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TOWN PLANNING: THE LAYING OUT OF CURVES

SUGGESTED DESIGN FOR GRAPH AND SLIDE RULE FOR COMPUTING PROPERTIES OF CURVES IN TOWN PLANNING WORK.

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

THE mathematical precision now generally required in Canada in block and lot surveys is probably no greater than that obtained in England insofar as each lot or unit of a subdivision is concerned. But whereas in Canada it is the practice to register a plan of subdivision consisting of a number of blocks, which in turn are made up of a number of lots, the single lot is generally the unit in England and its relation to other lots need not necessarily be accurately predetermined. One lot of a subdivision sold in Canada determines the location, shape, etc., of every other lot as shown on the plan of that registered subdivision. In England, as will be explained, each lot is dealt with entirely by itself. This fundamental difference has a consequent effect on the method of survey employed.

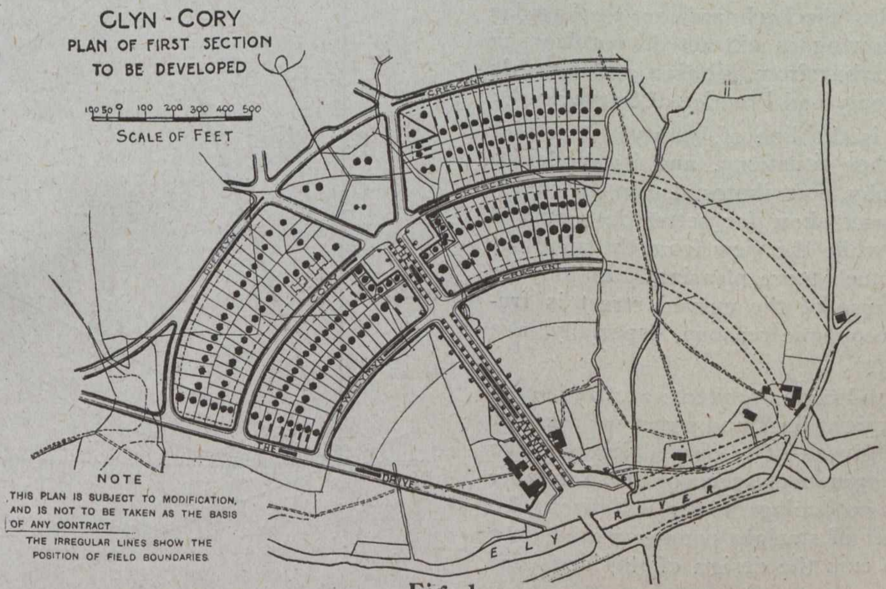


Fig. 1.

In England the general subdivision plan is usually approximately accurate, being compiled from preliminary surveys. On such preliminary plans there is, however, appended a note to the effect that "this plan is subject to modifications and must not be taken as the basis of any contract" (agreement of sale). Fig. 1 is a reproduction in part (on a much reduced scale) of the preliminary plan of Glyn-Cory Garden Village in Wales, from surveys by Mr. Thomas Adams, now town planning adviser to the Commission of Conservation, from whom the writer obtained the particulars of English practice referred to in this article. Lot dimensions and lot numbers, etc., being, when reduced, too small to be decipherable, have been blocked out, the lot numbers being replaced with full black circles. This subdivision lies along the face of a hill overlooking a river valley. Curved roads and other features will be noted.

The actual survey for the purpose of the deed of sale takes place only as each particular lot is sold. A plan of survey is appended to the deed and in some parts of England such a plan may be registered. Such registration is evidently different in effect from that, as in Canada, of the registration of the subdivision as a whole.

While temporary posts may be planted in the preliminary survey these are subsequently removed; after the final survey of a lot no posts or survey monuments of any description in connection with ordinary building lots are left, but most lots have fences erected on their exact boundaries. As every prominent physical feature, building, etc., in England is shown on the ordnance maps (scale 1-2,500) it is to these topographical features already located by survey that the corners or boundaries of the lots are referenced.

It has been pointed out that in the old country land is sold in small lots as wanted for building purposes; comparatively little is sold for speculation. Further, before a lot is sold the streets are graded and metalled, sewers, etc., installed. In this connection it might be noted that the problem of laying sewer and water mains, etc., within the limits of a curved street apparently does not present difficulties sufficient to justify the adoption of straight streets, as some engineers would insist, if such straight streets are not otherwise desirable.

It is not the purpose of this paper to make any comparative criticisms of English or Canadian methods, but as our provincial town planning acts are based largely on the British Housing and Town Planning Act of 1909, some details of English survey practice have been given. The writer's experience in the case of private surveys in Canada would lead him to believe that in those provinces where land is held under the Torrens system, the requirements of the Land Titles Offices could not, even if from some points of view it might seem advantageous, be easily changed. A basic requirement involves the posting of the corners of all lots having one or more curvilinear boundaries. The posts must be planted with a reasonable degree of accuracy and sufficient information shown on the plan so that lot or block closings may be mathematically checked.

Why do Canadian engineers seem to avoid curves? was a question recently asked by an admitted authority on town planning. The town planning engineer or the town planning surveyor of the future (whichever term is preferred) will undoubtedly have to combine the functions of both the municipal engineer and the surveyor as we now understand those terms in Canada. This point will be clearly realized by consulting town planning acts now in force or to be enacted in the different provinces. In the past, surveyors, usually more closely associated with such work, have seemed to avoid curves in the laying out of "subdivisions" for the following reasons:—

1. There is an admitted inability on the part of some surveyors to design and post curved lines, but in particular to calculate curve information.

2. The various difficulties met in designing, calculating and posting curved layouts have justified in the minds of some surveyors the use of the curve only in exceptional cases. With such objections there is no doubt also associated the fear that "lost" posts or monuments on curved lines could not be accurately relocated.

It is not necessary to consult town planning authorities to appreciate the aesthetic and often utilitarian value of the curved street. Probably every engineer has come in touch more or less directly with streets forced through at great expense on the checkerboard or rectangular block system. The following is extracted, not from a town planning treatise, but from Johnson and Smith's popular text on "The Theory and Practice of Surveying":

"'The curved line is the line of beauty' in street planning as in many other situations, and its moderate use, even in flat topography, contributes also to the charm of the variety. The houses show far better on a curved than on a straight line, while the view from the windows both front and side is much more pleasing. In hilly or rolling topography, the use of the curved street is frequently mandatory for economic reasons, especially in a residence section."

Plans prepared by landscape architects are frequently entirely devoid of any straight lines and street widths may be the only dimensions given. The curved lines shown must be resolved by the engineer or surveyor into a number of simple circular curves producing the desired effect. To replace them by a number of straight courses would, in a great many cases, be to ruin the design of the landscape architect.

It must be conceded, then, that curved street and other similar lines are necessary. The objections of some surveyors have been mentioned to the surveys involved in such cases. We can dismiss at once from our minds the surveyor who feels unable to cope with the calculations and other work involved in curved lay-outs. But in rough, wooded country the ordinary method (to be found in any standard work on surveying) of laying out curves by deflection angles involves, beside calculation, laborious cutting of trees—not only on the streets but also on the lots—that it would frequently be very desirable to leave untouched.

To make the calculation and laying out of curves as simple as possible is the object of both the graph and slide rule to be shortly described. It is suggested that on the ground only tangents to curves or lines parallel thereto should be run and the necessary offset information taken from the graph or slide rule. The effect of this is to greatly reduce the total length of lines to be run and cutting can be confined within the street limits. In the case of the slide rule it will be noted that, while desirable, it is not absolutely necessary that the traverse line from which offsets are measured should be "tangent." It is, however, necessary that the angle which the traverse line makes with the tangent and its distance (if any) from the point of tangency be known.

The width of a lot fronting on a curve is the actual length of the arc, not of one or a number of chords. For that reason the actual length of arc or the angle subtended by that arc at the centre of the circle is taken as the basis from which all other information can be found.

As complete curve information can be obtained from the slide rule it may be found useful for other purposes than that for which it was designed. For example, the plotting of a railway curve of large radius to a large scale frequently presents difficulty to the draftsman. Offsets from tangent in such cases may be conveniently obtained by the "curve" slide rule.

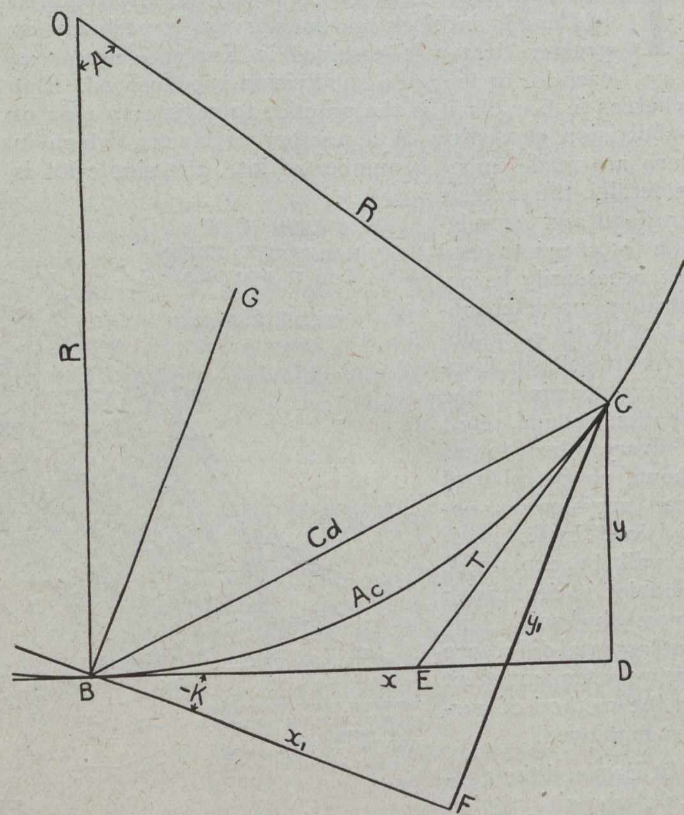


Fig. 2.

DESIGN FOR GRAPH AND SLIDE RULE FOR USE IN COMPUTING PROPERTIES OF CURVES.

In Fig. 2, representing a sector of a circle,

(a) R is the radius.

(b) A is the angle subtended at the centre of the circle by arc A_c or chord C_d.

(c) x and y are co-ordinates of point C from right-angled axes CB and BD, radius and tangent respectively to curve BC.

(d) x_1 and y_1 are co-ordinates of point C from any other right angled axes, as BG and BF, which make an angle K with the original axes.

(e) BE and EC (T) are tangents to curve at B and C from point E.

The trigonometrical relations between the various properties of the simple curve BC can be expressed as follows:—

(1) $A_c = R\frac{\pi}{180}A$ (5) $x_1 = x\frac{\sin [90^\circ - (A/2 - K)]}{\sin (90^\circ - A/2)}$

(2) $x = R \sin A$ (6) $y_1 = y\frac{\sin (A/2 - K)}{\sin A/2}$

(3) $y = R \text{ vers } A$ (7) $C_d = \frac{x}{\sin (90^\circ - A/2)}$

(4) $T = R \tan A/2$ (8) $C_d = 2 R \sin A/2$

The writer plotted the first four relations on a graph, cross-section linen 20 inches wide with 100 squares to the square inch being used. The axis of abscissae represent distance in feet (up to 560 feet) each division being equivalent to one foot. Along the axis of ordinates the radii (up to 2,000 feet) were plotted, each division representing 10 feet.

A study of Fig. 3 will show how the graph was prepared and how it may be used. OK, OL, OM and ON are evidently straight lines passing through O and represent the relations when the angle subtended at the centre of the circle is 10°. For a radius of 1,000 feet a curve which subtends an angle of 10° has a length of 174.5 feet along the arc. The offsets along and from tangent will be 173.6 and 15.2 respectively, and the length of the sub-

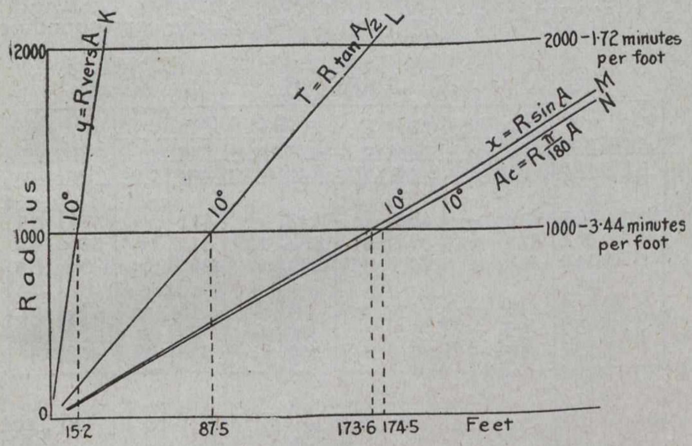


Fig. 3.

tangents 87.5 feet. For each degree of angle subtended at the centre other straight lines can be drawn in suitable distinguishing colors. The errors due to interpolating proportionately between the plotted degree lines can ordinarily be neglected.

Up to about 35° is the practical limit of the graph, as for larger angles the plotted lines giving x and A_c values would cut the horizontal cross-section lines at too acute an angle for accurate reading.

A light wooden straight-edge five feet in length is most convenient for plotting the straight lines. Around a stout pin driven into the drawing board close to point O, a rubber band can be placed to hold close the straight-edge on which one or two weights may be placed. For accuracy, the lines should first be drawn in pencil and then inked in. To prevent confusion, the lines within an inch or two of the axis of abscissae are best omitted except for perhaps each five or ten degree line. For any radius under 200 feet, values can be found for a radius ten times greater than that required and the results should then be divided by ten.

In Fig. 3, beside radius 1,000 on the right-hand side, will be noted the expression "3.44 minutes per foot." This means that in interpolating between each degree for A_c values, each foot (one division) on the horizontal line for 1,000-foot radius is equivalent to 3.44 minutes of angle subtended at the centre of the circle of that radius.

Similar values were determined and shown on the graph for each 100-foot radius. Other devices or means for shortening calculations or preventing confusion with lines too closely drawn will no doubt suggest themselves to anyone constructing or using such a graph.

For general use there are some objections to this graph, such as its size (about 2 feet by 5 feet), the difficulty of interpolating and the fact that it is necessarily confined within a certain limit of radius (2,000 feet), length of arc (560 feet) and angle subtended (35°). Mr. W. H. Herbert, B.Sc., of the Topographical Surveys Branch, is well versed in matters relating to nomography and when the writer submitted the graph for his criticism, he suggested that, as a rule, information shown on any graph can be readily obtained with a slide rule if suitable scales are, or can be, engraved thereon.

Slide Rule.—Acting on Mr. Herbert's suggestion, the writer has determined the modifications necessary to make the ordinary 10-inch slide rule suitable for use in computing the properties of curves.

On the face of the ordinary slide rule are the scales "A" and "D" representing the logarithms of the numbers indicated. Scale "A" is a "double" scale, or one in which the significant figures repeat themselves in the two equal sections, those in the second section being 10 times greater than those in the first section.

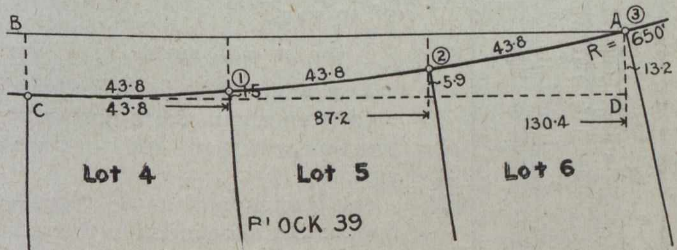


Fig. 4.

On the face of the slide are the corresponding scales "B" and "C". These can be left for the usual slide rule computations although the figures for these scales may have to be reduced in size to allow an "A_c" scale to be engraved between the "B" and "C" scale. This "A_c" scale would extend from about 35′ to 57° 18′, and is determined by the logarithmic value of the numbers (plotted to the same scale as those of scale "A" or "B") which represent the length of arc to radius 100 for various angles subtended at the centre of the circle.

On the back of the slide the usual sine "S" and tan "T" scales could be left, though for convenience the figures representing the graduations from 5° 43′ to 45° on the "T" scale could be changed to from 11° 26′ to 90°, or just twice the original figures. The log "L" scale could be replaced by vers "V" scale, which would extend from about 2° 34′ to 25° 50′. This versine scale has already been graduated on the D.L.S. slide rule and if a "curve" slide rule were to be made at the same factory, all the scales would be "standard" except probably the "A_c" scale. The cost of such a rule should therefore not be excessive.

With the aid of Chambers' tables and an engraver's tool, the writer, on his own slide rule, graduated both the "A_c" and "V" scales on the face of the slide (see Fig. 5). The resulting depressions were filled with red ink. In any arrangement, however, the "A_c", "V" and "S" scales would be used in conjunction with the "A"

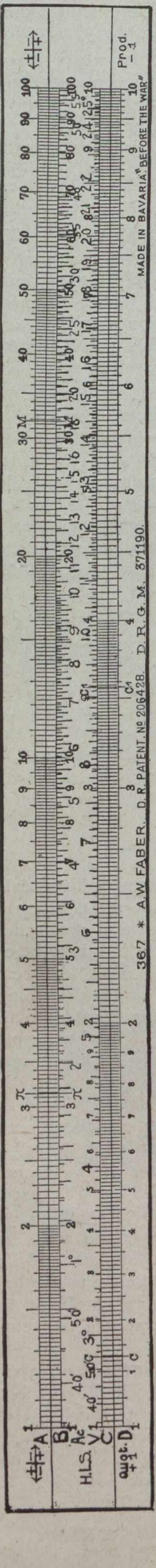


Fig. 5.

scale on the face of the rule, and the "T" scale in conjunction with the "D" scale.

Rules for Using "Curve" Slide Rule.

(1) $A_o = R \cdot \frac{\pi}{180} \cdot A$

Use scale "A_o" on slide (graduated from about 35′ to 57° 18′) in conjunction with scale "A" on face of rule.

(a) Radius and angle given—to find arc: Set slide index to the radius on scale "A" and the cursor to the angle subtended at the centre of circle by arc. The value of "arc × 100" will then be indicated by the cursor on scale "A".

(b) Radius and arc given—to find angle subtended at centre: Set slide index to the radius on scale "A" and below "arc × 100" will be found the required angle.

For angles below 35′ or above 57° 18′, use direct proportions, which in the case of small angles can be made in the convenient ratio of 10 to 1.

(2) $x = R \sin A$

Use scale "S" on slide (graduated from about 35′ to 90°) in conjunction with scale "A" on face of rule.

(a) Radius and angle given—to find x: Set slide index to the radius on scale "A" and the cursor to the given angle (which is the angle subtended at the centre of circle by a certain arc the length of which need not necessarily be known). The value "x × 100" will then be indicated by the cursor on scale "A".

For angles below 35′, since the sines of small angles are approximately proportional to the angles themselves, values can be determined by direct proportion using a ratio of 10 to 1 for convenience.

Up to 4° the difference between sine A and $\frac{\pi}{180} \cdot A$ is very small. The difference between x and A_o for a radius of 1,000 feet and an angle of 4° is only 0.056 feet which can ordinarily be neglected. Therefore, the portion up to 4° of the sine scale could, on the ordinary slide rule, be used to determine A_o values. Values for angles greater than 4° could be determined by direct proportion with a fair amount of accuracy.

(3) $y = R \text{ vers } A$

Use scale "V" on slide (graduated from about 2° 34′ to 25° 50′) with scale "A" on face of rule.

(a) Radius and angle given—to find y: Set slide index to the radius on scale "A" and the cursor to the given angle. The value "y × 1,000" will then be indicated by the cursor on scale "A".

For angles below 2° 34′—Since the versines of small angles are approximately proportional to the squares of the angles, values under 2° 34′ can be determined by using larger angles in the proportion of 10 to 1 and dividing the result by 100.

For angles above 25° 50′—Now, vers $A = \sin A \times \tan A/2$ and therefore values can be found by using the back of the slide on which are both the sine and tan scales.

(4) $T = R \tan A/2$.

Use "T" scale on slide (graduated (i) from about 5° 43′ to 45° or preferably by changing the figures only, (ii) from about 11° 26′ to 90°).

(a) Radius and angle given—to find T: Set slide index to the radius on scale "D" and the cursor to (i) one-half the angle "A" or (ii) the angle "A." The value "T × 10" will then be indicated by the cursor on scale "D".

For angles (i) below 5° 43′ or (ii) when A is less than 11° 26′. When A is between 0° and 4°, the corresponding sine of $A/2$ may be substituted. From 4° to 11° 26′, the corresponding sine of $A/2$ may be used, and the result increased by $\left(\frac{A/2 - 1}{10}\right)$ percent.

TABLE I

Calculation	SLIDE RULE				GRAPH				Drafting	
	Observer 1		Observer 2		Observer 1		Observer 2			
Offsets	Offset	Error	Offset	Error	Offset	Error	Offset	Error	Offset	Error
x										
Point ① 43·8	43·8	—	43·8	—	43·8	—	43·8	—	43·1	-0·7
② 87·2	87·3	+0·1	87·1	-0·1	87·25	+0·05	87·2	—	86·8	-0·4
③ 130·4	130·5	+0·1	130·5	+0·1	130·3	-0·1	130·3	+0·1	129·8	-0·6
y										
① 1·5	1·5	—	1·5	—	1·4	-0·1	1·5	—	1·6	+0·1
② 5·9	5·9	—	5·9	—	6·0	+0·1	5·9	—	5·7	-0·2
③ 13·2	13·2	—	13·3	+0·1	13·2	—	13·4	+0·2	13·2	—

(5) $x_1 = x \frac{\sin [90° - (A/2 - K)]}{\sin (90° - A/2)}$

(6) $y_1 = y \frac{\sin (A/2 - K)}{\sin A/2}$

(7) $C_d = \frac{x}{\sin (90° - A/2)}$

(8) $C_d = R \sin A/2$

Use scale "S" on slide in conjunction with scale "A" on face of rule.

For ordinary conditions equation (8) may be written $C_d = R \sin A$, where A is not over 4°.

Also, C_d can be ordinarily assumed equal to A_o for a value of A not over 6°.

The relations between A_o, x and C_d can therefore be thus expressed:—

$x = C_d = A_o$ for A not over 4°
and $C_d = A_o$ for A not over 6°

Ordinary 10-in. Slide Rule with "S" and "T" Scales.—From a study of the foregoing rules it will be apparent that the ordinary slide rule could be used though not so readily in computing properties of curves; x, T, x_1 and y_1 and C_d values could be directly obtained as on the "curve" slide rule.

By using the "S" scale up to 4° only and obtaining other values by direct proportion, A_o values may be obtained.

From the relation vers A = sin A × tan $A/2$, the versine of any angle from 11° 26′ to 90° can be obtained. When A is between 0° and 4° the corresponding sine of $A/2$ may be substituted. From 4° to 11° 26′ the corresponding sine $A/2$ may be used and the result increased by $\frac{A/2 - 1}{10}$ percent.

Accuracy to be Expected in Slide Rule Results.—Assuming that for the ordinary operation of multiplication the final reading can be made within 1/250 of an inch, it can be shown that the result read off can be relied on for equations 1, 2, 3 and 8 on the "A" scale to within 2 in 1,000, and for equation 4 on the "D" scale to within 1 in 1,000. When the versine is obtained from both the sine and tan scale the result might vary in the extreme by about 3 in 1,000 but would probably be less than this amount in error.

x_1 and y_1 values obtained from x and y values might vary up to 1/250th and are consequently not very reliable for large angles and radii.

The usefulness of the slide rule for computing properties of curves can be determined by a consideration of the accuracy desired in each particular case.

Actual Tests of Graph and Slide Rule.—Fig. 4 shows a portion of Block 39, St. Julien addition to Banff. It was desired to find offsets from line AB to points 2, 1 and C, DC a parallel to AB being tangent to curve at point C. The offsets were found by plotting and scaling to a scale of 20 feet to an inch.

In order to calculate offsets from AB it is necessary to first find offsets from CD. Then, by simple subtraction the desired offsets can be found.

Table I. shows results obtained by direct calculation, slide rule and graph. For comparison, values found by subtraction from the results as the draftsman obtained them by plotting and scaling are also given. The slide rule is sufficiently accurate for the case given and much more accurate than the scaling in this case. In any event, it is obvious that the slide rule or graph provides a comparatively quick and useful check on plotting or calculation from mathematical tables.

LEAKAGE FROM PIPE JOINTS.*

By F. A. Barbour.

THE fact stands out that in entirely metered systems, or in systems where the meters exceed 85 per cent. of the services, at least 20 per cent. of the water furnished is, on the average, unaccounted for, and the question arises as to whether we should be content with such a condition. It is to be noted that this 20 per cent. loss is not based on a comparison of pump records with the water sold, but on the figures furnished by superintendents as to the water unaccounted for in their systems, these figures presumably making corrections for such items as pump slippage. It would seem that a loss of 20 per cent., due to leakage from mains and services or to under-registration of meters, which undoubtedly represents the best conditions, is sufficiently sizable to justify careful consideration of possible remedies.

We all know that the total unaccounted-for water in unmetered systems is enormous; presumably we all agree that metering is the great remedy; and yet, as reported by the United States Department of Commerce, only 40 per cent. of the services are metered in 201 cities, containing 26,000,000 people and having an average per capita consumption of 139 gallons per day. This total loss is not the subject of our immediate discussion, but as a means of calling attention to present standards of management a few figures may not be amiss.

The total population in the United States supplied with water from public works may be taken, for present purposes, at 50,000,000 people, and the average amount of water furnished per day at 100 gallons per capita. The total water supplied daily by public works is, therefore, in round figures, 5,000,000,000 gallons. It is probably a safe statement that 50 per cent. of this quantity is wasted. Assuming the actual cost of furnishing the useless 2,500,000,000 gallons to be $25 per million gallons—and this is an extremely low figure—the cost per day of the water wasted is equal to $62,500, or $22,800,000 per year, which is equal to the interest on an investment of $500,000,000. Figured in this rough way, the results do not speak well for our present-day standard of management of water systems. If it should be answered that it is not practicable to prevent this loss, a reasonable reply would be that at least we should know more about its causes than apparently is known at the present time.

As already stated, metering is the great means of reducing the total waste on which the previous figures are based. There remains, however, the fact that in the fully metered systems, on the average, at least 20 per cent. of the water furnished is unaccounted for, and probably if more accurate data were available this percentage would be shown to be materially greater.

Emil Kuichling estimated 2,500 to 3,000 gallons per mile per day as the leakage from well-laid mains; Dexter Brackett estimated a leakage of from 10,000 to 15,000 gallons per day in the Metropolitan District; and John R. Freeman stated that his best guess of the underground leakage in New York was from 25 to 35 gallons per day per capita, equal to from 20,000 to 30,000 gallons per day per mile of pipe. In six cities, with 95 per cent. of the services metered, reported by Brackett in 1904, 36 per cent. of the water was unaccounted for, equal to an average loss of 11,300 gallons per mile of pipe. James H. Fuertes, in the 1906 report to the Merchants' Association of New York, presented statistics from thirteen cities in which on the average 82 per cent. of the services were metered, which showed that 31 per cent. of the supply was unaccounted for, equivalent to approximately 18,000 gallons per mile of pipe. What part of these losses are chargeable to the mains is unknown, but from the results of such leakage surveys as have been made, and from the reported actual losses discovered in some cities, it is probable that 7,500 gallons per mile of pipe per day is a conservative estimate of the water lost by leakage from the 60,000 miles of mains now in use in the public supplies of the United States, or 450,000,000 gallons daily. At $25 per million gallons, this is equal to a daily loss of $11,250 or $4,110,000 per year, or the interest on $100,000,000. In the light of this economic waste it would, therefore, appear that the subject of leakage from mains is worthy of careful consideration.

The Committee on Water Consumption of the New England Waterworks Association reported in 1913 that "in general it may be said that if in a well-metered system the water unaccounted for does not exceed 25 per cent. of the total pumpage, the practice is good." Doubtless this should be interpreted to mean that a 25 per cent. loss

*From paper read before the November meeting of the New England Waterworks Association.

is good compared with the average present practice, but is it good compared with the standard which should be set up in this age when we hear so much about conservation? Should we complacently accept a loss of 25 per cent. as inevitable, And if this loss cannot reasonably be much reduced in the systems already constructed, what about the possibility of better methods of construction in the pipe to be laid in the future? It is, of course, out of the question to consider the relaying of present systems or to do more than make leakage surveys and check the larger losses, but in the light of present knowledge, is it not time to undertake seriously an analysis of the causes responsible for the present large percentage of water unaccounted for? If these losses are chargeable to under-registration of meters, then this should be definitely made known, and consideration given to the possibility of developing more sensitive or more accurate measuring apparatus.

Are we taking sufficient care in testing pipe for water-tightness when laid? About 60 per cent. of those replying to a recent circular of the Committee on Leakage of the New England Waterworks Association state that the pipe is tested when laid, and all but six make the test before backfilling. In the writer's experience, testing before backfilling in the ordinary work of laying distribution systems is rare, and it is undoubtedly from the practice of simply turning on the water without any test that a considerable part of the present leakage develops. The standard of those who test, as indicated by the replies received, is "absolute tightness," but in the writer's experience this result is not easy to obtain, and only possible where the joints are gone over several times after the pressure is applied.

Where pipes are backfilled before testing, the allowable leakage, as determined by such test, has varied greatly in different specifications. John H. Gregory, at Columbus, made the limit 500 gallons per inch-mile per day. At Akron 200 gallons per inch-mile per day was specified, while actual results at Akron showed about 70 gallons per inch-mile per day. E. G. Bradbury, in his paper before the Association in 1914, proposed 100 gallons per inch-mile per day as a reasonable standard for the allowable leakage in testing after backfilling, and he figured that the difference between 500 and 100 gallons per inch-mile per day, estimating the cost of the water at $25 per million gallons, would equal a yearly cost of $5,256 for water lost in a city of 100,000 people, or, in other words, the city could afford to spend $470 per mile in order to save 400 gallons of leakage per inch-mile per day.

Again, are the present jointing methods the best qualified to maintain tightness after periods of use? Who knows anything about the comparative leakage when laid and after several years? In this latter connection the history of the work at Grandview, Ohio, is of interest. As reported by Mr. Bradbury, the supply is measured by a tested meter and all service pipes are metered. The 5.5 miles of pipe originally laid were tested before backfilling and the leakage before any connections were made amounted to .31 gallon per inch-mile per day, or, in other words, the system was practically watertight. Subsequently 0.9 miles of additional mains were laid, and gradually in the four years since the date of original construction the services have increased to the present number of 205. Either by less careful work in the extension or by depreciation of the original work, or by under-registration of the gradually increasing number of meters, the unaccounted-for water has increased until at the present time it averages about 150 gallons per inch-mile per day. An interesting feature in connection with these records is that the unaccounted-for water, based on three years' observations, averages 60 gallons per inch-mile per day during the six months from October to April, and 213 gallons during the six months from April to October. In other words, the records indicate in this system that the unaccounted-for water is three times as great during the summer as during the winter months. Whether some local explanation can be found for this result, or whether it is a reasonable result of temperature changes, is not known, but data from other systems showing the unaccounted-for water during periods of varying temperature would be of considerable interest.

SPECIFIC SPEED DIAGRAM FOR HYDRAULIC TURBINES.

The simple alignment diagram reproduced in the accompanying figure has been devised by C. D. Babcock, of Troy, N.Y., for finding the specific speeds of hydraulic turbines. It is believed to be smaller and handier than the older diagrams in use by turbine designers. The results are read in either English or metric units directly from the diagram, without computation.

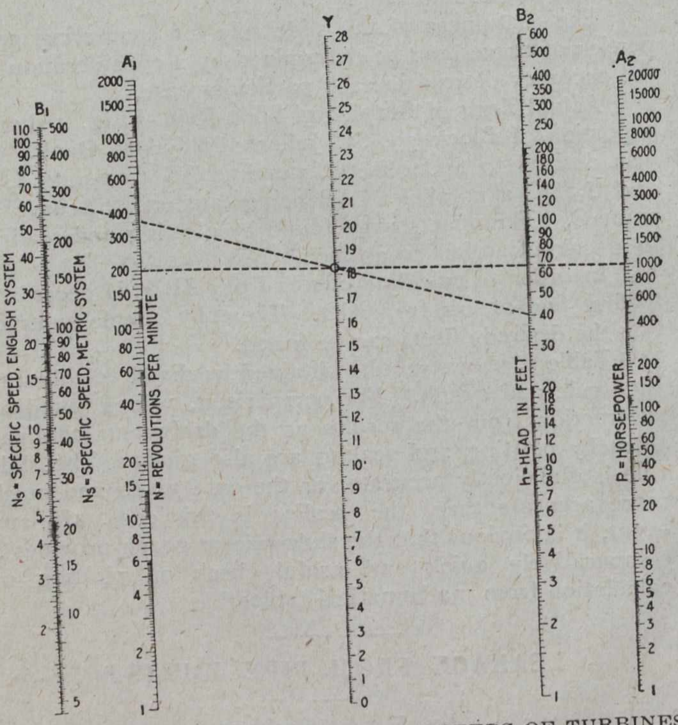


DIAGRAM FOR FINDING SPECIFIC SPEEDS OF TURBINES

The use of the diagram is nearly self-explanatory; a point is found on the Y-axis, or centre line, where intersects a straight line connecting the given values of horse-power and speed, A_1 and A_2 axes; this intersection point is joined to the given value of head, B_2 axis, and the line projected cuts the specific-speed line, B_1 axis, at the desired value.

The volume of coal traffic at four principal Atlantic seaports has been investigated by the United States Geological Survey. The figures are approximate only and give the totals in net tons for the year 1915. New York leads with about 27,000,000 tons; Hampton Roads comes next with about 16,000,000 tons; then Philadelphia with something over 13,000,000 tons, these figures not including the bituminous coal consumed in Philadelphia itself. The total receipts at Baltimore were about 7,600,000 tons.

WATER FILTRATION EXPERIENCE

ABSTRACT OF PAPER DELIVERED AT MONTHLY MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS IN MONTREAL, DECEMBER 14th, 1916

By H. G. HUNTER, M.Can.Soc.C.E.,
Resident Engineer, Montreal, N.Y. Continental Jewell Filtration Co.

WEBSTER'S definition of the word filter is: "Felt, fulled wool, this being used for straining liquors. (1) Felt. (2) Any porous article as a cloth, sand, or charcoal through which water or other liquid is passed to separate from it matter held in suspension, or, in some cases, dissolved impurities or coloring matter." This is a very good definition and may satisfy some of us, but surely a filter to remove impurities and color from water must be something more than "any porous article."

The filters to which this paper refers are those in the most common use in municipal water purification. Tile filters, felt strainers and the like, have no rightful place in this discussion, for they are unsuited to the treatment of large volumes of water and so consequently are not used for such purposes.

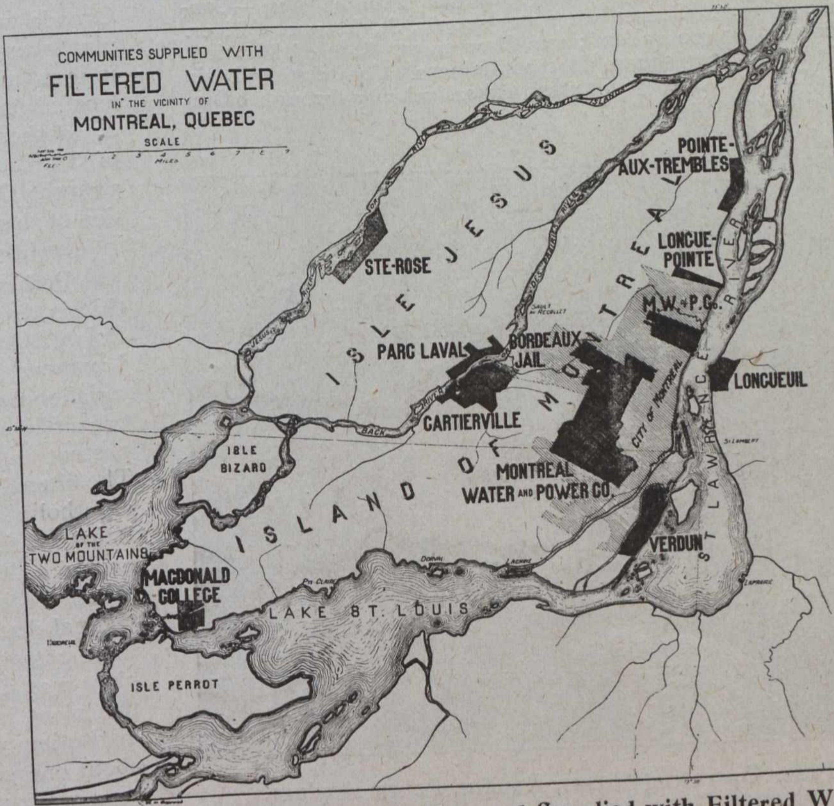
In municipal water filtration problems two primary objects are sought, namely, improvement of the physical imperfections of the raw water and the removal from it of bacterial life. Mud, silt, clay and amorphous debris give to the water an unpleasant appearance; make it muddy, or turbid and form a sediment in pipes and in vessels in which it is stored. Vegetable stains impart a distinct color to some waters—the Ottawa River is a good example of a stained water—and the removal of this color is desirable.

So far as we know, the presence of mud and silt, dead amorphous debris and vegetable stain, is not of significance so far as affecting the hygienic quality of the water is concerned, but by lending their individual and collective characteristics to it, the imagination is sometimes aroused in a hostile manner, and most people prefer a clear, colorless, sparkling water, to a muddy or yellow-stained colored water.

The microscopic life in water is of both harmless and harmful kinds. The higher forms are the microscopic plants which sometimes evidence themselves in the form of green or yellow slime on stagnant bodies of water; or microscopic animal life which lives upon the vegetable life, but which, so far as we know, does not directly, and of itself, produce disease. Even the bacteria, the lowest form of known life, are of two groups—the harmless and the disease-breeding kind. Both forms are of vegetable origin and constitution, but the harmful varieties always come from human sewage.

The writings of antiquity are silent on the subject of filtration of public water supplies. The first comprehensive and purposeful attempt to filter water for public use began with the construction of the filter plant at East Chelsea, London, England, in 1829. The avowed purpose of this filter was to strain out the suspended matters in the water and make it clearer. That such filtration would improve the hygienic qualities of the water was not then known, or even suspected, for the germ theory of disease was not seriously advanced until 1849, during the severe cholera epidemic in London. Three years later an Act of Parliament made compulsory the filtration of the entire water supply of the Metropolitan District of London.

But the idea was slow in gaining the confidence of the public, and it has been only within the lifetime of many of us now living that municipal water filtration has grown to the dignity of a science; an all-important agent in the prevention of disease. To-day, of the 110,000,000 people in Canada and the United States, over 20,000,000 or something like one in every five, are being supplied with filtered water.



Map Showing Districts Around Montreal Supplied with Filtered Water.

Without first acquiring some knowledge of the art and science of water purification, it is practically impossible, or to say the least very unwise, to apply theories of unknown qualities to the design of water filtration works, and except by mere chance find them to work out successfully in practice. I suppose that filter design might in a way be likened to racing yacht designing, where many of the best and fastest boats were laid down from models, whittled from a block of wood by a man who knew what he was doing.

Only through a vast amount of actual experience, plentifully dotted with disappointments and not a few failures of preconceived ideals, can an engineer, or a body of engineers, hope to become competently qualified to design water filtration works, which will give satisfactory service, under practically any set of conditions.

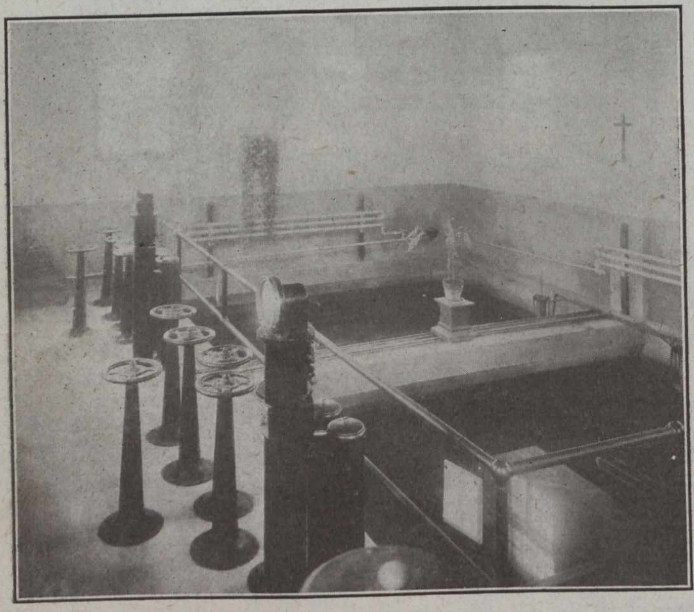
Water Filtration in Canada.—At this time there are in operation or building in Canada some 70 municipal water filtration plants, having a total daily capacity of 214,000,000 gallons, or enough to furnish 30 gallons daily to every inhabitant of the Dominion. Quebec has 177 public water supplies, with a daily capacity of 134,000,000 gallons. Over 30 of these supplies are recorded as having filters with a daily capacity of over 82,000,000 gallons.

In the city of Montreal and within a radius of 15 miles there is a population of about 750,000, supplied with water. Filter plants are constructed, which will in the near future, be supplying 95 per cent of this population with filtered water.

The following tabulation contains certain details of filter plants, recently constructed:—

NOTE—Capacities are daily capacities, gallons are Imperial gallons, coagulating basin time period and velocity of flow are theoretical.

Longue Pointe Asylum, Longue Pointe, Que.—Constructed, 1911. Source raw water supply, St. Lawrence River. Capacity, 625,000 gallons; two filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 1 hour and 45 minutes. Lineal velocity through basin, .25 feet per minute.



Filter Operating Room, Longue Pointe Asylum.

Montreal Water and Power Company, Montreal, Que.—Constructed, 1911-12. Source raw water supply, St. Lawrence River. Capacity, 25,000,000 gallons; 15 filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 1 hour. Lineal velocity through basin, 3½ feet per minute.

Bordeaux Jail, Bordeaux, Que. — Constructed, 1912. Source raw water supply, Back River (Ottawa River water). Capacity, 625,000 gallons; two filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 1 hour and 45 minutes. Lineal velocity through basin, .25 feet per minute.

St. Rose, Que.—Constructed, 1913-14. Source raw water supply, River Jesus (Ottawa River water). Capacity, 415,000 gallons; two filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 2 hours. Lineal velocity through basin, .25 feet per minute.

Laval des Rapides, Que.—Constructed, 1913-14. Source raw water supply, Back River (Ottawa River water). Capacity, 300,000 gallons; two filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 3 hours. Lineal velocity through basin, .17 feet per minute.

Cartierville, Que.—Constructed, 1915. Source raw water supply, Back River (Ottawa River water). Capacity, 830,000 gallons; three filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 3½ hours. Lineal velocity through basin, .17 feet per minute.

MacDonald College, Ste. Anne de Bellevue, Que.—Constructed, 1915-16. Source raw water supply, St. Lawrence River (Ottawa River water). Capacity, 240,000 gallons; two filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 4 hours. Lineal velocity through basin, .11 feet per minute.

Berthier, Que.—Constructed, 1916. Source raw water supply, St. Lawrence River. Capacity, 250,000 gallons; two filter units. Rate of filtration, 1.66 gallons per square foot per minute. Coagulating basin period, 1 hour and 15 minutes. Lineal velocity through basin, varies; circular baffled basin.

It will be noted from the above description that there is considerable variation in the coagulating period and the velocities through the coagulating basins. The experience gained from these several plants is, that all of the basins produce a water properly coagulated and in the desired condition to pass to the filters.

The first large mechanical filter plant constructed in Canada was for the Montreal Water and Power Co. The plant was placed in operation in June, 1912, and has been in continuous service since then. While the plant is located on the St. Lawrence River, it handles at one time or another, straight St. Lawrence River water; a mixture of St. Lawrence River and Ottawa River water; and straight Ottawa River water. A very complete description of this plant, by Mr. W. H. Sutherland, was published in *The Canadian Engineer*, January 23rd, 1913.

Perhaps one of the most successful plants in Canada, that is, from the point of perfect operation, is at Longue Pointe, Que. This plant takes raw water from the St. Lawrence River below the city of Montreal. The bacterial content of the raw water sometimes runs as high as one million per cubic centimeter and B. coli are always present in one hundredth of a cubic centimeter sample. The filtered water is used in the Hospital St. Jean de Dieu, a Catholic institution for the insane. Previous to the installation of the plant, typhoid and other intestinal diseases caused a death rate probably as high as 12 per thousand. Since the installation of the plant typhoid fever and intestinal diseases have been practically eliminated; in fact, there has not been a single case of typhoid fever since the plant was placed in operation. The raw water handled in this plant is so dangerous that those in authority at the institution provided for expert supervision of the plant about one year ago. The plant is operated and cared for by a woman, the wife of the engineer of the pumping station, under the direction of the expert.

At Longueuil, Quebec, there is a pressure filter plant without coagulating basin. This plant has a capacity of 1,250,000 gallons and is successfully filtering straight St. Lawrence River water.

Kinds of Water Filters.—Rapid sand filters is a generic term implying two essential types of filters, the gravity and the pressure. The gravity filter is one wherein the water is passed through the filtering medium by the force of gravity. Such filters are contained in open tanks and the raw water always passes through a coagulating period before reaching the filter. The pressure filter is enclosed in a steel tank and operates under pressure. The arrangement of the underdraining system is quite similar in both types of filters, and each has a bed of filtering material of about the same kind and depth of sand. The chief difference is as before stated, in that one operates under pressure and the other by gravity. The pressure filter requires less space than the gravity filter and is particularly applicable in certain cases where it is desired to avoid double pumping of the water, the filter then forming a part of the continuous piping system between the raw water pumps and the distribution system. A paper by H. C. Stevens, published in the Journal of the American Waterworks Association, Volume 3, Nos. 2 and 3, 1916, gives a very good summary of the present status of the pressure filter in municipal water filtration.

The gravity filter is of far wider usage, since it appears to be somewhat better suited to all around conditions, but it must not be forgotten that there are numerous cases where the pressure filter will prove distinctly better.

Preparatory Treatment of Water for Filtration.—In preparing raw water for gravity filtration it is always essential that it first be freed of a substantial percentage of the impurities it contains in order not to unnecessarily overload the filter, and thus unnecessarily decrease its reserve capacity and increase the cost of its operation. This preparatory treatment may be effected by long storage, whereby the suspended matters are separated out of the water by sedimentation, or by coagulation and sedimentation, in relatively small basins. The latter procedure is the one most commonly followed, since its effect is quicker and far more thorough and its cost far less.

In the preparatory treatment last mentioned an iron or aluminum salt is used as a coagulant, and sometimes a mixed salt of these two bases.

In Canada, sulphate of alumina is used chiefly. The action which is brought about by adding the aluminum salt to water was discovered thousands of years ago in China, and results in the release in the water of a flocculent, neutral hydrate of aluminum, which attracts and enmeshes the suspended and coloring matters in the water, including the bacteria, and thus forms relatively large aggregate which settle out rapidly in basins designed for that purpose. Such of the coagulated matter as passes the coagulating and settling basin is strained out by the filters, and a clear and colorless filtered water results.

The basins in which the raw water is prepared for filtration are of various types. Some are rectangular in plan, some square, some circular, their shape and size depending chiefly upon the character and volume of the water to be treated, and sometimes upon the topographical conditions met with.

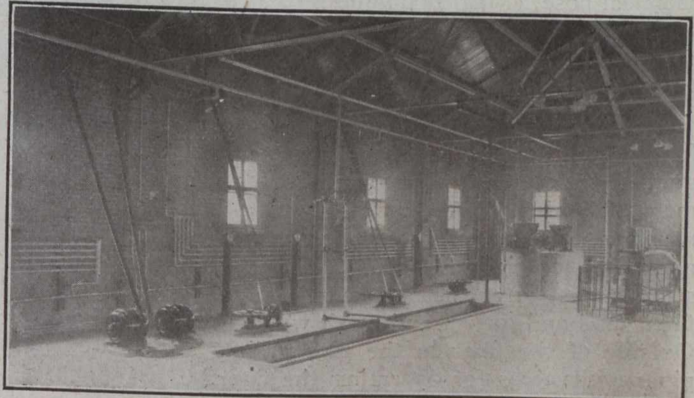
The design embodies well-known and essential features. First, the basin is divided into two compartments, so that one-half may be cleaned while the other is in use. It is important that the water enter the basin evenly throughout its width, and we find that to deliver the water, at or near the surface, is good practice. The effluent should be taken from near the surface, and evenly over the width of the basin. In a straight flow basin it is not found that baffles are necessary, other than that it is well to arrange to stop a "short cut" surface flow with a baffle near the inlet end.

In other basins where baffles are used, sudden and violent fluctuations in velocity of flow are avoided so far as possible, in order to prevent the breaking up of the forming coagula. Baffles are advisedly placed here and there in these basins to prevent the undesirable short-circuiting, and the cross-sections of the passages under and around these baffles are computed to a considerable degree of nicety in order to avoid sudden increases in the velocity of flow, which would not only tend to break up the forming flocs of hydrate, but sweep along with the flowing current, matters already brought to rest on the bottom of the basin.

It is necessary to have drains of ample size from a sump in the basin and gates on these located in a dry chamber. There should also be arranged an overflow of adequate dimensions. It is very convenient to provide water under pressure, inside of the basin, where a hose may be attached for washing out the deposits. In this climate the basins must be decked over and covered with earth to prevent freezing, which necessitates manholes properly located for access and lighting.

Application of Coagulant Solutions.—No department of the purification process is more important than that wherein the coagulant solutions are applied to the raw water as it enters the coagulating and settling basins. As the character of the raw water changes, the dose of coagulant must be changed accordingly, and unless this is done intelligently, not only are poor filtration results to be anticipated, but a material waste of coagulant is unavoidable. This coagulant costs money. Probably all of one-third of the cost of operation of a filter plant is represented by the cost of the coagulant. Insufficient coagulant means poor results, and too much coagulant means unnecessary waste. If the filtration result is unsatisfactory through the use of insufficient coagulant, its cost has been largely thrown away since no better than a poor result has come from its employment.

Where the devices for preparing coagulant solutions and the application of the same are clumsy, primative or require a great deal of manual attention, the dose is liable



Chemical Room, Montreal Water & Power Co.'s Plant.

to fluctuate sharply from time to time. This means alternate under and overdosing, which runs into considerable waste money.

There must be arranged in the plant a chemical storage room, chemical solution tanks and chemical feeding devices. The storage room should be arranged for convenience in getting material into it and in moving the material. The solution tanks, if possible, should be arranged so that the top of the tanks comes at the level of the storage room floor. There should be two solution tanks. The capacity of one of these tanks should be figured to suffice for at least 12 hours' supply, under the maximum quantity of solution needed. The tanks are arranged with dissolving racks, in which the sulphate of alumina is placed, spray pipes for directing the water on to it, and agitators for keeping the solution agitated and of uniform strength. Various arrangements for these solution tanks are satisfactory, and from experience I would avoid only agitators operated from countershaft, where belting and gearing is required. It is doubtful if it is good practice to use electric motors for driving the agitators. A water motor-driven agitator for each tank is in every way a satisfactory arrangement.

Where concrete tanks are used, some arrangement for protecting the concrete must be provided. A solution of sulphate of aluminum will attack concrete and in a short time eat away the surface of the concrete to a considerable extent. Present experience indicates that if the surface of the concrete, when dry, is treated with creosote oil and Barrett specification pitch, it will remain unimpaired for years.

The piping from a solution tank will, of course, provide for drainage and also for taking the solution from the tank to the chemical feeding devices. The solution on passing from the tank should be filtered. This filter should have an area so that the rate of filtration will be about 1.66 Imperial gallons per square foot per minute. It may be arranged in the bottom of the solution tank or outside of the tank. Provision to wash back with clean water must be made. The filtering material is gravel ranging in size from ⅛ in. to ⅜ in. and the thickness of the material from 4 ins. to 6 ins. This little arrangement for filtering alum is most important, particularly on the small plants.

The measuring devices for feeding the coagulant solution after filtering, can be any arrangement whereby a constant known quantity of solution can be fed and by which this quantity can be conveniently and quickly changed. The solution from the feeding devices can be conducted to the point of application in lead pipe, or chemical hose, either by pumping so as to feed by gravity, or through a pump suction box to feed to the suction of the low lift pumps.

Construction of the Filter Proper.—The rate of filtration adopted for mechanical filters is one hundred and four million Imperial gallons per acre per day, or 1.66 gallons per square foot per minute. The general arrangement of modern filters is well known. The filter shell is usually made of reinforced concrete, rectangular in shape and seven or eight feet deep. It is equipped with a strainer system at the bottom, about thirty-six inches of filter sand and gravel and wash water gutters at the top. Outside of the filter in the pipe gallery are located the pipes and valves for operating the filter.

The strainer system may be the combined or separate air system. On the design of the strainer system largely depends the uniform rate of filtration. This is so for two reasons: First, it must collect the water passing through the sand in uniform quantities over the whole area of the bed; second, it must distribute the wash water at a uniform rate over the whole bed. The distribution of the wash water is the most important detail to have correct in the filter. If this is defective or the waterways are too small the washing of the bed is not uniform and in a short time there will be alternate areas of clean and dirty sand.

The design of a strainer system for a bed having an area of 150 square feet, or less, should not be used for a bed of greater area; that is to say, a central manifold casting from which lateral pipes branch each way, to the sides of the bed, can be supplied with water from one end, while in beds of greater area the manifold pipe should receive its supply at the centre, or in very large beds, at two points. It is probable that a bed having an area of 420 square feet, which would equal a million Imperial gallon unit, should be designed with a manifold at each side and the lateral pipes laid between them, thus effecting a pipe system without dead ends. The manifold and lateral pipes should be of cast iron. In filters of small area, however, genuine wrought iron pipe is used for laterals.

The strainer caps or strainer heads, sometimes called sand valves, are of numerous and widely varying designs. Many of them are covered by patents. They are made of brass or bronze and so designed that the flow of water through them is broken up and equally distributed. Where the combined air and wash water system is used, a brass trap tube is usually required.

The placing of the strainer system in the bottom of the filter should be done with great care, particularly if the combined system is used. It is very important that the strainer caps be practically level throughout the area of the bed and a variation of over ⅛ of an inch is not permissible. Strainer caps should be spaced not more than 6 ins. on centres. After the strainer system is in place, the whole should be embedded in lean concrete and the surface finished off with a layer of good cement mortar about ¼ in. thick. This surface should be brought level with the lowest waterway to the strainer head.

Nine inches of properly graded gravel placed in the bottom of the bed is apparently sufficient. This gravel should be graded in size from ¾ in. to ⅛ in. On top of this, 27 ins. of carefully selected silica sand should be placed. The grading and the size of the sand is important from an economical point of view. If a sand not properly graded, that is, containing too large a percentage of fine particles, is used, the fine particles will eventually be washed out and it will be necessary to replace the material so lost. On the other hand, if the size of the sand is not larger than .60 millimeter and smaller than .37 millimeter, with a uniformity co-efficient of 1.65, practically no waste will occur from fine particles being washed away.

Wash water gutters are constructed of concrete, sheet iron, steel and of cast iron. The writer's experience has been with cast iron gutters and they have been found satisfactory. The top edges of the gutters should be planed to a straight line so as to permit the lip of all of the gutters in the bed to be set at one level. The distance above the surface of the sand at which these gutters should be placed, depends upon what the rate of application of wash water is to be. If filter washing is to be aided by compressed air agitation, then a vertical rise of wash water of 13 inches per minute will suffice. If no air is used, but dependence laid upon what is known as the "high velocity wash," as used at Cincinnati, Ohio, and elsewhere, then a vertical rise of wash water of 30 ins. per minute is not uncommon. Naturally the whole sand bed is floated when wash water is forced upwards through it, and the higher the velocity of upward flow of this water the higher the sand layer will rise, consequently, to avoid loss of sand, the wash water gutters must be placed sufficiently high so that whatever rate of application of water is employed the filter sand will not be washed out of the tank and so lost. The capacity of the gutter should be such as to carry off the flow when running within 1½ inches of full. It is important that the drain from the wash water sump be amply large to take away the wash water, and that the drain be so laid that air will not trap and cause a back flow.

Wash Water and Air Application Devices.—The washing of the bed by first applying air to agitate the sand and then the water, can successfully be done with a quantity of water that will equal a vertical rise of 13 inches per minute. In filter beds where air is not used for agitating the sand, but where revolving rakes are used for agitating, a vertical rise of 12 ins. per minute is sufficient.

(Concluded in the next issue.)

PROPOSED SPECIFICATIONS FOR HIGHWAY BRIDGES

PROPOSED RECOMMENDATIONS OF COMMITTEE OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS—ARE COMPREHENSIVE IN CHARACTER.

[In *The Canadian Engineer* for April 6th and 13th, 1916, articles appeared by E. H. Darling, A.M.Can.Soc.C.E., entitled "Impact Formulas for Highway Bridge Design." The first article of the series dealt with the history of two railway bridge impact formulas, showing their unsuitability for highway bridge design. The second article discussed the Dominion government and Ontario government impact formulas and made some suggestions as to their simplification. In view of the proposed specifications for highway bridges, a draft of which follows, and which were presented and discussed before a meeting of the Mechanical Section of the Canadian Society of Civil Engineers, held in Montreal, November 30th, Mr. Darling's articles will be of interest to all who are interested in the design of this particular type of bridge.—EDITOR.]

THE draft report of the committee appointed by the Society was read by Mr. P. B. Motley, chairman. The discussion which followed was participated in by Messrs. W. C. Thomson, Walter J. Francis (who was in the chair), H. B. Stuart, C. N. Monsarrat, P. L. Pratley, G. H. Duggan, F. P. Shearwood and Prof. Brown.

The proposed specifications are intended to apply to steel highway bridges carrying ordinary highway traffic with or without electric street cars. They will not, however, cover bridges which carry electric railways only, as these will be designed under the specification for steel railway bridges.

In the case of combination bridges, carrying both railway and highway traffic, the responsible engineers on each individual project will be expected to issue particular specifications governing the questions of loading and unit stresses. Further, insomuch that modern practice has adopted riveted structures for all ordinary highway work, the specifications will not cover pin bridges, so that in the instance of long and important structures, where eye-bars and pin connections might possibly be used to advantage, special clauses covering this class of work will need to be drawn up by the responsible engineer.

The range of service to be accommodated under the general head of highway traffic is, necessarily, extremely wide, but the following are the principal considerations which will enter fundamentally into the design of those structures covered by this specification.

Firstly.—The amount of money available for the construction and its effect on the question of the permanency or semi-permanency of the bridge and upon the question of providing for probable future increase in traffic.

Secondly.—The location of the bridge and the character of the roads in its neighborhood with the probability of their being subject to improvement.

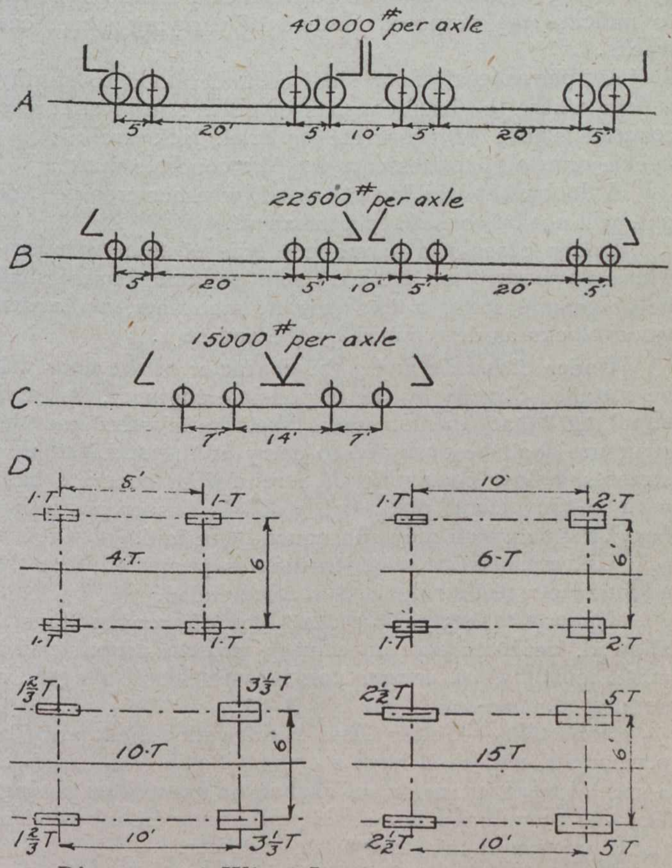
Thirdly.—The situation with respect to traffic as affecting the character of the flooring and the nature and magnitude of the superimposed loads.

With a view to meeting the whole range of conditions the specification classifies bridges according to the requirements of service and permanency under the following heads:—

Class 1 is intended to provide for first-class permanent structures situated on main arteries of traffic in large towns and cities where heavy concentrated loads, due to transportation of machinery and building material frequently occur. Bridges as designed under this class, will be equal in respect to permanency, rigidity, thickness of metal, and all details, to those built under the best railway practice.

Class 2 is intended to provide for city bridges in residential districts, where general traffic regulations limit both the loads carried on the highway and the speed of street car traffic. Bridges designed under this class will be equal to those designed under Class 1 in respect of general stiffness and constructional details.

Class 3 is intended to provide for highway bridges in towns where heavy manufacturing is not conducted and for bridges on main country highways. The need of providing for actual or possible street car traffic and the issuing of specifications regarding the street car loads are matters which will be left to the responsible engineer.



Diagrams of Wheel Loads Applying to Steel Highway Bridges.

Class 4 is intended to govern roadway bridges serving farming communities and situated on unpaved roads where it is unlikely that the character of the loading will change during the normal life of the structure.

Class 5 is intended to provide for bridges in remote or mountainous districts difficult of access, where lightness and first cost are prime considerations in determining the character of the proposed bridge.

The purpose of the classification is not to rigidly group every bridge under a specific head, but to guide the responsible engineer or purchasing authority in the making of suitable decisions regarding loads, unit stresses and general design; in consequence whereof the clauses touching upon these essential questions will refer to the various classes suggested. The engineer on important bridges will still be expected to use his professional judgment and his knowledge of local conditions, either of which may justifiably lead him to a combination or modification of the classes above outlined or of the clauses in the specification referring thereto.

Movable Bridges.—The specifications cover the design of the structural work for all kinds of movable spans, and include clauses governing the design of the machinery and machine parts of hand-operated swing bridges. In the case of power-operated swing spans, bascule or vertical lift bridges, where the machinery is an all-important feature of the construction, it is recommended that the design of these features be referred to an engineer specializing in this work.

Floors.—For bridges built under Classes 1 and 2 a careful description of the floor system to be employed should be supplied by the responsible engineer, preferably by drawing or detail sketch. Special care should be taken to indicate the proposed method of carrying street car tracks.

A "permanent" floor shall be understood to signify a floor where the base consists of either: (*a*) Reinforced concrete slabs; (*b*) concrete or brick jack arches; (*c*) buckle or trough plates carrying the concrete matte.

A floor where the base is wood, whether creosoted or not, will not be considered permanent.

Under Class 1 a permanent type of floor is everywhere demanded and the pavement or upper course shall be of granite setts, brick, asphalt, macadam, or treated wood blocks as determined by the engineer.

Under Classes 2 and 3 the character of the floor will be specified directly by the responsible engineer, but it is stipulated that the stringers shall be of steel and the structure shall be designed to carry at the specified unit stresses a floor consisting of a reinforced concrete base with a pavement of 4-inch wood blocks or any other heavier type which may subsequently be laid.

Under Class 4 a wooden floor is permitted, but the adoption of steel stringers is recommended.

Under Class 5 the lightest type of wooden floor is allowed, but even here an enquiry into the probable ultimate economy of longer panels with steel stringers is suggested.

Sidewalks.—Under Class 1 sidewalks shall also be permanent, and shall have a cement finish to the slab or a special wearing surface of asphalt or granolithic paving. For the remaining classes sidewalks may be of wood at the discretion of the responsible engineer.

Wooden Floors.—Wooden stringers shall not be used on greater spans than 15 feet and shall have a width of not less than 3 inches or one-fourth of their depth. They shall lap by each other on the floor beams to give each a full bearing and shall be bolted together, using washer separators not less than one-half inch thick in order to secure free circulation of air.

Wheel Guards.—On wooden floors wheel guards, of 6 x 4-in. timber, shall be provided at each side of the roadway and shall be supported on 2-inch blocks spaced not over 5 feet, held in place by a three-quarter inch bolt through the guard, the blocking piece and the timber floor. The splices in wheel guards shall be half lap joints 6 inches long, and shall occur over the blocking pieces.

For permanent floors the wheel guard will, generally, be formed of concrete effectively protected by steel angle rubbing pieces.

Scuppers.—On permanent floors of any description suitable scuppers shall be provided not less than 20 feet apart, so arranged to carry all drainage clear of steelwork.

Live Loads.—The varied character of the loads applied to highway bridges renders it impossible to include in a general specification a statement of the precise loading to be used on every bridge and any table of suggested typical loads must be recognized as necessarily having the following limited purposes:—

(*a*) To guide the responsible engineer in his choice of a structure in regard to capacity and efficiency.

(*b*) To indicate to non-technical officials or to engineers not specially experienced in bridge-work, what constitutes accepted good practice.

(*c*) To guard against the possibility of a structure being provided, which is insufficient to meet the immediate requirements or those reasonably certain to occur in the future.

On the other hand, the specifications should not prevent the building of very light bridges, which, while sufficiently strong to withstand the vertical and vibratory loadings, should be able to compete successfully in the matter of first cost and maintenance with the alternative wooden construction. The majority of existing light structures, which would fall under the 5th class, above indicated, have not been built to any of the recognized standard specifications, and, indeed, no present specifications in vogue in Canada permit of this, nevertheless necessary, class of bridge. With the idea of meeting both the financial and service requirements of such cases, the permissible loadings under Class 5, as well as certain other limitations, are less exacting than in the existing standard specifications.

Two Main Divisions.—The loading on a highway bridge, naturally, falls under two main divisions, the assumed uniformly distributed load and concentrated wheel loads. The first division will consist, generally, of crowds of people, animals in droves or a large number of light vehicles. Crowds of people, such as quickly gather at accidents or for sight-seeing, on city bridges, are seldom productive of 100 lb. sq. ft. average load, and for moving loads this figure would, undoubtedly, cover all cases to be provided for at ordinary unit stresses. Classes 1 and 2 are likely to experience such loads at frequent intervals and for almost unlimited lengths, while classes 3 and 4 may receive the same intensity of loading but far less often, and over smaller areas. Animals in droves, will never exceed 60 lbs. per square foot and for Class 5 this would represent the maximum load.

The second division will include all classes of heavy vehicles, such as street cars, auto trucks, horse-drawn lorries and road-making machinery. Local conditions alone can determine the type and magnitude of loading for which steel should be proportioned.

In bridges of Classes 1 and 2 the proximity of factories, wharves, railway yards, the nature of the street car service, the possibility of loads, due to building materials, cable spools, heavy guns, steam rollers, or traction engines must all be duly considered in specifying the applied concentrations. It may also be noted here that the authorities owning these classes of bridges are also generally empowered to regulate traffic, and it will devolve upon their executive engineer to consider the principle of equity involved in the question, whether the publicly owned bridge should be capable of accommodating some unusual "freak" load, avoidable at a certain cost to the transportation company, or whether the traffic regulations should not control the use of the bridge for such purposes on the basis of engineering economics.

The figures given in the following tables are considered safe maximums for usual cases, and are recommended for adoption only in default of specific information from the responsible engineer.

Impact.—The function of the so-called impact allowance is twofold. Firstly, to take care of actual increases in the magnitude of the applied load liable to occur at infrequent intervals. Secondly, to make provision for the increased stresses due to dynamic application of the loads. To the uniformly distributed loads described above only the first aspect of impact will apply, and insomuch as same maximum figures are recommended for adoption no further increment for use at normal unit stresses is considered necessary. To concentrated wheel loads both aspects of impact may be presumed to apply, and a simple percentage of the static load is suggested as the increment. It is believed that the effects of the dead load and the length of the span affected are suitably provided for in this percentage, insomuch as the concentrated loads will in general govern floor members only, and the type and weight of floor will bear some sensible relation to the magnitude and ferocity of the wheel loads.

Table of Live Loads.—1. For floor stringers, cross-beams, hangers, and any members of trusses and girders where concentrated wheel loads govern the sections.

	Uniform load.	Street cars.	Trucks, etc. See Dia. D.
Class 1	100 lbs. per sq. ft.	Dia. A	2-15 ton alongside or following
Class 2	100 lbs. per sq. ft.	Dia. B	1-15 ton
Class 3	100 lbs. per sq. ft.	Dia. B or C (if any)	1-10 ton
Class 4	80 lbs. per sq. ft.	None	1-6 ton
Class 5	60 lbs. per sq. ft.	None	1-4 ton

2. For trusses and girders—

	Uniform load.	Street cars.
Class 1.	100 lbs. per sq. ft. up to 200 ft., thence diminishing arithmetically to a minimum of 75 lbs. at 400 ft.	2,400 lbs. per ft. per track for freight cars. 2,000 lbs. per ft. per track for passenger cars.
Class 2.	100 lbs. per sq. ft. up to 100 ft., thence diminishing arithmetically to a minimum of 60 lbs. at 300 ft.	2,000 lbs. per ft. per track.
Class 3.	80 lbs. per sq. ft. up to 100 ft., thence diminishing arithmetically to a minimum of 50 lbs. at 200 ft.	1,600 lbs. per ft. per track if any.
Class 4.	80 lbs. per sq. ft. up to 80 ft., thence diminishing arithmetically to a minimum of 50 lbs. at 200 ft.	None.
Class 5.	60 lbs. per sq. ft. up to 60 ft., thence diminishing arithmetically to a minimum of 40 lbs. at 100 ft.	None.

Scope and Combination of Loads.—Uniform live loads shall be applied to full width of road surface between wheel guards and on sidewalks to the maximum clear width available for traffic. The assumed equivalent uniform live load for street cars shall be applicable to the whole length of the trackage on the span or any portion thereof. Each street car track shall be assumed to occupy 10 feet width of roadway. The following combinations shall be considered possible:—

Street car loads and other concentrated or uniform loads for floor beams and hangers.

Street car loads and half uniform load on remainder of floor surface for trusses of Classes 1, 2 and 3.

When sidewalks are carried on brackets outside of the main trusses provision shall be made in the trusses for the cantilever effect of loading one sidewalk and the full load surface between trusses with 75 per cent. of the specified uniform loading.

Impact.—The percentages of the live load from wheel concentrations to be added for impact will be as follows:—

To stringers, 40 per cent.

To floor beams and hangers and other truss members affected, 20 per cent.

The intention is that each of the branches of the Society shall discuss the suggestions as outlined, and submit whatever criticism they see fit. After that has been done the committee will consider all such criticisms and make their final recommendations at the annual meeting.

DRYDOCK FOR VANCOUVER.

An Ottawa dispatch says:—Arrangements have been completed for the construction of a large floating drydock at Vancouver. The structure will be a 16,000-ton, double-section dock, capable of handling a boat of 18,000 tons, which is the measure of maximum requirements on the Pacific to-day. The company is the Vancouver Drydocks, Limited, with Mr. Charles Meek, of Vancouver, as the moving spirit. Bonds to the amount of two million dollars have been sold to Breed, Elliott & Harrison, of Cincinnati. A ship repair and shipbuilding plant is a part of the plan decided upon. Contracts for construction and machinery are being let, and the company announces that it will have the dock in operation within a year. There will be subsidy aid from the governments of both the Dominion of Canada and the province of British Columbia, on the ground that the dock will be a commercial and naval asset.

Steamers sailing from Canadian ports on the Pacific at present are forced to dock for repairs at Hong Kong, at Kobe, Japan, or in Australia.

Water-power to the extent of 100,000 horse-power, for the generation of electrical energy, is about to be used at Telemarken, in Norway, by a Franco-American syndicate for electro-technical works.

A considerable impetus has been given to the mining in India of wolfram ore for the recovery of tungsten. Last year the total output was 2,645 tons—an increase of 13 per cent., and the value increased by 56.2 per cent.

Hydro-electric power plants are in existence in many places in South America. The Rio de Janeiro Tramway, Light and Power Company has a 50,000 horse-power plant fifty miles distant from the city. The Companhia Brazileirade de Energica Electrica, in Rio, has rights to supply power up to 150,000 horse-power. The main turbines are on the Piahanha River, while a power-house on the Itatinga Falls produces 60,000 horsepower. The harnessing of the San Francisco River has been contemplated, the Paulo Affonso Falls being calculated to yield 5,000,000 kilowatts. In 1913 the Germans supplied water-power plant to the value of £68,000 to South America.

SCOTCH METHOD OF CLEANING WATER MAINS.*

WATER mains lose capacity because of the formation of incrustations upon the inner surface and by sedimentary deposits. Both reduce the effective cross-section and increase the friction. Perhaps the formation of incrustations is the more important of the two. The reduction in capacity may become very great. A loss of 30 or 40 per cent. is not at all unusual. The modern remedy for such conditions is to clean out the mains. There are American methods of doing this, but it is the purpose of this article to give an account of a Scotch apparatus and the methods of using it.

The city of Ayr, in Scotland, derives its water supply chiefly from a lake in the neighborhood of the headwaters of the Doon River. This lake, Loch Finlas, is some twenty-odd miles to the south of Ayr. The supply is conveyed by a main 17 miles long to a service reservoir near Dalrymple which has a capacity of 7,000,000 gallons. For 2½ miles the main consists of 18-inch fire-clay pipe. The gradient of this stretch is 1 in 350. All the rest of the main consists of cast-iron, coated pipe. For 8 miles this main has a diameter of 16 inches and for 6½ miles, of 14 inches.

Scraping Cast-iron Mains.—It was determined to scrape the cast-iron sections. The consideration impelling to this determination was the necessity of quickly increasing the water supply some half million gallons per day. It was hoped that this increase might be realized and the laying of a new main deferred for a time. The main was laid in 1887 and was calculated to have at that time a capacity of 2,592,000 gallons per day; but whether this calculation was ever verified is doubtful. However, in 1903 the measured capacity was found to be 2,037,000 gallons, and for 1911 the capacity was determined to be 1,865,000. It would seem that there had been a total loss of some 727,000 gallons daily. It was not unreasonable to anticipate, in view of these figures, that cleaning might restore the main to a condition equal to the necessities at the moment. This hope was fully realized. In fact, the capacity determined subsequently to cleaning was found to be within 46,000 gallons per day of the original calculated capacity.

Cleaning is supposed by some to promote incrustation afterwards. Granting this, the cost is not great, especially when proper provisions have been made in the pipe line, and cleaning may very well prove economical.

Cost of Scraping.—The cost, as reported by Mr. Jas. Macfazdean, assistant burgh engineer, Ayr, is divided between the 14-inch and the 16-inch lines and includes in both cases certain apparatus of a more or less permanent character. For the 14-inch pipe, 6.43 miles, the total expense was $1,061, and for the 16-inch pipe, $1,926, or a grand total of $2,987. The apparatus cost for both sections amounted, however, to $2,091. It will be seen from these figures that the actual cost really chargeable against the one cleaning is no great amount—perhaps $1,200 (including depreciation, etc.), or $82.76 per mile. In the United States, these figures would doubtless be increased somewhat because of the presumably higher cost of labor.

A sample of incrustation from the main was subjected to chemical analysis with the result that 70 per cent. was found to be peroxide of iron. A much smaller percentage (2.57) was protoxide of iron. The carbonic acid percentage was 1.12. Water and organic matter accounted for 24.42 per cent. The remainder, totalling less than 2 per cent., was divided amongst several inorganic compounds. It will thus be seen that fully half of the incrustation came from the pipe. The water itself contains no iron. It is quite soft. Its analysis may be of practical interest, as affording a means of comparison:

	Grains per gal.
Total solids in solution	3.92
Chlorine	0.84
Sodium chloride equivalent	1.38
Ammonia (free)	0.0035
Ammonia (albuminoid)	0.0055
Oxygen necessary to oxidation of organic matter	0.42

The total hardness is estimated at 0.84 degrees.

It was decided to scrape the 14-inch section first. This decision seems now to be regarded as wrong, as that section was the lower part of the line. With the 14-inch main cleaned, the resistance to the on-coming water from the 16-inch pipe was so much less than with the smaller pipe uncleaned, that the pressure was reduced below proper working conditions in certain places, as described below.

Description of Process.—The whole line of cast-iron main was divided up into sections containing 1 or 2 miles each and hatch boxes were placed in position at the points of division. The bends were disregarded. This was permissible for the reason that the minimum radius of curvature was 18 feet. In placing hatch boxes, it is important, as Mr. Macfazdean points out, to take into account the disposal of large quantities of water in such wise as to effect no damage or inconvenience. These boxes may require to be left open for quite a number of hours, so that it is not permissible to locate them just anywhere. There will be an excavation, of course. It may seem advisable, in built-up sections, to wall these up and otherwise provide for permanence and accessibility. It is suggested that it is undesirable so to locate a hatch box as to have back drainage from any considerable length of pipe. Further, it is of importance to be able to control the water entering a given section at a point near the beginning of that section.

In the present case, the difficulties to be cared for were somewhat simplified because the main itself discharged into a reservoir containing nearly a three-days supply. The hatch boxes were placed, two at a time, every other day, under a requirement that water was to be shut off for no longer than 6 hours per day. There was only one considerable departure from the time requirement, and this was due to flood from the river.

The method of cleaning is briefly this: The hatch box is opened up and the scraping device put in place, when the lid is securely bolted on. Upon turning on the water, its forward impetus, operating against the pistons of the device, will serve to drive it ahead. Scrapers suitably disposed are carried along and perform their duty upon the incrusted surface of the pipe. The pressure was reckoned as a hydraulic head of 15 feet. There were two places where this head could not be relied upon, so that here hatch boxes were placed at either end of each of these short sections, so that the scraper could be hauled through by means of a line.

Prior to the cleaning of a section, the water is cut off from its length and a complete drainage effected. The hatch box covers are lifted off by means of a suitable

*Wated and Gas Review.

derrick or other device, and the scraper lowered into position in the upper box.

In a section about to be scraped, the main valves should be opened wide to avoid hindrance to the scraper. In order to prevent filling of service pipes with debris from the scraper's activity, they are to be shut off. As the air valves must be left open, they should be cleaned out after the work is over.

There will be a heavy discharge of water through the open hatch box at the far end of the section. A plug is put in place at one end where the hatch box opens into the part of the main next to be cleaned. Thus is prevented the washing of debris into that section. In the American system, a pipe is put in place at the far end of a section. This is inclined to the vertical and serves to throw the water out upon the general surface.

The scraper used on the 16-inch main weighed about 335 pounds. Going through the main it had an average speed of perhaps 2 miles an hour with a 15-foot hydraulic head back of it. It will be seen from this that the actual normal cleaning operation is by no means protracted. There were no very steep climbs taken by the scraper. There was one incline of 1 in 9½, 980 feet long, and no difficulty whatever was experienced in negotiating it.

The lower hatch box and its excavation must be pumped out after the work is over.

After the scraper arrives at the hatch box, which is its destination, the water is shut off. It is judged important to do this quite promptly, if the drainage from this point is not good. As the scraper passes the successive scour valves they are shut off. When the scraper has finished the section, these valves are opened up again. In order to get word back to the point of water control at the head of the section when the scraper finishes, a field telephone may be employed. Or, as in the present case, a system of signalling may be used.

Locating the Scraper.—When the scraper finished its first trip through a section, it was hauled back for a second. In this way, each section was given two cleanings without any delay between.

When the scraper is working its way between termini, it is very important to have some adequate means of locating it. It may, in fact, encounter an obstruction which it is incapable of passing or carrying along. There are ways of stirring it into activity, but these sometimes fail, when the only alternative left is to excavate down to the main and cut out a short length where the scraper is or else quite close to it. There are two principal methods of keeping track of the apparatus. One, employed in the United States, and perhaps elsewhere, is to attach a line to the rear end. The length of line at any moment will indicate the advance of the machine. Another method is to follow the ongoing apparatus by sound. Sometimes the noise is able to penetrate to the surface and reach the ear of an attendant workman without the aid of a special apparatus. At other times, a kind of stethoscope is employed. In this case, a number of men will set up the stethoscope at short intervals. When the slowly moving scraper passes the rear man he goes forward and sets up his instrument at the head of the line, and so on.

If the machine stops, it may at times be persuaded to resume by means of an induced water hammer. Presumably this is effected by a quick shutting off of the water and a quick subsequent release. Sometimes a mere jarring of the main will be sufficient; at others, a wisp of hay floated down to the rear end of the scraper may be successful in getting it going again.

Result of Cleaning.—The two portions of the cast-iron main were cleaned one year apart. The 16-inch main was originally laid in order to get a flow over high ground that was located in the first 8 miles. When the 14-inch main was scraped and its capacity restored, the pressure line at the junction fell to such an extent that at one point it was no higher than the pipe itself. The result was that the remainder of the line became nothing more than a series of inverted siphons and certain consumers were cut off from their supply. This condition required the closing down of some of the valves and a consequent throwing of the pressure back on the main behind. In consequence, the natural advantages of the cleaning operations upon this 14-inch section were not secured until the 16-inch section above was cleaned one year later.

The capacity was then almost fully restored to its original theoretical amount.

After a period of two years subsequent to the completion of the scraping, a capacity test was tried with the result that 40.5 per cent. of the gain was found to have been lost. In other words, in two years—or possibly we should call the interval something over two years because of the early cleaning of the 14-inch main—the interior condition was two-fifths as bad as before scraping.

It would seem that the necessity of a yearly cleaning, or even a more frequent one is indicated. The actual cost of cleaning is not great, once the hatch boxes have been built into the line and walled-in excavations provided. In the present instance, the scrapers themselves were purchased, one for each size of main. New leads and leathers are necessary for each cleaning operation. The incrustations in the pipe line were due to an oxidation of the iron, presumably at points left exposed by some imperfection in the coating process. Apparently, a nodule grows upward and radially from this centre, while a corrosive activity goes on downward into the metal and over the surface beneath the growing nodule. Layer grows upon layer, causing the nodule to project more and more. The spread of the corrosion on the metallic surface undermines the coating. A nodule cited by Mr. Macfazdean had a diameter of 1½ inches. The central decomposition of the iron was 3/16-inch deep and the general decomposition 1/16-inch. The coating and the iron were sound beyond the area covered by the nodule. Apparently, there is a somewhat regular increase of the corrosive effects while individual nodules continue distinct. Upon their coalescence, however, and the formation of a continuous layer of incrustation, corrosion slows up. There is reason to think that it will cease altogether when the coating of incrustation has reached a definite thickness, presumably different for differences in conditions as respects the chemical constitution of the iron and the water.

It will be of interest to add here that one main at least is known in which cleaning is done regularly year by year, where the loss of capacity and restoration are also regular and equal in amount. That is to say, during the year the capacity falls off, but is fully restored by the cleaning operation. This would not appear to bear out the idea that the pipe requires more frequent cleaning because of the cleaning itself.

It seems that some trouble has been experienced with having the plug at the lower hatch box driven up into the main ahead. A method of avoiding this difficulty has been to use a scoop in the pipe over the plug. It seems that a "fish cutter" has proved serviceable in preventing the scraper from sticking in the main.

A METHOD OF MAKING WEAR TESTS OF CONCRETE.*

By D. A. Abrams.

Summary.—The extensive use of concrete in the wearing surface of roads and pavements gives interest to wear tests of concrete.

A brief review is given of tests which have been used for determining the wearing resistance of concrete aggregates and concrete.

A method is described for conducting wear tests on concrete blocks 8 ins. square and 5 ins. thick by means of the Talbot-Jones rattler.

This method is believed to offer the following advantages:—

1. The concrete is subjected to a treatment which approximates that of service.
2. The test piece is of usual form and of sufficient size that representative concrete can be obtained.
3. The test pieces are convenient to make, store and handle, and require a relatively small amount of concrete.
4. The cost of tests is not excessive.
5. The machine used is found in numerous testing laboratories.
6. The wearing action takes place on the top or finished surface of the concrete. This makes it possible to study the effect of various surface treatments or finishes.
7. Several tests may be made at the same time, thus enabling more representative results to be obtained.
8. Tests may be made on sections of concrete cut from roads which have been in service.
9. Other paving materials, such as brick, granite blocks, etc., may be tested in the same way as the concrete.

THE extensive use of concrete as the wearing surface of roads and pavements has given renewed interest to experimental studies of the wearing resistance of concrete.

If weather resistance and structural stresses are properly provided for, the life of a road will depend on the wearing resistance of the material of which it is built. Satisfactory wearing resistance is one of the most important considerations of any materials to be used in road surfaces.

Wear, in the sense in which the term is here used, results from combinations of stresses such as abrasion, impact, bearing and crushing. Wearing resistance is a function of the hardness, toughness, brittleness, etc., of a material. In the case of homogeneous materials, such as natural rocks, it may be satisfactory to study the individual properties mentioned above; however, with a material of the nature of concrete, it is preferable to study the wearing resistance directly, without reference to the value of the more elemental properties.

Numerous testing machines have been designed for use in determining the abrasive resistance of natural rocks, cement mortars and brick. The following are typical of the methods which have been used:

Dorry Hardness Testing Machine.—The Dorry hardness testing machine has been used for natural rocks. The test pieces consist of 1-in. cylinders cut out by means of a core drill. The cylinders are tested in pairs by being held in a vertical position with a constant pressure against a revolving metal disk. The abrasive agents are crushed quartz and water. The hardness of the material under test is measured by the depth of wear. This test was devised by the French School of Bridges and Roads, and used by United States Office of Public Roads and Rural Engineering for tests of rocks for macadam road construction. This test is carried out with considerable difficulty and is of doubtful value as an indication of the useful properties of a rock; it is not adapted to testing concrete aggregates in the form in which such materials are delivered for use, the specimen being too small for use in mortar and concrete tests.

Machines with a cylindrical drum against which the test piece is held have been used in carrying out tests of the same nature as those made in the Dorry machine.

Sand Blast.—The sand blast has been used for testing the wearing qualities of natural rocks, bricks, etc.

On account of the absence of the element of impact, the above-mentioned methods are not satisfactory for tests of concrete.

Deval Abrasion Testing Machine.—The Deval abrasion testing machine for crushed rocks consists of a closed metal cylinder mounted in an inclined position on a horizontal axis which is caused to revolve at a fixed rate. The test sample consists of about 50 pieces of crushed rock weighing 5,000 g. The abrasive action is derived from the falling and rubbing of the particles on each other and on the walls of the cylinder, 10,000 revolutions at about 30 r.p.m. constituting a test. The percentage of wear is computed from the weight of material which is reduced to a size smaller than a 1/16-in. sieve. This test was devised by the French School of Public Bridges and Roads, and has been adopted by the American Society for Testing Materials as a standard test for abrasion of road materials. The indications of this test have been widely used as a criterion of the value of rocks for macadam road building. The test is of doubtful value in indicating the suitability of an aggregate for concrete road construction. The size of pieces required by the present standard test is not readily obtainable from the aggregates commonly used in concrete road construction. It is not applicable to tests of gravel.

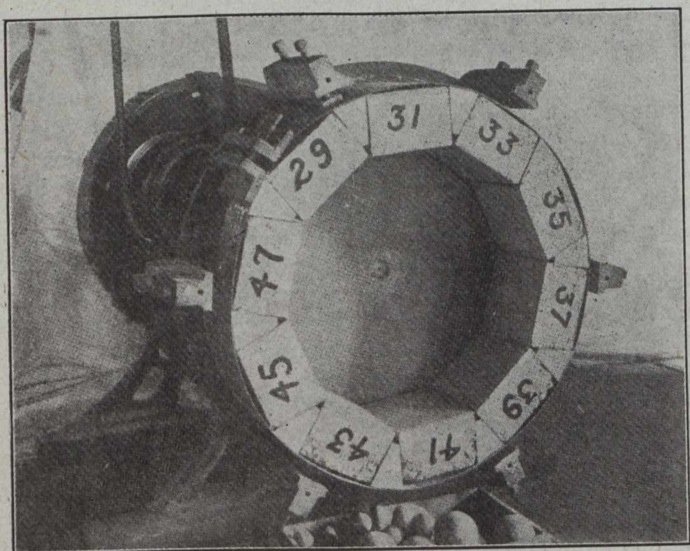


Fig. 1.—View of Blocks Before Test.

A modified form of the standard Deval test has been used for testing gravel by the Ohio State Highway Department. In this test 2,500 g. of gravel between the ½ and 1-in. screens, and a similar weight of material between the 1 and 2-in. screens, are used with an abrasive charge which consists of six cast-iron spheres 1⅞ ins. in diameter. Otherwise the test is conducted in the same way as the standard test.

Several attempts have been made to use the Deval machine for studying the wearing resistance of mortars

*Paper read before the American Society for Testing Materials.

and concretes. The test pieces used were small cubes or spheres of mortar or concrete, which were placed in the test chamber in sets of three or four, with or without a charge of metal shot. On account of the small test pieces which must be used, these tests have not proved entirely satisfactory.

Development of Rattler Test.—The development of the rattler test for paving brick is of interest in this connection. The present standard rattler is an adaptation of the ordinary foundry rattler. The Talbot-Jones rattler was designed for testing paving brick, but was not officially adopted as a standard method.

A "pavement determinator" was on exhibition in Detroit and at the Cement Show in Chicago in 1913, for use in testing sections of finished pavements. This was a motor-driven mechanism which subjected the pavement to impact stresses closely approximating the action of horses' hoofs. The cost of this method would make it prohibitive for either research or routine testing.

As early as 1913 Professor Charles F. Shoop, of the University of Minnesota, made use of the Talbot-Jones rattler for studying the wearing resistance of concrete.

In the tests carried out by Professor Shoop, the test piece was a ring 28 ins. inside diameter, 4 ins. thick and 8½ ins. wide. These rings were cast in a horizontal position with the axis vertical, and were reinforced with two circular steel bars.

Method of Testing.—The writer is now making studies of the wearing resistance of concrete at the Structural Materials Research Laboratory, Lewis Institute, Chicago, in which the Talbot-Jones rattler is being used. The machine is shown in Figs. 1 and 2. The test pieces consist of blocks 8 ins. square and 5 ins. in thickness. The blocks are arranged around the perimeter of the drum of the rattler, as shown in the accompanying illustrations. Ten blocks constitute a test set. The concrete test pieces are separated by wedge-shaped wood blocks. The ten-side polygon formed by the test blocks presents a nearly continuous inner surface, as shown in Fig. 2. The outside diameter of the polygon thus formed is 36 ins., and the inside diameter 26 ins. During the test, the front of the chamber is closed by means of a heavy wire screen.

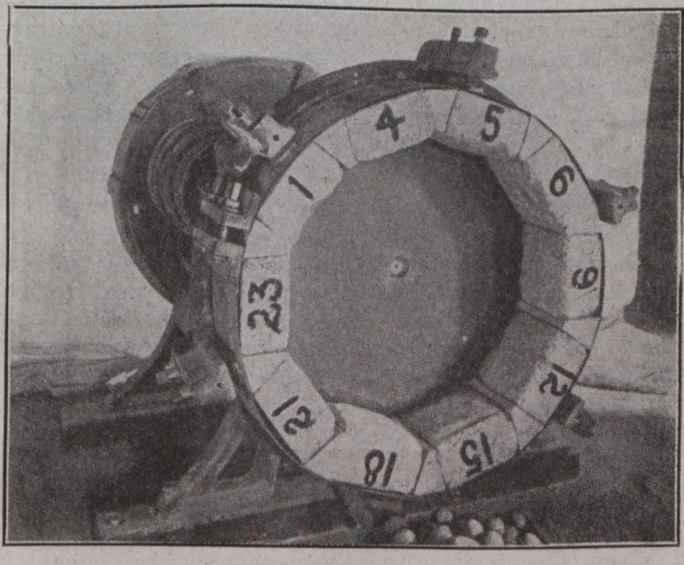


Fig. 2.—View of Blocks After Completion of Test.

The abrasive charge consists of 200 lbs. of cast-iron spheres—about 133 spheres 1⅞ ins. and 10 spheres 3¾ ins. in diameter. These spheres conform to the specifications for spheres for use in the standard rattler test of paving brick. The test consists of exposing the inner faces of the concrete blocks to the wearing action of the charge of cast-iron spheres for 3,600 revolutions, at the rate of about 30 r.p.m. Best results have been obtained by reversing the direction of the machine two or three times during the test. Each block is weighed immediately before and immediately after the test. The loss in weight is considered to be the wear. This loss may be reduced to a percentage of the original weight, or it may be expressed as depth of wear in inches. In comparing concretes of widely different characteristics, or in comparing concrete with other materials, the latter method is preferable.

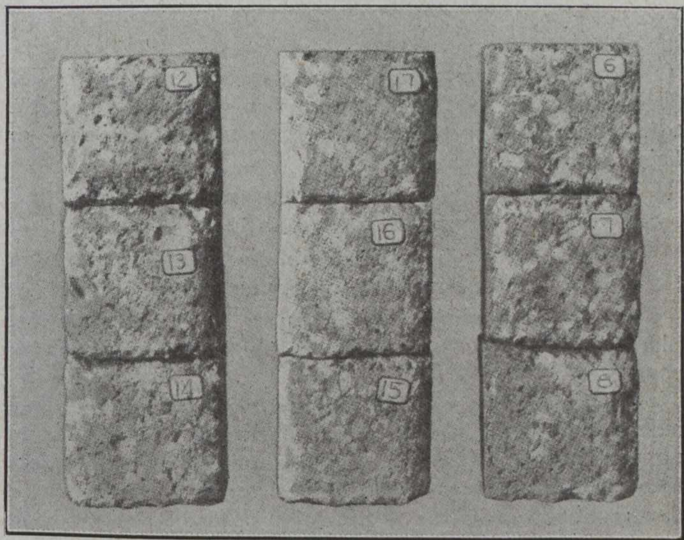


Fig. 3.—Concrete Blocks After Test. Blocks 8 ins. Square, 5 ins. Thick, Age About 5 Months.

Nos. 6, 7, 8 ....1 : 1½ : 2½ gravel concrete.
Nos. 12, 13, 14 ....1 : 2 : 3 gravel concrete.
Nos. 15, 16, 17 ....1 : 2 : 3 limestone concrete.

Results of Tests.—About 200 concrete blocks have been tested in this way. The tests thus far made have been carried out primarily for the purpose of studying the action of the machine. The weight of shot to be used, the proportion of small and large spheres, the rate and number of revolutions, the effect of the position of the block in the ring with reference to other blocks of the same or widely different properties, have been studied. A few variations in the mix, aggregates, condition of storage of the concrete, etc., have been made, but the tests are not considered to be of sufficient scope to justify presenting the results at this time. The loss in weight due to the test has varied from 8 to 25 per cent. Figs. 2 and 3 show the appearance of representative blocks after the test. A few paving brick have been tested in the same ring as the concrete blocks, with satisfactory results.

In making the concrete test blocks, it is our custom to proportion and mix each block separately. Only in this way can consistent results be secured. Metal forms made from 5-in. steel channels are used. These forms make it possible to mold the blocks of uniform size and true to shape. Blocks which have been stored in water or in damp sand are allowed to dry out a few hours prior to test, in order that the weights may not be appreciably affected by evaporation during the test.

Advantages of Rattler Test.—This method of making wear tests of concrete is believed to have the following advantages:—

1. The concrete is subjected to a treatment which approximates that of service.

2. The test piece is of usual form and of sufficient size that representative concrete can be obtained.

3. The test pieces are convenient to make, store and handle, and require a relatively small amount of concrete.

4. The cost of the tests is not excessive.

5. The machine used is found in numerous testing laboratories.

6. The wearing action takes place on the top or finished surface of the concrete. This makes it possible to study the effect of various surface treatments or finishes.

7. Several tests may be made at the same time, thus enabling more representative results to be obtained.

8. Tests may be made on sections of concrete cut from roads which have been in service.

9. Other paving materials such as brick, granite blocks, etc., may be tested in the same way as the concrete.

The tests indicate that this method may prove of considerable value in studying the relative merits of different aggregates, mixes, consistencies, time of mixing, surface treatment, etc., on the wearing resistance of concrete. It can readily be used as a control test on blocks made at frequent intervals as the work progresses.

NEW STEEL WORKS FOR SIBERIA.

It is reported that the Russian Government intends to lease for sixty years to a company with a capital of twenty million roubles (about £2,125,000) a large tract in the district of Kuznetsk (Government of Tomsk) in Siberia. The company are to erect new iron and steel works and to supply a fixed tonnage of rails and other railway material each year for the State Lines. The district is stated to have large coal and iron deposits, the ore having an iron content running in some cases from 58 to 65 per cent.

ELECTRO-CHEMICAL INDUSTRIES IN SOUTH AFRICA.

The Development of Resources Committee of the South African Institute of Electrical Engineers have issued a report on the possibilities of establishing in South Africa certain electro-chemical industries on a commercial basis. At present agriculture and mining require annually more than £2,000,000 worth of chemicals, all of which are imported into the country in the form of fertilizers, cyanide and nitrates. In order to manufacture these the chief essentials are cheap electricity, abundant coal, limestone and labor, all of which may be had in South Africa. The report considers the question of manufacturing certain specific compounds, and concludes that they can be made profitably provided the raw materials are obtainable at reasonable rates. The prospects of starting these new industries appear to be promising.

New Zealand authorities are studying the possibility of producing pig iron on a large scale by electricity, as much ore and ample water-power are available.

It is stated that the Turkish Government has cancelled the French concession for the building of a railroad from Smyrna to Kassaba, in Asia Minor, fifty-four miles south-east of Konieh, and the Franco-Belgian concession for a railway from Mudania, on the Sea of Marmora, to Brusa, about 100 miles south-east of the former town. The Turkish Government states that these railways will be built by the State.

CANADIAN SHIPS FOR NORWAY.

Mr. Bonar Law told the British House of Commons recently that the question of Canadian shipbuilding for Norwegian owners was under discussion with the Canadian government. It will be recalled that a Canadian order-in-council has been passed removing the war disabilities regarding shipbuilding in Canada for neutrals.

In Vancouver, contracts for three 8,800-ton steamers, valued at $3,500,000, have been signed, two with the Wallace shipyards at North Vancouver, and one with Coughlin and Sons, in Vancouver, and only required this assurance of the government that a transfer would be granted on completion to become effective. Orders for seven or eight other vessels will also, it is said, be given, and the total value will reach $20,000,000, the number of men employed be 2,500, and the monthly pay roll be $120,000.

The Chinese Mail Steamship Company (owners of the Pacific mail steamer "China") are understood to have bought two ocean steamers under construction at the Wallace shipyards for $2,500,000 each, delivery to be made within ten months.

Two transatlantic cargo vessels, now being built in Polson's yards, Toronto, for Norwegian owners at a cost of $1,000,000, will be completed next summer.

Messrs. Donald Macleod and Company, 52 Leadenhall Street, London, England, have written to the London press, stating that they have the "three 8,800-tonners, Robert Dollar type, one delivery end of July-early August, one October, and one November, building by the Wallace Shipbuilding Company, Vancouver, and we can sell them at $145 (£29) a ton for the first steamer and $140 (£28) for the two latter; also two 7,000-tonners building by Vickers, Montreal, delivery end of 1917, for which we will try $135 (£27) a ton, all net to us."

"British owners," say Messrs. Macleod, "can still secure these contracts, but now only after the Norwegian holders have taken their profit," and they protest. The London Times says of their protest: "The prices indicated above include the profit to the Norwegian contractors. The construction of large ships at the present time in Canadian yards for neutral owners certainly seems remarkable, but not more so than the fact that vessels should now be allowed to be built in the United Kingdom for neutral firms."

As a measure of government encouragement for shipbuilding in Canada, an order-in-council has been passed at Ottawa granting a 99 per cent. drawback of customs duties paid on materials used in the original construction of ships measuring over 500 tons gross tonnage built in Canada to be exported for outside registry. The vessels must be constructed so as to obtain a registry in Lloyd's satisfactory to the minister of customs, and their export on completion must, in each case, be authorized by order-in-council.

The richness of Sweden in water-power, and Denmark's natural poverty in any sources of power, has led to Sweden exporting electric power across the Sound. The works are established in the small river Laga, in Smaland, and the current is carried by overhead wires to Helsingborg, and thence by three submarine cables under the waters of the Sound to Marienlyet, north of Elsinore, on the island of Seeland. The Swedish power station sends 500 horse-power to Denmark, but the company undertakes to increase this to 5,000 horse-power. Precautions have been taken so far as possible to prevent the cables being fouled by the anchors of ships.

THE PREVENTION OF SLIDES ON THE PANAMA CANAL.*

In October, 1915, the President of the United States was advised by a member of the National Academy of Sciences—which was organized by an act of Congress to give expert advice to the President and Congress on scientific matters—who stated that one of its members had made an extensive study of earth slides in tropical countries, and was convinced that there were relatively simple ways by which they could be stopped, and suggested that a committee of mining engineers and geologists of the academy be appointed to consider his propositions. In consequence of this, the President of the United States requested that a committee be appointed by the National Academy of Sciences to "Consider and report upon the possibility of controlling the slides, which are seriously interfering with the use of the Panama Canal." From the correspondence it appears that at a meeting held in New York, ". . . the hope was repeatedly expressed that an effective solution may speedily be found."

The coming of the committee was welcomed on the Isthmus, for so much misinformation had been sent broadcast, doing more injury to the canal than the closing of it by the slides; confidence had been upset; and it was hoped not only that a remedy would be forthcoming, but that the report of the committee would be able to restore confidence in the project, especially as those connected with the work knew that the methods adopted would overcome the difficulties for good and all, given the time and money, and that the waterway would be all that had been expected.

The preliminary report by the committee of the National Academy of Sciences was submitted to the President in January, 1916. At that time they expected that their final report would be completed in April, but up to date it has not been received. The committee expressed the belief that every available and practicable device for controlling the water, both on the surface and underground should be employed, and to this end advocated covering the slopes with vegetation to prevent surface wash, closing peripheral cracks, draining undisturbed and threatened areas, and draining by tunnels.

For several years the expedient of covering the slopes with vegetation has been carried on, starting under the direction of Dr. Pittier, of the Smithsonian Institution. Where the surface of the ground is in motion, as in the case of active slides, the roots are disturbed, and the steady growth of vegetation is impracticable. Trees and vegetation of all kinds growing on the surface of the ground which broke in October, 1914, were carried down the slide and exercised no deterring effect whatsoever. On sliding ground there is not sufficient time to plant anything and no good would be accomplished. Where the banks consist of the red clay of the country, it is only after considerable difficulty that grass of any kind can be grown on them. Vegetation stops erosion; on this account the work was undertaken and is being carried on.

When peripheral cracks occur in rock with sufficient earth covering they may be effectually closed by the use of a hydraulic grader, as was done in an incipient slide on the west bank of the canal near Las Cascadas. The sluicing down of the earth into a uniform slope not only fills the cracks and prevents the access of surface water into them, but facilitates the drainage by providing a ready means of run-off into the canal. This method, while applied with good results at the north end of the East Culebra slide, so long as the material is at rest, a subsequent movement develops new cracks and irregularities so that until all loose clay and rock is removed and the final slope reached, the relief is temporary only. Where there is very little earth covering, as is the case on Culebra Hill, and where the cracks are wide and extend a great depth in rock, it is not practicable to close them permanently without expense that is disproportionate to the results obtained.

In compliance with the expressed wishes of the committee while on the Isthmus, subsurface tile drains have been installed within an area on Culebra Hill as an experiment. Also, as suggested by the committee, the fault fissure under the hard Obispo tuff on the north side of Contractors Hill has been sealed and a concrete-lined drain constructed, draining the surface water into the canal, with a view to the protection of the Cucaracha rock beds adjacent to this portion of Contractors Hill.

It is admitted that if the water could be entirely excluded the earth movements would cease, but unfortunately this is impossible. With the heavy tropical downpours the best that can be done is by drainage, to carry away what falls as rapidly as possible, but ground water can not be eliminated. So far as concerns ground water, the construction of the canal has created entirely new conditions. The old tributaries of the Chagres River and those of the Rio Grande, which formerly were natural drains, are now well above the water surface of the canal, and the canal has become the drainage channel for the country for miles on either side. Even assuming that were it possible to devise a system for getting rid of ground water, it must still exist below the surface of the water in the canal itself. The slides in question affect the banks for a considerable distance down, probably below the bottom of the canal, and if ground water be primarily the cause, then it can not be removed from the strata at which the trouble starts.

Surface drainage was maintained throughout the period of dry excavation. The adjacent country on either side of the canal was drained through the east and west diversions, which continued to act as drains, discharging their accumulated waters into the Chagres. In relieving the pressure, force pumps on barges have enabled the washing down of part of the material, as already explained. The hydraulic grader which was constructed in July, 1914, and put in commission in August, 1914, was built especially for opening channels to expedite surface drainage at various points along the line of the canal, and to maintain them, and this work has been carried on, although suspended south of the slide, due to the interruption and shut-off of the channel last fall and winter.

So long as the slides are active and the configurations of their surfaces change as rapidly as they now do, it is impracticable to open and maintain the permanent drains recommended in the moving areas. When equilibrium is restored, and as a means of promoting permanent stability, the drains of a permanent character should be constructed and maintained.

Drainage by tunnels has been considered in connection with data obtained since the committee's report was written, as the result of experiments suggested by the chairman of the committee, Dr. Van Hise, through whom the services of Prof. Warren J. Mead of the University of Wisconsin, were secured, and who was assisted by Mr.

*From the annual report of Gen. Geo. W. Goethals, Governor of the Panama Canal Zone, made public on November 20th.

Donald F. MacDonald in making tests of the rock formation in which the east and west Culebra and Cucaracha slides have occurred. The results of the experiments in brief were as follows:

Twenty-one average samples of the Cucaracha or sliding formation were taken from below the water level of the canal. These samples, completely saturated, contained 12.20 per cent. of water by weight, or 27.8 per cent. of volume. The 16 average samples taken from well above the level of ground water, where the rocks were much jointed and fractured, and, therefore, perfectly drained, contained 10.60 per cent. of water by weight. As shown above, 12.2 per cent. of water by weight fills all of the pore spaces of the rock; therefore, 10.6 per cent. by weight fills only 87 per cent. of them, leaving 13 per cent. of the total pore space as having been emptied by drainage and by drying. Now, 13 per cent. of 27.8 per cent. is 3.6 per cent. of the total volume of the rock. This shows that natural drainage of the most perfect kind would not remove more than 13 per cent. of the water by weight, equivalent to 3.6 per cent. of the volume of the rock. However, most of the samples from the drained rock were taken very close to the surface, so that very likely they lost some of their water through drying out by the heat of the sun, for the dry season was more than a month old at the time they were collected.

These facts show that while the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water, which obeys the laws of capillarity, and which cannot, therefore, be drained off. These experiments definitely established that all cures by drainage which had been offered to and urged on the canal authorities were absolutely futile, and the money which might have been wasted in worthless tunnels, wells, and acres of asphalt covering was saved for the only remedy that could bring permanent cure under the circumstances—dredging.

Before considering the suggestions that have been made for controlling or preventing the slides other than those already mentioned, it may be well to state what was attempted by the canal forces in this direction prior to the occurrence of the slides which are now active.

During the excavation of the Cut 22 slides and breaks of various extent occurred. The steps taken to protect exposed slopes by vegetation have been noted. It was believed that piles driven through the loose material into firm ground below and tied at the tops might check the movement, and this was tried at four of the slides, but without success. In some instances the piles were carried bodily down the slope; in others the underlying material, moving faster than the upper portion, inclined the piles away from the Cut, and in cases where the top surface moved faster than at the bottom, they inclined in the opposite direction. The remains of these piles can be seen at the present time in some of the areas so treated.

It was thought that in case of clay slides heavy riprap dumped on the surface would find its way through the loosened material to firm ground and check the movement, but this method was found as useless as the piling. Most of the riprap rock was taken out at the foot of the slope as the excavation proceeded. Experiments were made by concreting the face of the prism to prevent the disintegrating effect of the air on some of the softer rocks; this was done by use of a cement gun, by plastering the surface with cement mortar and by reinforced concrete, anchored to the side of the prism with pieces of rail. None of these methods was satisfactory or durable. The remnants of the French drains, which proved inadequate, were dug out at the bottom of the prism. The conclusion was reached that the only cure was the removal of all loosened material as it came into the Cut, and in case of breaks to relieve the weight, where possible, from the upper parts of the banks by steam shovels or sluicing operations.

In considering any method for stopping the slides some conception must be had of the enormous amount of material involved, as well as the method in which it acts. The banks at present giving trouble are from 300 ft. to approximately 550 ft. above sea level, and extend back 1,300 to 1,800 ft. from the faces of the prism, and from these farthest points to the water surface the entire mass is broken for a depth extending at least to the bottom of the canal. The movement is by fits and starts, sudden at first and gradually subsiding, with renewed activity after a period of quiescence. For instance, in August, 1916, a general movement occurred at the east Culebra slide and consisted of a settlement from 20 to 25 ft. vertically down at the rear portion of the area affected, some 1,300 ft. from the prism, by which a mass of material from the lower part was projected into the Cut beyond the centre line, reducing the depth of water along this line an average of 5 ft. Because of the width of the new channel, as well as the depth, navigation was not interrupted, but some idea may be had of the enormous amount of material that must be held back by any artificial construction or device similar to those which have been proposed, and the impossibility of their construction must be recognized.

Suggestions most frequently made have been along the line of sowing vegetation and of properly draining the area. These have already been considered. To sink a number of pipes and apply steam for drying out the subsoil would be prohibitive on the score of expense, even if it were practicable. It would be impossible to drive and hold such pipes through the material in case of motion. Pipes sunk for the purpose of pumping out the water are equally impracticable and impossible. From the experiments conducted by Prof. Warren J. Mead and Mr. MacDonald all the water could not be extracted by this method. Piling the entire area at regular intervals and tying the piles to anchors driven in the firm ground can not be done, nor would it secure the result anticipated by the proposers of this scheme.

The construction of retaining walls would require the excavation of material to secure the foundations, necessitating the removal of all the material in motion, when the need for the retaining wall would no longer exist. There is no form of construction that could be designed that would hold back the superimposed mass while the excavation for the foundations was in progress. The construction of inverts to hold down the bottom of the prism is impracticable and impossible.

Wire netting rolled over the bank and held in place by stakes would not prevent the movement, but would seriously interfere with the dredges in removing the material littered up with sections of wire mesh, which would break loose with every movement of the slide. Consolidating the mass by injecting grout would also be impossible; the pipes could not be driven to firm ground below and the earth and rock, as it now comes into the Cut, can be much more easily handled than would be the case were this material solidified by cement.

It was suggested that the slopes and the surface of the ground adjacent to the Cut be covered with asphalt, tar, or some preparation which would exclude water from the ground. This was also proposed by a member of the committee from the National Academy of Sciences. That the committee did not include it among its recommendations seems conclusive that in its opinion it was not practicable, and no further comment seems necessary.

The Creosoted Block Paving Co., Limited, Toronto, has moved from the Royal Bank Building to more commodious offices in the C.P.R. Building.

Editorial

GOVERNMENT AID FOR RESEARCH WORK.

Before the Empire Club of Toronto last week Prof. A. B. Macallum, the chairman of the newly created Advisory Council on Industrial and Scientific Research, outlined some of the methods which the council intends to use in the conduct of its work.

He showed how essential it was that a spirit of co-operation between industries, engineering colleges and the State be brought about. These are the media through which scientific research in Canada can be placed in the position which it should occupy. If we as a people hope in the future to compete with other countries, more intelligent attention must be paid to scientific research work, so vitally important at this period in our history.

Professor Macallum laid down as one of the first requirements a largely increased supply of competent researchers, coupled with a spirit of co-operation on the part of scientific men, working men, and business men. In addition to this, if the work of the council is to be resultful in the fullest meaning of that term it must secure and retain the hearty sympathy of scientific societies, universities, local authorities and governmental departments. This it will unquestionably receive. Neither condition will be effective without the other. The first cannot be secured rapidly at any time, and is for the moment out of the question. It was indicated, however, by the speaker that plans were now being formulated by which a number of research scholarships would be established by the government.

Much good work has been done in scientific research in our engineering colleges and this in the face of very serious handicaps so far as appliances and funds are concerned. Then there is the research work which might be done by individual firms or groups of firms representing certain specific industries. Much more might be done in this direction

All this simply means that more money must be forthcoming on the part of our Federal and provincial governments in the way of larger grants to colleges to be so used in part at any rate, as research studentships, in the establishment and maintenance of national laboratories similar to the Bureau of Standards in the United States or the National Physical Laboratory at Teddington, England.

Only in the measure that our industries are willing to employ scientific methods will they be able to compete with the outside markets. The period following the war will be a testing time to very many of them. It behoves them at this time, therefore, to lessen the handicap which will surely be put upon them if they are reluctant to use highly educated labor or to adopt up-to-date methods.

In the national interest it may be stated as a general principle that improved methods of production should be made available for all who may be interested.

WHEN AMMUNITION ORDERS CEASE—WHAT THEN?

One of the problems that is very naturally causing anxiety to manufacturers of munitions, heads of engineering corporations, steel manufacturers and others engaged in similar work, is what use is to be made of the great quantities of machinery, much of it of special design, after the war orders cease. It is estimated that from 50 to 75 per cent. of the machinery now being used in the turning out of munitions in Canada will have to be discarded. At least that is the estimate which has been made by a number of the more prominent manufacturers, who have intimate contact with this particular class of work.

Should the proportion of this machinery that will need to be scrapped turn out to be smaller, is it not likely that much of it will be used in lines of manufacturing in which there is already sufficient plant to supply the normal demand? If so, this can only have one effect, namely, the introduction of unhealthy competition, the slashing of prices and the disturbance of market conditions which will inevitably follow.

Could Canada secure a large volume of permanent export trade following the war, it would undoubtedly put a different complexion on the situation. Under normal conditions, the manufacturing capacity of Canada is not very much in excess of home consumption, and to enter the export trade on a permanent basis would involve considerable outlays of money for extension of plant and increased output. This is actually being done by some Canadian manufacturers and they stand to profit by the adoption of such a policy. Such firms as are making sure of strong and vigorous export connection in the countries which have more directly suffered from the war will unquestionably feel the effect of this changed condition less after the war, as by such connection they will be able to supply the demand for materials so necessary in the countries which have been devastated by war, and so be enabled to find work for much of the machinery now in their possession which otherwise might have to be relegated to the scrap pile.

Then, again, there are those who take the view that, as stocks of manufactured goods are very low, and there is a steady consumption going on which constantly is reducing these stocks, and as the railroads, for instance, have bought but little new equipment for two years or more, that the supplying of the domestic requirements immediately following the war will keep manufacturers fairly well employed for some little time after the war.

One of the by-products of the intensive manufacture to which many plants have been subjected is that they will in future be more efficient in their organization. Before the war, for instance, there were few concerns in Canada that understood how to work the higher grades of steel or working to close limits. Now there are hundreds of factories who can do these things successfully.

What shall be done with the special machinery after the war is but one of the problems which are engaging the thought of the best men in our country.

PERSONAL.

G. P. HOLMES, recently with the St. John's Mining Co. at Montezuma, Colo., has joined the engineering staff of the Aetna Chemical Co., at Drummondville, Quebec.

D. CROMBIE has been appointed general superintendent, Ontario Division, Canadian Northern Railway, Toronto, which position was held by A. J. Hills until recently.

J. C. O'DONNELL, formerly superintendent, District 3, Western Division, C.N.R., Edmonton, Alta., has been appointed superintendent of Districts 2 and 3, Central Division, Winnipeg.

Lieut.-Col. G. C. ROYCE, general manager of the Toronto Suburban Railway, is to command another battalion of the Queen's Own Rifles, Toronto, which is to be organized for overseas service.

M. W. JENNINGS has been appointed acting resident engineer and A. V. REDMOND acting division engineer, District 2, Transcontinental Division, Canadian Government Railways, Cochrane, Ont.

J. P. McKENZIE, assistant superintendent and electrical engineer, Saskatoon Municipal Railway, left Saskatoon on November 8th last for St. John's, Que., having been appointed a lieutenant in the Canadian Engineers, Canadian Expeditionary Force.

W. R. BAKER, C.V.O., secretary to the Canadian Pacific Railway and assistant to the president, has, at his own request, been relieved from his duties and placed on the retired list. E. ALEXANDER, formerly assistant secretary to the company, succeeds Mr. Baker.

W. H. RANDALL, of Toronto's Waterworks Department, attended the joint committee meeting of the American and New England Waterworks Associations on Standard Specifications for Cast-iron Pipe and Fittings, which was held in New York on Thursday, December 14.

G. H. HILL, assistant engineer, railway and traction department, General Electric Co., delivered an address before the Toronto Section, American Institute of Electrical Engineers, at the Engineers' Club, on Friday, December 15th, his subject being "Railroad Electrification."

J. B. CHALLIES, M.Can.Soc.C.E., has volunteered his services as secretary of the Honorary Advisory Council for Scientific and Industrial Research. Mr. Challies is a graduate of the University of Toronto and is well known for his excellent work as superintendent of the Water Powers Branch, Department of the Interior, Ottawa.

FRED. W. EVANS has been appointed manager of the Toronto branch of the Canadian Fairbanks-Morse Co., Limited. Mr. Evans has been acting manager of the Toronto branch for the past year, although his connection with the Canadian Fairbanks-Morse Co. dates back for a great many years. He has devoted special attention to the machine tool end of the organization.

E. HANSON, A.A.I.E.E, M.Inst.Mun.E., has been appointed secretary of the Institute of Municipal Engineers (London, Eng.) for Western Canada. It is the intention to inaugurate a campaign for members amongst municipal engineers in the West, with a view to securing closer co-operation amongst municipal engineers of all classes and furthering the cause of municipal engineering throughout Western Canada.

OBITUARY.

Lieut. GILBERT E. TYLER, manager of Winnipeg branch and director of E. R. Watts & Son, Limited, has died as a result of wounds received in action on September 15th. Lieut. Tyler was wounded three times, but persisted in leading his men until removed from the field. He has since been awarded the Military Cross. Lieut. Tyler will undoubtedly be remembered by a great many of our readers. He opened the Ottawa branch for E. R. Watts & Son in 1909 and subsequently was transferred to the Winnipeg branch.

CANADIAN SOCIETY OF CIVIL ENGINEERS, REGINA BRANCH.

At the annual meeting of the Regina Branch, Canadian Society of Civil Engineers, held recently, the following officers were elected: Chairman, L. A. Thornton; vice-chairman, W. R. Harris; members of executive, R. J. Lecky, E. G. W. Montgomery; secretary-treasurer, J. N. de Stein; auditors, Hugh R. MacKenzie, D. R. McCannell.

The following is a programme of papers which have been arranged for presentation by members of the branch during the ensuing year:—

"Notes on Town Planning," by L. A. Thornton; "Some Aspects of Indian Engineering," by E. G. W. Montgomery; "Drainage Problems in Saskatchewan," by C. S. Cameron, D.L.S.; "Specific Treatment of Concrete in Our Climate," by W. R. Harris; "Need of Engineering Supervision in Location, Construction and Maintenance of Public Highways in Saskatchewan," by H. Ross MacKenzie and E. W. Murray; "From Conception to Completion—the Western Railroad," by J. N. de Stein.

CANADIAN SOCIETY OF CIVIL ENGINEERS, MANITOBA BRANCH.

At the annual meeting of the Manitoba Branch, Canadian Society of Civil Engineers, which was held on Thursday evening, December 7th, the following officers were elected for next year:—

Chairman, W. L. Mackenzie; secretary-treasurer, A. W. Smith; executive committee, J. C. Holden, H. W. McLeod and M. V. Sauer; auditors, T. L. Roberts and B. S. McKenzie; committee on papers and discussions, E. T. Spidy, G. L. Guy and D. L. McLean; committee on research and investigation, E. Brydone-Jack, J. A. Douglas and T. L. Roberts; committee on library and trade publications, J. C. Holden, M. C. Hendry and J. A. Heaman.

Prof. M. A. Parker was the speaker of the evening, and gave a paper on "Air Pollution," which was most interesting.

Although Winnipeg is relatively free from the smoke nuisance, the speaker advised those present to take warning from the amount of smoke in some cities and not let Winnipeg become blackened in a similar way if this district becomes the manufacturing centre that it is hoped it will.

Enormous quantities of smoke are vomited forth in London, Eng., Pittsburgh, Pa., and other cities, and if such a tendency is to be prevented in Winnipeg the speaker felt that very serious consideration would have to be given the subject.