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TEST-LOADING UNTIL BREAKING POINT OF A 100--FOOT ARCH BRIDGE.

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On account of an exhibition in Düsseldorf, manufacturers interested in the cement industry decided to build a concrete arch bridge on the exhibition ground. It was the intention to let this bridge enter into the future street layout, and it was, therefore, designed for a 25-ton steam roller and 80 pounds per square foot uniformly distributed. Later on, however, circumstances occurred which made it necessary to change the street layout and remove the bridge, as it was of no use in the new scheme. An extraordinarily good opportunity was thereby given to test-load an actual concrete construction to destruction point, and make a very desirable comparison between theoretical and practical results.

The German Concrete Society undertook the planning of the loading and carrying out of the measuring was entrusted to the Government Testing Institute at Berlin.

The span of the bridge was 91.9 feet, the rise 6.6 feet and the width 29.5 feet. There were arranged 3-foot granite hinges with 6.88 and 8.00 feet radius, and the thickness of the arch was 2.8 feet between the hinges. The concrete mixture was 1:4:4. Before loading was commenced a wooden falsework was built up under the bridge, strong enough to bear the bridge and the loading materials when the breaking point was reached. The fill concrete over the arches was removed in order to figure out the stresses due to the test-load as exactly as possible; this concrete, having been a 1:6:6 mix, had become so hard during the six years the bridge was used that it would have influenced the results of the test due to its statical co-operation.

The following measuring apparatus was used in the test:

For determination of the angle-turning of the abutments a level was used on both sides (the bridge was situated close to the Rhine, in the direction north to south) over each of the four abutments.

The vertical and horizontal movements of the abutments were measured by the apparatus shown in Fig. 2. A pin (a) was fastened to the stones with gypsum, and this pin was connected with two wooden arms which, by means of rubber bands, were held in touch to two rolls (2 and 3 in Fig. 2) whose turning could be read off.

The turning of the huge stones was measured by levels on the land side. On the Rhine side pieces of plate were fastened to each hinge, which overlapped each other. For each loading stage a line was drawn in the plate below along the edge of the plate above, and the neutral position of these lines determined the turning angle.

The deflection of the arches was measured on both sides of the bridge and at three points for each arch, and for the whole bridge at 12 points, by the apparatus shown in Fig. 3.

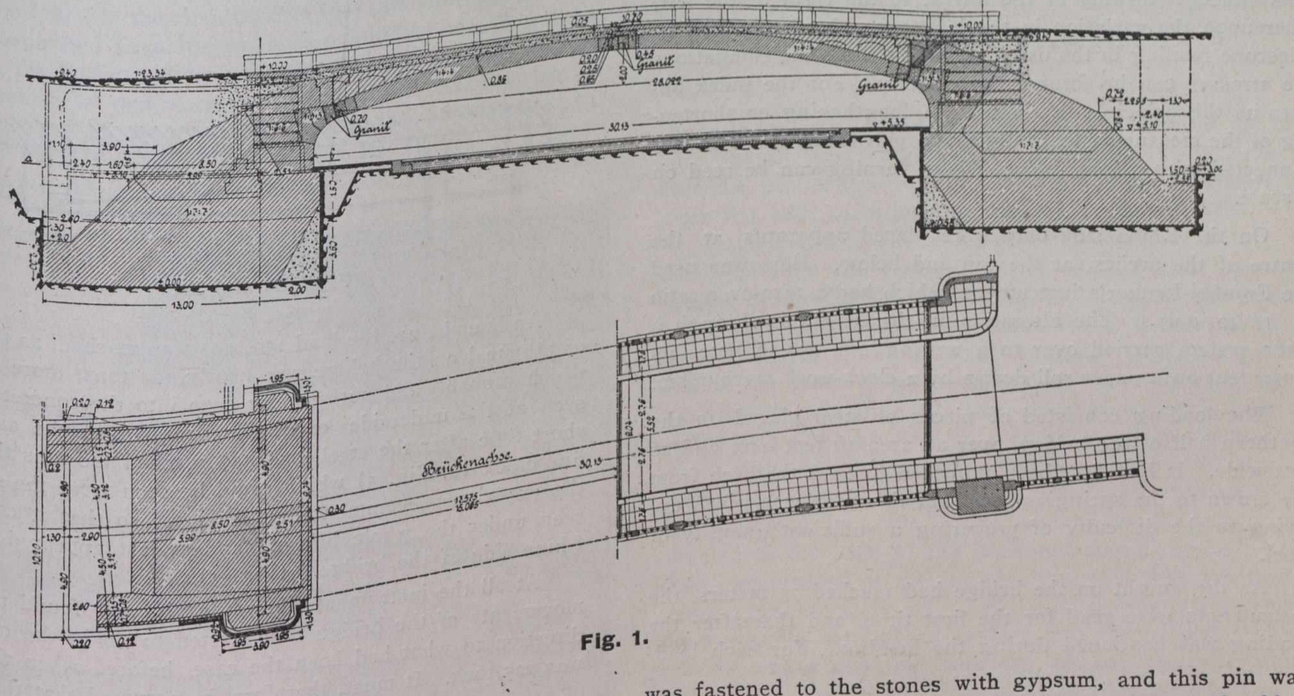


Fig. 1.

At the crown of the arches common inch scales were used, as greater vertical movements could be expected there.

It being an assumption for the correctness of the measuring that the piles, which carried the apparatus, were standing firmly, an investigation was set on foot to prove it. In a distance of 9 feet from the bridge a pile was driven opposite each of the apparatus. The piles were connected in pairs with timbers carrying levels. These did not show any movement during the loading of the bridge.

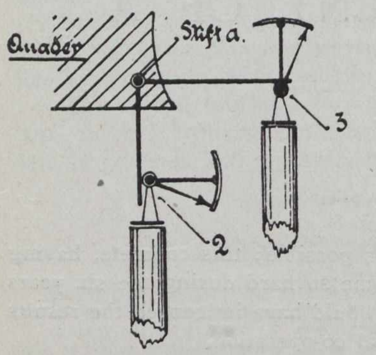


Fig. 2.

To determine the position of the resulting forces in the different sections of the arches and the value of the compression and tension stresses along the intrados and extrados a number of elongation measurements were taken at the centre of the arches by means of Martens mirror apparatus (Fig. 3 a), which give a minimum reading of 1/125,000 of an inch, and at the ends by an index apparatus (Fig. 3 b) which gives a reading of 1/60,000 of an inch. In the Martens apparatus the one end of the measuring spring is supported by a pin (p) put into the arch two inches from the edge, and between the other end and the pin (q) the mirror is placed. A change in the distance between the two pins effects a turning of the mirror to the right or the left, whereupon the variation in the length can be determined by telescope reading in the usual manner. From the elongations the stresses can be figured out directly. For the index apparatus the principle is similar. A lengthening or shortening of the measuring length effects a movement of a cylinder, connected with a long index, whose turning can be read on a scale.

On the Rhine side only were placed apparatus at the centre of the arches, at the top and below. Here was used the Frankel-Leuner's instrument, which had a turn-over ratio of 1/140 only. The alteration in the length is through a lever system carried over to a writing pin, which notes its movement on a paper roll drawn by a clock-work mechanism.

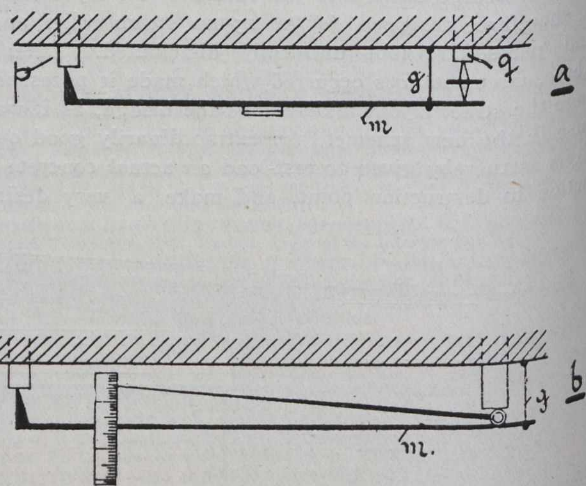
The loading consisted of pieces of steel placed on the southern half of the bridge, over an area 16 feet long and 26 feet wide. It had first been proposed to load the arch from the crown to the springing line, but this plan was given up, owing to the difficulty of procuring a sufficient quantity of steel.

As the weight on the bridge had reached 75 meters, the instruments were read for the first time, and thereafter the reading was continued during the loading. For each loading stage a measurement was taken every fifth minute, until no further alteration in the position could be seen.

The results of the observations are graphically shown in Fig. 4, which gives the alterations in the centre lines of the arch on the land side by loading increases of 75 tons; the curves give the vertical and horizontal movement of the abutment and the vertical movement of the crown, and the centre of the unloaded arch half; the measuring on the land side agreed perfectly with those on the Rhine side.

The increasing load produced first a uniformly increasing deflection at the crown and a curving and raising of the unloaded arch. In Fig. 4a and 4b is shown the movement of the arch axis under a load up to 225 tons. From Table I. it will be seen that this load gives a deflection at the crown at 2.2 of 1/25 inch and a raise in the centre of the unloaded half of the arch of 1.3.

As the test-load was increased to 225 tons a sudden change took place in the direction of the movements, due to a crack which had formed in the arch at the edge of the load. (Fig. 5). The testing institution speaks concerning this crack in the report of the experiments in the following way:—



Figs. 3a and 3b.

An hour before the load 150 tons was reached, as the load of the steel on the bridge was nearly 124 tons, more cracks, which probably did not go very deep into the concrete, were seen at the underside of the loaded part of the arch. A short time after the steel load had reached 140 tons the very fine crack (a, Fig. 5) which could be seen from the start of the experiment, commenced to enlarge, so that it could be seen under the whole bridge, and at last appeared on the Rhine side of the bridge. (Fig. 5).

At all the instruments, however, it was found that the movements of the bridge first started to go in the opposite direction to what had been the case before, when the load was 225 tons. It must, therefore, be assumed that the crack

Table I.

Point.	Movements in 1/25 of an inch. 75 Tons.	150 Tons.	225 Tons.	300 Tons.	400 Tons.
In vertical direction—					
Crown	—1.1	—1.6	—2.2	+0.5	+29.2
Centre of northern arch half	+0.5	+0.7	+1.3	—1.1	+20.0
Northern abutment stone	+0.1	+0.6	+0.7	+1.0	....
Southern abutment stone	+0.1	+0.4	+0.8	+0.7	....
In horizontal direction—					
Northern abutment stone	+0.2	+0.5	+0.7	+0.9	....
Southern abutment stone	—0.1	—0.6	—1.4	—1.5	....

+ Means movement upward or to the right. — Means movement downward or to the left.

occurring first under this action had penetrated so deeply into the concrete that it could influence the equilibrium of the arch. At 300 tons loading the crown had raised 2.7 (of 1/25 inch) over the position it had when loaded with 225 tons (Fig. 4c), and 0.5 over the original position at the commencement of the experiment. The next 100 tons called forth a further movement upward in this point of 28.7.

Consequent on this movement the unloaded northern arch half (to the right in Fig. 4) which hitherto had been curved strongly, was straightened again so that the centre had raised to 1.1 under the original position when the test-load was 300 tons; afterwards the arch turned upward around the hinge and at 400 tons load the centre was 20.0 over the point where it was situated when the bridge was loaded with its own weight alone.

The angle turnings measured at the levels on the hinge stones agreed with the above-mentioned movements. The crown hinge opened first downward, corresponding to the deflection at the top and toward the finishing of the experiment upward. The southern abutment hinge (to the left in Fig. 4), to which the loaded bridge is attached, opened up during the whole experiment, the northern down.

The hinge stone on the northern abutment moved in all, after the agreeing measurement on the land and Rhine side, .9 horizontally and 1.0 upward and turned ¾ backward in a loading from 0 to 300 tons. At the southern abutment a similar movement to respectively 1.5 and 0.7 took place, but the result of the level readings did not agree for this abutment with the mentioned movements. The reason can perhaps be found in the circumstance that this abutment had not been separated from the walls of a building standing close by, as the leading persons thought that it was better to save the expense of that work, as no importance was attached to the behavior of the abutments during the test-loading. As a very great number of instruments (in all 41) were used, it was possible, in spite of the many different disturbances

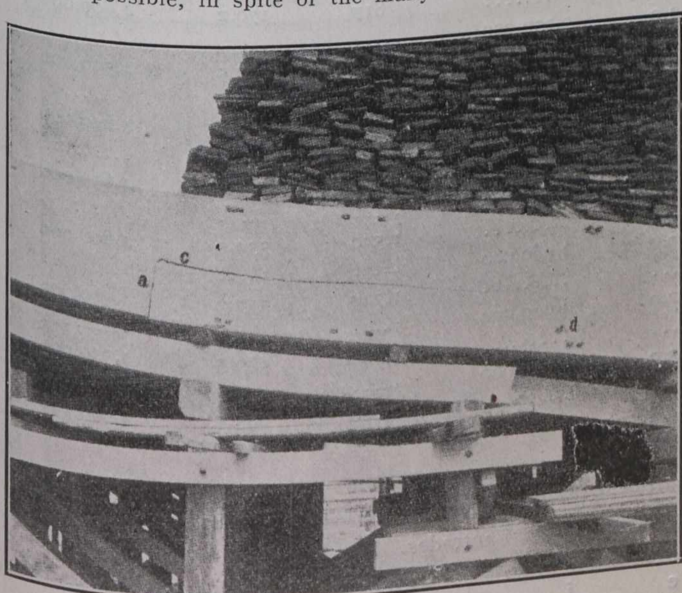


Fig. 5.

arising from changes of temperature, wind, etc., for each kind of measuring to find a sufficient number of agreeing apparatus, the reading of which could be used for comparing with the theoretical researches.

These results all aided in a determination of the pressure lines for the different loading stages. (Fig. 6). As the weight of the load and its position on the bridge were exactly measured and the specific gravity of the concrete in the arch had been found to be 2.36, the acting forces were fully known, both in regard to value and situation, and it was thus possible for each stage to draw an exactly determined pressure line, also the acting points of the pressures in the hinges had been measured. As the figure shows, the pressure line rises more and more under the loading by an increasing of the load from 0 to 225 tons, until, under influence of this load it reached the extrados of the arch. At

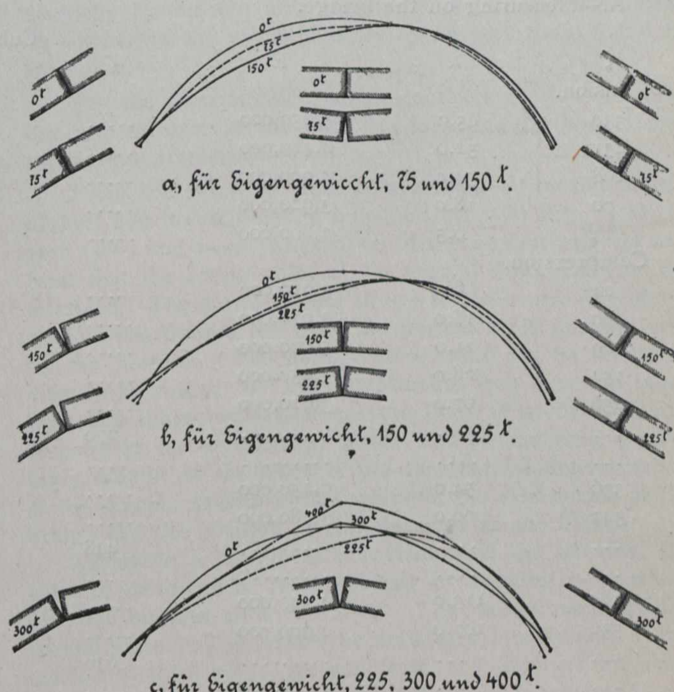


Fig. 4.

the intrados, rises corresponding to this position of the pressure line an increasing tension stress was shown. In the unloaded part of the arch the pressure line becomes more and more flat with corresponding tension at the extrados.

From Fig. 6 it will be seen that the distance of the pressure line from the centre line of the arch is essentially greater in the loaded side than in the unloaded, and greatest under that half of the steel load which is nearest to the crown; therefore, the greatest bending stress occurs here and at the same time considerable shear stresses, as the direction of the pressure line deviates so much from the centre line. The greatest unfavorable concentrated load produced such tension and shear stresses in the arch that it is not to be wondered that a poured joint, which otherwise was fully excluded from the bridge, and which accidentally was situated at the edge of the loading material, opened. The crack commenced at the intrados and was then transmitted upward into the arch and, as the statical examination shows, the crack was throughout so deep that the tension stress in the remaining concrete was 350 to 400 lbs. per square inch. When the length of the crack was equal to half of the arch thickness on the Rhine side and ¾ on the land side (300 tons load) a horizontal shear crack was visible. (Fig. 5). It was now assumed that the bridge would collapse, the thickness of the undamaged concrete being only 16 inches on one side and 8 inches on the other; but no break took place, and it was possible to increase the load by one-third up to 423 tons.

Between 225 and 300 tons the vertical crack came into full action, which can be seen from the fact that the extensometer, which was placed in the point d (Fig. 5) in the neighborhood of the crack, was suddenly unloaded, having hitherto shown increasing tension stresses. At the same time the agreeing reading on the four deflection meters at the crown of the arch showed that this point commenced to raise. This means that the loaded part of the arch tried to straighten, and corresponding to this a considerable rolling must have taken place in the crown hinge. This was also clearly visible by the levels. By this turning the pressure was moved downward, by which a new pressure line could be figured inside the undamaged concrete and which would explain the new

Table II.

Moduli of elasticity (E), stresses (ζ), and length alterations per unit (λ). E and ζ in lbs. per square inch, λ in 1/100,000 of the measure length.

A.—Measuring on the bridge.			B.—Measuring on the cubes. Cube No. 1.			Cube No. 2.		
ζ	λ	E	ζ	λ	E	ζ	λ	E
Tension.								
330	65.0	5,050,000	....	.....	....	.....	.....	....
231	52.0	4,440,000	....	.....	....	.....	.....	....
168	34.0	4,900,000	....	.....	....	.....	.....	....
70	18.0	3,920,000	....	.....	....	.....	.....	....
14	0.5	2,800,000	....	.....	....	.....	.....	....
Compression.								
24	6.0	3,910,000	....	.....	....	.....	.....	....
70	18.0	3,910,000	....	.....	....	.....	.....	....
129	21.0	5,600,000	....	.....	....	.....	.....	....
154	28.0	5,450,000	....	.....	....	.....	.....	....
256	67.0	3,920,000	....	.....	....	.....	.....	....
...	....	....	270	47.0	5,740,000	.....	.....	....
...	....	....	....	.....	....	272	42.3	6,450,000
336	54.0	6,150,000	....	.....	....	.....	.....	....
342	90.0	3,780,000	....	.....	....	.....	.....	....
...	....	....	448	80.3	5,600,000	.....	.....	....
...	....	....	....	.....	....	445	82.9	5,480,000
484	113.0	4,340,000	....	.....	....	.....	.....	....
532	107.0	4,900,000	....	.....	....	.....	.....	....
...	....	....	630	116.0	5,430,000	.....	.....	....
...	....	....	....	.....	....	636	128.2	4,960,000
706	160.0	4,440,000	....	.....	....	.....	.....	....
748	146.0	5,040,000	....	.....	....	.....	.....	....
...	....	....	809	154.0	5,250,000	.....	.....	....
...	....	....	....	.....	....	817	170.2	4,800,000
...	....	....	990	189.0	5,230,000	.....	.....	....
...	....	....	....	.....	....	1,000	217.5	4,590,000
...	....	....	1,170	228.0	5,120,000	.....	.....	....
...	....	....	....	.....	....	1,180	254.1	4,640,000
...	....	....	1,350	263.0	5,120,000	.....	.....	....
...	....	....	....	.....	....	1,360	292.1	4,650,000
...	....	....	1,520	305.0	4,980,000	.....	.....	....
...	....	....	....	.....	....	1,540	334.0	4,600,000
...	....	....	1,710	342.0	4,980,000	.....	.....	....
...	....	....	....	.....	....	1,720	377.3	4,560,000
...	....	....	1,890	382.0	4,940,000	.....	.....	....
...	....	....	....	.....	....	1,900	419.3	4,540,000
...	....	....	2,070	423.0	4,900,000	.....	.....	....
...	....	....	....	.....	....	2,080	475.5	4,480,000

Table III.

The elongations λ measured on 3.28 feet = 1 meter one-quarter of the span from the springing line in 1/25,000 inch.
+ Means elongation. — Means shortening. e Means extrados. i Means intrados.

	75 Tons. e	i	150 Tons. e	i	225 Tons. e	i	300 Tons. e	i
(a) Loaded part of arch	—54	+ 2	—107	+ 34	—146	+ 65	—213	+ 50
(b) Unloaded part of arch	—18	—67	— 6	—90	+ 18	—113	+ 52	—160

Comparison of measured and calculated stresses (in lbs. per square inch) at the same point:—

	Dead load. e	i	75 Tons. e	i	150 Tons. e	i	225 Tons. e	i	300 Tons. e	i
Loaded side measured	.....	.....	—335	+ 14	—532	+ 168	—750	+ 330	crack	acting
Loaded side calculated	—119	—154	—315	+ 8	—520	+ 153	—700	+ 194	crack	acting
Unloaded side measured	.....	.....	— 70	—256	— 24	—342	+ 70	—485	+ 231	—707
Unloaded side calculated	—119	—154	— 87	—235	— 8	—356	+ 54	—465	+ 265	—738

equilibrium. Without the hinge the movement at the top could not have taken place and the bridge would probably have broken down before the load had reached 300 tons.

The maximum compression stress is on calculation 2,320 lbs. per square inch under 423 tons load. At the vertical crack the tension stress was 350 tons, 400 lbs. per square

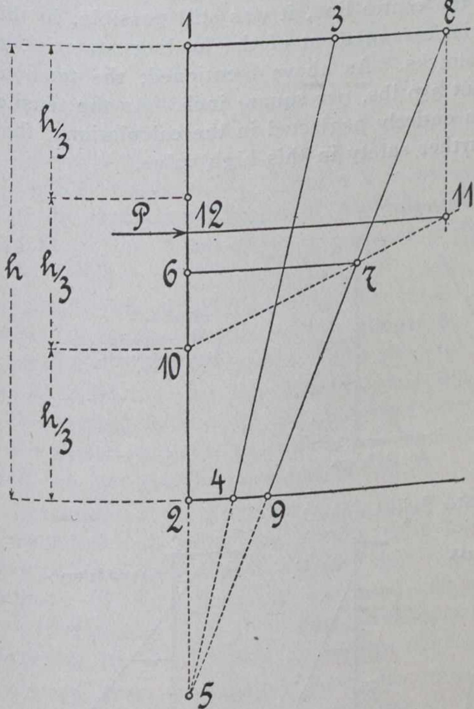


Fig. 7.

inch, and in the unloaded part of the arch the same stresses were found.

The object of measuring the elongations was to determine the position of the pressure line, the value of the acting stresses and to obtain information concerning the modu-

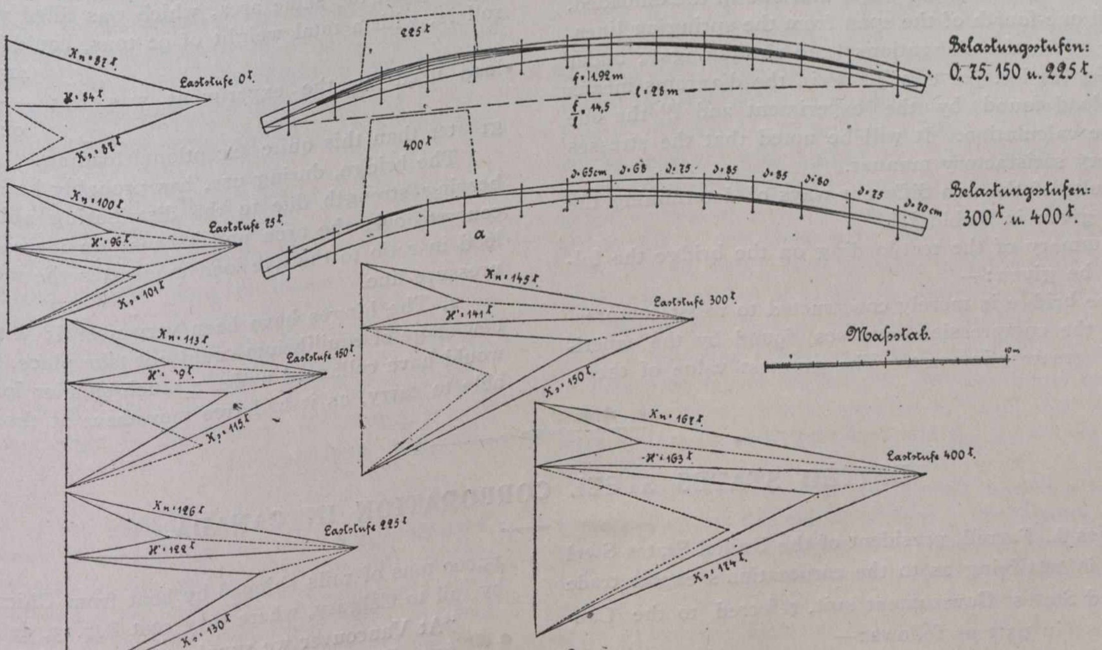


Fig. 6.

lus of elasticity of the concrete. The main difficulty of those problems consisted in the circumstance that these quantities are exceedingly small, and that the modulus of elasticity is not a constant, but varies with the value of the stresses.

The modulus of elasticity was also fixed in another way independent of the measuring. Two blocks were cut out of the concrete in the arch, from which cubes were sawed with 12-inch side. For two of these not only the compression strength was measured, but at the same time the value of the decrease in length corresponding to each stage of the pressure, by means of which it was possible to determine the moduli of elasticity, thus giving a specially good occasion to test the value of the elongations, stresses and moduli of elasticity figured out after observations on the bridge itself by comparing the values directly found with those found by the cubes.

For the determination of the location of the pressure line and stresses in the arch the following method of procedure was employed:—

From the value of the compression or tension in the highest and lowest point in a section (1—2 in Fig. 7) of the arch (1—3 and 2—4) the position of the neutral axis (5) and from that the acting point of the normal force could be determined. The normal stress (6—7) in the centre line of the section was figured out from the normal force and the area of the section. The normal force could not be measured directly by means of the instruments, but must be taken from the above-mentioned pressure lines (Fig. 6) with corresponding force polygons, which can be designed exceedingly exactly on the basis of the very careful determination of the specific gravity of the concrete, the dimensions of the bridge and the position of the pressures in the hinges.

Assuming a rectilinear distribution of the stresses, the value of these can be found directly by drawing 5—7, which give the stresses 1—8 and 2—9. The acting point of the normal force (12) is located by drawing a line through 7 and the lowest third point, 10, and from the intersection point of the line 10—7 and 8—11 (1—2) a line 11—12 (6—7). The length 1—3 and 2—4 are in this case the sum of the variations in the length from the test-load and the weight of structure; these last-mentioned could not be further measured on the bridge, but should have been measured as the falsework was remote. It was, therefore, necessary to make certain assumptions in order that they might be figured.

The value of the normal force in the unloaded part of the bridge could be directly found in the force polygon, but the alteration of the length must be figured out from a chosen value of the modulus of elasticity, which was fixed at 5,500,000 lbs. per square inch, after trying different values between 1,500,000 and 8,000,000. This value agrees very well with the laboratory experiments made with the cubes of the seven-year-old concrete, as shown in Table II. The compression experiments are in this case specially valuable, because the line of pressure for the dead load nearly coincides with the centre line of the arch and, therefore, only produces compression stresses.

As proof of the correctness of the situation of the pressure line and value of stresses found in this way, the sizes figured out by the statical examination serve.

reached in this case by means of the strongly concentrated load over the centre of one part of the arch was 2,740 lbs. per square inch, the concrete originally having been figured out with a permissible stress of 560 lbs. per square inch. By this five times increased stress no indication of the destruction of the concrete could be seen.

2. Although the arch was very flat and the pressure line close to the centre line, it was still possible, in this case by the special arrangement of the loading material, to develop tension cracks. As above mentioned, the tension strength was about 350 lbs. per square inch. As the tensile strength has been entirely neglected in the calculations, the structure has a further safety in this high value.

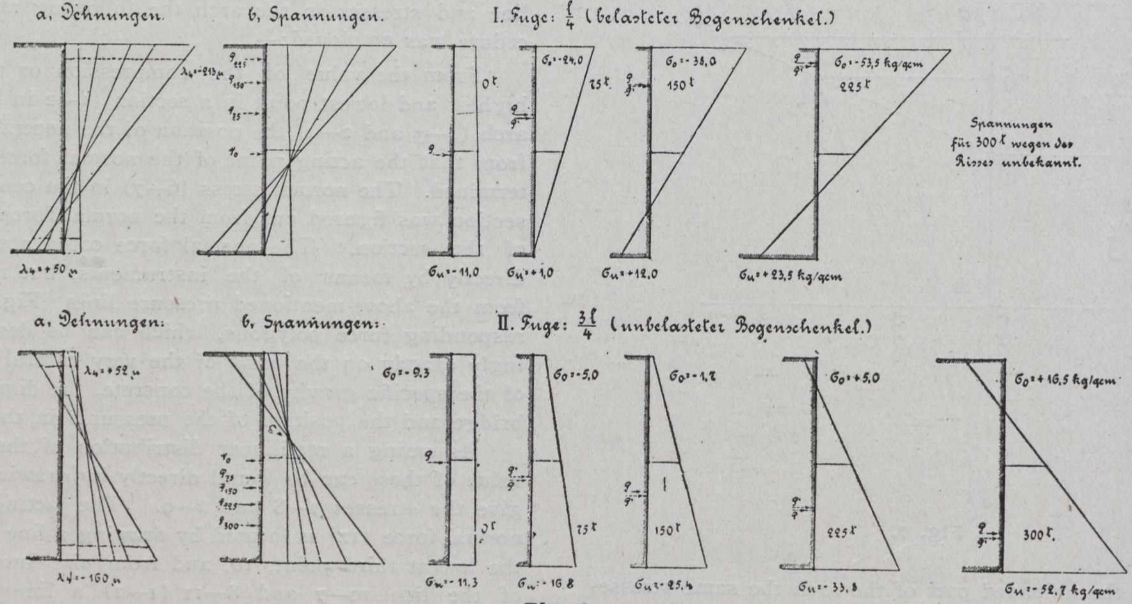


Fig. 8.

In Fig. 8. is given a graphical representation of the alteration in the length, found by Frunckle's apparatus and the hereafter calculated stresses, for one section of the loaded part of the arch (above in the Fig.) and one in the unloaded, both situated one-fourth of the span from the springing lines. Under a are given the elongations (and shortenings); under b the stresses (in kg. per c.m.^{2}). P in the diagrams means the normal load found by the experiment and P^1 the one found by the calculation. It will be noted that the stresses vary in a very satisfactory manner.

The results of the two different ways of determining the stresses are given in Table III.

As a summary of the test-loading on the bridge the following may be given:—

1. As the bridge is merely constructed to resist compression forces, the compression stresses found by the experiment are of greatest interest. The greatest value of these,

3. For giving an approximation of the weight of steel used, it may be compared with the common 23-ton steam rollers. On the same area, which was filled with steel, four rollers, with a total weight of 92 tons, could be placed; the load used by the experiment was thus $\frac{423}{92} = 4.6$ times greater than this quite exceptional loading.

The bridge, during use, has probably had a still greater bearing strength due to the distributing ability of the fill concrete over the arch and because an increase of the dead load in ratio to the live load moderates the movement of the pressure line.

4. The hinges have been very useful; without them the new stage of equilibrium could not take place, and the bridge would have collapsed under a much smaller load than it was able to carry, as it had free movement at three points.

UNITED STATES STEEL CORPORATION IN CANADA.

Mr. James A. Farrell, president of the United States Steel Corporation in testifying as to the corporation's export trade in the United States Government suit, referred to the Canadian business in part as follows:—

"Through Montreal we sell about 60,000 tons of wire product a year, sheet iron, mine rails, and sometimes standard rails, when they cannot be supplied by their own corporations. We are now supplying the Canadian Northern Railway with 25,000 tons of rails shipped by boat from Chicago and thence by rail to Calgary, where they cost $47.13, delivered.

"At Vancouver we supply much material, but the freight rate from Pittsburgh there is $18 a ton. Material from Liverpool or Antwerp may be shipped for $6 to $8 a ton. After we established our office there we found it necessary to run a steamship service there. Our ships leave about every two months, making stops all along the line. On the return we go into a general merchandising business."

INVESTIGATION OF METHODS OF OPERATING THE PITTSBURGH SLOW SAND WATER FILTRATION WORKS.

In July, 1910, George A. Johnson, consulting engineer of New York, was engaged by Hon. W. A. Magee, mayor of Pittsburgh, Pa., to make an investigation of certain features of construction and existing methods of operation of the slow sand water filtration works completed by that city in 1908 at a total cost of some $6,000,000. Mr. R. S. Weston, of Boston, Mass., was associated with Mr. Johnson on studies relating to the chemical phases of the problem.

The practical result of Mr. Johnson's investigation are set forth in the last annual report of Mr. Chas. A. Finley, superintendent of the Water Bureau. Abstracts from Mr. Finley's report follow:—

"It is noted with satisfaction that the total operating and maintenance charge for the year is almost $50,000 less than the cost of last year's operations. The total for the past year was $818,626.12; for the previous year $868,141.07. Most of this saving is due to the improved methods of operating the filtration plant, the saving in operation at this plant during the last year being about $40,000."

"The operation of the filtration plant for the past year has been attended with gratifying results from a financial and sanitary point of view, due to the fact that, with the improved methods of sand handling instituted last year, we were able to operate the plant about $40,000 cheaper than the cost of operating by the methods previously employed."

"It appeared, from an examination of the records, that the operating cost of our plant was unnecessarily high. It also appeared that, at certain seasons, we got unusually small yields from filters between cleanings."

"The question thus naturally divided itself along two lines:

"1st. A study of the actual operating conditions within the filters, such as methods employed for sand handling, etc.

"2nd. A study of the physical and chemical properties of the river water, for the purpose of devising methods of eliminating from the river water the causes of the excessive clogging, prior to its application to the sand filters.

"The first question has been handled and investigated by Mr. Johnson.

"The second question has been handled and investigated by Mr. Johnson and Mr. Weston, acting in conjunction.

"These investigations began in July, 1910, and extended over about eighteen months' time, to January, 1912.

"The principal changes in operating conditions within the filters were the introduction of the process of 'raking' the filters between 'scrapings,' thereby securing additional yields from the filters at less expense than by continuous scraping, and a change in the process of restoring sand from restoring by machine to restoring from open hose lines under water."

"The study of the physical and chemical properties of the river water was of necessity complicated and protracted, due to wide variation in the character of the water on account of seasonal and other changes. The investigations were continued until all the different types of water had been encountered, a large amount of data was compiled, careful study made thereof, and conclusions drawn therefrom."

"In line with the conclusions, a system for the preliminary treatment of the river water was designed, and the necessary contract plans prepared for the construction of the same."

"The result of these investigations indicates that the daily capacity of the plant can be increased from one hundred and twenty-five million gallons to two hundred million gallons without the construction of additional sand filters. The amount of water yielded by a filter between cleanings is an essential factor in the increased capacity of the plant. The prime object of preliminary treatment is the assurance of the necessary field between cleanings. With this yield assured, the rate of filtration, or the amount of water filtered daily through each filter, can be increased so as to produce a total daily yield of two hundred million gallons, and still maintain the economy of operation in sand handling."

"To arrive at this total daily capacity by slow sand filters, without preliminary treatment, under the present conditions, would require the construction of about thirty additional slow sand filters of one acre each. The approximate cost of this installation would be over two million dollars, not including the necessary land."

"The annual saving in sand handling alone is $40,000, with the plant as it now stands, and if we consider the difference in cost between the extension of the present sand filters, without preliminary treatment, and the introduction of preliminary treatment, without extending the sand filters, as developed by the investigation, said differences being, in round numbers, about $1,600,000, exclusive of land, and allow 5 per cent. annually on this saving, it amounts to $80,000, which, with the $40,000 saved in operation, makes a total of $120,000."

TRACK CONSTRUCTION ON PAVED STREETS.

At the recent convention of the American Railway Engineering Association one of the committees recommended the following practice on paved street construction:—

They recommended that treated ties should be used and should be laid on a bed of crushed rock, gravel or other suitable material, not less than 8 in. nor more than 12 in. in depth, placed in about 3-in. layers, each to be thoroughly rammed to compact it.

Vitrified tile drains were recommended to be not less than 6 in. in diameter, with open joints and leading to nearest point from which efficient drainage might be obtained or with sufficient outlets to reach sewers or drainage basins. These should be laid on either side of and between tracks, parallel with ballast line and outside of ties.

It was recommended that a 141-lb. girder rail of 9-in. depth, or one of similar section, with suitable tie-plates and screw spikes, should be used. The track should be filled in with crushed rock, gravel or other suitable material, allowing for a 2-in. cushion of sand to support the finished pavement.

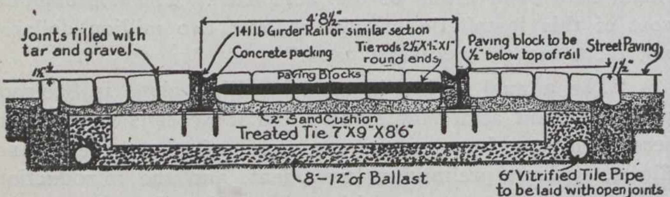
Ballast for paving foundation should be well rammed as it is installed. Two inches of good, sharp sand should be placed on top of the ballast. Paving should conform with municipal requirements, granite or trap rock blocks preferred. Hot tar and gravel should be poured into joints as a binder.

A test which may be of interest was one on cleaning stone ballast by the use of screens. The results of this test tended to show that a gang of twelve men, properly equipped with tools, would cover about 165 ft. of double track per day of ten hours, making the cost per mile of double track $640. This cost included the work of cleaning the ballast, dressing the track and disposing of the dirt. The labor charge included a foreman at $2.40 and eleven laborers at $1.60 each.

The report of the committee on buildings included a brief report on the advantages and disadvantages of various types of fright house floor construction in part as follows:—

Freight House Floors.—"Freight house floors should ordinarily be built to carry a uniformly distributed load of at least 250 lbs. per sq. ft. Except for small houses, a filled-in floor, considering the cost of maintenance, is ordinarily cheaper than joist construction. It is also advantageous, because it will carry the unusually heavy loads that sometimes occur.

"The usual method of construction consists of filling up to the required level with sand or gravel, thoroughly flushed and compacted. To ensure a dry floor, on this filling is laid a bed of cinders about 6 in. thick, thoroughly compacted. In the cinders are bedded sleepers, preferably about 4 in. x 6 in., laid flat, about 2-ft. 6-in. centers. These and the plank above them should be thoroughly treated with creosote of zinc chloride where there is to be an additional



Recommended Track Construction for Steam Railroads at Paved Street Crossings.

wearing surface applied. With untreated timber renewal is sometimes necessary within four years, though under favorable conditions a life considerably greater is usually obtained. When no cinders are used on top of the sand the decay seems to be hastened.

"In place of cinder filling and sleepers a layer of coal-tar pitch spread upon a layer of sand over a course of concrete is being quite extensively used. This is durable and is said to give good results. Specifications for this method are obtainable from the coal-tar producers.

"Either on the sleepers, laid in cinders, or on the pitch are laid planks about 2 in. thick. With the pitch sub-floor the plank should be laid with broken joints toenailed and embedded in the pitch by hammering until the proper stability is obtained. Care should be taken to see that they are brought to an exact grade. The plank need not necessarily be toenailed with the wooden sleepers.

"To get a smooth-wearing surface on top of the plank hard maple is generally preferable. It does not splinter and it wears evenly. It has a short life when exposed to the weather. It is growing scarce and getting expensive. Beech is often sold for maple, they being difficult to distinguish. It is somewhat darker in color and it splinters more. Birch is softer than beech or hard maple, but does not splinter so readily as beech.

"Gum, especially tupelo, is recommended as a substitute for maple, and it probably will, to some extent, displace it. It is darker in color and somewhat softer, but it wears evenly and it does not splinter much more than maple. Thorough seasoning is particularly essential. There is a large supply of gum in the South and its use for floors should be extensive.

"Under most conditions, the best floor can be had by laying the top floor diagonally, putting the plank lengthwise and the sleepers crosswise of the house, without any bearing on the side walls. Inequalities in settlement of the floor are then less liable to make trouble, the plank can be laid with minimum expense, and the top floor gives the best results after considerable wear. This costs for the top slightly more for laying and more for repairs. Where there is a pronounced amount of trucking in one route it is sometimes thought desirable to put the flooring parallel to this trucking but where the amount of traffic warrants it would seem best to put a runway of steel plates.

"Wood block pavements may be used in place of the board floor. They are best used on top of a concrete sub-floor, with a 1-in. sand cushion between. With wood blocks care should be taken to obtain sufficient expansion joints, as many floors have failed from a lack of this precaution. One inch for 50 ft. is about the correct amount. Care should also be taken to avoid the use of creosoted blocks where flour or similar articles which are easily damaged by odors are handled. There is also a chance of such damage from tar used in the expansion joints. Zinc chloride is for this reason recommended as a preservative for wood blocks when used for freight house floors. Zinc chloride is cheaper than creosote, and in a freight house the blocks will not suffer from the leaching which takes place when they are exposed to the weather, the main objection to the use of zinc chloride for treatment of cross-ties and paving blocks. It is almost impossible to get this kind of floor as smooth as a maple floor, but if properly laid it tends to wear smooth. It is adapted to points where wear is especially severe, such as are due to the handling of castings and heavy machinery. Its main advantages are in the ease with which it can be repaired. The blocks are ordinarily made of pine. It would seem that gum blocks would be better. Maple blocks are also used, but are expensive.

"Concrete has been used successfully where the wear is not too severe. There is a good deal of chance of damage by falling freight, and its use must be restricted to places where there is little chance of castings and similar articles being handled, unless the top surface is carefully made of the best of hard aggregates. Under such conditions excellent results have been obtained.

"A concrete sub-floor protected by a layer of asphalt mastic will give excellent results. It will cost more than the concrete floor, but it will not chip and scars made in its surface soon disappear. It is not so cold as the concrete floor and has been used for this purpose with success.

"Asphalt blocks properly made would seem to have some advantage for this purpose. They should make a smoother floor than the wood blocks and can be more easily repaired than the mastic floor."

RAILWAYS AND CIVIC WORKS AT REGINA, SASK.

The following civic works will be carried out this year:—Street railway extensions, $825,000; gas plant investigations, $25,000; trunk sewer (48-inch), $240,000; waterworks extension, $200,000; storm sewer mains, $60,000; power plant (new one), $425,000; electric light extensions, $250,000; health and scavenging equipment, $117,000; road making, $22,000; fire hall and motor equipment, $60,000; footbridge over Canadian Pacific Railway tracks, $35,000; winter fair auditorium, $134,000; police station and court, $180,000; hospital addition, $125,000; complete subways, $37,000; remodel market building, $7,500; domestic sewer mains, $630,000; domestic water mains, $420,000; paving, $580,000; paving (under old by-law), $550,000, (debentures sold); concrete sidewalks, $115,000; collegiate extension, $100,000.

As a railway centre Regina occupies a fine position. All three of the great transcontinental lines operate in and out of Regina. The Canadian Pacific Railway was the pioneer, but the Canadian Northern and the Grand Trunk Pacific has entered into an agreement with the city council to spend $1,000,000 on the erection of a large hotel, which will contain 275 sleeping rooms. This railway will also erect a large station at a cost of about $500,000. About eight hundred feet of train sheds will be built adjoining the station so that all trains arriving in the city will be under cover.

SOME WATER SUPPLY PROBLEMS OF THE WEST.*

By R. O. Wynne-Roberts, M. Inst. C.E., M. Can. Soc. C.E., F.R. San. Inst., etc., Consulting Engineer, Regina.

Owing to the gentleman who had arranged to read a paper to-night finding he had to leave the city, and would, therefore, not be able to fulfil his engagement, and, as the time was too short for others to fill the breach, it is to be hoped that the following note will furnish topics for discussion:—

Every country, district and town has water supply problems to solve. It is rare to find nature so generous as to furnish abundant, pure supply of water without leaving some difficulty, more or less great, for the engineer to surmount. We have only to study the conditions in Canada, which, perhaps, possesses the most bountiful supply of water of any country, to observe that a number of towns and cities are combatting with one difficulty or another. The supply of water is either difficult to procure, or it is limited in quantity, or it is not pure.

Whilst in the East and extreme West of Canada there is abundance of water, the problem in many places in the Middle West is to find a copious and pure supply, and it will be well to consider why it is often so difficult.

The author has during his career had a number of water problems to deal with, but when he visited Regina and was asked by the corporation, through your president, who was then City Commissioner, to conduct investigations with the view to augmenting the supply, he found new conditions, which had to be carefully studied.

Geological Formation.—One of many interesting features which had to be studied was that of the geological formation of the country, and in this connection it may be useful to describe the agencies which primarily contributed to form the topographical features of this part of the country.

The present surface is entirely of glacial origin. When the first great ice invasion of the glacial epoch moved southwards the surface of the country was doubtless much more rugged than it is to-day, and the valleys possibly drained in other directions. The great sheet of ice, many hundreds of feet in thickness, advanced slowly southwards, stripping loose material, crushing and levelling rocky hills; stones, gravel and mud became frozen to the ice, and increased the power of the glacier to wear down other rocky excrescences, etc. Enormous masses of crushed rock of many kinds were thus picked up and conveyed from the northern parts across this country into the United States. When the climate became warmer the ice gradually melted back, and huge streams of water, which flowed down from the ice sheets, and brought with them great quantities of detrital material, depositing the same in uneven masses, filling up valleys and forming the plains and hills which constitute the principal features of the prairies.

Where this great ice sheet halted from time to time terminal moraines were formed.

The second ice invasion again changed the surface of a large part of the country, disturbing the deposits left by its predecessor and redepositing the same.

These ice sheets advanced across Canada into the United States in the form of a huge tongue, and the glacial deposits can be found over vast territories. These masses of glaciated material vary in thickness, magnitude, shape, character, and distribution, and were laid in a most chaotic manner. The districts around Regina, for instance, are from 1,900 to 2,400 feet above sea-level, and about 600 to 1,100 feet above the Lake Agassiz, which was formed in the glacial period. This lake and other glacial lakes extended westwards as far as the Elbow on the South Saskatchewan River.

The channels or ravines cut out by the streams flowing from the ice sheets have been gradually or partially filled in by sand, silt and gravel washed out of the morainic deposits, building up the gentle slopes and flat plains between the banks. During the ages that have since elapsed the streams have eroded passages through these outwash plains, and in places undercutting the beds of drift, thereby tapping the underground water-bearing stratas and causing springs to appear on the surface.

The fine silt or mud, composed of disintegrated cretaceous rocks, which were carried by the ice sheets, formed the flat or very slightly undulating land surface of the prairies, which constitute the major portion of the country south of Regina. This material, called till, consists of pulverized rock forming impalpably fine clay mud, often intermixed with gravel, boulders and rock. This till, bluish-grey in color, although oxidized on the surface and underneath for a few feet to yellowish clay, is to be found over the country, extending to the Central States of America. It usually underlies the gravel deposits, and forms a more or less impervious substratum. The upper portion of this till is commonly softer and easily dug, while below it there is a sudden change to a hard and compact deposit, locally called hardpan. The probable cause of this (according to Mr. Upham) was the pressure of the enormous weight of the ice sheet upon the lower and older till, while the upper till was dropped loosely as the ice melted. The boulders, which are more or less plenty on the ridges and in valleys, are generally granite, gneiss, and schists brought from the northwest, and also limestone—the latter, being softer and more easily crushed, has been largely reduced to gravel, etc.; hence it is that the substratum consists mostly of limestone and clay.

It is important to note that the glacial till, consisting of a matrix of clay with pebbles and boulders, and, forming a more or less watertight mass, has intermingled and interbedded with it in a most extraordinary manner, and often lying above and below it porous water-laid sands and gravels, which constitute the water-bearing strata. In many places these beds of sand and gravel lie between two beds or till of different epochs of formation, but in a greater number of districts gravel beds of varying depths, thickness and character are to be found under the clay bed drift. It is, however, not possible to trace these beds for a great distance. The calcareous matter has been leached out of the older formation, but in the more recent accumulation it virtually remains without change; consequently, the water obtained for the latter beds are heavily charged with mineral salts.

The surficial layer of drift is generally open and fairly loose, with the result that water percolates rather freely into the subsoil. Owing to the uneven manner in which the glacial materials were deposited and to the undulating nature of the surface, it is inefficiently drained; there is a plexus of pools, sloughs, and swamps. The drift is often saturated nearly or even to the surface; hence it is that so many farmers are able to obtain a fairly abundant supply of water from shallow wells. In times of drought, however, the water table will be considerably reduced, and in some instances it will probably sink below the bottom of such wells. This is also the main reason why sloughs appear to dry up in seasons of drought.

In the case of the outwash sands and gravels to be found stretching out from the moraines, these beds, being very porous, readily absorb the rain falling upon them.

Sand dunes are found in some places, like Pilot Butte. These were formed by sand from the plains drifting with the winder and heaped up in cones or dunes or drifting sandhills. The time of formation of these dunes was probably

* Paper read before the Regina Engineering Society.

soon after the recession of the ice sheets and before vegetation had spread over their surface.

Rainfall.—The question which arises after ascertaining the areas of the possible watersheds is the quantity of rain falling on such sheds, more especially in prolonged periods of drought.

As a fairly typical example, we might consider Regina district. There are two rainfall observation stations on which the rainfall in the Regina district may be relied upon. These are the North-West Mounted Police barracks and Qu'Appelle. These, however, do not accurately represent the rainfall on the watersheds east and north-east of Regina, because the stations are lower than the waterheds in question.

By analysis of the recorded rainfall at these stations the mean annual rainfall is computed at about 16 inches. The next step to take is to ascertain the rainfall in any three driest consecutive years. The above-mentioned records were carefully examined, and it was found that it amounted to about 10.4 inches, or 65 per cent. of the mean annual precipitation.

Evaporation.—The problem that has to be next investigated is that of evaporation that takes place on the surface of the water and land. Part of the rain percolates into the ground to feed the water-bearing strata springs, etc., and sustain vegetation, another part is lost by drainage off the surface of the land into the streams, and a portion is evaporated. In the West, however, snow remains on the ground for months. The ground is frozen to a considerable depth; consequently, not much water percolates down to the substrata during winter. It must be remembered that evaporation goes on throughout the winter; when the spring arrives, much of the remaining water, in the form of snow and ice, when melted will drain away. Furthermore, in summer, some of the water which has percolated into the ground is absorbed by vegetation and then transpired into the atmosphere. There are, however, several depressions in the land surface, such at kettle-holes, etc., which retain water until it disappears into the ground or is evaporated. The phenomena of evaporation is an interesting one, and it is to be hoped that the Government will some day arrange for careful observations over a prolonged period to be made, for it has a very material influence on the question of water supply, irrigation, agriculture, etc. In general terms, evaporation is a product of many conditions, such as temperature of the air and water, duration and intensity of solar rays, the dryness and velocity of the air, etc. Evaporation increases with rainfall, but is much more uniform in districts of large rainfall, and in districts of low rainfall it is relatively high. So, in years of drought especially evaporation constitutes a very important factor in the problem of water supply.

The United States Government has conducted a long series of evaporation on the Salton Sea, California, where it was found that the evaporation ranged from 51 inches in 1908 to 69 inches in 1910. In Ohio it was 46 inches. It may be estimated that from the surface of water it is approximately 50 inches in the West, but what is lost by evaporation from the land surfaces is not possible to estimate at present.

Yield.—The yield from watersheds varies in every case, owing to the difference in physical features, such as mountains, valleys, as contrasted with flat or undulating prairies, rocky catchments as compared with porous plains, luxuriant vegetation, trees and foliage on the one hand and "prairie wool" on the other.

In the case of Regina water supply, after taking into consideration the many conditions and approximate similarity with water sheds in the States, it is estimated that by laying extensive collection pipe lines and sinking wells about one and one-quarter inches out of ten inches rain in the three driest consecutive years can be secured, but it cannot be assumed that a similar yield can be obtained from any other watershed in the prairie provinces, for it might be exceeded or be far less, as eveyrthing depends on local features.

There are available for Regina about 200 square miles of watersheds, and at the above rate it is estimated that about ten million gallons can be collected and delivered into the city.

Tapping the Supply.—Having ascertained what extent of catchments are available, the minimum rainfall in driest years, estimated the losses by floods, evaporation, absorption, and what is collectable, it then remains to be decided how best to tap the supply.

This depends on several conditions, such as topography of the district, substrata in which the water is expected to be found, inclination of the water-bearing stratas, etc.

While the author was conducting the investigations into the question of augmenting the water supply, he visited over two hundred farmers, and from them obtained information as to the nature of the stratas through which they sank wells and in which they found water; he also inspected over 800 square miles of country, and by this and other means in many places was able to locate the existence of water-bearing stratas, the direction in which they dipped, and the area of the watersheds. The author recommended sinking wells in Boggy Creek, where works had already been started, as it was the lowest point in that part of the catchment which could be utilized, and also the laying of collecting pipe lines in various directions.

Wells.—Authority was obtained to carry out the recommendations, and in April, 1912, the first well was sunk 108 feet, when a large volue of water overflowed at a height of twelve feet above ground. This well has continued to overflow at the rate of about 150,000 gallons per day. Up to the present time eighteen wells have been sunk, of which ten are overflowing, five are choked and three were unsatisfactory. The choked ones can be cleaned when necessary. Some of these wells are five inches in diameter and the rest are seven inches. They vary in depth from 65 feet to 192 feet. The underground pressure and the velocity of flow in some instances were too great to maintain a constant supply, as the large volume of water gushing out of the wells induced too great a current in the water-bearing strata, and this caused sand and other materials to be conveyed with the stream and choke the wells referred to. To overcome this difficulty it was decided to sink other wells in their immediate vicinity so as to relieve the pressure, and this has been partly successful. In some cases quicksand and soft clay cause trouble.

The stratas through which the wells were sunk were as follows:—

No. 2.	Feet.	No. 5.	Feet.	No. 17.	Feet.
Clay	6	Clay	38	Mud and clay.	40
Coarse sand...	20	Clay and gravel	5	Sand and gravel	2
Fine sand and clay	8	Gravel	30	Clay and sand	13
Fine sand ...	13	Yellow sand and quicksand	17	Fine sand ...	17
Gravel and sand	3	Clay and hardpan	10	Quicksand and clay	60
Sand	21			Hard clay	25
Hardpan	4			Clay and sand	18
Depth ...	75	Depth ...	100	Depth ...	175

The author, in October last, was consulted by the Carlyle town council in connection with the augmentation of the district supply of water. After making an inspection of the district around, the council was advised to sink a well on a certain patch of land. This well was sunk in April, 1913, and at a depth of 192 feet water was found under conditions which were predicted in the report.

Quality of Water.—Well water in the prairie districts is charged with lime salts, caused by contact with different kinds of limestone. This is common to almost all well waters in the West. As already stated, when the ice sheets were passing over the country a large quantity of rock was transported. The harder rocks survived the process of crushing better than the soft rocks; hence it is that in some districts hard rock boulders are to be found on the surface. It is estimated by the geologists that about 90 per cent. of the surface boulders are of hard rock and 10 per cent. soft rock, but in the substrata the proportions are reversed, and we find 90 per cent. of gravel is limestones of various kinds.

Water readily absorbs salts and gases, and, consequently, in its passage through the soil and different stratas, mineral salts are being absorbed. In addition to salts, water absorbs gases, and, as carbonic acid gas is present in the air and in the ground, it is taken up by the water, and this increases its solvent powers. When the water finds an outlet to the atmosphere, such as in the form of springs, some of the carbonic acid gas is lost and it becomes less heavily charged with lime and, consequently, a limited natural softening process takes place.

The water as supplied to Regina, for instance, contains carbonate and sulphate of lime and carbonate and sulphate of magnesia and other chemical constituents. These salts cause the water to be "hard," and the problem is how best to soften it. Hard water used in boilers causes sludge and scale to be formed, and these in time not only reduce the efficiency of the boiler, but also tend to cause overheating of the plates and other troubles.

The hardness of water is usually divided into two classes, namely, temporary hardness and permanent hardness. As already explained, water absorbs lime salts more readily when it contains carbonic acid gas. By heating the water, this gas is driven out and the carbonate of lime held in solution by means of such gas becomes insoluble, and its greater part, together with magnesium carbonate, is precipitated and forms sludge. Temporary hardness is that part of the total hardness which is precipitated by boiling. Boiling will not have the same action on the sulphate, chloride or nitrate of lime or magnesia, as these salts remain soluble. Permanent hardness represents these salts as well as the parts of the carbonates of lime and magnesia not precipitated by boiling. Temporary and permanent hardness, however, are relative terms, to denote the characteristics of hard waters.

Apart from the use of hard water for industrial purposes, it is of importance to consider it from the domestic viewpoint. One part of carbonate of lime decomposes 6.12 parts of stearate of sodium, and, as soap usually contains only 60 to 70 per cent. of stearate of sodium, about 9.5 (say, 10) parts of soap are required. Consequently, if 100,000 gallons of water per day are consumed in washing, cleaning and other purposes, in which operations soap is necessary, it is a simple calculation to ascertain the consumption of soap necessary to produce lather.

Each part (or one pound) of carbonate of lime per 100,000 parts (or pounds), which is equivalent to 10,000 gallons of water, requires about ten pounds of soap to obtain lather. This is equal to 100 pounds per 100,000 gallons. Water obtained from wells in the prairies contains, say, 20 parts of carbonate of lime per 100,000, so that the total theoretical consumption of soap will be 2,000 pounds per 100,000 gallons.

Soap is retailed at about ten cents per pound; therefore, one ton of soap will cost about $200, or about $2 per 1,000 gallons.

We will now consider softening of the water by means of lime. Carbonate of lime, $CaCo_3$, is nearly insoluble, but when carbonic acid gas is present, soluble bicarbonate of lime is formed. Dr. Clark's process, which has been in operation all the world over, in one form or other, for about half a century, consists of adding quicklime or slaked lime to the water, with the result that the active lime at once combines not only with the excess dissolved carbonic acid in the water and forms the practically insoluble carbonate of lime, but also robs the bicarbonate of lime of its semi-combined carbonic acid, so as to effect practically a total precipitation of all the lime present as carbonate. The active lime thus effects exactly the same result as would be produced by boiling.

In softening water by adding lime, theoretically, 0.56 parts of quicklime is required to remove each one part of carbonate of lime in 100,000 parts of water. In practice, however, more quicklime is required. Adopting the same basis for calculation, as is the case of the soap consumption, each part (or one pound) of carbonate of lime per 100,000 parts (or pounds), which is the same as 10,000 gallons of water, requires 0.56 parts or pounds of quicklime to remove the carbonate of lime. This is equal to 5.6 pounds per 100,000 gallons. The water contains, say, 20 parts of carbonate of lime per 100,000, so 112 pounds of quicklime are necessary. With lime at one cent. per pound, the cost of softening such water is $1.12 per 100,000 gallons, or 12 cents per 1,000 gallons. The actual cost will probably be nearly twice as much. It will thus be observed that softening by lime is, theoretically, about eighteen times cheaper than by soap.

Prairie water, however, as already stated, contains other salts than carbonate of lime, and we will see what it means to adopt a softening process to reduce them to an economical minimum. That will mean the adding of quicklime as well as soda ash.

Assuming that prairie well water contains:—

20 parts per 100,000 of calcium carbonate.
3 parts per 100,000 of magnesium carbonate.
15 parts per 100,000 of magnesium sulphate.

The quantity of quicklime to remove the calcium carbonate with the theoretical amount already mentioned, 112 pounds per 100,000 gallons.

The theoretical quantity of soda ash necessary to remove most of the magnesium carbonate will be 37.6 pounds, and to remove the magnesium sulphate 130 pounds per 100,000 gallons.

The cost will, theoretically, be:—

112 pounds of lime at one cent per pound....	$1.12
167.6 pounds of soda ash at three cents......	5.03
Total	$6.15

The cost of lime and soda is, therefore, equal to about six cents per 1,000 gallons, but in actual practice it will be more. To this must be added the cost of labor, supervision, capital charges, etc. As the cost is high, it is desirable to ascertain to what extent the hardness can be reduced, having regard to our local conditions with respect to cost of labor and materials. But this the author will not follow further at present.

Before any softening scheme can be undertaken with any degree of confidence and satisfaction, it is essential to obtain results of mineral analysis of the water to be treated, which is different to sanitary analysis. It must be clearly understood that the foregoing figures are only approximations submitted to illustrate the nature of the problems confronting the engineers in the West.

Before leaving the question of water softening it will doubtless be interesting to refer to another process, which is now before the public, and that is the Permutit process. Permutit is the trade name of an artificial zeolyte produced by a process invented by Dr. Gans, of Berlin, Germany. This material is granular in form, much line coarse, grey sand. It is usually placed between layers of fine gravel in a filter bed or tank. As the water passes through the permutit and exchange takes place. The sodium in the permutit exchanges with the calcium and magnesium in the water, and by this means the hardness of the water is reduced to zero. When the permutit has lost its power of exchange, or, in other words, it is exhausted, it can be revived by saturating it with a solution of common salt. In this case the sodium in the salt is exchanged for the calcium absorbed by the permutit, and, when the exchange is complete, the filter is washed and is ready for softening a further quantity of hard water.

There are a large number of water softening plants on the market, all worked on the same principle, but differ somewhat in details in the method of proportioning the lime and soda, and in the general arrangements, but it will be impossible in the space of this short paper to discuss them. The selection of plant suitable for Western waters so as to obtain uniform results at as low a cost as possible requires full consideration.

Sterilization.—As all waters in the West are more or less liable to pollution, it is necessary to adopt some means of sterilization. In this case there are several ways of sterilizing water, such as by ultra-violet rays, by chlorination, and by ozonation. The most popular method at present of sterilizing water is by adding a very small proportion of hypochlorite of lime, often as little as half a pound per 100,000 gallons, or one-half part per million. The quantity of sterilizer required depends, of course, on the quality of the water to be treated. This is a subject which would alone suffice to occupy an evening, and, consequently, can now only be touched upon as indicating one of the problems to be dealt with.

Filtration.—Towns situated near rivers or streams would seem to be much more fortunate as regards water supply than those remote from such streams; but it often occurs that the river water is polluted and muddy, or both, and problem is to effectually eliminate the mud or pollution. This is done by means of coagulation, settling basins, filters, etc.

In the West, climate, especially in winter, is rigorous; the temperature at times falls as low as minus 50 degrees Fahrenheit. Open settling basins and filters are, consequently, out of the question. They must be covered, and this increases the cost considerably, and some means has to be found by which the cost may be kept at a reasonable minimum. Temperature stresses are often greater than the stresses due to weight of water or earth, and, as solid masonry possesses elasticity only to a small degree, reinforced concrete would appear to be more suitable for works which are subject to expansion and contraction, due to a great range of temperature. The steel embedded in the concrete tends to distribute the stresses and prevents concentrated contraction or expansion. The author has observed on an excellently built dam, exposed to a less range of temperature than is experienced in the West, fractures in two or three places from top to bottom, splitting huge masonry blocks. In reinforced concrete structures, correctly designed and carefully built, such fractures are not so localized, owing to the greater distribution of stresses by the steel reinforcements.

Settling basins and filters can, of course, be built in reinforced concrete. It is a question worthy of careful consideration whether rapid mechanical filtration is more suitable and economical for muddy and impure waters drawn from rivers.

Water containing comminuted clay mud is difficult to treat without adding some coagulant. In New Orleans, clay was held in suspension in Mississippi water after many weeks' storage in settling tanks.

At Lorenzo Marques (Delagoa Bay) water very heavily charged with clay is satisfactorily clarified and purified by means of coagulation and filtration.

Prefilters are adopted in many places, especially on the European continent, to remove heavier sediment, and so relieve the ordinary filters of much work, and also secure greater purification.

There are some parts of the West where it is stated to be practically impossible to obtain water. Efforts have been made in some instances to discover water by means of electrical and other devices, and it would be interesting and instructive to know the results.

Having regard to the difficulty of finding an adequate water supply in portions of this province, and its consequent retardent effect on the development of the same, the Dominion Government has had plans prepared for drawing water from the South Saskatchewan River for distribution in the districts in question. In this scheme it is proposed to construct a dam across the river to generate electrical power for pumping the water through the conduits over the high banks The provincial government also, it is understood, is making investigations into this matter. This action on the part of the government only emphasizes the points already referred to in this paper with regard to the problems in connection with water supply in the West.

Distribution.—The last problem to be discussed in this paper is that of the distribution of water in the towns and cities. It is noticed, according to the press, that almost every city in Canada has a problem to solve in respect to the system of distribution mains. This question constitutes an important feature of city planning, for without city planning it is almost impossible to satisfactorily provide for the future. It may seem strange to include the supply of water in city planning, but it must be remembered that it concerns everything which will contribute to the material progress and prosperity of a city.

In the West, perhaps more than elsewhere, the growth of the population is so great that it is difficult to extend works of public utility collaterally with the expansion of the city. A village often grows into a town and then into a city in a remarkably short time, and it taxes its financial resources to provide water, sewers, streets, lights, etc., to all parts of a district as it is being built upon. But it is not a difficult matter to plan out a town or city ahead of its expansion and design the system of distribution mains and other works, so as to be sufficient for a city many times its present size, without incurring undue financial burdens on the present ratepayers. It will doubtless be recognized that it is much more costly to alter and enlarge works than it is to provide ample dimensions at first, especially in a country where towns increase so rapidly.

The actual facts are, that the authorities generally provide only for the present. Mains are, therefore, laid from time to time, and these are extended in various directions without first carefully considering what will be the ultimate result.

This possible development was foreseen by your president when city commissioner, and his successor, City Commissioner L. A. Thornton, with the author, submitted a joint report to the Regina City Council recommending a scheme of distribution mains, such as will suffice for a much larger city.

It was pointed out in the report that when any water mains are being laid in any part of the city they should conform as closely as possible to the sizes and directions shown on the plan attached to the report, so that whatever is done will ultimately constitute a part of the complete scheme.

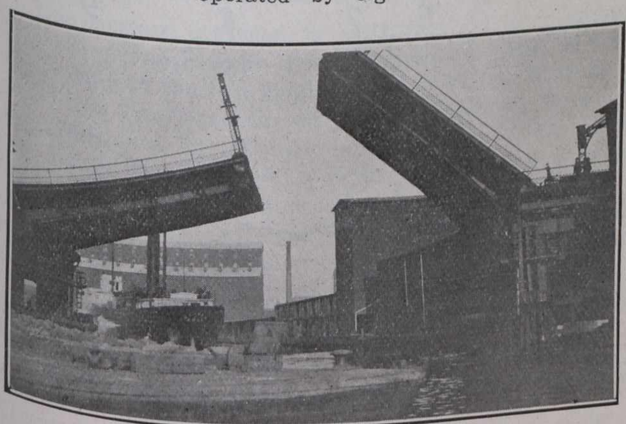
Although engineers have no greater insight into the future than other persons, they can at any rate calculate the probable population in different sections of the city and design works of adequate capacity, so that when any portion is being carried out from time to time, it will form a part of a satisfactory scheme of distribution.

In conclusion, there are doubtles many other problems which could with profit be dealt with in this paper, but time and opportunity have not been sufficient, yet it is to be hoped that what is presented will furnish ample topics for criticism and discussion.

SPEED OF DRAWBRIDGE OPERATION AND ITS VALUE.

By Henry Grattan Tyrrell, C.E.

The required speed of operation depends upon the location and natural conditions. Where the river banks are high, so that nearly all river travel can pass under the bridge, the speed of operation for the few openings required for tall-masted ships is not so essential as when the deck is near water, making it necessary to open the bridge for all kinds of craft, big and little. In remote places for only occasional service, a slow movement, perhaps by hand-power, may be permissible, as in the Nyasaland vertical lift bridge in South Africa, which is operated by eight men in twenty-five



Sixth Street Bascule in Milwaukee; One of the Most Recent Designs.

minutes, or the Hooghly pontoon draw at Calcutta which requires fifteen to twenty minutes to open it and as long to close it again. On the other hand, in busy cities and especially at low-level crossings, it is important to economize every second of time, and to install the most rapid operating machinery.

Swing bridges usually take from four to six minutes for a complete cycle, and this is facilitated by having the bridge so designed that the ends are reversible, and the bridge can then follow a boat around and continue moving in one direction. More time is needed if the bridge must open in one direction and after coming to a stop and waiting for the boat to pass, start up motion again in the reverse direction for closing. By continuous moving in one direction the swing bridges on the Tyne at Newcastle (1877) made a complete circuit in 2½ to 3 minutes. Bascules have the quickest movement, for the amount of lift can be suited to the size of boat, while a swing must perform a complete revolution for a craft of any kind, either large or small. The modern bascules in Rotterdam can be opened in 15 to 20 seconds in calm weather, and the experience with these structures in Holland cannot be surpassed, since that country is so extensively provided with canals and waterways. The speed is affected to some extent by the presence of snow and water on the floor, for these influence the balance and necessitate a little more power and time, and this provision becomes more serious in the colder districts, such as in lower Quebec, or in Western Canada, where the winter is more severe.

The importance of rapid operation in cities, such as at Vancouver in British Columbia, can best be appreciated by an example. A bridge which has 100 openings per day, of five minutes each, will delay street travel for a total period of eight hours, or one-third of the time, five to six hours of which will be during the day, or nearly half the working hours.

The economic speed of operation, and the investment which is permissible to secure it, or to reduce delays for any particular case, can readily be determined. Observation must be made of the nature and amount of travel on both street and river, and the number of water craft that would require a bridge opening. The value of public time which can be saved by the introduction of more adequate machinery will represent the interest on the investment which is permissible. The matter is easily understood by an example. The saving to the public by placing the bridge high enough to avoid too frequent openings is illustrated by one of the openings bridges at New York. The old low bridge, only eight feet above the water, had been opened on an average of forty times per day, while the new one, with an under clearance of 24 feet, needed opening only twelve times per day, though the new and heavier bridge had a slightly slower movement than its predecessor.

The saving of public time by the higher bridge was $4,000 per year, which is equivalent to 4 per cent. on $100,000. It was therefore economical to spend $100,000 additional on the new bridge to secure the greater under clearance and fewer openings.

These conditions apply wherever opening bridges are used, such as along the Canadian system of canals from lakes to the Atlantic, and on the proposed new canals from Georgian Bay eastward.

From forthcoming treatise entitled "Movable Bridges." By H. G. Tyrrell; 800 pages. Ready for press.

CAPITAL CHANGES.

The following companies have increased their capital stock: Dunlop Tire and Rubber Goods Company, Limited, from $993,000 to $1.300,000, by the issue of 3,070 shares of new preference stock of $100 each; the Walkerville Light and Power Company, Limited, from $25,000 to $100,000, by the issue of 750 shares of new stock of $100 each; the Hercules Garment Company, Limited, from $20,000 to $50,000, the increase consisting of 300 shares of $100 each; the Security Lumber Company, Limited, from $500,000 to $750,000, the increase consisting of 2,500 shares of $100 each; the Maritime Nail Company, Limited, from $250,000 to $3,250,000, the increase consisting of 30,000 shares of $100; the Carritte-Paterson Manufacturing Company, Limited, from $50,000 to $300,000, the increase to be divided into 2,500 shares of $100 each.

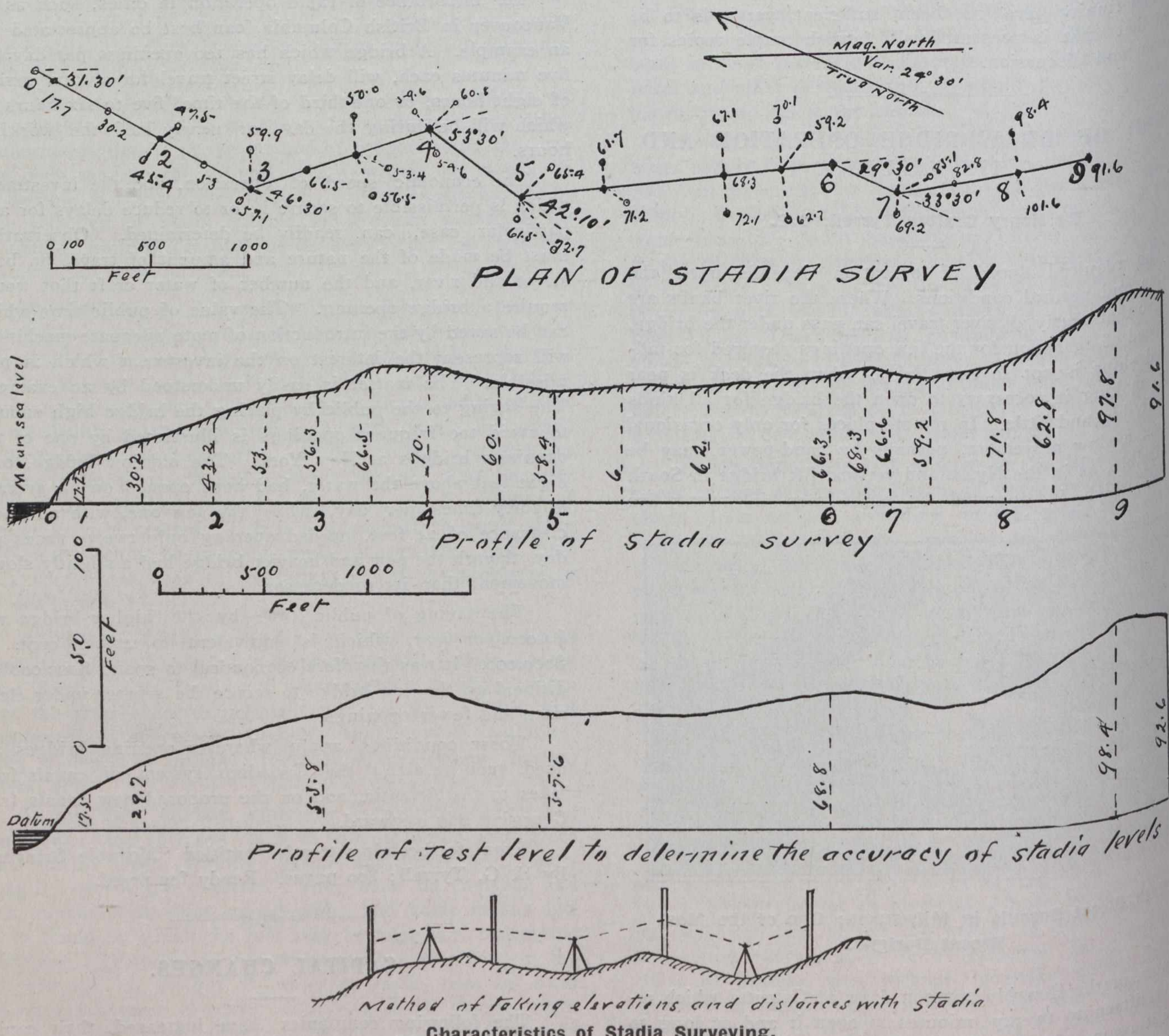
PRELIMINARY RAILWAY SURVEYING BY MEANS OF THE STADIA.

By J. A. Macdonald.*

In the present case the survey was started from mean sea level, that is, a point in the Gulf of St. Lawrence; not that the railway was intended to run to the sea (which it yet may) but in order to obtain a reliable and definite datum. At this point of starting there was quite a bank to the water's edge at mean tide. The transit was set up on the bank above and very carefully levelled. The rod was held at approximately the water's edge when it was judged by calculation, as well as observation, to be mean tide. The vertical angle to the rod was, as shown in the field book, —14°55 and the distance read on the rod .71. These data corrected gave an elevation of 17.7 feet and a distance of 65 The bearing by the compass was N. 31.30 E. This bearing was used. By an observation it was found that the difference between the magnetic bearing and the astronomical bearing was 24°30', that is, the needle varied 24°–30' west. Both are shown on the plan.

The next sight forward was S. 31.30 W. and an azimuth of 211°30, the distance by rod reading was 3.20, the angle elevation +2°15', which equalled a distance of 319 and a difference of level, or elevation, of 12.5 on a point on the tangent. From stat. 2 to stat. 3 the same bearing, S. 31.30 W., was produced, and points taken on either sides of the line to determine the topography. A point on the tangent 211°30 gave elevation 53. (above sea level). Left, 142°00'; distance, 1.13 (reduced to 109); vertical angle, +2°15'; difference of level 4.3 and elevation 47.5. Right, 312°30'; distance, 1.10 (reduced to 109); vertical angle +1°10'; difference of level, +2.2; elevation, 45.4. A hub, of course, was set at stat. 2. At stat. 3, a lock sight being taken, points were taken on either side before deflecting the angle. A point left 97°00' gave distance 1.82 and difference of level 3.6; right, 291°00', 83 for distance and 8' vertical. Another point, right, 328°00', gave rod reading 1.10 (reduced to 109); vertical angle 1°00'; difference of level, 1.8. A deflection angle of 46°30 was made and the same procedure gone on with. A form of the field book with notes for the beginning of the survey is appended.

In this way the topography of the country was obtained to great exactness. Only about half the number of men were required on the line than if a regular transit, level and topographic parties were maintained, and equal results were produced, though not so rapidly.



Characteristics of Stadia Surveying.

* Department of the Interior, Ottawa.

To test the accuracy of the stadia levels, a run of regular levels were made on the first portion of the line, a profile of which is given. It was found that the variations between the stadia calculations and the level were very little when the stadia observations were calculated by the regular methods.

This surveying with stadia means much work in camp in reducing and calculating the sights, but in a country where there is not much bush it is a rapid and satisfactory method. The regular party can be divided into two stadia parties for running the preliminary line. For exploration lines in new country it is an excellent method. The map-plans and profiles well illustrates the methods employed.

Station	Def. Angle	Bearing of Tangent	Points taken	Azimuths	Distance (Stadia reading)	Distance corrected	Vertical Angles	Compt. Diff. of Elevations	Elevations	Remarks
1	31°30	N.E. 31.30		31°30	.71	65	— 14.55	— 17.7	17.7	Mean Sea Level
2		S.W. 31.30	Tan	211°30	3.20	319	+ 2.15	+ 125	30.2	
			Tan	31°30	3.06	305	+ 2.30	+ 13.	43.2	
			Tan	211°30	2.70	269	2.05	+ 9.8	53.0	
			Left	142.	1.13	109	+ 2.15	+ 4.3	47.5	
3			Right	312.30	1.10	109	+ 1.10	+ 2.2	45.4	
			Tan	31.30	2.30	229	— .50	— 3.3	56.8	
			Left	97.	1.82	181	+ 1.10	3.6	59.9	
			Right	291.	.83	82	+ 30	.8	57.1	
			Right	328.	1.10	109	+ 1.00	+ 1.18	58.1	
4	46°30′	S.E. 15.	Tan	165.	2.70	368	+ 2.05	+ 9.7	66.2	
			Tan	345.	3.03	302	— .45	— 4.	70.	

One locating engineer, in particular, on the National Transcontinental Railway, several years ago, when the writer was working on the line, employed the stadia for most of his preliminary lines, and for all of his exploration lines. He divided his party into two units, one in charge of the transitman and the other in charge of the leveller. As a stadia party only requires about one-half the number of men to carry on the work satisfactorily that a transit party needs, he was in this way enabled to cover twice the area of ground than if he employed the transit alone.

At that time, in the wilds of Northwestern Ontario nothing comparatively was known of the country north of the Canadian Pacific Railway. There was no map of that wide range of country from Winnipeg east to Lake Nipigon. The country around Lake Nipigon was partly mapped. East of Lake Nipigon to Lake Abitibi was little known nor further east. The railway explorers sent in by the Grand Trunk Pacific in 1904-05-06, entered a dense wilderness, and were under great disadvantages. On entering this wilderness these hardy engineers were like a ship in mid-ocean without beacon, buoys or landmarks, and like the sailors on board ship, were forced to take astronomical observations for latitude, longitude and azimuth to find their bearings and make a start mapping the country by means of exploratory surveys. It was on these surveys that the value of the stadia was first prominently brought into play in Canadian railway surveying. The country west of Lake Nipigon was covered by lakes large and small. One could scarcely go a mile without striking a small lake. The larger lakes had to be traversed in order to map it. Here the stadia was used entirely. Very rapid work in the traversing of lakes was accomplished with the stadia. In this way was the country mapped and made possible for the final location.

WATER WASTE INVESTIGATION.

Water waste in our Canadian cities is a familiar subject, but we have not heard so much about waste in the smaller towns. W. D. Gerber, consulting engineer, of Chicago, presented a paper on this subject before the Illinois Water Supply Association, an abstract of which we publish herewith.

The curtailment of water waste is particularly desirable in places which secure their water supplies from deep or artesian wells. The continual draft on the wells has lowered the ground water level to such an extent that serious problems are presented in getting the water to the surface. With a less severe demand on such wells we may reasonably expect their life to be materially lengthened.

Those towns which draw their supply from rivers or other surface waters must, of course, treat such water to render it suitable for domestic purposes. These treatment plants, besides the treatment tanks and filters, usually have connected therewith large clear water reservoirs for the storage of a considerable quantity of the treated water. The capacity of the treatment plant, including the reservoir, is usually designed upon the consumption, and the consumption is usually taken as a factor of the total daily displacement of the pump plungers. If a large percentage of the pumpage is waste, we can readily see that the works will be designed too large for the immediate needs of the community, and with a consequent expenditure of funds that in many cities can be ill afforded.

In the design, then, of new equipment, and, subsequently, if the station is to be operated on an efficient and economical basis, and the supply conserved, all unnecessary pumping should be eliminated.

The causes of this unnecessary pumping or water waste can usually be grouped under five heads: Pump slip, underground leakage, defective plumbing, carelessness, or wilful waste and surreptitious connections.

With pumps of the direct acting or non-flywheel type, there is frequent complaint that the pumps pound, and several arrangements have been supplied to produce more of a cushion at the end of the stroke. This cushioning has the effect of shortening the stroke and, of course, thus reducing the volume of pumpage. The pump counter, however, goes on counting the number of revolutions, and the daily report card shows so many revolutions at full capacity as the volume of water pumped.

Pump slip is not, properly speaking, a water waste, but is rather a waste of pumping effort, and should be kept as low as is practical. Just where this practical limit is we do not know exactly, but undoubtedly the same limit would not apply to all cities or to all types of pumps. About all we can say is that the practical limit is the point where the value of the water gained through close-fitting plunger and valves would be less than the value of the additional power required to overcome the added friction due to the tight packing. However, an allowable slip of 3 to 5 per cent. does not seem to be out of line with good operation and practice.

The detection of underground leakage is a very different matter than that of discovering and measuring pump slip. The distribution mains are covered up and we can only guess at what has taken place by a detail study of the pumping chart. The demand or consumption for a few hours after midnight, say, from 12 to 4 o'clock, is frequently indicative of the tightness of the system. At this time of the day the consumption is, or should be, at its minimum, while if the relative demand is high it is an indication that something is wrong.

There is always some leakage from the mains that cannot be checked, and it is usual to allow a loss of 2,000 gals.

per minute of 12-inch pipe, while for sizes other than 12 inches, the allowable loss is taken in the same proportion as the ratio of the diameters. One drop a second is not much of a leakage, and yet one drop a second from every joint in a mile of pipe would amount to approximately 1,400 gals. in 24 hours.

When the volume of consumption is abnormally high, there is reason to suspect that there are unaccounted for losses, and the best way to satisfy oneself on the matter is to have a water waste survey made.

As an instance of what such a survey may accomplish, I wish to cite the results obtained in a city of some 3,500 people, in which the waterworks is owned by a private corporation. For some years the pumpage had been excessively large. Repeated appears to the consumers to be more careful brought no apparent relief, and finally an additional source of supply was developed entailing an expenditure of $10,000. This increased the available amount of water, but the volume of the pumpage in no way diminished, but rather increased. During April and the early part of May of last year the average daily pumpage varied from 680,000 to 700,000 gals. per 24 hours. A water waste survey located a blown-out lead joint in an 8-inch main wasting more than 300,000 gals. per day. This leak occurred under a broken stone-filled roadway, and behind a stone arch bridge at a point where the pipe was 14 feet below the street surface. The water was finding a ready outlet into the creek. Had this waste been discovered and stopped prior to the development of the new supply, the company would have been $10,000 better off in cash, and would have felt much easier in regard to the adequacy of their supply.

Another instance is a city of 2,000 population. The city operates a motor-driven 400,000-gal. triplex pump. From October, 1911, to June, 1912, it was necessary to operate the pump practically all the time to keep up the pressure, and even at that it seemed impossible to fill a 100-ft. standpipe more than half full. A water waste survey was made and a 4-inch pipe was found cracked squarely in two, permitting a leakage of 200,000 gals. per day, which found a ready outlet in an abandoned 12-inch tile storm water sewer, which crossed directly over the crack about 8 inches above the water main. There was no indication at the street surface of any such leak, though the pipe was laid but 4 feet deep, in fact the ground was not wet 2 feet away from the break. Incidentally I might add that the pump slippage was 25 per cent., leaving a consumption of about 100,000 gals. or 50 gals. per capita per day.

The method of making these surveys was substantially the same in both cases. At a point near the standpipe, an opening was made in the ground down to the main, and a 1-inch corporation tap was placed in the pipe in the usual way. A pitometer, which is a portable recording meter, was set up at this point, and a measurement of the flow during the night when the station was shut down was made. The city was then divided off into a number of districts, and during the day all the valves on the boundary line of the districts were closed, except one, which was left open to supply water to the district. That night after one o'clock this last valve in each district was closed, and the time when the valve went down was recorded. The rule was to begin at the outlying district and work toward the instrument. As each district was closed off from the supply the valves between it and the foregoing district were opened, so that when the night work was finished all the valves would be left open.

A comparison of the time each district was closed down, with the chart from the instrument, disclosed the district in which the loss occurred, for the minute the valve went down, which cut off the leak, the instrument recorded a drop in the rate of flow from the standpipe.

With the location of the loss in any particular district, it is generally a comparatively simple matter to locate the point of leakage by using an Aquaphone on the fire hydrants and sill cocks of the residences. Sometimes, however, the final location of the leakage is not so simple, and it is necessary to make a subdivision of the district, in this way usually the suspected territory may be reduced to a few blocks at the most.

The subdivision of a district into its smallest units is usually the method required when the losses are from defective plumbing, and in addition it is necessary to make a house to house inspection of the entire plumbing in each building. Carelessness in making proper plumbing repairs seems to be more prevalent in cities where the water is sold at a flat rate, the installation of meters having a wholesome effect on this class of consumers.

Carelessness as to fixture waste and wilful or deliberate waste are like defective plumbing, confined largely to the systems supplying water at flat rates. The sentiment seems to exist that so long as one is paying so much, what is the use of being careful, "We are entitled to all we can get out of the fixtures." This sentiment really reacts against the consumers. for with everyone in the same frame of mind the system becomes virtually a sieve, and of course the pressure is always low, especially in territory some distance from the pumping station. It all comes home to him in case of fire and no pressure.

Where such conditions exist it is sometimes a tedious task to locate and correct such losses, and the only way it can be done successfully is by a minute subdivision of the district, and night tests in the curb cock, together with daylight inspection of the individual premises. The returns in the value of the water saved usually far exceed the cost of doing the work.

Surreptitious or uncharted connections may occur almost anywhere, though they seem to be more frequent in the manufacturing districts of the larger cities. The making of a connection to a city water main by a private person or corporation is, of course, a deliberate intent to get something for nothing. Very frequently such connections are made from the fire service lines, which are extended into the grounds of the individual or company.

Where a survey indicates that there are surreptitious connections, the only way of definitely locating them is to segregate the suspected plant and measure the total amount of water going into the same. This, together with a very careful inspection of the fire lines and legitimate services, will usually produce a solution of the problem. It is needless to mention, however, that such work must be quietly and carefully done that correct results may be obtained.

It is a very unpleasant charge to make, but nevertheless it is true that in many of our cities and villages no record is kept of the location of the house service, and when the top of the curb box gets broken off or covered up, the service is "lost," and in case of repair or an order to shut off the service much time is lost in looking for the old box. In such cases the exact location of the service pipe can be quickly located by the use of a small electrical instrument called "A wireless pipe finder," and with the line of the service located in the ground, the shut-off box can be quite easily located by the use of a miner's compass, or as it is frequently called, a dip needle.

The latter instrument also comes in quite handy in locating street valves on the mains in unpaved streets where the boxes have been covered up by a road grader in crowning or shaping the surface of the street.

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CONTENTS OF THIS ISSUE.

EXPERT EVIDENCE.

A strong opposition to the present method of securing expert evidence in cases at law, and a growing feeling that expert witnesses should be designated by the Courts, led the American Institute of Consulting Engineers to hold a discussion on this most important subject a short time ago.

The discussion brought out many interesting facts and viewpoints which have a direct bearing on existing conditions in this country. The present custom here, as in the United States, is for each side in a controversy to employ its own expert witnesses, just as it employs other witnesses, and the experts are examined and cross-examined in the same manner as ordinary witnesses. After summing up the opinions offered and in closing the discussion the chairman referred to a class of questions that require expert testimony, which can only be furnished by professional engineers, such as the valuation of public utilities, conflicting claims of water power companies, and the like. In such cases he felt time would be saved and the cases would be better presented if studied from ex parte points of view before the action at law is begun. The appointment of engineer associates by the court would probably be helpful in clearing up conflicting and confusing testimony.

Throughout the discussion a number of the speakers spoke of the importance of effecting a reform in expert practice by insistence on a higher standard of professional etiquette. It is doubtful if this would be a sufficient remedy. Better conditions can only be brought about by joint action of the engineering and legal professions.

STREAM AND RIVER IMPROVEMENT.

The necessity for the proper conservation of the water resources of the Dominion, and their utilization for the maximum benefit of the public has often been emphasized in these columns. We are prone, however, to neglect the placing of the necessary safeguards until it is too late, or until force of circumstances compels action.

Coal consumption is advancing at a rapid pace, so rapid, in fact, that complete depletion of the present available supply is only a matter of a very few years. We have not the figures to hand for Canada, but in the United States, in 1890, 2.54 tons of coal per capita were used, or a total of about 158,000,000 tons; in 1912, 5.73 tons per capita were used, or a total of 550,000,000 tons. It is certain that the increasing per capita consumption and the increasing population will deplete the supply at a much higher rate. The logical outcome will be that in a very short time, probably less than twenty-five years, the United States will prohibit the export of coal.

As Ontario has no coal resources of her own necessity will force the development of many of our water powers, which are today either too far from the market for commercial development, or too costly for economic use.

Water power development on a large scale is a product of recent years, and attention has often been called to this fact as the reason for its subservience to older institutions. We have grown firmly fixed in the habit of considering our streams as intended primarily for navigation, and are, therefore, prone to overlook the fact that in some cases a stream may have a higher utility as a source of municipal water supply or for irrigation or for power.

The ever-increasing demand for electric power must be met by the increased development of hydro-electric projects of greater capital cost. Water storage will be a necessary adjunct to many of these developments, and the public will then properly appreciate the value and importance of gauging records.

In a recent issue of Conservation, in referring to the dangers of over-estimation of available power, the following pertinent remarks are made: that engineers consider the problem simpler and easier than it really is; that they have not the necessary data, and that, lacking these, they have failed to acquire properly experienced judgment in such matters. This only emphasizes the need of governmental aid in providing adequate funds for the securing of continuous records of stream flow.

It is important to remember that streams can be put to many uses. The interests of navigation should only be given their proper weight in the matter of river improvement. Water-power development, municipal water supply, irrigation supply, the reclamation and protection of flooded lands, and the other incidental uses of water must receive due attention if the maximum utility to the public is to be secured.

EDITORIAL COMMENT.

In a recent paper before the American Institution of Electrical Engineers Mr. Esheleman remarks that when winding coils for electric machinery he found he could only earn $1.10 on the night shift, while on the day shift he earned quite $2. Moreover, while only 5 per cent. of the coils wound in the day time failed to pass the insulation test, as many as 10-15 per cent. of those done at night were rejected. This is quoted as an example of the disastrous effect of imperfect artificial illumination on the speed and quality of work.

* * * *

Testifying recently before the Commons Committee on pollution of streams, Dr. C. A. Hodgetts, chief medical health officer of the Conservation Commission, declared in favor of a Federal department of health with wide powers. He said: "Health Acts in Canada are nice to look at, but are not enforced," he said. "Municipalities do what they please, and there is no central power to say "You must do this." There is nothing in the B.N.A. Act which relegates public health control to the province." Dr. Connell, of Kingston, said that cities such as Montreal, Ottawa, and Toronto polluted their own water supplies with sewage, and that every city should be compelled to treat its sewage. He considered the St. Lawrence was polluted for sixty to eighty miles below Montreal.

* * * *

The idea of electrifying the railways seems to have got a firm hold of the public mind in Sweden, and much progress towards carrying it into execution has been made already. The first great step is the electrification of the Kiiruna Railway from Kiiruna to the Norwegian frontier. This work has been advanced rapidly of late. A start has been made with the building of the transformer stations, and it is anticipated that the whole line will be opened for regular traffic in the course of this year. Satisfactory progress has also been made with the line between Stockholm and Saltsjöbaden, which is also to be completed this year. The State Railways besides have made extensive experiments with two Diesel electrical locomotives, which have given very satisfactory results, while five private lines have had the question of electrification examined by experts for the working out of estimates as to the cost, etc.

* * * *

A steamer intended for the Hydrographic Service of the Canadian Government was launched from the Neptune Works of Swan, Hunter & Wigham Richardson, Limited, on Thursday, the 8th inst. The vessel is 170 feet in length by 33½ feet beam, and will be built to attain the highest class in Lloyds' Register. She will be propelled by a set of triple expansion engines, supplied with steam by two boilers working under Howden's forced draught, both engines and boilers being constructed at the Neptune Works, and expected to drive the vessel at 12 knots per hour. The steamer will be schooner rigged. She is built of steel, and strengthened to enable her to run through ice, and will be completely outfitted for her intended service, having two motor launches, Lucas sounding machine, marine sentry, sounding winch, electric light, with projector, etc. Besides the usual accommodation for the deck and engine-room officers, there will be well-furnished rooms for the various officials engaged in survey work. The vessel is being constructed to the designs and under the superintendence of Mr. R. L. Newman, of Canada, whose representative in England is Mr. F. L. Warren, of London, and both Mr. Newman and Mr. Warren were present at the launch. As the steamer left the ways she was named the "Acadia," the naming ceremony being gracefully performed by Miss Hilda Thompson, daughter of Mr. R. Thompson, consulting engineer, of London.

THE WATERWORKS AND SEWAGE SYSTEMS OF CANADA.

Some few years ago *The Canadian Engineer* published a table showing the water consumption in various cities throughout Canada, together with other data covering the plants then in existence, which table attracted a good deal of attention at the time it was published.

TABLE I

NUMBER OF WATER-WORKS PLANTS IN EACH PROVINCE, CLASSIFIED ACCORDING TO SOURCE OF SUPPLY, MODE OF SUPPLY, POWER USED, ETC.

Province	No. of Plants Supplied From:			No. of Plants Using Filters	Mode of Supply		Kind of Power Used					Ownership		Rates on Which Charges Are Made		
	Springs or Wells	Lake	River		Gravity	Pumped	Water-Power	Steam	Electricity	Gas	Gasoline	Municipal	Private	Flat	Meter	Both F. and M.
Nova Scotia	13	12	4	1	19	10	1	9	—	—	—	25	4	18	—	10
New Brunswick	13	1	2	1	7	9	—	6	1	2	—	14	2	11	—	4
P.E. Island	3	—	—	—	1	2	—	2	—	—	—	2	1	—	—	2
Quebec	42	11	41	15	48	46	8	24	11	1	2	57	37	31	—	3
Ontario	69	28	47	19	18	126	21	66	24	7	6	125	19	75	6	55
Manitoba	4	—	4	2	—	8	—	6	—	1	1	8	—	3	3	—
Saskatchewan	12	—	3	3	4	11	—	4	2	—	4	15	—	7	5	2
Alberta	7	—	9	7	4	12	—	8	1	3	—	14	2	10	2	4
British Columbia	14	4	3	2	17	4	—	3	1	—	—	16	5	12	2	5
Canada	177	56	113	50	118	228	30	128	40	14	13	276	70	167	18	85

Table I.

In this connection engineers will, however, be pleased to learn that the Commission of Conservation undertook, some little time ago, to compile statistics covering this phase of engineering in Canada. As a result of their labors they have issued a book which contains a number of very interesting facts, and we are pleased, therefore, to be able to reprint the accompanying tables, taken from the report, which we are sure will be read with a good deal of interest by municipal engineers throughout the country.

The tables are self-explanatory. It is interesting to note the accompanying curve as showing the increase in the number of waterworks plants since 1850. From 1850 to 1875

TABLE II

NUMBER OF WATER-WORKS PLANTS IN CANADA AT THE BEGINNING OF EACH FIVE YEAR PERIOD, 1850-1911

Province	1850	1855	1860	1865	1870	1875	1880	1885	1890	1895	1900	1905	1911
Nova Scotia	1	1	1	1	2	3	3	5	11	20	24	29	29
New Brunswick	1	1	1	1	1	2	2	4	6	7	9	11	16
P.E. Island	—	—	—	—	—	—	—	—	1	1	1	2	3
Quebec	—	—	3	4	5	8	17	22	30	44	62	77	96
Ontario	2	3	5	5	5	10	20	28	59	85	100	119	144
Manitoba	—	—	—	—	—	—	—	—	—	2	3	6	8
Saskatchewan	—	—	—	—	—	—	—	—	—	—	—	2	15
Alberta	—	—	—	—	—	—	—	—	—	1	2	4	16
British Columbia	—	—	—	—	—	1	1	2	5	6	13	16	21
Canada	4	5	10	11	13	24	43	61	112	166	214	266	348

Table II.

SUMMARY TABLE

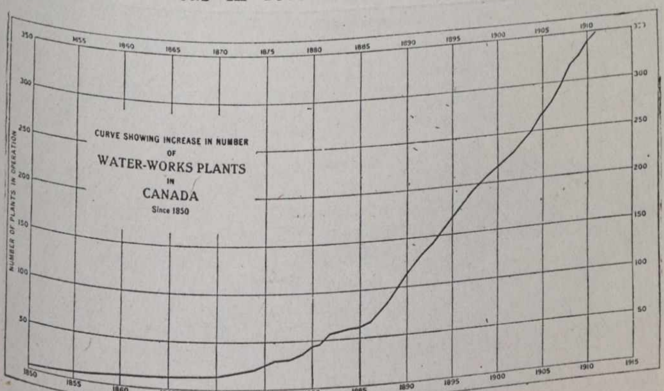
TOTAL COST OF PLANTS, CONSUMPTION, MAINTENANCE CHARGES, ETC., FOR THE DIFFERENT PROVINCES

(In this compilation, the items which it was impossible to obtain from the municipalities, have been estimated)

Province	Cost of Plants (dollars)	Total Daily Consumption (imp. gal.)	Annual Maintenance, exclusive of interest (dollars)	Total Length of Mains (miles)	Estimated cost per 1,000 gal.* (cents)	Estimated cost per Capita per year* (dollars)	Daily Consumption per Capita (imp. gal.)
Nova Scotia	4,534,682	24,436,662	176,602	393	7	3·76	147
Pr. Edward Is.	365,596	802,000	11,543	29	16·4	2·87	48
New Brunswick	3,563,939	15,278,500	101,616	186	8·2	4·82	161
Quebec	31,224,883	110,800,900	731,694	1,157	9·5	3·92	113
Ontario	37,813,147	153,203,363	1,601,077	2,182	9·6	4·21	120
Manitoba	4,852,868	9,794,213	251,141	297	20·6	3·46	46
Saskatchewan	2,461,810	4,480,000	131,202	156	23	3·86	46
Alberta	4,485,802	14,685,000	248,589	313	13	6·27	132
British Columbia	6,263,769	26,997,000	181,735	502	8·2	3·44	115
Canada	95,566,496	360,477,638	3,435,199	5,215	10	4·12	113

* These costs are approximate only, and have been calculated from the annual maintenance costs, plus an allowance of 10 per cent of the cost of plants for interest and for depreciation.

the development was not very rapid. From 1875 to 1890 the development was much more rapid, and it will be seen that since 1890 to 1910 the development has been fairly constant; whereas in 1880 there were about fifty plants,



in 1910 there were something like three hundred and sixty in operation.

Tables I. and II., together with the summarized table, reveal a number of interesting comparative facts. This interesting and valuable report was prepared by Leo G. Denis, C.E.

Plans for Victoria harbor improvements progress steadily. This year will see the large docks well under way. These are to be built by Sir John Jackson & Company, and something will be accomplished also in connection with the dredging of False Creek in Vancouver. To give better facilities for shipping, it is announced that the government will establish a drydock at Esquimalt, this being stated as part of the naval scheme on the Pacific. Mayor Baxter, of Vancouver, who was in Vancouver in connection with harbor and other matters, returned on the 1st instant, and reports that it is very probable that a drydock will be built at Vancouver along the lines of some of the schemes proposed heretofore.

WATERPROOFING CONCRETE.

To make cement and concrete impervious to water a number of waterproofing materials have been devised, such as "Medusa," sold by Stinson-Reeb Builders' Supply Company, of Montreal; "Pudlo," sold by W. H. Thornhill & Company, of Winnipeg; "J. M.," sold by the Canadian H. W. Johns-Manville Company, Limited; and the "Kahn Paste," sold by the Trussed Concrete Steel Company, of Canada, Limited, etc. The benefit derived from waterproofings of this nature, where resistance to water or dampness is desired, has been well established, and it may, therefore, be of interest to review briefly a few of the claims made by the various manufacturers.

Mr. Kennedy Stinson states that "Medusa" waterproofing does not affect the color, strength, setting or hardening qualities of concrete, and when used in the proper proportions it will make any concrete work impervious to water and prevents discoloration from rain. It prevents the white efflorescence which so often makes cement work unsightly, and also prevents the appearance of hair cracks on the surface. It has been shown by LeChatelier that the destruction of concrete by sea water is due to the diffusion of the sulphates of the water through the mass and the action of these salts on the constituents of the cement.

There is good reason to believe that "Medusa" waterproofing, by preventing this diffusion, will enable concrete to resist perfectly the injurious action of sea water. Mr. Stinson says that by the use of "Medusa," waterproofing qualities will be obtained which could otherwise be secured only by the use of very rich and expensive mixtures. "Medusa" is a dry, white powder consisting of fatty acids chemically combined with lime. It is thoroughly mixed dry with dry cement before the sand and water are added.

The name "Pudlo" is coined from "puddle," which, according to the dictionary, means "to make watertight by means of clay." "There is great loss of labor and loss of space when clay puddle is used for reservoirs, ponds, tanks, etc.," says Mr. Thornhill, "and Pudloed cement means quicker, easier and cheaper work, with all leakages avoided." "Pudlo" is a fine, white powder, which should be mixed with neat cement in varying proportions, according to the purpose for which it is required. It is said to prevent all leakages, making cellars and basements damp resistant, even when built alongside the water's edge. It prevents dampness rising in concrete floors and makes reinforced concrete absolutely dampproof.

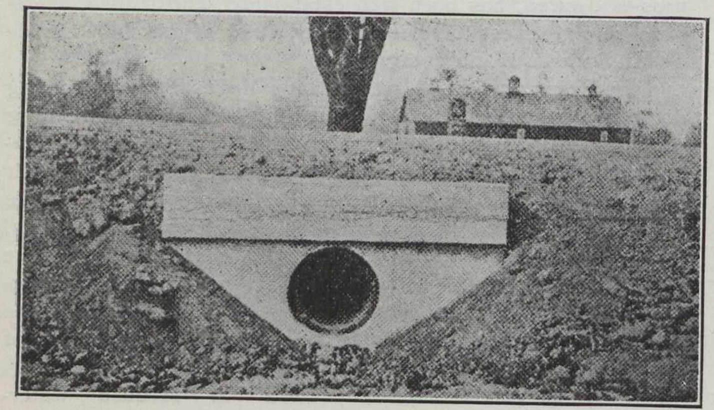
It allows flat roofing to be done in cement. It is said that "Pudlo" completely fills the voids in cement and cement mortar, and slightly increases the strength of same. The manufacture of "Pudlo" is based upon an earthy fat of such a nature that it enters into chemical amalgamation with cementitious substances. A chemical action is set up in the cement, owing to the silica in the cement being absorbed or dissolved by "Pudlo." The presence of hard silica in cement makes it porous. When the silica is dissolved the cement has no crevices left in it and percolation cannot occur. Mr. Thornhill especially calls attention to the advisability of "Pudlo" for sewers, which should certainly be air-proof and odor-proof. "Pudlo" will prevent hair cracks and efflorescence on cement work.

The Canadian H. W. Johns-Manville Company state that their "J. M." waterproofings are made of non-organic materials, and are practically everlasting. Their waterproofings have been used for basements, bridges, reservoirs, abutments, mastic floors, etc.

The "Kahn" waterproofings are in the form of a paste, which is dissolved in the water from which the concrete is made. Both paste and powder waterproofings are easily shipped and do not evaporate, so they have a certain amount of advantage in that regard over liquid waterproofings.

CONCRETE CULVERTS FOR COUNTRY ROADS.

In a recent bulletin issued by the North Carolina Geological and Economical Survey there is to be found much valuable information pertaining to the design and construction of concrete waterways for country roads. The bulletin is entitled "Culverts and Small Bridges for Country Roads in North Carolina," by C. R. Thomas, Highway Engineer, U.S. Office of Public Roads, and T. F. Hickerson, Highway Engineer of North Carolina.



Concrete End Wall for Pipe Culvert.

Some of the culverts have been built with Merillat collapsible cores and metal forms have been used by the highway department successfully in the construction of small bridges. The bulletin is in the nature of a textbook of waterways for highway builders, and its treatment of the concrete structure is plain, comprehensive and authoritative.

The following extracts are taken from the bulletin:

Concrete is a properly proportioned mixture of cement, sand and stone, which when mixed with water forms an artificial stone. It is called plain or reinforced depending on whether steel is used to give it additional strength.

Concrete culverts and bridges possess the following merits:

(1) Permanent; (2) Can be built with inexperienced labor; (3) Require no repairs; (4) Materials are readily obtained. On the other hand they must be properly designed and carefully built to be satisfactory.

Concrete Waterways.—Plain and reinforced concrete may be used in all shapes of waterways which usually occur on country roads. The shape to use, whether a pipe, box, slab or arch will usually depend on the location of the structure.

Staking Out: In laying out a waterway the length should first be determined. This is largely a matter of personal choice, but as a general rule structures having 25 square feet area of waterway or less should extend completely across the graded width, no guard rail being necessary; and those having over 25 square feet area of waterway should not be less than 15 feet long, preferably 20 feet.

The foundations are laid out according to the dimensions of the plans. A small stake is placed at each corner and a light cord is stretched between the stakes to serve as a guide in excavating the earth. The character of the soil sometimes makes it necessary to excavate beyond the width required for the concrete. The earth bottom should be trued with a straight edge and level. If footings are used, small stakes may be placed on the sides of the trench with their tops level with the top of the footing and the concrete brought up to them. It is important that the top of the footing should be true, as it is difficult to set the forms on any uneven surface.

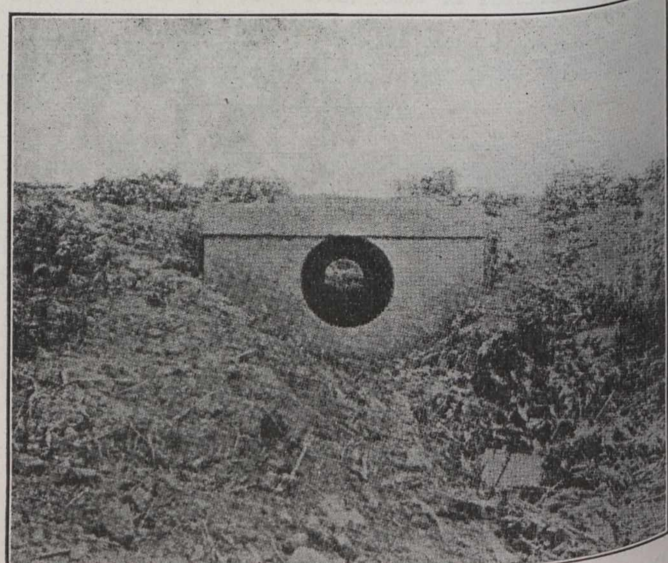
A tape, straight edge, and good carpenter's level are usually all the tools necessary to do the staking out. It is convenient to remember that the sides of a right triangle are in the ratio 3:4:5. For example, when the zero and 12 ft. marks on the tape are held together, and the 3 ft. and 7 ft. marks held along a wall the zero is perpendicular to the wall.

Except in waterways requiring a guard rail it is neither necessary nor advisable that the tops of both parapet walls be at the same elevation.

Methods of Design: All the culverts and bridges illustrated in this bulletin are designed to support a 15-ton road roller. 1:2:4 concrete is used for all slabs, beams, parapet walls, and reinforced bottoms. 1:2½:5 concrete is used in side walls and foundations. The concrete in beams and slabs is designed to be stressed to 700 pounds per square inch. The reinforcing steel is computed for plain square bars of mild steel with an allowable stress of 16,000 pounds per square inch. Round, twisted, or deformed bars may be used in place of these, provided the cross-sectional area of steel remains the same.

Pipe Culverts: Several designs for solid concrete pipe are shown. In building these a collapsible metal form similar to the one illustrated in Plate IV. has been found very convenient.

The form for the half-round culvert should be made of No. 10 gauge sheet metal with a 1½ x 1½-inch angle riveted on the edges, rods with turnbuckles 4 feet apart serving to spring the form. A beveled 2 x 4-inch wooden strip must be placed under each edge in order to strike the form. A piece of No. 10 gauge sheet metal cut to fit the top of the form will serve for an end wall form.

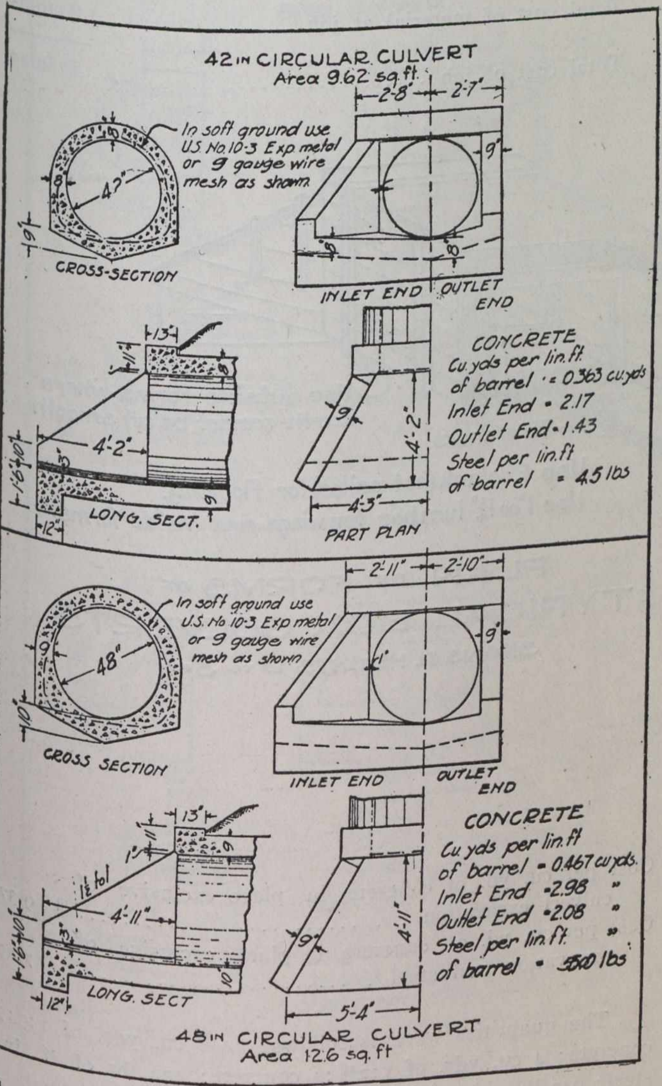


Culvert Made With Collapsible Form.

In building these culverts the bottom is put in level and allowed to set, being careful to have it true from end to end. The form is then placed and the concrete deposited for the length of the section. After 24 hours the form may be withdrawn and set for the next section of the pipe. Ordinarily no wooden forms are necessary except for the end walls.

Box Culverts: Plates VIII. and XI. are photographs of various types of end-walls for box culverts. Expanded metal or triangular wire mesh reinforcement may be used in place of the rods. These culverts are provided with baffle walls which in some cases, may be omitted at the upper end. At the lower end it may sometimes be necessary to increase the depth of the baffle wall or to place a baffle wall under the wings as well as at the end. In striking the inside forms the joists supporting the top of the culvert are knocked out, the top forms drop down and the side forms spring in. It is often possible to excavate the trench to the exact size and shape of the culvert, doing away with outside forms. However, the side walls must be thicker when this is done.

Guard Rails: Either pipe or solid concrete rails may be used on the concrete structures described. Pipe guard rails are cheap, sightly and on the whole, satisfactory, although they require some maintenance. They may be supported while the concrete is being placed, as shown in Fig. 11.



They should be given a thin coat of red lead and oil, followed by two good coats of white lead and oil after the bridge is completed. Pipe railing will cost about $0.50 per linear foot of single rail.

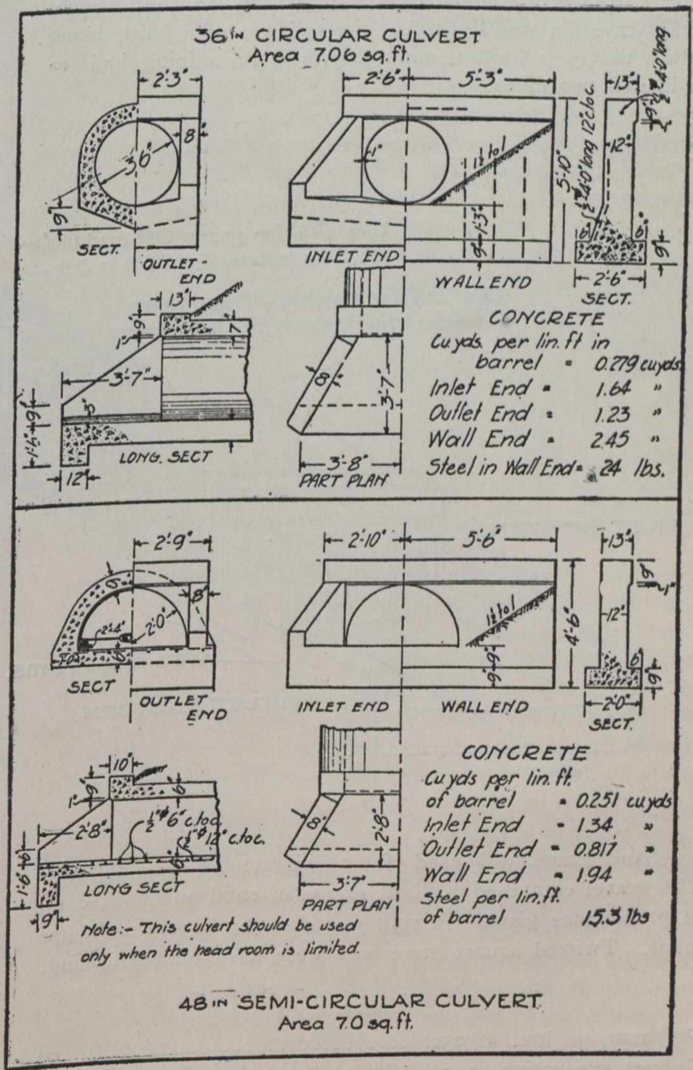
Concrete rails are very sightly but are difficult to construct and very expensive and are not recommended for ordinary country work.

Cost of Concrete.—The cost of concrete in small structures on country roads will vary somewhat from its cost in town or on large jobs. A main point of difference is probably in the cost of materials delivered on the job. Another difference comes in the delay and expense of continually moving the plant from one point to another.

The cost of hauling material to the work will be near 30 cents per cubic yard for every mile it must be hauled. An ordinary wide tread, slat bottom wagon bed containing a cubic yard is 38 ins. x 8 ft. 6 ins. x 12 ins. in size, inside dimensions, and is usually as much as the average team can handle over bad roads. An inch added to the height of the side boards increases the capacity of the bed .083 cubic yard.

Loading sand or gravel into a wagon bed will cost from 7 cents to 10 cents per cubic yard where shovels are kept busy, but may cost as high as 15 cents when the driver loads his own wagon.

A small gang with four good men mixing and one man shoveling material into barrows and putting on water, should mix and wheel 40 or 50 feet from 8 to 10 batches or 6 to 8 cubic yards of 1:2½:5 concrete, assuming a batch contains



one barrel (four bags) of cement. The cost of this mixing will vary from 80 cents to $1.15 per cubic yard.

On small jobs where new forms are required, the cost of framing and erecting the forms will never be less than $12 to $15 per 1,000 ft. B.M. of lumber used, due to the large amount of cutting and fitting necessary. On larger jobs the cost may be reduced to $8 to $10 per 1,000 ft. B.M. These costs are much less when old forms are used. Lumber will cost from $22.50 to $30 per 1,000 ft. B.M. Steel rods will cost from 1¾c. to 2¼c. per pound, delivered in most sections of the state.

The labor cost of bending and placing steel is about ½ cent per pound. This will be increased slightly if many rods greater than ¾ inch in diameter must be cut cold.

The cost of excavating for foundations will vary from 50 to 80 cents per cubic yard in dry earth and will generally vary between $1.50 and $3 per cubic yard where small puddle cofferdams not over 6 feet deep must be built.

Tearing down forms, finishing and cleaning up around the work will usually cost about 10 cents per cubic yard of concrete.

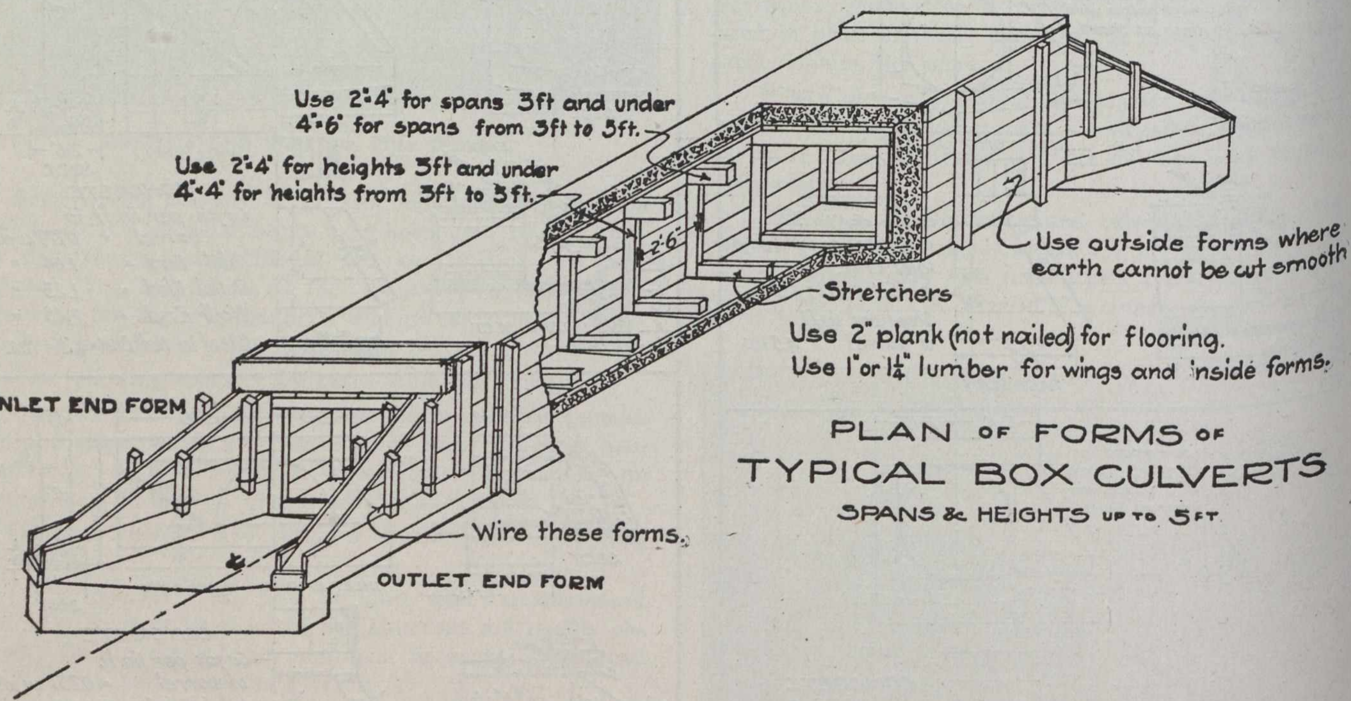
The cost of moving the plant from one job to another will usually be from $10 to $20, where the plant is not moved over five miles.

The cost data below is for a small 4 x 5 box culvert 26 feet long, built according to the designs in this bulletin and illustrated in Plate VIII.

The work was done by a regular county concrete gang, composed of a foreman seven men and two teams with drivers, and was completed in four days of 10 hours each. The excavation was light, but the soil was of a hard, black nature that was hard trimming. Water for mixing had to be hauled two miles.

Material (laid down at culvert).

Cement, 26 bbls. at $1.80	$ 46.80
Hauling cement, 12½ hrs. at 30c.	3.75
Gravel, 18½ cu. yds. at $1.10 f.o.b. cars Ennis, Texas	20.35
Hauling, 18½ cu. yds., 46 hrs., at 30c. (75c. per cu. yd.)	13.80
Steel, 1,072 lbs. at 2½c.	26.80
Hauling steel, 2 hrs. at 30c.	.00
Lumber, 1,000 ft. B.M. at $25	25.00
Hauling lumber, 3 hrs. at 30c.	.90
	$138.00
75% salvage on form lumber	18.75
Total cost of material at job	$119.25
Total cost of job	$180.45



Sand gravel was used for aggregate in the concrete. The gravel contained a slight excess of sand and worked up in proportions given. Mixing was done by hand with negro labor. Twisted square steel bars were used for reinforcing.

Labor.

Foreman, 40 hrs. at 25c.	$10.00
Culvert excavation, 9 cu. yds. at 80c.	7.20
Labor on forms	14.00
Mixing and placing, 120 hrs. at 15c.	18.00
Hauling water, 20 hrs. at 30c.	6.00
Cutting and placing steel, 10 hrs. at 15c.	1.50
Cleaning up and removing forms, 10 hrs. at 15c.	1.50
	$58.20
50% salvage on form lumber	7.00
	$51.20
Moving on and off job	10.00
Total labor at culvert	$61.20

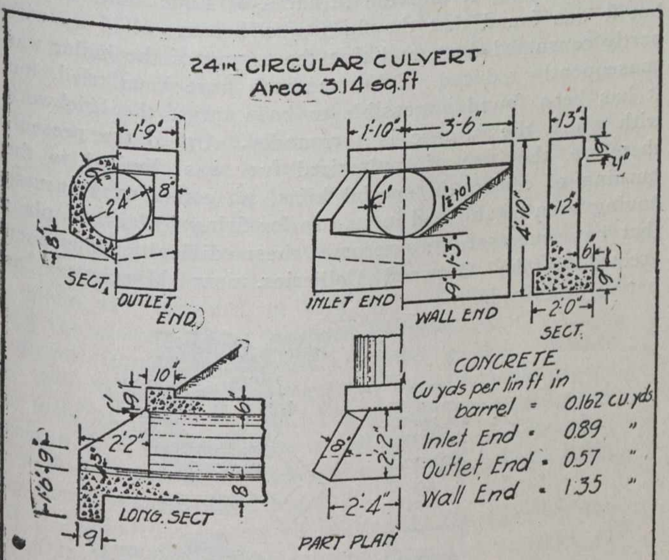
Cost per cu. yd. of concrete in place exclusive of culvert excavation	$ 9.37
Cost per cu. yd. of concrete in place exclusive of excavation and steel	7.85

The quantities were as follows: 14½ cu. yds. of 1:3:5 concrete; 4 cu. yds. of 1:2½:4 concrete; 432 lbs of ¾ in. steel; 640 lbs. of ½ in. steel; and 1,000 ft. B.M. of lumber.

In estimating the cost of work it is well to use a form similar to that shown for the cost data above. When it is desired to find the probable cost per cubic yard of concrete, Table VII. is convenient. The various amounts of each material are determined and multiplied by their cost per cubic yard laid down at the job, these costs varying for almost every case. The other costs which are more nearly constant may then be added as shown below.

For example, if 30 cu. yds. of 1:2½:5 concrete is needed and the cost of material laid down at the job is as given, its cost per cubic yard may be approximately estimated as follows:

Cement, 1.37 bbls. at $1.50		$2.06
Sand, 0.48 cu. yd. at $0.50		.24
Stone, 0.96 cu. yd. at $0.50 to $1.50	$0.50 to	1.45
Mixing and placing		1.00
Forms (labor and material)	.50 to	.75
Hauling material	.50 to	3.00
Foreman, moving, cleaning up, etc.		1.00
Plain concrete (per cubic yard)	$5.85 to	$9.50
Reinforcing steel (0.5% to 0.8%), 66 to 106 pounds at 3c. per pound in place	2.00 to	3.20
Reinforced concrete per cubic yard	$7.85 to	$12.70



It will be seen that the cost of hauling and the cost of stone or gravel will greatly influence the cost of the concrete.

Westinghouse, Church, Kerr and Company, are now in their new offices at Wall Street, New York City.

An issue of *The Canadian Engineer* for March the 28th, 1912, is desired. Subscriber sending in same will have subscription extended one month.

CONSTRUCTION WORK IN REGINA.

(Staff Correspondence.)

The much-talked-of money stringency does not seem to have had any great effect on building operations in Regina. Arrangements are being made for the early construction of the proposed new power house which will be situated on the banks of the Wascana Lake, and will cost about $425,000.

The library board is urging the city council to erect two new libraries—one in the northwest section of the city, and the other in the east end. So far the city council has looked with favor on the proposition.

The Parsons Construction Company have just completed the outside work on the Connaught School, and expect to have the remainder of the work finished in time for the occupation of the school by September 1, the commencement of the fall term. This school will contain 22 rooms and will contain equipment for manual training and domestic science in addition to the regular class-rooms.

The Regina College will erect this year: (a) Two towers on top of the present college building at a cost of $80,000; (b) a ladies' college and residence, funds for which have been provided for out of the Massey estate, at a cost of $100,000; (c) a boy's residence to cost $100,000.

The Anglican church also has an ambitious programme on hand, the most important of which is the St. Chad's College and Synod House. The college will be three stories and basement, and will be built of pressed brick and terra cotta trimmings, in the Gothic style of architecture. The main building of the college will be 175 feet by 60 feet. There will also be a chapel of the dimensions of 62 feet by 24 feet. The total cost will be about $100,000. The Synod House will be two stories and basement, built of the same material and same style of architecture as the college. The cost will be about $7,000.

It is expected that construction work will be commenced on the proposed new armories within the immediate future. The cost of the buildings is to be in the neighborhood of $250,000. There will be a full-sized basement and the area covered by the entire building will be 145 feet by 275 feet. The construction will be clinker brick. Arrangements will be made for a drill hall, club rooms, store rooms, bowling alleys, shooting galleries, officers' quarters, etc.

Architect Fortin is now busily engaged on the preparation of plans for the new Roman Catholic bishop's palace, which it is estimated will cost in the neighborhood of $50,000.

One of the best warehouses to be erected in Regina during the present year will be that of the British Columbia Sugar Refinery. The contract for the erection of this building has already been let. It will have ground dimensions of 150 feet by 113 feet, and will be of brick construction.

The house problem, which was a very vexatious one at the commencement of the spring season, has now been practically solved. The private firms doing business in the city have worked together well with this end in view, and the result has been that various firms have erected houses in groups varying from six to one hundred. The result has been that plenty of accommodation has now been made possible. The building of dwellings, however, continues to go steadily ahead, in order that the hundreds of newcomers who arrive weekly may be accommodated. Some of those who have taken out permits for houses, and the number of houses are named below: Seven houses on Montague Street for T. Davidson; five houses on Montague Street for Grant & Lounsborough; 20 houses in Lakeview; 34 houses in Eastview and Eastern Annex by J. K. McInnis & Sons; three houses in Rosemont by G. W. Sloan; 20 houses in Parliament Heights by Fraser and Keenleyside. The houses being erected by Fraser and Keenleyside will cost from $4,000 to $6,000 each and will be for rent.

Many high-class dwellings will be erected in Lakeview sub-division this year. Messrs. McCallum, Hill & Company have sold considerable of the property fronting on Albert Street at $80 per foot frontage. The lots so sold have not had a frontage of less than 80 feet and in some instances 100 feet. It is stipulated that the purchaser in each case erect a dwelling to cost at least $8,000, work on which must commence within two months. McCallum, Hill & Company estimate that the total value of dwellings to be erected on the $27,000 of this property sold within the past four days is $85,000 at least.

Dr. Andrews has requested the city council to allow him to try his new style of paving which, according to his statement, costs only a fraction of the cost of ordinary pavement. Dr. Andrews only asks a royalty of one cent per square yard, above actual cost price. Arrangements have been made for Dr. Andrews to meet the civic works committee before the contracts for paving are let.

Mayor Martin has been instructed officially by M. Donaldson of the G.T.P. Railway Company, that the work of constructing the $1,000,000 hotel "The QuAppelle" will be commenced immediately, the contract having already been let.

Howell, Smith & Company have announced their intention of erecting 50 houses of from six to eight rooms each, in the C.P.R. annex, providing the city will agree to extend the sewer and water mains to serve the property.

Balfour, Broadfoot Company have also announced their intention of erecting a number of high-class dwellings in Belvedere. Work will likely be commenced on them within the course of the next week or two.

Fordyce & MacNeil have announced that they will erect a $25,000 apartment block in Parliament Heights.

The police commission of Regina has turned down the plans for the police station prepared by Architect Fulton, and which were accepted by last year's commission. Competitive plans are being called for. Architect Fulton will be paid, however, for his work.

CANADA'S CANAL TRAFFIC.

The total quantity of freight passed through the several divisions of the Canadian canal system during the season of 1912 is as follows:—

——	Farm Stock	Forest Produce of Wood	Manufactures	Products of Mines	Agricultural Products	Total
	Tons	Tons	Tons	Tons	Tons	Tons
Sault Ste. Marie.	372	54,114	975,303	34,109,074	4,530,792	39.669,655
Welland..	678	227,684	625,569	797,072	1,205,912	2,851,915
St. Lawrence.......	9,375	578,760	464,091	1,305,395	1,119,567	3,477,188
Chambly..........	338	425,313	11.600	161,458	19,706	618,415
St. Peter's.......	2,996	11,161	7,583	37,642	15,427	74,809
Murray..........	37	706	101,511	67,379	448	170,081
Ottawa.	2,880	226,600	20,958	136,634	5,278	392,350
Rideau...........	3,151	28,642	18,814	105,531	3,995	160,133
Trent............	361	67,489	3,459	3,327	2,514	77,150
St. Andrew's......	......	14,153	60	81,299	37	95,549

The total quantity of freight moved on the Welland Canal was 2,851,915 tons, of which 1,205,912 tons were agricultural products.

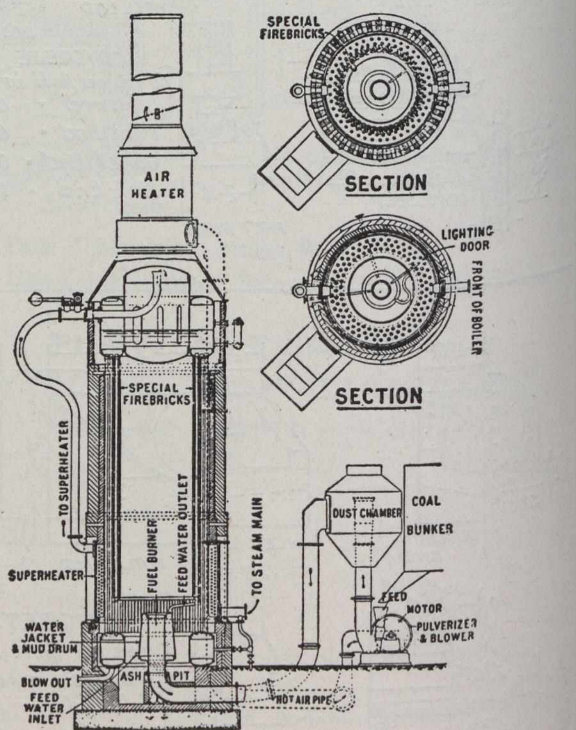
On the St. Lawrence canals the total quantity of freight moved was 3,477,188 tons, of which 1,119,567 were agricultural products, and 464,091 tons were manufactures.

On the Ottawa canals the total quantity of freight moved was 392,350 tons; of this quantity 226,600 tons were the produce of the forest.

THE BETTINGTON DUST-FUEL BOILER.

In these days, when the question of fuel occupies the minds of so many engineers and others interested in the generation and transmission of power, the following description of the Bettington boiler, gathered from a paper read by H. V. Hart before the Manchester Geological and Mining Society, will be of interest:—

It has long been known that an almost perfect combustion can be obtained by the introduction of finely pulverized coal, with a correct proportion of air, into a heated furnace. Attempts have been made in the past to burn dust by blowing it into the furnaces of Lancashire boilers, but it was found that the flues soon became filled up with partly consumed dust, and that the output of the boiler was consequently reduced. Other methods have been tried, but it has been found impossible to keep intact the brickwork with which the furnace is surrounded. Up to the present, therefore, the use of pulverized fuel was limited to the burning of cement in special kilns, no commercial success having been established in its use for firing boilers. A plant that has successfully overcome these difficulties has been erected at the Outwood Collieries, near Manchester, as herein described.



SECTIONAL VIEWS OF BETTINGTON BOILER

A complete system of dust collection has been installed. A fan, 25 inches in diameter, running at 680 revolutions per minute, and driven by a 12 horse-power motor, produces the suction required, and delivers the coal dust into a large cyclone collector some 20 feet high and 10 feet in diameter. The air and dust enter the collector at the side, and, the air being made to revolve, the dust separates and descends by gravity to the bottom of the cone, while the air is expelled at the top. Galvanized iron pipes of suitable diameter for carrying the dust are led from the tipplers, screen, collecting-belt, railway waggons, and bunker; two sweep-ups are also provided at the ground level. The coal dust is drawn off the collectors into colliery tubs, and deposited by means of a creeper and a hoist into the bunkers of the dust-fuel boiler.

The Bettington boiler is the outcome of many experiments made in America and South Africa, and was designed primarily for burning low-grade fuels in those countries. The boiler is constructed for a working pressure of 160 pounds per square inch, and to superheat the steam by 110 degrees Fahrenheit. It is of the vertical multitubular type, consisting of a bottom and a top heater, supported by three rows of tubes, 3¼ inches in diameter, and so designed that expansion can take place without straining the boiler, the air-heater and chimney being supported on brickwork independent of the boiler structure.

The boiler is fired by a central tuyere, or gas-jet, 14 inches in diameter. This tuyere is water-jacketed, and cooled by the feed-water, which is led by a special tube from the jacket to the top-header. The steam passes out from this top-header in a saturated state, and is led down to the superheater. The superheater is made up of a series of horizontal tubes which pass round the boiler, between the brickwork and the outer row of vertical tubes, the steam finally leaving the boiler at this level.

The fuel is led from the bunker, by means of a worm, into an electrically-driven pulverizer, running at 1,500 revolutions per minute. The pulverizer consists of a number of manganese-steel blades, or beaters, revolving in a casing lined with steel liners. These beaters grind up the coarser particles of coal, and constitute a fan which produces the necessary draught for forcing the dust into the furnace. Two slides are provided on each side of the casing for varying the amount of air required for combustion. Air is also drawn from the air-heater situated in the chimney stack, the coal-feed being regulated by a variable speed device fitted on the worm-shaft. The coal-dust is then forced, together with a correct proportion of air, into a separator; the fine dust is blown through a gauze, the larger particles falling down to be repulverized.

It is found that, owing to friction and expansion, the air soon loses its initial velocity, but that the particles of coaldust continue in their upward direction until they strike the top of the furnace, where, owing to gravity, and to the fact that they are cooled by striking the under side of the top-header, they descend, and, in exceeding the velocity of the air, become completely oxidized.

The size of the dust particles is, therefore, limited to that which can be completely consumed in the time occupied on the journey up and down the furnace; and it has been found in practice that this furnace will consume coarser particles of coal than any other which has hitherto been constructed for burning pulverized fuel.

The ash in the fuel, during its passage through the furnace, is converted into a liquid spray, the greater portion of which strikes the brickwork, and fills up the crevices. In lining the furnace, therefore, it is only necessary to build up the bricks by placing them one upon another, no fire-clay being needed; in fact, after a few weeks' working the interior will present a glazed appearance, forming one solid mass, and thus protecting the first row of tubes from the flames.

The internal face of the brickwork always remains in a semimolten state, forming a reserve of radiant heat, ready to be transformed into steam at a moment's notice, should there be a sudden demand.

This boiler compares very favorably in upkeep with any other boiler fitted with a mechanical stoker. It is found to be practically smokeless in operation, as only a film of grey dust is emitted from the stack.

The initial cost of the boiler is not heavy, when it is understood that neither economizer nor chimney-stack is needed; and the writer is of the opinion that in the larger sizes, it would not be more expensive in first-cost than other makes.

The advantages of this type of boiler may be summed up as follows: (1) High thermal efficiency, (2) smokeless combustion, (3) quick steaming, (4) flexibility in output, (5) small ground-space required, (6) no banked fires, (7) low radiation losses, and (8) the use of low-grade fuels.

INITIAL STRESSES IN STRUCTURAL STEEL.

By Joseph R. Worcester.

The subject of initial stresses in rolled members has received much attention in recent years, but no more than it deserves, for the reason that, under certain circumstances, it may result in very serious consequences.

A few years ago much attention was attached to a series of tests by Prof. Edgar Marburg, of the University of Pennsylvania (Proc. Am. Soc. Test. Mat., Vol. IX.), on I-beams of standard section and certain Bethlehem shapes, on account of the extremely low elastic limits reported. The cause of these low results was undoubtedly the initial stress near the junction of web and flange, produced by different rates of cooling of thick and thin metal.

More recently experiments by James E. Howard (Trans. Am. Soc. C.E., Vol. LXXIII.) and Professors Talbot and Moore, of the University of Illinois (Bulletin 44), have developed strikingly an early lack of proportionality of stress and strain in built-up columns, which can only be explained by internal initial stresses.

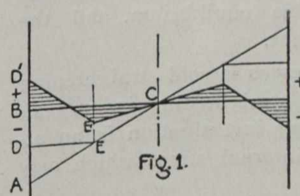


Fig. 1.

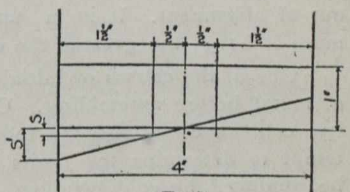


Fig. 2.

Another striking example of internal stress which has been known to many members of this Society has been in large I-beams which have suddenly, without provocation, split through a large part or the whole length of the web.

For many years it has been recognized that where steel is heated locally for forging there is likely to be produced a region between the heated and unheated portion where the metal is brittle and can be broken by a blow or shock. A striking instance of this came under the speaker's observation recently in the case of some 2-in. diameter steel truss rods which had been upset. One of these, in unloading from a team, had its upset end broken short off with a granular fracture. On testing the other rods, by striking the end with a sledge, it was found that several broke in the same way, while the rest could not be broken. A chemical analysis of one of the worst ends showed 0.408 per cent. C., 0.045 per cent. S., 0.065 per cent. P., 0.38 per cent. Mn., a result consistent with good metal. Though perhaps not so certainly established as other cases, it is quite probable that this fracture was induced by internal stresses caused by the local heating.

A similar effect in eyebars was noticed, soon after the introduction of steel into their manufacture, and led to the universal adoption of annealing furnaces long enough to anneal the whole bar at one time after forging. This practice has recently been proved by Mr. A. H. Emery to be of no benefit, as far as can be determined by tensile tests, as it decreases both the elastic limit and the ultimate strength, while no decrease in strength appears to follow from the local heat treatment, under direct tension as applied in the testing machine. It does not necessarily follow, however, that the annealing may not be a desirable precaution as a safeguard against shock.

Admitting, then, the prevalence of initial stresses, it is interesting to consider their origin with a view to guarding

* Presented before the Association of Engineering Societies.

against them where possible. When their origin is in some form of heat treatment, it is generally possible to overcome them by annealing, though this may not be the only or the best method.

When they are confined to members used in direct tension they may not be of serious import, because, on the application of stress to the member, the effect is to increase the initial tensile stresses already existing, reducing or neutralizing internal compressive stresses. As the applied load increases, a point is soon reached where the fibres carrying most of the tension reach the elastic limit and begin to stretch, after which a redistribution of stress occurs, spreading the stress over all the fibres equally.

A familiar example of this is in the case of a copper wire which may be coiled or crooked with internal stresses. We all know how if such a wire is stretched beyond the elastic limit all crooks immediately disappear. So with a steel member, if in tension it is in stable equilibrium, and a minute stretch can usually occur without harm to the structure.

With compression members, however, the case is radically different. In these, the first applied load, if initial conflicting stresses exist, tends to throw the whole member out of alignment. It is in unstable equilibrium, and the more it bows, the greater the danger.

One of the causes of initial stresses is cold straightening of metal before assembling. Cold straightening is, in reality, cold bending, and the following investigation is an attempt to determine the limits of internal stress which may be produced by cold bending.

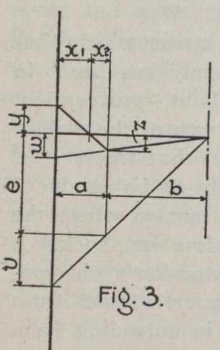


Fig. 3.

$$x_1 + x_2 = a \qquad [1]$$

$$\frac{x_1}{y} = \frac{x_2}{z} \qquad [2]$$

$$y + e = v + e - w \qquad [3]$$

$$\frac{v+e}{e} = \frac{a+b}{b} \qquad [4]$$

$$\frac{w}{z} = \frac{a+b}{b} \qquad [5]$$

$$\frac{yx_1}{2}\left(a+b-\frac{x_1}{3}\right) = (b+x_2)\frac{z}{2}\left(\frac{b+x_2+b}{2}\right)\frac{2}{3} \qquad [6]$$

Solving these equations, we obtain these values for y & z in terms of a, b & e:—

$$y = \frac{a(a+2b)}{2(a+b)^2}\,e \qquad z = \frac{a^2(2a+3b)}{2(a+b)^3}\,e.$$

It is well known that the material as it comes from the hot bed is almost always more or less out of line, and that in order to straighten it the most effective and simple method, and the one generally used, it to bend the member, in the direction opposite the initial curvature, enough so that when it springs back under its elasticity its alignment will be true. The effect of this bending beyond the straight line and allowing the elasticity to recover it to the correct point is to strain the outer fibres on each side beyond the elastic limit. The elastic recovery reverses the stress in the extreme fibres which have been overstraind, and leaves a condition of stress within the section something as shown by the diagram on the foregoing page.

This means that starting from one edge of the section we find at first a tensile fibre stress extending in a certain distance in constantly decreasing intensity until it reaches a point of no stress or a secondary neutral axis, beyond which the stress becomes compressive, increasing to a maximum at a point, the distance of which from the outer fibre is the same as that which limited the field of metal stressed above the elastic limit by the bending. From this point the compressive stress diminishes to the axis of the section, beyond which it becomes tensile again, increasing to a certain point from which it decreases again, again changing to compression at another secondary neutral axis and increasing in compressive stress until the opposite extreme fibre is reached.

In considering Fig 1, we see at once that with a symmetrical rectangular section we have two fields of tensile stresses and two fields of compressive stresses represented by triangles, and we find that certain assumptions may be made with regard to these fields which serve to fix their amounts.

In the first place, considering the effect of the bending, if the material was not strained beyond the elastic limit, the stresses on each side of the neutral axis would have been re-

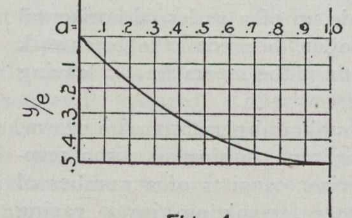


Fig. 4.

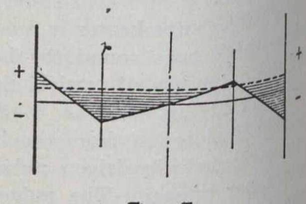


Fig. 5.

presented by a single triangle ABC. If, however, the stress AB is greater than the elastic limit of the metal, this triangle would be truncated by a line DE parallel to the cross section and distant from it an amount represented by the elastic limit of the material. When the bending stress is relieved, the line DEC assumes a new position D′E′C, the distance from D to D′ and from E to E′ being proportional to the distance from the neutral axis. This proportionality is one of the determining elements. Another is the fact that the total tensile stress multiplied by the distance of its centre of gravity from the neutral axis must equal the compressive stress multiplied by its axial distance. This is a necessary condition of equilibrium.

Lest it should be argued that the line DEC does not agree with the stress-strain diagram it should be borne in mind that in considering the elastic distortion we are dealing with an extremely minute deformation. Between adjacent planes of cross-section it is really infinitesimal, and any finite stretch would be so small as to produce practically no increment in stress. This consideration is valueless on account of its imaginary character. We might, therefore, without invalidating the argument, assume that we are considering the angle between two planes of cross-section separated by a finite distance, as, for instance, one inch.

Suppose, for example, a bar 4-in. by 1-in. bent edgewise, to a radius of curvature such that one quarter of its width along the neutral axis is still elastic and the balance, on each side, overstrained.

Referring to Fig. 2, the stretch S, at the limit of the elastic portion, will be about:

$$\frac{30{,}000}{30{,}000{,}000} = \frac{1}{1{,}000} \text{ inch.}$$

The stretch of the extreme fibre S′ will be:

$$0.001 \times \frac{1.5}{5} = 0.003.$$

The assumption is that the elongation of S′—S will not cause an appreciable increase in stress after the metal has reached the elastic limit.

$$S' - S = 0.003 - 0.001 = 0.002 = \frac{2}{10} \text{ per cent.}$$

If the gain in strength between the elastic limit and the ultimate is accompanied as it frequently is, with a stretch of 30 per cent., and we should assume the rate of gain proportional, this stretch of 0.2 per cent. would mean an increase of stress of about

$$\frac{0.2}{30.0} \times 30{,}000 = 200 \text{ lb.}$$

But, the characteristic of stress-strain diagrams is that there is a sudden yielding accompanied by a very considerable stretch with no increase in stress or even a slight falling off. To be sure, in assuming any sharp angle in the diagram, there is a slight error, as the corner should be rounded. It would be more exact to say that the lines assumed are tangent to the curves, but the effect of this rounding may be disregarded without invalidating the theory. Referring to Fig. 3, the above assumptions may be expressed algebraically as follows:

Letting $a+b=1$, we find that the equation for y assuming a as a variable is a parabola with its vertex at the neutral axis of the section of ½e, the parabola passing through the origin. This equation is $y=\left(a-\frac{a^2}{2}\right)e$, or $2a-a^2=\frac{2y}{e}$.

Expressing this result in words, it amounts to this: If a rectangular bar is bent so that it has any permanent set the internal maximum fibre stress may be obtained if we know to how great depth the outside portion of the section has been stressed beyond the elastic limit. The amount of this internal stress can never exceed one half the elastic limit, and between o and ½ e it varies according to the abscissas of a parabola of which the axis is the neutral axis of the section.

We may determine the depth to which fibres are stressed beyond the elastic limit, if we know the radius of curvature and the thickness or depth of the section. We know from mechanics that $\frac{1}{r}=\frac{e}{Ed}$, in which r is radius of curvature, e is elastic limit of the material, E is the modulus of elasticity and d is distance from the neutral axis to the extreme fibre. Using 30,000 for e and 30,000,000 for E, this formula becomes $r=1{,}000d$. In other words, the distance from the neutral axis to the fibre which is strained just to the elastic limit will be one thousandth of the radius of curvature; hence, if we know approximately the radius of curvature, we can tell at once what part of the thickness of the section is not overstressed, and, subtracting this from one half the total thickness, can find a. Taking a practical example of this we should obtain the following results.

Assume a bar 3-in. by 1-in. to be somewhat crooked edgeways and to be straightened in a press. Let us assume that in straightening it is curved to a radius of 12 ft., a very moderate assumption.

The width of metal not overstressed would be $\frac{12 \times 12}{1{,}000}=$ 0.144 in. each side of the neutral axis.

a would therefore $= 1.5 - 0.144$.
$= 1.356$ in.
or, on the basis of $a+b=1$.

$$a=\frac{1.356}{1.5}\times 1 = 0.9.$$

From the diagram, Fig. 4, we find that under these circumstances y, the initial fibre stress, amounts to 0.495 e, tension on one edge, and compression on the other, or approximately to 15,000 lb. per sq. in.

This means that in a bar which is quite straight and wholly innocent in appearance there may exist a compressive stress along one edge of 15,000 lb. per sq. in., while along the opposite edge is a tensile fibre stress of an equal amount; in other words, an inherent tendency to bend out of line on the least provocation. This condition cannot be detected by any of the usual methods of inspection, but might be suspected if we knew its history.

It will be noted that the above analysis applies only to a rectangular section. In the case of an irregular section such as an I-Beam, it is evident that if the bending is in the plane of the web, a lesser stress in the extreme fibre will produce equilibrium on account of the decreased area of the section in the parts nearer the neutral axis. On the other hand, however, if the bending is at right angles to the web, the converse is true, and the extreme fibre stress will be greater proportionally, and may easily approach nearer to the elastic limit. The same is true of a bar with a circular cross section.

Let us now consider the practical effect of these internal stresses. Referring again to Fig. 1, we see that if we apply an axial stress to a member which is already subjected to this condition of internal stress the effect will be to produce a condition as shown by Fig. 5

In this case we see at once that the areas of stress will be unbalanced so far as the rotating moment is concerned. The effect of this unbalanced condition will be to produce a tendency to spring out of line. If the axial stress is in tension, this tendency is offset by the axial stress itself, and even in case the extreme fibre stress exceeds the elastic limit, a slight yielding of these fibres soon distributes the stress more uniformly and so no serious results can occur. But if the axial stress is compressive, the tendency to spring is very serious and immediately throws the strut out of equilibrium, so that the bad effect of the internal fibre stress is accentuated. If the elastic limit is passed, the buckling may even go on to the point of failure.

It is not the present purpose to enlarge upon applications of the above theoretical considerations, but perhaps enough has been said to show the tremendous importance of eliminating cold straightening so far as possible from the ship treatment of metal which goes into compression members.

A copy of telephone statistics of the Dominion of Canada just issued shows that the total number of telephones in service in Canada is 370,884, 212,732 common battery and 158,152 magneto. During 1912 there was an increase of 37,738 in the number of telephones operated by common battery, and an increase of 30,387 in the number operated by magneto. The total number of miles of wire is given as 889,572. This is divided into urban and rural as follows: Urban, 636,961; rural, 252,610. This indicates that there is one mile of telephone wire in use for every 8.1 of the total population of the Dominion, and one telephone for every 19.3. There was one telephone for every 2.3 miles of wire. The class of wire used was as follows: Galvanized, 271,191 miles; copper, 20,096; overhead cable, 232,393; underground cable, 364,875; submarine cable, 1,015. The aggregate capital expenditure in telephones is now placed at $46,276,851, though the cost of real property is placed at something over $10,000,000 beyond this figure. This works out to a capitalization of $124.75 per telephone in use. The gross earnings from all telephone companies for the year amounted to about $12,250,000, as compared with a little over $10,000,000 the previous year. Operating expenses were 74.0 per cent. of gross earnings as compared with 69.32 for the previous year. Gross earnings work out to $33.90 per telephone in use or $13.79 per mile of wire.

THE RECLAMATION OF SWAMP AND OVERFLOW LANDS.

Mr. E. T. Perkins, of the National Drainage Congress of the United States, gives an argument for national direction for swamps and overflow lands in the Journal of the Western Society for Engineers for February, 1913. A summary of the argument is as follows:—

The national problem of controlling and regulating the Mississippi, is only a part of the problem of our swamp and overflowed land of approximately 74,000,000 acres lying in almost every state in the Union. The vast benefits to be derived from the reclamation of this great area are too obvious to require comment. It is generally known that these acres possess wonderfully fertile soil, capable of producing great crops for many years without defertilization to any marked degree.

The United States Department of Agriculture touched on this subject in Circular No. 76, Office of Experiment Stations, on "Swamp and Overflowed Lands in the United States," issued in 1907. The circular (basing the acreage to be reclaimed at 77,000,000) states:

In those states where large areas of swamp land have been thoroughly drained by open ditches and tile drains, the cost ranges from $6 to $20 per acre, while in places where tile drainage was not required the average cost has not exceeded $4 per acre. Judging from the prices which prevail in a large number of these districts where work of this kind is being carried on, it is safe to estimate that the 77,000,000 acres of swamp can be thoroughly drained and made fit for cultivation at an average cost of $15 per acre. The market value of these lands in their present shape ranges from $2 to $20 per acre, with an average of probably $8 per acre. Similar lands in different sections of the country that have been drained sell readily at $60 to $100 per acre at the completion of the work, and in many instances, when situated near large cities, they have sold as high as $400 per acre. To determine whether or not it will pay to drain these lands, we have but to consider the following figures:

Cash value of 77,000,000 acres after thorough drainage, at $60 per acre		$4,620,000,000
Present value of this land at $8 per acre	$ 616,000,000	
Cost of drainage at $15 per acre	1,155,000,000	
Value of land and cost of draining		1,771,000,000
Net increase in value		$2,849,000,000

These figures, though large, are not fanciful, but are based on results obtained in actual practice in different sections of the country where work of this kind has been done.

Since this circular was issued by the Department of Agriculture in 1907 many swamp and overflow acres have been reclaimed; the cost of reclamation undoubtedly has risen with the general increase in cost of things, but the value of the land also has risen, so it may be conservatively supposed that the net result as figured in 1907 is approximately the proper figure for to-day, upon the assumption that 100 per cent. of these lands could be reclaimed, which of course we know to be impossible.

Now, the reclamation of the great bulk of swamp and overflowed acres is largely dependent upon the control and regulation of the nearest main river system and its tributaries.

From the headwaters to the mouth it is not possible to reclaim or correct one part without at the same time exerting some influence, either for good or bad, upon the other portions.

This is a natural fact. When we try to subdivide one of the problems and solve each subdivision from our own limited viewpoint, and for our personal, selfish interests, we are making trouble for ourselves or someone else, or both. We are doing more; we are violating the laws of Nature which, before the arrival of man, establishel these drainage basins, and provided these drainage problems for us to solve. There is only one right solution to every problem; there may be found ways to find many answers, but only one of these can possible be the best.

Can we establish arbitrary boundaries, often in ignorance of existing physical conditions, ignoring natural problems and necessities, and say: "Here, this political body shall have jurisdiction, and there, that one?"

Physical, economic, social reasons demand that the reclamation of these 75,000,000 acres of swamp and overflowed lands, and the control of the waters that cause them, must be undertaken in a broad and comprehensive way—in a national way—and this cannot be done offhand.

There is no cure-all, no panacea. Careful investigation and study must be had that there may be developed a plan founded upon justice, equity, and good engineering. It must be constitutional, not only as regards the nation but as regards each state affected. In addition, every beneficiary, nation, state, corporation, individual, must in due proportion bear the expense of the improvement producing that benefit, either direct or indirect. With the insufficient data available I would hesitate to accept or reject at this time any particular plan.

But how shall we put into effect this general plan after we shall have formulated it?

The several states were granted all swamp and overflowed lands remaining unsold within their borders after September 28, 1850, for the specific purpose that the proceeds of their sale should be used in reclaiming them. So far as I know, Florida is the only state that is complying with the provision of the act, and except in Florida, practically all of these swamp lands have passed into private ownership in lots ranging from a few acres to many thousands, with the owners scattered about the world.

This condition of ownership is one of the difficulties that must be contended with. The Reclamation Act was designed to reclaim the federal lands of the West, and when private holdings were taken into a project it was by mutual consent and on a partnership basis. The government brings the water to the land after a certain percentage of the land owners in the project have agreed to join in its reclamation. No one is compelled to accept the use and benefit of this water if he has not so agreed, nor is he apt to be benefitted individually unless he does pay.

In the case of swamp and overflowed lands, however, it is not practical to drain or levee part of the land without affecting the rest; each tract of land will be benefited whether the owner desires such benefit or not, or whether he wants to pay his share of the cost of reclamation. For this reason most of the states containing swamp and overflowed lands have passed drainage laws allowing certain majorities either of lands or owners, to form drainage districts and so compel all persons owning lands within the district that may be benefited, to help pay the costs of reclamation.

Just as the states can help the individual land owners to organize their drainage districts, so can the federal government, in planning a complete system covering the entire drainage basin, by means of complete surveys and plans, work out efficient and harmonious plans for each individual project, if desired, and have each individual project harmonize with the general plan covering the entire drainage basin. This, I hold, is a national duty and a national necessity.

TYPHOID FEVER IN PITTSBURGH.

Before the installation of the water filtration works Pittsburgh had a typhoid fever death rate of practically double that of any other large American city. As set forth in the last report of Mr. C. A. Drake, superintendent of filtration, the first filter unit was started in December, 1907. All of peninsular Pittsburgh was receiving filtered water exclusively in October, 1908, and all of the south side, except the 20th ward, in February, 1909. The present typhoid fever death rate in the filtered water district shows that the purified water supply may well be included among the very safest supplies of the world.

The following table, showing typhoid fever statistics in certain important American cities, shows what the Pittsburgh filtration works, under skilled supervision, and with the final filtered product sterilized with hypochlorite of lime, has done in the line of cutting the typhoid fever death rate to a practical minimum. The results achieved at Pittsburgh in this line are by far the most gratifying and spectacular ever noted in the history of water purification in this country.

Typhoid Fever Death Rate in Certain American Cities.
(Death Rate per 100,000 Population.)

CITY	1906	1907	1908	1909	1910	1911	Supply Filtered or Unfiltered
Albany	20	20	11	19	15	15	Filtered
Atlanta	50	64	47	44	43	56	Filtered
Baltimore	34	41	31	23	41	26	Unfiltered
Boston	22	10	26	14	11	9	Unfiltered
Buffalo	24	29	21	23	20	25	Unfiltered
Chicago	18	18	15	12	14	10	Unfiltered
Cincinnati	71	46	19	13	6	11	Filtered
Cleveland	20	19	13	12	19	14	Unfiltered
Denver	68	67	58	24	30	18	Unfiltered
Indianapolis	39	29	26	22	31	23	Filtered
Kansas City	38	40	35	23	38	24	Unfiltered
Milwaukee	31	26	17	21	45	19	Unfiltered
Minneapolis	35	26	18	20	58	11	Unfiltered
Nashville	66	85	62	53	48	..	Unfiltered
New Orleans	30	56	31	25	28	25	Filtered
New York	15	17	12	12	12	10	Unfiltered
Omaha	28	24	22	31	75	18	Unfiltered
Philadelphia	74	60	36	22	17	13	Filtered
Richmond	44	41	50	24	22	18	Unfiltered
Washington	52	36	39	33	23	20	Filtered
*Pittsburgh	141	135	53	13	12	10	Filtered

* Filtered water district. Includes 410,000 of a total of 545,000 inhabitants of Pittsburgh.

The National Pipe and Foundry Company, Limited, whose head office was formerly in the Board of Trade Building, Montreal, has moved to larger quarters at 802 McGill Building, McGill and Notre Dame Streets, Montreal. The company's works are at Alexandria, Ontario, where they make tanks and wooden water pipe in all sizes from 2-inch to 24-inch for waterworks systems, domestic supply and hydraulic mining; insulated wire conduits, steam pipe casings and acid-proof pipe for mines, tanneries and pulp mills.

COAST TO COAST.

Halifax, N.S.—The completion of the three transcontinental railway systems by providing what they lack—a properly equipped Atlantic terminus—is the central idea of the Dominion government in spending twelve million dollars on new terminals at Halifax, contracts for which, it is expected, will be let shortly. Halifax thus becomes one of two great winter ports of Canada. Possessed of an unrivalled harbor which requires no dredging or improvements to navigation, it has lacked, always, those terminal facilities which are absolutely essential to the development of any port. Its present docking arrangements are adequate only for local shipping and go only part of the way in accommodating the present ocean trade. There is no provision either for the congestion that ofttimes arises or for that expansion which will be the resultant of the country's growth. Three transcontinental railways point to Halifax—the National Transcontinental and the Canadian Northern are definitely planned to go there, while the Canadian Pacific is equally anxious to have an independent entrance, through fuller running rights on the I.C.R. or a line of its own. The volume of traffic these roads will carry to Halifax necessitates, obviously, the enlargement of "the spout." It is considered absolutely essential to the proper completion of these great national undertakings that their ocean terminals should be commensurate to the requirements of that great and voluminous traffic they are carrying now, or will carry in the near future. In view of these considerations, the national importance of the Halifax work is apparent.

Montreal, Que.—That the by-law regulating street traffic is to be drastically remodelled, was announced at the city hall recently. The amendments to the by-law will be of such a nature that they will affect not only drivers of vehicles, autos, etc., but pedestrians as well. It appears that during his visit to Chicago last week Mayor Lavallee was much impressed with the system in vogue there. It is very simple yet very effective. At the densely congested streets two policemen are stationed. All vehicular traffic is stopped by the sounding of one whistle; while two whistles permit it to proceed. So soon as the one whistle is heard pedestrians make haste to cross the streets, but when two whistles are sounded they remain on the sidewalks till they hear the one whistle again. So familiar have these whistles become in Chicago that they are instantly understood and the system is said to work even better than the holding up of the policeman's hand. It is this system that Mayor Lavallee will inaugurate in Montreal. Chief Campeau is to be called before the Board of Control and given instructions in regard to the new order of things.

Montreal, Que.—One hundred thousand dollars has been appropriated in the sundry Civic Bill which has passed the Senate at Washington for the American end of the expenses of the International Joint Commission which is now engaged in one of the greatest surveys ever attempted between Canada and the United States. The commission has settled the Livingstone's Channel and the Rainy Lake question, and is now working on a big problem in connection with the Lake of the Woods, etc., and also on several complicated questions of pollution of waters at narrow points along the Great Lakes. The Lake of the Woods problem involves the interests of $75,000,000 of investment on the American side of the big sheet of water. The two governments want to know what is the best level to be established to serve the interests of all concerned. The sewage and pollution question is of vital interest to the region about Detroit, where the sewage of

600,000 persons is being dumped into the Detroit River, and on the Canadian side pollution from about 40,000 people is coming into the same water. The same condition exists at the lower end of Lake Erie and in the Niagara River, where the population of Buffalo is responsible for the pollution. So it is at Tonawanda and North Tonawanda, and at Niagara Falls city. It is claimed that the sewage spreads all over the lake, and that the St. Lawrence is polluted before it leaves the boundary line also.

Fort William, Ont.—The Dominion Government is maturing its plans for the building of interior terminal elevators in the West. The wheat production of the prairie provinces is increasing at such a rate as to cause a great strain upon the railways, despite their constant construction and the provision of new facilities at Port Arthur and Fort William. In addition to the large elevator now being built at Port Arthur, with a capacity of three and a quarter million bushels, and the rushing of work on the Hudson Bay Railway, the need of interior elevators is felt for relieving the congestion. For this purpose, an item is being put in the supplementary estimates. When these elevators are built all grain going in and coming out of them will be weighed and inspected and can be sold on inspection. This will enable the owners of grain to get a negotiable warehouse receipt upon which they can borrow money from the banks or sell the grain on the markets. The elevators will be so equipped as to treat wet and damaged grain, and will be of particular utility in providing a further reserve storage capacity. It is intended to build a few elevators at once to find out exactly what good they produce. If the results are satisfactory the government then will go further.

Toronto, Ont.—The Ontario Government is embarking upon extensive investigations in the matter of sewage disposal and the protection of the fresh water supplies of the province from contamination due to careless or unskilled methods. With the fact in mind that every provincial municipality located near lakes or rivers is facing serious problems of this nature, Dr. J. W. S. McCullough, chief officer of health, will visit in the summer months several places in Great Britain and the continent to discover assistance in solving the difficulties which come before his department. In view of the action taken by the provincial board, acting in conjunction with the International Joint Commission, to examine the boundary waters and discover the prevalence of pollution, a report will be forthcoming in November. The knowledge will then have been acquired by Dr. McCullough as the most practicable manner of dealing with the general situation. Legislation improved and amended at the recent session places within the jurisdiction of the board power to force instalment of whatever water systems they consider best, and if a purification plant or a sewage treating plant is thought necessary the municipality concerned will be obliged to install it without appeal to the people. This obviates much of the trouble which has occurred in unwilling towns in the past. Dr. McCullough will visit London first and go thence to Germany and France. He leaves Toronto during the week of July 1, and the trip will consume two months.

Quebec, Que.—In addition to the objections from the government of Saskatchewan to Hon. Frank Cochrane's bill providing for federal subsidies for the improvement of highways, the government of Quebec, through Sir Lomer Gouin, has now come out with a severe criticism of the bill as passed in the commons. In an official statement Sir Lomer says that it is to be greatly regretted that the federal government has not amended the bill in line with the demands of the opposition and of the senate. "I am," he says, "an advocate of good roads and I very greatly desire to see our roads improved as much as possible. But the federal government's bill does not satisfy me. I find it even dangerous in principle. It does not satisfy me because it does not insure an equitable distribution among the provinces of the moneys which parliament may vote. The ministers, it is true, have told us that according to the subsidy act these moneys will be distributed among the provinces according to population but the actual text of the law has not been worded so as to insure this. Moreover governments pass out of existence and the successors of the Borden government will not be bound by the word of the present prime minister. Why should not the present government follow the example of the fathers of confederation? Why should it not incorporate in the good roads bill the same principle which had been incorporated in the bill with regard to the advancement of agriculture? Moreover, this bill appears dangerous to me for it infringes the rights of the provinces and tends to narrow local autonomy. Article 92 of the B.N.A. Act specifies that the provinces shall have jurisdiction over all local undertakings but in what position would the provincial administration find themselves if the good roads bill became law in its present form? They would simply have to give up their rights and their prerogatives in order to get the subsidy which would be offered them or else they must give up the subsidy.

Montreal, Que.—A Town Planning Bill, under which every municipality would be compelled to draft plans of its future development, is strongly advocated by Controller Lachapelle. "Town planning," he said, "is to me the problem of the hour. The way building operations are carried on in the suburbs is a disgrace to the city. There should be a definite plan for the whole island of Montreal, homologated by the legislature, so that building would have to follow its lines; and a better-laid-out city would be gradually evolved. I think it would be a good idea to get the services of an expert, say from Europe, and give him a summer in which to draft his plan. The United States Government recognized the need of building its capital on a definite plan, and Washington is the pride of every American in consequence. The necessity of compelling municipalities to build along definite lines has been recognized by a number of European governments. They have made it compulsory for towns of over 5,000 inhabitants to build and expand on a definite scheme. We need, too a campaign of publicity to instruct the people and to bring before them the necessity of town-planning. We are annually faced with an increasing tide of immigration. The country population is moving into the city, and unless we do something quickly it will soon be almost impossible to do anything really effective. It is no use improving a little here and a little there. It is only wasted time. What we want is a definite plan."

Quebec, Que.—"This road will mean easily $1,000,000 annually to Quebec," said Mr. Geo. A. McNamee, secretary of the Automobile Club of Canada, as the first party this year to officially inspect the new King Edward highway passed along its route. Mr. McNamee was representing the club and Dr. Desaulniers, of St. Lambert, M.L.A., for Chambly, was the government for the time being. It was the first official look over the completed good road, on the way to Rouse's Point, N.Y. In all nearly twenty miles of the new work is now done, of the forty-five-mile long King Edward Road. In fine weather the new road is comfortably passable from Victoria Bridge to the New York state border line. In bad, wet weather the old St. Lambert to Laprairie section would not be any more "available" than it has for years in the past. But apart from the first twelve miles the motorist really has no great "kick" coming, especially when he looks back a year or more. Where sections of the new road have been built driving is a delight. The Lapresse road, one mile in length, was completed last year. That is the first mile in the "cut" through to St. Phillippe getting away from the impossible Laprairie section. The remainder of the nine miles is fast being constructed and will be completed, it is thought, by August. By that time all the various sections yet untouched will be linked up with the already completed good sections, and the good road will exist in its entirety. The last contracts for the work were signed immediately on the return from abroad of Sir Lomer Gouin, premier of the province, and the completion of the new highway is going on rapidly.

Victoria, B.C.—Now that Victoria is looking forward to the construction of one of the largest graving docks in the world at Esquimalt, some notes about the Gladstone dock at Liverpool, which is the largest in existence, will be of interest. The capacity is about 50 million gallons, and the cost was about $2,430,000, or about that of the proposed dock here. Work began at Seaforth in September, 1910, and after the necessary bank had been erected to keep the water out, in January, 1911, the work of excavation was begun on the shore proper. A commodious dock over 1,000 feet in length has been constructed, lined with half a million tons of concrete, with granite coping. The striking feature lies in the fact that the new receptable may be used not only as a graving dock, but as a wet dock, and that achievement is an interesting one. The ordinary graving dock is constructed in quite a different way from the wet dock. The sides slope and are provided with steps to facilitate the shoring of the vessel. The Gladstone dock is planned differently; it is so constructed that the giant vessel can either discharge cargo, as in the ordinary wet dock, or be repaired when the water has been run off. Exceptional circumstances necessitated the experiment, the plans for which, prepared by A. G. Lyster, were carried out by W. H. Jones. Dock gates were found to be impracticable. Two sets would have had to be fixed, and to obviate this it was decided to provide a sliding caisson. The caisson, when not in use, is kept in a chamber that runs off the dock, and is operated with ease. In another chamber the pumping machinery is installed. A commodious place, very like a small dock, it will be fitted with five Diesel engines, each of a thousand horse-power. The employment of oil engines is an innovation, for all the other pumping machinery on the dock estate is dependent on steam.

Edmonton, Alta.—Regarding the Rabbit Hills gravity system the Montreal experts have presented the following report: The system seems to have a number of points which would immediately commend themselves, namely, a natural intake which would form a rough settling basin in the river. Within a distance of a mile and a half of this point on the river there is a hill 120 feet above the general level of North and South Edmonton. Nearby there is a much smaller hill 32 feet higher than the former one. There is said to be in the immediate vicinity a supply of lignite which would enable the coal to be sent direct from the mine south to the boilers in the pumping station at the riverside. By locating the reservoir on the larger hill and running liberally proportioned mains to the city it would be possible to deliver water from this source at a pressure of, say, 30 or 35 pounds per square inch at the centre of the city on the general level. It would doubtless be necessary to raise this pressure in the city by booster pumps, although we have not included a price for such a pumping station in the estimates. On the plan we have indicated an intake and pump-house at the approximate elevation of 2,070, which would deliver the water through a pressure main to the raw water reservoir on the top of the highest hill, a distance of about two and a half miles through an elevation of 322 feet. From the raw water reservoir the water would pass by gravity through the filters to the main reservoir on the general elevation of 2,360, whence it would be delivered to the city through a double 36-inch pipe line about seven miles in length. Such a system would have the advantage of uniform continuous pumpage at the pump house, and it would give a low but uniform pressure in the pipe line leading to the city. The details of the estimate of cost of the Rabbit Hills gravity system are as follows: for a population of 100,000 the estimated cost is $6,263,133; a population of 150,000 will cost $7,189,983, and 200,000 will cost $9,447,172.

PERSONAL.

F. S. LAZIER, of the Department of Railways and Canals, who was stationed at Campbellford until recently, has just returned from an extensive tour of Western Canada. Mr. Lazier is now making Toronto his headquarters.

K. A. DUNPHY has been appointed resident engineer of the Canadian Pacific, District No. 2, Alberta division, with headquarters at Calgary, Alta., in place of J. Robertson.

MR. W. D. MURRIN, of London, Eng., formerly with the London United Railway, has been appointed mechanical superintendent of the entire system of the British Columbia Electric Railway Company, succeeding Mr. S. P. Thompson, of New York, who resigned.

MR. T. KENNARD THOMPSON, the well-known consulting engineer of New York, has been re-elected president of the Canadian Club of New York for another year.

MR. D. McD. CAMPBELL, city engineer of Sydney, N.S., has resigned owing to ill health, after serving the city for the past thirteen years.

MR. GEORGE H. TOD, of Toronto, who is the Canadian representative for Ashworth-Parker engines, Bennis mechanical stokers and Broadbent's cranes, capstans, etc., is making a six weeks' tour of Western Canada. Mr. Tod recently opened a western office at 601 Union Bank Building, Winnipeg.

MR. C. M. WATERMAN, manager of the Eugene Dietzgen Company, Limited, Toronto, is making a month's trip through Western Canada. Mr. Waterman will call on his return at his firm's Chicago factory, which is making every effort to fulfil all the requirements of the Canadian field. Mr. Dietzen, a brother of the founder of the firm, and one of the present heads of the business, will make an extensive trip through Canada later in the season.

OBITUARY.

There has just died at Hayward Heath, forty miles south of London, an Englishman whose name is known to railroad men throughout Canada; John Saxby, of the firm of Saxby & Farmer. He died, at the age of 92, on Wednesday, April 23. The first patent bearing Saxby's name was taken out in 1854, for a signal lamp with a movable inner case which changed the color of the light as the signal arm moved up or down. This was the joint invention of Saxby and W. V. Greenwood. Saxby's first interlocking patent—the invention which has made his name a household word among signal men all over the world—was taken out in June, 1856. His first installation was an interlocking of eight signals and six switches at Bricklayers' Arms Junction, where fifteen years before the semaphore designed by Gregory had been first introduced. In 1860, Austin Chambers patented an improvement on Saxby's idea, but a few months later Saxby made still further improvements, and thereafter kept the lead over all his competitors. His patent for preliminary latch locking was taken out in March, 1867. The firm of Saxby & Farmer was established about 1860. W. M. Punter is the Canadian representative of the firm with headquarters at Montreal.

ONTARIO HEALTH OFFICERS' ASSOCIATION.

The second annual meeting of the Ontario Health Officers' Association will convene at the Parliament Buildings on Thursday and Friday, May 29 and 30th.

Amongst those who will address this meeting are G. C. Whipple, Professor of Sanitary Engineering, Harvard University; Dr. Chas. A. Hodgetts, Medical Advisor to the Committee of Conservation; Dr. Chas. J. Hastings, Medical Officer of Health for Toronto; Lieutenant-Colonel Laurie, Port Arthur, and many others. It is provided by the statutes that all medical officers of health shall attend—as there are about 850 of these officers in the province, the attendance should be a large one.

COMING MEETINGS.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., 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 CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

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

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, 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, A. B. Lambe, 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. Mucklestone; 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, 534 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. ASSIOCATION.—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, The Thor Iron Works, 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, C. E. Bawden, Birkbeck Bld., 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, Edmund Burke; 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.

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