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DOCK DESIGN AND CONSTRUCTION IN FORT WILLIAM AND PORT ARTHUR

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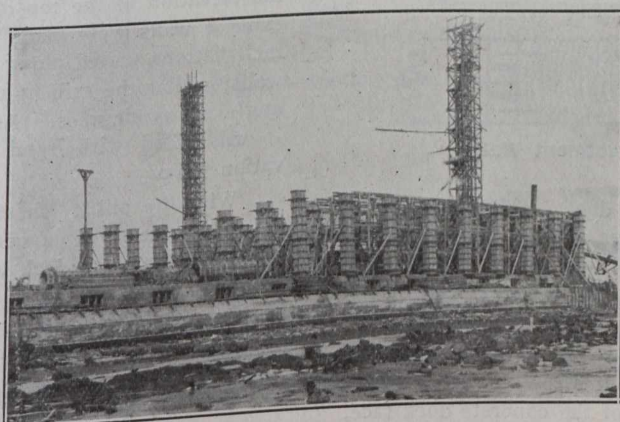
With an ideal location, associated with many other natural advantages, Fort William and Port Arthur, popularly known as the "Twin Cities," are destined to become one of the greatest inland ports of the American continent. Fort William and Port Arthur are separate townships, with their own municipal governments, but for all practical purposes may be considered as one port. Fort William's harbor consists chiefly of river frontage. The Kaministiquia River, popularly and for self-evident reasons, known as the "Kam," together with its offshoots, the McKellar and Mission Rivers, is the means of providing Fort William with 26 miles of land-locked harbor, with the addition of two islands by way of good measure. The natural channels of these rivers have been dredged to a depth of 30 feet; the "Kam" widened to 600 feet; the McKellar to 400 feet, and the Mission to 500 feet.

A turning basin upwards of 1,000 feet in width is about to be made 6½ miles from the mouth of the "Kam" and this will necessitate the removal of upwards of twenty-three acres of solid earth.



Showing Dock Wall, Taken from the Harbor.

Port Arthur, to whom Nature has not been quite so lavish in her gifts of water frontage, has, nevertheless, a harbor of which she is justly proud, and, furthermore, is the lucky possessor of a fine up-to-date shipbuilding plant (the western dry dock) where upwards of 900 men are employed, and from which many of the finest lake steamers have been turned out.

Those of my readers who may be interested in the Twin Cities harbor development might, with advantage, communicate with W. R. J. Burdett, the genial and energetic labor commissioner of Fort William, who will be pleased to supply them, as he has supplied me, with all available information.

As will be noted, Nature has provided the Twin Cities with the necessary water frontage, and it remains for the Dominion and civic authorities to take full advantage of the unique opportunities offered them of making the cities into the greatest of all lake ports. Much has been done in this direction, but more remains to be done. It behoves the responsible authorities to map out some approved system of planning and laying out their docks, and to see that all such work actually carried out is of a stable and permanent character. There is a decided tendency in these days to think only of present needs, and not of future requirements, and it is to be hoped that the authorities will avoid this error, and bear in mind that future generations will judge their work. There should be little fear of the result, however. The public men of Fort William and Port Arthur, backed up by the Dominion Government, are determined that their port will become a

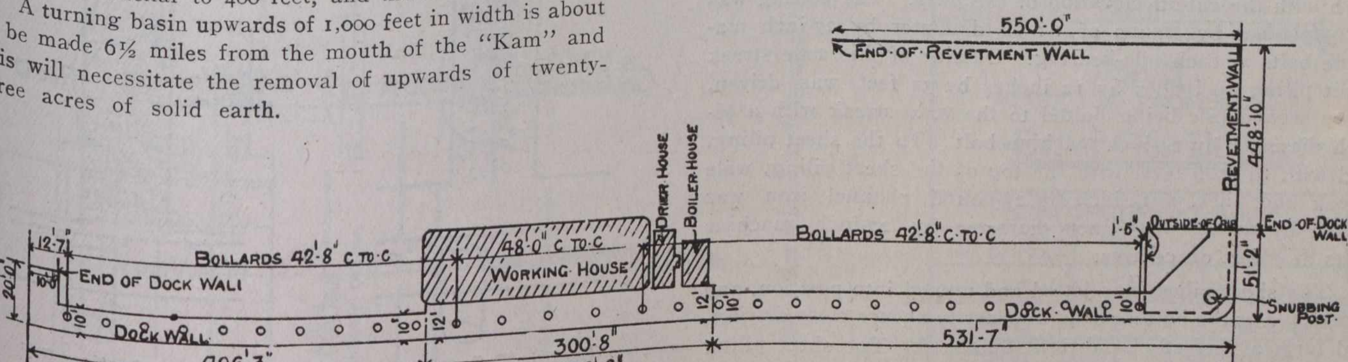


Fig. 1.—Twin City Dock Construction—Layout Plan.

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port of which they will have just reason to be proud, and with this feeling paramount, their efforts are bound to prove successful.

The greater part of the dockage in the Twin Cities port is provided by the different elevator companies, who have provided excellent facilities for the speedy loading of grain-carrying steamers. The government elevator at Port Arthur, now in course of erection by the Barnett McQueen Company, for whom E. D. Casseday is chief engineer, is a notable example of this, and it is the purpose of this article to deal with the elevator dock now under construction, and of which the writer of this article was the designer.

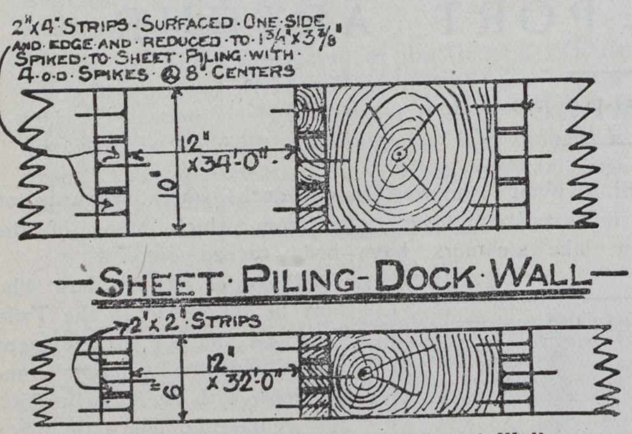


Fig. 2.—Sheet Piling Revetment Wall.

Fig. 1 shows the layout of the dock, which consists of concrete dock walls of 10 and 12 feet widths, and revetment walls of the lengths shown on the layout plan. It would, perhaps, be advisable to consider these different type walls separately, and this we will proceed to do.

Concrete Dock Walls.—A double row of piling was first driven with the centre line of the outer row, 2 feet 8 inches in from the outside of the face line of the concrete dock face, the piles being spaced 5 feet 4 inches centre to centre in both directions, and afterwards cut off at elevation 600.0, the level of mean low-water, Thunder Bay, on which the dock wall abuts. To the outside of the outer line of piles a 10-inch by 12-inch fir wale streak was bolted, the top of the wale streak being flush with the cut-off elevation of the piles. The bolting was accomplished by means of 1-inch diameter by 27-inch machine bolts at each pile-bearing. Outside of this wale streak sheet piling 10 inches by 12 inches by 34 feet was driven, every second pile being bolted to the wale streak with a ⅝-inch diameter by 24-inch machine bolt. To the sheet piling, and with the top level with the top of the sheet piling, wale streak and piles, a 12-inch by 25-pound channel iron was bolted by means of ¾-inch diameter by 27-inch machine bolts at 3 feet on centres.

The sheet piling was jetted and tapped into position, and sharpened at the bottom ends in order to ensure close driving, and form a perfectly sand-tight bulkhead. The sheet piling was furthermore tongued and grooved by building on to the edges 1¾-inch by 3⅜-inch strips of timber, obtained by surfacing one side and edge of 2-inch by 4-inch strips. The strips were spiked to the 10-inch by 12-inch sheet piling with 4 o.d. wire spikes spaced at 8 inches on centres. This construction is illustrated in Fig. 2.

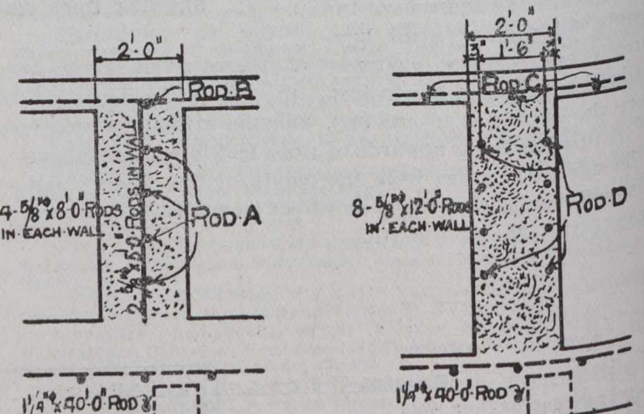
The 12-inch by 25-pound channel iron, to which reference has already been made, was punched to receive the ¾-inch diameter by 27-inch machine bolts, and also for 1¼-inch diameter anchor rods, spaced 5 feet 4 inches on centres. These anchor rods were attached to the channel by means of heavy nuts, and had a length of 40 feet with a 12-inch thread at each end. The anchor rods were passed through an anchor log held in position by means of spur piles, and attached to same by heavy nuts and washers.

A second line of anchor rods, 1¼-inch diameter by 58 feet, placed 10 feet 8 inches on centres, connected the previously mentioned anchor log, and a second anchor log held in position by the outer row of piles, forming a trestle required in connection with the general elevator construction. These anchor rods were furnished, as in the case of the 40-foot anchor rods, with heavy nuts and washers. Spur piles were cut off at elevation 602.0.

At the outer corner of the dock wall a timber crib 48 feet by 48 feet, divided into 16 compartments by means of tie walls, was placed. The crib was built of 12-inch by 12-inch timbers, the outer walls solid and the inner walls half open. The timbers in the outer walls were halved at the corners, thus forming perfectly strong joints, whilst the inside timbers, instead of resting one upon the other, as in the outer walls, were placed to cross one another at the junction points. Fig. 8 shows the method of construction. After being built, the crib, which, it should be noted, was 23 feet in depth, was sunk to a depth of 24 feet below mean low-water datum, the elevation of the top of the crib thus being 599.0. The exterior walls were made sand-tight by having 1-inch by 6-inch battens nailed along the joints, on the inside of the walls, whilst the crib at the outer corner was cut off at an angle of 45 degrees. After the crib was sunk in place, it was filled with sand and gravel to the top, or elevation 599.0.

With the piling, sheet piling, channel and crib in position the next stage in construction was the building of the reinforced concrete dock wall.

The dock wall, as previously stated, is built in 10 and 12-foot cross sectional widths. Starting at the inshore end, adjoining a 20-foot return end, the 10-foot section is carried for a length of 406 feet 3 inches. At this point the width of the wall is increased to 12 feet, in order to join up with the



Section C C **Fig. 9.** **Section F F**

building line of the working house, which is 12 feet from the face of the dock wall. This 12-foot section continues along the frontage of the working house, drier house and boiler house, for a distance of 300 feet 8 inches. From this point the 10-foot section is carried to the crib, where, at the outshore end, it is increased to a solid mass of concrete with a face radius of 33 feet. The plans and sections clearly show the methods of construction pursued. The inshore end at the return corner was similarly strengthened by a solid block of concrete, less in bulk, naturally, than was required for the outshore corner of dock wall.

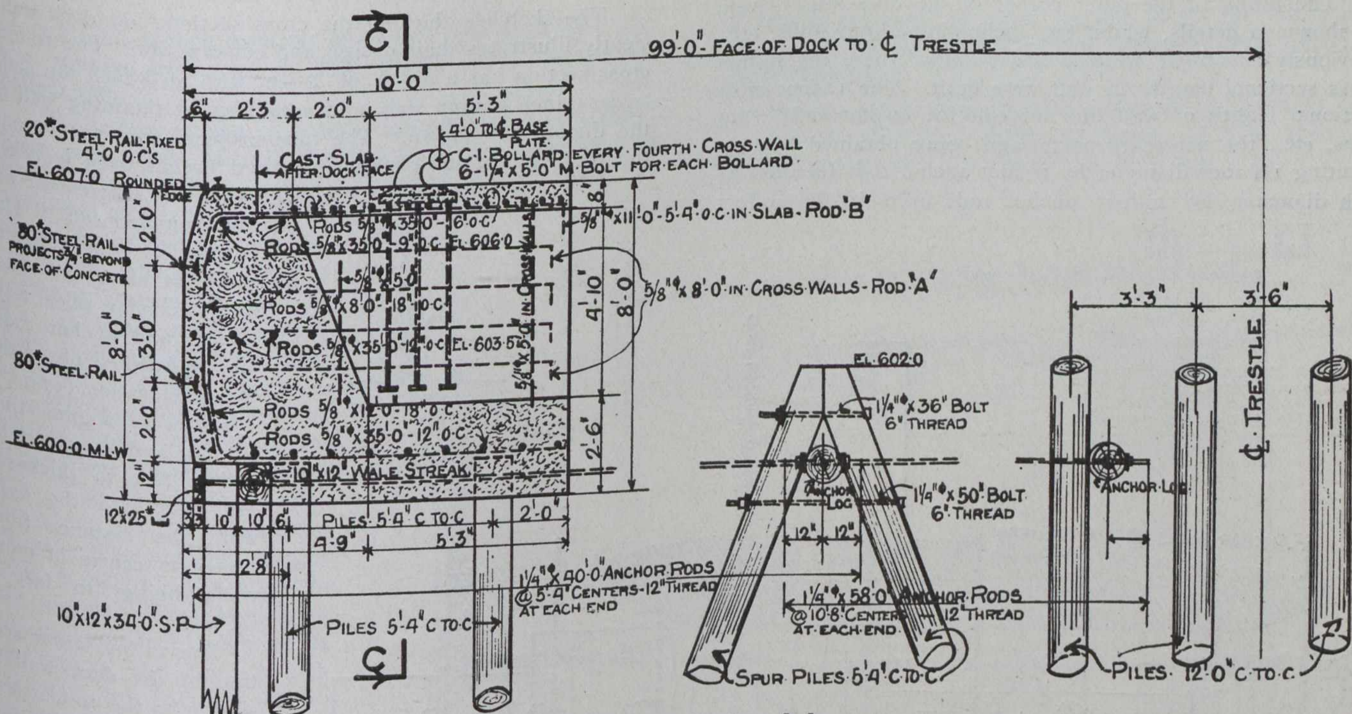


Fig. 4.—Section A A.

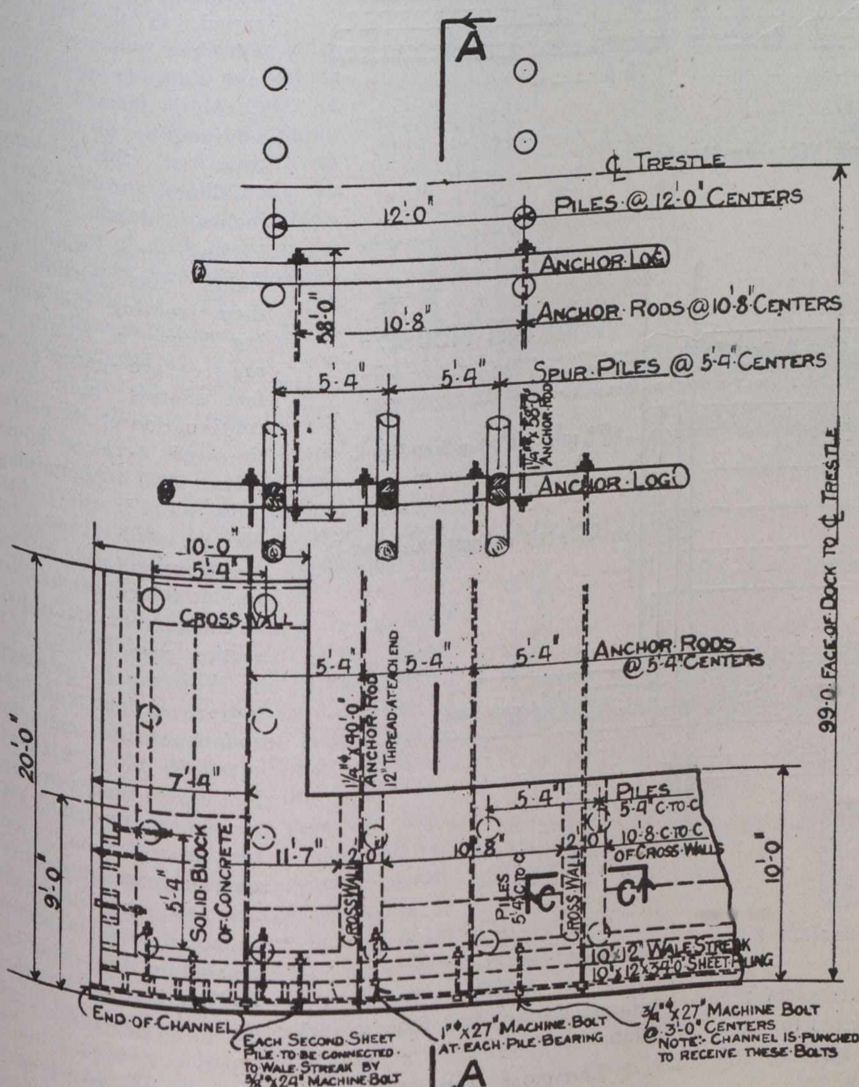
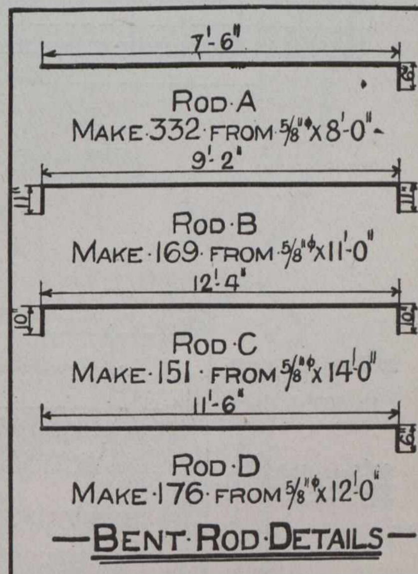


Fig. 3.—Plan at Inshore End.



Reinforcement List

No. of Rods	Size	Length
226	5/8"-Straight	5'-0"
1550	" "	8'-0" Includes 332 Bent Rods A
714	" "	12'-0"
160	" "	16'-0"
50	" "	22'-0"
12	" "	28'-0"
15	" "	30'-0"
1211	" "	35'-0"
169-B	" Bent	11'-0"
151-C	" "	14'-0
176-D	" "	12'-0"

Fig. 11.

The piling at the outer corner of the dock was driven, as shown in details, whilst the anchor logs, spur piles, etc., previously described, were necessary only where the 10-foot cross sectional lengths of wall were built. The 12-foot cross sectional length of wall did not call for anchor rods, spur piles, etc., the necessary anchorage being obtained by substituting 1¼-inch diameter by 16-foot anchor rods for the 1¼-inch diameter by 40-foot anchor rods used in the 10-foot section and carrying same through into the mattress of the elevator buildings, the mattress in turn being carried forward under the 12-foot section of dock wall, thus forming the bottom slab or foundation of same.

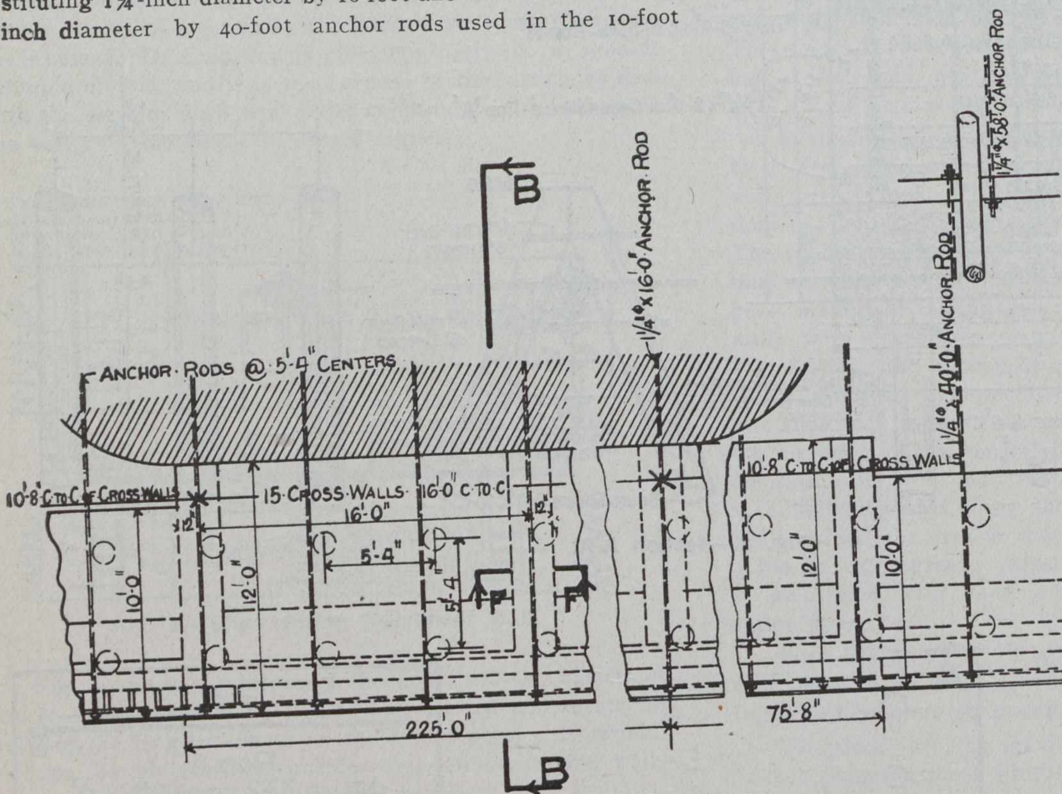


Fig. 5.—Plan Fronting Working House.

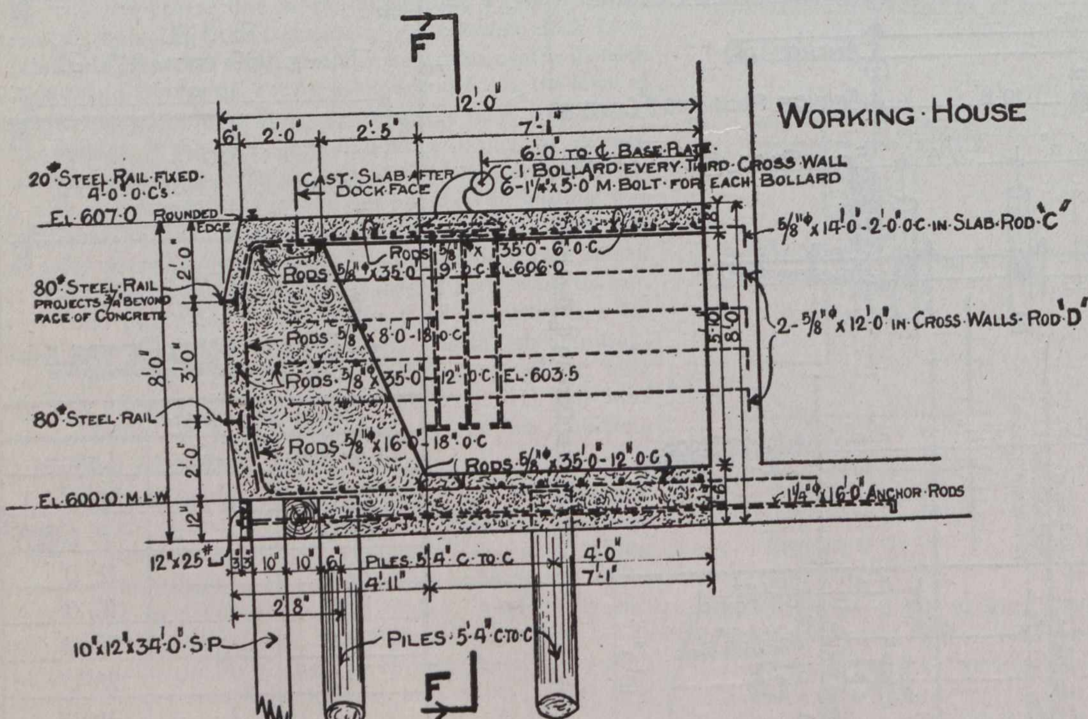


Fig. 6.—Section B B.

The sketches showing the cross sections of dock walls clearly illustrates their design and construction. The 10-foot cross section has a depth of 8 feet with an 8-inch top slab, 2-foot 6-inch bottom slab, and a connecting retaining wall of the dimensions shown. The face projects 6 inches beyond the back line of the channel iron and breaks back 6 inches at the top, the corner being rounded off. The bottom of the concrete starts at elevation 599.0, thus enclosing piles, wale streak, and anchor rods, and is finished off at the top at elevation 607.0.

Cross walls connecting the top and bottom slabs and 2 feet in thickness are cast with the dock wall, the distance from centre to centre of cross walls being 10 feet 8 inches.

The 12-foot cross section of the dock wall is similar to the 10-foot section as regards face formation and thickness of top slab. The connecting retaining wall is slightly varied, as the sketches will show, whilst the bottom slab, as previously stated, is formed by the continuation of the mattress of the elevator buildings, and is 1 foot 6 inches in depth.

The cross walls, or rather that portion of them fronting the working house, a length of 224 feet, are spaced at 16 feet centres, built on a continuation of the centre lines of working house columns. The remaining cross walls in the 12-foot section, whilst similar in construction, are built on 10-foot 8-inch centres, as in the case of the 10-foot section cross walls.

With regard to longitudinal reinforcement, the 10-foot section calls for 15⅝-inch diameter by 35-foot rods 6 inches on centres in the top slab, 3⅝-inch diameter by 35-foot rods 9 inches on centres, and 4⅝-inch diameter by 35-foot rods 12 inches on centres in the retaining wall section, and 9⅝-inch diameter by 35-foot rods 12 inches on centres in the bottom slab.

The cross sectional reinforcement consists of ⅝-inch diameter by 8-foot rods 18 inches on centres adjoining face of dock, and ⅝-inch diameter by 12-foot rods on similar centres, running from near the face of the dock through the bottom slab.

The 10-foot section cross walls are reinforced as follows: Four cross rods ⅝-inch diameter by 8 feet, denoted rods "A," and two ⅝-inch diameter by 5-foot vertical rods. An additional cross rod ⅝-inch diameter by 11 feet denoted rod "B," and spaced 5 feet 4 inches on centres is used in the top slab reinforcement. Rods "A" and "B" are bent as shown on details, Fig 11.

Turning to the 12-foot cross sectional wall, we find the reinforcement somewhat different. The longitudinal reinforcement consists of nineteen ⅝-inch diameter by 35-foot rods, 6 inches on centres in the top slab, three ⅝-inch diameter by 35-foot rods 9 inches on centres and four ⅝-inch diameter by 35-foot rods 12 inches on centres in the retaining wall section, and eleven ⅝-inch diameter by 35-foot rods 12 inches on centres in the bottom slab.

The cross sectional reinforcement consists of ⅝-inch diameter by 8-foot rods, 18 inches on centres adjoining face of dock, and ⅝-inch diameter by 16-foot rods on similar centres, running from near face of dock through the bottom slab into the working house mattress. The top slab is further reinforced with ⅝-inch diameter by 14-foot cross rods 2 feet on centres. These rods are denoted rods "C."

The cross walls are reinforced with two lines of rods consisting each of four ⅝-inch diameter by 12-foot rods, denoted rods "D." Rods "C" and "D" are bent as detailed and listed in Fig. 11.

C.I. mooring bollards were fixed on every fourth cross wall in the 10-foot section and part of the 12-foot section of wall, and on every third cross wall in the 224-foot length of the 12-foot section adjoining the working house, whilst at the outshore corner of the dock wall a C.I. standard snubbing post was fixed.

Along the face of the dock wall two lines of 80-pound steel rails were placed, with the top of the rails projecting ¾ inch beyond the concrete face of dock. This was rendered necessary as a means of protecting the dock face from the risk of abrasion by vessels.

Near the outer edge of the dock face, at the top, was laid a guard consisting of a 20-pound steel rail held in place by ½-inch by 2-inch flat bar clips, and ¾-inch diameter anchor bolts placed at 4 feet centres. The clips serve the double purpose of holding the rail in position, and by reason of raising the base of same ½-inch above the top of dock enable any surface water that may collect to drain off underneath the rail.

Details of the dock wall construction are given in Figs. 3, 4, 5, 6, 7, 8 and 9, whilst the details of bent rods and reinforcement list are shown on Fig. 11.

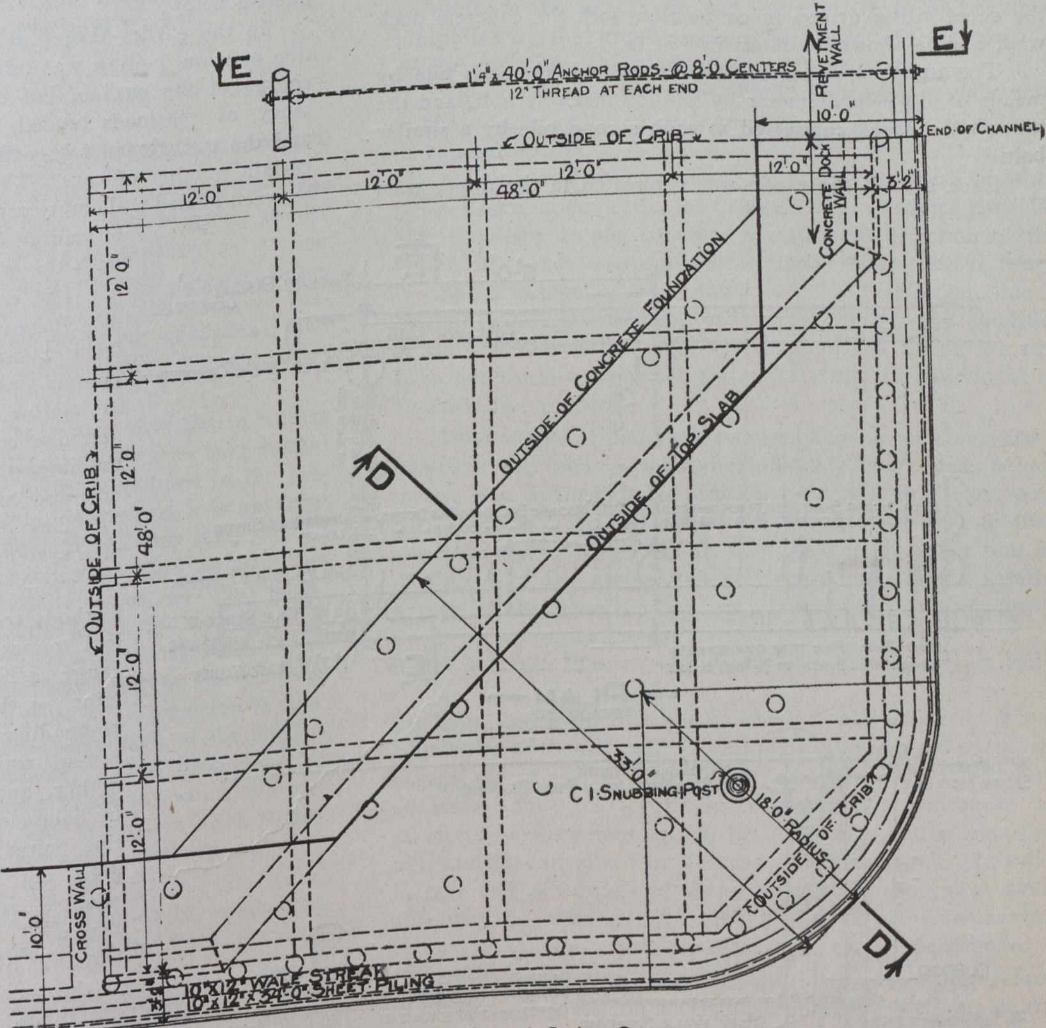


Fig. 7.—Plan at Outer Corner.

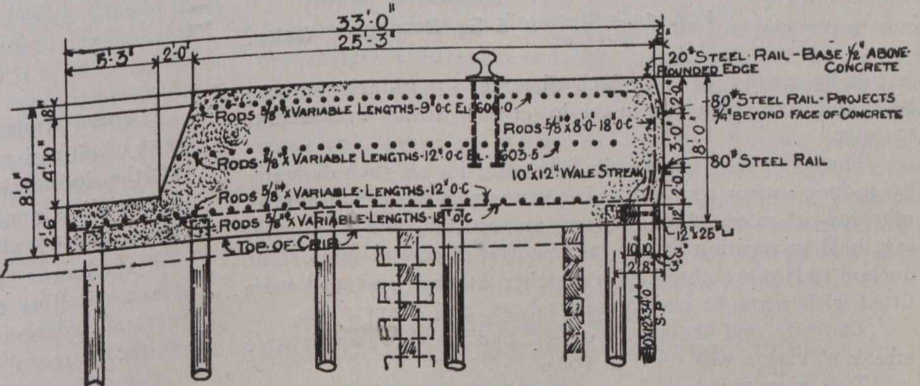


Fig. 8.—Section D D.

Revetment Walls.—Adjoining the crib end of the concrete dock wall revetment walls were built 448 feet 10 inches in length along the outshore end of the property, and 550 feet in length at right angles to last-mentioned portion and running inshore along the property line of the elevator property.

The revetment walls consist of a single row of piles, spaced 4 feet on centres to the outside of which two lines of

8-inch by 12-inch wale streaks were bolted, the wale streaks being 6 feet apart centre to centre. Outside of the wale streaks sheet piling 6 inches by 12 inches by 32 feet was driven, the piles being jetted and tapped into position and sharpened at the bottom ends in order to ensure close driving, and thus ensure perfectly sand-tight bulkhead. This sheet piling was tongued and grooved in a similar manner to the sheet piling driven in connection with the concrete dock wall, and as shown in detail in Fig. 2.

The upper wale streak was connected to each pile by means of a 1-inch diameter by 22-inch machine bolt, and the lower wale streak connected to each second pile by a similar bolt.

Each second sheet pile was connected to the upper wale

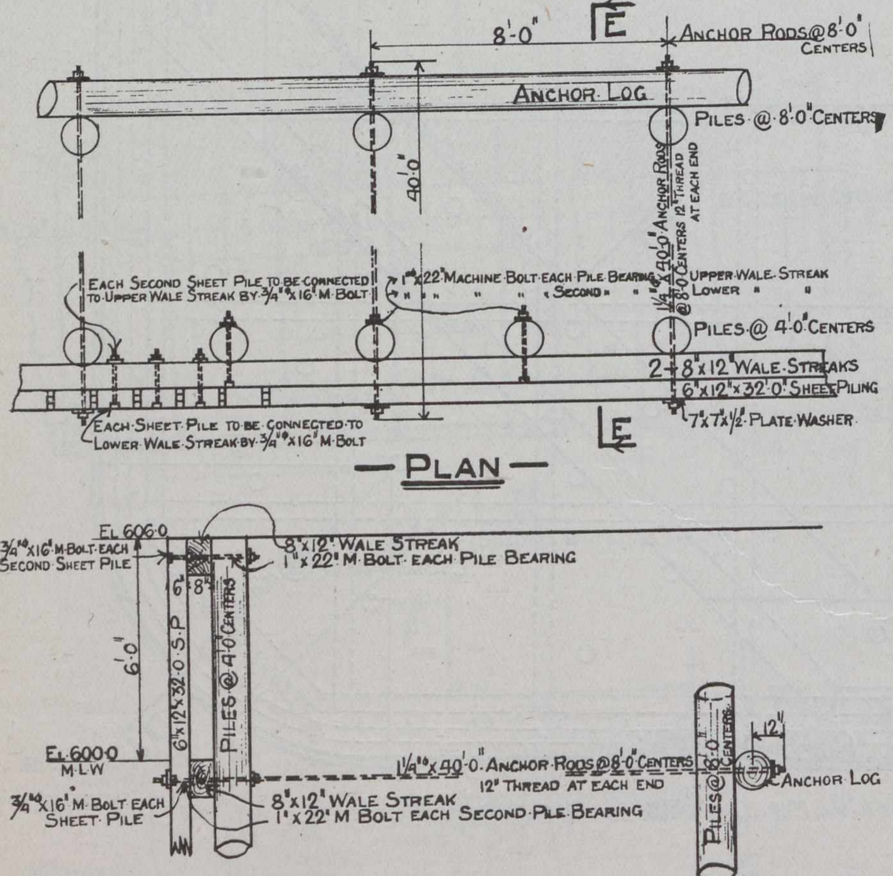


Fig. 10.—Section E E; Revetment Walls.

streak by means of a ¾-inch diameter by 16-inch machine bolt, and each sheet pile to the lower wale streak in a similar manner.

Through every second pile was passed a 1¼-inch diameter by 40-foot anchor rod, and this in turn was passed through a rear row of piles, placed 8 feet on centres, and an anchor log, held in position by the last-mentioned row of piles. The anchor rods were threaded 12 inches at each end and were fitted with wrought iron plate washers, and heavy nuts.

The pile and sheet pile cut-off and top of upper wale streak elevation was fixed at 606.0.

This elevator dock is now nearing completion, and is considered the most up-to-date dock of this particular type in the progressive port of the Twin Cities.

One of the world's newest big projects is a railway across the Sahara desert. The French government has finished its exploration. The task is difficult, but French engineers are masters. If France goes ahead plans may be ready this year.

THE HAULING CAPACITY OF LOCOMOTIVES.

At a recent meeting of the Western Canada Railway Club a paper was presented by H. D. Cameron, chief draughtsman of the mechanical department, Canadian Northern Railway, on the above subject, a portion of which we publish below.

In the earlier stages of railroading the important question of train loading was left to the discretion of the man in charge of the engine, but owing to the apparent inconsistency of the loads hauled, this method was soon changed, and the train loads for each class of engine was fixed at a certain number of cars. This method failed to discriminate between loaded and empty cars, and was followed by a system of loading by gross tonnage, i.e., it included both the weight of the car and the load.

The capacity of box cars has gradually increased in the last thirty-five years from 24,000 pounds to as high as 100,000 pounds, and the very apparent difference in hauling a train composed of empties, and one comprising loads only, disclosed the important bearing the ratio between tare and contents had on unit resistance.

This discovery led to the introduction of a system of equivalent tonnage rating.

There have been a number of different methods tried to arrive at correct equivalent tonnage. One suggestion was to arrange a special table or automatic calculator, so that the different resistances corresponding to various capacity cars, making up train, could be readily added together, and the proper tonnage obtained by balancing with calculated available tractive power of the engine. This scheme does not seem to have been generally adopted, and for present purposes the system used on the Canadian Northern Railway will be explained at length further on in the paper.

In order to follow the subject more easily we will consider it under the following sub-headings in sequence:—

1. Speed resistance.
2. Resistance due to curvature.
3. Grade resistance.
4. Tractive effort.

Speed Resistance.—Train resistance is defined as the sum of all resistances which constitute a tax on the adhesion of the locomotive. That part commonly called "speed resistance" is generally taken to mean all the different resistances that are effective on straight level track, viz. :—

1. Journal friction between journal and bearing.
2. Rolling friction between wheel and rail.
3. Atmospheric head-on resistance.
4. Atmospheric side resistance.
5. Flange friction, due to oscillation and concussion.
6. Stopping and starting resistance, or resistance due to change in velocity.

These are all variables and rather difficult to isolate and measure separately. They all act together, and, for ordinary practical purposes, it has been thought sufficient to obtain the average total resistance without determining the proportion of each individual part.

A number of the older formulæ show this resistance to be comparatively high at the start, gradually diminishing to about twelve miles per hour, and then increasing with the speed. The later formulæ, used by the American Locomotive Company and obtained from the Pennsylvania dynomometer records, show that the resistance between five to ten miles per hour and thirty to thirty-five miles per hour is approximately constant for each different weight of car.

The following table shows the resistance of various weights of freight cars on straight level track:—

Total weight of cars, tons (2,000 lbs.)	20	25	30	40	50	60	70	72
Resistance per ton, 5–30 miles per hour	7.84	6.62	5.78	4.65	3.94	3.44	3.06	3.00

This table shows a decided variation in resistance per ton offered by different sizes of cars. Cars weighing twenty tons require 7.84 lbs. per ton, while a seventy-two ton car needs only 3 lbs. under the same conditions. This shows quite clearly the advantage of using the largest cars possible, consistent with traffic and operating conditions, and also indicates the necessity of differentiating between large and small capacity cars.

It has been found from experiment that the resistance per ton is thirty per cent. greater in empty cars than loaded ones, and this is also a factor to be considered in the tonnage of trains. From the foregoing, therefore, it is apparent that the equivalent or equated tonnage calls for some method whereby all locomotives of the same class shall be loaded so that the trains composed of loads, empties, and part loads, in different capacity cars shall offer equal resistances. The method at present in use on the Canadian Northern Railway assumes that the ideal ratio between tare and contents is two to one, and any variation from this proportion is compensated for by adding a variable percentage of the surplus tare to the sum of tare and contents. This percentage of surplus tare varies with the ruling grade for which the tonnage is determined. Thirty per cent. is used on level, twenty per cent. for grades up to 0.5 per cent., and ten per cent. for grades from 0.5 per cent. to 1.5 per cent.

Weather Resistance.—Under the heading of weather resistance is included all resistances resulting from temperature variation, wind, and snow.

Experiments by Woodbury and Beauchamp Tower show that the temperature variation has a marked effect on journal friction. At approximately one hundred degrees Fahrenheit the coefficient of friction is a minimum, and increases as the temperature is lowered. In the case of a train allowed to stand for any length of time in cold weather, considerable difficulty is experienced when starting, and it is often necessary to move small sections at a time, in order to warm up and make it possible to start the whole train. This is commonly referred to as "frozen train," but dynamometer records show that resistance in starting is not changed suddenly, as one would expect with a frozen journal, but is more or less gradual. This condition makes generous reduction on account of temperature necessary and although there have been a number of tests in this connection, there does not yet seem to be much unanimity of opinion. The following table shows reductions now in use on the Canadian Northern Railway:

Temperature Reductions—Canadian Northern Railway.

Temperature.	Reduction.
Freezing (32 degrees) or above	Nil
32 degrees above to 16 degrees above, or bad rail	5 per cent.
15 degrees to zero	10 "
Zero to 10 degrees below	15 "
11 degrees to 20 degrees below	20 "
21 degrees below to 25 degrees below	25 "
26 degrees below to 30 degrees below	30

In applying these temperature reductions it should be borne in mind that as soon as journals get warmed up, ordinary warm weather conditions hold so far as journal friction is concerned. In making this reduction, the proximity of the ruling grade to a terminal or point where detention is liable to occur, must be a consideration.

Wind, or the resistance offered by the atmosphere, is proportional to the square of the velocity (in miles per hour) multiplied by the cross sectional end area of the locomotive or car, multiplied by a constant equal to 0.002.

The velocity of the wind should be added or subtracted to the velocity of the train, according as it is in the opposite or same direction.

Side winds have a tendency to cause pressure of wheel flanges against the rails, thus increasing resistance considerably. Owing to the constant variation in direction of this factor, it cannot be estimated with any degree of accuracy.

Speed resistance on account of flange friction, due to oscillation and concussion, varies according to the condition of track and road-bed, and speed at which trains are run. It is not usual to consider this apart from the frictional resistance due to speed.

Momentum.—In addition to supplying power necessary to overcome the various resistances already mentioned, a locomotive has to furnish an additional amount of energy every time there is a change in velocity, either from rest, or from one velocity to another. This energy, in pounds per ton, including both the momentum of translation and the rotative energy of the wheels, axles, etc., is expressed by Henderson in the formula $P = \frac{70 V^2}{S}$ where V is the velocity in miles per hour, and S the distance in which it was acquired. Where conditions of track will admit, advantage is taken of the energy stored up in descending a grade, so that it is only necessary for the locomotive to supply the difference between the energy required to lift the train up the opposing hill, and that acquired by descent of the approach. In order to take full advantage of these conditions, the power available may be obtained by adding together the momentum energy of the train and tractive power of the locomotive.

Grade Resistance.—Grade resistance is due to the retarding effect of gravity on a train ascending an incline. It differs from the speed resistance in that it is invariable, and can be calculated exactly.

Curve Resistance.—Our knowledge of resistance due to curvature is in about the same state as that regarding some of the factors, before mentioned, in speed resistance. A good many tests have been made, but the results have not been sufficiently exhaustive, and we are still compelled to accept some approximation for our estimates. Various estimates, by different authorities, run from 0.5 lbs. to 1.72 lbs. per degree of curvature. The American Locomotive Company have taken 0.80 as a suitable mean, and this seems to be a reasonable figure to adopt. When a truck traverses a curve there are two different classes of resistance, viz.,—

1. Forces originating in truck.
2. Centrifugal and centripetal forces.

Observation has shown that on curves the tendency is for the front outside wheel to hug the rail, and the rear axles tend to lie in a radial position. Owing to the outside wheel having to travel a slightly greater distance than that on the inner rail, and on account of the wheel not being free to turn on the axle, there is a combination sliding and rolling motion of the outer wheel which further adds to the resistance. The continued relative motion between car body and truck, when traversing a curve, adds considerably to the resistance, and efforts to reduce this to a minimum have been attempted by the adoption of roller side and centre bearings.

Experiments by Wellington show that the resistance is appreciably less with new rails, and becomes greater as the outer rail is worn to the shape of the flange. It has been found that speed influences curve resistance, and one test on a one degree curve gave one pound resistance at a speed of twelve miles per hour, and only one-half pound at twenty-two miles per hour. Experience has shown that length of wheel base considerably increases the resistance on a curve.

D—Curve in Degrees.—Centrifugal force is directly proportional to the weight multiplied by the square of the velocity. The usual practice is to elevate the outer rail a limited amount, from two to six inches, in order to counteract the tendency to lean toward the outside, and reduce the effect of the centrifugal force on the rails. From the above it is evident that a different elevation would be necessary for each different speed, and it is customary, for obvious reasons, to make this elevation suitable for passenger trains running at high speed. It is consequently too high for slow freight trains, and where curves happen to come on a ruling grade the tendency is to cause a slight increase in the resistance of the freight train. This is overcome by compensating the grade 0.04 per cent. for each degree in curvature.

Tractive Effort.—Having considered the various factors which go to make up train resistance. we now direct attention to the power developed by the locomotive, and particularly that part due to the friction between the rim of drivers and rail, and the power available for hauling train at rear of tender.

The available tractive power at slow speed is derived by equating the work done in the cylinders, to the work performed at the circumference of the drivers in one revolution. By the solution of the equation we obtain tractive effort—

$$\frac{\text{Mean effective pressure} \times (\text{piston diameter}) \times \text{stroke}}{\text{Diameter of driving wheel}}$$

The mean effective pressure is usually taken as eighty-five per cent. of the boiler pressure. In order to obtain greater accuracy it is customary to consider the resistances of locomotive and tender separate from the cars, and these may be grouped under the following headings:—

1. Internal friction of locomotive, found by experiment to be 22.2 lbs. per ton weight on the drivers.
2. Weight on drivers multiplied by grade resistance.
3. Resistance of engine and trailing trucks, and tenders taken same as car resistance in train.
4. Head-air resistance equal to $0.002\ V^2 \times A$ where V is miles per hour, and A the front area of engine (usually taken 120 square feet).
5. Curve resistance .8 lbs. per ton per degree.
6. Reduction necessary account of increase in speed, shown in attached table.

Table of Speed Factors.

Piston speed, feet per minute—	250.	275.	300.	325.	350.	375.	400.	425.	450.	475.	500.	525.	550.
Speed factor—	1.00	.976	.954	.932	.908	.886	.863	.840	.817	.795	.772	.750	.727

Piston speed, feet per minute—	575.	600.	625.	650.	675.	700.	725.	750.	775.	800.	850.	900.
Speed factor—	.704	.680	.660	.636	.614	.590	.570	.550	.530	.517	.487	.460

Piston speed, feet per minute—	950.	1,000.	1,100.	1,200.	1,300.	1,400.	1,500.	1,600.
Speed factor—	.435	.412	.372	.337	.307	.283	.261	.241

The sum of the above mentioned resistance must be deducted from the tractive effort, in order to obtain the net power available for hauling of trains. In order to illustrate this, let us take the example of a consolidation engine with the following dimensions:—

Cylinder, 24 x 32.
Wheel, 67 inches.
Boiler pressure, 180 lbs.
Weight on drivers, 104 tons.
Weight on engine truck, 12 tons.
Tender, loaded, 75 tons.

The problem is to find the net available tractive power and proper tonnage for this engine, in order that twenty miles per hour may be maintained on a 0.5 per cent. grade.

Tractive effort (MEP 85 per cent. of boiler pressure)—49,475 **lbs.**

Speed, twenty miles per hour, therefore piston speed of this engine is 629 feet per minute, and speed factor from above table is 65 per cent.

Available tractive effort at this speed........		32,158.75 lbs.
Resistance due to grade, account of weight on drivers 104 × 10	1,040	
Resistance due to grade and speed on tender (2-3 load) and engine truck —72 × 13.94	1,003	
Resistance due to head air—120 × 0.002 × 20 × 20	96	
Resistance due to internal friction—104 × 22.2	2308.8	4,447.80 lbs.
		27.711 lbs.

Tonnage, 50-ton capacity cars $\frac{27711}{13.94}$ 1,987 tons.

From the foregoing it is evident that the work done by an engine is limited by either the boiler capacity or the power adhesion. Engines are compared with respect to their adhesion by comparing the factors of adhesion, i.e., the ratio between weight on drivers, and tractive effort, which usually runs somewhere between 1-4 and 1-5.

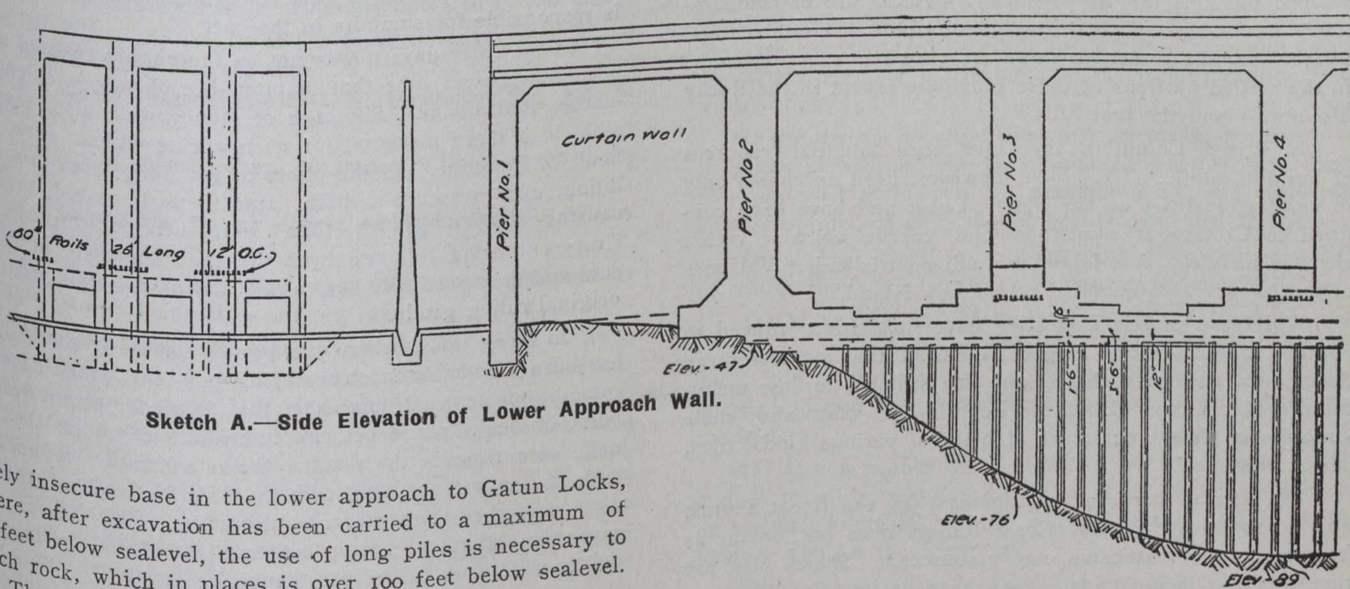
The boilers of most engines are unable to supply sufficient steam to develop full tractive effort at speeds higher than eight or ten miles per hour, and after this critica speed has been reached the boiler becomes the limiting factor to be considered in connection with load and speed. It will, therefore, be readily seen that on long level sections the boiler capacity becomes the principal factor in fixing train loads.

RAIL FAILURE TESTS.

Ninety per cent. of rail failures, as stated by Mr. M. H. Wickhorst, engineer of tests for the rail committee of the American Railway Engineering Association at the recent convention of the association, are failures either of the head or web, which constitute 50 per cent. of them; or of the base, which constitute 40 per cent. The cause of the former he ascribes to unsound ingots, and the remedy he says is a more uniform chemical structure in the ingot. For the base failures he blames laminations in the base, and suggests as a cure better mechanical rolling.

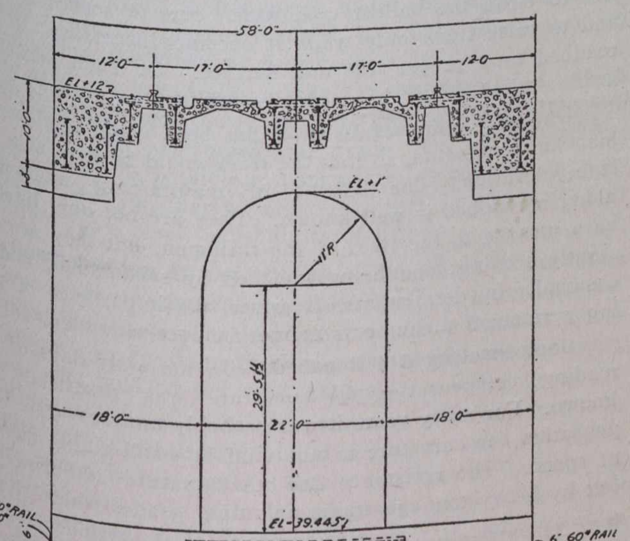
LOWER APPROACH WALL AT GATUN, PANAMA.

The lower approach wall of Gatun Locks, at the Atlantic end, differs from the five other approach walls in the Canal lock construction. The cellular form of reinforced concrete used for the upper approach walls at Gatun, Pedro Miguel, and Miraflores Locks could not be used in sea water, because of its possible effect on the steel reinforcement. The heavy U-section, double gravity-wall used for the lower centre guide walls at Pedro Miguel and Miraflores, and founded directly on rock, would be too heavy for the relatively insecure base in the lower approach to Gatun Locks, where, after excavation has been carried to a maximum of 50 feet below sealevel, the use of long piles is necessary to reach rock, which in places is over 100 feet below sealevel.



Sketch A.—Side Elevation of Lower Approach Wall.

The structure planned to meet these conditions comprises a series of piers, connected by flat spans above, to form a causeway of successive flat-span bridges. The original plans contemplated that the piers should rest on broad bases surmounting the piles, but would not be connected at bottom. Excavation revealed, however, softness in the earth overlying the rock which was not shown by the borings made at the time of determining the lock site. It became necessary to bind the piers together and protect them against transverse sliding. Accordingly, the piles, which are driven on four-foot centres, longitudinally and transversely, and on 3-foot centres for the outermost two hundred feet, are surmounted by a continuous base of concrete, which extends a foot below the top of the piles.



Sketch B.—Sectional View (Twenty, 50 ft. Apart, Support the Causeway).

This base is 58 feet wide. The bottom is level, but the top is a series of inverted stepped arches, described on a radius of 42 feet. The haunches between the successive inverted arches form the bases of the piers of the flat-span bridge. At the lowest step of the inverted arches, the thickness of the base is five feet seven inches; at the springing line it is 10 feet seven inches. Several of the arches were constructed with the soffit on a curve, but for the sake of speed in construction, with consequent economy, as well as to afford better bracing for the forms in the erection of the piers, the stepped arch was adopted. The lower part of each riser is on the circumference of a regular segment, with 42-foot radius, so the strength of the arch is not diminished. Reinforcement in the base consists of twenty continuous longitudinal rows of 70-pound rail, resting on the tops of piles; and duplicate rows of similar rail four feet six inches higher up. The side elevation of the base, and of a portion of the completed wall, is shown in the accompanying sketch marked A.

A transverse section of the wall is shown in Sketch B. Each pier, as shown, consists essentially of two piers, connected by a semi-circular arch. The horizontal normal section of each component is 18 by 10 feet; the inner sides are vertical for a height of 22 feet five and 11-32 inches, this point above the base being the springing line of the arch, which has a radius of 11 feet. On the outer faces the piers are vertical from base at elevation—39.37 feet, to the top, which is 12 feet above sealevel. The shaded sections shown in Sketch B are not parts of the pier proper, but of the spans connecting the piers in the causeway. The piers, 20 in number, are set 50 feet apart, centre to centre. The spans connecting them are carried by four 6-foot, and six 4-foot 6-inch plate girders, encased in concrete. The tops of the spans will be left uneven, in preparation for the grouting necessary to the laying of track for the towing locomotives.

The six spans of wall nearest the locks are closed by 2-foot curtain walls. This is to prevent water from surging from one approach channel to the other, between the piers, when a lock is discharging. Beyond the sixth pier the spans will be open, and the bottom of the spans will be two feet above the water. The wall will extend 1,016 feet from the line of the fender chains, and will contain approximately 45,000 cubic yards of concrete.

BUILDING MATERIALS IN WESTERN CANADA.

With the exception of British Columbia there is very little building stone produced in Western Canada. This is due to two causes. First, the rocks which underlie the developed portions of the Prairie Provinces are of comparatively recent age and are consequently soft in character and weather rapidly; second, there are very few rock exposures in the settled portions of these provinces except in the Rocky Mountains and the foot hills.

In British Columbia there are large potential resources of building stone. They have, however, been developed only in certain localities on the Pacific Coast and have been confined to Cretaceous sandstone and certain volcanic rocks, situated on Vancouver Island and adjacent islands. Varieties of marble are also quarried on Texada Island.

While the prairie Provinces have not been proved to contain building stone in great quantity they possess large deposits of lime-rock shales and clay suitable for the manufacture of cement; also large deposits of clay and shale suitable for the manufacture of brick of various kinds, tiles, sewer pipe, etc.

The region bordered on the east by the Great Plains, and on the west by the Coast Range, does not, so far as known, contain extensive clay resources. Shales also are rare because, in most instances, the deposits of argillaceous material have been altered to slaty rock or schists.

Exploration in the Pacific Coast region has, thus far, disclosed only a limited extent of clay resources, but important shale deposits are found at Sumas Mountain, southeast of Vancouver. Surface clays are more extensive than the shale deposits and a number of these clays are found in the vicinity of Vancouver, Victoria and on several of the islands in the Strait of Georgia.

The cement plants in operation in Western Canada are situated at Babcock, Manitoba; Winnipeg, Man., (under construction); Calgary, Alta.; Exshaw, Alta.; Blairmore, Alta. (one operating and one under construction); West of Edmonton, Alta. (one under construction); Todd Inlet, B.C. (one operating and one under construction).

In the above list there are four new plants described as under construction, but all expect to be in operation in the spring of 1913. The Rocky Mountains undoubtedly contain enormous deposits of raw material similar to that used at Blairmore and Exshaw which will be developed as the demand increases.

UNEXPECTED RAILWAY TESTS.

Fifty-one thousand surprise tests were conducted by the Pennsylvania Railroad last year to test the alertness of its men in heeding signals. In these there were 510 failures on the part of the men to obey the signals, and the railroad company, arguing that each of these failures contained the possibility of an accident, protests vigorously against a bill introduced into the New Jersey Legislature requiring the railroad to give previous notice in writing to the engineman where tests of apparatus are to be made.

RECOMMENDED PRACTICE IN RAILWAY LOCATION.

At the recent annual meeting of the American Railway Engineering Association, the following notes for railway location were presented by a committee on "The Economics of Railway Location":—

Value of Maintaining Original Profile.—Railroad profiles change in the course of years. It is a well-known fact that fills settle, causing deep sags in the grade line. The raising of tracks through cuts is cheaper than ditching, but is responsible for summits in the cuts.

In the early days it was not as thoroughly realized as it is at the present time that maintenance of way is chiefly a matter of drainage. Shortage of money was also responsible in a large measure, for narrow cuts which were difficult of drainage. In the effort to get away from this condition, and to secure a ditch, tracks were raised, thereby causing steeper grades than were originally projected. Every cut being followed by a fill, the sequence of raised cuts and depressed fills has caused a wide variation from the original ruling grade.

On some lines, where the profile has been checked, it has been found that stretches of 0.3 per cent. grade have become 1 per cent. If places of this character occur near a point of heavy resistance, an immediate effect on the tonnage of a train is the result. When an engine is working with its bar well forward, with the fireman tired out, the fire dirty, and the steam pressure dropping, such places will cause the stalling of a train, and in a short time the frequent delays will result in decreased tonnage rating.

Raising tracks is not as economical as the section foreman and supervisor would lead us to believe. While better drainage is undoubtedly secured, it is generally better practice to clean the ballast, and widen cuts to secure a ditch, and to raise track only when it becomes necessary to put roadbed to a proper line and surface. On such occasions, grade stakes should be used to establish the grades.

On many railroads an effort has been made to place permanent monuments, so that the track could be kept at a constant elevation. The difficulty of maintaining monuments along a roadbed is well known. They are not only likely to be a menace to the lives of the trainmen, but they are constantly settling, and being knocked by sectionmen, and occasionally by derailments. However, the importance of placing permanent monuments cannot be over-estimated.

Compensating Old Roadbeds.—In the early days of railroading, compensating for curvature was practically unknown. For many years it was probably unnecessary. Compensation for curvature is not vital to small trains running at speed. The resistance due to curvature is principally felt by heavy tonnage trains on ruling grades where the engine is rated at a high percentage of its cylinder tractive power. Various experiments have been made to determine how much reduction in grade would compensate for the added resistance of curvature. It has generally been the practice to compensate this at a stated amount, and, while this method is not as accurate as could be desired, it is very much better than no compensation at all. From considerable observation of the influence of curvature, together with the examination of numerous tests of its effect, it is felt that some rules can be laid down which will improve the present practice. The rules follow:

Rules for Grade Compensation.—1. Compensation .03 per degree:

(a) When the length of curve is less than half the length of the longest train.

(b) When a curve occurs within the first 20 ft. of rise of a grade.

(c) When curvature is in no sense limiting.

2. Compensate .035 per degree.

(a) When curves are between ½ and ¾ as long as the longest train.

(b) When the curve occurs between 20 ft. and 40 ft. of rise from the bottom of the grade.

3. Compensate .04 per degree.

(a) Where the curve is habitually operated at low speed.

(b) Where the length of the curve is longer than ¾ of the length of the longest train.

(c) Where super-elevation is excessive for freight trains.

(d) At all places where curvature is likely to be limiting.

4. Compensate .05 per degree wherever the loss of elevation can be spared.

An illustration will show what can be accomplished by compensation of curvature on old roadbeds:

Take a 0.5 per cent. grade five miles long, with an average curvature of 60 deg. per mile, without compensation. If the maximum curve is 6 deg. and the curve equal in length to the longest train, the curvature will have the same effect in limiting tonnage as a grade of 0.24 per cent. This, added to the 0.5 per cent. grade, would make a ruling grade of 0.74 per cent. The effect of the curvature on the five miles of grade would be 300 deg., which, at an average of 0.035 per degree, would amount to 10½ ft. If this 10½ ft. is added to the 132 ft. of rise in the five miles of grade, it will be equivalent to 142½ ft., or 28½ ft. to the mile, which is equal to a 0.54 per cent. grade. If this 0.54 per cent. compensated grade is laid so as to be superimposed immediately above the present roadbed, it will be found that by re-ballasting the track to permanent stakes on a 0.54 per cent. grade, a new ruling grade can be established, which will be 0.2 per cent. below the 0.74 per cent. equivalent to the 0.5 per cent. uncompensated grade. On a grade of this length, it will be possible to haul nearly 25 per cent. greater tonnage per train, thereby securing a very large economy in operation for a small expenditure of money.

Compensation of Low Grades.—The effect of curvature on low grades is generally greater than on heavy grades, provided the length of train is what would be justified by the low grade. In speaking of low grades, levels, 0.1 per cent., 0.2 per cent. and 0.3 per cent. grades are referred to.

On double track railroads, particular attention should be paid to curves, whether uphill, downhill, or level, at places where steam is being taken by the engine in moving in either direction. On virtual level grades each track should have its tangents slightly raised and its curves slightly sloping downhill, so that the pull by the engine may be uniform, and the resistance of the line constant. The value of keeping the line resistance constant becomes more important as the length of the train increases. One of the prime objections to hauling a long train is the danger of parting, and in this danger curvature plays an important part. If the line is crooked, having many short curves, it is usual for the slack of the train to be constantly taken up and let out. If the engine runs out on a bit of straight track, when the rear of the train is bunched on the curves, it will accelerate faster than the other end of the train. Unless the engineer is watching, and using the brakes slightly, he may pull out a drawbar. If, on the other hand, the front end of the train is on a curve, and the rear end on straight track, the tendency is for the rear end to run in on the front end, and break a knuckle. It should not be supposed that it is impossible to have different classes of compensation on each track of a double track railroad.

Super-Elevation.—From a scientific standpoint (not always from a financial view), it is evident that a six-track railroad is the most desirable for a road that handles a three-speed service. This will give a passenger track, a fast freight track, and a slow freight track in each direction. Without attempting to discuss at this time what will be gained by the operation of a six-track railroad, it should be said that as many tracks as possible are justified if a standpoint of super-elevation alone is considered. Of course, it becomes necessary for a train to stop occasionally on a curve, and for that particular case the super-elevation is always wrong.

Inasmuch as no super-elevation at all is necessary at very low speeds, it may be eliminated entirely on tracks that are used exclusively for standing cars, and very low super-elevation, if any, should be used in yard tracks.

On a single-track railroad carrying more than one class of traffic, there are two ways to treat super-elevation:

(1) Make the freight tonnage rating as great as possible, and in accordance with the ruling grade. In this case, it will be necessary to elevate the curves for freight speed, and run the passenger trains slowly over the ruling grades.

(2) Use a higher super-elevation for passenger speeds, and decrease the tonnage rating to make up for the increased resistance caused by the wheels of the freight trains binding against the lower rail.

Single-track railroads which are crooked can rarely haul as high a percentage of rating as double-track railroads, on account of the super-elevation being wrong. It is very easy to see that every down-grade becomes an up-grade for movements in the opposite direction on a single-track road. Inasmuch as the movement downhill is likely to be faster than the it is uphill, the super-elevation must be made for the downhill movement or introduce speed limits on downhill trains.

Resistance, Train, Total, Including Track.—On single lines that are exclusively for freight, super-elevation on ruling grades should be made for not over 15 miles per hour. It is less expensive to slow down the descending movement than to reduce tonnage rating on account of excessive super-elevation.

This is especially true on curves of large central angle. As an example, a curve of 18 deg. is cited. Two engines (one helping) hauling 3,500 tons of coal ordinarily stalled on an 8 deg. 30 ft. curve with 185 deg. central angle with 5½-in. elevation. The elevation was reduced to 3 ins. and no difficulty was had. This curve was compensated .04 per degree and was an 0.85 per cent. grade.

On many mountain roads a long train may be on seven or eight curves at once, and when such is the case, observation of minor points is of great value when tonnage is the main issue.

Spirals.—Without discussing the theory of the spiral as affecting railway grades, it should be said that the object of the spiral is twofold:

(1) To afford a run-off and a run-on from a level cross-section to a super-elevated cross-section.

(2) To ease the horizontal passage from a straight line to a curve.

It is evident that in passing from a level position to a super-elevated position, when the inner rail of the curve is laid at grade, the centre of gravity of the mass of the train must be raised through a distance equal to one-half the super-elevation. This is generally a minor rise, but in order to haul uniform tonnage this minor point should be carefully observed, especially where limiting conditions are found, such as places near the end of a long-continued effort. It has been proposed in the past that the inner rail be depressed a distance equal to one-half of the super-elevation, and the outer rail be raised the same amount. While this has been objected to by some railroad men, it can certainly be done and so maintained, and from a tonnage haulage standpoint it is desirable. It is submitted that the railway of the future, which is scientifically operated, will find conditions such as these limiting their tonnage unless care is taken. While it might be said that refinements in the track are unimportant, it should be borne in mind that, in order to realize the full value of improvements, these matters must be taken into consideration. A combination of correct conditions results in the most effective operation.

Reverse Curves.—Curves that reverse without any tangent between them mean operating expense. Not only must the super-elevation change abruptly, but the trucks must change their position in the same manner. It is considered good practice to leave room between the points of spiral for four freight cars to straighten up after they change direction. On most new construction, provision is made for at least 1,000 ft. between curves, and this practice is recommended unless great expense is involved.

Effects of Tunnels.—Many railroads are suffering today on account of the fact that during the early days of construction it was not thoroughly realized that a tunnel might be a limiting feature. The following are the causes of the limiting effect of tunnels: (1) A tunnel is dark, making the crew less confident. (2) A derailment in a tunnel is almost sure to result in serious damage and loss. (3) The heat in long tunnels, especially if of small section, is intense. (4) The track conditions, such as line and surface, are never as good as on the outside. (5) The rail is generally damp, causing either the excessive use of sand, or the slipping of drivers. (6) Drainage in tunnels is usually bad, and difficult to improve. (7) There are usually speed restrictions in tunnels. (8) It was formerly the practice to carry maximum grades through tunnels in order to shorten them. This serious defect in many cases makes tunnels the ruling points. (9) In tunnels of small section the use of helper engines is undesirable on account of the heat. (10) The smoke and gas add to discomfort of operation. (11) The impracticability of firing in long tunnels causes a drop in steam pressure.

There have been many plans devised for tunnel ventilation. Most of them are successful under some circumstances, but none is successful under all conditions. Long tunnels are generally built by means of shafts, and these shafts are sometimes left open to aid the ventilation. If the heat in the tunnel is greater than that outside, shafts will help when the atmosphere is low in humidity. When the humidity is high, shafts make but little difference in tunnel conditions. This is unfortunate, as tunnels at such times are very foul. Disc fans used in the shaft will operate satisfactorily sometimes, but their efficiency seems to vary about the same as the open shaft. Pure air blown down shafts is successful at times, but if the shaft is near the çentre, it generally happens that only one end of the tunnel is cleared out, the air remaining stationary at the other.

The Churchill system of ventilation, by which pure air is blown through the tunnel from one end through nozzles fitted at the sides of the tunnel, is successful, if the enginemen operate the locomotive so that the smoke is blown ahead of the engine. If two engines are used ahead on a train, and it is necessary to work the second engine, the position of the front engineer is unbearable. If one engine is used in the rear and one in front, and the smoke and gas from the second engine reaches the first one, the front engine crew are in the same position as in the case of the double-header, but if the train is skilfully handled, the smoke and gas of the rear engine will not reach the head engine. In tunnels where the grade inside is considerably less than the ruling grade, it is sometimes found possible to shut off one engine entirely, and in that case there is no difficulty, provided that the train does not move faster than the air current.

The natural tendency is to drive the engine as hard as possible through the tunnel on a heavy grade in order to get through quickly. The speed of the air currents in the Churchill system of ventilation in a tunnel a mile long usually averages about 8½ miles an hour over the whole distance. If the tunnel is being worked to anywhere near its capacity, the additional time in the tunnel may seriously limit the number of trains that may be put through. It has been found, however, that if the tunnel is cleaned out by the ventilating apparatus before the passage of each train, there is little difficulty in getting through. As a rule, the engine crews prefer this method.

Double-track tunnels are of sufficient section so that there is little discomfort in a tunnel a mile long, even if the locomotive is fired all the way through. The practice in Europe has always been much better than that in the United States in that even with single-track tunnels their section has been large enough so that they are less uncomfortable than those in this country. Tunnel ventilation in Europe is largely restricted to the dilution of locomotive gas with plenty of fresh air rather than driving the smoke and gas ahead of the engine.

In the construction of new tunnels, an effort should always be made to reduce the grade in the tunnel considerably below the ruling grade, so that there may be no need of touching the fire during the passage through the tunnel. Ample section to secure good conditions is essential. In this connection it should be noted that the effect of long single-track tunnels of narrow section on the ruling grade is to reduce the tonnage rating in the tunnel by 10 per cent. at least.

THREE NEW ALLOYS.

In their last official report as chemists to the American Institute of Metals, Arthur D. Little, Inc., of Boston, mention three new alloys among the various items of recent progress in the metal industry.

A French patent has recently been issued covering the production of two types of alloys from copper, zinc and silicon which are claimed to possess great tenacity, resistance to acids and alkalis and to be capable of rolling into finished shapes.

Another new alloy has been patented by the Ajax Metal Company, composed of iron, nickel and copper, which is claimed to be non-corrosive, malleable, of great tensile strength and capable of being rolled, drawn or cast.

A new type of pyrophoric alloy has been patented in Germany which consists of the addition of 5 per cent. metallic cerium to an alloy of manganese and antimony. The inventor claims excellent pyrophoric properties from this alloy which is essentially different from the other alloys of this type in which cerium is the main source of the pyrophoric characteristics.

COSTS OF CONCRETE PAVEMENTS.

In a paper before the American Society of Engineers and Contractors, and reprinted in the Journal of the Society, pp. 435 to 450, C. M. Boynton, inspecting engineer, Universal Portland Cement Company, writes on "Concrete Pavement; Methods and Cost of Construction." The following data is abstracted from same:—

An analysis of the material costs of one-course and two-course work will show that the difference is so very slight as to be doubtful of estimation. However close an approximation an estimate may be, it cannot be exact, and, therefore, it will readily be seen in the following formulas that the main consideration in choice of type of pavement must necessarily be dependent upon the materials available; and the type chosen will be that to which thy are best adapted. This formula is based on Taylor & Thompson's Table of Proportion.

Considering: C equal cost of cement per barrel,
G equal cost of gravel per cubic yard,
S equal cost of sand per cubic yard.

Then, for one-course work of 1:2:3 mix, 7 ins. thick, the material cost per square yard of pavement is .325C plus .0975S plus .146G; while for two-course work, 7 ins. thick, composed of 1:2½:5 base, and a 1:1½ top mortar, the material cost per square yard of pavement is .342C plus .1045S plus .133G.

These two formulas show the tendency to equalize the cost by small compensating differences in the several quantities and are given here to illustrate this point.

With good equipment and an average gang the actual cost of mixing and placing should not exceed 7 cents. per square yard for 7 ins. of concrete. To this should be added a cost of 3 cents per square yard for finishing and labor necessary for handling the forms, making a total for one-course work of 10 cents for mixing and placing. As has been stated, there is a slight difference in the cost of placing single and two-course work, with the advantage in favor of the former.

Placing expansion joints is such a simple operation that 1 cent per square yard should cover the cost. To this must be added the cost of metal joint and tarred felt delivered on the job, or the cost of filling the joint with a plastic filler.

On city streets the water supply is not a problem; but on country highways, where it is necessary either to haul or to pipe water a considerable distance, it is advisable to make a careful survey of the situation. In estimating the cost of water the amount required for keeping the pavement damp for a period of five days must not be neglected, and as this is an indefinite quantity dependent upon weather conditions, only an approximate cost can be suggested. On the Wayne County, Michigan, work the water for each road is costing $3.50 per day (the wage for a man looking after the pumping), plus oil and gasoline required in operating the engine and pump. Water for the Mukwanago Road in Milwaukee costs 1¼ cents per cubic yard of pavement. In this case the water is purchased from the city of Milwaukee or its suburbs. In both cases the contractor's and builder's equipment must include the necessary engines, pumps, piping, etc.

The cost of hauling water for use in constructing country highways of concrete is often an item worthy of careful consideration. The method of supplying water by piping is considered by the majority of contractors as most economical. Where water is available under sufficient pressure the pipe line can be attached directly to the city main, thus eliminating engine and pump, but where water is taken from a well, creek or river in vicinity of work, an engine and pump will be required. The cost of gasoline engines varies with rated horse-power from approximately $105 for a 2-h.p. engine to $320 for a 9-h.p. The cost of pumps would vary according to the capacity pressure required and the conditions under which work would be performed.

On one job in the vicinity of Milwaukee, 7,200 lin. ft. of 2-in. pipe at $6.80 per 100 ft. cost $489.60, and the laying, $20 per mile, amounting to $27.20, makes the total cost $516.80, or $0.72 per foot. On the other job 11,200 ft. of 2-in. pipe cost $1,008 laid, or $.09 per foot. For supplying water, the city of Milwaukee received $.005 per cubic yard of concrete mixed and $.005 for each square yard of pavement, making a cost of $.00583 per square yard of finished pavement.

Where the construction is small, the installation of efficient pumping equipment may not be justified, in which case hauling in tank wagons can be resorted to. One team hauling tanks having upwards of 350 gals. capacity will supply a mixer of ⅓ cu. yd. with sufficient water for a day's run, provided the haul is 1½ miles or less. On one job of 4,800 sq. yds. in Wisconsin the water cost $75 for the entire work, plus the cost of hauling and pumping, which was $7 a day for 19 days. Another contract was $10 for water and $4 a day for hauling. This work covered 3,500 sq. yds., but the haul was short and one team working half a day could keep the mixer supplied.

In discussing the cost of concrete pavements, a few examples of actual construction will help to make clear the division of expense. The first pavement was laid recently in a small town in the central part of Illinois, totaling 5,000 sq. yds. The total cost of the work was $3,964.02, excluding cost of equipment, which consisted of a ½ yd. Koehring mixer of the latest type and a 4½-h.p. gasoline engine, and also excluding the cost of the water for mixing and sprinkling. The pavement was 45 ft. wide and uniformly 5 ins. thick. The cost of the work was divided as follows:—

Superintendence	$ 140.00
1,457 bbls. cement	1,547.15
Sand, stone and gravel	1,284.97
Labor	560.07
Lumber and forms	35.00
Bitumen and creosoted blocks for joints	48.67
Coal and oil for mixer and engine	30.75
Excavation	307.41

A summation of these figures gives the cost of this road as $4.76 per cubic yard or $0.79 per square yard.

During the summer of 1912 Milwaukee County, Wisconsin, constructed several concrete highways to the south and southwest of Milwaukee. Data on a two days' run from one of these jobs were collected. Twenty-four men and a ⅓ yd. Smith mixer of the dumping type were able to place 94.1 cu. yds. or 470 sq. yds. of 9-ft. road 7 ins. thick at a total cost of $364.41, exclusive of cost of grading and interest and depreciation on equipment. The materials were furnished free to the contractor on the siding nearest the work and hauled to the job at his expense.

In figuring the cost of the road, the cost of materials to the county was included with the cost of mixing and placing carried by the contractor, and are itemized as follows:—

111.5 bbls. cement	$115.96
93 yds. bank-run gravel	94.86
Water piped from the city	19.27
Baker protection plates for expansion joints	29.07
Coal and oil for engine	4.00
Labor	101.25

This gives a cost per cubic yard of $3.98 and $0.79½ per square yard.

Another piece of construction work for Milwaukee was a road 18 ft. wide and 7 ins. thick. The work was done by 20 men, using a ½ yd. Chain Belt mixer with chute delivery. The water was piped along the road from the city as in the preceding case, but a 4½-h.p. gasoline engine was necessary to force the water up to the head required. The work recorded covered a period of four days and cost $1,128.46, exclusive of equipment and grading. The cost of piping and water for this and the preceding job was fully accounted for in a former paragraph. The cost of the work was divided as follows:—

414 bbls. cement	$430.92
92 yds. sand and 152.3 yds. gravel	340.84
Water	60.20
Baker protection plates for expansion joints	76.50
Coal and oil for mixer and engine	7.50
Labor	232.50

From these figures we arrive at a cost of $4.70 per cubic yard and $0.91 per square yard for the pavement.

In southwestern Michigan a short strip 798 ft. long, 9 ft. wide and 7 ins. thick of 1:2:4 concrete cost $717.83, exclusive of grading, equipment and water. The equipment consisted of a 7-cu. ft. Clover Leaf mixer, necessary wheelbarrows and shovels and lumber for forms. The gang on this road was much smaller than that of any of the other roads. Details of the cost were:—

225 bbls. cement	$234.00
69 yds. sand	37.59
136.35 yds. gravel	196.34
Gasoline and oil for mixer	10.00
Baker plates	96.00
Labor	144.00

This gives a cost per cubic yard of $4.68 and per square yard of $0.91.

In the west central part of Michigan 2,586 ft. of concrete 9 ft. 2 ins. wide and .55 of a foot thick were constructed by a township as an experiment. A gang of 12 men using a 7-cu. ft. side delivery Koehring mixer did the work for a total cost of $3,392.62, divided approximately as follows:—

746 bbls. cement	$ 870.00
655.9 yds. sand and gravel	553.28
Baker protection plates and filler	170.12
Labor	1,690.50

These figures give a cost of $7.28 per cubic yard or $1.31 per square yard. Had the cost of grading, excavation and culverts been added to the above, the cost of pavement would have been increased to $8.73 per cubic yard or $1.46 per square yard.

The following work was constructed in the north central part of Illinois during October and part of November of last year. The road is 5.500 ft. long, 12 ft. wide and has a uniform thickness of 6 ins. The total cost, not including water, macadam shoulders and equipment, was $7,089.42. The equipment consisted of a ½ yd. Koehring mixer, road grader, plows, scrapers, road roller and the necessary wheelbarrows and shovels. The cost was as follows:—

2,274 bbls. cement	$2,333.65
720 yds. sand	582.49
1,185 yds. gravel	1,787.93
Operative cost of mixer	51.99
Baker plates and creosoted wood blocks for expansion joints	160.03
Labor	2,282.52

The total of these figures determines the cost per cubic yard as $5.80 or $0.96 per square yard. No information was obtained on the cost of water for this work.

METHODS OF ESTIMATING STREAM FLOW WHEN STREAMS ARE FROZEN.*

By W. G. Hoyt.†

The usual methods of obtaining daily discharge of streams under open-water conditions may be briefly given as follows: Daily gauge heights are obtained from a gauge maintained at a permanent datum. Current meter measurements are made to determine the flow at different stages of the river. The results of these measurements are plotted with gauge heights as ordinates and discharge in second-feet as abscissas. A curve is drawn through these plotted points and the daily discharge is obtained by applying the mean daily gauge heights to the curve. If the channel is fairly permanent, such a curve will remain constant and measurements made from year to year will plot in close proximity to it.

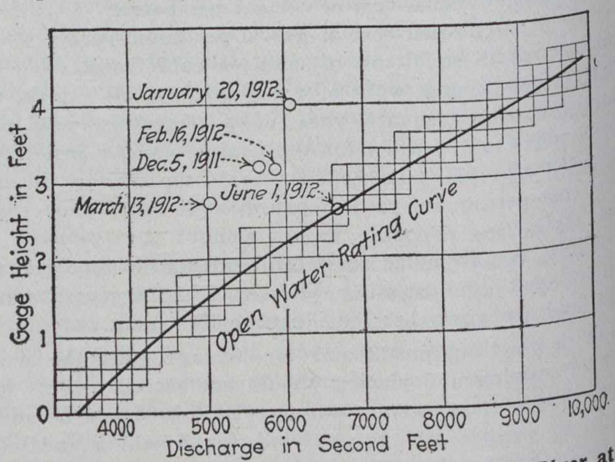


Fig. 1.—Open-Water Rating Curve for Rainy River at International Falls, Minn.

(The curve is based on a large number of current meter measurements and plotted winter measurements showing how relation between stage and discharge is destroyed by ice conditions).

When the temperature falls below freezing, numerous conditions affecting stream flow are liable to be produced which tend to destroy the otherwise fairly constant relation between stage and discharge, thus making it necessary to employ special methods to arrive at the true daily discharge. (Fig. 1.)

Measurements of discharge which indicate the flow at the time they are taken are fundamental in any method for winter estimates. The accuracy of the results will depend largely on the frequency of the measurements, and, in connection with records of gauge heights, temperature, precipitation and ice conditions, they form the basis for estimates of flow.

Precipitation is the cause of all run-off, and since temperature is the controlling factor in regulating the rate at which winter precipitation reaches the streams, it follows that temperature is, in general, the most important governing factor and should be given special consideration in making winter estimates of runoff.

Estimates of stream flow under winter conditions may be made by the following methods:

* Abstract of work of the United States Geological Survey.

† District Engineer, Water Resources Branch, United States Geological Survey, Old Capitol Building, St. Paul, Minn.

1. By the application of the gauge heights of the water surface to the open-water rating, when it is known that the controlling point for the gauge is clear of ice and that no backwater exists at the gauge.

2. By developing a curve based on discharge measurements and gauge heights to the water surface to which is applied directly, the open water-gauge heights as taken by the observer.

3. Basing the flow directly upon discharge measurements, taking into account the climate, ice conditions and gauge heights.

(a) By the eye method, working directly with the daily discharge, varying it between times of measurement by inspection of the temperature and precipitation records and gauge heights, and adjusting by comparison of results for nearby stations.

(b) By applying the open water rating to the gauge heights and applying to these discharges a coefficient as determined at times of measurements, varying the coefficient according to a knowledge of temperature, precipitation and ice conditions.

COMPUTATION OF FLOW DURING WINTER PERIODS OF.................................RIVER
AT
NEAR.......................................MONTH OF.................................19.....

Day	Max. Temp.	Min. Temp.	Pre-cipi-tation	Ice Thick-ness	Gage Height Water Surface	Esti-mated Back-Water	Effec-tive Gage Height	Esti-mated Dis-charge	Notes
1									
2									
3									
4									
30									
31									

MEAN DISCHARGE	SEC.-FT.	TOTAL MEAN		
..............To..............		Sec.-Ft. per sq. Mile		Computed by..........
..............to..............		Runoff Depth in Inches		Checked by..........
..............to..............		Runoff in Acre Feet		
Probable Maximum.....		Accuracy		
Probable Minimum.....				

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Fig. 3.—Suggested Form of Special Computation Sheet for Records and Estimates of Stream Flow Beneath Ice.

(c) By the graphic method, plotting the records of temperature, precipitation and gauge heights to the water surface and determining the amount of correction necessary to apply to the gauge heights in order that the open-water rating table may be used, basing the variation in this correction between times of measurements directly on the variations in gauge heights and temperature conditions and modifying the same by record of precipitation and ice conditions.

The accuracy of Method 1 depends primarily upon the location of the station. Stations are now located at several points in the United States and Canada at which this method is giving excellent results, but, as their number is few, the method can only be used in special cases.

The accuracy of Method 2 will depend largely upon the number of discharge measurements and their conformity to a true curve. It is believed that this method can be used at former stations than can Method 1.

The methods described in No. 3 will apply at practically all gauging stations which are affected by ice conditions. Method 3 (a) is the one now commonly used, but it is believed that 3 (b) and 3 (c) will give better results than 3 (a) and that Method 3 (c), which is described more fully hereafter, has an advantage over either 3 (a) or 3 (b).

A discharge measurement taken under ice conditions, when plotted to the open water gauge heights (Fig. 1), will always plot either on the open water curve or to the left, showing that the disturbing conditions result in a backwater effect. Therefore, to arrive at the true flow for a given gauge height it is only necessary to determine the magnitude of this backwater effect at the gauge. Since the formation of ice is due entirely to climatic conditions, it follows in general that the amount of backwater varies directly with climatic conditions.

Having determined accurately the amount of backwater at stated intervals by discharge measurements, it is possible to determine the backwater effect between times of measurement by constructing a curve of backwater. Such a curve can be drawn by following the observed gauge heights and the climatic and other conditions which cause the backwater.

The development of this method has been largely based on studies made during the winter of 1911 and 1912 on the Rainy River, at International Falls, Minn. At this point there is a regular current meter gauging station just below the plant of the Minnesota and Ontario Power and Paper Company. The Canadian Department of Public Works determines the flow at the plant by means of wheel ratings and the same flow is also computed by the United States Geological Survey at its regular gauging station. The average monthly variation in flow, as determined by these two methods during the five months from June to October, 1912, was 0.75 per cent.

The Rainy River, for some miles below the power plant, has a very slight slope, so that notwithstanding the fact that this part is usually free from ice, due possibly to the presence of acid from the paper mill and to the agitation of the water as it passes through the wheels, there is more or less backwater effect due to the formation of ice which occurs below the open water stretch.

We have, therefore, at this point a gauge station which is so affected by ice that the regular methods of computation of daily discharge do not apply, and also a station where the true daily flow is obtained, so that data are available for studying the effect of the ice. This study has been made graphically on Fig. 2, which shows the following curves:

1. The observed daily gauge height for the gauging station below the dam.

2. The corrected daily gauge height obtained by using the rating table for the station below the dam and finding the daily gauge height corresponding to the daily discharge given by the records of flow through the plant (no water passes over the dam).

3. The mean daily temperature at the gauging station.

4. The daily precipitation at the gauging station.

5. The daily backwater effect obtained by taking the difference between the observed and corrected gauge height curves, which shows the amount which the recorded gauge height reading should be corrected to give a gauge height which will, when used with the open water rating table, give the true discharge.

A study of the mean temperature curve and the backwater curve shows that these two curves tend to follow the same general direction, which confirms the assumptions previously stated. This is also borne out by records at other stations, and it is therefore believed that this relation will hold on the average steam, unless it is destroyed by unusual precipitation or ice conditions; that is, ice jams which cannot be taken into account in the construction of the backwater curve.

Based on this assumption, it is possible to construct the backwater curve from a comparatively few measurements of discharge distributed through the period affected by ice from which the backwater effect on the days on which they are taken can be obtained. By plotting these values as ordinates and days as abscissas under a daily temperature curve, it is possible to draw a curve through the point so plotted, following the same general shape as the temperature curve, which will give the backwater conditions for each day. In drawing this curve, account should be taken of the daily precipitation and of ice jams or other unusual conditions which may introduce backwater effect.

The circles plotted with the backwater curve (Fig. 2) show the backwater as determined from the discharge measurements on various days during the period in question. If these and the temperature records had been the only data available, a backwater curve could have been drawn which would have approximated the true backwater curve which was obtained from the daily records of flow over the dam. Of course care must be taken to study all the possible conditions which may affect the estimates.

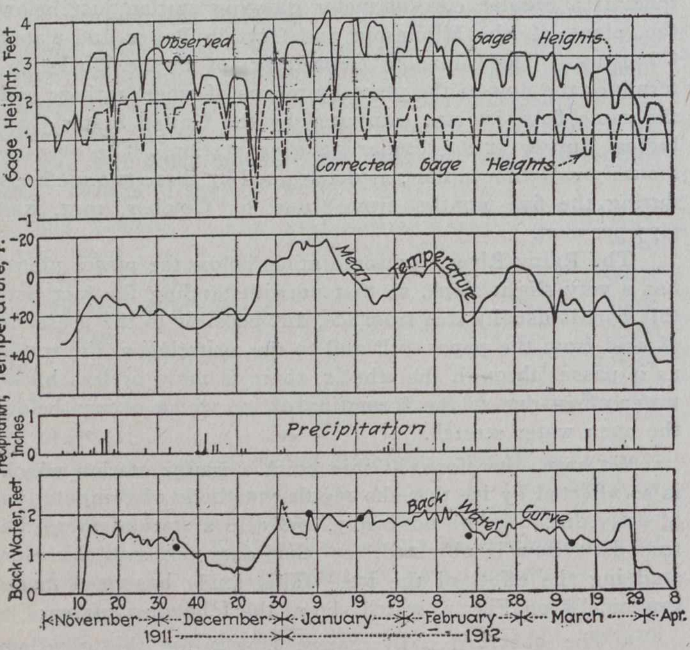

Fig. 2.—Various Observations at Rainy River Gauging Station, International Falls, Minn., November 1, 1911 to April 8, 1912.

(The observed gauge heights have been corrected on the basis of the backwater curve. The mean temperature was averaged in 5-day periods. The backwater observations were taken at the gauge. The full circles on and near the backwater curve indicate dates of current meter measurements).

Aside from giving more accurate results, this method has an advantage over any other method that has been devised, in that it gives a complete record of all the steps taken, so that the estimates may readily be reviewed or checked by a second person and show at once exactly how they were prepared.

The data necessary for use with this method are:

1. Daily gauge heights observed to the water surface through a hole made in the ice if the section is frozen over.

2. Records of daily temperature at the gauging station.

3. Record of mean precipitation over the drainage area above the gauging station.

4. Measurements of discharge* at intervals during the period when frozen conditions existed.

*See "Engineering News," Sept. 12, 1912, for methods of making.

As already stated, the accuracy of this method will depend upon the frequency of these measurements. If the winter conditions are more or less constant, less frequent measurements will be required, as it is during periods of thaws that the principal uncertainties occur. Regardless of this method, a special computation sheet should be used and some fairly standard method followed, which will bring winter estimates on a standard basis so that full records may be had. The headings on the typical card given in Fig. 3 are suggested for such a form.

In connection with this study, I wish to advance the following tentative conclusions, based upon observations of conditions in Minnesota since the fall of 1911:

1. Ice conditions usually cause backwater at the gauge.

2. Backwater increases rapidly at the beginning of each cold period, partly dropping off later.

3. The amount of backwater will tend to vary with the temperature.

4. Stream flow will drop off suddenly, following a cold period and will be partly regained later.

5. Stream flow tends to decrease when temperatures go below 32 degrees, but the flow tends to increase with any rise in temperature, especially when the minimum temperature goes above 32 degrees Fahrenheit.

6. A snow cover on the ice may cause increased backwater.

7. Flow may increase without a rise in gauge height, due to the wearing away of the ice.

SOME CANADIAN WATERWORKS STATISTICS.

On the average each person in Canada served by waterworks uses 113 Imperial gallons of water a day and pays $4.12 a year for it.

New Brunswick has the highest per capita consumption in Canada, viz., 161 gallons per head per day, while Manitoba and Saskatchewan have the lowest—46 gallons per head per day. The more general use of meters in the western provinces reduces waste and keeps the per capita consumption down to about the same amount as in European countries. The people of Manitoba pay the highest per capita rate for their water—$6.27 per year, while those of New Brunswick come next with a per capita cost per year of $4.82.

The following table shows the estimated cost per 1,000 gallons, the estimated cost per capita, and the daily consumption per capita:—

Province.	Estimated cost per 1,000 gal. (cents)	Estimated cost per capita per year (dollars)	Daily consumption per capita (Imp. gal.)
Nova Scotia	7	3.76	147
Prince Edward Island	16.4	2.87	48
New Brunswick	8.2	4.82	161
Quebec	9.5	3.92	113
Ontario	9.6	4.21	120
Manitoba	20.6	3.46	46
Saskatchewan	23.	3.86	46
Alberta	13.	6.27	132
British Columbia	8.2	3.44	115
Canada	10	4.12	113

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CONTENTS OF THIS ISSUE.

THE DEVELOPMENT OF FORT WILLIAM AND PORT ARTHUR.

In connection with an article in this issue on Dock Construction in Fort William and Port Arthur few people realize that these twin cities, located 1,700 miles from the Atlantic and 1,900 miles from the Pacific, and practically midway between our Atlantic and Pacific coasts, have, nevertheless, eighty per cent. of the total land area of the Dominion lying westward of them. The wealth of natural resources and the gigantic coming development of the great western portion of the Dominion are too well known to need comment here. The last harbor in Canadian territory westward of our Great Lake systems, it was the Canadian Pacific Railway, with its creation of the twin cities as a transfer point between rail and water traffic, that gave them their first hopeful outlook as an important locality. Previous to that, the route to the west was by water past Fort William and Port Arthur to Pigeon River, thence by Rainy River and Rainy Lake to Kenora. Of late years the making of Fort William into a first-class harbor and the tying up with it of the Grand Trunk Pacific and Canadian Northern Railway systems seems to assure its future in no uncertain terms.

It is doubtful whether the Hudson Bay route for the transports of the products of the West to Great Britain will ever prove as practical and feasible as some of our governments and optimistic citizens seem to think. Moreover, notwithstanding the construction of the Panama Canal and any subsequent diversion of Western traffic by that route, there must always be a tremendous traffic by rail and water between the east and west that will tax the capacity of the railways to the utmost and build up any cities which are located at the point of transfer into places of great activity. There have been signs, however, that Fort William and Port Arthur will not have to depend for their progress and importance solely on their location as the junction point of great rail and water transportation systems. It is true the transportation business at the head of the lakes requires the energy of 5,500 men, whose pay-roll amounts to over three million dollars to handle same, but important manufactures are also there. In 1912, the Canadian Car and Foundry Company started to erect a plant which guarantees to give employment to one thousand men for the first five years. Numerous other manufacturers, including the Atikokan Iron Company with a blast furnace of 200 tons per day capacity are there located. In great measure the citizens have to be grateful for the presence close to their doors of three great water falls capable of developing about 145,000 horse-power and of supplying energy to consumers at a cost ranging from fifteen to twenty-five dollars per horse-power per annum. At the Kakabeka Falls, close to Port Arthur, 45,000 horse-power has already been developed, and more energy, as we stated, is within easy reach.

The twin cities of Fort William and Port Arthur and their citizens are bound to witness paralleling their own expansion more of the material signs of the growth of Western Canada than probably any other city in Ontario. The northern shores of Lake Superior, with the exception of possibilities from the opening and establishment of extensive and great mining camps, does not, as far as nature is concerned, hold out much hope for the growth and support of a busy and modern city of large population. The development of Port Arthur and Fort William into such is a welcome sight, and is another striking illustration of the attending constructive results of modern transport and railway systems in giving impetus and opportunity for the settlement and development of civilization in localities where otherwise nature is so inhospitable as to have delayed for many long years any extensive inroad of civilized population.

THE UTILIZATION OF WASTE ROAD SPACE.

It has been very truthfully said that this is an age distinguished for its utilization of waste products. Wonderful advances have been made in this direction, and are being made every day. The utilization applies, however, more to the cities and their manufacturing industries than it does to the country's natural resources. In the partly settled regions of the country especially, one finds waste so enormous as to far offset beneficial gains in other ways.

Travelling through our Canadian forests, for instance, even where fire has not wrought havoc, one cannot help being impressed by the waste of fallen and rotting trees around, whose wood, as fuel, if obtainable to the inhabitants of the slums of nearby cities, would be a blessing and benefit. Our highway system might also be classed as a waste of considerable magnitude.

Consider country roads. The general width of a "right-of-way" is sixty-six feet. Of this sixty-six feet, the road proper, with the ditches, occupies from twelve to, say, twenty-two feet. That leaves two-thirds of our "right-of-way," or five and one-third acres per mile, unutilized in any beneficial way. In fact, in as far as many road sides are usually a mass of weeds, whose seeds are blown and carried on to neighboring farms, they might be said to be an active agent for harm to the community.

In Europe, the better roads are laid out with grass sown on each side and in many places fruit trees, whose products, handled by the Government, goes a long way towards paying for the up-keep of the roads. Very few people would consider it possible in America to ever grow fruit trees by the roadside and expect to harvest any products from same. Sad to relate, it would probably be looked upon by the travelling public of this continent as some philanthropic scheme for the easing and benefit of their gastronomic proclivities. It would still leave the problem of utilizing waste road sides in this country in some economically beneficial way unsolved. Unless, however, one can devise such means, the returning or renting (fencing off, if necessary), of unused portions of our country roads to those who will cultivate and put them to beneficial use, their ownership becomes a serious responsibility. Consider an ordinary township, divided into thirty-six sections, with a sixty-six foot road allowance between each, the road acreage amounts to 572.4 acres. If one allows twenty-two feet for actual width of ditches, etc., then there is left two-thirds of the acreage, or 382 acres, of land wasted per township. Figured out, it would probably be within facts to state that ten or twenty millions of acres will be lost as productive land to the communities of Canada and the United States if the side widths of road allowances be not utilized.

Country roads on this continent originally needed a highway allowance of sixty-six feet, mainly because, being in a forested country, it was necessary to protect travel and the roadway from falling trees, forest fires, etc. A width of sixty-six feet, with the road in the centre, under those circumstances, was very advisable. As land becomes cleared, outside the benefits of a former roadbed, one fails to see why it would not be advantageous that the roads should be constructed solely in the right or left portion of the "right-of-way." Such a course would leave a strip forty-four feet wide, which, with a single fence, might well be rentable or workable, and so reduce the cost of road maintenance itself.

It would certainly seem advisable, for the sake of providing for possible future increase in traffic, that all highway appropriations should continue to be the full sixty-six feet of width. The need, however, of highway associations seriously solving the problem of making their spare road area productive is one that will grow with age, and there appears in it a considerable and unappreciated opening to save some of the cost of road maintenance to the interested tax-payer.

EDITORIAL COMMENT.

An instance of the beneficial work being accomplished by the International Joint Commission on Waterways between the United States and Canada has lately come to hand in a decision handed out by the Commission in regard to the proposed dam to be built in the Detroit River at the head of the Livingstone Channel. This ship channel is partly in Canadian and partly in American waters. Deepening the upper part of the channel, it was thought, would have the effect of lowering to some extent the depth of water in the river above, and to correct this a dam to Blois Blanc Island on the Canadian side was to be built. The Canadian town of Amherstburg complained that it would injure their water front, and the question was referred to the Joint International Commission. The American interests urged the necessity of the dam to safeguard the enormous traffic up and down the Detroit River, and in this regard it might be mentioned that the tonnage on the Detroit River in 1912 reached the amazing total of ninety-five million tons, or over four times the amount of tonnage passing through the Suez Canal. The value of these shipments aggregated 80 million dollars. The decision recently handed out by the Commission in regard to the dyke which the town of Amherstburg objected to, proposes to substitute a dyke on the west side, which will have practically the same effect in safeguarding navigation while it will overcome the objections of the town of Amherstburg.

The Commission has been busy all spring on many internation questions, and is to be congratulated on the splendid work it is doing.

ELECTRIFICATION OF PANAMA RAILROAD.

Now that the relocation and reconstruction of the Panama Railroad is completed surveys are being made for the transmission of power for the operation of the line by electricity. The Gatum hydro-electric plant which is under construction will supply the energy required under normal conditions, but there will also be a connection with the present steam-driven electric plant at Miraflores. The transmission voltage will be 44,00, and this potential will be stepped down at various distribution centres for running the trains, lighting the canal, and supplying the power required for operating the various machine shops, the gates, and other appliances at the dams and locks. Bridges of the customary type for carrying the cables, etc., will span the tracks, the distance between them varying from 200 ft to 300 ft., according to the local curvature conditions of the railroad.

THE CAUSE AND DETECTION OF WATER WASTE.

The property owner pays for water waste in two ways. He pays in the form of a higher tax rate, for new watersheds, reservoirs, tunnels and pumping plants which are necessary to meet the demands caused by waste, and he pays for the waste in his water bill.

People think the water supply as plentiful as the air supply. They give no more thought of water dripping from a faucet not in use than they do to the breath they exhale. They don't know that a drip 1/32 of an inch in diameter, estimated on the meter value of water, represents in a year the loss of $11.68. They let their faucets drip, let their pipes leak and give no heed. There is plenty of water.

However, as population increases, water consumption increases and water supply decreases, and more and more it becomes necessary to seek new sources of supply, to build new reservoirs. Water famine rears its ugly head. Then they recognize that water should not be wasted and that where waste continues there must be compulsory conservation. City authorities force property owners to put meters in their buildings with a view to decreasing waste by penalizing the owner for allowing waste. He pays the penalty in the form of an increase in his water bill.

Take New York City, for example. Thanks to its prodigal water waste, taxpayers must pay $260,000,000 for a new system of supply, $10,000,000 more for a tunnel to carry it from the reservoirs and the constantly mounting cost of the upkeep of the system. When the time comes for the distribution of the new supply, new pipes must be laid in the city streets, for the old pipes will be unable to withstand the pressure. Likewise, new pipes must be laid in the buildings. And the taxpayer will see the cost of the new city mains reflected in his tax bill and will give the plumber more money for putting new pipes in his building.

If New York's water supply had been properly conserved, storage reservoirs, built at a cost of $50,000,000 or $60,000,000, would have furnished a sufficient supply, even though two years passed without a rainfall.

But even with the precautions which have been taken, the waste is still going on, and it is to the interest of all taxpayers, unless they wish to give up another half billion a few years hence, to make it their individual business to see that there is no waste of water in the premises which they own or occupy.

While it is held that all property using water should be metered and that the criminal or neglectful waste will not stop until this is done, it is not the purpose to discuss that subject here. It is intended to bring home to the individual property owner or lessee the fact that he can reduce his expenses and conversely increase his dividends by paying attention to water waste. A leak in a pipe is a leak in the pocketbook.

At the present time in New York all buildings used for business purposes are metered, as are buildings above a certain height used for dwelling places. All other property pays for its water on a frontage basis, that is, the charge is based on the number of front feet in the property and the number of water closets, bathtubs, etc., served. There is no way in which the city can detect the waste of water on premises which are rated on a front-foot basis. The man who pays on a meter basis pays for the front-foot waste because the meter rate is higher. Where the service pipe or trap (the city's pipe) is an inch or more in diameter the premises are supposed to be metered.

The meter rate, $1 per thousand cubic feet, averages much higher than the frontage rate, but despite this, proper supervision will make the water bill of the average metered property lower than that of the overage front-foot premises. The average consumption of water in a metered apartment house containing one or two water closets and bath, is 1,500 cubic feet per month per family. This does not include, of course, water used by the house plant for boiler, steam or refrigerating purposes. In a metered tenement house where there are no baths and water is used principally for domestic purposes and toilets the consumption will average 500 cubic feet per month.

In premises used for mercantile purposes the average consumption is difficult to determine, varying with the industry pursued. The same condition obtains in hotels and office buildings by reason of the fact that the occupancy of the rooms and the number of people in them are constantly changing.

In unmetered apartment houses there is a waste, on the average, of fifty per cent. of the supply sent through the pipes. This is due to negligence in caring for plumbing fixtures and delay in repairing leaks. The waste caused by leaks in water closets in unmetered apartment houses averages from 14,000 to 20,000 cubic feet a month, or a monetary loss, on a meter basis, of from $14 to $20. Underground leaks, overflowing roof tanks and the carelessness of tenants who leave taps running are additional contributors to the volume of waste. Some property owners assert that it is cheaper to let the water waste than it is to pay the plumber's bill. Although they may not realize it, these property owners are paying for the waste in their tax bills, but is it just to those who are paying the higher meter rate that they should also be compelled to pay for the waste caused by the owner who, in his ignorance and greed, says, "Oh, let it run, it doesn't cost me anything?"

Unless there is a marked increase from month to month in his bill the average owner of metered property is content to pay and take no steps to ascertain if he is getting what he is paying for. Or, perhaps, there is a small increase in his bill for a certain month. He pays no attention to it. The next month there is a still larger increase and he calls a plumber to investigate. The plumber finds a leak. But the owner must pay for the water he has not used. If this owner had in his employ an expert supervisor who knew what amount of water should be used, who could read the meter registerings intelligently and detect leaks before they became a charge on the property, the value of his services would soon become apparent in the decreased cost of maintenance.

An instance is known of a bill for $900 for water used in seven months in a seven-story metered apartment house, sheltering twenty-one families and including a store. Investigation revealed a leak due to a defective valve in an underground pipe on the house side of the meter. After the valve had been replaced by a new one the water bill for six months' consumption was $320. Since that time the total yearly bill has been $740.

In a factory building where the consumption was nearly 33,000 cubic feet per month the owner erected a roof tank to give a better supply to the upper floors. The consumption at once jumped to 110,000 cubic feet a month. The plumber neglected to put a ball float in the tank and the result was that the extra pressure at night, due to the fact that the supply was not being used, caused the tank to overflow. When the overflow and the cause were revealed the proper steps were taken to remedy them, and in the next three months the consumption dropped to 33,000 cubic feet per month. The services of the expert cost $20 or $30. The owner saved $77 and guaranteed himself against continuing to pay for water which he did not use.

In a certain hotel the water was used for refrigeration in twelve ice boxes. The consumption was between 150,000 and 190,000 cubic feet per month. The owner called an expert who told him something was wrong somewhere and that a thorough investigation should be made. The owner took no action, but the meter did and the water bills continued to grow. Finally he ordered the investigation. The expert found that water in a 2-inch overflow was running directly into a sewer. It couldn't do anything else by reason of the construction of the ice machine. A new machine put the consumption where it should be. How did the expert know something was wrong? Because he knew that in the adjoining building, also used as a hotel, a larger building containing more rooms and occupants, and therefore using rightfully more water than its neighbor, the consumption was only 150,000 cubic feet a month in the coldest weather, and in the summer as low as 115,000 cubic feet.

In a certain downtown office building, having an engine room equipment of the highest efficiency, water bills were found to be increasing regularly for the supply used on the upper stories. At the beginning of the expert's investigation the consumption was 15,000 cubic feet a day. He found that a number of toilets on these floors were leaking steadily day after day. His recommendations for the repairing of fixtures were carried out and the consumption dropped to between 7,000 and 9,000 cubic feet a day.

Note that in the instances cited the owner is paying $1 for every thousand cubic feet of water wasted; also saving $1 on every thousand cubic feet not wasted.

In another large office building there is a restaurant on the ground floor. The lessee put in an ice machine which was consuming apparently, when the expert was called in to explain why the water bill was so large, 395,000 cubic feet per month. The expert found that the ice machine from 7 p.m. to 6 a.m. was throwing water into a tank which overflowed. The expert showed a method by which this water could be utilized for other purposes than refrigeration and the waste stopped, and at the end of thirty days the consumption had been reduced to 135,000 gallons, the lessee was getting greater service from less water and had reduced his bills by $260 a month.

The owner of a tenement house having outside water closets found his water bills increasing steadily. He called in the expert, who found that defective hoppers, anti-freezing toilets and fixtures in a bad state of repair and general neglect were causing a large waste. In one closet showing a defective hopper the water was running into the ground through a hole in a sewer pipe. The meter was registering 35,000 cubic feet per month. After the proper repairs had been made the registration was from 1,500 to 2,000 cubic feet per month.

In the average metered business building experience has shown that water closets will waste, on an average from 14,000 to 19,000 cubic feet per month. In a prominent restaurant the water consumption had been between 9,000 and 10,000 cubic feet per month. A leak in a toilet jumped this consumption to 39,000 cubic feet in a month. When it was repaired the consumption returned to the first figure.

The causes of waste are many, and only an expert who is constantly meeting with their variations can determine their exact nature. In a large bread manufacturing plant the consumption, without apparent cause, leaped from 285,000 cubic feet a month to 587,000 cubic feet. The expert called to investigate found that while there were several points of waste the bulk of it was due to the forming of vegetation on an outside condenser used for refrigeration. The growth prevented the water from exercising its normal cooling power on the apparatus, so that more water had to be used to achieve the result that had formerly been brought about with a smaller quantity. The recommendations of the expert were carried out and the consumption reduced to about 200,000 cubic feet per month.

The examples herewith cited, all of which are taken from actual records, amply show that the average property owner or lessee is making a good investment in engaging a competent individual or firm to inspect his water supply plant throughout the year; to take full charge of water bills and make repairs to fixtures or pipes whenever they become necessary. The owner or lessee seldom has the knowledge and experience necessary to enable him to ascertain the one or more causes which produce water waste, even if he could spare the time demanded for a thorough investigation. The owner, as a rule, must rely on his agent to detect and correct conditions which cause waste. The agent, for the most part, depends on the superintendent, the engineer or the janitor of the premises, and no one of these three is usually sufficiently versed in the knowledge and experience, without which he will seek in vain for an explanation of why the owner is called upon to pay for more water than he is using.

A most striking example of how difficult it is to locate some leaks, and how thoroughly all means of determination must be employed to get at the truth, is shown by the following instance:—

In a manufacturing plant situated beside the water front a certain meter began to register a large increase in the amount of water used. The owner told the expert that there had been no actual increase in his consumption. A test of the meter, which was one of several, some of them being connected, showed that it was registering properly. In other words, the amount of water it registered was passing through the pipes. All the other meters and pipes were tested, but the instruments failed to record a leak. Yet the expert felt sure there must be one somewhere. He told the owner to shut off all the water. This was done, but the meter in question continued in operation, still registering a flow at the rate of 31,000 cubic feet a month. All water had been shut off, but here was water running There was only one thing to do—lay bare every bit of pipe connected to that meter. When the diggers had completed their work, a leak was found on the under side of the pipe. The water was spurting into the river without giving any sign of a leak.

STEEL FOUNDED RAILWAY CROSSING.

In most cases it is difficult to maintain a track efficiently at grade crossings owing to the tendency of the traffic to shift the crossings out of position and to crush the ballast that supports it. An interesting development in this connection is the use of steel longitudinal members to carry the rails at the crossing, connected so as to form a unit structure and to maintain the rails in the proper position. This system has been applied to a grade crossing at Muncie, Ind., where a singe track electric interurban railway crosses two parallel main tracks of the Cleveland, Cincinnati, Chicago, and St. Louis Railway on a curve having a radius of 17-07 ft. The daily traffic averages 64 electric cars and 18 steam trains. Each rail is carried on two 6-in. channels spaced 16 in. apart, and laid longitudinally with the flanges outward, connected at the bottom by 4 in. by 5-16 in. straps 2 ft. apart, and at the top by a continuous 5-16 in. plate 20 in. wide.

NORTHERN ATLANTIC SHIPPING

Hon. J. D. Hazen, (minister of marine and fisheries), replying to a question in the house of commons, remarked that the Imperial Board of Trade, had concluded arrangements for reporting the location and the movements of ice along the route of trans-Atlantic steamships during the spring months. This announcement is one of very great importance to shipping interests. The Titanic disaster of last spring and the subsequent inquiry respecting it made the desirability of this step abundantly clear. For this purpose the Scotia was despatched on the 8th instant to latitude 44° north, longitude 60° west, with instructions to report on the way any ice met and also to endeavor to note its southern limit. After having done so, the Scotia will proceed to St. John, Newfoundland, noting and reporting ice conditions met with. While at St. John, the Scotia will get into communication with all wireless stations on the Newfoundland, Labrador and Canadian coasts, and as accurately as possible ascertain existing conditions and the direction in which the ice has commenced to move. From St. John, the patrol boat will proceed to and report the southern limit of the drifting ice. Having located and reported the southern limit, the patrol will be northward to report icebergs or field ice along the coast of Newfoundland, and as far as Hamilton inlet.

The patrol is specially charged to be vigilant in the observance of ice nearing the steamship routes. The chief object of the expedition is to give warning to the steamship lines of the probable quantity of ice that will be in the vicinity of the track, and to give them any information that will assist them to form a judgment as to the advisability of giving any instructions for the greater safety of their vessels. On board the Scotia there are three scientists, the senior of whom will direct the movements of the vessel. They will take observations of the directions, velocity and depth of currents, together with the temperature and salinity of the water. In addition, meteorological observations of the upper air, including the investigation of the currents and temperature, will also be carefully taken. Acting in conjunction with the board of trade, I have concluded an arrangement whereby all messages from the patrol boat will be forwarded to the signal office at Quebec and from there promptly furnished to all interested parties. In this way the shipping interests at all the river St. Lawrence and Atlantic ports will be kept informed of the prevailing ice conditions.

To supplement the work done by the Scotia under the direction of the board of trade, I have made arrangements whereby the Marine and Fisheries Department will, immediately after the opening of navigation on the River St. Lawrence, despatch the C.G.S. Montcalm to patrol Cabot strait, at the entrance to the gulf, from Sydney harbor to the south coast of Newfoundland.

The location and movements of the ice in this region will be reported and full information will be furnished daily, or more frequently if found necessary, to the steamship companies. I have also arranged that Professor H. T. Barnes, of McGill University, who has, during the past several years, conducted experiments on one of the departmental steamers, shall be on board the Montcalm while performing this patrol service in Cabot strait. By means of his invention, the microthermometer, Professor Barnes has demonstrated the possibility of determining the approach to ice by any vessel equipped with his apparatus. Eager to avail myself of any scheme that promises to further safeguard navigation to the River St. Lawrence, I have directed that Professor Barnes, with a staff of assistants, shall join the ship in order to further demonstrate the utility of the invention, and with a view to its general adoption by shipping interests.

THE USEFULNESS OF COUNTY ENGINEERS.

The economic need of highways has been recognized on every hand, but the provision of a workable method for building them is not so easy to pass judgment upon. In the March issue of The Iowa Engineer Mr. F. R. White and Mr. J. H. Ames, assistant engineers of the Iowa Highway Commission, discuss under a heading "Is a County Engineer Necessary?" the need and advantages of county work which has an engineer at the head of it. A portion of this paper is abstracted and published below.

As a basis of comparison, let us consider the mileage of some of our largest railway systems to the mileage of our state public highways. The Chicago & Northwestern Railway has 9,700 miles of track, and the Chicago, Milwaukee & St. Paul Railway has 8,900 miles of track, or either of these great systems has less than one-tenth of the mileage that Iowa has in her public highways. Going a little farther, we find that the ten largest railway systems in the United States have a combined mileage of 103,000 or an amount approximately equal to the miles of public roads of this state.

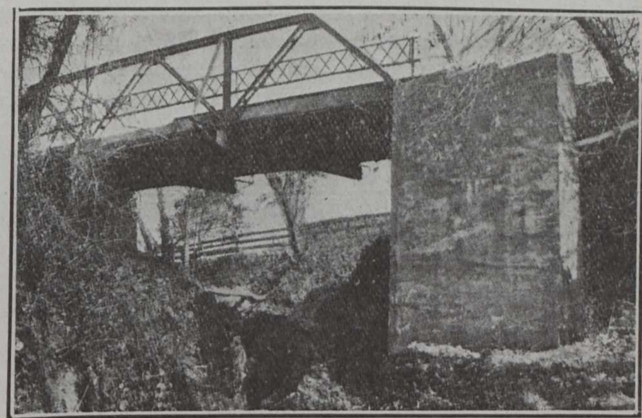

Fig. 1.—This 40-ft. Steel Span on 20-ft. Abutments has a Drainage Area of Only 69 Acres. Cost $5,187.

Of highways, perhaps not more than fifteen per cent. are what might be called "main travelled" roads. In improving our highways these main travelled roads will necessarily be the first to be given consideration. When we consider the amount of money to be spent upon this primary system of highways in order to properly provide for the present and anticipated future traffic, we are astounded at the enormity of the undertaking. In the average county in the state the cost of grading, draining, and gravelling the roads will amount to about $2,500 per mile. The cost of improving the 15,300 miles of such roads will be about $38,250,000 or an average of $386,500 per county. This includes only the "main travelled" roads, and does not take account of the amounts which the townships will spend on the township road systems.

No accurate statistics are available regarding the number of the bridges in Iowa. Adair county in the southwest part of the state has 4,200 bridges, of which over 2,000 are twenty-foot span or above. The majority of these 4,200 bridges are of more or less temporary nature and will require attention soon. Polk county has 930 bridges with an average span of 34 feet. Seven hundred and fifty of these bridges are at the present time either wood or steel, and are in very bad condition. This county has spent over $300,000 in the construction of 265 concrete structures which have an average span of 10.5 feet.

From the statistics available it appears that the average county has approximately 1,600 bridges. The average cost of replacing these structures with permanent work as shown above will be about $1,000 per bridge, or the total cost for building all the bridges of permanent construction will amount to $1,600,000 per county, or for the ninety-nine counties in the state the cost of permanent bridges will be about $158,400,000.

The state has expended in the past year, approximately $7,500,000 on roads and bridges; an average of $76,000 for each county. The proportionate expenditure for roads or for bridges cannot be accurately determined, but the bridge fund for the majority of the counties is close to $30,000 per year. In addition to that, the townships spend a large amount of their road fund on culvert work so that the funds as now spent are about equally divided between roads and bridges.

Any railway operating on sound business principles would have an efficient organization to superintend the expenditure of any considerable amount of money. They would demand complete plans and specifications and records which would show itemized statements concerning every dollar spent. No money would be paid out of the treasury until it could be shown to the board of directors that it was a legitimate expense. To secure these results they would employ an efficient engineering organization to make the surveys, establish the grades, write specifications, draw the plans, superintend construction and keep the construction records clear and straight.

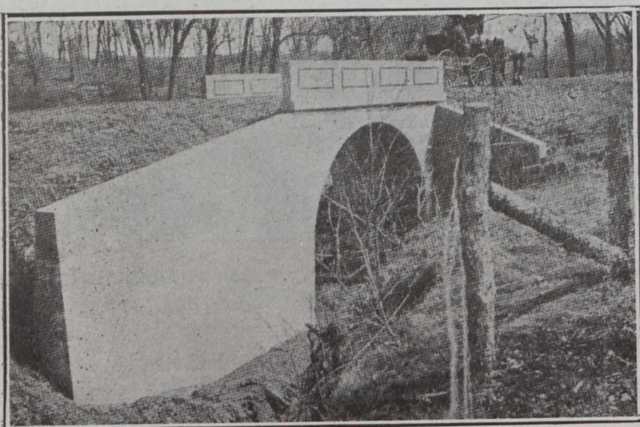

Fig. 2.—A Good Example of Improper Location and Excessive Length of Wing Wall.

Let us compare such an organization with the one in vogue in many of the counties of the state. It is a fact that the majority of the money spent on road work last year was expended without a plan or profile on file to show where or how the money was to be used.

Last season, one county confined the attention of their elevating grader crew to a short strip of road, possibly three miles in length. This work was in a hilly country where much cutting and filling was necessary, yet no survey was ever made of the road. When the work was completed, the superintendent was unable to tell the total yardage of material moved, or what the cost for moving the material had been per cubic yard. Had plans been prepared for this work and accurate cost data kept it would have been particularly valuable to the county in estimating future work under similar conditions. Most of the grading work has been done in such a manner as to provide insufficient surface drainage. Roads are graded and well crowned, yet the side ditch drainage has been incomplete. The water is allowed to collect in low places in the ditches and stand there until it evaporates or soaks into the roadway.

An example of absolute waste of money came to our attention recently. The board of supervisors, together with a number of interested taxpayers, attempted to construct a gravel road approximately nine miles in length. This road was located on low land with little surface drainage. Gravel was hauled upon this road and dumped so as to give a depth of ten inches. No provision was made for either sub-surface or surface drainage. The road was not even crowned before the gravel was placed. Such violation of engineering principles are costly experiments to the taxpayers, and show gross neglect or incompetence on the part of the supervising official.

The loss of money has not been confined to roads alone; investigations show that a very great loss has occurred in the bridge fund. Much of this loss is directly due to the yearly contract system which has been in vogue in many of the counties of the state. Under this system bridge contracts are let in blanket form. They call for no specific number of bridges and no specific location for any bridges bid upon, and as a result, the general design and the location of the structure in the field is left to the supervisor and bridge company's foreman. When such a contract is let, it is impossible to have detailed plans for the various bridges. Where any plans at all are submitted with the bids, such plans are incomplete, and will not fit the varying conditions of the different locations. Consequently when any bridge is built, there is item after item of extra charge for work not called for in the contract. Such charges, for work not covered by the contract, often run the price of the completed work up to a figure far in excess of what the work is worth, or what it might appear from the contract that the total price would be.

As an example of this, the following bill rendered by a bridge company for repairing an old 60 feet steel span is a good illustration.

To building 2 concrete abutments 12 feet deep and encasing old piers:

Building 1 (10-ft. 6-in.) wing, one 11-ft. 6-in., one 25-ft. 9-inch, and one 11-ft. 6-in. wing........	$2,935.00
Driving 11 steel piles at $7.00 each..............	77.00
Lowering old bridge 4 feet and cutting off old cylinders	160.00
Filling north and south sides, including removal of old approaches	184.00
Laying floor and hauling lumber and freight on same to Follett's	36.00
Steel joists for 60-ft. span at $5.50 per ft.	330.00
Lattice railing on span	96.00
Angle to reinforce floor beams for holding joists and drilling floor beams	74.00
	$3,882.00

This bridge after being repaired was yet an old, flimsy, steel bridge with wooden floor, and will have to be replaced in a few years. Under the same contract the county could have built a new 60-foot riveted steel bridge with concrete floor for $3,830.00 or an amount of $52.00 less than the price paid, and this price ($3,830.00) could have been reduced several hundred dollars if a competent engineer had been employed by the county, before letting the contract, to plan and superintend the work.

These specific examples are only a few of the many which occur each year under the present system. It is the direct result of the hit and miss methods of road construction that are costing the counties thousands of dollars annually. We are trying to build roads with only a part of an organization. We have the "Board of Directors" but have no adequate engineering organization.

Bridges must not be built too small to provide sufficient waterway for passing the run-off from the watershed above them, and in the interest of economy neither should they be made too large.

An example of the result of providing a waterway too small is known. The structure was a 50-foot arch bridge built in 1910. The cost to the county was about $3,000.00. Two years later, or in 1912, the structure collapsed during a freshet, and after the water had gone down it was found that the current had widened the channel by cutting behind the west abutment. As this was a patented type bridge which used the earth pressure behind the abutments to help support the arch, and which has shallow foundations as one of its characteristic features, the result of washing out the fill was the collapse of the structure.

As an example of building bridges too large for the demands of the drainage area, the bridge shown in Fig. 1 is a good illustration. Here a forty-foot riveted steel span with concrete floor and concrete abutments eighteen feet high was placed over a stream having a total drainage area of sixty-nine acres. This bridge cost the county $5,187, when the run-off from the watershed could have been carried by a 4-ft. x 4-ft. box culvert costing about $500. The county in which the bridge is located has an approximate area of 440,000 acres, and at the rate shown above it would cost $32,700,000 to bridge the entire county. The bridge fund in this county is about $30,000 per year, or at the above rate it would require the entire bridge fund for 1,100 years to get once over the county with so-called permanent bridges.

Under the systems usually used in the counties, the general design and the location of the structures are left to the supervisors and to the bridge company's foreman. The majority of supervisors are not trained bridge men, and the bridge company's foreman is not working for the county. As a result there are many examples of improper locations and designs. Bridges are often located several feet above the proper position. In a number of cases we have found concrete bridges located high upon the bank at one side of the stream, and with the pavement or floor six or ten feet above the stream bed. In other cases bridges are so located as to require excessive length of wing walls. In one case, a forty-foot span steel bridge with concrete abutments and three wing walls cost $2,925. This bridge was so located that the other wing wall was made 50 feet long, and the price paid for this wing was $2,262, or an amount nearly as great as the cost of the remainder of the bridge. Another bridge in the same county has one wing wall 80 feet long. This wing extended out into the field, and does not hold up any fill or serve any other purpose which would justify the expenditure of so much money.

In most cases, no estimates are prepared showing the labor and material required to build a given piece of work and when the work is completed the bill presented is allowed by the board without question. This is well illustrated by the record in one county where bills amounting to $57,000 and covering a whole year's work were allowed by the board at one session which lasted not more than three hours. Apparently none of these bills were checked against the structures built as evidenced by the following:—

One of the bills contained the item—

"Building concrete abutments and 2 wings, $737.10."

Investigation disclosed the fact that only one abutment had been built, and that it contained only 15.91 cubic yards of concrete, or the price paid was $46.33 per cubic yard. Another bill for construction on the bridge shown in Fig. 3, contained the item,

"One-half contract price for building concrete bulkheads 16 ft. x 20 ft. long on 48-in. steel culvert 36 ft. long .... $390.00"

The bridge is located on the line between two counties and hence the bill was presumably approved by two boards of supervisors. The bill apparently included only the building of the concrete bulkheads.

Investigation showed that the two bulkheads contained only 15.45 cubic yards of concrete or the price paid was at the rate of $50.48 per cubic yard. According to the engineer who made these investigations, a fair cost for the concrete in each of these jobs would be $12.50 per cubic yard. Another example of the loose system under which the bridge business is handled in many counties is shown by the following invoice:

To one 14-ft. span with 12-ft. foundations.........	$ 720.00
Less acct. abutments 8 ft. deep 8 ft. at $9.00	72.00
	$ 648.00
Lattice railing	$ 28.00
One 16-ft. wing, one 10-ft. and two 8-ft. wings.....	382.00
	$1,058.00

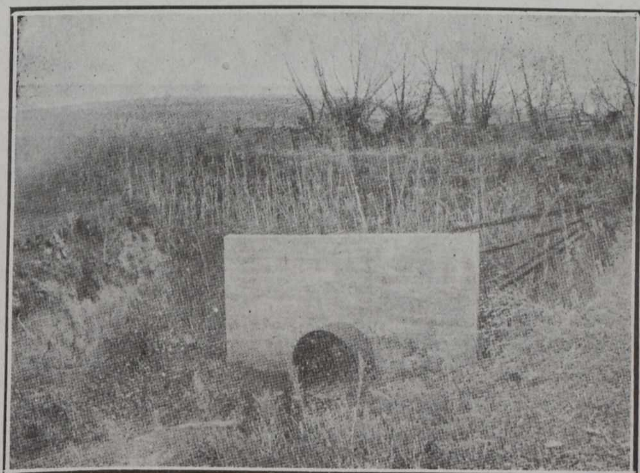

Fig. 3.—The Concrete in This Culvert Cost $50 per Cu. Yd.

When this bridge was examined it was found that the charge of $28 for lattice railing was a double charge, as the railing had already been paid for in the charge of $720 for the first item.

Quite often bridges are built which provide roadways entirely out of proportion to the requirements of present or anticipated future traffic. This was well illustrated in one county where a bridge was found with a 40-foot roadway. The location was such that an addition of filling over the culvert at some future date was impractical. The fact that the bridge was upon a road seldom frequented made this width of roadway very excessive. Not a mile from this bridge, on an adjacent road with a great deal more traffic was another bridge with an available roadway of less than twelve feet. Had a study been made of present and future traffic conditions on these structures, they would never have been built as we found them.

Frequently it is possible to relocate a road and thus avoid building one or more bridges. The following is given as a typical example. In one of the counties, a new road about three-quarters of a mile long was established in such a location that two forty-foot bridges, costing over $2,000 each, were required, when, by a slight relocation of this road, such as any engineer would make, both of these bridges could have been avoided at a saving of nearly $4,000 and a better road secured.

In some of the counties we have found conditions for which the county boards alone are responsible, yet, in the majority of cases the state is a partner with the county boards in the mismanagement of our highway funds, owing to the fact that inadequate laws and an insufficient organization have been provided for handling the work. Road building is a business and not a side issue to the management of a large farm, or extensive business enterprise. It is hardly fair to a farmer or business man to elect him to the office of county supervisor where he has the spending of thousands of dollars annually in a kind of work with which he is not familiar, and then not provide him with the assistance of men trained in that particular line.

Before we can expect to secure the best results from the money spent on our public roads, we must provide an efficient engineering organization to work with our board of supervisors. We must give our county supervisors the assistance of the technical training and years' of experience which go to make a finished road engineer.

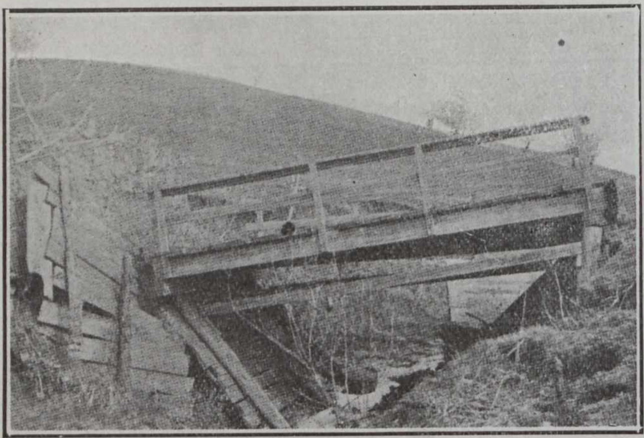

Fig. 4.—Not the Result of a Flood but Lack of Proper Pile Driving.

The legislature recognized this fact when, in 1910, it passed the bill creating the present State Highway Commission. The appropriation for carrying on the work was, however, pitiably small, and although increases in the appropriation have been made from time to time, yet the demands for assistance from the commission have increased at a much faster rate than have the appropriations, and the commission is at present unable to carry on the work properly on account of a lack of funds.

One of the most difficult parts of the work of the commission has been to get the bridge and road work constructed in the field exactly as shown on the plans. In the majority of cases the work has been constructed without any adequate inspection or engineering supervision in the field. At times, carefully prepared plans have been practically ignored, and in one instance a very inferior arch bridge was built from carefully prepared plans for a flat-top bridge.

To properly handle the work and prevent such miscarriage of plans as shown above, each county should employ a highway engineer whose duties would be:—

To survey the roads and prepare profiles and estimates giving proper attention to drainage, traffic, surfacing, etc.

To relocate roads so as to avoid expensive bridges and excessive cuts and fills.

To prepare detailed plans, specifications and estimates for each bridge built.

To survey the drainage areas and plan the bridges with due consideration to the waterway required.

To inspect the work frequently and see that it is done according to the plans and specifications.

To keep a complete and accurate record of the amount and locations of the work done.

Such an engineer working in connection with the State Highway Commission would complete the organization and would render invaluable service to the cause of "good roads."

DISTRIBUTING SYSTEM OF NEW YORK'S WATER SUPPLY.

The waters of the new aqueduct which is being constructed from the Catskill Mountains to New York, will empty into the Hill View Reservoir before their final plunge into the heart of the city.

The problem of admitting so large a flood into the metropolis is no small one, particularly when the chief demand for the water will come from those sections of Greater New York which lie many miles away. For the present, at least, little if any of the Catskill water will be used in Manhattan and the Bronx, but most of it will be consumed by the boroughs of Brooklyn, Queens, and Richmond. The water waste campaign which has been carried on for the past few years has so far reduced the consumption of water that the Croton system, which can furnish steadily 350,000,000 gallons of water per day, can easily take care of the immediate wants of Manhattan and the Bronx as well as the demand from these two boroughs for many years to come. It is not likely that the population in Manhattan will increase much unless it undergoes a marked vertical growth, for now there are practically no more vacant lots to be built upon. So that in estimating the future demands upon the Croton system we must consider chiefly the growth of population in the Bronx. In the other three boroughs of the city, however, there is a present demand for water and the probability of large increases in population in coming years.

To conduct the Catskill water into Brooklyn and Queens, it was decided to build a trunk line, so far beneath the surface that there would always be 150 feet of good solid rock for the roof of the tunnel, and provide a course for a subterranean river which could be tapped as needed for the city's supply, and which, at the same time, would be so completely buried that it would never menace the safety of structures above it. When this tunnel is completed it will be one of the most durable pieces of work ever constructed by man; for practically nothing but an earthquake can destroy it; and even this possibility is very remote, for the rock underlying New York is of very early formation and not at all liable to seismic disturbance. And so the city tunnel of the Catskill aqueduct is being bored through the rock on the average of 200 to 250 feet below the surface except in places where the nature of the rock is of such a character as to call for a much greater depth.

The first dip takes place just above the Harlem River, where the tunnel drops down 362 feet below the ground level. Then it runs practically horizontally until it passes the dip in the rock under 125th Street. Thence it rises again and maintains a practically constant level of 200 feet under the city, until it arrives at the ancient bed of the East River. A glance at the map of New York city will show that the East River makes a decided turn about the lower east side or "heel" of Manhattan. In pre-glacial times, the East River had no elbow in its course, but ran directly across the heel of Manhattan, and it wore away the rock in its bed to considerable depths. However, the large deposits of earth and rock carried by the glaciers caused the river to be pushed eastward out of its normal channel and over the solid rock beyond. When borings were made for the aqueduct through this section of the city, it was found necessary to lay it at a depth of about 750 feet below the surface. Much of the rock through this section is decayed and unfit to form the walls of a high-pressure aqueduct which is being built to last for all time. The present channel of the East River, on the other hand, passes over solid rock, and is comparatively very shallow. Seven hundred and fifty feet is an enormous depth, second only to the great siphon under the Hudson River, which is 1,114 feet below the river surface. It so happens that the deepest shaft ever sunk in New York city equals the height of the tallest building in the world.

Arrived in Brooklyn, the aqueduct rises again to within two or three hundred feet of the surface, and is pushed as far as it is possible to carry it in solid rock and yet communicate with the surface. This limit was found to be at the junction of Flatbush and Third Avenues. Here it was necessary to go through 215 feet of overlying earth before coming to the rock. The caisson method had to be resorted to and the caisson was sunk over 100 feet below the water line before rock was reached. Considerable difficulty was here experienced in sinking the shaft to the rock, because it called for the use of pneumatic pressure that taxed the endurance of the workmen to the limit. From here on the water will be conducted through pipes laid in a trench of a moderate depth below the surface. From the foot of Seventy-ninth Street, Bay Ridge, the conduit will be run across the Narrows to Staten Island, through a pipe 36 inches in diameter, provided with flexible joints, and laid in a submarine trench. The details of this section of the work have not yet been given out. However, tests have been made to discover at what depth the pipe line under the water must be buried. It is evident that it must lie far enough below ground to prevent its being entangled with anchors from large vessels that may have to anchor in the Narrows. The matter has been thoroughly investigated, and practical tests have been made by dragging anchors of large size along the bottom. It has been determined that if the pipe line is buried at least eight feet under the bed, it will be entirely safe. On the Staten Island side a 48-inch pipe will carry the water on up the hill and through a tunnel into Silver Lake reservoir, 120 miles from the source in the Catskills.

The greatest interest in this city section of the aqueduct attaches naturally to that part which is being excavated through solid rock under the busy city. It is a surprising fact that a work of such magnitude can be carried on directly under our feet without inconveniencing us in the least. The only surface evidence of the deep rock tunneling is to be found at the various shafts which are located in parks, or public squares. The principal difficulty that presented itself at first was the question of storing explosives for a work of such great proportion. To keep the necessary explosives on the surface was to harbor constant menaces to the lives of the citizens. The matter was finally solved by placing the dynamite magazines far under the surface in the rock, and setting the doors to these magazines so they will automatically close in case of an explosion and trap the hot and poisonous fumes in the rock chamber, where they can do no harm to the workmen. The idea was borrowed from European practice, where mining operations are conducted close to and sometimes directly under large cities. Access to the dynamite chamber is had through a zigzag drift. At each turn of the drift a pocket is excavated, and the chamber itself is made of large capacity. In this chamber the dynamite is stored under a protecting roof to keep off any fragments of rocks that might fall when jarred by the "shooting" in the tunnel. At the entrance of the drift a very substantial concrete bulkhead is built, and in this is a low doorway. The door is of massive construction, built of I-beams, sixteen inches deep and spaced apart with oak beams twelve inches square. The door has beveled edges, so that it will seat itself snugly in the doorway. The door is always kept open at an angle of about 45 degrees. In the magazine a thousand pounds of dynamite may be kept at a time. Should this be exploded, the explosion wave would have to travel down the zigzag passage and would lose much of its force at each abrupt turn, finally striking the door with greatly diminished energy. The door would be slammed shut by the blast of air issuing from the drift and would then be held shut by the gases of the exploded dynamite. A magazine of this sort has been constructed near the foot of each shaft—not at the foot, however, for fear that in case of a mishap, it might block the escape of the men. The magazines have been tested by exploding a number of sticks of dynamite around the first bend in the drift, and in every case the door has closed just as expected.

The work through the rock is being pushed very rapidly; at some of the shafts between 800 and 1,000 pounds of dynamite have been used daily. Within the last year millions of pounds of dynamite have been exploded under the city, while most of New York was totally oblivious to the fact. Already a number of the tunnel sections have been "holed" through. To expedite the work, one contractor is using an interesting form of shoveling machine, built especially for this work, so that it may be taken down the comparatively narrow shaft and be assembled to work within the small diameter of eleven feet, which is the size of the tunnel at the particular point where this machine is now being used. The machine is controlled by a single operator, and does the work of six laborers.

Some of the work on the city pressure tunnel has been hurried so far that certain sections are now being lined with concrete. The forms used for this purpose are very interesting. They cover 120 feet altogether and are arranged in two sections, sixty feet of the lower half of the tunnel being concreted in an advance of sixty feet of the upper part. The first step is to lay the "invert," that is, a narrow segment of the lining running along the bottom of the tunnel. This, when completed, forms the track upon which the forms for the rest of the lining travel. The forms are mounted on trucks with wheels tapered to fit the curve of the invert. The forms for the lower half cylinder are practically the same as those for the upper half cylinder. After the lining has set, the sides of the upper form may be drawn in to free them from the concrete, by operating the turnbuckles A, and those of the lower forms by operating the turnbuckle B. Then jacks may be unscrewed to lower the upper section slightly freeing it completely from the concrete and jacks E may be screwed up to raise the bottom section slightly upon the truck. In this collapsed condition the forms may be drawn forward to complete the next section of tunnel. It is quite a different task, however, to lay the concrete into the upper form. Sections of the plating of the upper forms are removed and the concrete is shoveled in, adding the plates step by step as necessary, until finally the topmost plate is added when the concrete can be introduced only from the end of the form. It will be observed that small pieces of board are temporarily nailed against the edge of the forms and fitted up as neatly as possible against the rock above, so as to retain the concrete until it sets. As each section is completed, grouting holes are left in the top through which, when the lining is completed otherwise, grout will be forced under high pressure to fill up all cracks and crevices and make the lining perfectly sound.

At each shaft access will be had to the tunnel through risers or vertical pipes, 48 or 72 inches in diameter. At most of the shafts two such pipes will be provided, each fitted with valves at the bottom which may be operated from the surface to close either of them when it is desired to gain access to them or to effect any necessary repairs. The valves at the bottom of the risers will be of such a design as to close automatically in case of an abnormal flow through the risers, due to the destruction of the valve at the top by explosion or other accident. At the top of the risers there will be two valves, the one nearer the riser being an emergency valve, which may be closed in case of any damage to the other valve.

It is probable that no immediate changes will be made in the water supply of Manhattan and Bronx, except that pipe lines will be run from the shafts to help out the existing supply in case of emergency. In Brooklyn and Queens, where thirty-five pumping stations are now required, most of the stations will be discontinued for the reason that the water will be delivered through the aqueduct at sufficient pressure to reach all parts. Only in one or two sections will pumping be necessary.

From Hill View reservoir the water will flow through a tunnel, 15 feet in diameter. This will be narrowed to 14, 13, 12 and 11 feet; which is the diameter of the rock tunnel at Fort Green Park, Brooklyn, and at the intersection of Flatbush and Third Avenues. From there on steel pipes, five and one-half feet in diameter and running down to four feet in diameter, will carry the water to the Narrows, and under New York Bay, at the Narrows, the line will be only three feet in diameter. This gradual shrinking of the aqueduct reminds one of those large rivers that flow cut of the mountains in sufficient volume to be navigable and even a menace to the surrounding country in time of flood, but which, when they reach the deserts are drunk up by the thirsty sands and sucked by the torrid sun until they vanish without any clearly defined terminus or possibly flow in a sickly stream to a small stagnant lagoon. Thus, when the entire Catskill system is completed and operating at its full capacity, the waters which three days before poured out of the Ashokan reservoir in a mighty flood, over seventeen feet in diameter, will reach Staten Island, a stream only 3 per cent. of its former size, after having been robbed by the rest of the thirsty city.

LIMITATIONS OF BITUMINOUS CARPET SURFACES.*

By A. W. Dean, M. Am. Soc. C. E.†

A bituminous carpet surface is well defined as "a bituminous surface of appreciable thickness formed on top of a road crust by the application of one or more coats of bituminous material, with gravel, sand or stone chips added." Such a carpet is not formed by the use of oil emulsions, consequently, emulsions will not be considered in this discussion, nor will a crust approximating two inches in thickness be considered, inasmuch as when a coat or blanket is made of such thickness, it ceases to become a carpet, but rather becomes an integral part of the road crust or pavement.

Limitations in the use of bituminous carpet surfaces are governed by three principal features. First, character of the road crust under the carpet. Second, character of the carpet itself, including both the bitumen and the grit or such material as is applied with the bitumen. Third, character of traffic to be sustained. Taking these in their order named, let us first consider the character of the crust.

This should be of such a nature and on such foundation that the weight of the traffic will be thoroughly sustained without any aid whatever from the carpet. For average traffic on suburban roads, a water bound macadam road on a suitable and sufficient foundation is an ideal crust upon which to apply a bituminous carpet, regardless of the nature of the bitumen used to form the carpet. Under some conditions, a cement concrete crust is excellent and preferable to water bound macadam, in that it has more stability and will withstand a greater load. A concrete crust, however, does not appear to hold a carpet of an asphaltic nature as well as it holds one formed by the use of tar, the adhesion being apparently less with the former than with the latter material. A crust of good gravel, thoroughly compacted, is good under restricted traffic conditions, but it does not appear to hold a carpet formed by the use of heavy asphaltic or tar binders, unless the carpet is made of such thickness that it becomes a part of the road crust. Heavy binders as referred to herein are intended to mean binders that require heating to a temperature of at least 180 deg. F. in order to permit satisfactory application. A bituminous carpet on a gravel road appears to be successful under comparatively light traffic if a bitumen is used that does not require heating to a temperature above 100 deg. F. before application.

A carpet formed by the use of any material on a dirt road is of no value whatever, as it breaks up under any kind of traffic and very soon ceases to be a carpet.

Continuing to the second principal feature, namely, the character of the bituminous carpet, we have again a very important factor. The kind of bitumen used and the method under which it is applied, the kind and amount of grit used, and the character of the grit, each and all have a very decided influence on the limitations of economical use. Experience has shown that a carpet must be uniform in thickness, and in order to be so the bitumen and grit must each be spread uniformly, and in order to spread the bitumen uniformly experience has shown that it must be distributed by means of pressure applied in some manner, either by introducing air or steam pressure directly into the tank in which the bitumen is contained, or in securing pressure by means of a pump of some form. Experience has demonstrated also that where it is desired to make a carpet requiring the bitumen to be applied at the rate of ½ gal. per sq. yd., uniformity is more successfully obtained by applying the bitumen in successive layers of approximately ¼ gal. per sq. yd., each layer of bitumen being covered with grit before the succeeding layer is applied.

The grit used for covering the bitumen should contain no clay or loam, and if the traffic to be borne is a mixed traffic, with steel tires predominating, it appears that the best and most lasting results are obtained by using a mixture of coarse and fine material, the coarse material consisting of tough pebbles, or stone broken to pebble size (approximately ½ in. in diameter), mixed with material of a finer nature, such as sand or a coarse grade of stone dust. Such mixing is better accomplished if the two grades of grit are applied separately in forming the blanket, that is, the coarser material being applied first and immediately followed by the finer material. Such method of application appears to give a firmer carpet that will withstand a greater amount of steel tire traffic than will a carpet formed by the use of either coarse or fine material alone. If a car-

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pet is to carry a traffic consisting largely of automobiles, the coarser material does not become as necessary, although it appears to be preferable.

The kind of bituminous material that it is preferable to use in a carpet is still a debatable subject, particularly as to whether tar or asphalt products are preferable, and in the use of asphalts, whether a heavy asphalt requiring high temperature (200 deg. F. or more) before application is preferable to one that does not require such high temperature. It has been the experience and observation of the writer, however, that the asphalts requiring high temperature before application give better and more permanent results under a mixed traffic than do the lighter asphalts. By mixed traffic, the writer means a combination of trucks, automobiles and heavy and light horse-drawn vehicles. A carpet formed with a heavy asphaltic material, however, does not withstand traffic consisting largely of heavy steel tired vehicles, the effect of such being to cut the blanket and cause it to crumble and to soon disappear from the surface.

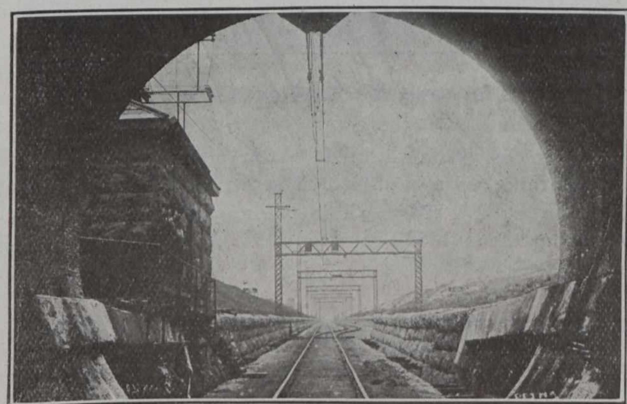
The third principal feature, namely, the character of traffic, must necessarily be considered in connection with the second principal feature, already discussed. In fact, neither one of these three features hereinbefore mentiond can be discussed entirely by itself, as each is dependent somewhat upon the others. With a suitable road crust to sustain a bituminous carpet, traffic is an extremely important factor in determining what type of materials to use for such a carpet. The amount, type and weight of vehicles must necessarily be considered. It has been demonstrated that a tar carpet will carry economically 100 automobiles per day per foot in width of roadway, together with a horse-drawn traffic of 15 vehicles per day per foot in width of roadway. On the other hand, a similar tar carpet failed under a traffic consisting of 20 heavy, horse-drawn, steel tired vehicles per foot in width of roadway per day, with only 8 automobiles per foot. This clearly demonstrates that a tar blanket is not suitable and should never be used to sustain heavy horse-drawn traffic, but is suitable and economical in carrying automobile traffic. Inasmuch as no particular wear appeared to be caused by the above mentioned automobile traffic, it is safe to assume that a much larger traffic could be economically carried. Records kept by the writer show that what has been stated above regarding the tar carpet is true also of the heavy asphaltic oil carpet. Failures that have occurred under the writer's observation with a heavy asphaltic oil carpet have occurred where the ratio of the number of automobiles to the number of horse-drawn vehicles was not any greater than two to one, and if the horse-drawn vehicles are of the heavy two-horse type, with narrow tyres, no amount of automobile traffic appears to be sufficient to counterbalance the destructive effect of 15 heavy horse-drawn vehicles per foot in width per day.

The writer is of the opinion that it is not wise at the present time to state general positive conclusions regarding limitations in the use of bituminous carpet surfaces. Such surfaces have been in use in this country only about four years, and the character and quality of the bitumen used at various times and in various places are so unequal, and the character of traffic over the highways is and has been changing so rapidly, that the results of experiments and observations have been variable. Positive and definite conclusions as to limitations can be drawn only after careful observation through a period of years, keeping a record of the kind and quality and amounts of material used in the carpet, and of the kinds, number and approximate weights of vehicles passing over the sections under observation.

THE ELECTRIFICATION OF TUNNELS.

With the announcement of the construction of several large tunnels by the different steam railways in the West, and the general electrification of tunnels in New York, etc., it is perhaps not out of place to recall and briefly describe the one large tunnel in use in Canada which, originally built for steam-operated trains, was electrolized and so operated in 1908, and has continued to give splendid satisfaction as such ever since.

The St. Clair tunnel under the St. Clair River, and connecting Sarnia, Ont., Canada, with Port Huron, Mich., United States of America, is more than two miles in length, including its approaches. The length of the tunnel proper is 6,025 feet, and the length of electric trackage, including yards, is approximately 12 miles. The tunnel has a maximum grade of two per cent., and was built under the St. Clair River by the Grand Trunk Railway under the supervision of Mr. Joseph Hobson, the chief engineer; Mr. T. E. Hillman, first assistant engineer, and Mr. M. S. Blacklock, second assistant engineer. It was constructed in order to overcome the obstacles presented by a navigable stream, alive with commerce during the summer, and often blocked by ice in winter, and previous to its opening the Grand Trunk Railway freighted the trains across the river by means of car-ferries. The tunnel is a continuous iron tube, nineteen feet ten inches in diameter, the total weight of iron being 56,000,000 pounds. Work was commenced in 1888, and the tunnel was opened for freight traffic in October, 1891, and passenger traffic in December of the same year. The cost was $2,700,000.

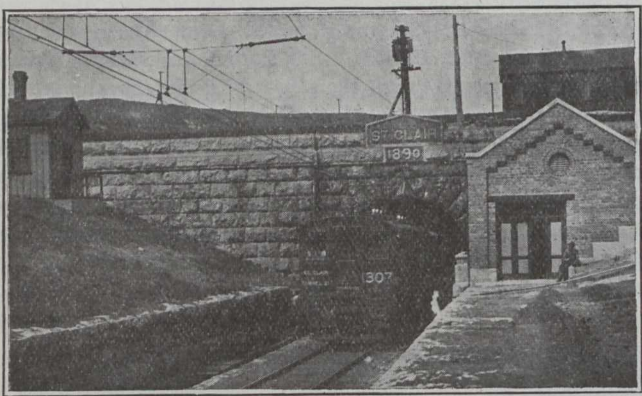


Western Portal of Tunnel.

Shortly after the opening of the tunnel for freight traffic the need of some method of doing away with the noxious and injurious gases, which formed from the smoke of the steam engines, was at once obvious. The natural remedy was the use of electric locomotives, and after mature deliberation, the Grand Trunk decided in favor of operating the tunnel by electricity. The power plant was located on the Port Huron bank of the St. Clair River and the length of zone electrified was four miles. The single-phase system was adopted, and the single catenary supported by structural steel bridges was the structural method used; the normal voltage being 3,300 volts. The Westinghouse Company finished the contract in May, 1908, and the cost was $600,000.

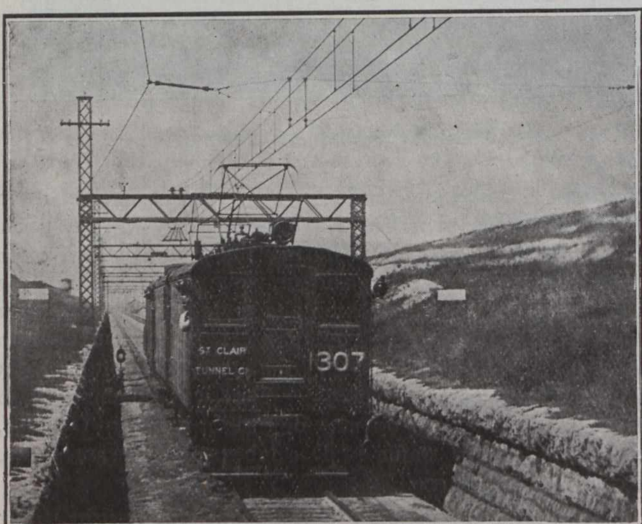
A comparison of the haulage before and after electrification is also interesting. The normal weight of trains hauled through the tunnel before electrification was 760 tons; after electrification it was 1,500 tons. The weight of the steam engines formerly used, which, when built, were the largest in the world, was 200,000 pounds; the weight of the two electrical engines in use is 270,000 pounds each. The electrical engines have a normal motor capacity of 1,500 horsepower and a normal draw-bar pull of 50,000 pounds. A maximum speed of 35 miles per hour, and a minimum speed of 10 miles an hour up a two per cent. grade with a 1,000-ton train.

The tunnel has been a paying proposition, as the train service now operated through the St. Clair tunnel is very



Entrance to Eastern Portal.

heavy. It is now lighted throughout, and presents the appearance of a well-lighted street instead of a tunnel sunk underneath a river, where the annual tonnage of vessels passing through is about twice as great as that passing through the Suez Canal.



Approach Grade and Engine.

In comparing the tunnel before and after electrification, one soon arrives at the conclusion that the correct method of operating a tunnel of any length is by electricity, as the evil-smelling and damp tunnel of before cannot be compared with the well-lighted, dry, and novel appearing passageway which the St. Clair tunnel now presents.

It is expected that New York's state barge canal will be ready as a whole in 1915. Locks are being built for 3,000-ton barges. An important percentage of the state's population lives within twenty miles of the canal on either side, and the motor truck will give farmers and manufacturers easy access.

THE INTERNATIONAL WATERWAYS COMMISSION.

In regard to the work now being carried on by the International Water Commission, Mr. L. J. Burpea, recently stated that three important questions were being investigated by the commission.

The first of these relates to the levels of the Lake of the Woods and its tributary waters. This to some may seem a comparatively small matter, but in reality it involves very large interests, as far apart as Winnipeg and Duluth. The investigation is the outcome of complaints as to damage to lands along these waterways by flooding. The farming communities would like the level of the lake lowered. On the other hand, navigation interests complain that the water in the lake and its connecting rivers is already too low for their purposes. There are the fishing and lumbering interests to be considered, and the very important interests of power development. To reach a decision which will be fair to all these interests, on both sides of the boundary, the commission cannot afford to act hastily, or without having the fullest possible information on the subject. It now has survey parties representing both countries, obtaining technical data upon which it may base its conclusions. It has already held hearings at International Falls and Warroad on the American, and at Kenora on the Canadian side, at which everyone interested in the question, from any point of view, was given full opportunity to present his views. With this evidence and the engineering data, the commission will be in a position to recommend to the Canadian and American governments a solution of what has become a very intricate and troublesome problem.

The second question that the commission is investigating, and in which connection it recently held a meeting in Detroit, is the building of a dam in the Detroit River, in connection with the Livingstone Channel. This dam is intended to be built partly in Canadian waters, and is designed to protect the interests of navigation. At the Detroit hearing, however, a considerable difference of opinion developed among engineers and shipmasters as to the advantages of the proposed work; the town of Amherstburg complained that it would injure their waterfront, and counsel on behalf of the Dominion Government argued that one of the principal objects of the dam (to raise the level of the water) would be nullified by the unauthorized diversion of water at Chicago for the drainage canal, that a simpler and cheaper remedy would be to prevent this diversion, and that it would be preferable to deal with the dam, not as an isolated work, but a part and parcel of a comprehensive scheme of development of all these international waters for the benefit of the people of both countries. On the other hand, the American interests urged the necessity of the dam to safeguard the enormous traffic up and down the Detroit River. Here, again, the commission has a difficult and intricate problem to solve, and one that must be approached with the utmost care and absolute impartiality. Incidentally the evidence brought out threw light upon the amazing development of the shipping industry on the Great Lakes, the tonnage on the Detroit River in 1912 reaching the tremendous total of 95,000,000 tons, or over four times the tonnage passing through the Suez Canal; and the value of these shipments aggregated $800,000,000.

The third question the commission is investigating on behalf of the two governments is the exceedingly important one of the pollution of boundary waters. If the commission never succeeded in accomplishing anything more than helping to safeguard Canadians and Americans living along the international boundary, it would more than justify its existence. In this great undertaking it has the hearty co-operation not only of the federal health authorities at Washington and Ottawa, but also of state and provincial boards of health on either side of the boundary. During the coming summer a thorough examination will be made by sanitary experts to ascertain the principal sources of pollution, and when this data has been collected and digested the commission will be in a position to consider the remedy or remedies best assigned to meet the situation.

In addition to these questions, referred to it by the two governments, the commission also has before it several applications involving the erection of dams and other works in boundary waters. In such questions as these, under the terms of the treaty, the decision of the commission is final. It is in effect an international court of appeal, or, as it has been described, a Hague Tribunal for America, to which everyone interested, either for or against, any project involving the use of boundary waters of navigation, power purposes, sanitary canals, or irrigation, may appeal with the assurance of a fair hearing and an impartial decision.

COAL MINE FATALITIES FOR 1912.

The coal mine accidents occuring in the United States during the year 1912 have been compiled by the United States Bureau of Mines, under the direction of Frederick W Horton.

Mr. Horton, in reviewing the year, says: "During the calendar year 1912 there were 2,360 men killed in and about the coal mines of the United States. Based on an output of 550,000,000 short tons of coal produced by 750,000 men, the death rate per 1,000 employed was 3.15, and the number of men killed for every 1,000,000 tons of coal mined was 4.29. The number of men killed was the least since 1906; the death rate per 1,000 employed was the smallest since 1899; the death rate per 1,000,000 tons of coal mined was the lowest, and the number of tons of coal produced in proportion to the number of men killed was the greatest on record. These facts offer indisputable evidence that conditions tending toward safety in coal mining are actually improving and that coal is now being mined with less danger to the miner than ever before. The general improvement in 1912, as compared with 1911, is shown by the following facts:

In 1912 the number of men killed in the coal mines of the United States was 359 less than in 1911—2,360 as compared with 2,719—a decrease of 13.2 per cent., and this in spite of the fact that there were more men employed in the mines and more coal mined than in any previous year.

The death rate per 1,000 men employed in 1912 was 3.15, as against 3.73 in the previous year, a decrease of 15.5 per cent.

During 1912 for every 1,000,000 tons of coal mined 4.29 men were killed, as compared with 5.48 men in 1911, a decrease of 21.7 per cent.

There was 233,000 tons of coal mined for each man killed in 1912, as compared with 183,000 tons in 1911, an increase of 50,000 tons, or 27.3 per cent.

Although the improvement in 1912 was greater than in any previous year for which accurate statistics are available, partly due, perhaps, to exceptionally mild weather during the last few months of the year decreasing the likelihood of disastrous coal-dust explosions, there has been an annual improvement for a number of years, as indicated by the accompanying table:—

Number of Men Killed in and About the Coal Mines of the United States in the Calendar Years 1907 to 1912, Inclusive, With Death Rates.

	—Number killed—			
Year.	Total.	Per 1,000 employed.	Per 1,000,000 short tons mined.	Production per death, short tons.
1907	3,197	4.88	6.93	144,000
1908	2,449	3.64	6.05	165,000
1909	2,668	4.00	5.79	173,000
1910	2,840	3.92	5.66	177,000
1911	2,719	3.73	5.48	183,000
1912	2,360	3.15	4.29	233,000

It will be noted from the foregoing table that the death rate per 1,000,000 tons of coal mined has decreased annually, that the production per death has increased each year since 1907, and that the death rate per 1,000 men employed has steadily decreased during the last four years.

This general improvement has been brought about by a combination of causes, the principal one of which has been more efficient and effective mine inspection on the part of the State mining departments and State mine inspectors throughout the country, supplemented by greater care on the part of both the operators and the miners. The investigative and educational work of the Bureau of Mines has kept the operator and the miner alive to the various dangers connected with coal mining and has shown what precautions should be taken to avoid these dangers. The bureau is, therefore, gratified with the improvement shown, particularly as the greatest improvement relates to dangers concerning which the bureau has been conducting special investigations, as is shown later. The bureau, however, can not too strongly express its appreciation of the co-operation of the State mining officials and the operators in the work of making coal mining safer.

Although there has been an annual improvement in mine-safety conditions since 1907, and a particularly notable one in 1912, a still greater decrease in the death rate can be effected. Whether or not such an improvement will be made in 1913 depends larg ly on the care exercised by the operators, superintendents foremen, and all others in authority, and by the miners as well, to prevent the rise of dangerous conditions and to avoid unnecessary risks when such conditions have arisen.

The R.M.S. "Kyle," which is being built and engined at the Neptune Works of Swan, Hunter and Wigham Richardson, Limited, to the order of the Reid Newfoundland Co., of St. John's, Newfoundland, was recently successfully launched. The steamer is intended for the mail and passenger service between Newfoundland and Labrador coast, and is exceptionally strongly constructed for running the ice which she will frequently meet on service. She is 220 ft. in length by 32 ft. beam and will be rigged as a two masted schooner. She is to be fitted with accommodation amidships for 68 first-class passengers, including dining saloon with seating accommodation for 32, ladies' room, smoking room, etc., and there will be a good promenade deck for the passengers' use. Aft there is to be accommodation for second class passengers, 102 men and 40 women, and there are two hospitals, one for men and one for women in a deck-house above. There will be a complete installation of electric light, including searchlight, efficient arrangement of steam heating suitable for the climate, and wireless telegraphy will also be fitted. The steamer will be propelled by single screw triple expansion engines.

COAST TO COAST.

Toronto, Ont.—The Niagara park commission is completing arrangements for the granting of a concession to a Spanish company for the installing of an aerial tramway over the whirlpool. The tramway will be about a third of a mile long and will cross from one Canadian shore to the other, greatly lessening the distance which is now covered by the International Railway which runs around the whirlpool. The immensity of the undertaking may be appreciated when it is considered that the pool must be spanned by a single cable with no support beyond the towers and anchors at each end, and that at the same time this cable must be sufficiently strong to carry the cars and passengers.

Toronto, Ont.—John Gott, chief electrical engineer of the Commercial Cable Company, has invented a device by which the Morse dot and dash signals can be used on long submarine cables, and by which a message was sent recently from Toronto to London, Eng., direct without relaying; that is, the message was sent by the ordinary land line Morse key and read on a Morse sounder. Lord Kelvin invented the first instrument to decipher signals, and it was called the Thomson reflecting galvonometer, or what is commonly known as the "mirror." The great objection to the "mirror" was that no permanent record of the message was sent, the reader calling off the message to an assistant as it was reflected. Sir William Thomson then invented the siphon recorder, which overcame the difficulty of not providing a record. In the siphon recorder a light coil of wire is suspended in the field of a powerful magnet, and the movements of the coil in response to the current through the cable are recorded on a narrow paper tape passed in front of a fine glass siphon attached by silk fibres to the suspended coil and dipping into an ink-well. The end of the siphon traces in ink a line on the tape, and this line goes up and down in response to the movements of the coil from side to side in response to a change in the polarity of the current. When a point of the line rises up above a fixed point it means a dot and a valley is a dash. Only practice can enable a man to read accurately and quickly a message by the siphon record. The technical details of the Gott invention are not being told at present, but the same voltage as at present used is required, and it is said that very little new machinery is needed. One feature of the Gott system is a delicate instrument which magnifies the faint note of the far-travelling dot and dash, and increases the volume of sound into a loud click. It is quite probable in the opinion of electricians that by Mr. Gott's invention it will be possible to transmit through automatic repeaters telegraph signals around the world, and the time will be less than one second.

Victoria, B.C.—A publication of the Pacific Highway Association of North America records the creation in Oregon of a State Highway Department, whose engineer will be at the service of all county courts that may desire advice and assistance from him. A strong point is made that all money raised by bonds for road purposes must be spent along permanent lines. Statistics are given showing amounts of money expended on roads in Oregon for the last four years and the number of miles of $5,000 per mile road could have been built for the same amount. The cost of the Pacific Highway through Cowlitz county is shown at $8,542.73 for grading and bridging per mile. The concluding paragraph of the bulletin runs: "The problems for the Pacific Highway Association to solve during the next two years are many. Among the most important is the erection of the Pacific Highway sign from Redding, California, to San Diego. In Oregon and Washington the problem is to encourage the local authorities to put the Pacific Highway in as good condition as possible before the Panama Exposition in 1915. The construction of the highway in California will be taken care of by the state. During the next two years, one, and probably two, hard surfaced roads will be completed throughout that state from north to south. In British Columbia the highway will be completed by the provincial government by 1915. This year British Columbia will spend approximately $6,000,000 on roads.

Saskatoon, Sask.—The subject of an interprovincial highway across Canada is on the programme of the Union of Canadian Municipalities for its next convention at Saskatoon. In order that the enterprise may be brought with united force to the attention of the Dominion and provincial governments, municipal councils are now being asked to adopt the following form of resolution: "Resolved, that this council is strongly in favor of the making by, or in conjunction with, the governments concerned, an interprovincial highway, of good standard construction, across Canada. This council request the Union of Canadian Municipalities to secure united action for the purpose."

Victoria, B.C.—Following the custom of previous years, the health authorities of this city soon will start another campaign against insanitary structures and the conditions which make them a menace to the public from the viewpoint of health and fire. For some time past the sanitary inspector has been making a tour of the city with a view of listing all those premises which, in his opinion, should be demolished, and at an early session of the city council authority to start condemnation proceedings against such buildings will be sought. There are at present on the list approximately fifty buildings and sheds which come within the list of dangerous premises. A great number of these are stables in the outlying sections, the condition of which cannot be improved to meet the by-law requirements in the way of sewer connection and other sanitary arrangements. Within the past two years the policy of the city in ordering the destruction of sheds has been followed. In Chinatown the campaign was especially energetic, with the result that a great number of insanitary wooden outhouses, verandahs, fences, etc., were destroyed, and in consequence the sanitary conditions in that section materially improved. The medical health officer, Dr. G. A. B. Hall, Sanitary Inspector Lancaster, and Fire Chief Davis are the officials who are chiefly concerned in this work, and their joint report will soon be forthcoming.

Calgary, Alta.—Mr. R. A. Ross, at present acting general manager of the Toronto Hydro-Electric, in his recent report to the city on the power question, made the following recommendations: "For future extensions thereafter, if there is no change in the art in the next few years, steam turbines with gas-fired boilers will be our recommendation, in spite of the greater economy of the gas engine. Should the development of the gas engine or gas turbine or some other improvement render it possible to utilize other sources of power than that recommended there will be no difficulty in introducing it later when it is ripe. Our recommendations are as above in spite of the fact that the gas engine, from a power standpoint, is the cheapest. In combination with hydro power steam from gas-fired boilers is cheaper than hydro and gas engine up to 20,000 kilowats. The natural gas engine is hampered as follows: The great capital investment being 100 per cent. more than for steam equipment. The whole service will depend upon the integrity of a pipe line 172 miles long. The large gas engine is not in such a stage of development as yet as will insure its success in your plant, and the use of smaller units would increase the capital and operating costs considerably over those indicated in our report. The advantages of steam as compared with gas in this case are as follows: The decreased capital cost involved. The utilization of natural gas with coal as a standby in case of failure of pipe line. The establishment of a plant in which every item has been tried out for years and in which no experimenting is necessary, and the greater probability of quick deliveries of apparatus."

Ottawa, Ont.—In regards the petitions that have been received from the landowners on a number of streets asking to have tarvia macadam streets constructed, Controller Nelson issued the following statement: "What we propose to do in these cases is to construct a more substantial roadway than the tarvia macadam as used on the Improvement Commission driveway. We propose to build up the streets of broken stone as in the case of the ordinary macadam road. Then have six inches of smaller broken stone mixed with tarvia and above this two inches of tarvia and very fine stone, covered with a layer of tarvia and dust. This, it is believed, will prove most satisfactory, making over eight inches of solid composition of broken stone and tarvia. The residents along Center Street who petitioned for an asphalt pavement last fall are now endeavoring to have it changed to this kind of roadway, which will be less expensive, not nearly as dusty, not so noisy, and does not require sprinkling. It is the intention of the works department to make several experiments in regard to the use of a simple top dressing of tarvia and dust along other streets. Last summer, on Mutchmore Street, west of Bank Street, we had the street swept and a thin coat of tarvia and dust put on. This was done only once, yet to-day, going along Mutchmore Street in this section, you will see the effect still remaining, and in places it is as smooth and hard as the top face of asphalt. We think that if this were done continuously for a number of years it would form a solid face on the street that would be as good as pavement. We are going to try it on Wurtemburg Street, from Rideau north to the end of the street; on McLeod, from Elgin to Bank Street, and on Fourth Avenue, west of Bank. This will be done out of general fund, less what will come out of the sprinkling that will be saved on these streets. The permanent tarvia macadam will be done under local improvement.

Regina, Sask.—Despite the general financial stringency, which is but slowly loosening up, building operations are in full swing in this city. The steel work has been completed now on the ten-story McCallum Hill building, and work is being rushed on putting on the tiling floors. The announcement has been made with respect to the change of plans of the Grand Trunk Pacific Railway. This company intended to erect a nine-story hotel at a cost of $1,000,000 and a two-story station. The hotel as originally designed will be erected. The station, however, will be much more elaborate. It will be a five-story structure, according to the official announcement, and it is now proposed to join the station and the hotel by means of a well-equipped underground passage. It is generally understood that the total cost will be well over $2,000,000. The Dominion Government has decided to dredge the Qu'Appelle River where it links up with the Fishing Lakes in the vicinity of Fort Qu'Appelle, and to construct three dams, which will considerably increase transportation facilities. The Provincial Government is draining the Wascana Lake in order to lay pipes for a reserve water supply for the Parliament buildings. Construction work on the street railway extensions has already been started, and at the present time there are about one hundred men at work, and in the course of the next month and a half it is expected that there will be at least four hundred employed. Altogether, $825,000 will be expended by the city on street railway work.

ELECTRIC DEVELOPMENT UNDER AN UNUSUAL HEAD OF WATER.

The Swiss, as a nation, are generally given credit for being the leaders in the design and manufacture of electric machinery designed for use under high heads of water. Word comes to hand of a power development scheme which outdoes, in the use of an available head of water of 5,412 feet, any previous development of which the writer is aware.

Mr. Boucher, of Lousanne, Switzerland, a civil engineer who has designed many other water power schemes with comparatively high heads, and who is a member of the board of the Society of the Electro Chimie, of Paris, has persuaded them to carry into execution the conversion of the water power of the Lake of Fully, near Martigny, in Canton Wallis, Switzerland, with a head of 5,412 feet, into electric energy. The execution of this project has been fully resolved upon, the work commenced, and the orders for the necessary materials placed.

The most interesting question in connection with this scheme arose when deciding in what manner the pipe line should be constructed in order to withstand a pressure of 2,425 lbs. per square inch at the lower end. However, a most satisfactory, as well as perfectly simple, solution was found.

The pipe line in a length of about 2¾ miles consists of pipes with inside diameters of 19 11/16 inches and 23⅝ inches, and thicknesses of from 15/64 inch to 1 25/32 inches. The pipes of the upper section will be of the well-known water gas lapwelded type, whereas those of the lower part will be seamless.

These seamless pipes, which are drawn in strong drawpresses from a steel ingot, and which can be made up to the largest diameters, offer as high a security as one could wish on account of their perfect homogeneity, especially for schemes of such high demands as the present.

The turbines for 15,000 horse-power will be built by the engineering firm of Piccard, Pictet & Company, Geneva. The construction of the pipe line is in the hands of Thyssen & Company, who possess at Muelheim-Ruhr extensive steel, plate, and tube works, as well as a water gas welding plant for large pipes, and where a great many pipe lines for water power plants have already been constructed.

PERSONAL.

MR. J. J. ANTONISEN, city engineer of Moose Jaw, Sask., has been appointed street railway commissioner at Brandon, Man. Mr. Antonisen is a graduate of Leipzig University and formerly divisional engineer for the Canadian Pacific Railway. Prior to going to Moose Jaw he was city engineer at Port Arthur, Ont.

MR. J. E. ASKWITH, assistant city engineer of Prince Albert, has been appointed first permanent town engineer of Redcliffe, Alta.

STANLEY H. FROME, resident engineer of the Grand Trunk Pacific Railway at Calgary, has been appointed to the staff of the city engineer of that city. Mr. Frome's work with the city will be connected with taking soundings and the construction of concrete bridges.

MR. W. W. BELL, until recently chief assistant to Major Hodgins for the construction work of the Grand Trunk Railway, has been appointed engineer for the construction of the Banff-Windmere Road.

OBITUARY.

MR. E. B. WINGATE, former city engineer of Hamilton, Ont., and one of the best known civil engineers in Canada, died recently at the age of 58 years. Deceased was a native of Philadelphia, Pa., where he received his education and was employed in the engineering department there. He planned the tunnel and bridge at the canal for the T. H. & B. Railway. He was shortly after appointed city engineer of Hamilton, from which position he resigned owing to ill-health caused by hardships suffered while engaged in railroad work in South America.

CANADIAN PUBLIC HEALTH ASSOCIATION CONGRESS.

The 3rd annual congress of the association will be held in Regina, Saskatchewan, September 18th, 19th and 20th. Local secretary, R. H. Murray, Bureau of Public Health, Regina.

Arrangements are now being made by a local committee and further information will be available in the course of a few weeks.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, Phelps Johnson; Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings,

QUEBEC BRANCH—Chairman, A. R. Decary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 584 Broughton Street.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary. James Lawler, Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, James Coleman; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary. J. C. Cameron.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman. Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.