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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Present Status of Reinforced Concrete Design

New Cement, Aggregate and Steel May Permit Increased Stresses—Structures Manufactured at Site, Hence Need Expert Supervision—Tests by Emergency Fleet Corporation Indicate Defects in Present By-Laws—Paper before Engineering Institute's Toronto Branch

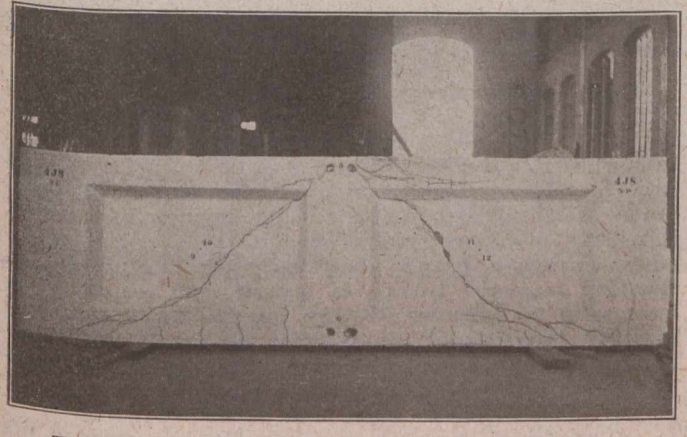
By F. G. ENGHOLM

F. G. Engholm & Partners, Ltd., Toronto

AT one time it was a great achievement to build bridges, dams, high-power engines, etc., and get these works to give service. The cost was a minor consideration; the various works were of such high commercial value that the actual cost of construction bore a small ratio to this value and was therefore a minor consideration. Service was the main consideration.

Conditions have changed. At the present moment the order of the day is service at a price, and a keen price. The commercial competition of the present day is not merely a matter of individual effort; it is now a matter of national importance. A nation that facilitates the quick development of engineering science and then takes advantage of that development is going to be away ahead of a nation that stagnates and provides no machinery by which engineering science can be developed.

Reinforced concrete as a material of construction offers advantages compared to other materials which in my opinion entitle it to the first place in the consideration of the commercial world of to-day. But Canada stagnates as far as reinforced concrete is concerned. There is no machinery by which engineering science can develop, and we have no reason to be particularly proud of it. We are tied up by a

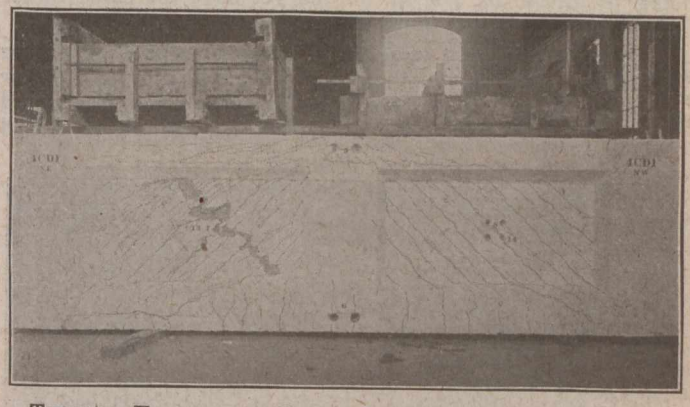


TYPICAL FAILURE OF BEAM BY DIAGONAL TENSION

Test by Emergency Fleet Corporation. Steel in this beam not sufficient to take diagonal tension. Note single crack and its width.

lack of proper understanding, and we are hampered with by-laws in every direction.

Consider for a moment the recent developments in reinforced concrete construction. Firstly, cement: There is a new cement called "Super-Cement," which, I believe, will shortly be put on the market. It is made by mixing a chemical with the clinker before grinding. This new cement shows an increase in strength of upwards of 25% over ordinary cement. Specimens 1 in. in thickness, made one of cement to three of quarry-run sand, have been standing under pressure of gasoline at 115 to 120 lbs. per sq. in. for nine weeks, the variation of pressure from 115 to 120 depending upon the temperature. Specimens four days old, 1-in. thick, using the same mixture, have withstood a water pressure of 30 lbs. per sq. in. Specimens made of one part cement to



TYPICAL FAILURE OF BEAM BY DIAGONAL COMPRESSION OF THE CONCRETE

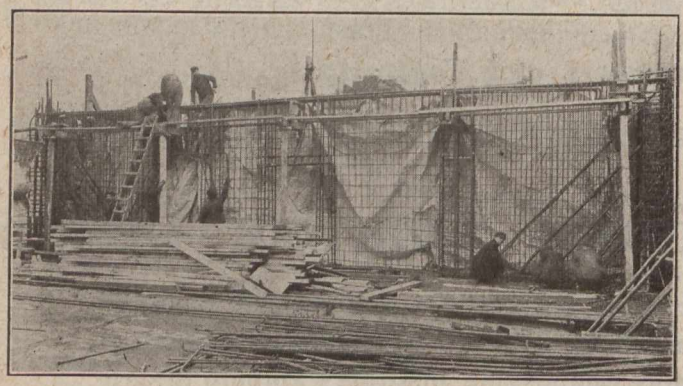
Test by Emergency Fleet Corporation. An excess of steel was provided to take diagonal tension and shear. Note large number and even distribution of diagonal tension cracks.

five parts limestone chippings (crusher run), when seven days old have withstood a water pressure of 28 lbs. per sq. in.

Secondly, aggregate: A new type of aggregate is made by fusing clay under special process. Concrete made from this fused clay, using ordinary cement (one part cement to three parts fused clay agregate up to ½ in. in size), gave strength of 3,380 lbs. per sq. in. at 7 days, and 4,350 lbs. per sq. in. at 28 days. The weight of concrete made from this aggregate is less than 106 lbs. per cu. ft. Structures made from this concrete show great economy, due to the reduction of deadweight of the structure. The United States government ships were made from this material. In a 3,500-ton ship, the relation of the deadweight carrying capacity and total displacement were 62% for concrete, compared with 65 to 68% for steel and 53% for wooden ships. The fire resistance of fused clay is extremely high.

Thirdly, steel: By physically developing ordinary mild steel, one can increase the stress of the yield point of the material, and also the ultimate stress. This steel is not manufactured in Canada, but is employed extensively in England and elsewhere. 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. In this special bar, the section adopted to give maximum efficiency is a round with 3 flats on it; that is, somewhat triangular with well rounded corners. The cross-sectional area is 95% that of a true circle. When this rod is cold twisted,



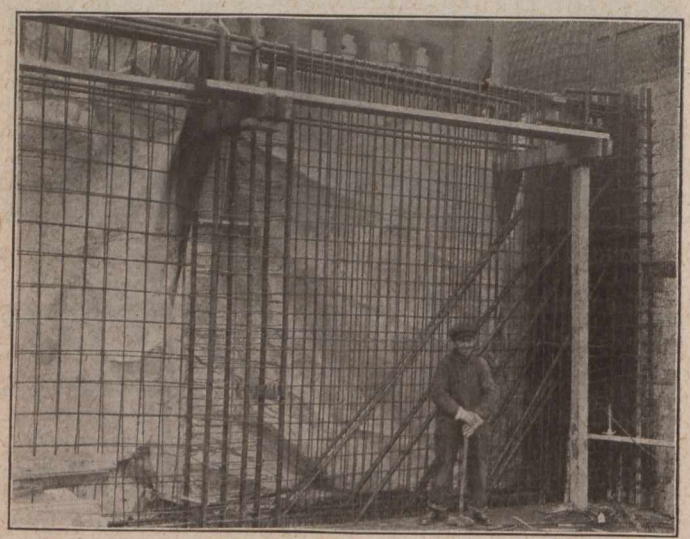
50-Ft. Beam to Carry 10 Stories

One of five similar beams in the Trusts & Guarantee Bldg., Toronto. This beam takes the place of a partition wall, and has openings for main corridor and office door. It is 14 ft. 6 in. deep, 21 ins. wide and 50 ft. long, overall. Apparent depth of construction at corridor opening, 24 ins.

the outer fibres do not become overstressed and the rod is just as convenient to handle and bend as an ordinary round rod.

The ultimate strength of this rod is about 85,000 to 95,000 lbs. per sq. in., and the stress at the yield point is about 55,000 lbs. per sq. in. It is safe to stress this steel to 22,000 lbs. per sq. in. and yet have the same factor of safety as ordinary mild steel at 16,000 lbs. per sq. in.

Now, if one were to design a bridge or a building taking the fullest advantage of these materials, and provide a factor of safety of, say, 10 at three months, these structures would not pass either the Ontario Railway and Municipal Board



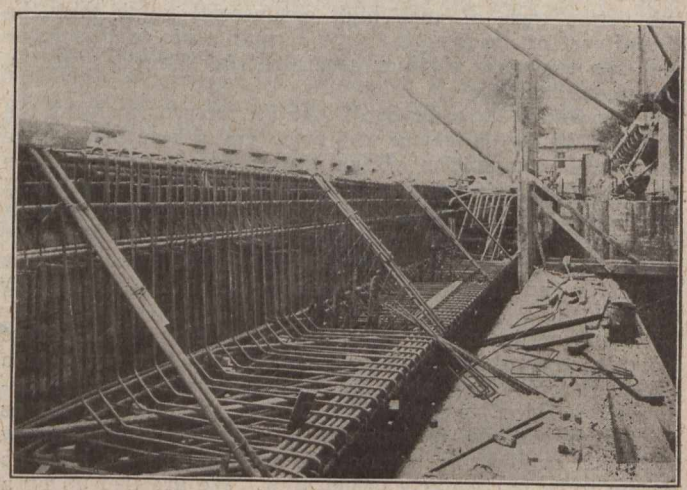
Closer View of Part of Trusts & Guarantee Beam, Showing Reinforcement at End

specifications nor the Toronto city by-laws. Yet steel structures having a factor of safety of only 4, can be built under these regulations.

At present there is no legislation to permit engineers to take full advantage of reinforced concrete as it now stands, let alone any recent improvements. Regarding the economy of concrete structures, such structures would be considerably cheaper than steel although they would be 2½ times stronger. The Birks building, Vancouver, built in 1912, cost 6.2 cents per cu. ft. for the reinforced concrete frame; i.e., columns, floors, retaining walls and foundations complete. The Trusts & Guarantee buidling, Toronto, built in 1915, cost 7.5 cents for the complete structural work. These structures could be built to-day for about 10½ cents, so that the increase in cost of reinforced concrete amounts to only about 50%. The reason for this low advance in cost is that the handling of concrete mechanically saves considerably in labor, and by designing a building so that the formwork can be used several times, one also saves considerably.

There is something wrong in the way in which reinforced concrete is controlled, and the reasons are likely as follows:—

1. Reinforced concrete is a buidilng material which is manufactured on the site; the contractor is the manufacturer. Considering the component parts of reinforced concrete—cement, sand, stone, steel and formwork—the only component part which is a finished manufactured product is the cement. The sand and stone are raw materials having a very low bulk cost compared to any manufactured product. The lumber used in the formwork is rough material, and the steel is in the form of ordinary round rods which bear a very low cost of manufacture—so low, in fact, that they might be classed, comparatively speaking, as raw material. The commercial power of vested interests in the manufacture of cement, sand, stone and reinforcing steel is small compared to the commercial power of the manufacturing interests of other building materials, such as structural steel, terra cotta tile, brick, timber, etc. Apart from the cement manufacturers, no one possesses any real power or is able to provide the necessary funds to advertise and push reinforced concrete as other materials have been pushed.



Reinforcement in Long Span Beam

Curtain wall of LaSalle Bridge, Montreal, forming continuous beam, 65-ft. span, to relieve the Stoney sluice gates of ice pressure. The limited dimensions of concrete called for heavy reinforcement.

2. It is comparatively easy for an architect or an engineer to design in steel, timber, etc., and superintend the construction. The calculation and construction are simple, and he is able to do the work himself. In the case of structural steel, the shop drawings are invariably prepared and paid for by the fabricating works, and the engineer or architect is relieved of that responsibility. If the architect or engineer employs reinforced concrete, he does so only at considerably increased trouble to himself, and corresponding increase in the expenses. It pays him to employ reinforced concrete specialists, but in so doing he has to obtain permission from his employer or client, and this reflects sometimes upon his own ability in the eyes of the client or employer. This is due to entire lack of understanding.

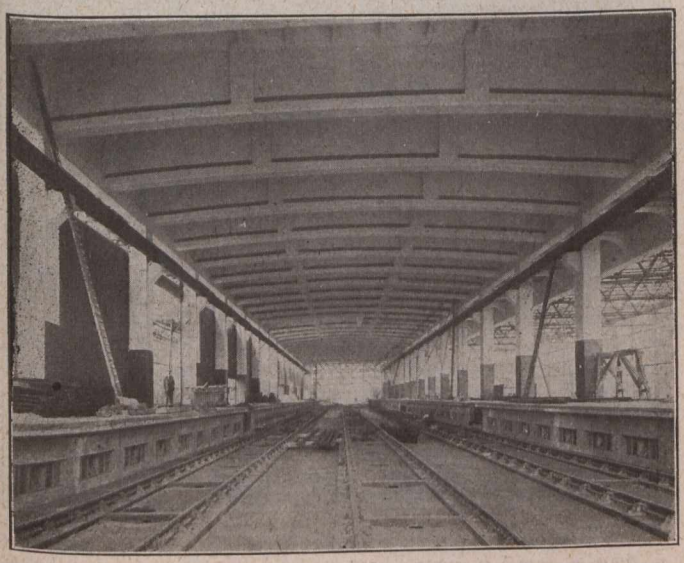
A reinforced concrete engineer who has made a life study of the work, and employs an expert staff to do the work, can save tremendously, compared with the efforts of anyone who is not familiar to any high degree with the subject. The actual cost of special engineering service in connection with reinforced concrete construction is absolutely negligible compared to the saving it is possible to effect over other materials of construction or the employment of engineers who lack practical experience.

3. As previously stated, reinforced concrete is manufactured on the site. Now, generally speaking, in the process of manufacturing any material, the work of manufacture is

thoroughly inspected and the material is tested carefully at the various stages of production, so that any error is corrected in the process of manufacture. Reinforced concrete is no exception; it is absolutely essential to check up by expert supervision the manufacture of the material in all its stages. The cost of this expert supervision is absolutely negligible compared to the results obtained, but all this comes under the heading of expert or special service, and any money expended thereon sticks out over and above the contract price, and is often looked upon by the owner from an entirely wrong point of view. Frequently he doesn't appreciate that he is getting full value for such expenditure, and he looks to his engineer or architect to supply such special service free of charge.

I believe that when these matters are fully appreciated and understood by business men there will be considerable increase in the use of reinforced concrete as a material of construction. The manufacture of reinforced concrete can be controlled by experts every bit as well as the manufacture of any other material, and the results obtained where expert service is employed are absolutely reliable to the highest degree. The old fallacy that it is possible at any time to get sand and stone instead of concrete is absolutely absurd; with competent inspection such a thing is practically impossible.

The difficulty of providing this special engineering service has led to great abuse of reinforced concrete as a material of construction. In the age of the deformed bar, the market was flooded with special sections of steel bars which were supposed to do all kinds of things. In the early days there was, of course, a big difference between the cost of reinforced concrete structures and other forms of construction, and contractors tendered a reinforced concrete scheme as an alternative method of construction on any job on which they were able to do so, and large profits were made. Some engineers, seeing this difference in price, sought a means of attaching their name to some special bars to establish



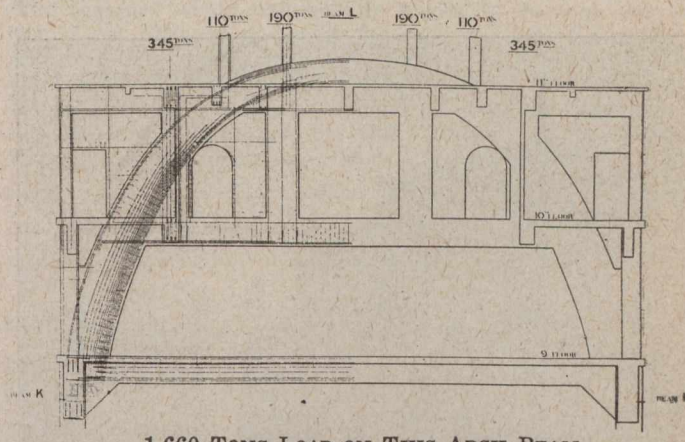
THESE BEAMS CARRY 336 LBS. PER SQ. FT.

South Lambeth Freight Depot, London, Eng. Series of beams, 55 ft 9 ins. clear span, carrying four warehouse floors.

an engineering practice in which designs and engineering service were supplied "free of charge" if this particular form of steel reinforcement were specified. Much unscrupulous competition was indulged in and many unsafe structures were built, so trouble occurred. Hence the rigid by-laws and the prejudice against reinforced concrete construction on the ground that it was not safe.

However, this condition is coming to an end and the situation is being more fully understood. It is now generally recognized that good steel is good steel, and that a square inch of steel is a square inch of steel, and that deformations do not make any particular difference other than increasing the difficulty of handling and bending, and disturbing the continuity of the fibres in the bar. The Emergency Fleet Corporation, I believe, now use round rods entirely. They are more efficient than anything else and give less trouble in the fabricating and building up of the reinforcement.

Few people recognize the large amount of detail work there is in reinforced concrete construction to give absolutely satisfactory results. The building up of large reinforced concrete structural members is just as much of an art as the rivetting and arrangement of structural sections



1,660 TONS LOAD ON THIS ARCH BEAM

Sketch showing distribution of load of main tower, Royal Liver Bldg., London, Eng. This beam is 60 ft. clear span.

in a large steel bridge. It has to be studied as a special feature, and good practice is based on very extensive experience; it is a special study. It is possible to increase the cost of reinforced concrete construction very greatly by any trouble or error in detailing reinforcements.

The writer's firm has a special system for doing this work. In a structure the reinforced concrete floor slabs are divided into bays; beams are numbered, columns are numbered, and in fact every structural member receives its own particular mark, and the steel in each member is detailed on sheets as well as being indicated on the drawings. The dimensions and the detail bending for each and every rod in the structure is given on these sheets. From these detail employment sheets, steel orders are prepared. The item number that is shown on the detail employment sheets is repeated on the steel order sheets, and the rods are grouped according to the various lengths and sizes, and are delivered on the job and tagged with this item number. The bending, size and lengths of each and every rod is doubly checked in preparing these sheets, so that the chance of any error is extremely small.

Large scale drawings are prepared of the intersections of members, and every detail properly worked out, so that if the steel fabricators follow faithfully the dimensions set out on these sheets, there is absolutely no trouble or difficulty in erection.

All this entails a very considerable amount of work. Very few engineers and architects, let alone the general business man, appreciate the vast amount of detailing that is absolutely essential in first-class reinforced concrete construction. Where special engineering service is not provided for, this detail work is always muddled through, and it ends in the contractor useing his own judgment on the site, with everything left to chance. Consequently many structures have proved unsatisfactory. The contractor often misjudges the labor charges and labor trouble in dealing with poorly engineered reinforced concrete; he loses money; everybody is unhappy, everything is unsatisfactory,—some more people prejudiced against reinforced concrete.

Notwithstanding these obstacles, reinforced concrete has made great headway and has proven itself, when properly designed and constructed, to possess the highest ideals in efficiency and permanence of any form of construction known to engineering science at the present day.

The United States Bureau of Standards, together with the Emergency Fleet Corporation, have been conducting the most comprehensive tests on reinforced concrete that exist at

the present day. They have shown up many fallacies and have definitely shown that various by-laws have fallen very wide of their mark in the control of stresses, etc.

The fact was that if ships were to be made of reinforced concrete and were to comply with any of the existing by-laws and regulations, it would have been necessary for them to have shells at least 15 ins. thick, as compared with the 4 ins. finally adopted.

Tests of large reinforced concrete beams were started to make certain that no mistake was being made in using

REINFORCED CONCRETE SHIP, 7,500 TONS
U.S. government ship, "Palo-Alto."

the 4-in. shell. These first tests were made on: (a) Beams 4 ft. 4 ins. deep and 18 ft. 6 ins. long; (b) one beam 10 ft. deep and 22 ft. long; and (c) specimen ship frames of full-size cross-section and 20 ft. span. The frames were cut off at a point corresponding to the point of inflection, or 4 ft. 6 ins. above the top of the keel. The tests were made in the 10,000,000-lb. testing machine at the Bureau of Standards laboratory in Pittsburgh.

For the beams the load was applied at the centre of the span upon the upper flange. The beams were supported at each end on a steel plate girder. The beam 10 ft. deep was first loaded forty times with 640,000 lbs., which was four times as much as the maximum which the standards of the Joint Committee on Concrete and Reinforced Concrete would have allowed as its working load. The widest crack at the first application of this load was thirteen one-thousandths of an inch, and with forty repetitions of the load there was no appreciable increase in widths of cracks. The beam was then inverted and load was applied in the opposite direction, causing failure at 1,363,000 lbs., or nine times as much as the Joint Committee standards for reinforced concrete design would have allowed as a working load.

To about the middle of 1919, over 600 beams and ship frames were tested. These beams varied in depth from 18 ins. to 10 ft., and in lengths up to 20 ft. The tests involved over 20 items of interest, including bond, shear, etc. In regard to shear, a certain number of beams were made with webs reinforced against shear in various ways. In some, vertical stirrups alone were employed. In others, diagonal stirrups sloping upwards towards the supports were employed. In some others, diagonals in both directions, sloping both upward and downward towards the supports, crossing each other at an angle of about 90 degrees, were employed. And in still others, horizontal bars were also used.

The main tension and compression members of this series of beams were made strong in proportion to the webs, in order to ensure a failure by shear. The web thicknesses varied from 3 ins. to 8 ins., the main members projecting about 6 ins. on either side of the web.

In order to overcome the discrepancies which might result from the fact that the main members composed a rigid frame around the web, one series of beams without the webs was tested, and from the results obtained it was possible to deduce very closely the true shear value of the web.

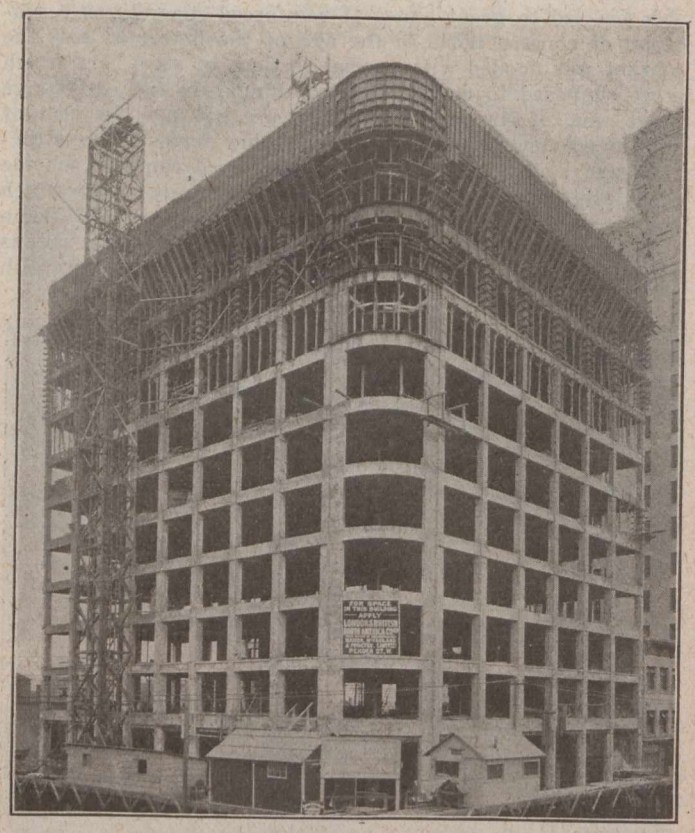
The failures were practically all shear failures as designed, and the diagonal cracks, no matter what the relation of depth to length, were inclined at an angle of about 45 degs.

The cracks in the specimens were very minute in width, so that it was necessary to paint them that they might show up properly in the accompanying photographs.

One of the accompanying photographs shows diagonal tension failure with small amount of web steel. Another shows beam with web reinforcement of sufficient amount to cause failure to the concrete by diagonal compression. Note the uniform spacing and the large number of cracks.

With the high percentages of web reinforcement, the diagonal cracks were finer and uniformly distributed over quite a wide area. With smaller percentages of web reinforcement, the cracks were fewer and further apart, and at the same time wider.

It was found that the shear carried was dependent upon two things: Firstly, the amount of shear reinforcement; and secondly, the diagonal compression strength of the concrete, values as high as 2,500 lbs. per sq. in. being



REINFORCED CONCRETE FRAME, BIRKS BLDG., VANCOUVER
Built in 1912. Cost 6.2 cents per cu. ft., in condition shown above. This photograph taken ten weeks after work started above level of ground floor. Area, 100 by 120 ft.

recorded at failure of a concrete having an ultimate strength in straight compression of about 4,000 lbs. per sq. in.

It can easily be seen that if all the shear is taken by the steel, the only limitations to the ultimate strength of the member are the amount of shear reinforcement and the diagonal compressive strength of the concrete in the web.

The arbitrary restrictions of the various by-laws, Ontario Railway and Municipal Board specifications, etc., limiting the shear stress under these conditions to such values as 100 or 120 lbs. per sq. in. on the concrete, are utter fallacy.

The tests carried out by the Emergency Fleet Corporation have distinctly shown that text book theories are largely at fault. Many people have the opinion that because something is in print in a text book, it must be absolutely

authentic and unquestionable. This point of view is entirely wrong. I know of one case in particular,—a text book on reinforced concrete almost as big as a family Bible, written by two men neither of whom, I think, had actually carried out or been responsible for the carrying out, designing or supervision of any reinforced concrete work whatever. They were clever mathematicians and very good hands with scissors and paste. Generally speaking, one finds on investigation that the writers of text books on reinforced concrete construction have usually been responsible for only very few jobs. We at once realize, of course, that other writers have had most creditable experience, and we highly value their works. Of course, a large number of men who happen to be in possession of a $5 text book on reinforced concrete, consider themselves highly qualified reinforced concrete engineers by virtue of this text book, and one often comes across a considerable amount of work carried out by such people; hence more prejudice against reinforced concrete.

The experimental work of the United States Bureau of Standards and the Emergency Fleet Corporation are public property and open for the benefit of the world at large. These experiments have been conducted by independent parties and are absolutely unquestionable in their authenticity, and can be accepted without any qualms whatsoever. It is possible that millions of dollars can be saved in building and engineering construction throughout Canada by the proper revision of by-laws throughout the various cities with regard to reinforced concrete construction. An excellent opportunity exists at the present time for the formation of a special committee of reinforced concrete engineers to study the experimental data of the Emergency Fleet Corporation and United States Bureau of Standards, and to make proper recommendations to the various cities for changes in the various by-laws. Business men should be made acquainted with these changes and become familiar with the saving such changes would involve in construction, so that they can definitely demand that the building codes be revised. In these days, when the cost of construction has almost risen out of sight, and where millions of dollars' worth of work are being held up because of this high cost, and the manufacturing business in Canada is suffering severely from the situation, there is an urgent call for immediate action.

Accompanying is a table showing the stresses determined by the various authorities as shown. In the last line of the table the writer shows what he considers good value which would serve the public in the best manner possible to give combination of high efficiency and safety.

It must be realized in reinforced concrete that low stresses do not serve a particularly useful purpose to protect the public against poor workmanship. Designers are forced to design along certain lines in order to achieve the most economical results and yet pass the by-laws. The general tendency of these by-laws is to call for work with a large amount of concrete and small amount of steel, resulting in exceptionally heavy deadweight of structure. This does not necessarily protect the public, because, for instance, if concrete be entirely relied upon to take compression and shear stress, if by any manner of means any reversal of stress should take place, it would tend to introduce tension into a member instead of compression, and the structure would collapse if no steel were used at this particular point. If the designer used less concrete and put some steel in at this particular point, the structure would resist successfully considerable reversal of stress, and no trouble would arise. The designer would undoubtedly prefer to do this, but he would get little or no credit for such method of construction under present by-laws, and it would prove a more costly method of construction. So, under existing conditions, the public are not necessarily safeguarded by low stresses.

The arbitrary values for the bending moment in continuous and semi-continuous beams should be entirely abolished, and the bending moments used should be those which are the maximum that actually can occur in the structure. The arbitrary values given by the city of Toronto, the Joint Committee and the Ontario Railway and Municipal Board are as follows:—

PERMISSIBLE STRESSES IN REINFORCED CONCRETE AS SPECIFIED BY VARIOUS AUTHORITIES

	1:2:4 Concrete.					1:1½:3 Concrete.					1:1:2 Concrete.				
	Compr. in Beams.	Direct Compr.	Shear in Concrete.	Diag. Compr.	Hooped Cols. Lim. Concrete Stress.	Compr. in Beams.	Direct Compr.	Shear in Concrete.	Diag. Compr.	Hooped Cols. Lim. Concrete Stress.	Compr. in Beams.	Direct Compr.	Shear in Concrete.	Diag. Compr.	Hooped Cols. Lim. Concrete Stress.
Toronto by-laws (original) .	600	450	40	100	...	750	562	50	125	...	750	562	50	125	....
Toronto by-laws (concessions)	650	...	..	150	650	812	...	..	187	812	975	....	..	187	1,000
Joint Committee*	650	450	40	100	608	812	562	50	125	870	975	675	60	150	1,045
London County Council, 1915	600	600	60	180	800	675	675	67	202	900	750	750	75	225	1,000
Amer. Conc. Institute*	750	500	40	150	...	938	625	50	188	...	1,125	750	60	225	....
Emer. Fleet Corp.	...	...	..	...	...	...	...	..	...	...	1,500	1,000	50	500	....
Ont. Ry. & Mun. Board	600	500	40	120	...	650	550	45	120	...	650	550	45	120	....
Recommended by writer* ..	750	600	50	250	...	1,000	700	60	375	...	1,250	800	70	500	....

*With granite or trap-rock concrete, 10% higher stress values are allowed. Stress allowed in steel, 16,000 lbs. per sq. in. by all specifications excepting those of the Ontario Railway and Municipal Board, which allow only 15,000 lbs. per sq. in., although the steel is exactly the same as that for which they allow 16,000 lbs. when used in steel structures.

ARBITRARY BENDING MOMENTS

	Semi-continuous. Centre.	Support.	Continuous. Support.	Centre.
Toronto by-laws (original)	$+wl^2/9$	$-wl^2/9$	$-wl^2/10$	$+wl^2/10$
Toronto by-laws (concessions)	$+wl^2/10$	$-wl^2/10$	$-wl^2/12$	$+wl^2/12$
Joint committee	$+wl^2/10$	$-wl^2/10$	$-wl^2/12$	$+wl^2/12$
Ont. Ry. & Mun. Board	$+wl^2/10$	$-wl^2/10$	$-wl^2/12$	$+wl^2/12$
		$-wl^2/8$ if only two spans.		

Special attention should be given to the revision of the arbitrary restrictions defining:—

1. Load distribution in reinforced concrete.
2. Distribution of stress, such as the amount of slab acting as compression member in T-beam.
3. Impact.
4. Provision of proper reinforcement to take shear.
5. Anchorage of reinforcement, particularly shear members.

The above should all be properly revised for reinforced concrete, taking into account the monolithic nature of the material.

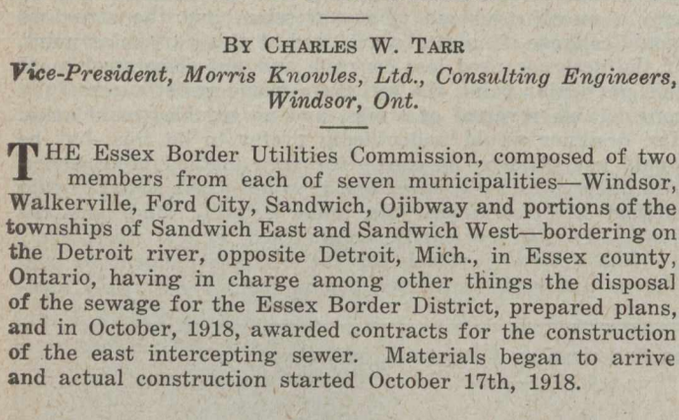
The only real solution for the safety of the public is that it should be made compulsory to employ a properly qualified reinforced concrete engineer to be made responsible for the design and supervision of construction on the site. He should be independent of the contractor, and he should not be interested in the merchandising of materials in any way. He should be permitted to design the work without any outside competition. It is essential that he should have had considerable experience in the design and supervision of reinforced concrete construction and that he should be thoroughly familiar with the experimental work and teachings of the Emergency Fleet Corporation and the United States Bureau of Standards.

UNIT COST OF LABOR ON CONSTRUCTION OF INTERCEPTING SEWER FOR ESSEX BORDER UTILITIES COMMISSION

By Charles W. Tarr

Vice-President, Morris Knowles, Ltd., Consulting Engineers, Windsor, Ont.

THE Essex Border Utilities Commission, composed of two members from each of seven municipalities—Windsor, Walkerville, Ford City, Sandwich, Ojibway and portions of the townships of Sandwich East and Sandwich West—bordering on the Detroit river, opposite Detroit, Mich., in Essex county, Ontario, having in charge among other things the disposal of the sewage for the Essex Border District, prepared plans, and in October, 1918, awarded contracts for the construction of the east intercepting sewer. Materials began to arrive and actual construction started October 17th, 1918.



Hoist for Handling Excavated Material

This east intercepting sewer serves for the present to discharge the sanitary flow from Ford City and Walkerville into the Detroit river below the existing water works intakes, and later will form a portion of a complete intercepting system, with an outlet at one point, where disinfection and purification facilities can be installed.

The line runs along Sandwich street, which follows the Detroit river and is fast becoming lined with business and industrial interests. Travel on this street is much congested, especially through Walkerville and near the plant of the Ford Motor Co. in Ford City. A trolley line extends along 1½ miles of the line, and a crossing under the main lines of the Grand Trunk Railway was necessary. The plans for this section of interceptor provided for a pumping station, which is now under construction, but which was not included in the above-mentioned contract.

Quantity of Work

The work to be done consisted of building:—

942 lineal feet 15-in. vitrified pipe sewer;
1,469 " " 18-in. " " "
1,555 " " 20-in. " " "
2,585 " " 24-in. " " "
2,037 " " 30-in. segment block sewer;
3,709 " " 33-in. " " "
254 " " 20-in. reinforced concrete force main;
48 brick manholes with concrete base and cast-iron frame and cover;
2 measuring chambers, with venturi tubes; and
3 regulating chambers at junctions with existing combined sewers.

The work fell naturally into three classes: (1) The main interceptor, with manholes and force main; (2) the two measuring chambers, with their venturi tubes; (3) the regulators at existing combined sewers, and connections for sanitary flow only.

The two last classes of work were not large or of a special nature, and their cost is given as total only.

About 81% of the sewer was laid in tunnel and shaft excavation, the material being largely a blue knifing clay, to which that method was especially adaptable. In order to delay traffic as little as possible, the interceptor was placed under the sidewalk or parking space wherever practicable. About one mile was placed directly under the sidewalk, which was disturbed only where shafts were located.

The force main crossing under the main line of the Grand Trunk, a double-track railway with sidings, was laid in open cut, the two main-line tracks being supported on stringers over caps on round piles. The other two crossings under spur tracks were made without special work, the usual concrete envelope 4 ins. thick, as specified by the Ontario Railway Board, being put around the pipe at all railroad crossings. Three crossings under the trolley track caused no inconvenience to the tunnelers.

A section of the work 1,843 ft. long, with depths from 11 to 18 ft., was excavated by means of a trenching machine. Backfilling the open cut trench was done with a team and scraper, using a long cable to span the trench.

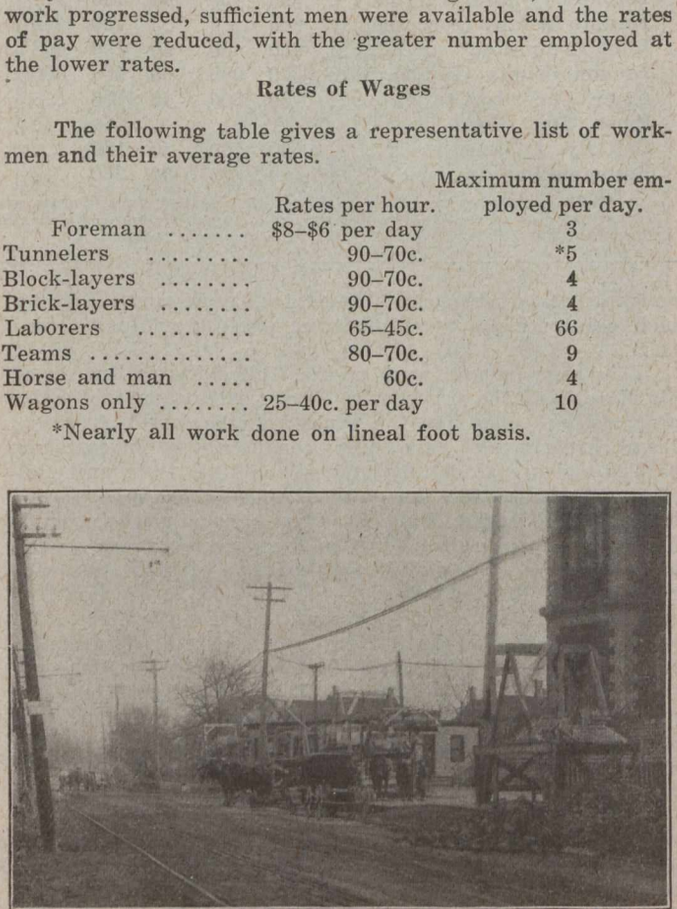
At the start of the work, it was expected that some difficulty would be encountered in securing labor, but as the work progressed, sufficient men were available and the rates of pay were reduced, with the greater number employed at the lower rates.

Rates of Wages

The following table gives a representative list of workmen and their average rates.

	Rates per hour.	Maximum number employed per day.
Foreman	$8–$6 per day	3
Tunnelers	90–70c.	*5
Block-layers	90–70c.	4
Brick-layers	90–70c.	4
Laborers	65–45c.	66
Teams	80–70c.	9
Horse and man	60c.	4
Wagons only	25–40c. per day	10

*Nearly all work done on lineal foot basis.



Work Did Not Interfere with Traffic

A large amount of the work was done on a production basis, which made for shorter hours and greater progress. The tunneler and shaft-digger, also the bricklayer on the manholes, worked on this basis at the following rates:—

	Rate per lineal ft.	Maximum daily production.
Tunneling	$1.35–$0.80	113 ft.
Shaft sinking	$3.50–$2.20	40 vert. ft.
Manholes	$1.25 per vertical ft.	122 ft.

The maximum force was employed during the two weeks ending January 16th, 1919, it being over three times the

amount employed in November, 1918, when work was well under way, and four times that at the end of May, 1919, when the larger part of the work had been completed.

Shaft Excavation

Shaft sinking was done by hand, using picks, spades and grubs, the material being shoveled from platforms placed at vertical intervals of approximately 7 ft. Generally the major portion of the material was piled alongside the shaft for backfilling. Two men worked together in the bottom, being paid for the number of vertical feet excavated. The platform and top men worked by the hour.

The shafts, spaced about 75 ft. apart, averaged 5 by 8 ft. in area, with depths from 11 ft to 21 ft. Of the shaft excavation 80% was in hard, yellow clay, requiring sharp picks to loosen it. All shafts were braced, using rangers 6 ins. by 8 ins., with lagging 2 ins. by 8 ins., spaced 8 ins. apart. Where the depth of the sewer exceeded 10 ft., the 5 by 8 ft. shaft was used; but in shallow excavation, an elongated, narrow shaft about 15 ft. in length was used, leaving about 35 ft. between shafts to be tunnelled.

Tunnel Excavation

Tunnelling was done by men experienced in that type of work; clothed in oil-skins and using short spades, they passed the excavated material back to a mucker who in turn loaded it at the bottom of the shaft into a bucket holding about one-quarter cubic yard, from which point it was drawn to the top by a horse-operated windlass especially made for this work. Two shafts with four headings were worked simultaneously and required the following force and equipment: 4 tunnelers, 4 to 8 muckers, 2 top men, 1 horse and driver and 8 mud buckets.

Both Hoists Operated Simultaneously

The hoist used was a portable frame outfit, occuping a space about 6 by 10 ft., with a platform 5 ft. above ground level, on which a short pair of rails were fastened and a flat car operated. Two hoists were generally operated together, one of which was equipped with a vertical drum and horizontal lever, to which a horse was hitched. Cables from this drum ran over sheaves and down each shaft, being so wound that as one was lowered the other was raised. The horse was equipped with a swivel yoke and could be readily turned to travel in either direction around the centre of the drum.

A mud bucket being filled at the bottom of the shaft, it was raised as an empty one was lowered in the adjoining shaft. The top man ran his transfer car under the full bucket and attached an empty bucket to the cable. The full bucket on the transfer car was pushed to the edge of the platform and emptied into a wagon. One pair of horses handled two wagons, leaving an empty one at the hoist while removing the loaded one to the spoil dump.

Pipe Laying and Backfilling

Block-laying and pipe-laying followed the completion of excavation between shafts, the heavier pipe being lowered by means of the usual type of A-frame windlass, having a light wagon wheel on the end of the shaft and a friction brake. Backfill in the tunnel was done by the block-layer or pipe-layer with blue clay, packing it in by hand as each joint of pipe was laid. Backfill in the shafts was partially made by dumping wagon loads of material from excavation ahead through holes in platforms over the shaft openings.

The feature of the work was that it was started in October and pushed to completion through the winter season, thus releasing the labor and equipment in June and July to take up the summer contracts.

The elapsed time was 267 days, or 9 months. Subtracting 38 Sundays, the total number of working days were 229. The workings days lost totalled 10¼, due to armistice (2), Christmas (1) and rain (7¼). The total days worked were 218¾. The length of work was 12,551 ft., or 57 ft. per day worked.

Excavation Costs

The largest cost item of the work was excavation, as the interceptor was laid at a depth of 12 ft. to 22 ft., with an average depth of about 18 ft. The following table gives itemized labor costs for shaft and tunnel excavation. This is actual cost, without profit or workmen's compensation, and the considerable variation in unit prices is due to particular local conditions encountered and to the necessity of varying the rates of pay to meet the labor conditions encountered.

UNIT COSTS AND DATA ON SHAFT EXCAVATION

Diam. sewer in inches,	Segment block. 33″	33″	30″	Vitrified sewer pipe. 24″	20″	18″
Number of shafts opened, ...	52	13	31	39	19	9
Average depth in ft.	10-18	18-22	14-19	15-21	19-20	12-20
Total cu. yds. shaft excav., ...	966	406	835	805	394	152
Aver. cu. yds. per shaft, ...	18.5	31.3	27.0	20.6	20.7	17.0
Total cost shaft excav., ...	$2,787	$2,125	$4,809	$1,913	$1,254	$505
Average cost per shaft, ...	$54	$163	$155	$49	$66	$56
Average cost per cu. yd.	$2.90	$5.20	$5.75	$2.38	$3.18	$3.30

UNIT COSTS AND DATA ON TUNNEL EXCAVATION

Length of tunnel in ft., ...	2,295	728	1,744	2,289	1,427	502
Average size in ins., ...	43 x 54	43 x 54	40 x 48	34 x 48	29 x 40	29 x 40
Cu. yds. per ft., ..	.50	.50	.40	.28	.25	.25
Total cu. yds., ...	1,148	364	698	641	357	126
Total cost tunnel excav., ...	$6,591	$1,626	$5,151	$5,088	$2,966	$1,039
Aver. cost per lin. ft., ...	$2.87	$2.23	$2.95	$2.22	$1.89	$2.07
Aver. cost per cu. yd.	$5.74	$4.47	$7.48	$7.94	$8.30	$8.24

Pipe Laying Cost

The following table gives unit costs for laying pipe and backfilling shafts and open trench. These also, are actual costs without profit or workmen's compensation. Wherever pipe was laid in tunnel, the cost includes backfilling, because as each length of pipe was laid, the opening above it, approximately 12 ins., was immediately filled and tamped with blue clay.

The unit costs for backfilling are for shafts and open trench only, as the backfilling in tunnel was included in pipe-laying, as explained above.

PIPE LAYING COSTS

Diam. sewer in inches.	33	33	30	24	20	18	15	20*
Length of pipe in ft., ..	2,799	822	1,966	2,540	1,535	1,446	928	252
Total cost pipe laying,..	$2,710	$933	$2,592	$1,699	$864	$482†	$131‡	$241
Cost per foot,.....	$.97	$1.14	$1.32	$.67	$.56	$.33	$.14	$.96

BACKFILLING COSTS

Diam. sewer in inches.	33	33	30	24	20	18	15	20*
Total cu. yds., ...	708	334	725	762	355	1,113¶	979‖	113
Total cost backfilling,....	$671	$120	$173	$331	$225	$570	$733	$109
Cost per cu. yd., ...	$.95	$.36	$.24	$.43	$.63	$.51	$.75	$.96

*Force main. †61% in open trench. ‡100% in open trench. ¶88% in open trench. ‖100% in open trench.

This work was done on the basis of actual cost, plus a fixed fee on a sliding scale. The fixed fee for completing the work was $12,000, being about 10% of the estimated cost of the work. This fee was increased by 25% of any saving the contractor made on his estimated cost, and decreased by 10% of any amount he exceeded his estimate. The total labor cost, exclusive of workmen's compensation, which runs about 2½% of the payroll, and also exclusive of profit, was as follows:—

	Cost of Work	Cu. yd.	Per cent. of labor cost.
Shaft excavation,	$13,393	$3.77	21.3
Tunnel excavation,	22,461	6.75	35.8
Backfilling,	2,932	.58	4.6
Machine and open-cut excavation,	2,581	....	4.1
Pipe-laying,	9,652	....	15.4
Manholes,	2,780	58.00 each	4.4
Paving,	1,187	....	1.9
Removing supplies and cleaning up,	7,088	....	11.2
Pumping, miscellaneous repairs, etc.	780	....	1.3
	$62,854		100.0

The total cost of the work is shown in the following table:—

		Per cent. of whole cost.
Labor from above table,	$ 62,850	50.2
Regulators (labor),	4,500	3.6
Hauling materials,	2,150	1.8
Materials and equipment, including workmen's compensation,	44,000	35.2
Profit,	11,500	9.2
	$125,000	100.0

Personnel

The interceptor was constructed by Merlo, Merlo & Ray, Ltd., contractors, Walkerville, Ont. The interceptor was designed and the construction work supervised by the firm of Morris Knowles, Ltd., whose president, Mr. Knowles, is chief engineer of the Essex Border Utilities Commission.

C. B. & C. I. CONFERENCE AT OTTAWA

TENTATIVE arrangements have been made for the second general conference of the Association of Canadian Building and Construction Industries, to be held February 2nd to 4th at Chateau Laurier, Ottawa. The proposed program schedules the opening session for 10 a.m., Monday, February 2nd, when the delegates will register and committees will be appointed and announcements made. At 11 a.m. there will be a meeting of the national council, and at 1 p.m. a luncheon at which N. W. Rowell will deliver an address on the recent international labor conference at Washington, D.C.

At 2.30, Monday afternoon, the president will deliver an address, followed by notice of motions and reports of committees. At 8 p.m. there will be individual meetings of the three sections of the conference, namely, general contracting, trade contracting and supply, and also meetings of various committees.

At 10 a.m., Tuesday, February 3rd, the business session will be resumed with the report of the committee on constitution, to be followed by discussion and action in regard to same. At the luncheon at 1 p.m. there will be an address by John C. Frazee, secretary of the National Federation of Construction Industries. The sections and committees will again meet at 2.30 p.m., and at 8 p.m. they will report to the general conference.

Wednesday, February 4th, will be the last day of the conference, and at 10 a.m. the report of the nominating committee will be received, followed by election of officers. At the luncheon at 1 p.m. there will be fraternal greetings by representatives of other associations. At 3.30 p.m., Wednesday, the new committees will hold meetings for the planning of their year's work.

TO MANUFACTURE ENGLISH MACHINERY

Bawden Machine Co., Ltd., Toronto, Have Obtained License to Make and Sell Robey Engines, Thompson Boilers, Bridge's Transmissions, Hindley Engines, Etc.

AFTER a long period of detailed negotiations and preparatory study, the Bawden Machine Co., Ltd., Toronto, have secured Canadian selling rights for Alley & MacLellan, Ltd., Glasgow, Scotland, and sole license rights to manufacture and sell in Canada the products of the following English and Scotch firms: Robey & Co., Ltd., Lincoln, Eng.; John Thompson, Ltd., Wolverhampton, Eng.; David Bridge & Co., Ltd., Castleton, Manchester, Eng.; E. S. Hindley & Co., Ltd., Bourton, Dorsetshire, Eng.; Brown Bros., Ltd., Edinburgh, Scotland; and Bow, MacLachlan, Ltd., Paisley, Scotland.

These companies are supplying the Bawden Machine Co. with complete drawings of all their lines, together with engineering data, so that in case of breakage on any machines which have been or will be imported into Canada, the Bawden Machine Co. will be able to manufacture the needed repair parts without delay.

In addition to their main lines of pumps, valves, hydrants, etc., the Bawden Machine Co., Ltd., have for several years past been manufacturers of special machinery of many kinds, including rubber machinery, hydraulic presses, tire molds, rubber mill supplies, printing presses and automatic machinery, and have at present the necessary shop facilities for building many parts of the heavier machinery for which they have arranged to be Canadian representatives. Mr. Bawden is also adding a new bay to his plant to enable him to take care of these new lines.

A. G. Hill, sales manager of the Bawden Machine Co., spent a great part of last year in the plants of the above-mentioned companies, going into details of design and manufacture, after convincing them that their lines should be manufactured in Canada and that the Bawden Co. were equipped to handle them.

Alley & McLellan, Ltd., manufacture air compressors, valves and water works supplies, and are already well known in many parts of Canada. Robey & Co., Ltd., make a line of semi-Diesel oil engines, which should meet with good demand in Canada, and also manufacture steam engines and air compressors and mining machinery.

The Thompson water-tube boiler is new to this country, but has been sold widely in Great Britain, South America, Africa and India, where the company has direct representation. John Thompson, Ltd., also manufacture corrugated furnaces. Bridge's friction clutch is known in Canada, as is also this firm's rubber and textile-working machinery, which they have been manufacturing continuously for 50 years.

Brown Bros. and Bow, MacLachlan, Ltd., are manufacturers of telemotors, steering gears and steam-boat auxiliary machinery. E. S. Hindley are well-known makers of high-speed steam engines.

In order to connect Gowganda, Matchewan, Larder Lake and neighboring mining camps in Northern Ontario with the Temiskaming and Northern Ontario Railway, the construction of a system of narrow-gauge railways is proposed.

The directors of the Dominion Steel Corporation have confirmed the appointment to the newly constituted London advisory committee of the following: Viscount Furness, Sir Wm. Beardmore, Gen. the Hon. Sir Newton Moore, Henry Steele, Benjamin Talbot and Col. W. Grant Morden, all of whom are associated with the English interests which some weeks ago acquired 50,000 shares of the company's common stock.

Bureau of Standards Criticizes Hydro's Method

Of Proportioning Concrete Materials—Engineer in Charge of Bureau's Concrete Research Work Says Mr. Young's Modified Surface Area Method Is Uneconomical and More Limited in Scope Than Old Volumetric Method

In the January 1st issue there appeared an article by ***Roderick B. Young*** *descriptive of the practical application of the surface area method of proportioning concrete materials. This method is being used, apparently with great success, at High Falls, on the Queenston-Chippawa work and in concreting penstocks at the Ontario Power Co.'s plant.* ***But G. M. Williams,*** *who is in charge of concrete research work for the U.S. Bureau of Standards, declares that Mr. Young's method restricts the engineer and that it results in concretes lower in strength, harder to handle and less economical of cement than other concretes which might be produced from the same aggregate by use of the usual volumetric methods of proportioning. In the following letter to The Canadian Engineer, Mr. Williams discusses Mr. Young's article and claims that there is little in common between the Hydro's method of proportioning and the methods proposed by Prof. Abrams and Mr. Edwards.*—EDITOR.

STUDY of the article, "Practical Application of Surface Area Method," in the January 1st, 1920, issue of *The Canadian Engineer* indicates to the writer that neither the requirements of Prof. Abrams' fineness modulus theory, nor those of the surface area theory of Mr. Edwards, are met by the methods employed by Mr. Young. Further, it can be shown that the assumption made for the selection of the "economical" mixture is erroneous, and that the methods employed lead to results similar in practical application to those which may now be obtained by the common method of volumetric proportioning. The terms "surface area" and "water-cement ratio" as used are merely new terms for expressing the same qualities which are now determined in the volumetric method of proportioning.

The one term or factor which Mr. Young adopts from the "fineness modulus" theory is that of "water-cement ratio." This is, of course, equivalent to the term "per cent of mixing water by weight of cement." The one factor adopted from the "surface area" theory is the method of proportioning the cement according to surface area of aggregate. It is therefore seen that the "fineness modulus" expression and the water formula of Prof. Abrams are discarded, as has been the water formula proposed by Mr. Edwards.

Predetermines "Most Economical Grading"

Both of the foregoing proponents of new methods of proportioning included, in their theories, water formulas which, it was claimed, would result in equal consistencies and equal strengths for all workable mixtures. General laws were stated by which strength could be predicted for all normal concretes. The method employed by Mr. Young narrows the conclusion down to the possible value of any particular predetermined grading of an aggregate because of the limitation which he places on surface areas. Referring to a water formula which he has developed, but does not present, he states: "It is not general in its application and its constants have to be determined for each different class of material." However, as he states, a water formula is not necessary for the application of the method which he employs, since "the simplest way is for the operator to add water until, in his judgment, the mixture is of the required mobility" for what he calls normal consistency.

The first and greatest limitation which Mr. Young employs, and which removes his method from any possibility of being of general application to wide ranges of combinations, as was claimed for the methods proposed by Prof. Abrams and Mr. Edwards, is the determination at the outset, without the employment of strength tests, of the "most economical aggregate grading," which he states to be "the one containing the lowest surface areas per cubic foot of material which can be successfully handled and placed."

Whereas the surface area theory proposed by Mr. Edwards would admit of the use of wide variation in gradation (large differences in surface areas), Mr. Young at the beginning limits his aggregates to the "lowest areas which can be worked." Such a result is, of course, obtained by keeping the fine material in the sand or fine aggregate to a minimum. In usual concrete mixes, where the ratios of fine to coarse are as 1 to 2 (such as 1:2:4, 1:3:6, etc.) the area of the sand is usually more than 90% of the total area of both coarse and fine. Therefore, to obtain low areas it is necessary that the grading of the sand, the material whose variation most greatly influences workability and segregation, be made as coarse as possible and still permit of a workable mix.

Furthermore, the use of high area aggregates requires larger quantities of cement, which, if the same flowabilities are obtained, result in high strengths which are unnecessary and uneconomical. It is clear that this limitation to low area aggregates is essential for economy, and as a result the method employed is narrow and limited, rather than broad and general as that proposed by Mr. Edwards.

Results in Harsh Mixtures

It would be interesting to see the test data on which Mr. Young bases his conclusion that low surface areas are most economical. Tests made along this very line with which the writer is familiar do not bear out this basic assumption. It is found that the limitation of aggregates to low total areas results in harsh, "difficult-to-work" mixes whose strengths are lower than mixtures having higher surface areas. It is also found that the quantity of cement required per cubic yard of wet concrete is greater for such harsh, low area mixtures than for the high area mixtures.

The resulting concrete which Mr. Young's method provides, in reality results in false economy, since the concretes are more difficult to place, have lower compressive strengths and require a slightly greater quantity of cement. In other words, the use of low surface area aggregates is generally opposed to economy and strength. The concretes shown below were made with sands of varying degrees of fineness combined with the same gradation of coarse aggregate, all from the same source of supply:—

Aggregate Number	Surface Area Sq. Ins. Per 100 g. Aggregate	Surface Area Sq. Ins. Per Gram Cement	Pounds Cement for 1 Cu. Yd. Concrete	Compressive Strength, Lbs. Per Sq. In.
1	103	5.0	603	1,873
2	114	5.6	600	2,456
3	167	8.2	600	2,348
4	233	11.6	600	2,508
5	268	13.3	601	2,627
6	315	15.4	597	2,830
7	393	19.2	594	2,865

Proportions, 1 : 1½ : 3 by volume. Age, 28 days. Equal flowabilities for all.

These concretes are fully comparable since equal consistencies, or flowabilities, were obtained as measured on the "flow table." Concretes 1 and 2 were so harsh that they would be ruled out as unworkable; No. 3 was a somewhat harsh but workable concrete. The ease of working, or plasticity, increased with the amount of fine material in the sand, and it is seen that strengths were not reduced.

The tendency to seggregate when very fluid was less marked as the amount of fine material in sand or the surface area increased. It is also found, with flowabilities equal, that the cement paste in a high area mix contains a smaller proportion of water than in one having a low area. This condition no doubt partially accounts for the higher strengths of the mixes containing the higher quantities of fine aggregate. In such mixes, although the calculated *w/c* relation

may be equal or nearly so for two mixtures, the paste of the low area mix will be the wetter, so that the true *w/c* relations may be quite different. Further, as the flowabilities of the two are equally increased, the low area aggregate concrete will be the first to segregate and become difficult to handle.

For apparent economy the modified surface area theory as employed by Mr. Young necessitates the selection of such an aggregate as No. 3 or No. 4 above. The resulting concrete requires slightly more cement per cubic yard, has a lower compressive strength and is more difficult to place. Such a condition results since the basis of the modified method is the erroneous assumption that the most economical mixture is one having the lowest total surface area and which is near the border line of workability.

It is apparent that the making of strength tests does not enter into the procedure of this modified theory until after the "economical" mixture of aggregate is selected. After surface area is determined, which process will later be referred to, various ratios of cement to areas (100 sq. ft.) of aggregate are selected; concretes are then made up of equal consistencies, as determined by eye, and compressive strength for each mix determined. The strength values with calculated factors for areas and water-cement ratios are then plotted, and the limiting factors for various classes of concretes determined from the resulting curves.

Differs Little from Present Methods

That this method differs little from methods at present in use, except that the measured and calculated factors are given different names, is apparent from the following:—

In practice we have found that with Potomac river materials the proportion of 1 part sand to 2 parts aggregate is about the limit of coarseness which it is desirable to use. Less fine sand in the fine aggregate or a smaller ratio of sand to coarse aggregate results in harsh concretes, difficult to properly place, while with the same flowability a finer sand or more sand increases workability and results in less segregation in the wetter mixes. The above 1:2 combination is probably quite similar to that which Mr. Young would select as his "economical grading" if using our materials. In accordance with Mr. Young's next step in the process we will make up concretes having the same consistencies or flowabilities, with the following proportions of cement to aggregate: 1:1½:3, 1:2:4, 1:2½:5, 1:3:6 and 1:4:8.

Recent determinations indicate Potomac river materials to have the approximate areas of 1,830 sq. ft. per 100 lbs. and 86 sq. ft. per 100 lbs. respectively for the sand and gravel.

The following data will then result:—

Proportions,	1:1½:3	1:2:4	1:2½:5	1:3:6	1:4:8
Cement, lbs. per 100 sq. ft.	3.3	2.5	2.0	1.65	1.24
Per cent water by weight of cement, or *w/c*,	Increases as quantity of cement decreases.				
Strength,	Decreases as quantity of cement decreases.				

It is seen from the above that a table similar to Mr. Young's Table 2 will result. Although we may not be accustomed to calculating and viewing our mix from the viewpoint of surface area and the cement-surface area relation, the relation is there and may be obtained by computation.

Although we may not be accustomed to calculating or expressing water in terms of quantity of cement, the relation is also there. Percentage of water by weight of cement is calculated as easily as water-cement ratio, but it is seen that both are incidental and a resultant, for any given flowability, of the predetermined grading and mix.

Our results may be plotted in the same manner as Mr. Young's Figs. 3 and 4, and we may likewise draw up Table 3.

In the field, the quantity of cement and mixing water may be varied as described by Mr. Young, and the strength of the resulting concrete may be checked in the same manner by molding samples of field concrete.

However, with our present knowledge of the advantage to be gained by using more fine aggregate (greater surface area) in our mix, we would not confine ourselves to such a low area combination as is required by the economical considerations of Mr. Young's modified method. Very likely we would reduce the above number of mixes and add a similar series in which the sand-gravel ratio would be 2½:3½ or even larger, or add more fines to the sand and maintain the same relative proportions.

Past tests show that the 2½:3½ or 2½:4 ratio mixes will have greater workability for the same flowability, and higher strengths, and will require less cement per cubic yard of concrete. While the surface area method limits the investigator to low area aggregates, the old volumetric trial method obtains identical results and permits the use of wide variation in gradations which are generally found to result in more satisfactory concretes.

As has been previously shown by other investigators, the method employed by Mr. Edwards and Mr. Young for determining surface areas is unnecessarily laborious. With any system of sand sieves constants can be calculated for approximate areas of unit weights of materials passing any one sieve and retained on the next size smaller. Since the assumption that all particles are spherical is at best only approximate, the areas calculated can be assumed to be proportional to the true areas and will serve the purpose fully as well. The counting of particles is tedious and time-consuming, and is not justified by the results obtained. For the Tyler system of sand sieves, the following series of constants greatly simplify this determination:—

Tyler sieves		Approximate surface
Passing	Retained on	area, ins. per 100 grams.
⅜	4	50
4	8	100
8	14	200
14	28	400
28	48	800
48	100	1.600
100		3,200

As to the material passing a 100 or 150-mesh sieve, it may be possible to ignore the dust in proportioning the cement, but any proposed water formula must give consideration to this size since its water requirement is only slightly less than that of an equal quantity of cement.

Good Supervision at Mixer

With regard to the results shown by Mr. Young in the table where comparison is made of the concrete used on two jobs, it is interesting to note that the use of the modified surface area method resulted in the old volumetric proportion of 1:2:4 for a concrete having a strength of 2,000 pounds. It is not clear why these strength results should show the merits or demerits of any method of proportioning. The writer is inclined to believe that they show the effect of good supervision at the mixer in the case of the "Hydro's" concrete and more careless work on the other job. The variations in strength found for the "outside" concrete are no greater than those commonly obtained when little supervision is given the loading of carts and the addition of mixing water. The uniform results on the "Hydro" work merely reflect better uniformity in the process of measuring aggregates and mixing water, and such improvement may be effected on any work regardless of the theory of proportioning.

In the case of Fig. 4, the writer agrees that the curve shown is representative of the variation in strength with increase in mixing water and change in cement content for this one graded aggregate, but if appreciable change is made in the aggregate grading, a series of such curves will be obtained, all falling within a band or zone whose width is greatly dependent upon the number of gradings employed. Reference to Tables 8, 9, 10, 11 and 12, also Table 5, of Technical Paper No. 58, Bureau of Standards, will show the wide ranges in strengths obtained with various gradings of aggregates when flowabilities are constant.

Mr. Young's statements relating to field practice and better supervision of the process of mixing concrete are

very much to the point. The adoption of systematic sampling of concretes after placing in the forms, and bringing the test results to the attention of those who are responsible for the field work, will do much to raise the standard of quality.

In conclusion, the writer believes, from a study of this article as well as from studies of tests which have complied with every step in the process as outlined by Mr. Young, that:—

1. Mr. Young's modified method has little in common with the theories for proportioning mixtures proposed by Prof. Abrams and Mr. Edwards.

2. This modified method restricts the engineer to the use of harsh low-area aggregates which must carry relatively small quantities of fine sand, and therefore is not general but is bounded with narrow limitations, applicable only to any one single grading of aggregate.

3. It is not a method which permits the best grading of any aggregate to be chosen, but arbitrarily chooses a definite grading and merely shows the variation in strength which will result when various proportions of cement are used with this definite combination of sizes.

4. The coarse gradings made necessary for apparent economy are harsh working, of lower compressive strengths, and require slightly more cement, than would gradings of higher surface area which might be obtained from the same aggregate.

5. Because of the limitation as to area of aggregate, this surface area method is less general in scope than the volumetric method of proportioning now in general use.

PUBLIC WORKS AND "ECONOMY"*

By S. Baker
City Clerk, London, Ont.

RECREATION and art galleries are more important than a low tax rate. "The wolf at the door" will compel men to work, and good citizenship will see that we have sanitary factory laws, fair wages and proper housing. But it is not wages that determine living conditions; it is living conditions that determine wages. If a city provides parks, proper amusement and recreation grounds, and works of art, to raise the physical and moral tone of its people, improved labor conditions, better housing and higher wages will follow. A city well planned and governed can demand and secure a better class of citizens.

Waste and reckless expenditure are wrong, but when economy takes the form of reducing all expenditures, it is likely to prove to be penny-wise and pound-foolish. It is merely negative and leads nowhere. The incurring of expenditures by municipalities should first be approved by a municipal bureau under government control, with competent expert financiers and engineers to prevent wasteful or foolish works, but no necessary work should be unduly held back. These works in most cases increase the resources of the municipality more than its liabilities.

Forethought, continuity of purpose, public initiative, co-ordination of effort, intelligence in administration and single-mindedness in public life are infinitely more important to a city than the lowering of the tax rate.

*Excerpt from paper read at the Southwestern Ontario Town Planning Conference.

It is announced that Hon. F. C. Biggs, Ontario's Minister of Public Works, has decided to have all toll roads taken over by the county and provincial road systems and all tolls abolished.

When the Toronto street railway is taken over by the city in 1921, the price that will be paid for the railway, rolling stock and other equipment will be determined by arbitration. The city hall estimate of what Toronto will have to pay is between $8,000,000 and $10,000,000.

Letter to the Editor

OPPRESSORS OF THE POOR

By J. G. Sullivan
Consulting Engineer, Winnipeg, Man.

Sir,—One does not have to be a student of history to know that there has existed in the old worlds up to recent times a condition which made it practically impossible for any individual to remove himself from the class into which he happened to be born. Even those of us whose fathers came from Great Britain have been told many times by father or grandfather that a gentleman was a man who did not have to work for a living, and that he was in a class by himself, protected in his holdings of land, etc., by laws of entail; and no matter how depraved he might become, the laws and customs maintained him in his position and he and his offspring existed without working. They told us that other classes were tradesmen, farmers and laborers, and that it was next to impossible for any of these to enter into the gentleman's class.

Practically All are Workers

We do not have to go very far in the Bible before we are told that God Himself said to Adam, "With labor and toil shalt thou eat thereof all the days of your life." It would not appear entirely illogical to classify the "gentleman" described above as an oppressor of the poor. Such conditions do not exist in Canada or the United States. Mention a successful rich man, and in ninety-nine cases out of a hundred, you have named one of the hardest working men in the country. In this country we are practically all workers, and if there are oppressors of the poor we must look for them among the workers.

The radical labor leader will tell you that the arch fiend is the capitalist, without defining what he means by the word capitalist. We would not expect him to include a poor widow who may have a few thousand dollars in the savings bank, although we are not sure how he would class this same widow if she should draw out her savings and purchase war bonds or railway or other commercial stocks.

Capital is what we have saved out of what has been produced, the sole means of sustaining the life of the industrial worker, for as a matter of fact, the industrial worker, whom the radical leader tries to make you believe is the only producer, is not a producer of the real necessities of life, but rather of luxuries which follow where people have been frugal and saved up some capital which will permit them to enjoy luxuries.

False Teachings of Radicals

The real producers of the necessities of life are the farmers, and if they had been controlled and guided by the teachings of the present leaders of industrial workers, it is the writer's belief that a universal famine would exist on this earth to-day, and the first to die would be the industrial worker. The writer has no quarrel with industrial workers or their leaders, but rather with the false teachings of the radicals. For instance, it is a common teaching that the industrial worker is underpaid, and that he is producing all the way from twice to twenty times the amount that he is being paid for. If that were a fact, we would expect to see the wealth of the world increasing at a tremendous rate. What are the actual facts?

The estimated wealth of the world at the beginning of the war did not exceed one trillion dollars. This consisted mostly of tools of production and maintenance used for the comfort and happiness of mankind created by capital, which in turn was created by frugality and sacrifice. The value of the world's plant has not increased during the past five years, but in all probability has decreased in actual value,

although on account of the depreciation of the measure of value, those who do not wish to know or hear the truth may produce statistics to prove the contrary. They will surely ask, "Where did all the war millionaires come from?" The answer is easy: "They did not get it from what was produced during these years, for we consumed more than we produced. They made these millions at the expense of the capital of others." The world during the past five years can be compared with the thoughtless man who has a home or a farm left to him and immediately places a heavy mortgage on same, buys an auto, diamond rings for the wife and fine clothes for the children, and in general lives like a prince. When the house-servant and the man who drives the auto see such extravagance they say: "We are the only ones around here who work. All this money is coming from our labor." Then the trouble begins.

Small Wealth per Capita

A trillon dollars looks like a lot of wealth. It is a considerable sum, but when you divide it by the number of people on earth, about one billion seven hundred millions, we get a sum that comes within the scope of the minds of most of us, namely, about $600. Whether one believes in the Bible or not, he must admit that what was said about toiling for a living is true, otherwise, after some six thousand years of toil and sacrifice, we would have accumulated more than $600 each. If we allowed no credit for the things that God put on the earth for man's use, which he could take without any exertion, and if we start with a capital of one dollar, this capital has increased at the rate of about one half of one per cent. a year.

Let us take the case of the United States, a comparatively new country to civilization. The estimated wealth of the United States in December, 1917, was two hundred and twenty billions of dollars. If we assume that the accumulation of this wealth started four hundred years ago, and that the value of the natural resources, such as wild prairie lands and timber, which required no human exertion to create their present assessed value, amounted to the low sum of $100,000,000, then the increase would be considerably less than 2% per year. Further, if we entirely ignore the value of the natural resources and started with a capital of one dollar, then the increase would be less than 7% per year. But we know as a matter of fact that this latter figure is not correct, for that would mean that the wealth of the country would double every ten years.

Railway Operation as Example

Enough has been said to show how foolish is the doctrine that there is wealth enough in the world for all of us to live in comfort and ease if it were equally distributed. We must look some place else for the oppressors of the poor. The miser may accumulate millions, but they are only saved up for the future happiness and comfort of the human race; none of them are carried across the River Styx. They will continue to serve the world for years after their accumulator has been forgotten.

We will assume that the average man will accept as an axiom the statements that it is impossible for the world to consume more than it produces, that the capital of the world is not large, and that the rate of increase is small and must be maintained in order to supply the means by which industrial workers can make a living. If the above be granted, then we can logically say that the oppressor of the poor is the man who consumes more than he creates.

It is a hard problem to say how much a man has a right to consume, therefore a difficult thing to lay your hand on the real culprit, but as a great majority of the industrial workers spend all they get, let us analyze the subject from the point of remuneration for services and try to find out who, if any, are being paid for more than they create.

Because the writer is more or less familiar with the railway business, and further, because of published facts of that business in the United States, we will take that industry as an example.

If the United States had not taken over the operation of the railways, and the private companies had to pay the wages that are now being paid, it is a safe guess that 50% of the railways would now be either in the hands of receivers or ready to be taken over by receivers, and the bondholders would not be getting interest on their capital. There would practically be no dividends paid on stocks,—only by the very few strong companies. This burden is being carried by the general taxpayer, and I do not believe that there are very many who think that the holders of railway securities are getting what is justly due them, to say nothing about getting too much, and the majority of the people know that if 50% of the roads were in the hands of receivers that the security-holders would not be getting a just return on their capital; therefore, we can eliminate them from the class of oppressors of the poor.

The shippers of the country, whether rightfully or not, believe that freight and passenger rates are high enough. If that view be correct, the railways are being paid for all they create, and we practically have only the employees left among which to find the oppressors of the poor, if there are any in that industry.

High-Salaried Officials

The radical labor leader will at once point to the high-salaried officer and say, "There is the man." Representative Sims has published in the Congressional Record a list of the names of railway officials who were paid $20,000 or more per year in 1917, the last year of private operation. There were about two hundred names on this list—about one hundredth of one per cent. of the total number of employees. The aggregate amount paid these two hundred men was $6,644,074, or a little over $33,200 each per year. If the services of these officers had been dispensed with, and the money divided among the other employees, they would have each received less than $4 more per annum than they were actually paid. Surely these two hundred men were not very grievous oppressors of the poor.

Director-General Hines, on November 14th, 1919, submitted to the president of the senate a report in response to the August 20th resolution of the senate calling for information re rates of pay of railway employees. (For further and more detailed information, see "Railway Age," October 3rd, 10th, November 7th, 14th, 1919.) The figures in this report show that several classes of organized labor are receiving as much and in some cases more than is being paid to the division officers.

Recently, in speaking to a railway superintendent who had formerly been a locomotive engineer, I was told that on account of the depreciated value of the dollar, it was getting next to impossible for him to make both ends meet,—he had to dress well and keep up his end in a small town, and was finally compelled to sell his automobile to one of his locomotive firemen.

Organized Labor Taking All

He said, further, that he did not see how the company could afford to raise his pay, for if they did, then they would have to raise the salary of thousands of others who were unorganized, and he did not see how it could be done, as organized labor is taking all and more than the company can afford to pay. He asked and answered this question: "Do you think it is just that a locomotive engineer should get more pay per month for working seven to nine hours per day, three or four days a week, than I receive for working seven days a week and from ten to twenty hours per day? Whom do you consider is the greater producer?" The answer was: "He has the advantage over me that he has back of him the brute force of a large combination; and still they talk about the wrongs of the poor and brotherly love! I cannot understand how a locomotive engineer that preaches such doctrines, and in some cases draws from $2.50 to $3 per hour for actual time worked, can look in the face of his auto-driver, whom he pays at the rate of thirty to forty cents per hour, when he knows that it requires more brains, five times as much energy and more responsibility to drive an auto-

mobile than it does to drive a locomotive." He concluded by adding: "I know what I am talking about, because I am speaking from several years of experience in this business."

See the "Railway Age" for October 3rd, 1919, for an account of the testimony of Timothy Shea, acting president of the Brotherhood of Locomotive Firemen, before the United States Board of Railroad Wages and Conditions. Asked if the question of thrift did enter into the situation, Mr. Shea said he did not think it was possible for working people to curtail expenditures any more; that the men he represents are living "right on the margin" and depriving themselves and their families of the necessities of life.

"Do you represent any men who are buying automobiles and those things?" asked Mr. Morse.

"I do not hear of any firemen, or many firemen, buying automobiles," replied Mr. Shea.

"You would not regard an automobile as a necessity, would you?" asked Mr. Morse.

"Yes, I would."

"Well, I have denied myself a necessity all my life, then," said Mr. Morse, who was general manager of a railroad before becoming a member of the wage board.

No Sacrifices by Organized Labor

"An automobile may be a necessity to any man," said Mr. Shea. "I have an automobile, and it is a necessity to me and my family to a considerable extent. That would apply with equal force to any man, and I think we have reached a period of our life where the laboring man must enjoy some of the necessaries and luxuries of life. I do not think the time is at hand when the American working man should be required to make any great sacrifices now. They have made their sacrifice."

The writer does not care to dispute Mr. Shea's testimony; he would only be too glad to approve of the idea if the production of the world to-day were such that it would permit of every fireman and every other man doing like work to enjoy the luxury of an automobile; but unfortunately that is not the condition at the present time.

Now as to the real oppressors of the poor. The reader can draw his own conclusions; the writer is not interested; his idea of sport is a fair "free-for-all," but as the radical labor leader has so much to say on this subject, the writer cannot refrain from pointing out the fact if, through brute force of large combinations, organized labor can increase their pay only 20% above what they are producing, they are oppressing their unorganized brothers to that extent.

The radical will reply that the answer is for everybody to be organized, but that is a fallacy, for with everybody effectually organized excepting the high-salaried officers, there would be left to divide only the $4 per man that was paid to the high-salaried man, and the wages of the auto-driver would be equal to those of the locomotive driver, and the latter would be considerably reduced from what they are now.

The Real Oppressors

We know that the radical has not got that $33,200 to two hundred officials out of his mind, so let us take a concrete example. Supposing, for the sake of the example, that brains, energy and ability do not count, and that these men are each getting ten times what they should receive. Then they are oppressing the poor to the extent of the wages of nine times 200, or 1,800 men. But if a million organized railroad employees are getting 5% more than they are entitled to, they are oppressing the poor by a million times 5%, or the wages of 50,000 men. The reader can draw his own conclusions as to who are the real oppressors of the poor.

The sooner labor leaders realize that the industrial workers of the world cannot lift themselves very far by their own boot-straps, the better it will be for the workers as well as everybody else on this earth. At the beginning of the war it was only natural that the law of supply and demand would somewhat increase the price of wheat, meats and materials required for war purposes but all can remember how soon the labor leader who shouts so loud, about the crime of treating labor as a commodity did that same thing and took every advantage of the law of supply and demand. We saw war munition and shipbuilding workers getting from 75c. to $1.25 per hour, and five to ten times these figures in some cases where they actually exerted themselves and did piece-work. At the same time other equally skilled tradesmen, such as carpenters or painters, were actually working for from 35c. to 55c. per hour, and to the writer's mind this was the major factor in starting old H. C. L. on his way. Other tradesmen and laborers could not be expected to be contented under the circumstances and the trouble began.

Industrial workers attempted to do the impossible—to get two or three times the value of what they produced—but another natural law took partial care of that hold-up: The value of the measure of "value" depreciated, and the industrial worker, instead of getting what he wanted, only succeeded in getting a relatively small percentage at the expense of unorganized labor and of those straight-salaried men whose salaries did not go up in the same ratio that the value of the dollar went down.

Money is only a medium of exchange, and the fluctuation of its value is incorrectly interpreted as the high or low cost of everything else. Here on the prairie we can build a mile of railroad to-day cheaper than we could twenty years ago if one measures the cost in what we are producing, namely, bushels of wheat.

There is just one real remedy for all this industrial trouble; that is, more production. When the organized industrial workers realize that fact and change their present ideas of getting as much money as possible for the least amount of time and smallest amount of output, to working a reasonable amount of time to the limit of their ability and capacity, the sooner will they be able to enjoy, rightfully and more universally, the privilege of going to and from their labor in their own automobiles.

J. G. SULLIVAN,
Consulting Engineer.

Winnipeg, Man., January 1st, 1920.

SEEKS POWER FRANCHISE IN EDMONTON

THAT it is the aim of his principals to construct a model power station in Edmonton as an example to other Canadian cities, is the statement of Robert H. Parsons, of London, Eng., who has asked for a 20-year franchise.

Confirming a cabled offer to the Edmonton council, Mr. Parsons writes: "If any proposition of this nature would be entertained by the council, I should be prepared to return at once to Edmonton and submit a definite offer on the lines indicated. I am connected in a consulting capacity with one of the largest and oldest electrical engineering firms in Great Britain, who will stand at the back of my proposal.

"They are desirous not so much of making profit out of such a contract, as of organizing in the west a model and efficient power station which they can point to as an example when looking for contracts for power and lighting plants in Canada. I need scarcely add that the fullest financial guarantees will be given for the proper carrying out of such a contract, including the return of the plant in first-class condition at the end of the contract.

"From my intimate knowledge of the plant and of local conditions I am confident that I can submit an offer which would be advantageous to the city and I should be glad if you would kindly advise me by cable as to how the council would regard the question of the granting of an operating and maintenance contract."

It is expected that a highway bridge, to cost probably $200,000, will be built over the St. John river, between Edmundston, N.B., and Madawaska, Maine, this year. The new structure will connect highways recently built in Quebec, New Brunswick and Maine.

NEW WATER SUPPLY FOR CHATHAM

THAT the water works plant at Chatham, Ont., is overtaxed and most of its equipment nearing the time when it will no longer be of service, is the opinion expressed in a report recently made by E. A. James, consulting engineer, Toronto. To enlarge the present plant and provide the apparatus necessary to give Chatham a safe and sufficient supply, would necessitate expenditures that are not warranted, says Mr. James. In planning the city's future supply, therefore, he allowed for a new pumping and filtration plant in the three schemes studied, namely, the Thames supply (from the Thames river), the Snye supply (from the Chenal Ecarte), and the Erie supply (from Lake Erie).

Each scheme includes the improvement of the present settling basin by paving and the construction of a division wall.

The pipe lines and intakes have been designed to meet the requirements of a population of 45,000; and the pumps and filters, which can be enlarged whenever necessary, for a population of 25,000.

The Thames Scheme

In the Thames scheme, the proposed intake would be located about four miles farther up the Thames river than the present intake, in order to reduce the danger of contamination by the sewage of Chatham, which, with the pronounced upstream currents of the river, constitutes a serious menace to the present water supply. The cost is estimated as follows:—

Intake and low-lift pumping station on the Thames	$ 22,000
Wood-stave pipe, 17,500 lin. ft., 22 ins. diameter..	60,000
Pumping station and filtration plant adjacent to present settling basin,	134,000
Elevated steel tank in Chatham,	17,000
Lining present reservoir and constructing division wall,	38,000
Engineering and contingencies,	29,000
Total estimated cost	$300,000

The Snye Supply

The Snye supply would be obtained from the Snye or Chenal Ecarte river, and the intake would be located very close to the Wallaceburg intake, avoiding the pollution of the Sydenham river and Little Bear creek and the spring backflow to Johnston channel.

The estimated cost of this scheme is as follows:—

Intake and low-lift pumping station at the Snye,	$ 24,000
Wood-stave pipe, 112,790 lin. ft., 24 ins. diameter, with river crossing,	425,000
Pumping station and filtration plant adjacent to present reservoir,	134,000
Lining present reservoir and constructing division walls,	38,000
Engineering and contingencies,	62,000
Total estimated cost,	$683,000

The Erie Project

In the Erie scheme, water would be pumped from Lake Erie through a long intake pipe to a reservoir at the high point of the Erie ridge, about 1¼ miles from the lake shore, and then allowed to flow by gravity to the city. The fire pumps would be located in a pump-house in Chatham near the present reservoir. The filtration plant would be located near Lake Erie. The total cost of this scheme would be $600,500, estimated as follows:—

Intake,	$ 36,000
Filtration plant and pumping station,	118,000
Reservoir on Erie ridge,	40,000
Wood-stave pipe, 66,725 lin. ft., 24 ins. diameter,	260,000
Pumping station in Chatham for fire protection,	60,000
Lining present reservoir and constructing division walls,	38,000
Engineering and contingencies,	56,500
Total estimated cost.	$608,500

The consulting engineers, in comparing the advantages and disadvantages of the three schemes, state that while the Thames supply is the cheapest and the water can be made safe for domestic use, it cannot be made palatable and would be expensive to soften.

The water from the Snye river is cool, clear and soft, the only disadvantage of the scheme being its high initial cost. The disadvantage of the Lake Erie water is its frequent turbidity, but with filtration, this water, like the Snye water, would be first class for domestic and industrial purposes. The maintenance and operation of both the Snye and Erie schemes would cost about the same amount, but the pipe line from Lake Erie would have an advantage over that from the Snye in that is does not cross any rivers or large drainage ditches.

The total revenue from the sale of water in 1918 in Chatham was $34,398, with an average daily consumption of 1,115,000 Imperial gallons. To carry the additional capital expenditure occasioned by obtaining water from the River Thames, based on 30-year debentures at 5½%, it would be necessary to raise the water rates to produce an additional revenue of $20,000 per annum; for the Snye scheme, $46,000 per annum; and for the Erie scheme, $41,200 per annum.

A referendum was recently submitted to the citizens by the city council, asking whether they favored the Thames or the Erie scheme, and the people voted in favor of constructing the Thames project. The Board of Commerce of Chatham is opposing this, however, although it favors the construction of new rapid sand filters and the repair of the present water works plant, including the installation of new pumping machinery as required. The city council have not yet decided which plan they will adopt.

FEDERAL AID ALLOTTED TO PROVINCES

ACCORDING to plans now being made, this year will be an active one in carrying out the good roads policy of the Dominion government, whereby $20,000,000 is to be spent in the next five years in granting 40% federal aid in the construction of approved highways.

Following is the contemplated division of the government's $20,000,000 on the basis of population, and the amounts, totalling $30,000,000, required from each province:—

	Federal grant.	Provincial expenditure.
Alberta	$1,477,810	$2,216,715
British Columbia	1,251,955	1,877,933
Manitoba	1,602,265	2,403,397
New Brunswick	1,163,845	1,745,767
Nova Scotia	1,468,720	2,203,080
Ontario	5,877,275	8,815,912
Prince Edward Island	603,455	902,183
Quebec	4,748,420	7,122,630
Saskatchewan	1,806,255	2,709,383

The grants will be made and the work directed by the Department of Railways and Canals, with A. W. Campbell as highway commissioner. Regulations governing the expenditures have been drawn up by an Honorary Advisory Committee consisting of Hon. C. A. Magrath, Ottawa; J. P. Mullarkey, Montreal; and Home Smith, Toronto.

Specifications for the proposed Mount Pleasant carline in Toronto have been completed, and contractors have been asked to submit tenders. The work will include: (1) Widening the pavement on St. Clair avenue, east of Yonge street, and installing new walks, besides permanent double tracks and pavement in the centre of the street, which has also to be graded; (2) grading Mount Pleasant road and installing a temporary ballast line with overhead wires, etc. (3) laying concrete walks on various sections of Mount Pleasant road; (4) constructing certain bridges and trestles; (5) providing thirteen cars.

RUNNYMEDE AND SWANSEA SEWERAGE SCHEME

IN addition to the reports on the proposed sewerage schemes for the eastern and western divisions of the township of York, Ontario, abstracts of which were published in *The Canadian Engineer* for December 18th and 25th, the engineers, Frank Barber and his associate, R. Wynne-Roberts, have submitted a preliminary report on a sewerage scheme for the Runnymede and Swansea division of York township, from which report the following information is abstracted.

This division includes the part of the township extending along the western limit of the city of Toronto, from Corbett avenue on the north to the lake on the south, and between the city limits on the east and Scarlett road, Langmuir avenue, Baby Point Road and Riverside Drive on the west, an area measuring about 743 acres.

About 320 acres situated between the above area and the Humber river are not included in this division, as the land is too low-lying to drain by gravity into the proposed sewers. Should such low-lying land be built upon, it will be necessary either to treat the sewage in small independent plants, or to pump it to the sewers included in the scheme.

The works commissioner of Toronto stated on November 3rd, 1915, that the sewage from the upper area from Florence avenue to Annette street, measuring about 280 acres, could be drained into the city sewers, as they are of ample capacity to accommodate the dry weather flow and also to take the storm water from the area bounded by Jane street, Runnymede road, Annette street and south side of St. John's road. The area for which complete accommodation could be provided would be about 88 acres. The city authorities stipulated that the storm water from the upper portion of the Runnymede district should have a storm water intercepting sewer on St. John's road, discharging into the Humber river.

To Drain Into Toronto's Sewers

For the present it is proposed that Runnymede road, Norval, Crisco, Ravenal, Hertford, Henrietta and Cobourg streets shall drain into the city sewers.

Although the houses on one side of Runnymede road and Annette street are in the township, the streets are in the city, and it is considered advisable that the city system should receive their drainage, and also that from Windermere, Durie, and Beresford avenues between St. John's road and Annette street, because the natural outlet from these streets lies in the direction of the city sewers.

These areas measure about 71 acres, of which about 10 acres drain into the city sewers in Runnymede road and Annette street. The cost of the township sewers would be about $46,000, and the annual capital cost about 40 cents per foot frontage, exclusive of city charges. The average frontage in these areas is about 230 ft. per acre.

Inasmuch as the city authorities state they cannot afford facilities for the discharge of this sewage and storm water into their sewers, the engineers propose draining the remainder of the Runnymede district into a trunk sewer in Jane street at St. Clair avenue, crossing through the Jane St. subway, and thus obviate the floods which occur there. This trunk sewer will join St. John's road and continue along that street to Brookside avenue, Brunell avenue, Raymond avenue, and Old Belt Line as far as Cataract avenue, where a relief sewer will discharge the volume over six times the dry weather flow into the Humber river. The trunk sewer will continue along the old Belt Line to Morningside avenue, along Morningside avenue, Lavinia avenue, McConnell avenue and Runnymede avenue extension to a sewerage treatment plant, say between Windermere avenue and Ellis avenue, opposite Ormskirk avenue.

To Cost $1,256,200

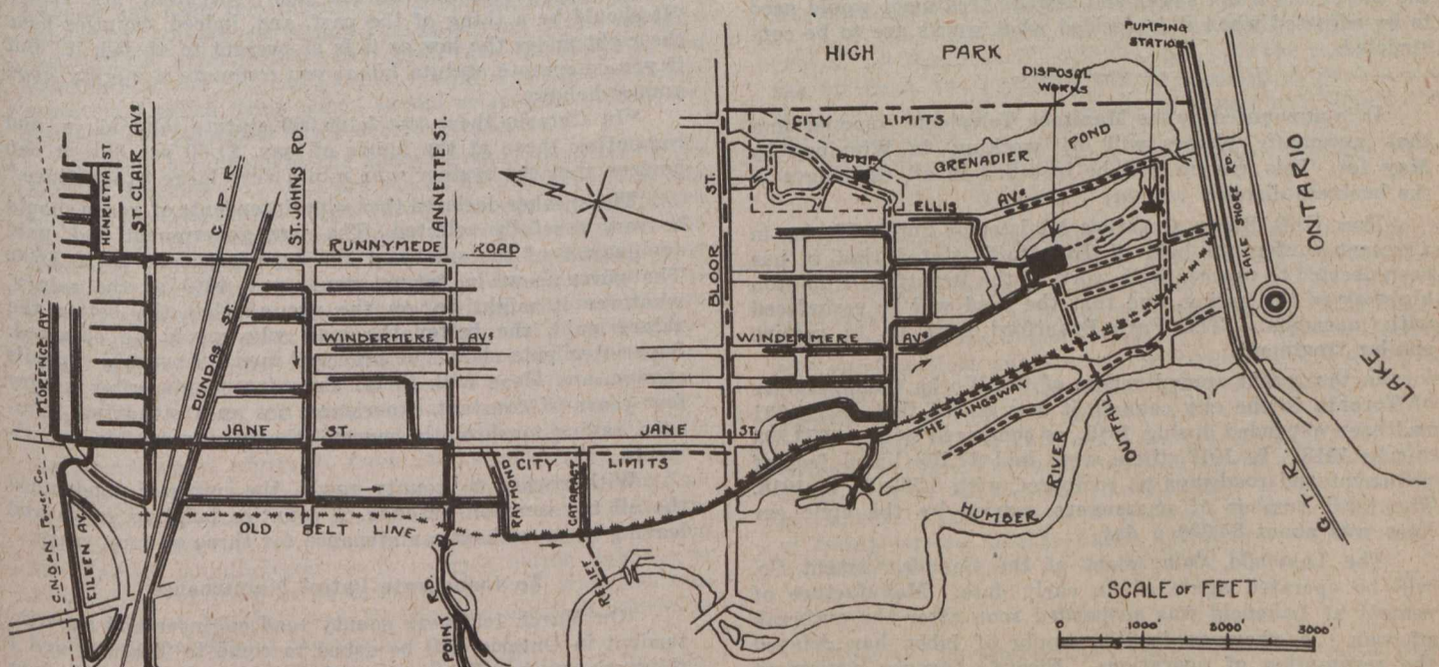
Owing to the topography of the Swansea district and Riverside estate, an area included by the old Belt Line, Garboyd avenue, Southport road, Windermere avenue (south of Ormskirk) and Ellis avenue (south of St. Olave's road), must be sewered on the separate system. A separate sewer will be provided and the sewage pumped into the above-mentioned treatment works, and the effluent and storm water will be discharged into the river near Ormskirk avenue.

About seven acres of land will be required for the works in this section, to which the drainage of 6.72 acres will be led.

The estimated cost of the scheme (excluding those portions which the engineers recommend should drain into the city sewers) is as follows:—

Trunk sewers	$593,800
Laterals	436,400
Relief sewers	20,000
Treatment works	200,000
Pumps, etc.	6,000
Total	$1,256,200

The annual capital cost of the scheme is $121,000, assuming that the debentures for trunk sewers and treatment



PROPOSED SEWERAGE SCHEME FOR RUNNYMEDE AND SWANSEA DISTRICTS, YORK TOWNSHIP, ONT.

works are redeemed in 30 years at 6%, which entails an annual expenditure of about 7¼ cents per dollar, and that the cost of laterals are repaid in ten years at 6%, which means an annual cost of 13⅓ cents on the dollar.

The following tabulation gives the estimated cost in detail; the second column showing what the capital cost will be if everything be repaid in 30 years at 6%:—

Trunk sewers, ...	$593,800 @ .0727	$ 43,170	$43,170
Laterals, ...	436,400 @ .133	58,040	31,726
Relief sewers, ...	20,000 @ .0727	1,454	1,454
Pumps, etc., ...	6,000 @ .133	796	436
Treatment works, ...	200,000 @ .0727	14,540	14,540
Maintenance, power and repair of pumps, ...	.....	3,000	3,000
Total, ...		$121,000	$94,326

The average assessable frontage per acre in this division is about 280 ft., and in the whole division there will therefore be about 188,200 ft. frontage. The estimated annual capital cost per foot frontage will be about 65 cents on the 30 and 10-year basis, and 50 cents on the 30-year basis.

Owing to the local topographical conditions and the difficulty of foreseeing what developments will take place, especially in the Swansea district, Messrs. Barber and Wynne-Roberts point out that considerable revision may be necessary when the location of the treatment works is definitely known. It is also possible that some arrangement might be made with the Toronto Harbor Commission for the discharge of storm water and sewage effluent.

The area which is bounded on the north by Bloor street, on the east by High Park, on the west by Thompson street, and on the south by Grenadier pond, must either be provided with a separate system of sewers, and the sewage discharged into an independent treatment plant, or have its sewage pumped into the Swansea sewers.

In the addenda to their report, the engineers recommend that this small district, measuring about 40 acres, be sewered on the separate system and the sewage pumped into the proposed Morningside avenue sewer. The whole area measures about 60 acres, but it is not known whether more than 40 acres can be subdivided.

The estimated capital cost of the sewers, tank, pumps and buildings will be about $23,000. The annual capital cost, on the same basis as in the other divisions, without including any proportion of the cost of the larger scheme, will be 37 cents per foot frontage if redeemed in 10 years, or 23 cents if paid in 30 years. The proportion to be charged for the use of the trunk sewer and sewage treatment would need to be adjusted when it is decided what works are to be constructed.

It is announced by the Manitoba Telephone Commissioner that automatic phones will be working in Winnipeg by May 1st. This system will be installed in all exchanges in the business district.

Hon. F. C. Biggs, Ontario's Minister of Public Works, in a recent conference held at Brantford, stated that it has been decided to proceed with work on the Brantford-Hamilton highway in the spring, and that the road will be resurfaced with macadam. The Paris-Brantford road is to receive similar treatment.

In the recent annual report of the Works Commissioner of Toronto to the city council, it was stated that $5,311,001 had been expended during 1919, as compared with $4,373,398 during 1918. In 1919, there were laid 47,278 lineal feet of pavement and roadways as compared with 3,533 ft. in 1918. The total number of passengers carried by the civic car lines was about 84,000 a day.

The Lakefield, Ont., plant of the Canada Cement Co. will be operated again at an early date. Manufacture of cement at Lakefield was suspended soon after the outbreak of war. A shortage in the supply of labor has delayed the resumption of operations. Electric furnace equipment was installed in the plant for the production of steel from shell turnings, but had not yet been completed when the armistice was signed.

ONTARIO'S "U. F. O." HIGHWAY POLICY

ONTARIO'S highway policy under the new United Farmers-Labor government was outlined by Hon. F. C. Biggs, provincial minister of public works and highways, at a recent meeting of the Ottawa Board of Trade.

County roads are to be taken over as provincial roads, making a total of 1,600 miles on which the federal government will be asked to pay a 40% grant. The provincial government will pay 42%, and the remaining 18% is to be paid by municipalities.

"Provincial highways," says Mr. Biggs, "are to be built of such materials as the character of the country through which they pass may justify.

"Probably the biggest problem we have to-day is that of the cost of living," he continued. "I have asked myself if we cannot spend the money we get for motor licenses, the money the Dominion grants for roads, and a general appropriation from the consolidated funds of the province on roads in such a way as to reduce the cost of living. And I am convinced we can, for nothing will so tend to reduce this cost as good roads throughout the province.

Will Have Trunk Roads

"I have been told many times that we need trunk roads throughout the province. Of course we do, and we are going to have them, but not all produce can be brought to the consumer by trunk roads, and this is especially true in Ontario because of the geographical shape of the province. Most people, I think, will admit that trunk roads are little use for this purpose unless we have feeders for them.

"Ninety per cent. of the roads that have been taken over by the province are provincial county roads, which are roads of major importance,—the most important roads outside of the trunk roads.

"Every road taken over by the province as a county road means just that much less expenditure by the local townships, and, therefore, that much more money that can be expended in extending township roads.

"It is our policy to pay townships 20% of the cost of their roads, which are not as important as county roads. This work must be done under government supervision.

Opposes Statute Labor

"I have no use for statute labor," declared Mr. Biggs. "It should be a thing of the past, and, indeed, counties have the right under the law as it is at present to abolish it. But if you communte statute labor, you commute a mighty good annual holiday.

"In Ontario there are 1,100,000 statute labor days, and computing these at the figure of, say, $1.50 per day, it can be seen that the system runs into a very large expenditure."

The speaker declared that superintendents of roads should be very carefully selected. The late government had paid one-quarter of the salary of the superintendent up to $600. The government in future would pay 40% of the salary, whatever it might be, on the ground that the better the salary paid, the better the man who would be obtained. Superintendents should be practical men. Township councils change, and ideas with them. Superintendents, after a very few years of constant experience, act as a steadying influence, saving much of the money otherwise wasted in experiments.

With regard to county roads, the minister condemned the all too common practise of counties building roads and leaving them without maintenance for three or four years.

To Inaugurate Patrol Maintenance

"On March 1st every county road engineer and superintendent in Ontario will be asked to come to Toronto, and I think we can instill into them the absolute loss the province is suffering by letting roads go by default through lack of constant supervision," he said.

(Concluded on page 168)

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HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

ENGLISH FIRMS USE CANADIAN SHOP

ONE of the main stumbling blocks which English manufacturers have encountered in selling machinery in Canada has been the difficulty of supplying repair parts or rendering shop service of any kind to buyers. After a year's negotiations, arrangements have been fully completed by the Bawden Machine Co., Ltd., Toronto, with a number of representative English firms which should solve this difficulty so far as these particular firms are concerned.

By this arrangement the adequate shop facilities of the Bawden Machine Co., Ltd., are placed at the disposal of the English manufacturers. This Toronto firm will manufacture all parts of the English machinery for which they have the necessary equipment, and will also supply all possible repair parts. Those parts which cannot be produced in Canada so cheaply as they can be produced in England, or which require investment of too much capital in proportion to prospective sales, will be shipped from England. A complete stock of those repair parts which must come from England will be carried in Toronto. All parts that are manufactured in Toronto will, of course, be made in accordance with English designs and, where advisable, from English patterns.

This sort of arrangement is ideal for English manufacturers of machinery who wish to establish permanent connections in this country. Buyers to-day demand service, and the English manufacturer is in a much better position to render that service if he be supported by local shop facilities of an adequate nature, owned by the firm which is interested in the original sale of the machinery.

These agencies were arranged by A. G. Hill, sales manager of the Bawden Machine Co., Ltd., as a result of three trips to England, one about a year ago, one last summer, and the third last fall, which would indicate that the arrangements have been carefully made. We understand from Mr. Hill that a sales engineering staff is being built up, and that every effort will be made to secure business for the British firms now that the exchange rates are so favorable to British sales in Canada. He states that the firms with whom he has made arrangements are particularly desirous of establishing export trade and have promised preferred deliveries to Canada.

ENGINEERING INSTITUTE'S ANNUAL MEETING

FOLLOWING is the official program of the annual meeting of the Engineering Institute of Canada, to be held next Tuesday, Wednesday and Thursday in Montreal, and of the general professional meeting of the Montreal branch of the institute, which will be held at the same time:—

Tuesday, January 27th

9.00 a.m.—Opening of registration at headquarters, 176 Mansfield St.

10.00 a.m.—Calling to order of annual meeting, appointment of scrutineers, reception of reports.

12.50 p.m.—Adjournment of business session until 2.45.

1.15 p.m.—Luncheon at Windsor Hotel for members and ladies and invited guests.

1.50 p.m.—Formal welcome and greeting.

2.00 p.m.—Address, "Modern Highway Problems," by F. W. James, assistant chief engineer, Bureau of Roads, Washington, D.C.

2.45 p.m.—Resuming of business session.

4.10 p.m.—Reception of report of scrutineers.

4.20 p.m.—Address by Col. R. W. Leonard, retiring president.

5.00 p.m.—Inauguration of R. A. Ross, incoming president.

9.00 p.m.—Reception and dance, Rose Room, Windsor Hotel.

Wednesday, January 28th

10.00 a.m.—Calling to order of professional meeting, at headquarters. "The Training of the Chemical Engineer," by Dr. R. F. Ruttan, professor of chemistry and director of the chemical laboratories, McGill University. "The Importance of Physics in Engineering Education," by Dr. A. S. Eve, Macdonald professor of physics, McGill University. Discusion by four authorities on technical education.

1.10 p.m.—Leave Windsor Hotel on special cars for Northern Electric company's works.

1.30 p.m.—Luncheon, as guests of Paul F. Sise, president of the Northern Electric Co., Ltd. At the conclusion of the luncheon, the members will be escorted in parties over the works, and will be at liberty to depart any time before the closing hour.

7.45 p.m.—Annual banquet, Rose Room, Windsor Hotel.

Thursday, January 29th

10.00 a.m.—Continuation of professional meeting at headquarters. "Quebec's Water Power Policy and the Work of the Quebec Streams Commission," by Olivier Lefebvre, chief engineer, Quebec Streams Commission. "The Operation of the Quebec Public Health Act," by Theo. J. Lafreniere, chief sanitary engineer to the Superior Board of Health, Province of Quebec. "Quebec's Highways," by Alex. Fraser, assistant chief engineer, Quebec's Department of Roads.

2.30 p.m.—"The Pulp and Paper Industry," by Ferd. van Bruyssel. "The Policy of the Air Board of Canada," by Lieut.-Col. O. M. Biggar, vice-chairman of the Air Board of Canada. "The Forests of Quebec," by G. S. Piche, chief of forest service, Quebec Lands and Forest Department.

8.30 p.m.—Smoker at the Windsor Hotel.

That the Prescott-Ottawa road will be called the Prince of Wales Highway has been officially announced by Dr. E. G. Deville, surveyor-general of the topographical surveys branch, Department of the Interior

PERSONALS

BLAIR RIPLEY, who has been appointed engineer of the Ontario district, C.P.R., with headquarters at Toronto, was born August 29th, 1880, in Oxford, Nova Scotia. He commenced engineering activities in 1898 in minor capacities with the Canadian Northwest Irrigation Co., in Alberta, and from 1901 to 1903 was assistant engineer of the Great Falls & Canada Ry. Co., the Alberta Ry. & Coal Co., and the St. Mary's River Ry. Co. The last mentioned company promoted him to the position of engineer of construction, and he left this company in order to accept a similar position with the Alberta Railway & Irrigation Co. In 1905 Mr. Ripley joined the G.T.P. Ry. staff and for the next two years served as resident engineer in Manitoba and Saskatchewan, and assistant engineer on harbor work at Prince Rupert, B.C. In 1907 he became resident engineer for the C. P.R. on grade revision between Maple Creek and Medicine Hat, and then engineer in charge of field work in connection with the Lethbridge viaduct, on completion of which he was appointed engineer in charge of the Old Man's river viaduct at Macleod, and later in charge of the viaduct at Outlook, Sask. When the C.P.R. purchased the Dominion Atlantic Ry., in June, 1910, Mr. Ripley was sent to Nova Scotia to report on possible improvements to that railway, which was one of the oldest in Canada, and to organize a staff and prepare for replacement of many difficult bridges in the tidal waters of the Bay of Fundy. In June, 1912, he was placed in charge of the North Toronto grade separation and terminal construction, which he completed before going overseas in 1916. On the recommendation of the C.P.R., Mr. Ripley was commissioned lieutenant-colonel in command of the first Canadian railway construction battalion, which commenced active operations in France in October, 1916. While overseas, he was personally congratulated on the work performed by his battalion by the commander-in-chief, two of the army commanders and the director-general of transportation. He was mentioned twice in despatches, and was awarded the D.S.O. and invested with companionship in the Order of the British Empire. Col. Ripley returned to Canada last April, and after two months' rest on the Pacific coast, he rejoined the C.P.R. and has since been engaged on special work. He is a member of the Institution of Civil Engineers of Great Britain, the Engineering Institute of Canada and the American Society of Civil Engineers.

W. J. MURPHY has been appointed acting superintendent of the Edmonton electric light department.

C. H. ATTWOOD has been transferred from Ottawa to the Manitoba hydrometric survey of the Dominion Water Power Branch.

H. A. PAQUETTE, of Levis, P.Q., general manager of the Lauzon Engineering Works, has resigned that position and has organized the Levis File Co.

WILLIAM SMAILL has been appointed chief engineer of the Northern Construction Co., Vancouver. Mr. Smaill was formerly field superintendent of the Winnipeg Aqueduct Construction Co.

A. D. SWAN, of Montreal, consulting engineer to the Vancouver Harbor Commission, is now in Vancouver for the purpose of supervising the construction of the first new pier included in his plans for the development of Vancouver harbor.

J. J. MCARTHUR, H.M. Boundary Commissioner, has been in conference at Ottawa during the past month with E. C. Barnard, U.S. Boundary Commissioner, and has dealt with a number of questions relating to the International boundary.

E. L. COUSINS, chief engineer and manager of the Toronto Harbor Commission, and industrial commissioner of the city of Toronto, will leave for England within the next few days in order to make an effort to secure new industries for that city.

JOHN A. WILSON, of Vancouver, has been appointed, by British Columbia's minister of public works, as acting inspector of dykes, with jurisdiction over the lower Fraser district. During the war Mr. Wilson was at the front with the Royal Engineers.

C. H. SCHEMAN has been appointed general sales manager of the Chicago Bridge & Iron Co., Ltd., and has opened a sales and engineering office in the Bank of Toronto building, 260 St. James St., Montreal. Mr. Scheman is a graduate of Iowa University and was formerly sales engineer for the northwestern portion of the United States for the Chicago Bridge & Iron Works, Chicago.

CHANGES IN TORONTO STEEL FIRM

ANNOUNCEMENT was recently made of the withdrawal of C. R. Peckover from the well-known firm of Baines & Peckover, iron and steel merchants, Toronto. Business will be carried on by a newly incorporated company under the name of Baines & David, Ltd., with offices at 98 Esplanade East, as previously, and retaining the same warehouse at the Eastern Harbor Terminal. Mr. Peckover has formed a new firm, called Peckover's, Ltd., and will establish offices and warehouse at the foot of Spadina Ave., Toronto.

W. M. David, who has joined R. A. Baines in the new firm of Baines and David, Ltd., has been with the firm of Baines & Peckover since 1906, and has been sales manager for several years past. He has been connected with the iron and steel business throughout his career, as has also Mr. Baines, who founded the business of Baines & Peckover in 1894.

Mr. Peckover came to Canada from Scranton, Pa., 23 years ago, and after a year with the Rice, Lewis Co., he joined Mr. Baines, who was then agent for the London Rolling Mills and the London Bolt & Hinge Works. With Mr. Peckover in Peckover's, Ltd., will be J. G. Near, who has been with Drummond, McCall & Co., Ltd., of Montreal and Toronto, for the past 18 years. Associated with Peckover's, Ltd., will be another new firm, Steel Working, Ltd., whose plant will be in operation within the next couple of weeks.

ONTARIO'S "U. F. O." HIGHWAY POLICY

(Continued from page 166)

"Each road must have stone dumps along its length, or piles of stone chips or gravel. There must be a section-man of some sort, with a vehicle, a wheelbarrow, horse and cart or jitney, and just as soon as a hole develops in that road, this section-man will go to it, will pick it out and will fill it afresh and level. Only by taking such care will the roads continue to remain good. Otherwise they will soon disappear."

Speaking of county roads, which have been taken over by the province, which are important roads leading from town to town, or market roads, Mr. Biggs said the Ontario government hoped to satisfy the federal government that there would soon be 1,600 miles of these roads in Ontario fit to receive the government 40% grant.

Referring to the Ottawa-Prescott highway, Mr. Biggs stated that two-thirds of this road is graded already, and that the whole will be completed before fall.