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CONSULTING ENGINEERS

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Loop Station and One Right of Way at Hamilton

Is Plan Advocated by Consulting Engineers as Solution of Railway Problem in that City—Entrances for C.N.R. and Hydro-Radials—Present Situation of Hamilton Said to be Responsible for Much of Freight Blockade near Frontier—Abstract of Report by

W. F. TYE and N. CAUCHON
Consulting Engineer, Montreal Consulting Engineer, Ottawa

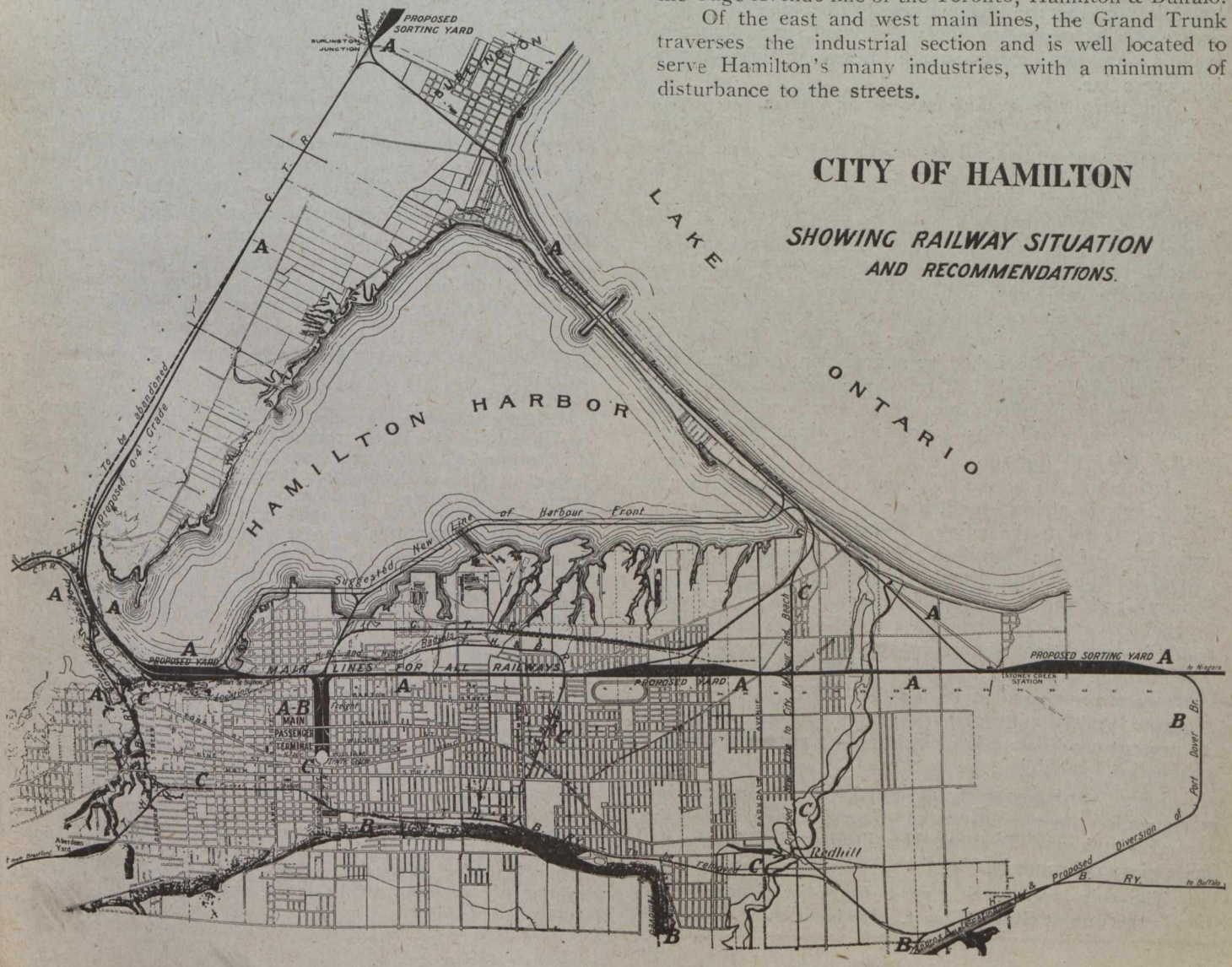
HAMILTON occupies a comparatively narrow strip of land, from one and a half to two and a half miles in width, between Burlington Bay and the mountain. This narrow strip is further restricted by broken ground and deep marshes on the west. A certain amount of settlement has developed on the mountain, which has not yet been included in the city limits. This section is difficult of access, and is not likely to grow rapidly until better facilities are provided, so may be left out of present consideration.

The city's development must, of necessity, be in an easterly direction. The strip of land on which Hamilton is built is so narrow, much of the traffic must be carried on a few east and west arterial highways, making the ultimate separation of railway and street grades imperative.

Hamilton, in proportion to its population, is probably the greatest manufacturing centre in Canada. The industries are, in a very large measure, confined to the district north of Barton and east of James Street.

Traversing this narrow restricted area from east to west are two main lines of railway—the Grand Trunk, paralleling more or less closely the water front, and the Toronto, Hamilton & Buffalo Railway paralleling the base of the mountain. To these are added two cross-town lines—the Ferguson Avenue line of the Grand Trunk and the Gage Avenue line of the Toronto, Hamilton & Buffalo.

Of the east and west main lines, the Grand Trunk traverses the industrial section and is well located to serve Hamilton's many industries, with a minimum of disturbance to the streets.



The Toronto, Hamilton & Buffalo traverses the uptown residential section. At the time of its construction there were absolutely no industries on this line, though a few small ones have since started up. Such a location is the worst which could have been selected to serve the city's industries, though it gives a good location for passenger service. As might easily have been foreseen, it has been found necessary for that company to build a cross-town line at Gage Avenue, with steep gradients to reach the industries. Thus, so far as Hamilton's industries are concerned, the location of the Toronto, Hamilton & Buffalo gives the maximum of disturbance to the streets, together with the greatest expense to the railway, in gathering and distributing its local freight traffic. This is further accentuated by the necessarily inconvenient location of its sorting yard and distributing system.

It would be a great improvement to the city if the Toronto, Hamilton & Buffalo could be moved from its present location to the Grand Trunk right-of-way. We understand that this can only be done by negotiation, as its removal does not come within the jurisdiction of the board of railway commissioners, who only have power to change a line within one mile of its established location, though it has unlimited power in regard to grade separation.

The cross-town lines are even more objectionable to the city than is the main line of the Toronto, Hamilton & Buffalo. It is not possible to remove the Gage Avenue line of the Toronto, Hamilton & Buffalo, unless a considerable portion of the main line is also moved, as it is essential that this road have access to the industries which are mostly located along the water front, and it cannot, from its present location, reach these industries except by a cross line.

The Ferguson Avenue cross-town line of the Grand Trunk is, at present, the worst offender of all. This line crosses at right angles, all the main, east and west traffic arteries in the heart of the city. Its whole length is practically a yard, with spurs to reach unimportant or easily movable industries. From the main line of the Grand Trunk, as far as King William Street, almost constant switching is carried on. It destroys, in a great measure, the value of surrounding property; it is a serious and increasing obstruction to the free movement of street traffic and should be eliminated or depressed. Its removal could only be accomplished by negotiation, and could not be ordered by the board of railway commissioners, as it would have to be moved more than a mile. The board, however, could order its depression, which would be a very costly undertaking.

Lying entirely across the front of Hamilton harbor is a low, narrow strip of land, known as Burlington Beach.

Transversing the whole length of this beach is the main line of the Hamilton and Northwestern Railway, owned by the Grand Trunk, with which it connects at Stoney Creek and Burlington Junction. This, as is shown on the attached map, could give a cut-off for all through traffic between the Niagara frontier and Toronto points. The line is a single track, in poor physical condition, without any sorting yard at its eastern end, in which to separate local Hamilton from through Toronto traffic. In its present condition it is of little use to reduce the traffic congestion in the city.

Large yards, properly designed, are of prime importance for the expeditious handling of traffic. Both the Grand Trunk and Toronto, Hamilton & Buffalo are deficient in yard room in Hamilton.

The only large sorting yard which the Grand Trunk has is the one at Stuart Street. Its location is such that all freight from the Niagara frontier must be hauled through the city before the local can be separated from the through traffic.

The Toronto, Hamilton & Buffalo's only large sorting yard at Aberdeen Avenue is still more awkwardly located, as it is not even on its through line to Toronto and is on an adverse grade.

The prevailing railway conditions in Hamilton are, undoubtedly, the principal reason for the present congestion of traffic from the Niagara frontier, causing such a serious shortage of coal, which hampers the production of war and other materials.

Two new roads—the Canadian Northern and the Hydro-radials—are now seeking entrance to the city by a route shown on the accompanying map. Both roads appear to claim practically the same right-of-way.

The Canadian Northern has submitted plans and profiles, and has purchased much right-of-way.

Its profile shows one stretch of 6,000 feet of 0.6 per cent. uncompensated grade, equivalent to about 0.65 per cent. compensated, and another stretch of about 6,000 feet of 0.5 per cent. uncompensated grade, equivalent to about 0.55 per cent. compensated. Both of these grades are adverse to inbound Canadian business.

The Hydro-radial has also submitted plans and profiles, but the plan is on such a small scale, it is difficult to definitely locate it. Its location appears to be either exactly over the same ground as the Canadian Northern, or closely parallel. Its grades are practically the same as the Canadian Northern. We have no information as to what the Hydro-radial has done towards procuring the right-of-way.

As it is proposed to carry all the streets, except those in the industrial districts, either over or under the main lines, this route does about as little damage as could any entirely new line passing through a crowded, busy city. They would, however, add other east and west lines traversing the narrow and crowded strip upon which Hamilton is built. They cut the parks from end to end, and would require additional new sets of spurs to all industries, where two sets already exist.

The conditions would be bad enough if the two new roads should have a joint entrance. If on parallel independent lines, there would be required, including those now in existence, four independent sets of spurs to all industries, which would make traffic conditions intolerable.*

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*NOTE.—Messrs. Tye and Cauchon here include voluminous details of the three proposals.

Proposal "A," for new lines only, is to take all through freight traffic via Burlington Beach; to build new sorting yards east of Stoney Creek station and at Burlington Junction; to establish a common right-of-way for new lines parallel to the G.T.R.; to build a double track and electrify both lines; to depress the T. H. & B. connection with the new line and drill a short tunnel under the Hamilton-London line; to build a western yard for the use of all lines, and also a new central yard; and to build a new union head-on station at Cannon St.

Proposal "B" includes the above and the elimination of the Ferguson Ave. cross lines, and the construction of a loop station instead of a head-on station.

Proposal "C" includes the above and the concentration on one right-of-way through the city of all lines existing or to be built, thus removing the T. H. & B. from the southern part of the city. The T. H. & B. and all other roads to use a union station with depressed loop at King William Street, carrying Barton Street in a subway, and Cannon and Wilson Streets on bridges. This scheme includes the construction of a sea-wall along the harbor front and the reclamation of low-lying land for industrial purposes, with a comprehensive system of switching tracks to be operated by the terminal company.—EDITOR.

The first (Proposal "A") refers to entrance for new railways only, and is prepared on a basis whereby the city should not be obliged to contribute in any way to the cost.

The second (Proposal "B") refers to the entrance of new lines, and the elimination of the Ferguson Avenue cross-town line.

The third (Proposal "C") refers to the entrance of the new lines, and concentrating on one main line right-of-way through the city all lines existing and to be built.

We strongly recommend proposal "C" as the ultimate ideal towards which Hamilton must work. Much of it can only be accomplished by negotiation. It will be somewhat expensive, but if the two new roads built through the city and Toronto, Hamilton & Buffalo join in the terminal company, the expenses would be shared by four railway companies and the city, and so would not bear heavily on any one.

The advantages to the railway companies would be:

It will much reduce the cost of the entrances of new railways.

It will much reduce the operating expenses of the new railways and materially reduce those of the existing lines.

It will give the Grand Trunk an added income from the use of its spurs, etc., by the new companies.

It will give the railways ample yard room—which they now lack.

The use of the Burlington Beach line for all through traffic will much reduce the congestion in Hamilton, and permit the railway companies to handle more traffic between the Niagara frontier and all Ontario points.

It will cut out large grade separation costs which are bound to come in the future.

It will consolidate and improve the switching and distribution system, and permit them to give a better service at less cost.

The elimination of level crossings will increase the speed and safety of all passenger trains, and the railways will share in the greater development and prosperity of Hamilton, and the industries which will result from the better service.

The construction of a proper system of railway yards in Hamilton, and sending all through freight by way of Burlington Beach will in a great measure relieve the freight congestion from the Niagara frontier, which is now causing so much loss and inconvenience, not only to Hamilton, but to all southwestern Ontario.

The proposed entrance for new lines will not add a single level crossing in the city.

The consolidation of the switching system will do away with many duplicate spurs and level crossings in the industrial district, and it will restore Hunter Street and a portion of Ferguson Avenue to their rightful purpose.

The carrying out of the whole plan will eliminate all level crossings on Ferguson Avenue, on the Toronto, Hamilton & Buffalo main line, and on the Gage Avenue town line.

In this connection it is well to point out that any scheme of grade separation on the Toronto, Hamilton & Buffalo main line is bound to cause many streets to be closed, and many changes in grades of other streets, none of which will be advantageous to the city. Such changes would affect every through east and west street south of Main Street.

One union station centrally located would be a decided advantage to the travelling public over the present arrangement of two separate stations, one of which is very inconveniently located.

We have been asked to report on the effect of the new railway location on the entrance of the Toronto-Hamilton highway. We understand that two different solutions of the problem of carrying a highway across the deep ravines in the vicinity of the Valley Inn Road have been advanced. The one known as the Armstrong fill contemplates a construction of an embankment across the western arm of Burlington Bay, near the Valley Inn Road, connecting with the present subway under the Grand Trunk at that point.

The new railway will pass the mouth of this subway about highway level. This would necessitate all highway traffic emerging from the subway onto the level railway crossing, without a clear view in either direction. This would be so dangerous as to be intolerable.

Building the Armstrong fill high enough to permit of carrying it over the present Grand Trunk with a legal clearance would involve a fill of some 85 feet in height above water level, which would be uneconomical. We do not know if the advocates of the Armstrong fill have advanced any solution for the entrance of the roads from Guelph, Freelton, Waterdown, etc. The other proposal is to carry the Toronto-Hamilton highway over the western arm of Burlington Bay on the high-level bridge high enough to clear the tracks of the Grand Trunk Railway with the legal clearance, and to concentrate the roads from Guelph, Freelton, Waterdown, etc., and to carry them over the old outlet of the Dundas marsh on another bridge.

The new railway entrances would not interfere with this proposal, except that it would be necessary to plan a bridge across the western arm of Burlington Bay, so that its piers would not interfere with the new entrance.

We understand the estimated cost of these two bridges is $600,000.

Possible use of present roadbed of Grand Trunk as highway entrance.

Should the Grand Trunk join in with the new roads in building the improved grade from Burlington Junction to the Stuart Street station, as recommended, it would have no further use for its old roadbed from some point near Waterdown station to a point on the large fill at the old entrance to the the canal.

The old roadbed might be secured, the highway diverted to it, the large fill at the old entrance widened, and raised, at its southern end, and an exceedingly good entrance for the highway and roads for Guelph, Freelton, Waterdown, etc., obtained without the construction of expensive bridges.

The advisability of using this latter proposal would entirely depend on the time in which the new railway should be built, and whether the G.T.R. should join in its construction or not.

It would well solve the problem in a most economic manner, but it is obvious the highway could not wait a long time for the G.T.R. to change its lines.

Hamilton Railway Scheme for the Future, Say the Engineers

In a letter accompanying the above report, Messrs. Tye and Cauchon say that they do not believe any new railway entrances into Hamilton will be built for some time to come. "It is certain," they write, "that the existing companies neither could, would or should raise money for anything except necessities at the present time. It seems entirely unlikely that the Canadian government would permit the Canadian Northern to closely parallel the G.T.R. from Toronto to the Niagara frontier, at a

time when the government must assume such huge liabilities as the result of these roads paralleling and duplicating one another in other parts of Canada.

"It seems entirely unlikely that the Hydro-radials will build at this time when, if conscription goes into force, it would be impossible to obtain a sufficient supply of labor, and certainly inadvisable to withdraw this labor from other and indispensable work when the cost of everything going into the construction of a road is double that of normal times; when in view of the fact that existing roads are short of hundreds of locomotives and thousands of cars, and every locomotive and car works are busy on war orders for the Allies, it would be practically impossible to get rolling stock; when hundreds of miles of rails only laid a few years ago are being torn up and sent to France; when the money markets of England, France, United States, Belgium, Germany, and every other lending country are pre-empted by their own governments for war purposes; when it would be impossible to economically raise the money for its construction; or at a time when the cost of construction would forever double its fixed charges over and above those it would have if built in normal times.

"The first of the works outlined in this report to be carried out should undoubtedly be the construction of the Stoney Creek yard and the improvement of the Burlington Beach line.

"This is of such national importance that it may well be looked on as a war measure, and should be done at once. It would go far towards relieving the congestion of traffic from the Niagara frontier, and facilitate the supplying of coal, steel, etc., to munition factories.

"When the new roads are prepared to come in, Hamilton should insist that they follow the route outlined, and should vigorously press for the carrying out of various other works outlined."

SCREENING ROAD GRAVEL.

In order to give the best service under heavy travel, gravel must often be screened and sometimes is crushed before screening. Where the bank gravel does not contain pebbles too large to go into the road but has too much sand, as is often the case, road builders in Michigan have developed a method of screening out the fine material which deserves to be widely known.

At the gravel pit are kept a number of screens. Each is about 6 feet long and a little over 3 feet wide; the wire screen has three or four meshes to the inch and is held in a rectangular wooden frame. When a wagon reaches the pit the long side of a screen is fixed to one side of the body by means of hooks and supports holding it in an inclined position, with its bottom on the side board and the top about 3 feet higher and projecting over the ground. The gravel is shovelled from the pit and thrown across the wagon against this screen. The fine stuff passes through the meshes and falls to the ground and the part suitable for road building slides down the screen into the wagon.

According to the state highway commissioner, F. F. Rogers, it costs only a little over 20 cents per cubic yard to deliver screened gravel from the pit into the wagons, ready to be hauled to the roads, whereas it costs twice as much to screen it on a mason's screen and then shovel it into the wagons. As a method of obtaining screened gravel at a low cost from banks where large pebbles need not be taken out, it seems to have decided merit.—American Highway Association.

MONTREAL AQUEDUCT CONTROVERSY.

As reported in last week's issue of *The Canadian Engineer*, the ratepaying engineers of Montreal submitted a memorandum to the city, criticizing the report of Consulting Engineers Vautelet, McRae and St. Laurent. At the end of the memorandum are summarized the questions submitted verbally to the consulting engineers at a board of control meeting, and the engineers' replies. Following are some of the most interesting questions and answers as reported in the ratepaying engineers' booklet of comments:—

Does the first paragraph of "Recommendations" (page 41 of Report) signify that Project No. II is the one which the Board of Engineers formally recommended as a justifiable and true economic solution of the Aqueduct proposition as it exists to-day? Ans.—No.

Is it not a fact that the board recommend that no work be done in the tail race, that the plans for the hydro-electric power house should not be started, and that no work should be done in the head race rock section and easterly earth section, until a final decision has been reached and the source of power determined? Ans.—Yes.

If a final decision has yet to be reached as to choice of a project, is it not a fact that none of the five products considered by the experts has been recommended by them in their report? Ans.—Yes, because it is impossible to recommend on account of contractor having to be dealt with.

If the Project No. I. or II. is definitely recommended to us, why then does the Board of Engineers in contradiction to this, recommend that tenders be called for the purchase of power, and intimate in Article 3 of Recommendations that the source of power is yet to be determined? Ans.—The Board of Engineers cannot recommend any of the projects because they have no figures to go on from contractors. Wrote to power companies according to instructions from Mr. Villeneuve. When we have figures from power companies and contractors will then be able to form an opinion.

In Article 3 of Recommendations which of the five projects is referred to in speaking of changes and additions to the present contract (Cook Construction Co.) for which the experts recommend us to ask tenders from the contractor? What are the changes and additions referred to? Ans.—Paving of head race—extra six inches of concrete, and enlargement of tail race.

Is the board prepared to say definitely that all work necessary to complete the various projects can be done for the estimates given? Ans.—No, it cannot be done for the estimates given inasmuch as the prices have changed and are subject to change from day to day.

Should not the cost of the lengthening of the guard pier be added to the capital cost of projects No. I., II. and III., and omitted from projects IV. and V.? Ans.—No. No guard pier required. Later on when the scheme has been put into operation, the engineer of the city will be in a position to judge if it is advantageous for the city to extend the guard pier.

Why did the Board omit the cost of their bridges from the capital cost? Ans.—Because it has nothing to do with the canal itself. Cheap bridges could be built as formerly.

Is it not strictly obligatory, and an elementary rule in financial and industrial projects for the construction of public works to charge to the capital cost the amount of interest on the sums expended on the works during the execution or installation of same? Ans.—The report speaks for itself. We have added net charges.

Why did the Board recommend the paving of the head race, even if it were used for water supply only, and power purchased or produced by steam? Ans.—Simply stated that where walls were built the bottom should be paved to protect the walls.

Did the Board include this cost in the capital cost of Schemes I., II. and III.? Ans.—Yes.

An average consumption of 100,000,000 imp. gals. per 24 hours will not be required for many years, so that the amount of 8,570 h.p. will be only required in the distant future. Where, then, is the financial benefit or the economy for the ratepayers in executing project No. II., which will give us surplus power which we cannot use for pumping for a number of years, and will also increase the capital cost over present requirements by at least two million dollars, according to the figures of the report; will not the return still be disproportionate to the problematical advantages that have been suggested (the manufacture of ice)? Ans.—Necessary to look ahead many years, because power, electric or steam, will increase—40 to 50 years.

Which of the five projects is the one which the experts take the responsibility of recommending for execution? Ans.—After we have figures from the power companies and contractors we will be in a position to recommend a project definitely.

What has been considered "as the near future" by the Board when they refer on page 22, par. 4, to the probable time when the city will require to pump 100,000,000 imp. gals. for daily domestic supply? Ans.—Nine to ten years.

MONTREAL TO CANCEL COOK CONTRACT AND SUSPEND AQUEDUCT WORK.

During a conference held last week by the Montreal city controllers and representatives of the Cook Construction Co., contractors for the aqueduct enlargement, Controller Villeneuve, seconded by Controller Ross, gave notice of a motion to suspend the work and cancel the contract, on account of the high cost of labor and materials, the conditions of which will not become normal until after the war.

It was stated after the meeting by Controller Ross that the Cook Company had agreed that, in the event of the contract being cancelled, the company would not make any claims for anticipated profits.

Discussing the notice of motion after the meeting, Controller Ross said: "We propose to cancel the contract with the Cook Company, but we hope that with the return of better times the city will be in a position to carry out the scheme as modified by the consulting engineers.

"Owing to war conditions it is desirable to both sides to cancel the contract. As regards the city this is due to the difficulty of floating the necessary bonds in the present condition of the money market, and as regards the contractor there is the increased price of materials, the high cost of labor, and the difficulty of getting deliveries of steel and other material.

"Any further work done on the aqueduct will be for the purpose of securing an alternative water supply, as, in case the regular supply through the conduit becomes interrupted, we intend using the open excavation. The power developments we can postpone for the present, but it is necessary that we secure our water supply in case an interruption occurs."

Letter to the Editor

The Engineer: A Monk is He!

Sir,—The editorial on "Reconstruction and the Engineer" in your issue of July 5th was good reading. You state that "it is a mystery why the engineer is inarticulate." The engineer is acknowledged to have peculiar faculties for organizing. The first man to be called by Britain was Kitchener. France called Joffre, and the United States enlisted the services of Hoover—all engineers who were capable of doing great things. When the first great exhibition was to be held in London, Prince Consort was a most active worker, and at a meeting when the question was discussed as to who should be the organizer, the Prince insisted upon having an engineer. It is recognized that the engineer is the man who develops industries which employ millions; who utilizes the raw materials of a country, converting them into sources of immense wealth; who constructs railways under water, through mountains and up to their summits; who builds crafts which navigate under water, on the seas and in the air; who make machines which produce things for the people and others which wreak vengeance upon the ruthless enemies. But in the administration of the business of the nation, of which he is so active a citizen, he takes a very insignificant part. Is this not due to the conception founded upon the traditional attitude of the profession?

Some years ago, by invitation, I read a paper on "Engineering, Past and Present," at the last meeting of a society which was thereafter to unite with another, and advantage was taken to refer to the absence of cohesion among engineers. Almost every other profession and almost every craft have organizations to represent them in a more or less aggressive manner, but our societies are representative only so far as they are purely professional organizations to afford facilities for the exchange of technical information. Beyond that we are virtually a modern order of monks, ordained to a life of service, with unwritten observances with regard to worldly affairs apart from those relating to the profession. If we carry the analogy further, we will find much that is common between the engineer-monk of to-day and the Benedictine monk of old. Study, work, worship, silence, humility, obedience, retirement, self-abnegation, and so on, are articles of faith which, more or less, belong to both orders, although the essential basic ideals are somewhat dissimilar.

Civilization owes much to the monks for their contribution to, and their preservation of, the best of literature, art, science and music. Civilization is also indebted to engineers for the marvellous developments which are due to their devotion to work. But monks, nevertheless, failed to give the world the fullest measure of their usefulness and their talents, and, moreover, monarchism and asceticism may have had their places in the early ages when conditions were so different, but it must now be recognized that they are out of date, and can render vastly more service to the people by uniting with the people instead of withdrawing from them.

The traditional attitude of engineers as a corporate body with respect to national politics is somewhat anomalous. Our voices are seldom heard on any question of importance. We know that the legal profession and

the medical profession take a more active part in politics, but engineers seem to be aloof from the world of politics, by which I mean statecraft and not partisanship. We have no representatives at Ottawa, and very few, if any, in the provincial parliaments. What wonder, then, that engineers are not reckoned upon as a power that ought to be strong and active, but whose strength is lost by the absence of co-ordinated cohesion.

What is it that engineers could do in the sphere of politics? Should we not have the departments which control railways, canals, harbors, water-powers, municipal governments, city planning, etc., under a political head who is an engineer? It is irrational to expect great spending and administrative departments to be intelligently represented by men who probably had previously never been within the precincts of such offices, or who had never given the problems any consideration. It is difficult to see how great schemes for the advancement of technical development of the country can be adequately handled by men who have neither the training nor the trend of mind to measure the advantages and disadvantages. Yet this is what occurs. Why are engineers silent observers and not the actors in the national theatre of our land? It would seem as if we were obsessed by the traditions set by our forefathers, which have become idols and require some iconoclast who has sufficient nerve and confidence to demolish them.

R. O. WYNNE-ROBERTS,
M.Can.Soc.C.E.

Toronto, July 9th, 1917.

PITTING OF WATER TURBINES.

In a paper read last February before the Western Society of Engineers, Prof. S. J. Zowski, of the University of Michigan, states that the designer of water turbines has control over pitting to a great extent. Even though the designer cannot do away with it entirely in every case, he says, it can at least be reduced to a minimum by observing the following rules in the design of the turbines:—

1. Avoid small bucket angles altogether in high head turbines and do not allow the angle under which the water approaches the runner to be very large.

2. Do not place the turbine any higher above the tail race than is absolutely necessary.

3. When designing low head runners which you may want to use at different occasions and under different conditions, use the largest bucket angles possible.

4. Do not design the buckets and guide vanes with an exaggerated parallelity at the ends; rather introduce a slight nozzle effect so that the flow will be accelerated throughout.

5. Make the guide and bucket vane tips pointed so that the eddies will be as short as possible.

6. Make the guide vane ends as thin as consideration of strength and building will allow.

7. Place the guide vanes far enough from the runner to allow the streams to join into a ring before they enter the runner.

8. Avoid all sharp turns and depressions. Check the design of the runner surface carefully to determine whether there is a throttling effect, which should be avoided absolutely. Do the same after the runner is built.

9. Examine the guide vanes in different positions and make sure that there is no place where the opening is smaller than at the discharge point.

The intensity of pitting depends also on the potential which we get from other causes than simple chemical action. We can, therefore, counteract pitting by removing these causes if it is possible to do this. Thus:—

1. We should try to get castings as homogeneous as possible, both in chemical and physical structure, and also as free of impurities as possible.

1. Where pitting is liable to occur, the parts should be machined all over. Finishing, like any other strain, changes the physical structure of the metal, and, therefore, partial finishing causes potential—even scratches and blows will do it.

3. The castings should be designed and moulded in such a manner that uniform cooling is secured. Strains due to unequal cooling will create potential.

DEVELOP WATER POWER TO SAVE COAL.*

By Leo G. Denis, B.Sc.,
Hydro-Electric Engineer, Commission of Conservation.

Canada depends upon the United States for a large portion of her coal supply both for domestic and industrial purposes; she is therefore much interested in the coal conditions obtaining there. A recent communication from Secretary F. K. Lane, of the U.S. Department of the Interior, shows how acute the situation has been made by the entrance of our neighbors into the war. One of the remedies urged, particularly applicable to Canada, is the immediate conservation of fuel by the efficient use of all available water-power.

Elimination of unnecessary consumption of coal is considered a problem of national interest and of immediate concern. New power requirements should therefore be met, so far as practicable, by utilization of hydro-electric energy; this would also apply to present steam-generating energy consuming coal or oil in its production.

Thus, all water available at water-power plants should be utilized to produce energy up to the capacity of the works and the requirements of the population and industries within transmission distance of the site; every facility should also be given for the efficient development of new sites. In regions where water-power can be made available, steam power plants should be operated only to carry loads in excess of those that can be carried by water-power plants.

The adoption of this course, in many cases, would mean cheaper operation, particularly in view of the rapidly increasing price of coal.

Every additional hydro-electric horse-power used in Canada means the yearly liberation of from 10 to 12 tons of coal for domestic heating or other purposes where hydro-electric energy cannot be so effectively substituted.

*From "Conservation."

The Lyman Tube and Supply Co., Limited, are now in their new building, 10 Ste. Sophie Lane, Montreal. It is a five-story and basement reinforced concrete structure. The basement is used as a machine shop; the first floor as a stock room for steel tubing; the top floor as offices; and a portion of the remaining space as stock room for railway supplies, hoists, etc., while the remainder of the space will be rented.

DESIGN OF A RAILWAY TANK.*

THE design of a modern railway tank is, on the whole, a simple problem, but it involves a few very interesting points, not found in any other structure, that are well worth consideration.

A 50,000-gallon elliptical bottom tank 20 feet to the bottom will be taken as a typical example and the design investigated.

Tank.

The shell or straight cylindrical portion of the tank is designed by the well-known stand pipe formula,

$$t = \frac{2.6 \times H \times D}{S \times E},$$

in which

t = thickness of plate in inches.
H = head of water, or height of shell, in feet.
D = diameter of tank in feet.
S = unit stress in plate in lbs. per sq. in.
E = efficiency of joint.

Assuming a plate thickness of one-quarter inch and substituting the values given in the accompanying diagram gives a unit stress of 6,660 lbs. per square inch.

The thickness of plate in the tank bottom is given by the approximate formula.

$$t = \frac{2.3 \times H \times D}{S \times E}$$

which, with the correct values substituted, gives a unit stress of 8,220 lbs. per square inch.

Quarter-inch plate is ample in thickness for the mud drum and gives, according to the first formula, a stress of 5,130 lbs. per square inch in tension, and figuring the maximum possible amount of water that could be carried on it as a column, a stress of 5,000 lbs. per square inch in compression.

Tower.

The tower is subject to three loads—water, wind and metal.

The water load on each post is equal to one-quarter of the difference between the total weight of water in the tank and the weight of the portion supported by the mud drum. This mud drum, or riser, acts as an additional column at the centre of the tank. In the absence of an exact mathematical determination of the load on the mud drum we may get some idea of its ability to carry this load by comparing it to a flat flexible plate 22 ft. in diameter supported at its outer edge, and at the centre by a ring 6 ft. in diameter. Consider a sector of this plate similar to a sector of a circular roof between adjacent trusses which is subject to a uniform load per unit of area. The total reaction at the large end of this sector is 1.47 times the reaction at the smaller end on the 6-ft. supporting ring. On this basis, exclusive of the 6-ft. cylinder of water at the centre of the tank, the mud drum carries approximately .4 of the water in the tank, or all the water within a cylinder 14 ft. in diameter. As the comparison is not exact, and furthermore, as the bottom is made heavy enough to carry all of the water regardless of the mud drum, we may safely say that the mud drum acting as a column can be relied upon to carry a cylinder of water 4 ft. larger than its own diameter. The water load shown on the diagram is computed on this basis.

The metal load is one-quarter of the total weight of the structure less the weight of the mud drum, shoes and anchors.

The wind load on the tank is assumed at 15 lbs. per square foot of projected area, or 6,800 lbs., and acts at the centre of gravity of the area. The wind load on the tower and riser is assumed at 200 lbs. per vertical foot, one-half of which, or 2,560 lbs., is considered acting at the top of the columns. The other half of the total tower load acts at the base, and may be disregarded as it has no effect on the stresses in the members.

The wind stresses may be determined easily by the graphical method. The stress diagram given has been drawn using the total loads, or loads for both sides of the tower, consequently the true stress in the rods with the wind blowing from direction A is one half of that given by the diagram. The maximum column stress is .707 times the value obtained from the diagram, which may be easily proved by taking moments about a line intersecting the axis of the tower and perpendicular to the direction of the wind.

Columns.

For the columns, or posts, two channels 10 ins. x 15 lbs. give a comparatively low unit stress; 12,850 lbs. per square inch and an $\frac{L}{R}$ or slenderness ratio of 79.

Rods.

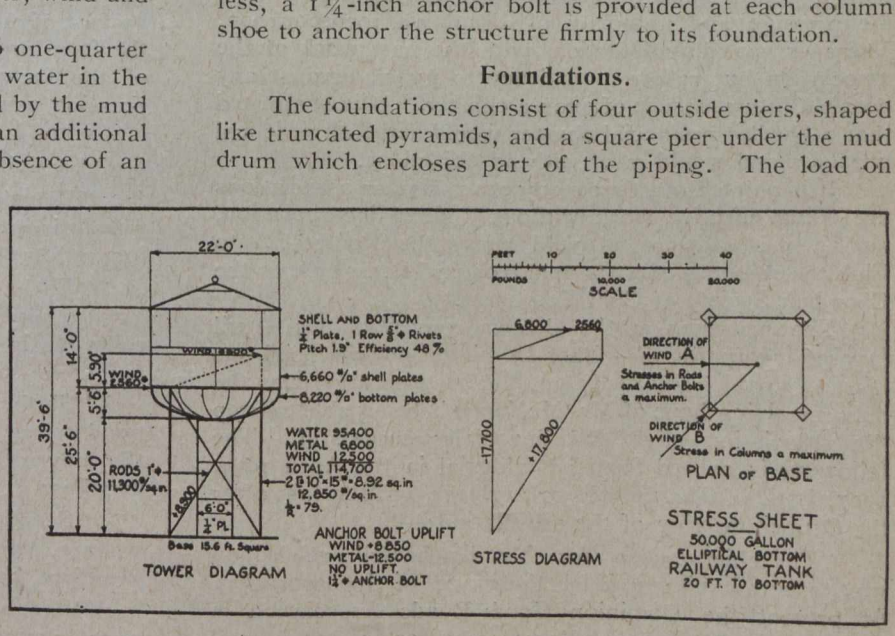
The diagonal tension members, which receive their maximum stress only when the wind is blowing at a very high velocity, consist of 1-inch diameter rods, and the greatest unit stress to be expected is 11,300 lbs. per square inch.

Anchor Bolts.

There is no uplift on the anchor bolts. Even when the tank is empty the weight of the metal is enough to absorb the tension in the windward column. Nevertheless, a 1¼-inch anchor bolt is provided at each column shoe to anchor the structure firmly to its foundation.

Foundations.

The foundations consist of four outside piers, shaped like truncated pyramids, and a square pier under the mud drum which encloses part of the piping. The load on each of the four outside piers consists of the maximum column load plus the weight of the concrete. The centre pier carries the weight of the mud drum and all the water it supports. For average soil conditions a unit bearing pressure of 3,600 lbs. per square foot is a conservative value. The piers should be large enough at the base so that this figure is not exceeded. A total depth of six



*From "The Water Tower," published by the Chicago Bridge & Iron Works.

feet is ordinarily sufficient to carry the foundations below the frost line. For this tank the four outside piers should be six feet square at the base and the centre pier from seven to eight feet square.

ONTARIO OPPOSES ROAD ASSOC. CHARTER.

The province of Ontario is opposing the incorporation of the Dominion Good Roads Association, which has applied for a Dominion charter, according to an announcement by W. A. McLean, head of the Ontario Provincial Highways Department, and past-president of the association.

The province considers that roads are subject to provincial control and that any organization having for its purpose the education of the public in regard to the good roads movement, should be incorporated under provincial charter. It looks upon the Ottawa bill as an infringement of provincial rights of incorporation.

The bill came before the House last Friday, and was referred back to committee so that the objections of the provincial government might be reviewed.

J. Duchastel, city engineer of Outremont, is the president of the association, and Geo. A. McNamee, of Montreal, secretary. The association has already held four annual conventions and exhibitions, the first in Montreal, the second in Toronto, the third in Montreal and the fourth—held in April, 1917—in Ottawa. Mr. McLean was president of the association the year the convention was held in Toronto. Mr. Duchastel was president last year and was re-elected at Ottawa.

The stand taken by the Ontario officials indicates a big split in the association. There is no fight between Ontario and Quebec interests for control of the association, but rather a feeling of doubt among some members of the association in both provinces as to whether it is wise to confer upon the association, as now constituted, the prestige and authority of Dominion incorporation. There is no dissatisfaction with the past work of the association but rather a tendency to guard against any possible future misuse of such a charter. It is suggested that a Quebec provincial charter would serve all practical purposes and would meet with no objections.

It is pointed out that many other similar associations are doing effective work without Federal incorporation, and there is a desire to avoid giving the Montreal Auto Club the standing of a national technical body such as the Canadian Society of Civil Engineers.

The sentiment at the Ottawa convention last April favored incorporation—either Dominion or provincial—as it was generally admitted that such incorporation was the only remaining hope of Mr. McNamee's being able to keep the association alive and financially successful. The following is quoted from an editorial in the April 19th, 1917, issue of *The Canadian Engineer*, written just after the Ottawa meeting of the association:—

"The chief reason for Mr. Duchastel's re-election was to permit him to finish the work of incorporation. At present the Dominion Good Roads Association is largely a myth. It has officers and directors but no roll of membership, no by-laws, no official prestige and no legal existence. It has 'carried on' entirely on good-will —largely the good-will of the manufacturers who have most generously supported the exhibitions, often at very great cost.

"This condition of affairs could not continue. The number of exhibitors and the size of the exhibits appeared to decrease each year. This year there was almost the irreducible minimum of exhibits despite the efficient and energetic work of Mr. Leach, the superintendent of the exhibition. It was seen that some other mode of support would have to be found if the congress were to be continued. It was decided, therefore, to incorporate the association under Dominion charter, and to have a paid membership list.

"Fees will probably range from $1 a year for ordinary members to $100 a year for manufacturing members. This will distribute the cost of the propaganda more equitably and will give everyone a chance to pay toward the good work, making the congresses more independent of the support of exhibiting manufacturers."

The Ontario protest has been lodged with the best of good-will toward the association, it is said, but upon broad principles that are far-reaching, and the result will likely be the withdrawal of the application for Dominion charter and the securing of a provincial charter instead, which would restore harmony to the association.

ROAD BUILDING RESOLUTIONS.

A large number of persons engaged in many professions and callings recently met at Columbus under the auspices of the Ohio Good Roads Federation and after a discussion of business conditions in both city and country adopted the following concise statement of reasons for continuing road work:—

"Whereas, first, the efficiency of our industrial, commercial and agricultural activities should not be lessened or handicapped by war hysteria;

"Second, our financial resources are in a healthy condition, no stringency in the money market exists, there is ample employment at good wages for all labor, the agricultural districts promise an unusual acreage and harvest yield, every pound of meat and bushel of grain the farm produces can be sold at profit prices, and none of the factors that usually contribute to business depression now exists;

"Third, any policy of government that retards any useful activity will correspondingly harm other industries;

"Fourth, one great economic need of the farm and farmer is improved highways that will assist in transporting products of farm, field and garden to the market.;

"Fifth, freight congestion in great centres of traffic creates imperative need for good highways to supplement railroads in transporting the products of the industrial and commercial world.;

"Sixth, the war in Europe has demonstrated that good roads are powerful adjuncts in national defence in the movement of armies, war munitions and all military supplies;

"Seventh, good roads are important factors in rural welfare, contentment and vitalizing of rural America; therefore, be it

"Resolved, that this conference urge the national and state administrations, state highway department, county commissioners, county surveyors, township trustees and municipal councils to adopt and go forward with a vigorous, progressive road building program. We commend all county commissioners and road builders who have gone forward in road building and are doing their utmost to place Ohio in the lead in the improvement of highways."

FLUSHING—ITS PLACE IN THE STREET CLEANING FIELD.

By Raymond W. Parlin,
Engineer with the New York Bureau of Municipal Research.

[In *The Canadian Engineer* for March 15th, 1917, there appeared an article under this title which dealt with hand flushing methods. The present article is devoted particularly to mechanical flushing equipment.—EDITOR.]

THE various types of mechanical flushing equipment which have so far been produced may be listed approximately in the order of their development as follows:—

1. Ordinary sprinkling wagons operating with their valves wide open.
2. Horse-drawn flushers utilizing air pressure.

Fig. 1.—Two-Motor System Combination Power Flusher and Sprinkler.
Note the Sprinkling Nozzles in Front, Which Wet the Dirt Ahead of the Flushing Nozzles; also the Adjustable Nozzles in Front and at the Side, Which Carry Dirt to Catch Basins or Deposit It at Intervals at Operator's Will.

3. Horse-drawn flushers equipped with gasoline-driven pumps.
4. Automobile flushers with either plunger or centrifugal pumps driven directly from the automobile engine, separately driven, or driven by means of an electric motor which secures its power from the engine, or in case of an electric automobile directly from the storage battery.
5. Trailer machines which may be attached to an automobile tractor.
6. Equipment for street railway work, the development of which has been as follows: (*a*) Ordinary street railway sprinklers with valves wide open; (*b*) special flushing cars with rigidly attached nozzles supplied with pressure by a pump; (*c*) special flushing cars with a flushing nozzle attached to a swinging arm which enables the car to clean a wide street.
7. Combination equipment, such as a flusher and squeegee mounted either on an auto truck or tractor and trailer.

The size of the tank carried determines the distance which the machine can travel per filling. This means that larger tanks, by saving time in loading, will enable the equipment to cover more area per shift. At the same time, the size and weight of the equipment and the operating expenses are increased. Just what the economic limit in tank size is has not as yet been determined, but 1,200 and 1,500-gallon tanks are at present most commonly used on automobile equipment and 750-gallon tanks appear to represent the maximum size for horse-drawn equipment. The limits of size for tanks on trailers and street railway cars are considerably higher.

Basis for Comparing Results.

Each type of equipment has its own characteristics. Assuming that several types are physically adaptable to local conditions, the problem which confronts public officials is that of choosing the particular type and method of using equipment which will most efficiently and economically perform the work under local conditions. This generally boils down to the question of what type of equipment will do satisfactory work at the least cost.

Elements Affecting Costs.

The more important elements which affect flushing costs are given below:—

(1) The quality of work required; (2) the condition of the pavement; (3) the length of the working season in days and shifts per day; (4) the rates of pay for employees and teams; (5) the cost of supplies and water; (6) the type of equipment.

Standards of Quality Needed.

Standards of measurement have not yet been developed for the work of street cleaning. It is evident that a measure must indicate the relation between the quantity of dirt remaining on a given area of street after cleaning, to the quantity present on the same area prior to cleaning. It is also evident that until it is possible to measure the quality of work, the comparative results can only be expressed upon an arbitrary basis or measured by personal judgment. An interesting step in the direction of a generally applicable standard of measurement has recently

Fig. 2.—Auto Flusher. Note the Special Flushing Head Carrying Fine Nozzles.

been made by the efficiency department of the city of Los Angeles, Cal. This is as follows:—

"On each route a section of street was selected for use in determining the percentage of dust removed by flushing. The section selected was 50 feet long and free from visible litter. Its width was the width of the street (or that part of the street which was flushed) less a gutter strip at each curb. The gutter strips were excluded from the test area because of the deposits that might occur in them from the flushing of other sections of the street, and because usually they would not be dry in time for a proper completion of the test. The test area was divided into five equal sections, each 10 feet wide. Assume them as numbered consecutively, 1 to 5. Sections 1 and 5 were cleaned very carefully before flushing as late in the evening as was possible, to avoid interference from traffic and to approximate as closely as possible the street condition at the time of flushing. Soft, fine-haired push brooms were used. The sweeping was carefully and thoroughly done and the cleanings were collected and so marked as to identify the section of their origin.

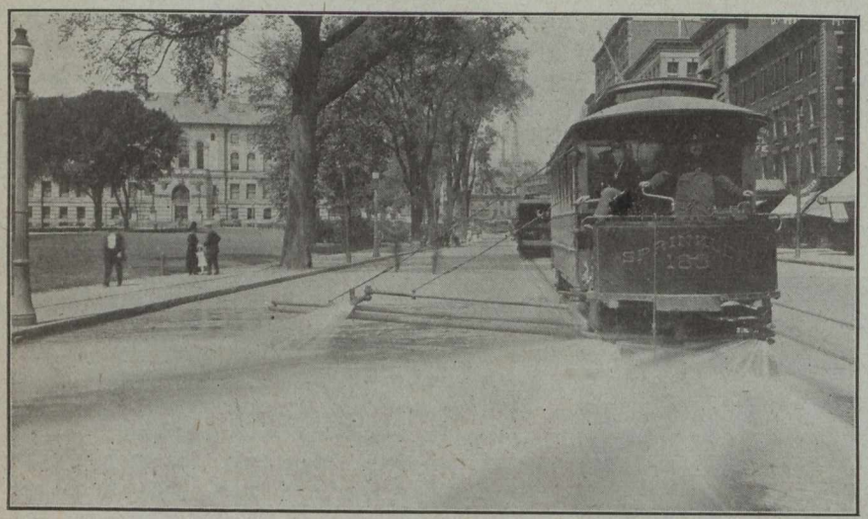


Fig. 4.—Street Railway Flusher. Note Swinging Arms Carrying Nozzle which Enable Machine to Clean Wide Streets.

"Early the following morning, after the street had been flushed and had dried out, and before the regular hand-sweeper and the full flow of traffic had come on, Section 3 was cleaned in the same manner. Sections 2 and 4 were not used except to provide areas contiguous to Section 3, which would correspond to the rest of the street.

"The materials collected were carefully weighed and screened. The average of the collections from Sections 1 and 5 was used as closely approximating the weight and composition of dirt on Section 3 before flushing. The weight and composition of dirt on Section 3 after flushing was obtained by direct experiment as explained above."

The quality of cleaning by the flushing method is very largely dependent upon the number of trips which a machine makes over a given area, or the amount of time which is spent on this area. In some cities it is the practice on dry days to give the pavement a preliminary sprinkling before flushing with the view to loosening the dirt from the street surface. Other cities, in cleaning streets thirty to forty feet wide, flush the whole street in a single trip. Perhaps the most general practice on streets of this width is to complete the flushing in four trips through the street, which means that a strip eight to ten feet wide is cleaned each trip.

Defective Pavements Increase Cost of Cleaning.

Poorly designed pavements or those in poor repair will increase the cost of flushing in two ways: First, by forcing the equipment to spend more time in cleaning a given area or to travel more times over the ground to secure a thorough cleaning, and second, by increasing the cost of repairs and reducing the life of the equipment by exposing it to unreasonably hard usage.

Small cities which do not have over 40,000 square yards of hard pavement to clean each day can better afford to use hose equipment if hydrants are close enough together and plenty of water is available. If local conditions prevent the use of hose then horse-drawn equipment is economical if only flushing is required. If both flushing on the hard pavements and sprinkling on the macadam or gravel streets is desired, the automobile appears to be by far the most economical equipment.

In large cities there appears to be no doubt that the automobile and street car equipment are the most economical perhaps with the possible exception of those small or inaccessible areas which the larger equipment cannot reach. On such areas hose equipment can well be used as auxiliary to the machines.

Wherever the city has areas of more than 120,000 square yards on street railway streets, the street car equipment should be economical. Wherever the street car franchise provides for the sprinkling of the right-of-way the adoption of this type of equipment is especially to be desired; first, to eliminate sprinkling, and second, to replace it by flushing, which is greatly to be preferred.

Fig. 3.—Automobile Squeegee.

Fig. 5.—Auto Flusher. Note Fixed Nozzles and Sprinkler Heads.

Fig. 6.—Another Type of Auto Flusher.

Fig. 7.—Two-Motor System Combination Power Flusher and Sprinkler, Complete with Electric Lighting and Starting Equipment; 1,200-gallon Tank.

Wherever such franchises exist it should be possible for the municipality and the street railway company to enter into an arrangement which will be of benefit to both. The costs of street cleaning should be reduced and if really effective sprinkling of the railway area has been provided, the expense to the traction company should be reduced as well.

WORK OF CANADIAN RAILWAY TROOPS AT THE FRONT.

The Government has received from General Headquarters in France the following summary of the work of the Canadian railway troops for the month of April:—

Broad-gauge Lines—

Miles located	44·75
Miles graded	36.25
Miles grade repaired	43·55
Miles track laid	51.50
Miles ballasted	46.45
Miles surfaced	43·67
Average number of miles maintained	60.70
Average number O. R., C. R. T. daily on construction	1,597
Average number O. R., C. R. T. daily on maintenance	686
Casualties from shell-fire, officers, nil; O. R.	7
Average number of British unskilled labor attached	2,660

In most cases these lines were laid over the remains of old metre gauge lines, which tended to hinder rather than help the work. Owing to the destruction of the lines by the enemy it was necessary to do a considerable amount of bridge work.

Narrow-gauge Lines—

Miles located	57·58
Miles graded	64.98
Miles grade repaired	28.74
Miles track laid	72.89
Miles ballasted	77.84
Miles surfaced	49.63
Average number of miles maintained	100.06
Average number O R., C. R. T. daily on construction	2,504
Average number O. R., C. R. T. daily on maintenance	1,258
Casualties from shell-fire, officers, 3; O. R.	75
Average number of British labor attached	3,276

Weather conditions during the beginning of April were bad; in many cases, building of narrow-gauge railways was carried out under shell and machine-gun fire, the former necessitating constant patrolling and repairing.

According to a Professional Paper, issued by the United States Geological Survey, there are many seams in the great coal fields in the Western States which at one time or another have become ignited, and have burned along their outcrops, making the overlying strata into terra cotta, and in places fusing and re-crystallizing the shale and sandstone cover into a kind of natural slag. The burning, which in some cases may have been produced by lightning, in others by prairie or camp fires, has been so common as to affect most of the coal seams in an area of more than 200,000 square miles.

CEMENT JOINTS FOR CAST-IRON WATER MAINS.

IN *The Canadian Engineer* for May 24th an abstract of Clark H. Shaw's paper on "Cement Joints for Cast-iron Water Mains" appeared. The following discussion of this paper, which is taken from the Proceedings of the American Society of Civil Engineers, will be of interest:—

Harry Y. Carson, Jun.Am.Soc.C.E. (by letter).—It would be a valuable addition to engineering literature if some one were to compile a comprehensive and authoritative paper or thesis on joints for cast-iron pipe. Much has appeared in the technical press, as well as before technical societies, with reference to the leakage of water and gas from underground mains, but, obviously, not enough has yet been done to bring about a general improvement in the prevention of these large percentages of wasted water and gas. This paper is a valuable contribution to such literature as now exists.

The causes for the normal leakage at joints in mains may be classified as follows: (1) Contraction and expansion; (2) unequal settlement; (3) vibration and shock.

A fourth cause may be corrosion, but a very able paper entitled "External Corrosion of Cast-Iron Pipe," by Marshall R. Pugh, M.Am.Soc.C.E., points out that deterioration in cast-iron pipe, as compared to other materials, is practically nil; that the oldest cast-iron pipe, flanged, and in 1-m. lengths, put into service more than 250 years ago has shown no appreciable loss in wall thickness or strength, and that: "experience has not been sufficiently long to establish just what its life is." The chief consideration for cast-iron pipe, therefore, may be said to centre about the type of joint best suited to prevent waste through leakage.

Contraction and expansion exist in all mains, and vary in direct proportion to changes in the temperature of the pipe line. The movement caused thereby, though slight, and scarcely ever exceeding 2 ins. per 1,000 ft., is absolutely irresistible, and its effect must be taken care of properly, or disaster is sure to result. No material is of sufficient strength to resist its power if rigidly maintained against it. Contraction and expansion produce by far the greatest proportion of normal leakage in mains. Because of its inelasticity and fragility, cement, as a material for jointing cast-iron pipe, has always been questioned. This in spite of the fact that it is very cheap.

The author makes the following statement: "Long Beach now has 60 miles of cast-iron water mains, * * * laid with joints of this (cement) type. All these pipes are under pressures ranging from 40 to 80 lbs. per square inch, and are giving perfect satisfaction."

He presents no data, however, by which the satisfactory performance of the line may be measured, as he has not submitted any information as to tests made for leakage or figures as to its quantity. Manifestly, without this information it is difficult to see how the line can be stated to be perfectly satisfactory.

The principal advantage of bell and spigot pipe when packed with lead lies in its ability to take care of the always existent contraction and expansion at its joints, without fracture. Cement joints may reduce the number of joints actually leaking, but rigidity is increased to such an extent that there may result an increasing number of fractures at those points. The net leakage with cement joints, however, is probably not materially different from lead.

Flanged jointed pipe, in order to withstand expansion and contraction, must have expansion joints at very frequent intervals.

Regardless of the kind of jointing material used, the unequal settlement of a pipe line may cause normal leakage as well as breakage, with extraordinary leakage. Damage ensues from settlement almost in direct proportion to the relative rigidity of the joint. Flanged pipe is particularly unsuited to conditions where unequal settlement prevails as is the case in the down-town or business districts of cities, where the streets are so frequently torn up.

Vibration and shock are exceedingly deleterious to joints which are rigid, and here again the pipe line suffers in direct proportion to its rigidity. The general results are similar to those caused by unequal settlement. Moreover, main leakage will increase as the system gets older, on account of the loosening of the joints, through contraction and expansion, settlement, and vibration.

A pipe joint in which packing materials of every character are entirely eliminated, so as to have a ground metal-to-metal connection, should give the most desirable results of all. Joints of this construction have now been in successful service for more than 15 years; and their more general adoption will proceed from the excellent results which have been obtained from their use for cast-iron mains. In joints of this type the bell and spigot ends of the pipe are machined at slightly different tapers, so that, when entered in a tight manner, the line may settle without leakage. Such a pipe line is capable of taking a rough contour over the trench bottom, or of assuming a comparatively small radius on any change of alignment.

Without the slightest leak whatever, pipe and fittings made with the machine flexible joints have been used successfully to convey hot water and fluids, such as steam, where the maximum expansion and contraction would be expected.

Furthermore, cast-iron pipe in which all jointing material is eliminated gives an ideal line. It cannot fail by subsequent deterioration of the joining material. For instance, there are many alkaline soils where cement is quickly attacked by chemical action, which, however, does not corrode the pipe itself. Moreover, such materials as lead, oakum, and cement, by virtue of their resistance to stray electric currents, are known to increase the damage to cast-iron mains, that sometimes follows the improper return of electric currents from trolley car systems.

In so far as settlement and vibration or shock become effective factors in causing leakage from cement and lead joints, or from flanged joints due to breakage in the latter, no leakage has resulted from proper metal-to-metal joints, and records have repeatedly shown that such joints have withstood successfully and without failure the most severe conditions known in practice.

F. M. Randlett, Assoc.M.Am.Soc.C.E. (by letter).—This paper is of added interest to the writer as the Water Department of Portland, Ore., has been experimenting with cement joints for the past year.

During 1916, there were laid 1,910 ft. of 8-in. and 362 ft. of 12-in. cast-iron pipe with cement joints, with the most satisfactory results.

For the purpose of investigation, and to illustrate the manner of using the materials, three lines of 8-in. cast-iron pipe were laid, according to the specifications of the New England Water Works Association, as follows:—

Line No. 1. Neat cement joints; 3.5 lbs. per joint; some waste; cement joint about 3 ins. deep.

Line No. 2. Leadite joints; 4 lbs. per joint; 2 ins. of leadite.

Line No. 3. Pig lead joints, caulked; 13.11 lbs. per joint; 2 ins. of lead.

Each line consisted of eight full lengths, with the four centre lengths arranged so that their supports could be removed.

All were laid approximately level, and were plugged and subjected to 85 lbs. internal water pressure continuously after completing and setting the joints.

The two end lengths of each line were braced securely, and were supported and weighted down with fifteen lengths of 8-in. cast-iron pipe laid across the three lines on each end.

Batter boards were set up over each of the five joints, and a centre-punch mark was put on the pipe under the centre line mark for each line on the batter boards. A flat space was filed on each length before being centre-punched, and all measurements were taken later between the pipe and the batter boards at these points.

Several observations were taken from time to time, but Tables 3 and 4 show the results of the tests as completed. Line No. 1 was loaded with 200 lbs., placed at the centre of each length after the supports were removed.

Line No. 2 developed leaks at once, but not until one or two of the joints had pulled out considerably were they in such a condition that recaulking would not have been sufficient to stop the leaking entirely.

Line No. 3 developed leaks at several joints, varying from a fine stream to a slow drip. All these leaks had practically stopped at the time of the last observation.

Table 3.

Pipe.	Line No. 1.		Line No. 2.		Line No. 3.		Remarks.
	No.	Weight, in pounds.	No.	Weight, in pounds.	No.	Weight, in pounds.	
a.....	2505	553	1826	550	1251	580	
b.....	2101	593	1227	571	1270	560	
c.....	2135	563	1322	566	1217	570	Suspended lengths.
d.....	533	565	1300	570	1329	560	
e.....	2439	574	1267	562	1775	582	
f.....	2526	566	455	560	903	577	
g.....	1751	570	2390	567	884	579	
h.....	2862	566	2220	570	1753	581	
Averages..	.....	567.5	.....	564.25	.....	573.625	

Table 4.—Joint Tests. Measurements on Observation Points.

The First and Last Measurement in Each Observation is on the Fixed Pipe at Each End of Each Line.

Distances, in feet, from Batter Board to Top of Pipe.

	Date: 4/24/16	Date: 5/10/16.	Difference.	Distance, in feet, from point to point along center line of pipe.	Moved.	Location of punch mark.
b—1	0.855	0.942	0.097		0.006 West	0.82 East of bell.
b—2	0.818	0.907	0.089	.....	0.075 "	0.77 " " "
b—3	0.781	0.825	0.034	.....	0.010 "	0.75 " " "
d—1	0.873	1.259	0.386 *b* to *d*	13.71	0.009 West	0.82 West of bell.
d—2	0.844	2.350	1.506 *b* to *d*	13.71	0.06 "	0.95 " " "
d—3	0.790	1.480	0.690 *b* to *d*	13.73	0.015 "	0.92 " " "
e—1	0.870	1.360	0.490 *d* to *e*	11.97	0.01 N. E.	0.81 West of bell.
e—2	0.880	2.988	2.158 *d* to *e*	11.975	0.015 West	0.85 " " "
e—3	0.812	1.760	0.948 *d* to *e*	11.98	0.010 East	0.75 " " "
f—1	0.802	1.160	0.358 *e* to *f*	12.285	.....	0.97 West of bell.
f—2	0.782	2.217	1.435 *e* to *f*	12.36	.....	1.155 " " "
f—3	0.770	1.401	0.631 *e* to *f*	12.45	0.015 East	1.175 " " "
g—1	0.847	0.890	0.043 *f* to *g*	12.72	0.001 West	1.62 West of bell.
g—2	0.812	0.843	0.031 *f* to *g*	12.63	.....	1.725 " " "
g—3	0.758	0.792	0.034 *f* to *g*	12.52	.....	1.62 " " "

Supports removed after first observation.

Line No. 1 has developed absolutely no leaks, even under the additional load of 200 lbs. per length. Lack of time has prevented loading and observing the effect of such loading to destruction of the pipe or joint. This will be done later.

Fig. 1 shows how the three mains were laid. The letters refer to the length of pipe under which they appear. The punch marks were lettered according to the length of pipe on which they occur, and the joints were lettered according to the length of pipe containing the punch mark. The longitudinal distance was measured from punch mark to punch mark.

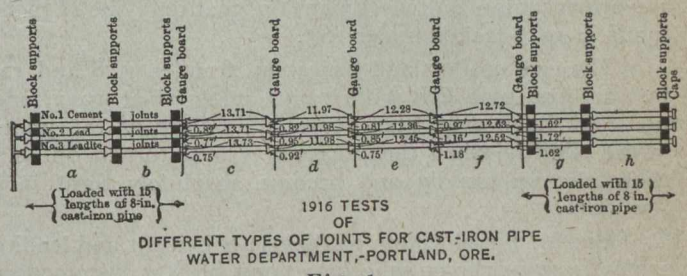


Fig. 1.

The cost per pound of the joint material was: Hemp, $0.03; lead, $0.09; leadite, $0.12; cement, $0.0055.

The cost per joint for material was about as follows:

Line No. 1—
Hemp, 0.20 lbs. at $0.003 ..... $0.006
Cement, 3.5 lbs. at $0.0055 ..... 0.01925
$0.02525

Line No. 2—
Hemp, 0.45 lbs. at $0.03 ..... $0.0135
Leadite, 4.00 lbs. at $0.12 ..... 0.48
0.4935

Line No. 3—
Hemp, 0.45 lbs. at $0.03 ..... $0.0135
Lead, 13.00 lbs. at $0.09 ..... 1.1799
1.1934

The average weight per foot of the 12-ft. lengths of pipe, including the bells, was:

Line No. 1—567.5 lbs. per length = 47.25 lbs. per ft.
Line No. 2—564.25 lbs. per length = 47.0 lbs. per ft.
Line No. 3—573.625 lbs. per length = 47.75 lbs. per ft.

The actual weight of pipe suspended was:

Line No. 1—2,288 + 800 (sand) = 3,088 lbs.
Line No. 2 ..... 2,326 lbs.
Line No. 3 ..... 2,311 lbs.

In the case of Line No. 1, this would indicate, with the superimposed load of 200 lbs. per length, an extreme fiber stress of about 9,000 lbs. per square inch. This may be within the elastic limit of cast iron, which varies from 6,000 to 20,000 lbs. per square inch.

Conclusions.

The conclusions from these experiments are that for all ordinary mains, cement joints are superior to either lead or leadite; that leadite may often be used to advantage when time for setting of cement is not allowable; and that there are conditions where a lead joint might pull or blow out without breaking the pipe, and could be re-caulked and the main put in service more quickly than if cement were used.

The cost of making up joints is apparently in favor of leadite, with the cement joint next, and the lead joint the highest.

Mr. Shaw's statements in regard to the mixture of water and cement are substantiated by the work of Portland, except that the addition of from 15 to 20% of fine sand facilitates the ramming of the joint, and apparently does not materially weaken it. In dry weather it is neces-

sary to keep the joint wet outside and inside, if possible, from 24 to 48 hours. If the joint is allowed to dry while setting, during the first few hours, shrinkage takes place, and this may or may not be taken up under pressure.

It is the custom of the Portland Water Department to test all lines to 50 lbs. in excess of the normal pressure before putting the line in service, and it may be said, for the cement joints and workmanship, that only one of those made in 1916 leaked under test.

The city of Portland has about 6 miles of 8 and 12-in. cast-iron pipe laid with leadite joints since 1912, and no leaks have ever been reported. Many of the joints sweat slightly when the pressure is first turned on, but they take up rapidly and become absolutely tight in a few days.

Most of the objection to the use of cement and leadite comes from workmen who have long been accustomed to the use of lead, but the writer has not heard of any complaint from engineers or foremen who have given either a fair trial. The Portland Water Department contemplates a very general use of cement joints in future work.

It is hoped Mr. Shaw's paper will bring out additional facts and opinions on this subject.

Walter Pearl, M.Am.Soc.C.E. (by letter).—In these days of Twentieth Century progress, and under the present duress of military requirements concerning our minerals and metals, this paper presents much matter for interesting discussion, in the way of economy, along the line of public work, as the latter must be continuous, and extend indefinitely, as long as civilization exists, regardless of whether the world is at peace or only striving for peace.

During several years of hydraulic engineering practice, embracing waterworks construction for municipalities, the writer has noted the rapid exchange or substitution of the baser materials, metals, or elements, for those of refined, or combination metals and construction materials; in the case of wood, timber, and lumber, more metal is being used in the constructive combination.

Recently, bids were received in the State of Washington for a steel highway bridge, but as it was afterwards found that a concrete bridge would cost only a trifle more, a bid was accepted for work of this class, considering the small margin in favor of the permanence of a concrete structure. There have been many similar instances lately, and as all branches of the government and all individuals must now practice economy, this paper offers suggestions along many lines.

The method of making the cement joints is described very clearly and concisely, including the method of breaking or loosening them, all of which would necessitate less time and expense, apparently, than is ordinarily required in melting, pouring, and driving lead joints, after caulking the joint with oakum or hemp in the usual manner, or the necessary expense and labor of melting the lead from the joints in disconnecting them; these elements of time and labor are favorable to the cement joint. However, more data and experience with the cement joint should be available before final conclusions can be reached regarding the relative cost of the two kinds of joints; former data cannot be used at the present time in making up a table showing the cost of lead joints.

It is a question with the writer whether the cement, as described, is sufficiently wet to fill all the joint space, and, certainly, great care must be taken in driving or caulking the cement, as the joint space is limited, and irregularities in the pipe often provide very small space, even for hot lead.

Table 5, showing the joint space, etc., in cast-iron pipes, is taken from the catalogue of a manufacturer of cast-iron pipes.

Table 5.—Some Dimensions of Cast-Iron Water Pipe.
(Thickness of shell proportioned for 100 lb. static pressure.)

Diameter, in inches.	Length, over all.	Thickness of shell, in inches.	Depth of hub, in inches.	Joint room, in inches.
4	12 ft. 4 in.	7/16	3	5/16
6	12 " 4 "	1/2	3	5/16
8	12 " 4 "	17/32	3	5/16
10	12 " 6 "	19/32	3	5/16
12	12 " 6 "	5/8	3 1/4	5/16
14	12 " 5 "	11/16	3 1/4	5/16
16	12 " 5 "	3/4	3 1/2	3/8
18	12 " 5 "	25/32	3 1/2	3/8
20	12 " 5 "	27/32	3 1/2	3/8
24	12 " 5 "	15/16	3 3/4	3/8

The figures in Table 5 may be assumed as standard, but as the flask, mould, and pattern vary slightly with different manufacturers, the "joint room" may suffer. Table 5 shows what a limited space there is in the hub or bell for cement after the spigot end is entered, for a thickness of not less than 1/4 to 1/2 in. of cement should be required throughout the entire joint. This thickness might prevent the possibilities of seepage or leaks in the joints of the pipe constructed under the author's supervision. The paper gives no information regarding the joint space. In laying a line of pipe such as described, great care would be necessary in securing, as nearly as possible, perfect alignment and grade, in order to have uniform joint space.

It would seem that cement joints could only be used with straight lines of pipe under low pressures. In a joint of a 6-in. cast-iron pipe, when laid straight, the space is 5/16 in., and on a curve of 250 ft. radius, the resulting space would be practically 3/16 in., or 1/8 in. on a curve of 166 ft. radius. Numerous ups and downs in grade could not be permitted, thus showing the necessity of laying such pipe according to the method of laying sewer pipe. This matter of joint space has been gone into at some length by the writer, as he realizes the difficulty of pouring the lead in a close joint, and more especially in caulking it.

Another question arises, as to whether cement joints in a cast-iron main will stand the strain and shocks due to the sudden closing of valves and hydrants (though not necessary, such things sometimes happen), causing water-hammer, ram, and vibration in the line of pipe, which might crack or injure the cement joints, causing leakage, expense, and annoyance. This is likely to occur in a gravity pipe line, and, in a pumping line, the constant vibration might cause seepage and leaks to develop in the cement in due time. It is well known that cement and concrete will crack and disintegrate where there are sudden shocks or continuous vibration, though it will stand great pressure due to head or weight, if not subject to disturbance.

The author has described cases where pipes with cement joints were laid in made or filled ground, and where settlement occurred without injuring the joints or causing leakage; also where a parallel trench caused the caving of the pipe trench, leaving the pipe hanging unsupported in the air for a time, without even causing seepage in any of the joints. The reason for this, doubtless, was the gradual giving way of the ground supporting the main. Had the shock been sudden, the results might have been different.

It may be conceded that no other base metal having the qualities of lead—so ductile and homogeneous—seems

to be as well adapted for the joints of cast-iron pipe under pressure. Lead joints may be driven or re-caulked, and all leakage stopped, while the pressure is on, which is quite an advantage over cement, as it would be impossible, practically, to secure any bond with the cement after it had thoroughly set. In case of an important leak it would be necessary to shut off all pressure on the main, and possibly the water would have to be drawn off; then, after removing all the original cement, an entire new joint would have to be made.

In a grade-line pipe, there is no doubt that cement joints would be safe and economical; but in a high-pressure cast-iron main, it would appear to the writer to be difficult to find a substitute for lead joints; under the present prevailing high prices of materials, and especially metals, the cost and the special requirements relative to the safety of the structure, should be well considered before work begins.

It is possible that this paper may bring out some discussion relative to the likelihood of electrolysis along a cast-iron main with cement joints paralleling electric car lines; it would seem that, as cement is a non-conductor, such a line of pipe would be unfavorable to electrolytic action, as the current being so frequently broken would leave the main in minor quantities without causing deterioration; however, experiments would demonstrate this matter more satisfactorily.

The author states that the cement joint for cast-iron pipe has passed the experimental stage, especially in work with which he has been connected, and that such joints are safe and satisfactory. The work seems novel to the writer, and he is indebted to the author for attracting his attention to new construction methods.

H. G. Moulton, M.Am.Soc.C.E.—With respect to the use of Portland cement instead of lead in forming joints for cast-iron water mains, it may be said that this is the method against which there is every theoretical objection, but in favor of which there is the practical argument that it has become a demonstrated success in actual practice. For a number of years past the use of cement for this purpose has been standard practice in Los Angeles, a thriving municipality of some 350,000 population, and the speaker is indebted to William Mulholland, M.Am.Soc.C.E., chief engineer of the Bureau of Water-works and Supply of that city, for much interesting information in regard to this method of making joints. The following statements in regard to costs and conditions in Los Angeles are in a large measure based on figures furnished by Mr. Mulholland.

The advantage in favor of this method lies in its great economy. In 1912 about 9,000 ft. of 30-in. high-pressure water main were laid in Los Angeles. Cement at that time was quoted at $2 per bbl. there and lead cost 5 cents per lb. The total saving on the job by using cement instead of lead was approximately $3,500. At present comparative prices of lead, cement, and labor, the saving would be very much greater, and, of course, on 36 or 48-in. mains a very large saving is possible.

An additional advantage in the use of cement lies in its insulating effect, in that it appears to act as a perfect seal between the separate sections of pipe and thus to reduce materially the effect of electrolysis. As damage to cast-iron pipe from stray electric currents has resulted in deterioration of water mains in many places, any type of joint which tends to reduce such damage, by stopping the flow of stray current along the pipe, is worthy of serious consideration.

The arguments against the use of the cement joint are based on a fear that temperature changes, resulting in uneven expansion and contraction, would tend to break up the joint, and also on doubt as to the action of pipe caulked by this method in the event of settlement, in filled ground or otherwise. In Los Angeles, the usual practice is to refrain from the use of cement joints where pipe must be laid on fills, probably on the assumption that, in case of settlement opening up joints, they can be re-caulked more easily if lead is used. In Long Beach, however, as mentioned in the paper, the cement joint has been used in filled ground, and also under conditions where trenches adjacent to the pipe have allowed sections of it to sag over a length of 40 ft. in one instance; and another instance is mentioned in the paper where some 98 ft. of pipe broke away and dropped into a trench with all the joints remaining in perfect condition, except those at the actual point of rupture.

In regard to the question of the ability of pipe to span extensive distances when the supporting ground is washed away, it may be said that, in designing connections for water pipe lines, good practice does not call for laying them out as suspension bridge connections, under the assumption that the pipe should be able to hang suspended over extensive spaces without failure. Under all normal conditions, a water pipe joint need only be considered in regard to its ability to prevent the leakage of water with reasonably continuous support and with a proper depth of cover above. Its behavior under abnormal conditions, where it has to hang suspended over wash-outs or cave-ins, is a matter of interest only from a standpoint of curiosity, and one is certainly not justified in designing all pipe on the assumption that it must meet conditions such as this, and providing special connections for this purpose.

In regard to the question of temperature changes, it may be said that there is seldom a variation of more than 50° between the winter and summer temperatures in city water mains. In winter, temperatures lower than 32° Fahr. cannot exist, on account of the fact that, at this point, the water changes to ice; and above a temperature of 85°, it is certainly too hot for use as drinking water. In Los Angeles the maximum variation in temperature is from 45° Fahr. in winter to 82° in summer, or a total range of 37° Fahr. Under this range, no trouble has been experienced with cement joints from leakage introduced by temperature stresses.

This paper brings up an interesting method which was first devised in California, and the success of which has been proved there on an extensive scale. It is no longer in an experimental stage, and is worthy of serious consideration on the part of eastern municipalities. The saving in expense made possible by the substitution of cement for lead in the joints of cast-iron pipe is so great that all the larger eastern cities would be justified in commencing immediately the use of cement joints in an experimental way in outlying districts, working gradually in to more important parts of the water system as the advantages and limitations of the method are developed in each municipality.

The author is entitled to a large measure of credit for having brought thus forcibly before the society the advantages of a pioneer engineering method having great possibilities, which the engineering profession as a whole has been slow to recognize and adopt.

Three hundred and eighty-four electric hoists with 25 h.p. motors are used to handle the hinged spouts of the new ore dock (No. 5) of the Duluth, Missabe and Northern Railway at Duluth, Minn.

REINFORCED CONCRETE FOR SHIPS.*

IT is sometimes supposed that the idea of using reinforced concrete for the construction of ships and other floating structures is a novelty. This, however, is a mistake, for the first application of the material in this way dates from a period when the building of steel ships had not even been begun.

The first reinforced vessel was in the form of a small boat built in 1849 by a Frenchman named Lambot, at Miravel, and the boat is still in service after a practical test of 68 years. It was inspected in 1850 by the French government, but, as too often happens when government officials are concerned, the further development of the idea was left to private enterprise. Towards the end of last century, the possibilities of reinforced concrete for all kinds of structural work began to be more widely recognized, and the material was applied to the construction of vessels of various classes in different parts of the world.

Some Early Examples.

One of the first examples was a floating chalet supported by a reinforced concrete pontoon, measuring 67 ft. long by 21 ft. wide, built in Rome during the year 1897. Another interesting example built in the succeeding year was a schooner employed for some years in the North Atlantic coasting trade, the serviceability of this form of construction having been practically demonstrated by the fact that the vessel escaped without injury after having been driven on the rocks near Cape Charles. One of the first reinforced concrete barges in Europe was completed early in the present century from the designs of M. Hennebique, of Paris, on the River Lozere, where it has since been in continuous operation for dredging purposes. The vessel measures 50 ft. long by 13 ft. wide by 3 ft. 4 ins. deep, and it is recorded that the initial cost was much less than that of a timber or steel structure of the same dimensions, while the practical absence of maintenance charges has added very considerably to the ultimate economy effected.

Other barges, lighters and pontoons followed in fairly rapid succession, the firm of Gabellini, of Rome, having been particularly enterprising in the new branch of work. By the end of 1912 they had constructed at least 20 vessels of the lighter class and over 60 pontoons for floating bridges. Included in the former category were several large lighters for the Italian government and a steam collier, these and all other vessels of the same class having been constructed with double hulls and watertight compartments. In Germany, reinforced concrete vessels of the motor launch and barge types have been constructed, among the latter being a barge 130 ft. long by 20 ft. beam, said to have been built at a cost of 25 per cent. less than that of a steel barge. In North and South America a good many barges and pontoons have been constructed in reinforced concrete during the last ten years. Typical examples are furnished by a barge at Ontario, 81 ft. long by 24 ft. beam by 7 ft. deep; a fleet of lighters, 100 ft. long by 30 ft. beam, built at San Francisco for the coasting trade; several lighters and pontoons on the Panama Canal; and some scows 112 ft. long by 28 ft. beam built at Fairfield.

Comparatively little has been done in Great Britain towards the development of reinforced concrete shipbuilding up to the present date, with the exception of a lighter constructed in 1910 on the Mouchel-Hennebique system for the Manchester Ship Canal Company. This vessel carries machinery and coal representing a load of some 200 tons, and contains chambers for the reception of large quantities of sludge dredged from the canal. It is 100 ft. long by 28 ft. wide by 13 ft. deep, and draws 5 ft. 6 ins. of water when fully loaded. The skin of the hull is 3 ins. thick, and the lighter is constructed in several watertight compartments. Some activity in the development of barge and shipbuilding has been reported from Norway, where several barges have recently been built, and it is stated that a reinforced concrete steamship of 3,000 tons is now in hand. Last month it was stated in a Copenhagen paper that the first Danish building yard for reinforced concrete vessels is almost complete, and that two barges, of 80 tons and 43 tons respectively, are expected to be launched this summer.

*From the London Times.

Future Possibilities.

It is evident from the examples cited that reinforced concrete has earned a definite claim to be regarded as a real shipbuilding material, particularly for vessels of moderate size. Whether it will prove equally suitable for the construction of large steamships, including ocean liners and warships, is a question that can be answered only by the results of future experience. In the meantime the material possesses obvious advantages for the building of many useful types of craft. Among its recommendations are simplicity and rapidity of construction, the readiness with which repairs can be executed, high resistance to strain and shock, incombustibility and fire-resistance, relatively low cost, and the virtual elimination of maintenance charges. Experience appears to show that the skin-resistance of a reinforced concrete vessel to passage through water is slight, owing to the smoothness of the surface and the absence of joints, and the ease with which scraping can be effected.

Thanks to the elastic strength of the material, reinforced concrete lends itself to the most modern developments in shipbuilding design, and although the skin of the hull must necessarily be thicker than when steel plates are used, it need scarcely be thicker than would be the case if timber were employed. Assuming 3 ins. to be the thickness adopted the weight per square foot would be less than that of steel 1 in. thick. Therefore, the question of deadweight does not appear to constitute a very serious objection, especially in view of the fact that the weight of the hull of a vessel is small in comparison with the weight of equipment, fittings and cargo.

A Torpedo Testing Station.

Turning now from ships, barges and pontoons, attention will be drawn to some other types of floating structures in which reinforced concrete can be employed with advantage. The most interesting example of the caisson class is furnished by the "Batterie des Maures," a torpedo-testing station built for the firm of Schneider, of Le Creusot. At present forming a kind of artificial island in the Mediterranean, this structure was built partly in a dry dock belonging to the Forges et Chantiers de la Mediteranee, and completed at moorings outside the dock. The battery was then towed by a couple of steam tugs for a distance of some 30 miles through the sea and sunk upon a prepared bed in deep water.

The lower part of the Batterie des Maures is a caisson, above which rises a superstructure of two stories surmounted by a spacious deck. The caisson is 50 ft. high by 77 ft. long by 45 ft. wide at the base, and 65 ft. long by 35 ft. wide at the top, the outer walls being 6 ins. thick, and the interior partition walls 4 ins. thick. The superstructure rises about 20 ft. above the top of the

caisson, the end over the torpedo tubes projecting 17 ft. in cantilever and forming an observation chamber for watching the course of torpedoes discharged from the tubes. The discharging chamber, occupying the central part of the caisson, is 45 ft. long by 18 ft. wide and has five tubes, three of which are below and two above water-level. The latter are in embrasures protected by steel shutters which can be closed in rough weather, and provision was made for the insertion of a timber cofferdam whenever required to permit the space in front of the subaqueous tubes to be pumped dry for the purposes of examination or repair. At the level of the lower deck in the superstructure a gangway runs around the top of the discharging chamber, and landing stages are provided for hoisting boats and materials. A travelling crane runs transversely through the battery below the second deck, the ends of the rails projecting 11 ft. 6 ins. at each end to facilitate loading and unloading operations. Another travelling crane is installed longitudinally over the discharging chamber for handling torpedoes and workshop material. On the lower deck are machine rooms and workshops, the machine rooms being equipped with two 65-h.p. internal combustion engines direct coupled to 40-kw. generators. From these sets current is supplied to air compressors, pumps, hoisting appliances, travelling cranes, and machine tools in the workshops. On the upper deck living accommodation is provided for the resident staff, the deck above being equipped with a look-out turret, masts for signalling, and other accessories.

When completed in readiness for its voyage across the sea the battery had a displacement of 2,600 tons and drew 26 ft. of water. After having been sunk in position, the total deadweight of the battery, with its contents and ballast added for sinking, was 9,000 tons, and its displacement was then 3,700 tons.

The stability of the battery on its foundation bed is amply assured by the excess weight of 5,300 tons over that of the water displaced, and the monolithic nature of the reinforced concrete construction, combined with a well-designed system of reinforcement, insure the elastic strength and rigidity necessary for withstanding the impact of waves in the roughest weather.

Before the adoption of this ingenious application of reinforced concrete was decided upon, several alternative projects were considered, the most practicable of these embodying the construction of an open steel platform with a moored workshop, lighter carrying torpedoes and machinery. This would have provided a somewhat inconvenient fair-weather installation, far inferior to that represented by the compact, self-contained battery, briefly described above, embodied in the scheme submitted by Mr. Hennebique. of Paris.

Floating Caissons.

While of less striking character than the structure just considered, reinforced concrete caissons for pier and jetty construction are not without practical interest. Floating caissons for this class of work have been used on a large scale in different parts of the world, a good example being furnished by those applied in the construction of new quays in Alexandria Harbor, where five large caissons were built on shore, towed out to position, and sunk to form a jetty some 330 ft. in length. The caissons were 65 ft. 8 ins. long by 26 ft. 3 ins. wide near the top, where the width was increased to 29 ft. 6 ins. by cantilever projections. Two caissons were 17 ft. 9 ins. high, and the other three 23 ft. high. The largest caissons weighed about 400 tons and drew between 6 ft. and 7 ft. of water when being towed out to position. After they had been filled their total weight was 2,500 tons, approximately, this being the weight of material it would have been necessary to transport and deposit on the bed of the harbor to obtain the required stability. By the adoption of reinforced concrete caissons the total weight of material towed out was only 400 tons, the remainder, employed as filling, having been very easily transported along the top of the caissons after the latter had been sunk in place.

It may be pointed out here that one of the problems to be solved in the design of floating caissons is to provide economically for the severe strains due to the considerable head of water acting upon the sides of the structure. The latest development with this aim provides for the construction of caissons designed so that the strains shall not act upon plane surfaces but around circular surfaces disposed with the outer walls. In this type of caisson patented a few years ago by Mr. J. S. E. de Vesian, pressure being distributed practically all around the circle, no bending moments are developed and nothing but compressive stresses have to be resisted.

Other types of floating structures in reinforced concrete for which there should be a big future are floating docks and railway ferries. The examples of pontoons already cited are sufficient to indicate that there would be no difficulty in constructing reinforced concrete ferry vessels capable of transporting railway trains and other classes of vehicles. Reports from Norway show that a small floating dock for lighters is in course of completion at the present time.

Effects of Sea Water.

In conclusion, brief reference may appropriately be made to the objection sometimes raised against the employment of concrete in sea water on the ground that the material may be injured by the action of saline substances in solution. The universal employment of concrete in marine works all over the world, including undertakings of such importance as the National Harbor at Dover, and the Panama Canal, ought to be sufficient answer to any doubts that may be entertained. While badly made concrete has suffered deterioration in a few cases, there is ample evidence of the fact that correctly proportioned and carefully prepared concrete is not injured by prolonged immersion in sea water. A series of tests commenced seven years ago in Boston Harbor, U.S.A., and still in progress, showed in 1914 that specimens made of really good concrete were in splendid condition after five years' alternate immersion and exposure to air, while other specimens of poor concrete had suffered considerably under the same conditions. Practical experience in this country is equally convincing.

Statistics just completed under the supervision of J. D. Northrop, of the United States Geological Survey, Department of the Interior, indicate that for the year 1916 the quantity of "natural" asphalt, including bituminous rock, grahamite, gilsonite, wurtzilite, and the natural paraffin, ozokerite, produced and sold at mines and quarries in the United States was 98,477 short tons, a gain of 22,726 tons, or 30 per cent., in quantity compared with 1015. Ozokerite from domestic sources reappeared in the statistics of production for the first time since 1907. The quantity of asphalt produced in 1916 by refining from crude asphaltic oils of domestic origin increased only 3½ per cent. as compared with that produced in 1915, and the quantity of similar material refined in the United States from Mexican petroleum increased 47 per cent. as a consequence of which the net gain over production in 1915 was nearly 20 per cent. California led all other states in the production of refined asphalt, its output from sixteen refineries in 1916 amounting to 257,930 short tons.

LAKE OF THE WOODS LEVELS.

Leo. G. Denis, writing in "Conservation," the official organ of the Commission of Conservation, says:—

"The recent decision of the International Joint Commission regarding the investigation into the Lake of the Woods water levels is another example of the importance and benefit to be derived from the proper presentation and firm adhesion to our justified contentions in international water-power problems.

"The Commission of Conservation, as in all boundary water questions, took particular interest in the Lake of the Woods case, and it is gratifying to note that practically all the principles contended for have been recognized in the recommendations of the Joint Commission to the governments of the two countries. The conclusions were only reached after a most thorough investigation and study covering a period of three years and including a complete field survey of certain portions of the region affected.

"The effect on the large water-powers of the Winnipeg River is of particular interest to Canada and should prove a strong stimulus to the industrial development of the Winnipeg district. Water power is recognized as a dominant factor and the water level for the Lake of the Woods permits the latter and other lakes to be used as immense regulating reservoirs for the benefit of Winnipeg River water-powers. In this connection it is of interest to note that the Commission of Conservation which, long since, recognized the importance of these water-powers and that proper forest cover should be conserved in their upper waters, has strongly recommended that the Lake of the Woods watershed be set apart as a forest reserve.

"The flood conditions of 1916 strikingly emphasized the urgent need for an efficient co-ordinated system of regulation and control of the waters of this drainage system. This is provided for in the recent report, which also includes the safeguard of the interests of navigation, forests, and others."

ENGINEERS VISIT WINNIPEG AQUEDUCT.

Members of the Manitoba Branch of the Canadian Society of Civil Engineers will inspect the Winnipeg Shoal-Lake aqueduct work on Saturday, July 21st, as the guests of the Winnipeg Water District Commissioners. The excursion is being managed by Mr. W. G. Chace, chief engineer of the work. The trains will leave St. Boniface Station at 8 a.m. Notification has been sent to all the members of the branch by A. W. Smith, secretary-treasurer of the branch, but members of other branches of the Society, who may happen to be in Winnipeg on July 21st are invited to take part in the excursion.

By vote of the executive committee of the American Society of Municipal Improvements, the annual convention of the Society has been postponed one year on account of so many members being, or about to be, on war duty. The convention was to have been held in New Orleans, La., November 12th to 16th, so will likely be held in that city in November, 1918.

The Reid-Waples Contracting Co., of Philadelphia, have converted a touring car into a portable compressor unit for operating a cement gun. The original clutch is retained, which allows the motor to run free from the compressor. When air is required, the clutch pedal is thrown out and the original gear shift brought into play, which permits using three speeds of the engine in compressing air and increases the efficiency of the unit according to the demands made by the extent and character of the work under way.

The council of the city of Los Angeles, Cal., has just adopted specifications for the construction of sanitary sewers within the city which permit the use of concrete sewer pipe. The specifications require the pipe to be mechanically tamped and fed, the aggregates to be carefully selected and graded, and proportioned, one part of cement to three of aggregates. The tests require 15 lbs. hydrostatic pressure held for five minutes without percolation, a 30-lb. fracture test and a 5 per cent. absorption test. These tests are similar to but more severe than those recommended this year by Committee "C4" of the American Society for Testing Materials.

BRITISH COLUMBIA'S SHIPBUILDING.

"The shipbuilding industry is rapidly developing on this coast," said Mr. White, assistant chairman of the Canadian Commission of Conservation, speaking at Victoria recently. "Following the preliminary operations at the Wallace Shipyards, North Vancouver, and the yards of the Cameron Genoa Mills Shipbuilding Company, Victoria, the Foundation Company is preparing for the construction of five vessels at Victoria, the Peter Lyall Company, of Montreal, has taken over the No. 2 yards of the Wallace Shipyards and has several contracts on hand; and negotiations are proceeding for the taking over of the shipbuilding yards of the Grand Trunk Pacific Railway at Prince Rupert by the Union Iron Works, of San Francisco, of the big marine firms on the American Pacific Coast. At present about 40 boats will be built. This industrial activity is important to the welfare of the province.

"Shipbuilding has a direct and favorable bearing on trade and is a favorable factor in provincial development. Only recently British Columbia mills were unable to ship lumber overseas for the lack of bottoms. Construction of ships was started and to date seven have been completed. Most of these are already on the high seas with 1,500,000 feet of lumber each, while the others are either taking on cargo or preparing to do so. Just that much more lumber can be manufactured and shipped, for the business is available if there are transportation facilities."

ELECTRIC RAILWAY WOULD SELL.

The British Columbia Electric Railway have offered to sell their holdings, Mayor McBeath, of Vancouver, said recently. It is said that the company would be willing to accept in payment provincial bonds, bearing interest at a reasonable rate, the provincial government to take over the interurban lines and operate them and the different cities, such as Victoria, Vancouver and New Westminster, to take over the lines within their borders and running out to the suburbs beyond the city limits. The government would take over the light and power plants, supplying power at a fixed rate to the different cities.

Professor Adam Shortt, who will go into the transportation problem as a commission of one, appointed by the provincial government, is expected to reach Victoria this week.

"SCOTIA'S" FIRST STEEL SHIP.

The S.S. War Wasp, the first steel ocean-going steamer built in Nova Scotia, was successfully launched on Monday by the Nova Scotia Steel Company. Work on this vessel was commenced in October last. The boat has a carrying capacity of about 2,000 tons, a displacement when loaded of 2,870 tons and a speed of eleven knots per hour. The dimensions are as follows: Length, between perpendiculars, 220 feet; moulded depth, 20 feet, and beam, 35 feet.

The War Wasp has been sold to the British government. A second vessel, about 25 per cent. larger, is under construction, and a third vessel will occupy the berth vacated by the War Wasp.

BITOSLAG PAVING CONTRACTS.

Among the contracts recently received by the Bitoslag Paving Co. of New York are the following:—Fulton County, Ga., 20,000 yds. for drive west of Lakewood Park; Allegheny County, Pa., 20,000 sq. yds. additional to the 20,000 yds. laid last year; Coatsville, Pa., 25,000 yds.; Mahanoy City, Pa., 30,000 yds.; Homewood Cemetery, Pittsburgh, 3,000 yds.; South Bend, Ind., 30,000 yds. As this pavement is a new type developed within the last few years, the award of these contracts will naturally be of interest to highway engineers.

There was a typographical error in the article on "Cement-Gun Construction Methods," page 28 of last week's issue. The eighth line of the second paragraph should have read, "⅞-inch x 6-inch plank," instead of "⅞-inch x 6-foot plank."

Editorials

MODERN STREET CLEANING.

On another page of this issue are shown a number of views of the types of machines that are cleaning the streets of many of our large cities in the most modern manner. The old, unsanitary dry hand-brush is being rapidly relegated to the dark ages when the dread power of street germs was not properly appreciated. The only absolutely sanitary method of street cleaning is by flushing, and either motor-driven or horse-drawn flushers should be strenuously advocated by every city and town engineer.

For the last thirteen years, street dust has been the subject of much study by eminent bacteriologists, and the causative connection between street dust and many diseases is now clearly established.

B. coli. comm., B. tuberculosis, the bacterium pneumococcus, staphylococcus and streptococcus, pyogeneus, diphtheria, anthrax, tetanus, have been recognized as permanent inhabitants of street dust. Out of forty-six inoculations of animals with bacteria from city dusts,—an experiment tried by a prominent doctor some years ago,—thirty-two caused infectious diseases.

Another well-known authority states that among the diseases that lurk in the dust on the streets are tonsilitis, quinsy, laryngitis, pneumonia, rhinitis, influenza, tuberculosis, poliomeylitis, asthma, rheumatism, diarrhoea, skin disease, conjunctivitis, trauma of the cornea, nasal catarrh, frontal sinus and middle ear disease. And physicians all say that dust may, by predisposing an irritated condition of the respiratory organs, so lower the vitality of the mucosa that the development of any germ deposited thereon will be favored. In fact, suspicion now points strongly toward street dust as one of the worst etiological mischief makers with which we are afflicted.

Ex-President Theodore Roosevelt said, in a speech at Buffalo some years ago, that we should be sufficiently civilized and intelligent to get rid of our sewage by some other means than by putting it into our drinking water. He might have added that we should get rid of street dusts —which are just as dangerous as human sewage—by some other means than by allowing them to be pulverized and blown into our nostrils, or brushed into the air periodically by the old methods of street cleaning still in force in many of our cities,—even in Toronto!

Flushing is here to stay. It is a proven success for practically all kinds of pavements. It is the only absolutely sanitary method of keeping streets clean. It does away with the white wing and preserves the self-respect of the cleaners, or operators.

An outfit of flushing machines would do three things for any municipality: it would lower the death rate; it would save thousands of dollars for its citizens through loss of time on account of sickness; it would abolish a vile job which someone otherwise must perform.

There are two types of flushing machines which have been developed within recent years which will meet with popular favor. One of them is the combination flusher and sprinkler, so arranged that the machine will throw a sprinkling spray ahead of the flusher, wetting the dirt, and follow up with the flush in such manner that heavy deposits can be carried along the gutter to the catch-basins or deposited at intervals at the operator's will.

The other type is the combination sprinkler, flusher and squeegee, the squeegee carrying the dirt to any given point or catch-basin. The first combination machine on this continent has been constructed under designs by Commissioner Featherston, of New York City. It is a flusher-sweeper-trailer, with an 1,800 U.S. gallon tank, an electrically driven pump and either an electrically driven squeegee or electrically driven broom.

It will interest all city engineers to note the results secured by this machine, which is now being tested. It is problematical whether the squeegee would improve on the flush and clean the gutter and adjacent strip to better advantage, or whether the controlled flush will prove to be the best solution owing to the deposits in cracks and depressions which the squeegee might leave on rough or uneven pavements.

OFFICIAL STANDARDS OF WATER ANALYSIS.

The Chemical and Bacteriological Section of the American Water Works Association, following the recent annual meeting at Richmond, recommended the appointment of a committee to be known as "Committee on Official Standards of Water Analysis." This committee is composed of the following: Messrs. Robert B. Morse, engineer, State Board of Health, Maryland; Wm. J. Orchard, engineer and bacteriologist, New York; Edward Bartow, chemist, State Board of Health, Illinois; C. A. Haskins, engineer, State Board of Health, Kansas; and Joseph Race, city bacteriologist and chemist, Ottawa. The duties of this committee will be to consider official standards of water analysis, their interpretations and methods, also methods for getting the recommendations before the association and the general public.

The effort to arrive at a standard of purity for water is undoubtedly a step in the right direction. While various states "across the line" have at different times made tentative standards, these have been in most instances purely local in their application and have never shown any indication of becoming universally adopted.

The American Public Health and Marine Hospital Service some years ago fixed a standard for the treasury regulations governing the purity of the water carried by interstate traffic and this stated that the water should not contain more than 2 B. coli per 100 c.cms. and not more than 100 bacteria per c.cm. on agar at 37° C. As this applies to all interstate traffic it practically sets a minimum standard for every state and also for water carried into contiguous territory. Regulations are now being prepared for the water carried by international water carriers, *i.e.*, boats on the Great Lakes and on both coasts, and at present it would appear that the American Treasury standard will be the one adopted both by Canada and the United States unless some opposition develops.

In view of these facts this would seem to be the time for all those in Canada interested in the design, construction and operation of waterworks, to consider whether they are satisfied to adopt this standard, for once adopted it will be very difficult to have it altered. Should such

standards become applicable to international carriers, they automatically set a standard for a majority of the provinces of Canada, and they would in all probability become the general standards for the Dominion.

TRADE AND TRANSPORTATION.

In the report of the special Canadian trade commission to Great Britain, France and Italy, just published, considerable emphasis is placed upon the problem of ocean transportation. The commissioners think that the established lines between Canada and the allied nations have not given that service in linking this country with other countries which might have been expected. Freight rates have been of such a character as seriously to impair their usefulness as a means of developing Canadian trade.

"Canada's ocean transportation will have to be completely reorganized if the Dominion is to derive the fullest benefit from her natural resources and manufactured products," says the report. A suggestion of the commission, one member dissenting, is the centralization under Imperial control, say, in London, of ocean cargo tonnage available by tramp steamers, which form the larger proportion of the tonnage. Employment of ships might be so adjusted, it is thought, that the different means of the Empire might be met as the requirements of the crop or season might demand. "If such a mobilization of Imperial transportation facilities could be achieved," says the commission, "it would lead to an adjustment of freight carrying which would ensure adequate return to the steamers and at the same time bring about a reduction of freight rates which would enormously assist transportation between Canada, the ports of Great Britain and the allied nations. This is a novel suggestion. A centrally controlled commercial fleet, placed during the busy season in various parts of the Empire, would probably have a drastic effect on the freight rates of privately owned vessels. Whether such a scheme is practicable and could satisfy various needs without conflict of interest in various parts of the Empire is a matter for decision when further information is available.

"The ocean carriers, until the war broke out, were apparently strong enough to withstand all the influence of government commissions and of governments themselves exerted with a view to regulating freight rates and sailing schedules. The war has brought about important changes in the world's shipping. Governments have, as war measures, taken an active interest in the control of shipping. How far this influence will be exerted after the war is problematical. One may reasonably expect, however, considerable opposition from shipping companies to any scheme of government control of ocean transportation. These considerations do not belittle the fact that the problem of ocean transportation is one for serious consideration by the governments of the British Empire."

Our trade commission points out that they were confronted by this problem at every point. The commission feels that it can only report conditions respecting freight rates as they find them, but they reaffirm their belief that the question is a matter of such material importance to the country's export and import business that they recommend "as strongly as possible a complete governmental survey of the freight situation, and prompt application of such remedial measures as may be found necessary."

The report is one of 158 pages, and contains many other important recommendations, together with valuable information concerning the competition which Canadian manufacturers must expect to meet in marketing their goods, especially in Great Britain, France and Italy. The commissioners signing the report are Mr. J. W. Woods, chairman; Mr. T. Wardleworth, vice-chairman; Mr. W. F. Hatheway, Mr. F. Pauzé, Mr. H. E. Dupré and Mr. G. W. Allan. They have produced an exceptionally useful document which has much matter for the active consideration of the government, our manufacturers and trade interests generally.

DON'T HAMPER THE FARMER!

Considerably more than half a million men formerly engaged in productive occupations have been enrolled either in the Canadian army or engaged in munition, military or non-productive work of some kind or other connected with the war. A large percentage of these men were farmers. In the United States, before another year has passed, a million men will be called to arms, of which more than a quarter will likely be drawn from agricultural pursuits. This all means that a great strain will be put upon the farmers of the continent, who are already being urged to do everything possible to increase the production of their lands.

The farmers have responded nobly to the world's call for food, but of what use is it to produce food supplies if they cannot be delivered to market? Corn that stays in the farmer's cribs, as it was held for months during last winter in many places, does nobody any good. Wheat that stays on the farms helps only the rats.

The feeders of the railroads, our public roads to shipping points, must not be neglected so that the good work of the farmers is rendered of little avail by inability to get the stuff from the land into cars. Some people seem to think that good roads are a luxury because their grandfathers did not have them. They forget that their grandfathers did not have to feed 110,000,000 Canadian and American mouths, not to mention a lot of hungry ones among the 46,000,000 people of Great Britain and Ireland and the 40,000,000 of France. All grandfather had to do was to supply food for four or five million persons. His ways are interesting to read about but worthless to copy. Why hamper the farmer who is helping to win the war, by making him try to haul food supplies over roads that even grandfather would "cuss"? Our roads must be maintained and new ones built where the demands of food production dictate. Economy is the order of the day, but not false economy.

The Minnesota Supreme Court has upheld the city of Minneapolis in its plan of assessment for Marshall Avenue paving. A portion of the street has a street car line on it, and the company paved the part of the street occupied by its tracks. The property owners along the car line were assessed $5.50 a front foot, and, where there was no car line, $8.20 a front foot for creosoted wood block, all put in under one order. The property owners paying the higher rate brought suit, maintaining that the assessment should be uniform along the entire length of the street. Quoting from the decision: "Street car tracks and the operation of cars circumscribe the use of the street. The situation is much the same in principle as it would be if one portion of the street between curbs were wider than another."