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CONCRETE WHARF SUPPORTS IN SALT WATER*

DESCRIBES METHODS USED IN PREPARATION OF CONCRETE SUPPORTS FOR SERVICE IN SEA WATER.

By **THOMAS S. WILLIAMS,**

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SAN FRANCISCO harbor is situated on San Francisco Bay, which is connected with the Pacific Ocean by a strait called the Golden Gate, about three miles long by one mile wide. The waters of a number of large rivers eventually find their way into the bay, nevertheless, on account of its size and proximity to the ocean its waters are substantially as salt as the sea. The result is that salt-water marine borers, known as teredos and limnoria, familiar along the entire Pacific Coast and elsewhere in the salt waters of the globe, infest San Francisco harbor likewise, and on account of their destructiveness to wooden piles in their natural condition it has been found necessary by various means to guard against their depredations.

Different woods—pine, fir and eucalyptus—have been tried, but all proved unavailing.

Different methods of wrapping and otherwise preserving the natural wood, some of them patented, were used without satisfactory results.

An untreated wooden pile of fir or pine will last only about a year. The borers are fastidious enough to prefer clear salt water, consequently muddy water or water fouled by sewage is some protection to the wood. It is, however, substantially accurate to say that the life of a green pile is only a year.

A creosoted wooden pile lasts according to the clearness of the water, from fifteen to twenty years, but, of course, great care must be exercised to secure piles that are properly creosoted, not only as to the materials used, but as to the processes employed.

Finally, experience has forced us to settle in practice at the present time upon two main types of construction of wharf supports: First, creosoted wooden piles; second, concrete supports.

Notwithstanding that concrete construction is from two to three times as costly as creosoted wood, our present practice is to use concrete wherever the foundation conditions permit.

As is well known, the great advantage claimed for concrete is its durability. Frequently we see it described as "permanent" construction, but experience with this class of construction either in San Francisco harbor or elsewhere under modern traffic conditions has not been sufficiently long or varied to permit of a sure deduction as to just how "permanent" even the best concrete is.

Being a manufactured article composed of various ingredients, mixed in varying proportions and by different methods, all concrete is not the same. Some of it is good; much of it very bad.

Moreover, the chemical action of salt water upon even the best concrete is a mooted question among engineers. Whether such action is deleterious, in periods short or long, I do not undertake to discuss, but the result of twenty years' experience with concrete in San Francisco harbor shows that on good concrete no appreciable adverse effect due merely to the action of salt water has become visible.

Likewise, electrolysis, due to escaping electricity, is said in some localities frequently to have rapidly deteriorated the steel reinforcing rods used in concrete constructions and thus contributed to the disintegration of the concrete.

Of the alleged effect of electrolysis, we can furnish no evidence from San Francisco harbor, because steel reinforcement is of so recent use that data on the point mentioned are not forthcoming. Our practice now is, never to use concrete unless reinforced by steel rods.

Concrete supports, used in our piers, wharves or seawall, have been of two main types, one called cylinders and the other piles; the striking difference between the two being that the cylinders are put in as wet concrete fresh from the mixer and allowed to set in position inside of a wooden frame, whereas the piles are manufactured on shore, thoroughly seasoned by being allowed to set at least thirty days and frequently as long as sixty days, and then are driven into position by a pile-driver or steam hammer. Frequently it is necessary also to use with the hammer the aid of a water-jet, which is employed where certain hard bottoms require it.

I shall describe the concrete pile first, and afterwards the concrete cylinder, with a brief reference to our experience with both.

When I mention piles hereafter, please understand that I have reference only to this character of pile, made of concrete and thoroughly cured on shore and then carried to the work and driven into position.

The use of such a premoulded concrete pile in harbor construction is comparatively of very recent origin. We are not aware just where it was first employed, but San Francisco is, at any rate, among the pioneers in its use. We doubt whether any other American harbor has used them as freely. They were first driven in that harbor in 1911, at first rather gingerly for work close in shore, but emboldened by apparent success we gradually extended their use until we are now able to exhibit a new pier just completed, 200 feet wide and 900 feet long, entirely supported by concrete driven piles.

The first piles used by us were 66 feet long, 16 inches square, and were employed to sustain concrete masses under ferry aprons.

*Read before the American Association of Port Authorities, Montreal, Oct. 1-4, 1916.

In a pier just completed the length of piles varies from about 40 to 106 feet, and they were placed with centres 11 x 12 feet apart.

The pile is reinforced with longitudinal steel rods, four of them, each five-eighths of an inch square, being set in piles 16 inches square and from 35 to 40 feet long, and eight rods each one inch square in piles 20 inches square and from 90 to 100 feet long.

In order to facilitate driving, the piles are given a taper, beginning about ten feet from the point, tapering to ten inches square.

In setting the reinforcement, soft steel wire, one-quarter of an inch in diameter, is wound spirally around the rods, with spacing for the wire of about six inches.

It may be of interest to state that one of these piles 20 inches square and 100 feet long weighs about 20 tons.

In designing such a pier it is necessary to drive test piles of wood in advance, so as to determine bottom conditions. Borings are also made. In the plans, the length of each pile is specified. If it turns out to be too long when actually driven to refusal, the top of the pile is blasted off with dynamite, and if it turns out to be too short, it is built up by concrete to the proper level.

A question may arise in your minds as to the difficulty of handling without marring such a long and heavy pile. On the contrary, with a proper pile-driving rig it is marvelous to see how deftly and safely the pile, grasped at three or four points by wire ropes, is dragged and lifted along the wharf or sometimes from shore to barge, and thence hoisted into driving position.

As a long pile, frequently 90 to 100 feet in length, goes into the air, it is most interesting to note what elasticity it possesses, shown by its bending and flapping like a monster whip, but straightening out most perfectly when it is set in the pile-driving frame.

Another question may arise as to possibility of fracture in hard driving. Here is shown the most astonishing result. Local engineers who have made observations during the process of driving have repeatedly confessed to us their amazement that the pile can stand the powerful hammering it receives with almost perfectly satisfactory results. Generally speaking, not a crack, big or little, is visible.

The top of the pile, during the driving, is protected by a rope cushion and a wooden block about six inches thick, and usually the point is not protected at all. It might be supposed that the point, under such circumstances, would spread out or mushroom, but such is not the case, even in hard compacted sand or clay.

In sea-wall construction, however, where we first put in at base a loose rock fill and then drive such piles through the rock as supports for the deck or bulkhead wharf, a hole is made for the pile by driving a wooden "bull-dozer" ahead of it, and the point of the pile is often protected by a steel shoe.

Thus far we have driven piles only into good, firm holding ground, securing usually a penetration of about thirty to forty feet.

Much of our water-front is very soft mud, running frequently to a depth of 100 feet or more, before stiffness is found, and in such regions the concrete pile has not yet been used.

Sometimes the depth of the water at the outer end of our piers puts a limit on the length of piles practicable in such locations.

Results already obtained in handling piles up to 106 feet long and 20 inches square are encouraging us to try even larger piles in some contemplated work, and very likely before long piles 115 to 125 feet long and 2 feet square may be tried. Of course, such piles will necessitate specially built drivers.

Comparing such concrete piles with concrete cylinders, it must be acknowledged that the piles to the lay mind give a most satisfying sense of real strength and durability. You see them made, you can examine them, you know whether there are voids or not, you see them hauled and lifted into position and stand hammering of tremendous force, and you go away with a feeling that that particular thing will stay put for a long, long time. You have all the gratification that comes only from ocular demonstration.

One does not get the same consciousness of sureness from the cylinder type, especially where the concrete cylinder is supported under the mud by wooden piles, which is necessary in the absence of a sufficiently hard bottom to sustain the loads.

Let us turn now to the cylinder form of concrete supports.

They may be divided into two main types as used in the harbor of San Francisco.

The first type was introduced about fifteen years ago and has been entirely abandoned because of its deficiencies manifested by the lapse of time in many piers.

The composition of this type was as follows: Wooden piles, sometimes one, sometimes three close together, were driven to refusal, the tops coming up to near the wharf deck, then a wooden stave form of cylindrical shape was placed around them and driven into the bottom, no steel reinforcement being used, and then the concrete was poured in and allowed to set as best it might. Generally speaking, the mud was too deep to permit one to say that there was any bed-rock or hard bottom at all under this construction. Such cylinders were about three feet in diameter.

It will be seen that in reality this type could be best described as a wooden support, protected by concrete, because the wooden piles carried the load of the wharf and also sustained the concrete, the theory being merely to protect the wood from marine borers by the casing of concrete.

To be clear, I may add that these borers cannot live below the mud line, and, of course, it is well known that wood while covered by water or mud will last indefinitely.

The design of such cylinders, which almost uniformly proved failures, contemplated that the bottom of the concrete would extend about two feet below the mud line. The calculation was that this was sufficiently deep to guard against shifting or other removal of the mud, that might in consequence expose the wooden piles to the attacks of the voracious teredo.

This calculation proved futile. Modern vessels with their swift and powerful propellers, raised such a disturbance of the waters, that the mud was whipped or sucked away from the supporting wooden piles. The teredos thereupon honeycombed them full of holes in short order, and the concrete columns above them necessarily fell into the water. This was a common occurrence in piers so designed.

Such cylinders were all built without steel reinforcement, but the absence of the reinforcement was manifestly not the particular cause of failure in this instance, as the whole cylinder fell when the wooden supports were eaten off by the teredo.

Another serious mistake, with costly consequences, was made by pouring the wet concrete mixture into the cylinders without removing the water from the bottom of the form. The result invariably was that such wet mixture deposited in water never did set into true concrete at all, since the cement was practically washed out of it. Disintegration of the bottoms of such cylinders followed rapidly.

We have mentioned the faulty design, due to not putting the end of the concrete cylinder deep enough into the mud, and we have mentioned the ignorant method of depositing the concrete mixture into water at the bottom of the form, and when we add the fact that probably the mixture itself was often bad or defective in its cement or rock or other ingredient or in the proportions employed, we have accounted for the resulting condition of such cylinders, which for the most part were costly failures.

From these causes about twenty-five per cent. of our piers went out of commission in the past four years, such piers varying in age from six to twelve years.

It was impossible to repair them with concrete and subsequently they had to be rebuilt with creosoted wooden piles driven in and set with considerable difficulty and cost under the existing wharf decks and sheds.

Profiting by the experience of their predecessors, our engineers in the past four years have improved on the old type of concrete cylinder and in the actual work of installing them in several noticeable respects, and have employed what we may designate as our second type of concrete cylinders.

This type is really founded on an entirely different principle.

If wooden piles are used to support the cylinder, as they must be in mud bottoms where there is no bed-rock, the piles are driven to about eight feet below the permanent dredge line, and come up into the concrete cylinder only about five feet, the theory being that the wood supports the cylinder and then the cylinder supports the wharf. This arrangement, we believe, guards sufficiently against the possibility that the wood will, by shifting of the mud, become exposed to teredo attacks.

The method is first to drive a steel shell, or caisson, in cylindrical shape into the bottom, so that it can be sealed. The mud is dredged out of it and the water pumped out, and the wooden form with the steel reinforcement already set in it is lowered into the steel shell. Great care is taken to clean and dry the bottom of the form as thoroughly as possible, and then the concrete mixture is poured in and tamped down by hand.

After the concrete is set, the steel shell is pulled off by the pile-driving apparatus and again used elsewhere.

Steel reinforcing rods are always used, usually three-quarters of an inch square, and from eight to twelve rods in each cylinder. The concrete columns when finished are from three to four feet in diameter.

Spiral wire hooping is also used around the reinforcement, as already described with respect to the concrete piles.

The mixing of the concrete is carefully inspected by competent inspectors of our own selection; the cement, steel and concrete are tested by our own testing engineers; and the cement is bought by us and furnished to the contractor for the work.

It may be of interest to add that in the concrete mixture now used in the harbor of San Francisco, the proportion of cement to the aggregate is 1 to 5 in the pile, and 1 to 6 in the wharf deck and cylinders.

Our experience with cylinders has warranted the deduction that where at all practicable the cylinders should rest on bed-rock, thus avoiding the use of wooden supports below them. By bed-rock, of course, we mean any bottom hard enough to carry the load.

In San Francisco harbor, as far as it has been improved, such bed-rock has been found in only one limited district, and in that stretch seven piers have been built, supported by concrete columns or cylinders of the type last described, and going down to hard-pan and without any wooden supports under them at all. These piers range from 130 to 200 feet wide and from 650 to 800 feet long.

Our pier-head line is limited by the United States government to a distance of 800 feet from the sea-wall, or shore line bulkhead.

Where a greater length of pier than 800 feet is desired, the object is accomplished by inclining the pier at an angle to the sea-wall, thus affording some berths of over 900 or 1,000 feet in length.

The minimum depth of water is 33 feet at the bulkhead line, which depth is enjoined by statute, and the depth at the outer end of the pier averages over 50 feet, and in a number of cases is as much as 70 feet.

It happens that the best bottom is in the district where the water is deepest, and consequently the construction of piers resting on concrete cylinders going down to bed-rock in this district was necessarily very expensive.

Some idea of the quantities involved in building such a pier, 200 feet wide, 800 feet long, in water much of it 50 to 60 feet deep and supported by concrete columns three to four feet in diameter, may be gathered by reflecting that the outer end of the pier would be as high as a five-story building; and with a shed on top of that about 35 feet high.

If the depth of water is not too great and the bottom is of such character as permits us a choice between concrete piles and concrete cylinders as wharf supports, experience with both types has brought us to a decision in favor of the piles. As I have said, we feel better satisfied that we know what we have got.

In short, where bottom conditions permit, we exercise a preference in favor of concrete over wood, however treated or protected; and when it comes to concrete we prefer the driven pile type to the built-up cylinder type.

TORONTO TERMINALS RAILWAYS COMPANY.

At the annual meeting of the Toronto Terminals Railways Company, Mr. Howard G. Kelley, president of the company, reported good progress on the construction of the new station building in Toronto, which will be owned and occupied jointly by the Canadian Pacific and Grand Trunk Railway companies, each of which holds an equal interest in the property. The steel work on the new building was reported as practically all complete, and the stone work is being delivered and cut preparatory to its erection, which it is expected will be commenced during the present month.

The directors and officers of the company were elected as follows: Directors, Messrs. George Bury, I. G. Ogden and E. W. Beatty, K.C., representing the Canadian Pacific Railway Company, and Messrs. E. J. Chamberlin, Howard G. Kelley and J. E. Dalrymple, representing the Grand Trunk Railway Company. Officers, Mr. Howard G. Kelley, President; Mr. Geo. Bury, vice-president; Mr. Henry Philips, secretary; Mr. H. E. Suckling, treasurer; Mr. W. H. Ardley, auditor; Mr. J. W. Leonard, general manager; Mr. W. C. Chisholm, K.C., general solicitor; Mr. J. R. W. Ambrose, chief engineer; Messrs. W. H. Biggar, K.C., E. W. Beatty, K.C., general counsel; Messrs. H. R. Safford and J. M. R. Fairbairn, consulting engineers.

OTTAWA PUBLIC COMFORT STATION.

By H. L. Seymour, A.M.Can.Soc.C.E.

UNDER the excellent town-planning legislation now enacted, or to be enacted, in most of our Canadian provinces, the questions of location, design and maintenance of public comfort stations will undoubtedly receive full consideration in town planning schemes for new areas or for changes in old civic plans. For town planning consists essentially in the careful and intelligent planning for the present and future needs of the community.

The necessity of public comfort stations is one that will more and more undoubtedly be brought to the attention of the municipal engineer in Canada. Especially will this be true in the small city or town where he is the engineering "maid-of-all-work" and expected to have very wide knowledge even to designing and constructing a public comfort station for which ordinarily the services of an architect and a sanitary engineer are retained.

One hundred years ago, all sanitary matters, and particularly those relating to sewage and sewage disposal, received but scant attention. Sewers, while regarded as necessary, were not considered a fit subject for discussion and much less for scientific investigation; their construction and maintenance were left to the lowest type of laborers with results often inimical to health. Sanitary engineering and sanitation are subjects now receiving, however, a great deal of attention from at least a part of the engineering and medical profession. This is gradually having its effect on the layman, who, though he may not understand fully the distinction between, say, typhoid and colon bacilli, yet has some grasp of the bacterial theory of disease and is generally anxious to keep clear of microbes, bacteria or whatever the scientist cares to call them. But there still remains a feeling of what for a better term may be called "false modesty" in regard to many sanitary matters. When the question of a public comfort station at last forces itself upon the attention of a municipality then is this feeling, based not on reason but mostly in prejudice, most prevalent. The location,

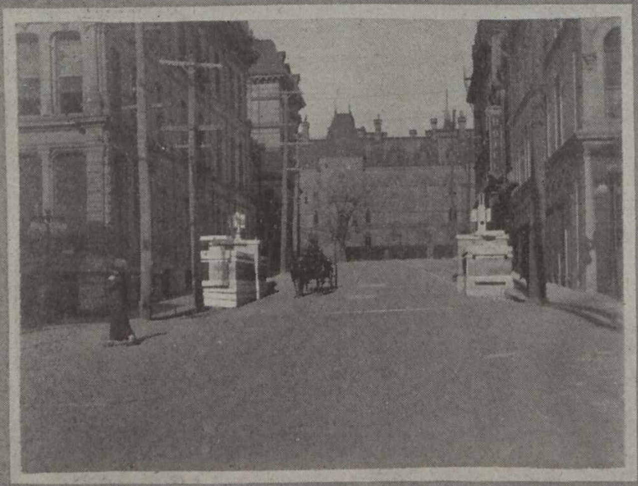


Fig. 1.—View of Ottawa Public Comfort Station Looking North on O'Connor Street.

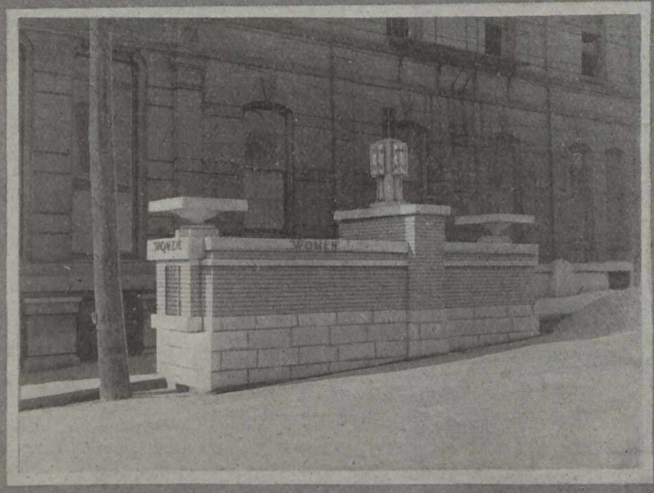


Fig. 2.—A Closer View of One of the Entrances.

There does not seem to have been any good reason why the question of public comfort stations has not received greater attention before. In Canada, as in the United States, we have depended largely on hotels, railway stations and department stores to look after our citizens in this respect. This has worked an injustice to all parties concerned. As far as the writer knows, there is not, nor there never has been, any legal obligation on the part of hotels or similar institutions to provide public comfort conveniences. Many people are forced with reluctance to avail themselves of such accommodation, which is not always the best. About a year ago, in his annual address, President W. T. Sedgwick, Ph.D., of the American Public Health Association, made the following significant statement:—

"Probably the most flagrant failure in American sanitation to-day is the almost universal lack of public convenience or comfort stations in American cities and towns. The stranger within the gates of most American cities seeks in vain for any public sanitary conveniences, being referred, if he is well dressed, to hotels or other semi-public buildings or, if he is poorly dressed, to saloons or railway stations, or other semi-private or public-service places."

design and policy of maintenance of a public comfort station may be so altered to meet the views of "false modesty" and "false economy" advocates that its usefulness is impaired and its healthfulness endangered.

The history of the Ottawa Public Comfort Station is rather typical and illustrates a number of points that might prove of interest to the municipal engineer and aldermen of the city or town impressed with the advisability and necessity of one or more public comfort stations.

Until recently the capital of Canada, with its population now running rapidly beyond the hundred thousand line had not a single comfort station within its boundaries. After a discussion lasting from ten to fifteen years the lack has now been supplied—but only so far as the centre of the city is concerned—by the completion of the work illustrated in the photographs that accompany this article. Commenting on a similar instance in a New England city where ten years of effort was necessary to get a comfort station built, Prof. Sedgwick said in the address referred to above: "Failure like this to provide proper public toilet facilities in our towns and cities is to fail in one of the very elements of sound public health service."

Mr. Fras. C. Sullivan, an Ottawa architect and engineer, was commissioned to prepare a scheme and plans.

He has given considerable attention to this whole question and during the last ten years has inspected a number of comfort stations in the United States. He found, in common with those who have made investigations and given the question serious thought, that the comfort station which shamefacedly hides itself under ground or in a corner is left to be used only by the lower class of the population. City councils tend to deny to such places proper appropriation for maintenance.

Mr. Sullivan, therefore, proposed a public comfort station in the city hall square, with an approach and showing above ground that would be likely to make the people understand that the institution was intended for the benefit of all.

Opposition developed to the location. But the site ultimately chosen has advantages as it would probably be impossible to choose a spot nearer to the busiest part of the city. It is within four blocks of the Central Station and on O'Connor Street within a few feet of its junction with the main (Sparks) street that the new comfort station has been built.

For some time after the contract had been let and construction was supposed to have begun, the initial work was delayed by the controversy over the appearance which the comfort station should present from the street. As gathered from accounts in the public press, what was wanted by some was a hole in the ground and a ventilation stand-pipe. The disguising of this pipe seemed to be the only æsthetic problem involved in the matter as they viewed it.

The architect, on the other hand, tried to convince Ottawa that such a construction was worthy of what he considered correct architectural treatment. A compromise was finally effected and Fig. 1 shows what passers-by see of the Ottawa comfort station. Without pretending to criticize from an architectural standpoint, the writer feels that whatever the original design may have been, the result now attained, having regard to the possibilities of the location, is very pleasing.

The advantages of the all-above-ground station, which is the preferred type in France and Germany, are many. From a sanitary point of view there is the assurance of fresh air for ventilation, sunlight for illumination and natural disinfection. The A B C of sanitation is cleanliness; that is easily made possible by plenty of fresh air and sunlight in which objectionable bacteria cannot long exist. Again, the sewer connections can always be made without having recourse to pumping; automatic sewage ejectors, necessary in many underground stations, do not always operate satisfactorily, as experience has shown.

The above-ground station also lends itself more readily to architectural treatment. It need not be made too conspicuous but, on the other hand, it should not be hidden away where its usefulness is curtailed and it becomes a tribute merely to false modesty. As to the disadvantages, no space may be available in the area to be served for an above-ground station, and there may be some cases in which such a building would prove a real detriment to a neighborhood. As to this latter point, however, the case of (as the writer recollects it) a Seattle business man might be cited who some years ago strenuously opposed the erection of a public comfort station in his locality. He went so far as to instruct his lawyers to get out an injunction, but they advised him that such action under the circumstances could not be legally taken. A year or so after the station was in operation he expressed himself as very pleased with the results from his own business standpoint, and said the best thing that ever happened was that he was not allowed to have the injunction made effective.

The Ottawa station, except the entrances or approaches, is on account of its location, necessarily all under ground. It occupies the space under the whole width of the roadway of O'Connor Street, being in all 44 feet wide. There is a clearance on the street of over 30 feet for traffic and 7 feet for pedestrians on each side. The exposed parts of the structure are faced with local

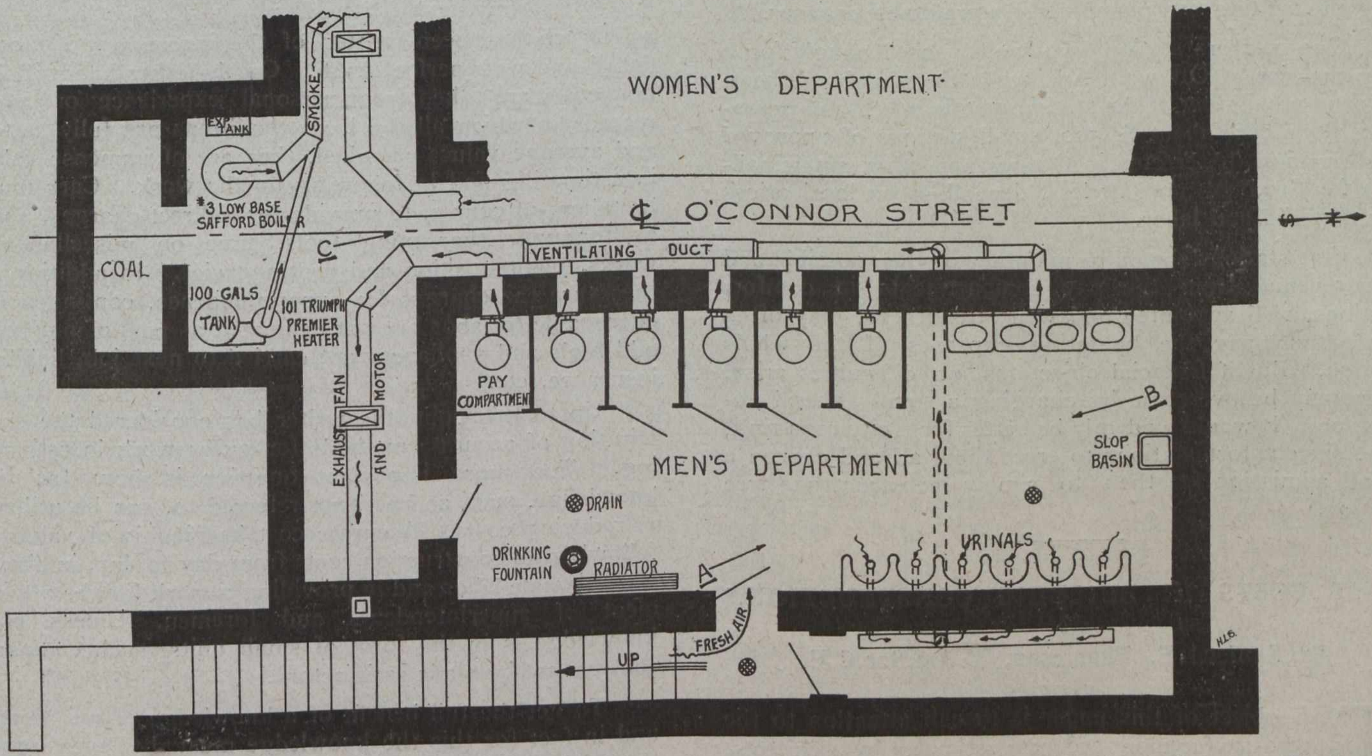


Fig. 3.—Half Floor Plan of Ottawa Public Comfort Station, Showing General Arrangement of Fixtures, Heating Apparatus and Methods of Ventilation.

limestone, rustic brick and topped with Indiana stone. The exterior walls are of concrete and the partitions of brick.

The interior arrangements of the station are generally indicated in Fig. 3. It may be said that the interiors of all modern public comfort stations are very similar, the arrangement and kind of fixtures, shape, and dimension of the building, and general arrangement of the various compartments being the only details in which they differ.

The Ottawa station is, as usual, divided into two equal parts, the space on one side being for women and on the other for men, the general arrangements of the interior fixtures for the latter being shown in Fig. 3.

The total contract price of the comfort station was $19,708.26, the work being acceptably carried out by Messrs. Murphy Bros., of Ottawa; Messrs. A. Gauthier & Co., sanitary and heating engineers, of Ottawa, installing the heating and plumbing in a creditable manner.

One comfort station is obviously not enough for a city the size of Ottawa. And while the plumbing, heating and ventilating of the station now in successful operation alone cost about $4,500, small stations of approved design might be erected in Ottawa and other municipalities for $10,000, more or less, depending on local prices for material and labor.

Free stations should be maintained when possible and the revenue from the pay compartments in comfort stations, well appointed and well attended to, may often more than pay the operating expenses of the whole station. But if financial objections or difficulties arise, they may be overcome by charging a small general admission. It would evidently be better for a city requiring, say, six comfort stations to erect them all and charge a small admission fee than to simply construct one free station.

UNIT COSTS IN BUILDING CONSTRUCTION.*

By Sanford E. Thompson, M.Am.Soc.C.E.

THE object of this paper is to call attention to the necessity for more accurate estimates by architects, engineers and contractors, and to the possibility of reducing construction costs by a more thorough analysis and organization of operations.

Unquestionably the methods of management, especially on construction jobs, affect the cost to a very large extent, but it is hardly conceivable that differences of 50 per cent., as often noticed in tenders for the same contract, can be accounted for in this way. Such variations must be due to one of three causes: (1) Inaccurate estimates of volumes or costs of materials; (2) inaccurate estimates of labor costs; or (3) inaccurate estimates of overhead costs and profits.

Material costs are usually figured without trouble. The variation in overhead costs by two different estimators may be large, but the difference on any one job can hardly account for more than 10 per cent. The big variation, then, must be in the estimated labor cost. As a matter of fact, this is the item on which money is made or lost in contracting.

In reinforced concrete construction, the greatest discrepancy lies in the cost of forms. It is here that the contractor is apt to be fooled unless he is either well provided with unit costs, or has previously handled work of an identical nature.

Suppose, for example, a builder has been accustomed to building forms for heavy concrete work, and finds from his records that the cost of labor for such forms is 50 cents per cubic yard. He bids on a reinforced concrete building, and adds 50 per cent., or 100 per cent. to be on the safe side, and figures $1 per cubic yard for labor on forms, with the result that he may find the actual cost to be about $4 per cubic yard and discover, further, that the cubic yard basis is absolutely incorrect. He then adopts the square foot as the unit. This is better, but as shown by an example from actual experience given at length in the paper (but not repeated here owing to limitations of space), estimates on this basis may be absolutely incorrect if prepared by a contractor with limited experience of reinforced concrete construction.

Much has been written of the inaccuracy of "cost data" and with perfect truth. On the other hand, if the unit costs are taken from personal experience or from records in which all the local conditions are fully stated and average values compiled, they are of immense value in estimating and in following up the work. Care must be taken, of course, to provide for indirect charges, such as foreman, sharpening tools, time on miscellaneous works, plant erection and contingencies. In addition to these are the charges for superintendence, contingencies chargeable to labor but not estimated as part of pay roll, odd tools and appliances not carried to next job, liability insurance, etc.

Up to this point the writer has considered the substitution of accurate methods for guess work in estimating. The more important question is how far the knowledge, such as has been referred to, can be utilized in reducing costs. Accurate cost keeping is of value in following up construction costs from day to day, in showing up waste labor and in providing a mark for the attainment of superintendents and foremen. Unless cost knowledge is in the form of small units, such comparisons cannot be made satisfactory.

To get the full benefit of a knowledge of unit costs, and in fact for this the knowledge must be even more thorough and include the unit times of performing the various operations, it must be utilized in planning the work in advance and in distributing materials and jobs; in selecting materials and methods which will result in lowest labor costs; in adapting the construction plant to the special conditions; and, carried to its ultimate end, in laying out jobs for the workmen and giving them a reward for accomplishment.

Such management as this involves the adoption of factory methods in construction. Already the need of this is being recognized, but to a limited degree only. The president of one of our large and most up-to-date construction companies stated recently that on one job he made a saving of $10,000 by the adoption of methods involving systematic planning and routing.

Limitation of time forbids a more complete discussion of this most important problem. Full economy in construction, however, will only be attained as the builder discards the haphazard rule-of-thumb method and considers his job with a view to thorough analysis, planning functional methods and a complete study of details. By such methods as these will the labor of construction be brought to a more scientific basis and more nearly on a par with the material end of the work.

*From a paper read before the American Concrete Inst.

DIGESTION OF ACTIVATED SLUDGE.*

By Harrison P. Eddy,
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

AMONG the industrial wastes disposal problems which have been troublesome in Massachusetts during the past decade, is that of a large sheepskin tannery. While a satisfactory effluent can be produced by any one of several different methods, investigations have been carried out to determine, by actual test, their practicability and efficiency, with a view to ascertaining which is the best method for adoption.

These investigations have included the construction and operation for over a year of a trickling filter, and for nearly a year, of an activated sludge plant. Both processes have been demonstrated to be applicable to the treatment of these wastes. The latter appears to require as much as 10 cu. ft. of free air per gallon of wastes treated and that the aeration be continued for a period of about 12 hours. Quiescent sedimentation for two hours is required for efficient removal of the suspended matter after aeration.

Under these conditions the clarification and oxidation may be expected to be fully equal to and probably better than those obtained by a trickling filter 7½ ft. deep operating at a rate of 750,000 gallons per acre per day.

The wastes used for these tests were first passed through sedimentation tanks, to remove the major portion of the suspended solids, in order to prevent the accumulation of a large quantity of very heavy matter in the aerating tank. This preliminary treatment also provided for equalizing the quality of the wastes.

Because of this treatment the sludge produced by the activated sludge process consisted principally of substances which had been in colloidal or dissolved condition and it may have been more susceptible to bacterial attack than sludge comprising the coarse suspended matter as well as substances precipitated from colloidal and dissolved condition.

The settled wastes were much stronger than average unsettled municipal sewage, as shown by Table I.

Table I.—Analyses of Settled Tannery Wastes and Unsettled Municipal Sewage.

Determination	Settled Tannery Wastes Mar. 6—July 17, p.p.m.	Unsettled Worcester, Mass. Sewage, p.p.m.
Oxygen consumed	702	193
Albuminoid ammonia	14.4	7.1
Total solids	2,740	882
Loss on ignition	635	429

The results of these analyses indicate that the tannery wastes, even after efficient sedimentation, were in a general way three times as strong as the municipal sewage of the city of Worcester. Furthermore, the wastes contained large quantities of fats originating partly in the tannery proper and partly in the wool scouring department. The fats determined by extraction with ether, amounted to about 140 p.p.m. In addition, about an equal quantity of fat was present in the form of soaps.

Sludge Accumulation Period.—The tests were begun December 29, 1915, and while there was a gradual accumulation of sludge, it early became evident that the process of activating the sludge would be exceedingly slow, as the temperature of the wastes was below 50° F. The wastes were therefore warmed to about 70° F., by discharging live steam into the aerating tank for the necessary period of time. The quantity of sludge accumulated gradually until the end of the period, February 7, 1916, when it amounted to about 20% of the normal capacity of the tank, equivalent to about 25% of its influent capacity.

The sludge produced at first, was similar to that resulting from plain sedimentation, except that it was less dense. When the treatment began to be effective the sludge became coarse and feathery in nature and purplish-brown in color. Later it lost the purple color and the flocks became finer. Records of the quantity of air used, of temperature, volume of sludge produced, proportion of water in the sludge, and data relating to digestion, for this and succeeding periods, are given in Table II.

During this period 11,030 gallons of sludge per million gallons of influent, were produced and accumulated in the aeration tank. The results of analyses of samples carefully taken, indicate that about 71% of the organic substances removed from the sewage, were unaccounted for by the analysis of the sludge.

Sludge Activation Period.—With a view to increasing the activity of the sludge, the contents of the tank, after being filled on February 7, were continuously aerated until March 6, no wastes being introduced between these dates. The loss of organic matter during this period amounted to 40.7%, the volume of sludge being reduced 62.4%. It is somewhat surprising to find that the actual reduction in solid matters was very much less than during the previous period of one filling a day. One explanation of this difference may be that during the earlier period the larger volume of wastes aerated, in proportion to sludge, provided a larger quantity of matter easily attacked by bacteria, whereas during the second period the sludge had already been worked over by them for a considerable time.

On one occasion, through an error, the air was turned on at full pressure, causing the violent agitation of the tank contents. This resulted in a marked disintegration of the sludge, after which settled samples from the aeration tank were decidedly muddy in appearance. The fine suspended matter into which the sludge had been broken up, did not recoagulate on further normal aeration.

Period of Operation on One Filling per Day.—Beginning March 6, the aeration tank was put into operation again on a schedule of one filling each working day, the contents of the tank being heated, by the introduction of live steam, to a temperature of about 70° F. During this period the total quantity of sludge increased over 100%, although the average quantity present per filling was but 24.3% of the influent. The sludge became darker in color and more flocculent. When freshly collected, it had only a slight earthy odor, but on standing over night developed a disagreeable fishy smell.

Period of Operation with Increased Proportion of Sludge.—The period from April 3 to May 1 was marked by an increase in the proportion of sludge to the quantity of wastes treated. The tank was operated on the basis of one filling each working day and the wastes were artificially heated to approximately 70° F. As there was only a slight accumulation of sludge during the period, the quantity of influent was reduced to increase the proportion of the sludge, which averaged 28.7% of the influent treated. With this increase in proportion of sludge, there was a decrease in the turbidity of the

*Read before the American Society of Municipal Improvement, October 11-14, 1916.

effluent, which had previously been very marked. Most of the samples which were decidedly turbid passed the putrescibility tests, indicating that stability may precede clarification under some circumstances. In spite of the net increase in the volume of sludge in the tank during this period, the total volume of sludge produced per million gallons of wastes treated, from the beginning of the test to May 1, was reduced 23% below the corresponding quantity as of April 3. There was an apparent loss of 93.8% of total solids and 89.7% of organic matter.

Period of Operation on One Filling per Day.—The period from May 1 to May 29 differed from the preceding one mainly because artificial heating of the contents of the aeration tank was discontinued. The tank was filled six times a week, each filling being aerated for about 21 hours, except that the Saturday filling received about 45 hours' aeration. As in previous periods, the proportion of activated sludge was slightly greater than in the preceding period. The volume of sludge present decreased until May 15 and then increased again, the net increase for the period being 3,150 gallons per million gallons of wastes treated. The total volume of sludge produced per million gallons of wastes treated to June 2 was 3,910 gallons, a decrease of 6.2% from that produced to May 1.

The loss of total solids during this period amounted to 90.1% and of organic matter to 88.0%.

Period of Operation on Two Fillings a Day.—From May 29 to June 21 the aeration tank was filled twice daily, thus reducing the period of aeration slightly over 50%.

Table II.—Data Relating to Digestion of Activated Sludge.

Period	No. of cubic feet Free Air used per gal. of influent	Average Temperature in Aeration Tank. Degrees F.	Volume of Sludge produced to date. Gals. per m.g.	Proportion of Water in Sludge. Per cent.	Quantity Removed from Wastes. Lbs. per m.g.	Quantity Found in Sludge. Lbs. per m.g.	Quantity Digested Lbs. per m.g.	Quantity Digested Per cent.*
Dec. 29-Feb. 7 (sludge accum. period)	12.20	59.3	11,030	98.6				
Total solids					3,811	1,225	2,586	67.9
Organic matter					2,840	815	2,025	71.3
Mineral matter					971	410	561	57.8
Fats					995	Not determined		
Feb. 7-Mar. 6 (period of sludge activ't'n)	457	67.1	(Period of continuous aeration)					
Total solids								30.1
Organic matter								40.7
Mineral matter								18.1
Fats								
Mar. 6-Apr. 3 (period of 1 filling daily)	17.19		5,410	97.24				
Artificial heat		69.5						
Total solids					6,230	2,362	3,868	62.1
Organic matter					4,680	1,675	3,005	62.9
Mineral matter					1,550	687	863	55.3
Fats					1,470	219	1,251	85.1
Apr. 3-May 1 (period of 1 filling daily)	18.31		4,170	97.16				
Artificial heat		69.8						
Total solids					5,420	339	5,081	93.8
Organic matter					3,980	411	3,569	89.7
Mineral matter					1,440	—72	1,512	105.0
Fats					1,175	32	1,143	97.3
May 1-May 29 (period of 1 filling daily)	14.30	69.4	3,910	97.45				
Total solids					3,780	374	3,406	90.1
Organic matter					3,060	368	2,692	88.0
Mineral matter					720	6	714	99.2
Fats					454	28	426	93.8
May 29-June 21 (period of 2 fill'gs daily)	11.00	72.0	2,770	97.03				
Total solids					1,612	28	1,584	98.9
Organic matter					1,227	42	1,185	96.6
Mineral matter					385	—14	399	103.7
Fats					476	—227	703	147.6
June 21-July 17 (period of 2 fillings per day with occasional removal of sludge)	10.99	79	4,630†	97.79				
Total solids					3,740	1,592	2,148	57.5
Organic matter					2,960	1,208	1,752	59.2
Mineral matter					780	384	396	50.1
Fats					814	374	440	54.1
Dec. 29-July 17 (summary								
Total solids					4,070	896	3,174	78.0
Organic matter					3,155	692	2,463	78.1
Mineral matter					915	204	711	77.8
Fats					893	101	792	88.7

* Based on amounts removed from influent and amounts remaining in sludge. † Nearly 10,000 gal. per gal. of influent produced during this period.

Beginning June 12, the effluent became decidely muddy in appearance, due to the presence of much finely divided suspended matter which did not settle out in the period of sedimentation afforded. It was evident that the sludge was becoming disintegrated, but this condition could not have been due to violent agitation, since the air had been applied at only a moderate pressure. The proportion of sludge was much greater than during the preceding period, though not unreasonably large, being only about 30% of the total volume aerated.

On June 13 the top water was still muddier in appearance, and aeration was continued for an additional nine hours with no improvement in the appearance of the effluent. In fact, there was no improvement in the effluent throughout this period, although air was applied at widely differing rates and different periods of aeration were afforded. The effluent for the week ending June 19 showed 200 parts per million of suspended solids.

Although no sludge had been removed from the aeration tank since the beginning of the tests on December 29, sufficient sludge had not accumulated during the six months to afford as large a proportion of activated sludge as was desired for the tests. It is probable that the long-continued aeration of the sludge had produced a humus-like substance, which became so great in quantity that it could no longer be held mechanically in the body of the sludge and was drawn off as semi-colloidal non-settling matter.

The fine suspended matter drawn off was comparatively stable, like humus, and the sludge was in a highly activated condition. In fact, it may be said that the unsatisfactory appearance of the effluent was due to over-activation of the sludge. The only remedy appeared to be to remove a portion of this old sludge, with a view to building up a larger proportion of fresh sludge.

Accordingly, on June 21, nearly half of the sludge was removed, and the aeration tank continued in operation on two fillings a day. The effluent from the first filling after reducing the proportion of sludge, showed no appreciable improvement in clarification, but the effluent from the next filling showed a marked improvement, and after two days the effluent became nearly normal, the suspended matter having been reduced from about 200 p.p.m. on June 21 to about 50 p.p.m. on June 24. The volume of sludge in the aeration tank increased nearly 40% in eight fillings.

There was a net loss of 13.8% in the volume of sludge in the tank during the period, but this was not wholly due to bacterial action as a large quantity of fine disintegrated sludge was carried away in the effluent, as previously mentioned. The volume of sludge produced to June 21 was 2,770 gallons per million gallons of wastes treated, a reduction of 29.2% from that on June 2.

The loss in total solids during this period amounted to 98.9% and of organic matter to 96.6%. Computation showed that the loss in total solids from March 6 to June 21 amounted to 82% and that in organic matter to 80.9%. The loss in fats during this period of somewhat over three months amounted to 98%.

Period of Operation on Two Fillings a Day, with Removal of Sludge.—From June 21 to July 17 the test was continued on two fillings of the tank each day. On June 21 half of the sludge was removed and a rapid accumulation of sludge followed. On July 5 another removal of half of the sludge was made, and again on July 17.

After removing half of the sludge from the aeration tank on June 21, the effluent began to lose its muddy appearance, and on June 24 it had merely a distinct turbidity with suspended matter equivalent to about 50 parts per million. On June 28 the effluent became decidedly turbid and the stability decreased materially. The second day after the removal of about half of the sludge on July 5, the effluent was only slightly turbid and contained only about 18 parts per million of suspended matter. It was perfectly stable.

The total volume of sludge produced during the period was equivalent to nearly 10,000 gallons per million gallons of wastes treated, nearly as much as for the first period. By removing the sludge frequently, time was not allowed for the bacterial action which would have caused liquefaction and gasification. The volume of sludge produced to July 17 was 4,630 gallons per million gallons of wastes treated—an increase of 67% over that produced prior to June 21. The total solids removed from the wastes, but unaccounted for in the sludge, amounted to 57.5% and the organic matter to 59.2%. There was a similar loss in fats, amounting to 54.1%.

Sludge Digestion.—One of the most significant facts developed by this test is the disappearance of material removed from the wastes and which at first thought would be expected to be present in the sludge.

It is a law of chemistry that when chemical action takes place the sum of the resulting substances is equal in weight to the sum of the substances entering into the reaction. Matter is indestructible. It follows, therefore, that the amount of solids disappearing must have passed into the atmosphere as gas. It may fairly be assumed that bacterial action was largely responsible for this loss. The liquefaction and gasification of sewage solids by bacteria is called bacterial digestion. By reference to Table II. it will be seen that during this test from December 29 to July 17 there was lost, through such digestion, 78.1% of the organic matter removed from the wastes.

Bacterial digestion of organic matter is generally accompanied by an increase in mineral matter. In this case there appears to have been an actual decrease in mineral matter of 77.8%. It is hardly conceivable that bacteria could have digested mineral matter. It is quite possible, however, for mineral matter to be so changed in composition, as a result of bacterial action, that the fixed matter remaining after ignition will have a different weight. For example, calcium nitrate may be precipitated by carbon dioxide resulting from bacterial action, in the form of calcium carbonate, which, after ignition, would be weighed as calcium oxide with an apparent loss of about 56%.

It seems quite certain that chemical action taking place during aeration explains the apparent loss in mineral matter. With such a variety of chemicals as is found in these wastes, it is to be expected that a variety of chemical reactions will take place on aeration. The marked avidity of the wastes for oxygen shows that chemical oxidation takes place on aeration.

Quantity of Sludge Produced.—The quantity of sludge which will be produced by the activated sludge process will depend upon the method of operation and the extent to which bacterial digestion of the sludge is carried. The results of these tests show that it is possible to activate the sludge to the point where there is practically no increase in the volume of sludge. To do this undoubtedly requires the expenditure of an amount of air greatly in excess of that required to produce a satisfactory effluent.

On the other hand, it does not appear to be possible to accomplish satisfactory purification of the wastes by this process without considerable digestion of sludge.

With the most economical use of air, the volume of sludge to be disposed of will probably not exceed 10,000 gallons per million gallons of wastes treated.

During the period of sludge accumulation from December 29 to February 7, there was produced a total of about 11,000 gallons of sludge per million gallons of wastes treated. During the period of sludge activation from February 7 to March 6, this volume was reduced 62%. After operating on one filling a day until May 23, the total volume of sludge produced was less than 3,000 gallons per million gallons of wastes treated. After starting on the schedule of 2 fillings a day the sludge became more voluminous, but owing to over-activation the volume of sludge decreased until June 21, when the total volume of sludge produced fell to 2,770 gallons per million gallons of wastes treated up to that time. During the period from June 21 to July 17, with occasional removal of sludge from the aeration tank, the sludge production was nearly 10,000 gallons per million gallons of wastes treated. During the latter part of this period the sludge was not kept as well activated as is desirable. With better activation of the sludge the volume would be reduced.

Digestion of Fats.—It is particularly interesting to note the digestion of fats which occurred during this test. From the beginning until July 17 the quantity of fats which disappeared and were apparently digested by bacterial action, amounted to 88.7% of the quantity removed from the influent. This quantity was intrinsically large, amounting to 5,792 lbs. per million gallons, equivalent to nearly 91 parts per million. In other methods applied to the treatment of municipal sewage, it has been found that the digestion of fats was a relatively slow process and quite the reverse of the action in this test.

Increasing Volume of Sludge by Its Partial Removal.—It appears to be essential to efficient clarification, and probably to the production of a stable effluent, to remove the sludge at relatively frequent intervals. If this is not done the sludge becomes over-activated, resulting in disintegration, a turbid effluent and a reduction in the volume of sludge. By withdrawing a portion of the sludge at regular and frequent intervals it is to be expected that a larger quantity of sludge will be produced and that it will be of such a character as to perform its function more efficiently than if allowed to remain too long in service.

It is conceivable that under some conditions over-activation of the sludge may be warranted as a means of reducing its volume and the difficulty of its ultimate disposal. This would be where the quantity produced or the ingredients of fertilizing value are too small to warrant an attempt to convert the sludge into marketable fertilizer.

RAILWAY AND HIGHWAY.*

By C. A. Magrath, Ottawa.

THE railway is life. On this continent no farming district can hold its own if it has not railway communication with the markets and centres of population, and our distribution of railway lines has proceeded with little or no control on the part of the people. We have an enormous mileage in proportion to our population; but the earlier distribution of our railway lines was governed by the earlier and mistaken view of the economics of land transportation. People thought that railway rates were to be governed by competition alone, and towns and districts fought with each other to secure rival railways, only to discover that the competitors did not compete. To the era of competition has succeeded that of regulation; but the fruit of the old method is to be seen in the eccentric and unscientific distribution of our branch railways—the lines that serve the farmers. All over the country, but more especially on the prairies, we see districts which are over-served interspersed with districts which are under-served.

Methods forecast results, while results indicate methods. A map hangs in the Railway Committee room of the House of Commons on which is marked every railway project which has been chartered by the Parliament of Canada. It is a remarkable document, eloquent of the utter lack of system with which this all-important subject has been handled. If all the lines which have been authorized were to be built, some would have to be constructed underground, for only so could they find space. Still, the methods have produced the results, and it is no secret that the transportation situation in Canada is approaching a very critical stage indeed. It is to be hoped that we shall not stumble blindly into that critical stage, trusting to mere luck to stagger out again to firm ground. We know the results we must obtain in transportation if we are to be a factor in this North American Continent. We are living beside a great people who do not stop at half measures, and it is with them that we must to a large extent compete in the markets of the world. And the results at which we should aim: what are they? A scientific distribution of rails throughout the country that will obtain the maximum of traffic at a minimum of cost. That result does not seem possible with railway companies "invading each other's territory" as has been the practice in the past. It must be admitted that the problem of determining the method is very far from being easy at this stage of our railway development. It requires courage and an honest, fair treatment of honest investment.

Good Roads Policy Needed.—The railway is supplemented by the highway. Often it costs more to transport the farmer's produce from his farm to the nearest railway station than it does to move it from that station to tidewater. Good market roads are necessary if the farmer is to sell his wares at a fair profit. The whole problem of the highway, perhaps of land transportation in general, has been changed of late by the advent of the motor car; new methods of construction must be devised, and at the same time new opportunities in local transportation are afforded to farmers. One has only to set on one side the picture of a neighborhood intersected with suitable roads leading to a market town, and served by motor trucks carrying loads of two or three tons at eight miles an hour; and on the other the much more familiar scene of a neighborhood provided with wretched tracks over which two-horse teams drag one-ton loads at two miles an hour; and he will realize what a chance the new vehicle offers if our population has the enterprise and the capital to make the advance. A Good Roads Policy—national, provincial and municipal—a policy that will develop highways to the point only of meeting the business needs of the users—is an urgent need of the day.

*Abstract from booklet, "Some Phases of Public Service."

NECESSITY FOR LIMITING THE LOADS, SPEED AND SIZE OF VEHICLES.*

By Eugene W. Stern, M.Can.Soc.C.E.,
Chief Engineer in Charge of Highways, Borough of Manhattan, City of New York.

DURING the past year a great deal of damage has been caused to some of the best pavements in the Borough of Manhattan, City of New York, by heavily loaded, steel-tired trailers hauled by motor vehicles. The destruction has been so rapid that it has brought to the attention of the authorities the necessity for limiting the loads on vehicles to be hauled over the city streets.

In recent years, there has also developed a greatly increased use of the motor vehicle, with increase in size, so that many of the streets in business sections of the city are becoming congested. Unless some limitation is placed upon the size of vehicles, this condition will continue to become worse.

As the weight and size of the vehicle increases, the question of limiting the speed also, must be considered, for it becomes evident that what would be a reasonable speed for an ordinary size vehicle of moderate weight would be detrimental to the public interests in larger and heavier ones.

Damage Caused by Vehicles to City Streets.—The most damage seems to be caused by steel-tired vehicles hauled by motor trucks, or trailers, as they are called.

The case in point is here given: A contractor's outfit hauling rock from the subway excavation on Broadway is made up of a tractor and trailer. The latter carries six large buckets, weighing about 15 tons. Its wheels are

Type of Heavy Trailer Carrying 15 to 18 Tons of Broken Rock Which Caused Excessive Damage to Pavements.

41 ins. in diameter with 8½-in. wide steel tires. The load per inch width of tire is about 1,400 pounds.

The springs on the front axle are spiral and on the rear, flat. They are very stiff, and this fact has unquestionably contributed towards the destructive effect of the wheel loads of the trailer. The jarring effect of the loaded vehicle is such that people along the route travelled complain about excessive vibration in their buildings.

The route traversed has been along West 42nd Street from 8th to 10th Avenues; north on 10th Avenue to 50th Street; west on 50th Street to the dump dock on the North River.

The age and character of pavements on the route is as follows:—

42nd Street from 8th to 9th Avenues—Sheet asphalt on concrete foundation, completed July 22, 1912.

Showing Damage to Granite Blocks.

42nd Street from 9th to 10th Avenues—Improved granite on concrete foundation, completed November 14, 1912.

10th Avenue from 42nd to 50th Streets—Improved granite on concrete foundation, completed February 26, 1913.

50th Street from 10th to 11th Avenues—Sheet asphalt on concrete foundation, completed August 27, 1912.

50th Street from 11th to 12th Avenues—Improved granite on concrete foundation, completed May 25, 1912.

It will thus be noted that these pavements are all substantially about four years old. They are considered among our best pavements, and have been laid in conformity with the latest specifications. Up to the time when the damage began to be done by the above-mentioned trailers, no appreciable amount of wear had been noticed beyond what ordinarily might be expected on thoroughfares with as much traffic as have the streets above mentioned.

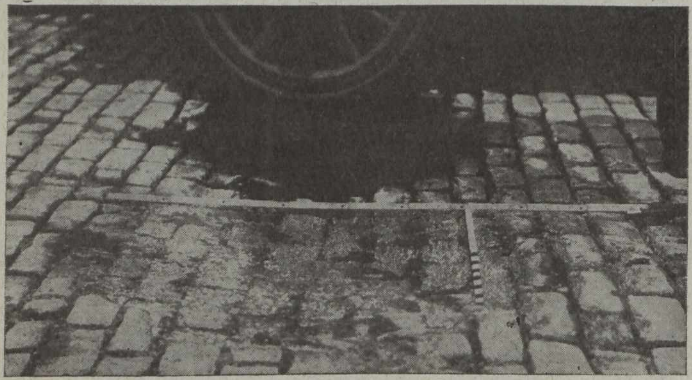
The mischief has all been done in a very short space of time (about nine months), and has amounted to 5,400 yards of repairs on granite (equal to 32% of the total area), costing $6,000, and 1,900 yards of repairs on sheet asphalt (equal to 30% of the total area), costing $1,900; whereas, prior to this time, the average cost per year of maintenance on the granite was $150, and on the sheet asphalt, $70.

The accompanying photographs show the kind of damage that has been done. On granite pavements the granite blocks have been literally crushed and ground into powder. In many cases the blocks were split. The granite used has given splendid service on other streets of the city. The granite on 42nd Street, between 9th and 10th Avenues, was quarried at North Jay, Me., and has a crushing strength of about 20,000 lbs. per square inch. The granite used on 10th Avenue from 42nd to 50th Street, was quarried at Rockport, Mass., and has a crushing strength of 25,000 lbs. per square inch. The granite used on 50th Street was quarried at Salisbury, N.C., and has a crushing strength of 40,000 lbs. per square inch.

*Paper read at Convention of the American Society of Municipal Improvements, Newark, N.J., October 11th, 1916.

On the sheet asphalt, the destructive effect has been equally startling. In some places it has been ground to small bits; in other places the wearing surface has been completely broken and cracked. It shows many depressions, waves and ruts and shoves.

In many cases the 6-inch concrete base has been shattered; however, in many other cases where the wearing surface has been damaged, the foundation remains intact.



Showing Depression.

The speed of these vehicles was about 6 miles per hour in the day time, and at night it was considerably higher—12 and 14 miles per hour, and even 16 at times.

The effect of rubber-tired traffic has been carefully investigated, and practically no damage has been caused by motor vehicles in which all of the wheels are covered with rubber, beyond what is reasonable, although there are some types of heavily loaded trucks in use in the city. Our first-class pavements show practically no additional expense for maintenance beyond a reasonable amount.

The manufacturers of motor vehicles have found by experience that about 750 lbs. per inch width of tire is about all the load the rubber tire will stand, and this load, together with the resiliency of the rubber and the adequate springs on motor vehicles which good construction demands, seem both together to be the saving features in protecting the pavements against undue wear, even under heavy loads.

The trailer, however, comes in an entirely different class. Not being rigidly connected with the vehicle having the engine and the more or less delicate mechanism, it need not have the rubber tires, nor the easy springs to prevent damage to the tractor, hence builders of these, who form a distinct class from the motor vehicle manufacturers, have allowed their fancy no restrictions in the designs of the tractors, their principal object being to provide a vehicle having the greatest tonnage capacity at the least cost, without considering the destructive effect on the pavement caused by the excessive loads, narrow steel tires, small diameter of wheels, and inadequate springs.

It becomes evident, therefore, that immediate action must be taken to protect not only the pavements of the cities and the municipalities immediately surrounding the cities, but also the country highways which are liable to be exposed to such kinds of traffic, or the taxpayers will be called upon to make very heavy payments to maintain their streets and highways, although these may have been constructed in a thoroughly first-class manner and in accordance with the latest ideas.

It goes without saying that a vehicle that would break down the best kinds of city pavements in a short space of a few months, will cause much greater damage to even a first-class country highway much more rapidly.

It would appear to the speaker that regulations properly framed to protect the pavements against the destructive effects of excessive loading in vehicles, should take into account the following factors:—

1. That the wearing or damaging effect of wheel loads on pavements is a function of (*a*) the load; (*b*) the diameter of the wheel; (*c*) the width of tire; (*d*) whether or not the tire is of a resilient material such as rubber, or of steel; (*e*) the kind of springs.

2. That speed has considerable to do with the damaging effect of heavy loads.

An investigation of the laws and ordinances governing the weights and loads of vehicles, etc., adopted by eight states and 49 cities in the United States and Europe, goes to show that only a few laws have been drafted in accordance with modern conditions. It is surprising that even to-day in this country, certain communities require that the width of the tire should depend on the diameter of the axle, regardless of the loading; others make no distinction in the regulations between a wheel large or small in diameter, while still others treat rubber and steel-tired wheels the same.

Among the most up-to-date ordinances are the following:—

Chicago, Ill.—Maximum weight of vehicle, 15 tons; maximum load on any one axle, 12 tons; maximum load on the wheel, 6 tons; maximum load per inch width of tire, 1,000 lbs.; maximum length, 40 ft.; maximum width, 8 ft. 6 ins. Speed: Compatible with safety, but not to exceed 9 miles per hour. Not to exceed 4 miles per hour when truck has defective tire which would cause injury to pavement. Motor trucks must have rubber tires. Trailers may have steel tires.

New York State.—Maximum weight of vehicle, 14 tons; maximum load on any one axle, 9 tons; maximum load per inch width, 800 lbs.; maximum width, 8 ft. 4 ins. (except traction engines, which may have a width of 9 ft. 2 ins.). Speed: Over 4 tons, 15 miles per hour; over 6

Showing Character of Depression to Pavement.

tons, 6 miles per hour, with steel tires, 12 miles per hour with rubber tires.

State of New Jersey.—Maximum weight of vehicle, 12½ tons; maximum load per inch width of tire, 800 lbs. Speed: 4 tons, 12 miles per hour (iron tires); 6 tons, 8 miles per hour (iron tires), 10 miles per hour (rubber tires).

State of Pennsylvania.—Maximum weight of vehicle, 12 tons; maximum load on any one axle, 9 tons; maximum load per inch width of tire, 750 lbs.; maximum width, 7 ft. 6 ins.; for buses in large cities, 8 ft. 4 ins.

State of Massachusetts.—Maximum weight of vehicle, 14 tons; maximum load per inch width of tire, 800 lbs. (except for hard pavements). Speed: 4 tons, 15 miles per hour; 6 tons, 6 miles per hour with iron or steel tires, 12 miles per hour with rubber or similar tires.

Oakland, Cal.—Maximum weight of vehicle, 14 tons; maximum load per inch width of tire, 800 lbs. (except for hard pavements). Speed: 4 tons, 6 miles per hour with iron or steel tires, 12 miles per hour with rubber tires.

England.—The English have much the most complete and scientific ordinances of any that the writer has examined. Maximum weight of vehicle, 12 tons; maximum load on any one axle, 8 tons (for trailers, 4 tons); maximum weight of vehicle, without load, 5 tons; combined weight of motor car and trailer, 6½ tons; weight on axle to be proportioned to diameter of wheel. The load per inch width of tire (steel) shall be 840 lbs. for wheels 3 ft. in diameter; and an additional allowance of 9⅓ lbs. for every additional inch in diameter beyond 3 ft.; and for wheels less than 3 ft. in diameter, a deduction of 18⅔ lbs. per inch width of tire for every inch less in diameter than 3 ft.

Another Sample of the Effect of Too Heavy Loads.

Vehicles for military service limited as follows: Weight of car unladen, 6 tons; weight of car with trailer, 8 tons; unit of registered axle weight with tires shod with cross-bars, 560 lbs.; maximum width, 90 ins. for 3 tons; 90 ins. for trailer. Speed: Dependent on axle weight for iron-tired vehicles; 6 tons, 12 miles per hour for rubber tires; over 6 tons, 8 miles per hour for rubber tires. Should car unladen weigh more than 3 tons, speed is limited to 8 miles per hour. If motor draws trailer, maximum speed is 5 miles per hour.

Width of Vehicles.—Unless some limitation is placed upon the size of vehicles, the tendency will be to make them larger and larger, until they will become a nuisance and congest the highways. This is now becoming evident in the City of New York, as well as in other cities.

In order to provide reasonable standing room on each side of a street and at the same time allow traffic to proceed in both directions, we are forced to limit the width which vehicles take up.

Many of our streets have roadways only 30 feet between curbs. It thus becomes evident that vehicles over 7 feet in width do not allow for two to pass, even using the utmost care. While it is becoming necessary to widen roadways in the Borough, it is very difficult to add more than two feet to each side—a 30-ft. roadway is thus converted into a 34-ft. roadway. In this case, a 7½-ft. width for a vehicle would be the limit.

In conclusion, the writer submits that this subject is one of paramount interest to all cities, and that the time has now arrived when the issues must be squarely faced.

Appendix.

Memoranda regarding dimensions, weight, etc., of trucks used on the subway construction work to haul rock from shafts at 39th, 41st and 43rd Streets, New York, N.Y.:—

Trailer—Platform over all, 22.2 ft. x 8.6 ft.

Wheel base—11.5 ft.

Tread base—6.55 ft.

Length over all, including tractor and trailer, 33 ft.

Rear wheels of trailer, 41 ins. diameter, 8½-in. wide steel tires.

Rear wheels on tractor, 32 ins. diameter, with double 6-in. rubber tires.

Axle of trailer, 2¾ ins. x 5½ ins. deep.

Rear springs, flat, 53 ins. long, having 20 leaves ½ in. thick by 3½ ins. wide.

The trucks carry six skips which, when loaded with stone, weigh from 2½ to 3 tons each.

There are 10 of these trucks in operation. They work 16 hours per day and each makes about one round trip every hour. The total number of trips, therefore, for the ten vehicles is 160 per day.

Following is memoranda regarding granite:—

Location: 42nd Street, 9th to 10th Avenues.
Quarry: North Jay, Me.
Crushing strength: 20,000 lbs. per square inch.
Percentage of repairs: 1915, .4; 9 mos. of 1916, 45.

Location: 10th Avenue, 42nd to 50th Streets.
Quarry: Rockport, Mass.
Crushing strength: 25,000 lbs. per square inch.
Percentage of repairs: 1915, .5; 9 mos. of 1916, 26.

Location: 50th Street, 11th to 12th Avenues.
Quarry: Salisbury, N.C.
Crushing strength: 40,000 lbs. per square inch.
Percentage of repairs: 1915, .6; 9 mos. of 1916, 36.

RAILWAY CONSTRUCTION IN RUSSIA.

A commission has been appointed by the Russian Government to provide for a systematic increase annually of the various railway systems for the next five years of 3,950 miles per year, 2,650 miles to be constructed by the State, and 1,300 miles by private enterprise. The estimates amount to $116,000 per mile. These extensions will be begun next year. The total railway mileage in the Empire at present amounts to 36,700 in European Russia, and 7,300 miles in Asiatic Russia.

One of the largest single concrete arches in the world, weighing 11,000 tons and costing $60,000, will be built by the Salt Lake Railroad at the intersection of Sawmill Canyon and Clover Creek, Nevada. The arch will be 93 feet long, 23 feet high and extend 18 feet below the stream bed, and will be capable of sustaining 73,680 tons. The big arch will be built beneath and around the trestle now in use there, and as it changes from wet concrete into solid artificial stone, the trestles will be removed while traffic is carried on all the time. 165,000 feet of lumber will be used to keep the concrete from touching the trestles.

STANDARD SPECIFICATIONS FOR HYDRANTS AND VALVES.

THE committee on Standard Specifications for Hydrants and Valves, appointed by the American Waterworks Association, have presented their report. The modified specifications for hydrants are as follows:—

1. **Size.**—Classification: The size of hydrant shall be designated by the nominal diameter of the valve opening, which must be at least 4 inches for hydrants having two 2½-inch hose nozzles; 5 inches for hydrants having three 2½-inch nozzles, and 6 inches for hydrants having four 2½-inch nozzles; and shall be classed as one-way, two-way, three-way or four-way, etc., according to the number of 2½-inch hose outlets for which they are designed.

Area of Water-Way: The net area of the hydrant at the smallest part, when the valve is wide open, must not be less than 120 per cent. that of the valve opening.

Bell Ends or Flange Ends: All hydrants must be fitted with bell ends to fit standard cast-iron pipe, or if flanged they must be fitted with flanges of the standard dimensions corresponding to the pressure under which they are to be used; connecting pipe or flange from main to hydrant in no case to be less in diameter than the valve opening. (The standards referred to are those adopted or that may be adopted by this association.)

2. **General Design.**—Type: Hydrants may be of compression or gate type.

Change in Diameter: Any change in diameter of the water passage through the hydrant must have easy curve, and all outlets must have rounded corners of good radius.

Water Hammer: Hydrants must be so designed, particularly as regards the pitch of the thread of the operating stem, that, when properly operated a water hammer will not be caused which will give an increased pressure to exceed the working pressure, when such pressure is over 60 pounds, nor increase the pressure more than 60 pounds when operated under less working pressure than 60 pounds.

Broken Hydrant: Valves when shut must remain reasonably tight when upper portion of barrel is broken off.

Friction Loss: With a 5-foot hydrant discharging 250 gallons per minute, through each 2½-inch outlet, the total friction loss of the hydrant must not exceed 2 pounds for two-way, 3 pounds for three-way, and 4 pounds for four-way hydrants.

Strapping: When requested, hydrants must be fitted with 2 lugs, so that the leaded joint underground can be strapped.

Flange Joints Above Ground: When hydrant barrel is made in two sections, the upper flange connection must be at least 2 inches above the ground line.

3. **Material.**—Hydrant Body: The hydrant body must be made of cast iron.

Cast Iron: All castings shall be made from a superior quality of iron, remelted in cupola or air furnace, tough and even grain, and shall possess a tensile strength of 22,000 pounds per square inch. The casting must be clean and perfect, without blow or sand holes, or defects of any kind. No plugging or stopping of holes will be allowed.

Specimen Bars: Specimen bars of the metal used, each being 26 inches long, by 2 inches wide, and 1 inch thick, shall be made without charge, as often as the engineer may direct, and in default of definite instructions, the contractor shall make and test at least one bar from each heat or run of metal. The bars when placed flatwise upon supports 24 inches apart, and loaded in the centre, shall support a load of 2,200 pounds, and show a deflection of not less than 0.35 of an inch, before breaking; or, if preferred, tensile bars shall be made which shall show a breaking point of not less than 22,000 pounds per square inch. Bars must be cast as nearly as possible to the dimensions without finishing, but corrections may be made by the engineer for variations in width and thickness, and the corrected result must conform to the above requirements.

Wrought Iron: All wrought iron shall be of the best quality of refined iron of a tensile strength of at least 45,000 pounds per square inch.

Composition Metals: All composition or other non-corrodible metals used to be of the best quality, to have a tensile strength of not less than 32,000 pounds per square inch, with a 5 per cent. reduction of area at breaking point.

4. **Hose Nipples and Valves.**—Hose Nipples: Hose nipples must be of bronze or suitable non-corrodible metal, either threaded with a fine thread into the hydrants and securely pinned in place, or carefully locked and caulked in place.

Hose Threads: Hose threads on all hydrants to be installed in any given community must of necessity be interchangeable with those already in service, but, where practicable, threads should conform to the National Standard.

5. **Hydrant Seat and Gate.**—Seat: The seat must be made of bronze or suitable non-corrodible metal, securely fastened in place.

Valve: The valve must be faced with a yielding material, such as rubber or leather, except that, if of the gate type, a bronze ring may be used. The valve must be designed so that it can be easily removed for repairs without digging up the hydrant.

6. **Drip Valve.**—Drip: A positively operating non-corrodible drip valve must be provided and arranged so as to properly drain the hydrant when the main valve is closed. The seat for the waste valve, which must be fastened in the hydrant securely, must be made of non-corrodible material. All other parts of the drip mechanism must be so designed as to be easily removed without digging up the hydrant.

7. **Operating Parts.**—Operating Threads: The operating threads of the hydrant must be so arranged as to do away with the working of any iron or steel parts against iron or steel. Either the operating screw or the operating nut must be made of non-corrodible metal, and sufficiently strong to perform the work for which intended.

Top Nut: The stem must terminate at the top in a nut of pentagonal shape, finished with slight taper to 1½-inch from point to flat, except for hydrants to be installed where existing hydrants have different shape or size of nut, in which case the additional hydrants must have operating nuts similar to the old one for uniformity. The nut socket in the wrench must be made without taper, so as to be reversible.

8. **Stuffing Box and Gland.**—Stuffing Box: The stuffing box and gland must be of bronze or suitable non-corrodible metal or bushed with bronze or suitable non-corrodible metal when an iron or steel stem is used, or when an iron operating stem nut passes through the stuffing box. When packing nut is used, it must be made of bronze or suitable non-corrodible metal. The bottom

of the box and end of the gland or packing nut must be slightly beveled.

Gland Bolts: Gland bolts or stubs must be at least ½-inch in diameter. Bolts or stubs may be either of bronze or suitable non-corrodible metal, iron or steel. The nuts must always be of bronze or suitable non-corrodible metal.

9. Hydrant Top.—Top: The hydrant top must be designed so as to make the hydrant as weather-proof as possible, and thus overcome the danger from water getting in and freezing around the stem. Provisions must be made for oiling, both for lubrication and to prevent corrosion. A reasonably tight fit should be made around the stems.

Lettering: There must be cast on top of the hydrant in characters raised ⅛-inch, an arrow at least 2½ inches long, and the word "open" in letters ½ inch high and ⅛ inch in relief, indicating direction to turn to open the hydrant.

10. Hose Cap.—Caps: Hose caps must be provided for all outlets, and must be securely chained to the barrel with a chain constructed of material not less than ⅛ inch in diameter.

Cap Nut: The hose cap nut must be of the same size and shape as the top or operating nut.

Washer in Cap: When requested by the purchaser, a leather, rubber or lead washer must be provided in the hose cap, set in a groove to prevent its falling out when the cap is removed.

11. Markings.—Marking: The hydrant must be marked with the name or particular mark of the manufacturer. All letters and figures must be cast on the hydrant barrel above the ground line.

12. Testing.—Testing: Hydrants for pressures of 150 pounds or less, after being assembled, shall be tested by hydraulic pressure to 300 pounds per square inch, before leaving the factory. If the working pressure is over 150 pounds per square inch the hydrants must be tested to twice the working pressure. The test must be made with the valve open in order to test the whole barrel for porosity, and strength of hydrant body. A second test must be made with valve shut, in order to test the strength and tightness of the valve.

13. Directions to Open.—Opening: Hydrants must open to the left (counter clockwise) except those to be installed where existing hydrants open to the right, in which case the additional hydrants must turn the same as the old ones for the sake of uniformity.

Extensive deposits of molybdenum are said to have been discovered on farms near Mandal, in Norway, and have recently been taken over by a company. The production is at the rate of about three tons weekly.

Newfoundland has copper ores, some running from 4 to 30 per cent. copper, with which little was done until after the war broke out. The production in 1915 was about 15,000 tons, of which 12,150 tons, worth $151,372, went to the United States, and the remainder to England, as against about 2,000 tons as the 1914 output, valued at $15,000, and all taken by the United States.

The output of spelter in Great Britain is comparatively small, being about one-fifth of that annually produced by Germany, the largest European producer. The annual production for the past ten years has remained steadily between 50,000 tons and 60,000 tons. In 1913 Great Britain produced 58,200 long tons, or 6 per cent. of the world's total, as compared with 56,300 long tons in 1912. Germany is the largest producer of zinc, the output for 1913 being about 280,000 tons, while Belgium annually produced 200,000 tons.

EXPERIMENTAL RESEARCH WITH ROAD-BUILDING MATERIALS.*

By H. K. Benson.

THE great variety of materials somewhat indiscriminately used in the building of roads has suggested the possibility of applying the spirit of scientific research to them in a manner analogous to that by which it is applied to materials used in the manufacturing industries. The practical man often looks with disfavor upon the so-called experiments of science since usually he forgets to learn the real value of the unsuccessful experiment. The writer well remembers the statement of Dr. Remsen, the great American pioneer chemist, that it is one of the tragedies of science that the failures of scientific research are not recorded. In other words, we often learn more of the basic facts underlying a given problem from what we are unable to accomplish than from the things which actually are done. The failure of a given attempt should not, therefore, be accounted as loss but rather as a contribution to the total sum of knowledge which has accumulated about a particular subject. . . . This experience brings me to the main object of my appearance before your body—to plead for the scientific scrutiny of all road-building work. The time has, of course, gone by for the annual festival when the neighbors all gathered by the roadside to "work out" their road taxes. How well I remember the pleasant times we used to enjoy on those occasions! We now import from distant places, carefully manufactured commodities and out of them our roads are being constructed. The operation is costly and for this reason has its limitations. If it is true that we are passing through a transitional stage, then every bit of evidence collected and put on record will hasten the passage from the present stage to the final or ideal road of the future. What do we understand by scientific scrutiny? First, there is involved a complete record of construction of every type of road during construction, then a continuous record of inspection during the life of the road, and a final drawing of conclusions as to the good and bad qualities of a given type of construction. This involves an organization which is not subject to change as periodically as county officials come and go. Next in this programme is an aggressive movement to profit from the advances of science through the adoption of new materials and new methods of construction and their subjection to service tests and record. This requires a willingness to consider road problems with an open mind—to admit that the present materials and methods are transitory. Even in the maintenance of roads, it involves the trying out and testing of methods. Some county commissioners believe that the only method of maintaining an earth road, for example, is to periodically haul gravel upon it and then, after it is full of mud holes, to haul some more gravel. It is granted that every official has a right to his own convictions, but would it not be conducive to a better state of knowledge to try out the patrol system, in a certain district for a term of years—the use of the drag in another district—the gravel method in another, and so on It is admitted that such a policy would smack of experimentation—that road officials did not know in their own minds what is best—admissions which, in the writer's opinion, are the beginning of wisdom.

*Extracts from a paper entitled "Experimental Research as Applied to Road Materials," presented at the annual convention of the Washington State Association of County Engineers, Tacoma, Wash., September 14-16, 1916.

Experiments conceived in a knowledge of exact conditions, pursued along exactly defined lines and concluded with definite results have inaugurated some of the world's greatest industries. It is not unreasonable to believe that the same procedure will establish for us the means for building the highways upon which great multitudes pass back and forth to exchange commodities and increase the volume of trade.

HEAVY-OIL ENGINES.*

By S. B. Daugherty, Buffalo, N.Y.

In a consideration of the oil engine, the questions at once arise: What kind of oil is suitable? Are supplies of fuel available in sufficient quantities in various parts of the country? Will the probable production of oil in years to come be equal to the demand?

To answer the first question requires a word of explanation as to the types of oil engines. Broadly, there are two—the low-compression engine, wherein ignition is effected by the injection of the oil spray against a heated surface, or even by an electric igniter, as in gas engines; and the high-compression, or Diesel type, with ignition from the heat of compression of the air charge. The low-compression engines are the simpler and cheaper, but, on the other hand, suitable fuels for use in them are fewer and higher priced, and the thermal efficiency is less. These limitations tend to restrict the use of low-compression engines to smaller installations. Suitable oils are kerosene, the lighter distillates and light crude oils.

The high-compression or Diesel-type engines can, in general, utilize any liquid fuel. It is to be remembered that there is no strict line of demarcation between the types, but that they tend to merge one into the other. The grades of suitable oils vary inversely as the grade of the engine,—the cheaper and simpler the engine, the higher the grade of oil required; the more elaborate and specialized the engine, the lower the grade of oil which may be successfully used.

Oil Engines, Diesel and Semi-Diesel.—This paper will consider Diesel type engines particularly. It is now twenty-two years since the engine was patented in Germany. The engine was developed by the Augsburg-Nürnberg Co. The first commercial engine was put in service in 1897, and, according to the Augsburg-Nürnberg Company, was still in service and running satisfactorily in 1911.

The Diesel engine is unique, in that it was designed to fit a theory. Some of the paragraphs in Diesel's patent show clearly that his calculations were not entirely correct; for instance, his statement that there is "no increase in the temperature produced on the introduction of the fuel, or at most only a very slight one, and the highest or extreme temperature is produced by the compression of the air. It is, therefore, under control and will be kept within moderate limits, and, moreover, in view of the cooling of the products of combustion by the subsequent expansion, no artificial cooling is required for the cylinder, the mean temperature of the gases being such that the parts of the engine can be kept tight and lubricated"; also that "the exhaust may be cooled by expansion below the temperature of the atmosphere and utilized for refrigerating purposes." Experiment has proven these statements incorrect, but in its essential features his theory was sound. The first claim in his patent covers the engine so completely that, so far as I am aware, no infringement was ever attempted. This is the claim: "The herein-described process of converting the heat energy of fuel into work, consisting of first compressing air, or a mixture of air and neutral gas or vapor, to a degree producing a temperature above the igniting point of the fuel to be consumed, then gradually introducing the fuel for combustion into the compressed air, expanding against a resistance sufficiently to prevent an essential increase of temperature and pressure, then discontinuing the supply of fuel and further expanding without transfer of heat."

The first Diesel engine was a vertical machine, and this design was followed in subsequent engines until it became so standardized in Europe that the opinion prevails to a great extent that there must be some vital reason for the adoption of the vertical type. The first commercial engine was a twin-cylinder vertical engine of 60 b.h.p. Both horizontal and vertical Diesel engines are now being built in the United States, and the expiration of Diesel's patent in July, 1912, was the occasion of many builders entering the field.

In addition to Diesel engines, the De La Vergne type FH engine should be mentioned. It is classed as semi-Diesel but its equipment includes all of the essentials of a Diesel engine, and the compression needs only to be raised from about 350 to 500 lbs. in order to bring it into the Diesel class. The economy of this engine is practically the same as that of the true Diesel type.

The main feature of the Diesel engine is its economy. The measure of efficiency of a prime mover is the percentage of potential power actually obtained for useful work. In the transformation of heat energy into useful power various losses occur. If steam be the medium, there will be a loss of heat in the boiler, due to radiation, to the escape of heat into the stack with the gases formed by combustion of the fuel, and to imperfect combustion of the fuel. Heat in the steam is lost by radiation, and a very considerable amount is rejected in the exhaust. Friction accounts for a further loss, and so, with steam as a prime mover, the percentage of actual heat in the fuel that is transformed into work ranges from 6 per cent. to 16 per cent. For intermittent operation, where a considerable portion of the fuel burned is for stand-by service, the percentage may be even lower. In the internal-combustion engine the heat losses are due to radiation, to heat carried off in the jacket water and in the exhaust, and to friction. The principal saving is in the reduction of the amount of heat lost in the exhaust.

The effective thermal efficiencies of various prime movers are about as follows:

Non-condensing steam engine	8.4	to 6.6	per cent.
Condensing steam engine and turbine using superheated steam...	15	to 10	" "
Suction gas engine	23	to 18	" "
Four-cycle Diesel engine	34	to 32	" "

The significance of this Diesel-engine economy can best be appreciated by a familiar comparison: Assume that a touring car can be run twelve miles on a gallon of gasoline which costs 23 cents per gallon and weighs about 6 lbs. Assume that the engine has a thermal efficiency of 18 per cent., and that the effective heating value of the gasoline is 114,000 B.t.u. per gallon.

Fuel oil weighing about 7.5 lbs. per gallon would have an effective heating value of about 135,000 B.t.u.

*Abstracted from a paper read before the Chicago section of the American Society of Mechanical Engineers.

per gallon. On this basis of relative heat values and efficiencies a Diesel-type engine would drive a car 26 miles on a gallon of oil, as compared with 12 miles with gasoline. But 7.66 gallons of oil can be purchased for the price of one gallon of gasoline, so that the distance covered for 23 cents worth of fuel would be 200 miles with oil and 12 miles with gasoline, or 16.6 times.

In a comparison of vertical and horizontal Diesel engines the detail most discussed is the piston. Vertical builders call attention to the weight of the piston, and the side pressure thereby produced on the cylinder bore, in the case of the horizontal engine. The fact that the first Diesel engines were built vertical, and that excessive height was undesirable, probably led to the use of trunk pistons. For the same reason a connecting rod of a length but slightly more than five cranks has been used in vertical engines. An analysis of the forces prevailing throughout the cycle of operations shows that the side pressure on the cylinder walls, due to the angularity of the connecting rod, is far greater than the pressure due to the weight of a piston, even though the piston lies horizontally. Any increase in connecting-rod length means a proportional decrease in the side thrust. Ordinarily an increase in the length of the connecting rod of one crank length decreases the side thrust an amount equal to the weight of a piston and wrist pin, or, in other words, a vertical trunk-piston engine with a connecting rod five cranks long is subjected to about the same side pressure on the cylinder wall as a horizontal trunk-piston engine with a connecting rod six cranks long.

Type of Diesel Engine and Lubrication.—The matter of cylinder lubrication is another feature of superiority in horizontal engines. In the vertical type it is absolutely essential, in order to secure a distribution of the lubricant around the cylinder bore, to supply the oil through a number of feeds, as many as four per cylinder on the smallest sizes and more on larger diameters. A horizontal cylinder, on the other hand, even of the largest size that is practicable to build, can be effectively lubricated over its whole surface from a single feed on the upper side. Gravity helps to distribute the oil.

Success in Diesel-Engine Operation.—On the showing of economy of the Diesel engine, one might ask why the engines are not in more general use. One answer is that those who are in a position to reap the most benefit are not aware of the possibilities. Perhaps they have heard of an oil-engine installation that has not come up to expectations. Without investigation, they immediately condemn oil engines in general. Or it may be that even when an engine of a suitable type has been installed, satisfactory operation is not obtained on account of the failure of the men in charge to properly care for the engine.

It is evident that in a machine that requires uniformly high pressure to properly ignite the fuel charge, any appreciable leakage of valves or piston rings results in faulty ignition. This applies to the compressor which furnishes the spraying air as well as to the power cylinder. On the other hand, a little intelligent care will prevent trouble of this kind. I know of no case where the proverb, "a stitch in time saves nine," is more applicable.

Another cause of trouble that is avoidable is overloading. A moment's consideration will make plain the ill effects of overloading. In any internal-combustion engine the amount of fuel burned is limited by the oxygen in the charge of air at the end of the compression stroke. In the case of a Diesel-type engine the time available for burning the fuel charge at full load will not exceed 35 deg. of crank travel. In the case of an engine running 200 r.p.m. this is equivalent to 1/34 of a second. During this time the oil must enter the cylinder, come in contact with the necessary oxygen, and be consumed. There must of necessity be some excess oxygen in order to effect complete combustion of the fuel. The effect of overloading is to increase the fuel charge so that the amount is greater than can be burned clean with the air that is available. The result is that combustion continues after expansion has begun, and if the overload is great it may even be that the charge will be still burning when the exhaust valve is opened. The temperature of the exhaust gases is then so far above normal that the valve becomes distorted with the heat, causing leaks which still further aggravate the trouble. If an engine be allowed to run with a leaking valve it is only a question of a few hours until both valve and seat will be cut out by hot gases blowing through at high velocities. The secret of success in operating a Diesel engine is in taking care of just such relatively small items. When you find an owner who condemns this type of engine, you will generally find that he is careless, and allows his engine to get out of order in some small particular, and then complains about unreliability, high cost of repairs, etc.

AMERICAN ROAD BUILDERS' ASSOCIATION.

The fourteenth annual convention of the American Road Builders' Association will be held in Mechanics Building, Boston, Massachusetts, during the week beginning February 5, 1917. The programme, which is in course of preparation, will include papers and discussions on subjects connected with road and bridge building and street paving by the foremost authorities of the United States and Canada.

In connection with the convention, and in the same building, will be held the eighth National Good Roads Show. This exposition will include exhibits by leading manufacturers in the United States of the machinery and materials used in road and paving construction and maintenance.

This exhibition, which has been a feature of the American Road Builders' Association conventions for a number of years, has increased in size and interest year after year. The coming exhibition takes on added importance on account of the enormous sum of money appropriated under the recently enacted Federal Aid Law and the additional large sums to be expended for road building by the various states and smaller units of government.

Mechanics Building, in which the convention and Good Roads Show will be held, is admirably situated and fully equipped for the purpose. It is located on Huntington Avenue, within convenient distance of the leading hotels and business district of Boston. The building is well lighted and heated, and is thoroughly modern in its appointments. It contains ample space for practically any number of exhibits, and is adaptable to exhibits of any size, as the floor plans just published indicate.

The management announces that the services of Mr. H. G. McConnaughy have been secured as director of exhibits. Mr. McConnaughy has had many years' experience in this line of work and is well-known in connection with the management of the exhibitions held under the auspices of the American Electric Railway Manufacturers' Association.

THE CITY MANAGER.*

By Gaylord C. Cummin.

ENGINEERS have been entirely too content in the past to take credit only for their technical achievements, and leave the glories of dreams that come true, of wonders of administrative effort, of wise and judicial counsel which have made our country great, to rest on the brow of those who were in positions of prominence, and to whom they do not rightfully belong.

A real engineer is much more than a man who juggles with figures and formulæ, and makes queer designs on a drawing board. A real engineer must know for what purpose he plans both economically and physically; he must know how his plans can become financially possible; in short, he must be an administrator in order to make his designs accomplished facts, and to build efficiently and well.

In this field of public service the engineer has always taken a much more subordinate position than that to which he was entitled. Seventy-five per cent. of the problems which occur in the administration of our cities are engineering problems pure and simple, and the rest of them are such that an engineer is at least as well fitted to handle as a man trained along any other line, they being largely problems of organization and social justice. The vital municipal problems are pure water and plenty of it, adequate sewers, clean streets, proper buildings, adequate transportation facilities, efficient police and fire protection, proper education and recreational facilities, etc.,—these things to be secured with the smallest expenditure of money possible to get the needed results.

Most of these are engineering problems and can be best handled by engineers; hence our opportunity once the citizens can be educated to the point where the administrative part of the government is judged on its ability as such, political questions being relegated to the legislative branch where they belong.

The so-called "Commission" form of municipal government is a decided improvement in some ways, but falls far short of the ideal. This plan consists, in brief, of a small council elected at large which constitutes the legislative body, each member being made the administrative head of one of the city departments. This is an improvement, because ward lines are eliminated and the organization somewhat simplified, but still has a lack of centralized responsibility, places men in technical positions who are not specially qualified for them, and is positively vicious in making a man's success as a commissioner depend upon the success of his particular department and not the success of the city as a whole. This will result in time in a majority of the commission dividing the bulk of the funds among their departments, because in this way they can show more results, and the minority taking what is left, although their departments may be the most important. Under the commission form there is no fundamental improvement in organization, the improved results coming from an awakened public interest in municipal affairs shown by the fact that any change in government was made.

The commission-manager form of city government is an exact parallel to the form which our experience has taught is the only one under which satisfactory results can be obtained in business. It is not presented as bringing about a municipal millennium. Nor, is it new in principle—only in application. There are no mysterious or wonderworking powers concealed within it. It is simply the application to city government of the only methods by which we have been able to manage business corporations efficiently. It does not insure efficient government. No charter form can do that, but it is the only form under which efficient government can be expected, judging by our experience in business.

It consists briefly of a small council elected at large, corresponding to a board of directors and whose duties are purely legislative. This body appoints the chief administrative officer, the city manager, who corresponds to the general manager of a corporation, and who has complete control of the whole administrative machinery. He holds office at the pleasure of the commission and is responsible to it for his acts. Responsibility is absolutely centralized on the commission and through them on the manager.

There is never any chance to dodge an issue by placing the blame on somebody else. If anything goes wrong in the administrative branch the manager can be held responsible and the people can call their representatives to strict account for mistakes and inefficiency in the administrative branch, because of the commission's power to remove at will the city manager.

What has been the result of this mode of operation? In the city manager cities party politics has been entirely eliminated from the administrative side of city affairs. A man's beliefs on the tariff has no bearing upon his efficiency as a waterworks superintendent.

We have teamwork in our organization and nothing can be accomplished without that. We must have it because the department head that refuses to work in harmony with the manager will soon be looking for another job, and the manager who will not work with his commission will not last very long.

Our department heads are selected for special fitness for the positions which they hold, and not because they are "good fellows." The manager must select on this basis because an inefficient department head will reflect on the manager and he cannot evade his responsibility.

Responsibility is centralized from top to bottom and this is the best incentive to honesty and efficiency that has yet been devised.

The special point of interest to engineers is that all the larger cities operating under this form of government have engineers as city managers and they are making good. In fact, in many cases none but engineers are being considered. A city manager must be primarily an executive, but given that qualification, the engineer is preferred over men of other professions, because such a large percentage of the problems which arise are engineering problems.

There are now over eighty cities and towns operating under this plan and the number is just about doubling each year. Where are we to find the city managers for these openings? Most of them will be drawn from the engineering profession direct, for a good many years, but finally we hope that the plan will spread so that a man can take it up as a profession, start as manager of a small town after having received an engineering education, and be promoted to larger ones if he makes good.

In this field there will be in the near future many openings for engineers, well paid, permanent positions, where the engineer can at last take his proper place in public service to the lasting benefit of both engineer and citizen.

*Journal of the Western Society of Engineers.

WATERS AND WATER-POWERS.*

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

DURING the past year attention was devoted to the completion of two important reports. The first of these, on the Water-Powers of Manitoba, Saskatchewan and Alberta, had already reached an advanced stage, but a considerable amount of additional information, which has become available during the year, has been added. Much of this additional information was obtained through the Water Power Branch of the Department of the Interior investigating water-powers in the Prairie Provinces. The report contains a comprehensive description of practically all the rivers which have been surveyed or explored in this portion of the Dominion and which offer water-power possibilities. Gauging stations have also been established on many of these rivers, to obtain accurate and continuous data respecting the flow at different times of the year, and tables, showing at a glance its history in this respect since observations were commenced, are included under each stream. The more northerly rivers are also described in all the details which available data permit. Particular attention was given to information from a water-power viewpoint, such as description and descents of rapids, and nature of the banks and beds of the rivers.

Information of Water-Power Possibilities.—A feature of this report, which will be of interest to those desiring to obtain a general idea of the water-power possibilities, without entering into detailed descriptions, are the tabulated statements appearing as appendices I., II., and III. and the accompanying map of reference. Practically all the power sites, falls or rapids referred to in the text, and upon which fairly definite information is available, are enumerated in a concise form for ready reference. The rivers are grouped into three classes, graded according to available data, each appendix covering one class. Under the first are the Saskatchewan River and tributaries and other streams flowing into Lake Winnipeg, enumerating 121 power sites, for all of which fairly dependable information as to flow and descent is available; particularly is this so of the Winnipeg and Bow Rivers, which have been carefully surveyed. The second includes 116 rapids or falls on rivers for which complete data on flow are not available, but where it has been possible to estimate this during the open season. The third gives descents of 53 rapids or falls, but no attempt is made to estimate the flow. The report is fully illustrated, including many sketch plans and diagrams.

Waterworks and Sewerage Systems.—This enlarged and revised edition of the report on Waterworks of Canada, first published in 1912, has been issued, and contains short descriptions of all waterworks and sewerage systems in the Dominion. This report is also fully illustrated. Under Part I., some 528 waterworks plants are covered, while the sewerage systems and treatment plants in 279 municipalities are described in Part II. Several tables, compiled from the data in the report and summarizing points of special interest, are included. The subject of sewerage and sewage disposal is given more space than in the previous edition, and an introductory tabulated statement shows how serious the question of stream pollution is becoming in Canada. This shows the great number of our inland waters receiving raw or untreated sewage; particularly is this the case in the eastern portion of the Dominion, while in the west we have the excellent example of the province of Saskatchewan, where 80 per cent. of the sewerage systems have treatment plants. The supply of water to communities is universally recognized as the most important function of inland waters, and, if grossly polluted, they become a great menace to water supply systems drawing water therefrom. This may be the case even where filters are employed, as a grossly polluted source of supply may overload the filter, which latter should only be regarded as an additional factor of safety in an operation which should begin with the proper treatment of the sewage before it is discharged into any body of water.

New Water-Power Enterprises.—Although there was not a very large increase shown in Canada along the lines of new water-power enterprise during the year, a few are to be noted. Winnipeg has added some 13,000 h.p. to its municipal plant at Point-du-Bois. The Laurentide Power Co. has inaugurated its new hydro-electric development at Grand'mère on the St. Maurice River, the ultimate capacity of which is to be 125,000 h.p. The Eugenia Fall plant, on the Beaver River, has been placed in operation by the Hydro-Electric Power Commission of Ontario, with an initial capacity of 4,500 h.p., under the relatively high head of 540 feet. This plant forms a part of the Commission's system which now covers practically the whole of southwestern Ontario. The Hawkesbury Electric Light and Power Co. has completed and put in operation its new hydro-electric plant at Bell Fall, on the Rouge River, 5,000 h.p. being developed, under 60 feet head. Among the new projects proposed during the year may be mentioned that of developing 600,000 h.p. at the Grande décharge of the Saguenay River, with the object of manufacturing chemical fertilizers.

The St. Maurice River is the largest entering the St. Lawrence between Montreal and the Saguenay. With a drainage area of over 16,000 square miles, it possesses many important water-power sites, three of the largest being already utilized at Shawinigan Fall, Grand'mère and La Tuque. Both the developed and latent powers on this river are of great value, not only on account of their large capacity but also from their geographical position. The Quebec Streams Commission, realizing the great benefits which accrue from conservation storage of the upper waters of the St. Maurice, selected it as one of the first rivers to receive their attention.

After careful studies, it was decided to establish the main reservoir at La Loutre Rapids, 38 miles in an air line north of the National Transcontinental Railway, at the lower end of a long intricate chain of lakes.

It is of special interest, inasmuch as it will be the largest reservoir in North America, and the third largest in the world, being exceeded by the Assuan reservoir, on the Nile, 3,750,000 million cubic feet, and the Gatun Lake, at Panama, 183,000 million, as compared with the La Loutre, 160,000 million. The next largest in North America is the Elephant Butte reservoir in New Mexico, with an eventual capacity of 115,000 million cubic feet.

The dam site is in entirely unsettled country, and, by the shortest available route, is 50 miles distant from Weymont and Parent, the nearest railway stations.

The material for the dam, aggregating 25,000 tons, will be transported 30 miles by water on the St. Maurice, and by a construction railway for the remaining 20 miles.

The dam is to be 1,720 feet long, of four straight sections, with 851 feet of spillway. Among the notable

*From Seventh Annual Report of Commission of Conservation.

features are a movable sluice for logs and rubbish, a long measuring weir, and means for heating the gate chambers by hot blast pipes. Test borings having shown solid rock underlying the site, the plain gravity-type dam built of cyclopean masonry was selected, the profile allowing for an assumed ice pressure of 50,000 lbs. per linear foot acting at the overflow weir level. Comparing the size of the dam with the enormous capacity of the reservoir created, the advantages of the location are shown in an extremely favorable light; the quantity of concrete needed is 70,000 cubic yards and the capacity—160,000 million cubic feet—a unit figure of 0.44 cubic yard of concrete per million cubic feet as compared with 4.78 cubic yards of concrete per million cubic feet for the Elephant Butte dam.

With regard to the benefits derived from the construction of this immense reservoir, the 160,000 million cubic feet stored represent a flow of 12,345 sec.-ft. for 150 days or 6,172 sec.-ft. for 300 days. From this additional supply, the present minimum flow of 6,000 sec.-ft. in the river could be raised to 15,000 sec.-ft. at Shawinigan, leaving an over-supply in a very low year. But it was decided to regulate for only 12,000 sec.-ft. flow, in order to allow for loss of water in the long distance of 220 miles over which the water has to flow to Shawinigan and to meet needs for floating logs at times when such water is not needed for power.

Between the reservoir and the mouth of the St. Maurice, there are no less than 17 power sites with heads of from 10 feet to 150 feet, and whose aggregate descents total 800 feet; this figure would be increased to at least 900 feet by the dams erected in developing the various sites. This represents a total capacity of approximately 350,000 theoretical h.p. under present conditions, while it is estimated that some 900,000 h.p. will be available when the flow is regulated from the reservoir. At Shawinigan, Grand'mère, and La Tuque alone, the three sites at present utilized on the St. Maurice, the potentiality will be raised from an aggregate of some 190,000 theoretical horse-power to over 400,000 horse-power.

Provinces Co-operate.—It is gratifying to note that, in practically all the provinces, systematic investigation and adequate regulation of water-powers have been provided for. Nova Scotia joined in this most important work during the past year, when, in accordance with a recommendation of the Committee on Waters and Water-Powers, a co-operative arrangement between the Dominion Water Power Branch and the Provincial Water Power Commission was inaugurated. Much excellent progress has already been made, practically every power-producing river has been covered by reconnaissance investigations, and 25 permanent gauging stations have been established. It is understood that tentative negotiations are under way towards a similar arrangement with New Brunswick.

Standardize Information.—The officials of the various federal and provincial organizations dealing with waters and water-powers are making an effort to co-ordinate, systematize and standardize their work. It is further proposed to publish all hydrographic data throughout the Dominion in a uniform manner, easily accessible to interested parties, as soon as possible after the information is obtained. Under present conditions much valuable information is sometimes buried in voluminous publications or reports dealing with perhaps four or five other subjects, and published a year or two after the data have become available.

THINGS WE DO NOT KNOW ABOUT STRUCTURAL ENGINEERING.*

OMITTING the assumptions relative to the loads, it is apparent that the assumptions which enter the design of a bridge which demand special attention on the part of the designer refer to the following: Secondary stresses; distribution of stress in a member; and distribution of stress in a connection.

Secondary Stresses.—One of the fundamental assumptions in stress analysis is that connections are frictionless hinges. If a truss having frictionless hinges is deflected, the members meeting at a joint are free to rotate relative to each other and no bending stresses are produced in the members. If, however, the connections are rigid, when a truss is deflected the members are not free to rotate relative to each other and bending stresses, known as secondary stresses, are produced. These secondary stresses can be determined mathematically. While all are willing to admit that, theoretically, secondary stresses exist, many, apparently because of the elaborateness of the calculations necessary for their determination, look upon them as something invented by the mathematician for the further torture of the soul of the engineer. The strain-gauge, however, has come to the support of the mathematician and secondary stresses are known to be a reality.

Distribution of Stresses in a Member.—The area of the section required for a member subjected to a known stress is obtained by dividing the total stress by the allowable unit stress for the material. This is virtually equivalent to assuming that the stress is uniformly distributed over the area of a section of the member. Tests show that if an angle is riveted to a gusset plate by means of rivets in one leg only, the full strength of the angle can not be developed. Members of trusses are much larger than the single angles tested, and some portions of the section are a considerable distance from the central point in the connection. Engineers recognize the necessity of attaching the member to the gusset plate over as large a portion of the section as possible.

Distribution of Stresses in Connections.—The discussion of the distribution of stresses in a member is equally pertinent to the distribution of stresses in a connection. If the connection is made up of a number of parts each of which is to take a certain prescribed portion of the total stress, each part must have just sufficient rigidity to enable it to take its portion of the total stress. This condition it is practically impossible to obtain.

In a riveted connection the stress is not uniformly distributed among the rivets. The rivets are distributed over a considerable distance, and the intensity of the stress in the gusset plate at its outer edge is zero, whereas the intensity of the stress in the member at the same point is a maximum. The intensity of the stress in the main member at its end is zero whereas the intensity of the stress in the gusset plate at the same point is a maximum. At some intermediate point the intensity of the stresses in the gusset plate and in the main member are equal. Designate this point as the working point. If the main member is in tension, the portion of the member between the working point and the edge of the gusset plate will elongate more under stress than the corresponding part of the gusset plate and, therefore, the rivets at the edge of the gusset plate will be strained more than the rivets at the working point.

*From a paper by W. M. Wilson, Assistant Professor of Structural Engineering, University of Illinois, before the Western Society of Engineers.

Editorial

THE MANUFACTURE OF NITRATES AND ITS RELATION TO THE EXPORTATION OF ELECTRICITY.

The Canadian Engineer called attention editorially in its issue of July 27th, 1916, to the dangers involved in the Niagara export power situation; and in the same issue an article entitled "Exportation of Electricity," by Arthur V. White, of Toronto, consulting engineer to the Commission of Conservation, showed the advisability of retaining the water power assets of Canada as a working basis upon which a *quid pro quo* could be given in exchange for coal or other commodities, should it become more difficult in the future to import these from the United States.

Pointed emphasis is given to the correctness of the stand taken in the above-mentioned editorial and article, by a circular which has been distributed to United States chemists and scientists, calling to their attention that in the event of war a very large portion of the bituminous coal supply of the United States would be needed for the production of nitric acid for government use.

From the statistics given in the circular it is evident that, under present industrial methods of coal treatment, practically the entire bituminous coal output would be needed to produce annually as much nitric acid as is now being used by Germany. It is stated that the apparatus for recovering the coal nitrogen in the form of ammonia, and then converting it into nitric acid, is not nearly so expensive as the plant needed to take nitrogen from the air; and that the methods by which Germany has increased her annual output of air-nitrates by 100,000 tons of nitrogen since the beginning of the war, are "far more expensive than those open to us."

The warning of Sir Wm. Crookes in 1897 that the world would begin in 1926 to face a nitrogen famine unless steps were taken to prevent it, has led to many important new discoveries and inventions, all aimed at putting off or indefinitely postponing that fateful time. The people of the United States are congratulating themselves that the dormant nitrogen supplies of their coal beds, combined with the new methods accessible to render that supply valuable, make them independent in regard to their nitrogen sources for a long time to come.

The new values and new importance being attached to the coal beds make it more likely than ever that the day will come when the United States will prohibit the exportation of coal unless in exchange for other products that are equally valuable. It is highly important, then, that Canada should export no more electricity and that she should stop as much of the present exportation as possible, so as to add to her own capacity for producing air-nitrates, should the need appear, and also by so doing to retain, as Mr. White says, the *quid pro quo* that will ensure her future coal supply from the United States.

Neither Canada nor the United States should act in such matters prompted by any spirit of coercion; but each country is within its rights in seeking, first of all, to conserve its natural assets either for its own people or else for satisfactory exchange.

TOWNSHIP ROAD ORGANIZATION AND SUPERVISION.

There are in the province of Ontario 55,000 miles of road. Of this total mileage about 13,000 miles are but little improved; about 20,000 miles are well graded roads; about 22,000 miles have been surfaced with gravel or broken stone. These figures are taken from a pamphlet recently issued by the Ontario Department of Public Highways entitled "Regulations Respecting Township Road Superintendents."

It is claimed that less than 20 per cent. of this total, if properly improved, would carry 80 per cent. of the traffic. Such a system of leading market roads is in need of thorough construction or at least resurfacing, which is being carried out under the county organization plan. The greater mileage of roads must, however, remain under township control. It is very evident that if the most lasting results are to be obtained it is essential that:

1. Responsibility should be definitely centralized, and fixed in one overseer so that there is a strong incentive for him to obtain the best results and avoid mistakes.

2. The undertaking as a whole, and each detail of it, should be carefully studied and planned in advance. This can only be done by making it the permanent business of one man, who can advise and guide the council from year to year.

3. Experience and skill should be brought to bear on the work. A township overseer should be kept in office just as permanently as is a clerk or treasurer, and in this way only can townships build up an efficient plan of experienced road management.

At the present time, when the amount of money available is perhaps somewhat reduced, it is very desirable that township road management be brought to a high degree of efficiency.

As it is now, there are some thirty-five or forty thousand pathmasters in Ontario, with the result that in many instances at least there is considerable overlapping and in other cases there is not enough work to do to keep them all constantly employed.

If, instead of this plan, it were possible to place in every township a single permanent road superintendent it would tend to more efficient handling of the problem.

If the responsibility could thus be placed upon one specific party instead of, as now, on several, it would surely lead to better results. Such an official, knowing what was expected of him, could plan his work according to the season. Grading could be done in the spring and not left until the ground is dry and hard and consequently more costly to put in shape. Culverts could be placed at the proper time and not left until the autumn when frost and rain make it inadvisable and expensive to carry out such work.

There are very many good reasons why the more general adoption of this township road superintendent plan would prove more efficient than that which now obtains, and it is hoped that township councils will more generally give the plan careful and favorable consideration.

PERSONAL.

CHARLES SMITH, K.C., has been appointed secretary of the Quebec Harbor Commission.

W. W. BROOKFIELD, of Welland, Ont., has been appointed good roads superintendent of Welland County, to succeed the late Major James Sheppard.

CHARLES F. SPROTT, of Burnaby Lake, B.C., has been appointed a member of the North Fraser Harbor Commission to succeed Robert Abernethy, who has resigned.

R. F. RANDOLPH, of the Bethlehem Steel Company, has been engaged by the Dominion Steel Corporation, Limited, Sydney, N.S., as general superintendent of all steel work.

WILL H. BALTZELL has been appointed chief engineer of the Canadian Steel Corporation, Limited, with offices at Ojibway, Ont. This is the Canadian branch of the United States Steel Corporation.

E. P. MATHEWSON has resigned as manager of the reduction works of the Anaconda Copper Company to accept the position of general manager for the British America Nickel Corporation of Sudbury, Ont., with headquarters at Toronto.

Lieut. J. T. WALKER, a young Toronto architect, who for about four years was employed with Messrs. Darling and Pearson, and immediately before enlistment was in the educational department at the city hall, is reported missing since September 20.

Capt. W. J. LOUDON, son of Mr. J. S. Loudon, assistant manager of the Standard Bank of Canada, Toronto, was wounded in action on October 21st. Capt. Loudon is by profession a civil engineer and has been employed in the construction of several lines of railway.

W. C. HAWKINS, of Hamilton, Ont., managing director of the Dominion Power and Transmission Co., and F. W. TEELE, of Boston, Mass., formerly vice-president and general manager of Porto Rico Railways Co., have been elected to the board of the Southern Canada Power Co.

ALLAN PURVIS, general superintendent of the Eastern Division, Canadian Pacific Railway Co., has been appointed to temporarily succeed Mr. J. T. Arundel, general superintendent of the Ontario Division, who is absent on account of illness. J. H. BOYLE will succeed Mr. Purvis on the Eastern Division.

Col. G. G. NASMITH, C.M.G., director of the Health Department, Toronto, is returning home from the front, his work there having been practically completed. Since the outbreak of the war Col. Nasmith has been rendering valuable services in sanitary work for the C.E.F., both at Valcartier and in Europe.

H. R. MacMILLAN, chief forester of British Columbia, has recently returned from a trip to England, South and East Africa, India, Australia and New Zealand, and expects to leave shortly for China and Japan. He was sent out by his government to investigate trade openings in connection with the lumber industry and his advance report is said to be most favorable.

OBITUARY.

WILLIAM HORNER, builder and contractor, of Winnipeg, Man., passed away recently at the age of 56 years.

ROBERT HASTWELL, superintendent of the International Malleable Iron Works at Guelph, Ont., passed away recently following a short illness. Previous to coming to Guelph Mr. Hastwell was for twenty-five years in the employ of the Illinois Malleable Iron Works.

Word was received last week by relatives that Capt. FRANK ROSS NEWMAN had died as a result of wounds. Capt. Newman was born at Montreal 38 years ago, and was educated at the Montreal High School. He became associated in 1903 with the Canadian Fairbanks-Morse Co., Limited, as manager of their Winnipeg branch. Four years later he joined the staff of Caverhill, Learmont & Co., Winnipeg, and remained with that firm until 1911, when he returned to Montreal and subsequently rejoined the Canadian Fairbanks-Morse Co., Limited, as manager of the Toronto branch.

At the outbreak of war he joined the Queen's Own and went overseas in May, 1915, as quartermaster and captain of the 19th battalion. He left England for France in September, 1915. Last summer Capt. Newman was ill for two months with trench fever. Upon his return to the front he was made adjutant of his battalion, but he had not occupied his new post for more than two weeks before he was wounded in the knee and in the face by shrapnel.

He was transferred to a London hospital, where it was reported that he was progressing favorably. Tetanus resulted, however, and the end came rather suddenly. The report of his death was a shock to a large number of friends among the engineers and contractors throughout Ontario and Manitoba. He is survived by his mother and a sister, and by two brothers, Mr. J. G. Newman, of the McClary Manufacturing Co., and Lieut. H. Newman, of the reinforcing company of the 5th Royal Scots, now awaiting orders to proceed overseas.

CANADIAN SOCIETY OF CIVIL ENGINEERS, TORONTO BRANCH.

Before the Toronto Branch, Canadian Society of Civil Engineers, on November 9th, Mr. William Storrie, A.M.Can.Soc.C.E., will read a paper on the drifting sand water purification plant at Toronto Island. Mr. William Gore, member of the Institution of Civil Engineers, the inventor of the system, will be present and will explain the design. Free discussion is invited.

COMING MEETINGS.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS. Annual meeting at La Salle Hotel, Chicago, October 30-November 4. Secretary, J. A. Andreucetti, C.J.N.W. Railway, Chicago.

AMERICAN MINING CONGRESS. In Chicago, November 13. Secretary, J. F. Callbreath, Munsey Bldg., Washington, D.C.

NATIONAL COMMERCIAL GAS ASSOCIATION. Convention in Atlantic City, N.J., November 13-18. Secretary, Louis Stotz, 61 Broadway, New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS. Convention in Washington, D.C., November 14. Secretary, W. H. Connolly, Washington.

KANSAS GOOD ROADS ASSOCIATION. Annual meeting in Lawrence Society headquarters in Kansas City, November 16-17.