roads are an economic necessity. This bare statement, a comparatively few years ago, would have furnished the text for hours of bitter discussion in almost any gathering at which it might have been introduced. It is a proposition which would receive the unanimous support of this meeting or any similar one to-day. This result has been brought about by the most satisfactory method of proof possible. Good roads have been built in many sections and the results have convinced the most sceptical. They have reduced transportation costs, enlarged social intercourse, improved educational opportunities, increased rural church attendance and saved human lives by bringing the physician nearer to his patient.

What has become of the fear that paying for them would bankrupt the community? Who pays for good roads?

Roads Pay for Themselves

Like good advertising, good roads pay for themselves. Good roads do cost money, but they save out of all proportion to their cost. To be more concrete, let us examine the Toronto-Hamilton Highway, the cost of which was a very live subject about four years ago. Approximately, 40% of its cost is borne by the provincial government out of consolidated revenue, but the ultimate source was the motorists' fees. Speaking in Toronto last week, A. W. Campbell, director of highways, Ottawa, said that improved roads would save annually approximately 20% of the investment in motor vehicles. He included reduced fuel consumption and reduced charges for upkeep of vehicles. The motorist is a willing contributor for road improvement and he can afford to be if he gets his money's worth in satisfactory construction.

The cities of Toronto and Hamilton together contributed 30% of the cost. In bad weather Bronte is now nearer Toronto, so far as time is concerned, than New Toronto was before construction began. Farm produce from the Grimsby section is hauled direct to the Toronto market. Hamilton has one of the best, if not the best, farmers' markets in Canada.

Just at this time, when the larger Canadian cities feel that they are called upon to contribute too large a share of provincial funds, the experience of Detroit, Mich., may be interesting. For road taxation purposes, Detroit is part of the county of Wayne and pays in direct proportion to assessed valuation. On October 1st, 1906, when Wayne county began its county road system, the total county valuation was $418,070,750, of which Detroit's share was $355,363,747, or approximately 85%. On October 1st, 1915, the total valuation was $694,158,333, of which Detroit's share was $558,043,950, or only 80%. In other words, while the valuation of Detroit, during a period of phenomenal growth, increased by 57%, the valuation of the townships in the same period has increased by 117%. In addition, the city had annexed some of the most desirable township property. Detroit has found a satisfactory way to reduce its share of the burden.

Meeting Taxes Willingly

Counties on the Toronto-Hamilton Highway pay approximately $6,000 per mile. In some cases, the charges are actually less than the county paid for maintenance of less durable types previously. In all cases, increased assessments will place the carrying charges in reality upon the taxpayers whose properties have been improved. The townships pay $4,000 per mile, which may be assessed on property adjoining the highway, or over the entire township, or by a combination of the two methods.

In any case, the cost will largely fall on those directly benefiting. Farmers six miles away have hauled their produce to wayside markets along the highway. In at least one instance, the township's share has been placed on the entire township, but in any case the individual property owner is meeting his share of cost willingly. One owner writing on January 22nd, 1920, says:—

"Property along the Hamilton and Toronto Highway in the locality where I live has increased enormously in value in the past seven or eight years, during which time the highway was first discussed and finally built. For instance, land lying between the road and the lake has jumped, I would say, from an average of three to five hundred an acre, to an average of from four to six thousand per acre. One definite transaction is the Crystal Beach, which immediately adjoins my farm. This property, which lies between the road and the lake, running in depth from three to four hundred feet, consists of a little over eight acres. It was purchased from Mr. ...... in 1911, for $4,500. All of the lots into which this property was sub-divided have been sold and quite a number which changed hands during 1919, sold for $1,500 or better per lot. Figuring the average of these lots, this is at a rate of between $5,500 and $6,000 per acre.

"Further back on the next concession along which the radial line runs, both Mr. ...... and I sold a number of parcels of five and ten acres last summer at prices a little better than $500 per acre. This was bare land without trees or buildings, and lies about two-thirds of a mile back from the highway. Any amount of land along that road could have been purchased eight years ago for between $100 and $150 per acre."

An Objector Convinced

A Clarkson farmer wrote the commission, January 17th, 1917, saying in part:—

"I have much pleasure in expressing my high appreciation of the value of the road to the residents of this section of the township. Being one of the principal objectors to the building of the highway on account of the damage I thought it would do to my property, it is only fair to say that the way the frontage has been improved has made my place much more valuable, while the road itself is of incalculable value to me as a fruit grower. For example, this year my only cost for wagon repairs has been the setting of the tires, while formerly the expense of keeping my wagon in running order has been as high as fifty or sixty dollars. I am able to take large loads of produce to Toronto without tiring my team, and save several hours on the way, as well as the large expense of shipping by express and the commission for selling, and it would be hard to compute the saving in dollars in one season."

Would Pay Double Cost

Speaking before the Ontario Good Roads' Association in March, 1918, R. H. Lush said: "I happen to be on the Toronto-Hamilton Highway where we now have a frontage tax of a cent and a half per foot, and every ratepayer on the road is quite willing to pay it." The chairman asked: "Would you pay twice a cent and a half per foot rather than be without the road?" Mr. Lush replied: "Certainly. I pay quite a bit now but I would not be without it. I think it will be worth many thousands to me when I want to sell my property. Not only that, but I can now go to market with my produce with ease, and when you consider all the advantages it is a cinch to pay frontage tax."

Another property owner, writing January 27th, 1920, says:—

"Land values have, undoubtedly, increased since the construction and completion of the highway. Of course, you will realize that one of the reasons for the increase, especially of these portions adjacent to the lake, is the fact of their having lake frontage, which makes it desirable from a standpoint of summer homes for city residents, and as a great number of the better portions are gradually being picked up, the remaining parts are increasing in value.

"East of Burlington, land is now being held at anywhere from twenty to thirty dollars per foot frontage. I made a sale last fall of a portion of my farm, fronting on

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*Excerpts from address to Brantford Rotary Club.

the highway and running back to the lake shore, at thirty dollars per foot.

"I understand that Mr. ...... sold a certain frontage at twenty-five dollars per foot last year. Mr. ...... bought a nine-acre holding from Mr. ......, just east of Appleby Road, and paid in the neighborhood of twenty-five dollars per foot. Several Crystal Beach lots changed hands at about thirty-five dollars per foot. The cost has not been a cause for worry since the advantages have been seen."

Some United States Statistics

A road which is better than its predecessor, will win for itself warm friends and supporters, but there are certain conditions of traffic and surroundings which justify high-class construction. It has been possible for me to secure figures concerning contracts awarded in 28 states of the United States during 1919. These figures refer to state contracts only, no county or township contracts being included.

Including only those mileages where some form of surfacing was applied, a summary shows that of 4,516.76 miles placed under contract in 1919, 2,455.58 were cement-concrete; 395.96, bituminous concrete; 88.83, sheet asphalt; 254.05, brick; 0.20, stone block; 0.30, asphalt block; 344.95, bituminous macadam; 224.51, macadam; and 752.38, gravel.

It is significant that 3,194.92 miles, or more than 70% of the total, is for a type higher than bituminous macadam.

The cement-concrete road yardage, exclusive of streets and lanes, placed under contract in the United States during 1919 totalled 40,453,337 sq. yds., equivalent to 3,830 miles of road 18 ft. in width.

There are some good reasons for this preponderance of high-class construction, comparatively high in first cost. First, there is the saving in tractive effort.

In 1917, the Good Roads Bureau of the California State Automobile Association, conducted a series of tests showing the pull in pounds per ton required to move a load over various types of unimproved and improved highways. The results are summarized as follows:—

Pull in Pounds per Ton

Over level, unsurfaced concrete	27.6
Concrete base, ⅜-in. skin top asphaltic oil and screenings	49.2
Waterbound macadam, level, good condition	64.30
Concrete base, 1½-in. Topeka top, level, good condition	68.50
Gravel road, good condition, level	78.20
Earth road, fine dust, level	92.00
Earth road, stiff mud on top, firm underneath, level	218.00
Loose gravel, not packed down, new road, level	263.00

The White Co., Cleveland, in co-operation with the Portland Cement Association, conducted a series of tests on various types of highways in the vicinity of Cleveland, Ohio. These tests were made in the fall of 1918 during cool weather. Five two-ton trucks, loaded to capacity, were run repeatedly over various sections of paved and improved roads. The average mileage per gallon of gasoline is shown by the following table:—

	Miles per gal.
Earth	5.78
Fair gravel	7.19
Good gravel	9.39
Fair bituminous macadam	9.48
Fair brick	9.88
Good brick	11.44
Concrete	11.78

In the Iowa State Highway Commission's "Service Bulletin" for September, 1919, are given results secured from tests made by the Good Roads Section of the Engineering Experiment Station of Iowa State College, at Ames. A heavy aviation type army truck with a gross weight of truck and load of nearly eight tons was used in the series of tests. The gasoline consumption has been reduced to an equivalent level road so that the effect of any grades that might occur has been eliminated:—

Kind of road surface.	Miles per gal.	Ton-miles per gal.
Ordinary gravel	2.22	17.8
Gravel in excellent condition	2.66	22.42
Bithulithic	2.86	22.8
Concrete in good condition	3.83	30.64
Monolithic brick	3.84	30.72

To capitalize the savings that would result from carrying all of our traffic on a hard road surface in good condition would provide a sum for road improvement beyond the dreams of the president of the Canadian Good Roads Association.

Maintenance Costs

Maintenance figures are likely to be misleading unless all of the conditions are known. Sometimes only surface maintenance is included. In other instances figures include all expenditures on the highway. In the instances cited, details will be given as far as known:—

STATE OF WASHINGTON FOR YEAR 1918

Type of surface.	Mileage.	Cost per mile.
Brick pavement (excessive brick costs due to extensive replacements made necessary by roadbed settlement, etc.)	8.81	$755.08
Concrete	102.38	111.61
Asphaltic concrete	23.24	338.68
Bitulithic and Warrenite	17.77	289.45
Sheet asphalt	5.97	34.68
Half-width concrete and half-width gravel and macadam	8.53	288.61
Bituminous macadam	40.06	490.03
Waterbound macadam	125.05	418.52
Crushed rock surfacing	66.30	483.61
Gravel surfacing	825.81	428.48

The cost figures include all expenditures reported upon the highway, its roadbed, drainage facilities, surfacing or pavement; also apportionment of costs of equipment, supplies and supervision:—

OHIO

Figures Published in State Highway Report, 1916.

Type.	Mileage.	Cost per mile per year.
Concrete	203	$ 51.00
Brick	381	105.00
Gravel	40	194.00
Macadam	731	263.00

NEW YORK

Maintenance Cost for Entire Roadway, 1915 to 1918.

Type.	Miles maintained.	Aver. cost per mile per year.
Bituminous penetration	2,793	$490
Gravel	173	843
Waterbound macadam	2,451	911
Brick	284	210
Cement concrete	208	138
Second-class concrete	291	938
Mixed method, bituminous on concrete	89	356

Commissioner Greene, of New York, says 80.48 miles of macadam roads which were built in 1912 at an average cost of $11,874 per mile had cost by January 1st, 1919, an average of $8,723 per mile for maintenance, the average maintenance per mile per year being $1,342.

Toronto-Hamilton Highway Maintenance

Toronto-Hamilton Highway expenditure on road-surface only, for labor, materials and superintendence, has been:—

Concrete.	1916. 16 miles.	1917. 31 miles.	1918. 36 miles.	1919. 36 miles.
Chiselling joints	$512.34	$ 948.28	$ 581.14	....
Tarring cracks & joints	377.05	767.70	1,614.45	....
	$889.39	$1,715.98	$2,195.59	$1,726.68
Average cost per mile	$ 55.59	$ 55.35	$ 60.99	$ 47.83

A study of the haulage costs and upkeep charges will serve to explain the present tendency in main highway construction where experience is being crystallized into action. There is still a better and a loftier reason for high-class construction. It makes for a higher type of citizenship. In 1916, when chief engineer of the Toronto-Hamilton Highway, it was my good fortune one day to have dinner in a farm-house fronting on the highway. Over our final cup of tea, I said to the good lady of the house, "Well, what do you think of the new road?" I will never forget her reply: "Mr. Van Scoyoc, words cannot tell what it is doing for us. We have lived here for twenty years, ever since we were married. Our children are growing up here. As you know, this road was not previously the most travelled. On account of the heavy sand, it was avoided in dry weather, but was the only possible road when rain made the clay stretches on Dundas street impassable.

"Travellers were few. We used to huddle by the window in the front parlor and carefully peek out under the shades to watch them go by. Everybody's head was down. If it was necessary to turn out to pass another rig, we had to close our ears to keep out the burning language. They cursed the country, the province, the county, the township, the farm, and the other man. We were ashamed. But now hundreds go by where one went by before. Every one is sitting up straight with a smile on his face. We sit on the front balcony and enjoy the cheery greetings. When they pass another rig, there is a wave of the hand. Often we hear, 'A fine day,' 'A dandy road,' 'Best crops we have ever seen.' We are proud of our farm, our township, our county, our province, our country."

That is the spirit that will make our country great. Let us say with Ruskin: "Therefore, when we build, let us think that we build forever. Let it not be for present delight, nor for present use alone. Let it be such work as our descendants will thank us for, and let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them, and that men will say as they look upon the labor and wrought substance of them: 'See this our Fathers did for us.'"

PUBLICATIONS RECEIVED

Malleable Cast Iron—By S. Jones Parsons. Published by Constable & Co., Ltd., London, Eng. Second edition, revised. 171 pages, 86 illustrations, 6 by 9 ins. Price, $3.50.

Fuel, Water and Gas Analysis for Steam Users—By John B. C. Kershow. Published by Constable & Co., Ltd., 10 Orange St., Leicester Sq., W.C., London, Eng. Second edition, revised and enlarged. 200 pages, illustrated, six tables, 6 by 9 ins. Price, $3.

The annual meeting of the Associated Manufacturers of Water Purifying Equipment was held at the Bellevue Stratford Hotel, Philadelphia, February 4th, 1920. Practically the entire membership was represented. Born of war-time necessity to assist in speedy production of water-purifying equipment, the association now continues with the object of assisting in every way the water-purifying industry as a whole. Much has been accomplished in the past year; standard sizes for pressure filters have been agreed upon, and much progress has been made by the committees on standards in making preliminary report on sizes and strength of materials entering into filter construction. The committee is also working on the standardization of contracts. It is anticipated that during the coming year an acceptable standard contract form will be prepared for use by the associated manufacturers. Arthur M. Crane, representing the New York Continental Jewell Filtration Co., was elected chairman for the year 1920, succeeding F. B. Leopold, of the Pittsburgh Filter Co. H. B. Tate, of the Borromite Co. of America, continues as secretary-treasurer. Membership in the association is open to all firms engaged in water treatment.

DEVELOPMENT OF ACTIVATED SLUDGE PROCESS AT MANCHESTER, ENG.*

Description of the continuous-flow unit for the treatment of the sewage at the Withington works by the activated sludge process, with accompanying plan, was given in the last annual report.

A Lea flow recorder has since been installed for the more accurate measurement of the volume of sewage treated by this plant. This installation is placed at the exit end of the plant, and the purified effluent is measured as it passes over one or more V notches. Four such weirs are provided, so as to obtain an accurate record of considerable variations in actual flow.

During the year a total volume of 59,288,000 gallons of sewage, which had been screened and passed through detritus tanks whose capacity is equal to approximately forty minutes' dry-weather flow, was treated in this plant, an average of 172,000 gallons per day (actually in operation).

The plant was out of commission for a period of twenty days in consequence of the closing down of the power plant.

The operation of the plant has been handicapped by an uncertain air supply consequent on difficulties experienced, especially during the summer months, in maintaining an adequate steam supply.

The actual volume of sewage purified by this plant has, of course, been influenced materially by this factor and also by reason of its use as a demonstration plant for the purpose of obtaining additional information with respect to the factors controlling its economic operation.

The following typical average analytical returns will give a general idea of the results obtained:—

Average Results in Grains per Gallon

Dry Weather Sewage—Low Air Supply

Flow roughly proportional to rate the sewage is received.	Screened and detritus-freed sewage.	Effluent.
Four hours' oxygen absorption	2.73	.51
Free and saline ammonia	1.86	1.62
Albuminoid ammonia	.46	.08
Nitrite and nitrate (in terms of NH_3)	—	.10
Dissolved oxygen absorption (†Royal Commission Test)	—	.65
Volume of sewage treated	250,000 gallons per day.	
Air consumption	1.0 cu. ft. free air per gal. of sewage treated.	

Dry Weather Sewage—Maximum Air Supply

Uniform rate of flow.	Screened and detritus-freed sewage.	Effluent.
Four hours' oxygen absorption	2.47	.46
Free and saline ammonia	2.10	1.08
Albuminoid ammonia	.415	.07
Nitrite and nitrate (in terms of NH_3)	—	.45
Dissolved oxygen absorption (†Royal Commission Test)	—	.65
Suspended solids	12.6	2.1
Volume of sewage treated	250,000 gallons per day.	
Air consumption	1.7 cu. ft. air per gal. of sewage treated	

Wet Weather Sewage—Low Air Supply

Uniform rate of flow.	Screened and detritus-freed sewage.	Effluent.
Four hours' oxygen absorption	1.77	.47
Free and saline ammonia	1.36	1.14
Albuminoid ammonia	.325	.09
Nitrite and nitrate (in terms of NH_3)	—	.26
Dissolved oxygen absorption (†Royal Commission Test)	—	.70
Suspended solids	9.1	2.4
Volume of sewage treated (average)	344,000 gallons per day.	
Air consumption	0.80 cu. ft. free air per gal. of sewage treated.	

†Standard recommended = 1.40

*Excerpts from annual report of Manchester Rivers Department.

The experience gained with this installation during the year under observation may be summarized as follows:—

1. The satisfactory results previously published obtained by the treatment of the Withington sewage by the activated sludge process have been well maintained.

2. The idea that the scientific control required for the successful operation of the process would render its adoption impracticable has been proved to be without foundation. Provided care is taken to establish the factors controlling success—i.e., the period of aëration and volume of air required for the production of a satisfactory effluent from any given sewage—no difficulty need arise in the operation of an activated sludge plant if proper attention is paid to the efficient settlement of the sludge and to its regular return to the aëration chamber, so as to maintain the requisite volume of sludge in contact with the sewage.

3. This volume may vary considerably—e.g., from 15% to 30%—by volume measured after one hour's settlement, without interfering materially with the purification effect. Unless a high degree of nitrification is desired, the operation of the plant is facilitated by employing a sludge content approaching the lower of these two limits. In this way there is less liability of difficulty with sludge settlement, and, of course, the volume of sludge in circulation—i.e., to be raised by air lift—is reduced, while it is quite sufficient to produce a perfectly clarified and thoroughly stable effluent.

4. One of the outstanding features of the experience with this plant is the highly satisfactory operation of the diffusers employed. It has not been necessary to replace any of these diffusers, although at the time of writing they have been in actual operation for a period of two years. Only six of the 300 employed have been removed from the tank, and replaced after cleaning, to remedy indifferent diffusion. It is also important to note that, so far, no signs of clogging have been observed. Careful observations of the air pressure employed give no indications of any rise due to increased friction. The air pressure only varies from 3.1 lb. to 3.25 lb., dependent on the volume of air passed through the diffusers. In this connection it will be remembered that the depth of water in the aëration tank is 6 ft., measured from diffuser to water level.

5. The earlier determinations of the column of air required have been confirmed. Unless a high degree of nitrification is required, an air consumption of 1.0 cu. ft. of free air compressed to 3.1 lb. per gallon of sewage treated is sufficient to produce a satisfactory effluent under average conditions. In periods of dry weather this volume should be increased to a minimum of 1.25 cu. ft., mainly to avoid disturbance with the settlement of the sludge. It would appear that the additional air supply is concerned with the maintenance of a thoroughly active state of the sludge, and it is possible that re-aëration of the sludge prior to its return to the aëration chamber might be advantageous, even with a weak sewage of the character of that treated at the Withington works. In wet weather, when the sewage is diluted by rain, satisfactory effluents may be maintained with an air consumption as low as 0.8 cu. ft. free air (compressed to 3.1 lb.) per gallon of sewage treated.

6. In view of the criticism directed against the employment of a more or less uniform rate of flow throughout the twenty-four hours, comparative trials have been made with the rate of flow, roughly proportional to the rate it is received at the works—i.e., with the day flow approximately double the night flow. The results obtained show that the purification is well maintained, although the composition of the final effluent varies slightly on account of the fact that the average strength of the sewage thus treated is increased.

7. Further determinations of the sludge production agree fairly closely with the figure already published of 0.5 ton dry matter per 1,000,000 gallons of sewage treated. The actual volume of sludge this solid matter represents depends on the means adopted for the removal of the surplus sludge from the installation. The water content of the sludge removed need not exceed 98.8%, which means an actual sludge production of approximately 42 tons per 1,000,000 gallons sewage treated. As previously reported, the volume of this sludge can be considerably reduced by ordinary settlement.

As stated in the last report, the problem of dewatering the resultant sludge so that full advantage may be taken of its value as a fertilizer has received attention, but the progress made in this direction is not such as could be desired.

Fairly extensive trials have been made with an experimental continuously-operated centrifuge. The sludge has been treated by this machine, both with and without preliminary treatment, such treatment having included (1) settlement; (2) acidification; (3) application of heat.

Dewatering Results Not Encouraging

The results so far obtained are not very encouraging, the best trial under most favorable circumstances yielding a product containing 85% water. While this means a very great reduction in the volume of the sludge treated, the water content is still too high to consider direct heat as a means of reducing the material to a marketable product. A considered report of this research is reserved for a later communication when other preliminary methods of treatment have been studied, including the application of electrical energy. It is also proposed to compare the effect produced by treatment under various conditions, in a special experimental press, with that of centrifugal action.

Fill and Draw Plant

The "fill and draw" activated sludge plant at Davyhulme, a general description of which appeared in the appendix to the annual report for the year ending March, 1917, has been in operation throughout the year. Generally speaking, this tank, whose capacity is 20,000 gallons, has received three fillings per day, with an average aëration period of five hours, and has thus dealt with 45,000 gallons of screened sewage per day.

The following average analytical returns show that a satisfactory effluent has been obtained:—

Results in Grains per Gallon

	Screened sewage.	Effluent.
Four hours' oxygen absorption	6.64	.93
Percentage purification	—	86%
Free and saline ammonia	1.94	.93
Albuminoid ammonia	.54	.09
Percentage purification	—	85%
Nitrite and nitrate (in terms of NH_3)	—	.44
Dissolved oxygen absorption ...... (*Royal Commission Test)	—	.58

*Standard recommended = 1.40.

The arrangement of this experimental plant precludes any addition to the information already obtained with respect to the economics of the process. It has therefore been kept in operation mainly to note the results to be obtained, over long periods, in the treatment of the city sewage, containing as it does a great variety of trade wastes.

It is satisfactory to report that there has been no material interference, due to the presence in the sewage of inhibitory trade waste, during the year under observation. As previously reported, however, the trouble has been experienced occasionally by the admittance to the tank of an undue proportion of oily matter, which, although it has not interfered with the bacterial activity of the sludge, has, by emulsification, resulted in the production of turbid effluents. Such experience confirms the opinion, frequently expressed, that arrangements should be made whereby any appreciable amount of oils, etc., are removed from the sewage prior to treatment in the aëration chamber. This has been borne in mind in the design of the large scale continuous-flow unit described below.

Large Scale Continuous-Flow Plant

This plant, to which a brief reference was made in the last report, has been under construction during the year under observation. Its design is based on the experience gained with the operation of the plants at the Withington works and elsewhere, and also on the information obtained from a glass demonstration tank constructed by Messrs. Jones & Attwood, Ltd., at their works to study the currents produced by the admission of diffused air into water.

Briefly, the plant may be described as follows:—

Preliminary Grit Chambers.—These detritus chambers are provided owing to the inadequacy in times of heavy rainfall of the existing screening and detritus chamber at the entrance to the works. The dimensions of each of these two chambers are 12 ft. 8 ins. by 15 ft. by 8 ft. 6 ins. deep (approximate water level), and their combined capacity is 20,000 gallons. Two Clifford inlets are arranged in each tank, and the sewage is raised by air lifts (combined capacity 2,000,000 gallons per day) from these preliminary grit chambers to the aëration chamber. These chambers should also act as grease traps and arrest any undue proportion of oily matter in the sewage.

Aëration Chamber.—The aëration chamber, which is 241 ft. long and 9 ft. deep (water level to diffuser), is divided by two longitudinal walls so as to form a channel 8 ft. wide and 723 ft. in length. Its capacity is 322,425 gallons. The floor of the tank is level throughout. Aëration is effected through lines of diffusers placed alongside the curved footings of the divisional walls on one side of the channel only. The diffusers are each 4 ft. by 7 ins. (over all), so that their total area is approximately one-fourteenth of the aëration tank area. The ratio of actual diffusion area to total tank area is approximately 1:18. An overhead system of air pipes is provided, and the air admitted to the diffusers by a series of down-pipes, one to each diffuser. Valves are arranged on the air mains so that the tank may be sectionized so far as air supply is concerned. In addition, each down-pipe is fitted with a needle and orifice control for securing uniform air distribution. Cross-baffle walls, each with 3-ft. by 1-ft. openings over the diffuser line, are constructed at intervals of 16 ft. along the whole length of the aëration channel.

Sludge Re-aëration Channel.—This channel runs alongside the aëration chamber, and is consequently 121 ft. long. It is 4 ft. 6 ins. wide, and its capacity is 52,650 gallons. The re-aëration of the sludge as it passes down this channel from the settlement tanks to meet the incoming sewage passing into the aëration chamber is effected through diffusers arranged similarly to those in the aëration tank. Cross-baffle walls are also provided. Surplus sludge will be removed from the end of this channel adjacent to the grit chamber through a pipe which passes to the existing sludge subway.

Settlement Tanks.—Two types of settlement tanks are provided, which can be operated independently or together in parallel:—

(a) Circular Tank.—The diameter of this tank is 29 ft. 2 ins., and its mean depth to water level is 11 ft. 6 ins., with a water-holding capacity of 56,130 gallons. Four Clifford inlets arranged symmetrically are provided, and the effluent leaves over the periphery cill. A helical scraper operated through gear from a water wheel fixed in the discharge effluent channel is provided to move the deposited sludge to an opening in the centre of the floor of the tank which communicates with a separate sludge pit. An air lift is fixed in this sump, by means of which the sludge is discharged into the sludge re-aëration channel.

(b) Inverted Pyramidal Tank, with four pockets.—This tank is 28 ft. 8 ins. square; its depth from water level to the apex of the pyramids is 21 ft. 6 ins. Its water-holding capacity is 69,370 gallons. Four Clifford inlets are arranged over the centre of each of the pyramidal pockets, and the effluent leaves the tank over a periphery cill. Earthenware pipes convey the deposited sludge to four separate sludge pits, each provided with air lift for discharging the sludge into the re-aëration channel.

The effluent from the plant passes through a measurement chamber prior to its discharge to the culvert entering the canal. It is anticipated that this plant will be capable of treating 1,000,000 gallons of the city sewage per day, with the production of a satisfactory effluent. At this rate the sewage treated would receive approximately six hours' aëration, and the sludge prior to its return to the aëration chamber would be re-aërated for from two to four hours, dependent on the volume of sludge in circulation.

While the general lay-out of this plant is somewhat similar to that of the installation at the Withington works, it differs in many respects from the latter plant in actual design. Such alterations in design have been adopted with the idea mainly of reducing the cost of construction without lowering the efficiency of the plant. The chief new features are the flat-bottomed aëration chamber, which does away with the costly concrete ridges employed in the Withington plant, and a reduction to the extent of 50% of the diffusion area, with consequent considerable saving in the equipment charges. In addition, arrangements are provided for the re-aëration of the sludge in circulation, which it is considered will be advantageous in the case of the treatment of a strong trade sewage. The success or otherwise of this new design of aëration chamber will depend very largely on the volume of air required to produce a floor velocity sufficient to obviate the deposition of the sludge.

At the time of signing this report the construction and equipment of this plant is practically complete, but unfortunately it cannot be brought into actual operation until an auxiliary power supply is available. This matter has been subject to unavoidable delay, but a scheme is now in hand whereby electrical power will be obtained from the nearest public supply. The air necessary for the operation of the plant will be obtained from three electrically-driven Reavell air compressors, the capacity of each of which is 500 cu. ft. per minute.

PROTECTION OF WOODEN BRIDGES FROM FIRE

It is said that practically ninety per cent of the fires in wooden bridges and trestles of railways are caused by sparks from locomotives. In order to prevent these fires being so general a report was submitted at the annual meeting of the Railway Fire Protective Association, from which the following recommendations are taken:—

That effective spark screens be provided in the front end of all locomotives and carefully maintained.

That ash pans and grates be made tight and kept in good working order, as the dropping of hot coals or ashes is a source of a large amount of the trouble.

That special places be provided for the dumping of cinders and ashes, and grates are not to be shaken down except at safe points.

That all combustible refuse, such as dry leaves, dead grass, weeds, brush and rubbish, be cleared away from under and around all wooden bridges.

That the decks of all wooden bridges, between the rails, be covered with No. 22 galvanized iron, this to prevent sparks from setting fire to the structure should they be dropped from the locomotive.

As a further preventive measure, it is recommended that all wooden bridges be coated with a fireproof or fire-retardent paint, demonstration having proven some of them to be of excellent protection, and that they can be applied at a cost no greater than that of ordinary paint.

The committee also recommended that one water barrel and one pail be provided for all wooden bridges of a length of 50 ft. or less, and two water barrels and two pails, one to each barrel, be provided for all bridges whose length is more than 50 ft. up to a length of 150 ft., and one water barrel and one pail be provided for each additional 150 ft.

That where a bridge requires one or two barrels and pails, the same are to be placed at the ends of the bridge, located at proper clearance from the track and buried in the ground to within 6 in. of the top, and where barrels and pails are located in the middle of the bridge they are to be located at proper clearance from the rails and the top of the barrel is to be provided with wood or iron cover.

In the past great difficulty has been experienced in keeping pails intact with the water barrels, especially where galvanized iron pails or fire buckets have been used, and they are invariably missing when wanted, and it is therefore recommended that a square wooden bucket of unfinished lumber be provided and that the same be suspended in the water inside of the barrel.

As a further means of extinguishing the blaze, it is recommended that all locomotives be equipped with fire-fighting apparatus.

Compensation of Engineers Should Be Increased

Absolute Value the Proper Basis of Remuneration—Changes in Wholesale and Retail Prices and Rents Most Likely to Continue for Indefinite Time—Justice to Salaried Men and Routine Workers Best Policy to Preserve Engineering Organizations

AFTER thorough study of the conditions existing in national, state and municipal engineering departments, and in railroad offices, consulting engineers' offices, and industrial organizations of various kinds, the U.S. Engineering Council's committee on classification and compensation of engineers has presented a report entitled "The Just Basis for Fixing the Compensation of Engineers."

The members of the committee are: Arthur S. Tuttle (chairman), deputy chief engineer, Board of Estimate and Apportionment, New York; Francis Lee Stuart, consulting engineer, New York; John C. Hoyt, hydraulic engineer in charge, Surface Water Division, U.S. Geological Survey, Washington; Charles W. Baker, president, Baker Economic Transport Corporation, New York; M. O. Leighton, consulting engineer, and Engineering Council's resident representative at Washington; Frank H. Clark, general superintendent, B. & O.R.R., Baltimore; Bion J. Arnold, consulting engineer, Chicago; M. M. O'Shaughnessy, city engineer, San Francisco; F. W. Cappelen, city engineer, Minneapolis; J. S. Conway, deputy commissioner of lighthouses, Washington; O. C. Merrill, chief engineer, Forest Service, Department of Agriculture, Washington.

Following is practically the complete text of the committee's report, which, in view of the similarity of conditions, applies equally or with even greater force to the compensation of Canadian engineers:—

In order to determine what is a fair rate of compensation for engineering service at the present time, the question may be approached from two different points of view: First, what increase should be made in engineers' pay to compensate for the great reduction in the value of the dollar which has taken place in the last five years? Second, how may the intrinsic value of engineering service be determined?

Decrease in Dollar's Value

A great deal of misunderstanding and injustice would be avoided in all our industrial relations were there a clear understanding of the fact that all prices to-day, whether of wages or salaries, or commodities, must be compared with the change which has taken place in the value of the dollar before it can be determined whether the price, measured by an absolute standard, has moved up or down. It should be obvious to everyone that the value of the dollar is measured solely by its purchasing power. Whether it be a dollar received as wages by workmen, a dollar received as salary by an engineer, or a dollar received by a manufacturer in payment for goods sold, the actual amount of value which will be received in each case *will depend upon the average amount of other commodities which the dollar received will purchase.*

Changes in Wholesale Prices

The "index numbers" which are regularly published by various statistical bureaus are an average of the *wholesale* market prices of a large number of standard commodities. In making up the index numbers the prices of the different commodities and classes of commodities are weighted in proportion to the per capita consumption of each. Thus, a comparison of the index number at a given date with index numbers at preceeding and following dates shows the change in average wholesale market prices, and such a comparison shows also the change in the purchasing power, or value, of a dollar in the wholesale market.

This is illustrated in Table 1, in which the numbers in the last column, representing the buying power of a dollar, are the reciprocals of the index numbers. The index numbers in Column 2, it will be understood, are the amount of money required to buy a certain amount of certain standard goods at wholesale on a given date. Thus, if the index number on a given date is, for example, $110, then on that date one dollar will buy 1/110 of this amount.

TABLE 1—DUN'S INDEX NUMBERS*

Showing Variations in the Cost of Living and in the Purchasing Power of the Dollar from 1896 to December 1st, 1919

Date	Dun's Index Number	Corresponding Number Indicating Relative Power of One Dollar
Jan. 1, 1896	$ 77.780	1,285
" " 1897	75.502	1,325
" " 1898	79.940	1,251
" " 1899	80.423	1,243
" " 1900	95.295	1,049
" " 1901	95.668	1,045
" " 1902	101.587	986
" " 1903	100.356	996
" " 1904	100.142	999
" " 1905	100.318	997
" " 1906	104.464	956
" " 1907	107.264	932
" " 1908	113.282	881
" " 1909	111.848	894
" " 1910	123.434	810
" " 1911	115.102	868
" " 1912	123.438	810
" " 1913	120.832	828
" " 1914	124.528	803
" " 1915	124.168	805
" " 1916	137.660	726
" " 1917	169.562	590
" " 1918	222.175	450
" " 1919	230.146	434
July 1, 1919	233.707	428
Aug. 1, 1919	241.650	414
Sept. 1, 1919	238.342	419
Oct. 1, 1919	235.867	424
Nov. 1, 1919	238.573	419
Dec. 1, 1919	244.639	409

*"Dun's Index Numbers" are compiled by R. G. Dun & Co. from the average wholesale prices of about 300 standard commodities arranged in seven groups, as follows: (1) Breadstuffs; (2) meat; (3) dairy and garden; (4) other food; (5) clothing; (6) metals; (7) miscellaneous. The price of each of these commodities is multiplied by a figure determined as the estimated per capita consumption of that commodity. The commodities listed under "miscellaneous" include such articles as coal, petroleum, building material and drugs, so that the individual's expense for fuel and shelter is at least partially represented in the total.

The index number for wholesale prices published by R. G. Dun & Co., are believed to be the most reliable record obtainable of price changes in the wholesale markets for the following reasons: First, they are issued by an organization in close touch with business throughout the country; second, they are compiled by an organization entirely without bias in favor of either capital or labor; third, they have been collected and published over a long series of years; fourth, they are based on the wholesale market prices of some 300 commodities, and largely eliminate the erratic variations which occur when a smaller number of commodities is used to determine the index number.

Changes in Retail Prices

In order to determine the change which has taken place in the value of the dollar it is necessary to investigate changes in retail prices as well as those in wholesale prices. Especially where wages and salaries are concerned, it is the changes in retail prices that determine the buying power of the dollar received.

In general, the changes in retail prices follow the general course of the changes in wholesale prices. There is, however, more or less variation in different localities. Where such variation occurs it will generally consist in a *greater* proportionate increase of retail than of wholesale prices. Under the stimulus of the abnormal demand of the past five years, which is chiefly responsible for the great increase in prices, it is common knowledge that the retailer has frequently advanced his prices faster than the wholesale dealer.

The curve showing the percentage of increase in prices plotted from the Dun index numbers, therefore, in so far as it is in error in indicating the change in the value of a dollar spent in retail purchasing, is in error by understating the decrease in the value of the dollar which has taken place.

Changes in House Rents

In the long run the prices paid for house rents and for personal service change to correspond with the change in commodity prices; but rents change more slowly than the market prices of commodities, so that allowance must be made for this "lag" in determining the change in value of the dollar. This is especially the case where such a sudden and rapid increase in market prices of commodities occurs as has taken place in the past five years.

Furthermore, the rise in rents varies in different cities. In some munition towns, rents rose with a bound in 1915, and so did prices for personal service. In most of the larger cities rents did not rise materially until 1919.

In order to determine accurately the change in value of the dollar in a given community, therefore, an estimate must be made of the change in retail prices compared with wholesale, and of the rate of change in rents and personal service charges.

The September "Bulletin" of the U.S. Department of Labor contains tables showing the results of the Department's investigation of the increase in the cost of living in 17 important industrial cities of the United States for December, 1915, 1917 and 1918, and June, 1919, as compared with December, 1914.

TABLE 2—INCREASE IN WHOLESALE PRICES AND IN COST OF LIVING

Date	Dun's Index Number for Wholesale Prices, Percentage of Increase over December 1st, 1914	Bureau of Labor's Percentage of Increase in Cost of Living over December 1st, 1914
Dec. 1, 1915	7.2	1.07
" " 1916	35.4	14.94
" " 1917	77.4	41.81
" " 1918	85.6	73.40
June 1, 1919	83.7	76.24
Dec. 1, 1919	97.1	.....

Averaging the figures for these 17 cities, it is found that the increase in the cost of living in June, 1919, over December, 1914, was 76.24%. This so-called percentage of "increase in the cost of living" really represents the percentage of increase which has taken place in all prices, including rent and service as well as commodities. Its reciprocal, therefore, represents the decrease in value of the dollar which has taken place.

Present Prices Compared with 1914

In order to compare readily these Bureau of Labor figures with Dun's index numbers, Table 2 has been compiled, in which the prices of December, 1914, are taken as a base and the percentage of increase is shown for each date to December 1st, 1919.

As explained above, the chief reason why the "cost of living" figures have increased less rapidly than the increase in commodity prices, is the delay in readjustment of house rentals. The Bureau of Labor figures bring down the record only to June 1st, 1919. Since that date there has been a great increase in house rentals all over the country. There are no statistics to show the amount of this increase and its effect on the cost of living, but there is good reason to believe that this increase, coupled with the general increase in charges for personal service that has taken place during 1919, and the advance of prices by retail merchants at a greater rate than the wholesale price increase, is sufficient to make the percentage of increase in the cost of living indicated by the Dun's statistics a true record of the change in the value of the dollar at the present time.

There is still another item to be considered. The percentage of increase in wholesale prices shown in Table 2 records the increase over the prices on December 1st, 1914. A more accurate comparison would be to take the average prices for the entire year 1914 as the base with which to make the comparison. The average of Dun's index numbers for the 12 months of 1919 was $122.20. The average wholesale prices of commodities on December 1st, 1919, were therefore double the average prices for the year 1914. The value of the dollar to-day, therefore, in the wholesale market is just half what it was during 1914, and it is less than it was at any time during the war.

Changes in "Cost of Living"

The customary reference to the general increase of prices above reviewed as 'the high cost of living," has tended to confuse the minds of many people. Some employers have argued that the high cost of living was not their affair. They have declared the real trouble to be "the cost of high living." On the other hand, engineers or other professional workers, and many classes of salaried men have hesitated to press claims for increased pay on the ground that changes in the cost of living make it difficult to live on their incomes. Such men rightly feel that their living expenses are their own private affair.

When, however, it is clearly understood that what has taken place is a change in the value of the dollar, the claim for an increase in the rate of pay measured in dollars rests on entirely different ground. The proper and dignified position for the engineer is to assume that his work should receive at least the same compensation in absolute value that it received five years ago, and that therefore the compensation measured in dollars should be increased by whatever amount is necessary to offset the decreased value of the dollar.

There can be no denial of the justice of this claim, even though the difficulty of satisfying it to the full extent in many departments of engineering work is recognized. The compensation of many engineers is dependent upon laws and ordinances, custom and precedent. Great inertia must often be overcome to effect a change. In many cases the compensation of the engineer, like that of many other public servants, is dependent upon revenue raised by taxation; and the difficulties in increasing tax rates to correspond to the great decrease in the value of the dollar, are known to everyone.

Construction Salaries Readily Adjustable

Engineers engaged in business on their own account have to meet the difficulty of raising their fees to offset the changed value of the dollar, a task especially difficult in fields of enginering where work is inactive and the competition for it is keen; yet without such increase they cannot adequately raise the pay of their own employees. This illustrates anew the need for emphasizing the change in value of the dollar, rather than the change in living costs. The former is at once recognized to bear directly on fair prices for goods sold and for the fees charged by professional men as well as on wages and salaries.

On the other hand, there are many cases where there is no real obstacle to a prompt adjustment of the engineer's compensation to the full amount indicated by the decreased buying power of the dollar. In carrying on construction work, the salaries paid to engineers are a small percentage of the total cost. The wage workers, both those organized in trade unions and even the unskilled and ignorant laborers on the work, have received increases in compensation in many cases fully equal to the change in the value of the dollar, and in some cases far exceeding it. If the engineers on such work are paid the same percentage of the total cost that they were in 1914, their increased pay will fully offset the changed value of the dollar. The same thing is true of engineers employed in manufacturing industries, and here the compensation of engineers has been largely increased.

Justice to Salaried Men

At this time especially, employers who represent invested capital and those responsible for work in the public service, stand in great need of the loyal support and co-operation of their salaried professional staff. It is exceptional where salaries have been increased to fully correspond to their decreased purchasing power. The injustice in thus reducing the rate of compensation for loyal and efficient service paid to the very men on whose brains and fidelity the country is more dependent than on any other class, is truly a fatal error.

How Long Will High Prices Stay?

There has been reluctance to raise salaries to correspond to the changed value of the dollar because of the idea that prices were to drop back with the conclusion of the war. So far from this being the case, the above quoted records show that following the lull in business after the armistice, prices have risen above even the war-time scale, and are now at the highest point ever reached. Business has largely readjusted itself to the changed conditions and the activity in some lines exceeds that registered during the war.

At the bottom of the changed price conditions is the surplus of demand over supply. The world urgently needs more food and coal and steel and cotton, more of the goods made from them and from other raw materials, than are now being produced. The competition among buyers that sent prices soaring in the early years of the war, is still an active force to maintain prices.

The only two things which can restore prices to their former level are increased production or decreased consumption. World-wide disorganization of industry and of government, deficient capital and deficient transport facilities all tend to reduce production. The world of consumers, long held down to a war diet and war clothing, now eagerly seeks to replenish its larder and wardrobe and to repair and renew its stock of buildings and machinery.

The outlook is that it will take years to again organize the world's equipment for production and distribution, including finance, transportation by land and sea, and merchandizing, so that the demands of consumers may be met as before the war and prices be brought back to former level.

If this analysis be correct, then all classes of workers whose compensation is below the general level will continue to suffer a hardship. The inevitable tendency will be to drive the competent men in these poorly paid callings out into other better paid occupations. Delay in adjusting the pay of the engineer to compensate for the decreased value of the dollar, therefore, does serious harm not only to him but to the public.

Have Already Suffered Losses

It may well be argued further that the high scale of prices, or low dollar value, has continued now for fully three years. During that time, the engineer who has had but little increase in salary has suffered a heavy monetary loss through causes entirely beyond his control.

The present price level is not considered merely temporary by such of our government agencies as the Department of Labor and the Federal Reserve Board, or by such economists as Irving Fisher and J. S. Holden. Substantial relief from the high cost of living, therefore, cannot reasonably be expected through a decrease in prices; it must be met by increases in salaries.

From the above considerations, the committee feels justified in urging that a readjustment of compensation should be based on the assumption that the present sale of prices is to continue for an indefinite time.

It will be generally agreed that the salary of an engineer ought to be at least sufficient to enable him to live in the manner which his position and responsibility call for, and in addition to repay within a reasonable time the investment in time and money he has made in gaining the education and experience which is necessary for his work.

The Living Wage Principle

There is a wide general acceptance of the principle that the worker in any occupation should receive at least a reasonable living wage. By a "living wage" is meant the amount which will maintain in decency and comfort both the incumbent of the position and his dependents.

There are certain positions which are ordinarily occupied by young men and women who are starting on their life work, and who have not yet assumed family responsibilities. In so far as the incumbents of these positions fill them temporarily as a means of advancement to positions of greater compensation—in effect serving as apprentices—the living wage need not be based on a "family" standard.

When, however, any position is likely to be occupied more than temporarily by individuals of an age at which they should naturally assume family responsibilities, the minimum salary for the position should not be less than that necessary to maintain an average family in respectability.

Engineering Work Inadequately Paid

Unfortunately, there has been for fully a decade a tendency to lower the pay of engineers. The law of supply and demand has operated to reduce the pay of engineers in many branches of the profession far below the standards of decent living.

This has not benefited the public. On the contrary, by paying too low a rate for engineering service, the inevitable tendency has been to lower its quality. This has been especially marked in the case of engineers in federal, state and municipal service. Here the inertia which prevails in all public affairs has prevented the engineers from receiving more than a trifling part of the increase in pay, measured in dollars, that is required to offset the shrinkage in the dollar value.

The obvious result has been to drive out of the public service the best and ablest men, who can obtain better positions elsewhere, and to leave only the men who by reason of age or inferior ability cannot make such a change.

Waste and Danger

It cannot be too strongly emphasized that the public losses through cheap engineering service many times the amount it may seem to save through lower salaries. The professional engineer in a responsible position in designing, constructing or executive direction of important work should have initiative, sound judgment, broad knowledge and executive ability. Lack of these qualities often results in great loss of money, often by needlessly increasing the cost of work of which the public never knows. Safety of life and limb is also so frequently dependent on the skill and fidelity of the engineer that danger is incurred when the quality of engineering service is sacrificed through a false idea of economy. The investigation of the Quebec bridge disaster of 1907 showed that the engineer primarily responsible for the safety of its design was being paid at so niggardly a rate as to be unable to provide a sufficient and competent staff to properly supervise the work.

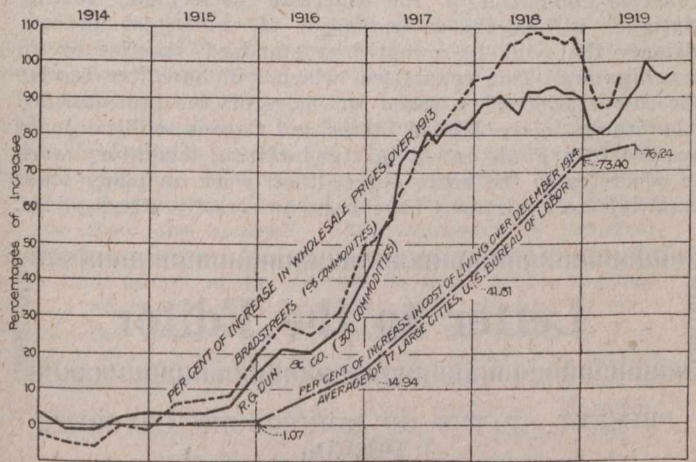
The movement, therefore, to give engineers just compensation for their services is not merely a movement for the benefit of the engineering profession. It is even more a movement to benefit the public by securing for it a high quality of engineering service.

This matter deserves emphasis here because where readjustment of salaries has taken place to compensate for the changed value of the dollar, it has been common to confine the increase to the lower-paid men, and to do little for the men receiving salaries above $3,000. There is no longer an excuse for this, as the above review amply proves. The measure of seeming economy, also, is very small; because the engineers in the higher positions are few in number compared with the rank and file of professional workers.

Routine Workers in the Profession

It is frankly recognized that there is another class of technical work—of a routine order—which calls for little in the way of initiative, originality or judgment. Much of this routine technical work in the field, the office, the shop or the laboratory can be and is being done by boys and young men with limited education and no more training than that afforded by a correspondence school or a few months' study in a trade school. Most of this work does require, however, a degree of reliability and fidelity which deserves fair compensation. The best guide to fair rates of pay for this class of technical workers is found by comparison with the standard rates of wages paid to skilled workers in the trades. These workmen are now generally receiving rates of pay much higher than the routine technical worker, and in many cases higher than even the engineer who carries large responsibility for design or administration.

The federal government is now paying thousands of its highly-trained clerical and technical force less than a living wage. Except for the temporary bonus of $240 a year for positions paying salaries of $2,500 or less, no attention has been paid to the constantly diminishing purchasing power



PERCENTAGE OF INCREASE IN WHOLESALE PRICES OVER THE AVERAGE FOR 1913, AS SHOWN BY DUN'S AND BRADSTREET'S INDEX NUMBERS

of the salaries paid to this class of employees. On the other hand, the government has given full recognition to increased living costs in fixing the wages of organized labor.

A "shipfitter" in the Navy Yard, for example, receives $1,750 a year while he is learning how to do his work; after three months' apprenticeship he gets $2,000. If he is made a "straw boss" in charge of 12 or more men, he gets $2,450, and if a "sub-foreman" in charge of 30 or more men, he gets $2,900. A blacksmith (heavy fire) gets $2,400. A "heavy hammer and machine forger" gets $3,700.

In many instances the amount paid for skilled labor is greater than the amount paid to the trained government engineer. Over 40 of the labor crafts were awarded a rate of wage of $2,000 and more by the Labor Adjustment Board.

The skilled laborer is not required to know how to read or write, and he may receive full pay after an experience varying from two weeks to six months. The government engineering employee, on the other hand, to get an equivalent amount of pay, must have had from two to eight years' experience if he is not a technical graduate, and in many instances will not be admitted at all without a technical degree, and then only with from two to four years' practical experience.

Many other comparisons might be made between the worker at a trade or the factory employee and the routine worker in engineering, showing how low is the pay of the latter compared with the former; but no further proof is necessary to show that the technical worker is not receiving what his services are worth. The inevitable result of such underpaid service is a deterioration in its quality. The men in these lower grades have, as a rule, not the same incentive of professional pride that often keeps the men carrying larger responsibilities faithfully at work, even when their pay is inadequate.

Even though a temporary over-supply of men trained in engineering work may make it possible to keep salaries for these brain workers below the wages of laborers, the inevitable result will be a dissatisfied working force which carries out the daily routine without energy or good will, and the public's work will not be done with efficiency or economy.

REPORT ON MONTREAL AQUEDUCT

R. S. & W. S. Lea Advise Administrative Commission to Complete Project as Water Supply Source at Cost of $1,683,000, and to Build New Pumping Plant Costing $850,000

ONE of the problems facing the Adminstrative Commission of Montreal is to decide how to utilize the work that has been done on the Montreal aqueduct project, which was suspended before the Commission was appointed. In an effort to solve this problem, the Commission requested W. S. and R. S. Lea, consulting engineers, Montreal, to investigate and advise on the engineering economics of the project as it now stands. Messrs. Lea have presented their report, submitting three schemes and discussing their relative advantages.

The first, which would cost the city $1,683,000, is to use the new aqueduct as a water supply source for domestic purposes. The second scheme, which would cost the city $6,000,000, is to use the aqueduct for water supply and limited power development. To carry out this scheme an auxiliary steam plant would be needed.

The third scheme, which would cost $10,000,000, is along the lines of the power scheme of the original project, and would supply power for pumping water and for lighting streets.

The chief recommendations are as follows: "The main question we have been asked to deal with in this investigation is the completion of the aqueduct, and it is recommended that the aqueduct be completed without delay for water supply purposes only at an estimated cost of $1,683,000.

"That a new motor-driven pumping plant be provided at an estimated cost of $850,000, with an initial installation of five 30-million gallon per day units, and with provision in the building for the accommodation of three additional units operating on electrical power purchased from the Montreal Light, Heat and Power Co.

"That the rated capacity of the water filtration plant be increased to a total of 120 million gallons per day at an approximate cost of $2,000,000.

"That additional elevated reservoir storage be installed in connection with such system to provide for eight hours' stand-by storage over and above the capacity required for equalizing purposes.

"The estimates of cost given above are for the aqueduct pumping plant and filter plant, and include engineering, inspection and interest during construction."

At the 28th annual meeting of the Association of Ontario Land Surveyors, held last week in Toronto, it was decided to co-operate with the Association of Dominion Land Surveyors in the formation of a national organization to promote the status of surveyors. The officers elected for the coming year are as follows: President, T. B. LeMay; vice-president, G. A. McCubbin; secretary-treasurer, L. V. Rorke.

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PRINCIPAL CONTENTS

FUTURE OF THE J. C. T. O.

At a recent meeting held in Toronto, the members of the Joint Committee of Technical Organizations debated the future of that body and the possibility of incorporating it along permanent lines. After a thorough discussion, it was moved that the J. C. T. O. be disbanded, and this motion was carried, but subsequently a motion for reconsideration was presented, and it was decided to refer the question of whether there should be a permanent J. C. T. O. to the joint legislation committee which will meet at an early date to discuss the Engineering Institute's draft bill for registration and licensing of engineers.

This joint legislation committee will consist of a small number of representatives from each of the six main technical societies in Toronto, and, according to the present program, the fate of the J. C. T. O. will be left with that committee.

At the above-mentioned meeting of the J. C. T. O., an excellent suggestion was made by A. H. Harkness, consulting engineer, Toronto, who favored the suspension of the J. C. T. O. as at present organized, but suggested the formation of a permanent committee consisting of the executives of all the technical societies in Ontario. "Questions of common interest could be discussed by this committee of executives," said Mr. Harkness, "and joint action could be taken in all such matters with the assurance of having the entire membership of all the societies behind all decisions made by the committee. In important matters, it is to be presumed that the executives would receive instruction and guidance at general meetings of their respective societies."

The work done by the J. C. T. O. during the war demonstrated that co-operation, even among societies, is desirable. The joint legislation committee will find some way, surely, of perpetuating this co-operation.

CONSISTENCY OF CONCRETE

Perhaps the most prolific source of disputes between various investigators engaged in concrete research work has been the lack of any generally accepted method for determining the consistency of concrete mixtures. What one laboratory calls normal consistency, may be considered a wet mix by another laboratory or a harsh mix by some other investigator. Consistency and flowability have also been somewhat confused.

The U. S. Bureau of Standards has devised a "flow-table" test, based on the determination of the increase in diameter of a sample after it has been jolted a given number of times by a table arranged to be lifted and dropped through a definite height by means of a cam mounted on a suitable shaft. Professor Abrams, of the Lewis Institute, has introduced a "slump test," by which he measures the slump or spread of a small sample after the mold has been suddenly removed. The Hydro-Electric Power Commission of Ontario have a "chute test," by which they determine the angle to which a steel chute must be raised before a bucketful of concrete in the upper end of the chute will flow to the bottom of the chute. Capt. Edwards, who devised the surface area theory, judges consistency merely by the appearance of the mixture, as do many other investigators. Every laboratory seems to have its own favorite method of determining uniform consistency.

One of the problems that will be studied this year by the Concrete Committee of the American Society for Testing Materials will be the determination of some test for consistency that will be accepted as standard practice by all investigators. This committee, which will hereafter receive the co-operation of a dozen or more of the best-qualified laboratories in the Uinted States and Canada, will no doubt succeed to a great extent in standardizing laboratory work in concretes to the same degree that work on many other materials and mixtures have been universally standardized.

Letter to the Editor

PRESENT STATUS OF REINFORCED CONCRETE DESIGN

Sir,—I have been interested—besides somewhat amused—at the rather radical article in your issue of January 22nd, under the title of "Present Status of Reinforced Concrete Design." There is considerable that is valuable in it and any appeal to engineers and to the public to keep up to the times should receive the support of everyone interested in the sound and conservative advancement of engineering design and construction.

The writer of the article seems to have a somewhat antagonistic attitude, however. Possible zeal and interest have led him on a bit and so I cannot but feel that his statement, "Many people have the opinion that because something is in print in a text book it must be absolutely authentic and unquestionable," is also not unquestionable. Following this, however, there are a few lines in which the writer gets something off his chest, so to speak, that has been there for some time, as it seems to me that this was a challenge to text book writers and users of text books. I am not a text book writer but I am, owing to the character of my present work, a user of text books to a considerable extent and furthermore, I can lay claim to personal acquaintance with several writers of text books.

For the above reasons, then, permit me to say a few words about text books and their writers on their behalf. As a rule, text book writers (I speak of the reliable books) are men of experience, men who have played the game, men who are, unlike the producer of the above mentioned article, conservative in their statements, and who do not put things into print that have not received the test of time, technical criticism and sound experience.

Necessarily text books cannot be kept strictly up to date. For obvious reasons, all the text books cannot be revised every year nor can they contain the results of the latest experimental investigations. Perhaps it is well they cannot do so, for experimental results are not always as reliable in practice as one might suppose offhand.

There are, these days, too many text books being published; not because they contain material that is "largely at fault" as our writer would have us believe but because they add absolutely nothing to the already existing excellent work on the subject. In other words, they have no reason for their existence excepting perhaps some fanciful arrangement of the material conceived by the author as possessing some advantage over those already in print.

Then there are authors who publish books from the wrong point of view, especially books on applied mechanics by mathematicians. This, to be sure, is because they have had no practical experience, but one could hardly criticize the contents of books even so written, which are generally poor for teaching purposes, as "largely at fault." Because a text book does not agree with our opinions, it does not necessarily follow that it is "largely at fault."

On the other hand, there are some engineers who can neither understand technical books nor appreciate those they think they understand and who, therefore, criticize and condemn all text books. Such engineers usually have a high opinion of their own knowledge of mechanics and recline contentedly in the shade of their ignorance instead of endeavoring to enhance their knowledge of such subjects in the sunshine of some reliable text book.

I have sounded many a note of warning to students about believing all that they read in our engineering journals, proceedings of engineering societies, special pamphlets, etc. As an example of this, the article I have already mentioned fulfils all requirements in the following statement: "In physically developing a square rod (cold twisting the rod), to get the maximum efficiency of the treatment the corners are always overstressed and brittle, owing to the greater distance from the centre." This statement is incorrect. The maximum stress for a square rod twisted below the elastic limit is not at the corners as most people suppose. There is no reason to believe that when the rod is overstressed, the corners are overstressed the most; in fact, since they are not the first parts of the material to become overstressed, there is reason to believe they would not be overstressed as much as some other portions. However, this is not intended to be a dissertion on torsion, but is merely to show that one should not swallow whole all statements in print, especially when they come from those who might well spend a little more time in studying reliable text books and a little less time in writing about them in a derogatory manner.

I. F. MORRISON,
Assistant Professor of Structural Engineering,
University of Alberta.

Edmonton, Alta., January 30th, 1920.

PERSONALS

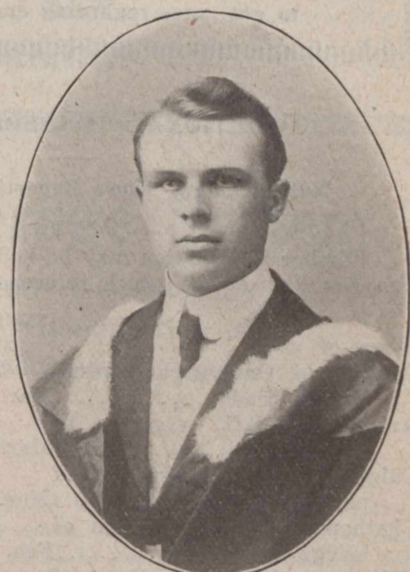
J. A. W. BROWN has severed his connection with the Trussed Concrete Steel Co. of Canada, Ltd., and is now chief engineer of the W. H. Yates Construction Co., Ltd., Hamilton, Ont.

ROYAL LESAGE will continue in private practice as a civil engineer and land surveyor at 76 St. Gabriel St., Montreal. Mr. LeSage was a partner in the firm of Ouimet & LeSage, which partnership was recently dissolved.

RICHARD L. NIXON has accepted the chair of engineering at King's College, Windsor, N.S. Mr. Nixon has been on the engineering staff of the Nova Scotia Highway Board. He is a graduate of the Nova Scotia Technical College.

THOMAS ADAMS, town planning adviser to the Commission of Conservation and to the Housing Committee of the Dominion Cabinet, has been retained by the cities of Spokane, Wash., and Cincinnati, O., to prepare city planning schemes.

L. LEON THERIAULT, who was recently appointed town manager of Edmundston, N.B., was born in September, 1884, at Grande Anse, Gloucester County, N.B. He was educated at the Bathurst Superior School, Sacred Heart College and the University of New Brunswick. He graduated in 1905 at Sacred Heart College, Caraquet, N.B., with the degree of Bachelor of Science, and in 1909 from the University of New Brunswick with the degree of B.Sc. in civil engineering. For the following six months Mr. Theriault was construction engineer for the Albert Manufacturing Co., completing five miles of narrow gauge railway, an 80-ft. wooden bridge and dock improvements, for the opening of plaster quarries. He returned to New Brunswick early in 1910 and obtained a provincial land surveyor's license, and practised as such for one year. From 1911-4 he was employed as an assistant Dominion land surveyor in the four western provinces on base line surveys and town planning. Having returned to New Brunswick in the fall of 1914 on account of ill-health, he was employed by the town of Bathurst to supervise the construction of its water works and sewerage system. Since May, 1917, Mr. Theriault has been with the New Brunswick department of public works as district road engineer in charge of the construction of 400 miles of main highways and numerous branch roads.



WILLIAM YOUNG, for six years comptroller of water rights for the province of British Columbia, has resigned and is now practising as a consulting engineer in Vancouver.

COL. GEORGE A. JOHNSON, Utilities Division, Construction Division of the United States Army, has resigned his commission, and will be discharged from the service March 1st. Some time ago announcement was made in this column of the formation of the firm of Johnson & Benham, consulting engineers, with offices in New York and Kansas City. Col. Johnson will hereafter be the directing head of that firm.

J. D. JONES, general superintendent of the Algoma Steel Corporation, has been appointed general manager of that company, succeeding the late Capt. David Kyle. From 1912 to 1916, Mr. Jones was an official of the Algoma Steel Corporation, but he resigned in the latter year to become chief engineer of the Gary, Ind., plant of the U.S. Steel Corporation. Last September he rejoined the Algoma staff as general superintendent.

JAMES WHITE, deputy head of the Commission of Conservation, Ottawa, and J. E. CHALIFOUR, chief geographer of Canada, have received the gold medal which was awarded to them in 1917 by the Geographical Society of Paris. The striking of this medal, which is known as the Alexandre de la Roquette prize, was delayed by the war. This award was for the "best work on the geography of the northern countries," and was awarded on account of the "Atlas of Canada."

HERBERT PERCY HEYWOOD has been appointed engineer of sewers and drainage on the staff of George Clark, designing engineer of the Toronto Harbor Commission. Mr. Heywood succeeds W. S. Harvey, who resigned two months ago to accept a position in the United States. Mr. Heywood was at the front with the 3rd Battalion, Canadian Railway Troops, and since the armistice has been on the sales engineering staff of the Lock Joint Pipe Co., New York, at first as English representative and latterly as representative for Eastern Canada.

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or proposed, contracts awarded, changes in staffs, etc.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer*, to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Alexandria, Ont., asphalt penetration roads	Mar. 1.	Feb. 12.	43
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Kerr Robert, Sask., extension of telephone line	Mar. 5.	Feb. 19.	48
Kitchener, Ont., factory addition	Mar. 1.	Feb. 19.	43
Kitchener, Ont., plumbing, heating and electrical work	Mar. 1.	Feb. 19.	46
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Niagara Falls, Ont., motor pumper	Mar. 15.	Feb. 19.	50
Quebec, Que., interior building work	Feb. 27.	Feb. 19.	46
Richmond Tp., Ont., work on highway	Mar. 9.	Feb. 19.	52
Saugeen Tp., Ont., erection of school	Mar. 1.	Feb. 12.	50
St. Thomas, Ont., asphalt pavement	Mar. 1.	Feb. 19.	50
Toronto, Ont., construction of six bridges	Feb. 27.	Feb. 19.	52
Toronto, Ont., asphaltic road oil pumps	Mar. 15.	Feb. 19.	45
Toronto, Ont., street cars	Mar. 16.	Feb. 19.	50
Tyendinaga Tp., Ont., work on highway	Mar. 9.	Feb. 12.	45
Victoria, B.C., work on building	Feb. 29.	Feb. 5.	46
Winnipeg, Man., underdrainage of 8-ft. pressure pipe	Mar. 1.	Feb. 19.	52
Winnipeg, Man., two rotary oil pumps and electric motors	Mar. 8.	Feb. 19.	45
Winnipeg, Man., extension to power-house	Mar. 8.	Feb. 19.	45

BRIDGES, ROADS AND STREETS

Birtle, Man.—Tenders for the draining and grading of fifty-two miles of road will be received by W. B. Chapman, Secretary-treasurer, up to six o'clock p.m., March 2nd, 1920. Specifications may be obtained at the office of the Good Roads Board, Winnipeg, or of W. B. Chapman, Birtle, Man.

Brantford Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister, Provincial Highways, up to 12 o'clock noon, Tuesday, March 23rd, 1920, for construction of concrete pavement, etc. (See official advertisement in this issue.)

Calgary, Alta.—City Commissioners recommended that tenders be called for special intersectional work for Eighth Ave. and Centre St., and for the approach to Centre St. bridge. City engineer, Geo. W. Craig.

Calgary, Alta.—City council received the following tenders for construction of proposed new bridge at Hillhurst. Fegles Construction Co., $213,000; A. G. Creelman Co., $262,-999.55; L. O. Beam, Regina, $251,311.59; Foundation Co., of British Columbia $214,901.15; city engineer, $204,000. Contract not yet awarded.

Cornwall, Ont.—Tenders will be received by Adrain I. MacDonell, county clerk, Cornwall, Ont., up to noon, Friday, March 12th, 1920, for road construction in United Counties of Stormont, Dundas and Glengarry. (See official advertisement in this issue.)

Cornwall, Ont.—Tenders will be received by Adrian I. MacDonell, county clerk, Cornwall, Ont., up to 12 o'clock noon, Friday, March 12th, 1920, for road-making equipment.

Galt, Ont.—Grand River Ry. Co. plans removal of its bridge crossing the Grand River to a new location.

Guelph, Ont.—Tenders will be called by Wellington County Engineer O'Connor for the erection of a new concrete Victoria bridge.

Halifax, N.S.—Tenders will be received at the office of the Provincial Highways Board, province of Nova Scotia, Halifax, N.S., up to noon, Saturday, March 6th, 1920, for the construction of the highway known as the St. Margaret's Bay Rd. Plans and specifications are on file in the office of J. W. Roland, Chief Engineer. (See official advertisement in this issue.)

Halifax, N.S.—Provincial Highways Commission plans extensive improvements to roads this year. Chief engineer, Mr. Roland.

Hamilton, Ont.—Board of Control considering widening of Merirck St. and York St. City engineer, E. R. Gray.

Hamilton, Ont.—R. W. Kelly, president of the Western Ontario Highway Association, has arranged for a deputation from the association and from municipalities between Niagara Falls and Windsor to wait on the Ontario government, March 3rd, when the Premier and Cabinet will be asked to have Provincial highways made of a permanent nature, surfaced with asphalt or brick.

Hamilton, Ont.—City will establish a new civic asphalt plant on Ferguson Ave.

Kingston Tp., Ont.—Tenders will be received by Chas. F. Adair, clerk, Cataraqui, Ont., until 6 o'clock p.m., March 6th, 1920, for crushing 800 toise (at per toise) of stone for road building and road repairs.

London, Ont.—A ruling by the city solicitor that the city council is not bound by the recent vote of the people against the construction of a new $140,000 bridge over the Thames at Ridout St., will be voted on by the council, and it is expected that the span will be proceeded with at once. City engineer, H. A. Brazier.