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THE CANADIAN ENGINEER

ESTABLISHED 1893

ISSUED WEEKLY IN THE INTERESTS OF THE CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MINING, MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

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JULY—DECEMBER, 1913

THE CANADIAN ENGINEER

Head Office, 62 Church St., TORONTO

MONTREAL WINNIPEG

INDEX TO VOLUME 25

JULY to DECEMBER, 1913

NOTE.—Figures in page columns refer to the continuous paging of this volume, except in the department of the index devoted to "Contracts," in which the figure in the first column denotes the number of the issue in the volume (26 issues in all), and the second number denotes the page in that issue. As an example, "Addition to Factory, Vancouver........................6, 82," indicates page 82 of issue No. 6.

AUTHORS.

EDITORIAL.

*Illustrated.

LEADING ARTICLES.

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The Canadian Engineer

An Engineering Weekly

PLATE GIRDER BRIDGES IN RAILWAY CONSTRUCTION

PART II.

CONSIDERATION OF SECTIONS OF MATERIAL—THE FRAMING OF THE VARIOUS SECTIONS—SHIPMENT AND ERECTION OF PLATE GIRDER SPANS—ADAPTABILITY OF DESIGN TO SHOP PRACTICE AND ERECTION CONDITIONS

By C. H. MARRS, C.E.

Erecting Engineer, Hamilton Bridge Works Company, Hamilton, Ont.

THE first part of this article, appearing in June 26th issue, after enumerating the various advantages of plate girder construction, for example, simplicity and uniformity of construction, solidity and durability, speed in erection, and low office cost, went into the calculation of the stresses due to the loads. The methods by which the ordinary dead and live loads are obtained do not form a part of the article as the reader may refer to any authoritative text on the subject for them. Following, the various sections of material to be used in design are next in consideration.

The web plate is first determined, as its depth is already decided, and 10,000 pounds per square inch of gross section is the unit which is generally used in obtaining the required thickness of web. It may, however, be necessary in some cases, to use a thicker web than is required by this unit in order that the end shear may be transmitted to the flange angles in a length equal to the depth of the girder. This is only probable when the web is connected to the flanges by single lines of rivets and the number of rivets is, therefore, more limited.

The flanges of girders are determined, as in trusses, by dividing the total bending moment at any point by the product of the effective depth and the unit tensile stress. The difference between girders and trusses is that the flange stress varies gradually throughout the length of the girders, while in trusses it is constant between panel points. The bottom flange is usually figured at 16,000 pounds per square inch of net section, and the top flange is made the same total gross section as the bottom, with the restriction that the unsupported length of the flange must not exceed twelve times its width. This limits the spacing of floor beams and cross-brace frames.

As the centre of gravity of flanges cannot be known until the sections are determined, a great amount of time is usually wasted in assuming a centre of gravity and making approximate calculations, and this operation repeated several times until the section is finally settled. Table 1 gives a useful table for railway girders. By use of it the required flange can be determined by one calculation and the labor of figuring the net sections and centre of gravity is avoided.

The effective depth used should never be greater than the distance, back to back, of flange angles.

There is a wide diversity of opinion among engineers as to whether part of the web should be counted as flange area. For this to be so, the flanges and web must act as a solid beam and theoretically 1/6 of the gross section of web would act as flange section, but it is considered to be 1/8 on account of deduction of rivet holes.

Since the bending stresses in the web do not act at any one point, but over the total depth of the web, having a maximum intensity at the edge of the web and zero at the centre, it is very difficult to properly splice the webs to take care of these stresses. It involves a great many rivets and extra material, which, in cases of heavy girders, is worth more than the material saved in the flanges. Moreover, if the web is considered to take tension, it is good practice to plane its edges to avoid tearing, and this is additional expense.

In some cases where the web does not need to be spliced, owing to possible lengths that can be procured from the mills, there would be a saving of material and cost, to consider 1/8 of the web as flange section. But, since it is only an assumption that the girder acts as a solid beam, and since the flanges are figured the same as in trusses, it seems advisable to consider that the web resists shear only; the only difference being that the web acts continuously instead of at panel points. The top flange of deck plate girders is often made an H-shaped section of four angles and side plates. The main advantage of this section is its suitability to easy framing of the deck ties, as there are no rivets or cover plates to be taken care of. The objections to such a section are, that it is more difficult to manufacture, because extra drawings are necessary and the shop work is more expensive; this for the reason that in modern shops equipped with spacing tables, it is a big advantage to have both flanges similar. Moreover, the H-flange is not as strong to resist buckling from handling and from compression stresses, as is the more common section composed of two angles and cover plates. Hence, if it is used, the brace frames should be made with the top strut the same depth as the flange section. This is necessary because the top laterals are at the elevation of the bottom of the H-section, which is some distance below the deck, and because the web stiffener angles must break at the bottom of the H-shaped flange, which is a marked weakness.

Stiffener Angles.—These are an important factor in the strength of girders and, as their duty is not generally understood, they deserve some explanation. They may be divided into two classes, viz., those that resist concentrated loads and those which merely prevent web buckling. The end stiffeners transmit the total end reaction to the web plate where it is converted into shearing stresses. As these stiffener angles are ground to fit the curved fillet of the flange angles, it is evident that a large part of the reaction is transmitted to the stiffeners by direct bearing of the outstanding leg on the flange angles, and it is therefore necessary to have this leg as wide as the flange angles will permit, and care should be exercised in the shop to ensure that these angles have an exact fit and true bearing. In arriving at the sections

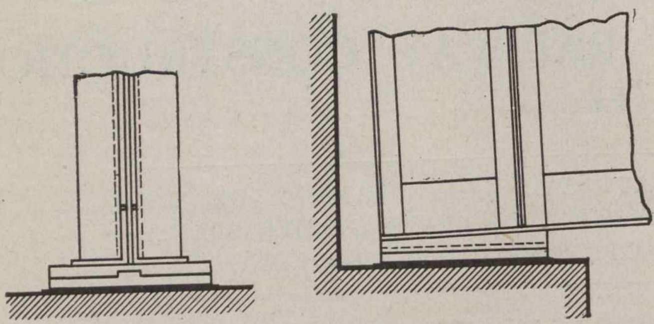

Fig. 1.—Sliding Bearing.

of end stiffeners, it is usual to consider that they act in conjunction with the filler plates, as a column of length equal to the depth of the girder, and that the end reaction produces a the compression which is constant throughout the length of the column, whereas in reality, the stress diminishes from a maximum at the bottom to zero at the top. As the filler plates cannot be considered to bear on the flange angles in actual practice, the stiffener angles must take the entire stress at the break between the filler and toe of the flange angles; and it is at, or below this point, that the failure of end stiffeners would usually occur. Taking this into account, and also the fact that the bearing of the outstanding leg does not transmit all the end reaction, but that part of it will go into the other leg through bearing on the fillet and rivets at the bottom, it is a common practice to use end stiffener angles, the gross

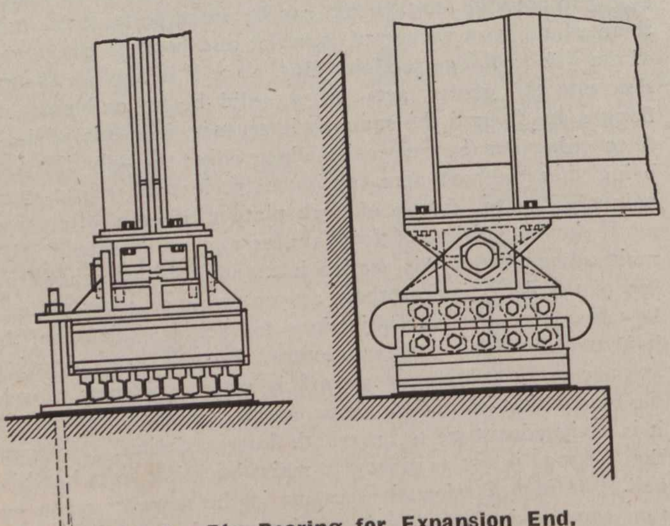

Fig. 2.—Pin Bearing for Expansion End.

section of which is considered to resist the reaction at 12,000 pounds per square inch. In addition to these considerations, the designer must use judgment in the selection of the angles, so that the outstanding leg will be thick enough to prevent its buckling near the bottom, where it is highly stressed. There should also be sufficient rivets connecting these stiffeners to the web to transmit the reaction intended.

Intermediate stiffeners which are merely intended to prevent the web plate from buckling, do not cause the designers of girders much worry, as all railroads have adopted standard sections for different depths of girders and certain limitations as to the spacing of them, but it is a satisfaction to know that their failure in actual structures has been very rare. They have been generally determined by formulae based on compression in the web plate due to shearing forces acting upon it. This seems the most reasonable method. The spacing of these intermediate stiffeners should therefore depend on the shearing stresses, and this would necessitate their being spaced closer towards the end of the girder.

Theoretically there is no reason for the intermediate stiffener angles to bear on the bottom flange, but it is always done in practice and makes a neater job. It is necessary, however, in the top flanges because it tends to prevent the outstanding leg of the flange angles from buckling and in deck girders it helps to transmit the loads from the track into the web plate.

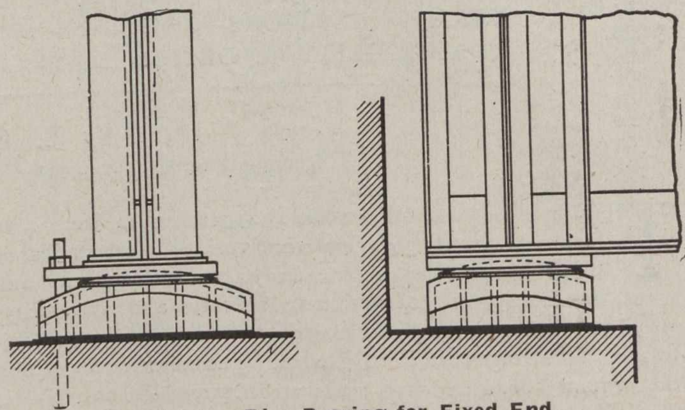

Fig. 3.—Disc Bearing for Fixed End.

Pier Members.—They are determined in area, by the unit, 400 pounds per square inch for concrete masonry. For spans up to 75 feet in length sliding masonry plates only are used, as indicated in Fig. 1, with a tongue and groove to resist side motion. The groove should be on the upper shoe plate as shown, so that dirt and water cannot lodge in it.

With this type of bearing it is advisable to consider that the stiffeners over the inside edge might have to take 75 per cent. of the total end reaction, because any deflection in the span tends to move the end reaction to this point.

For spans 75 feet long or over, pedestals are necessary to properly distribute the bearing pressure, and to adjust themselves to deflection and camber. Fig. 2 indicates the pin type which is generally used in the United States, and it may be made up of structural shapes, or cast steel. By means of the pin the bridge is securely anchored to the bottom pedestal.

Nearly all Canadian railroads use the disc bearing, as shown in Fig. 3, and it is superior to the pin type in many ways. It is sure to have a true bearing, as it adjusts itself in all directions to suit uneven masonry and deflection in the span. It is also convenient in erection as the girders can be dropped into place with a minimum trouble in adjustment.

In the disc type most of the end reaction should be considered to enter the girder over the centre of the disc with a small proportion at each edge, while in the pin type, where the shoe is deeper, all the end stiffeners can be considered to take an equal share.

Expansion in Girders.—This condition should be provided for to the extent of one inch for each 80 feet of span, and for all spans over 75 feet in length roller nests must be used at one end. These should be constructed so that the sides may be taken off and the rollers cleaned and oiled; also in such a way that they will shut out as much dirt as possible and not hold water. Fig. 2 represents a good design for roller nests, in which segmental rollers are indicated, the lower bearing surface being a nest of rails. The segmental rollers are convenient because they occupy a minimum space for a large diameter. The rails are important because dust will not lie under the rollers, but will fall through, affording easy removal. Bearing plates should always be made thicker, to allow for rust of ½ inch in thickness.

Stringers and Floor Beams.—These constitute the floor system in through plate girder spans. As the stringers are merely deck girders of reduced length, their design is similar. They should be made as deep as practicable, and should be riveted to the webs of the floor beams. Two lines of stringers per track is good practice, but four lines are more able to resist derailed trains, and do not require such large ties.

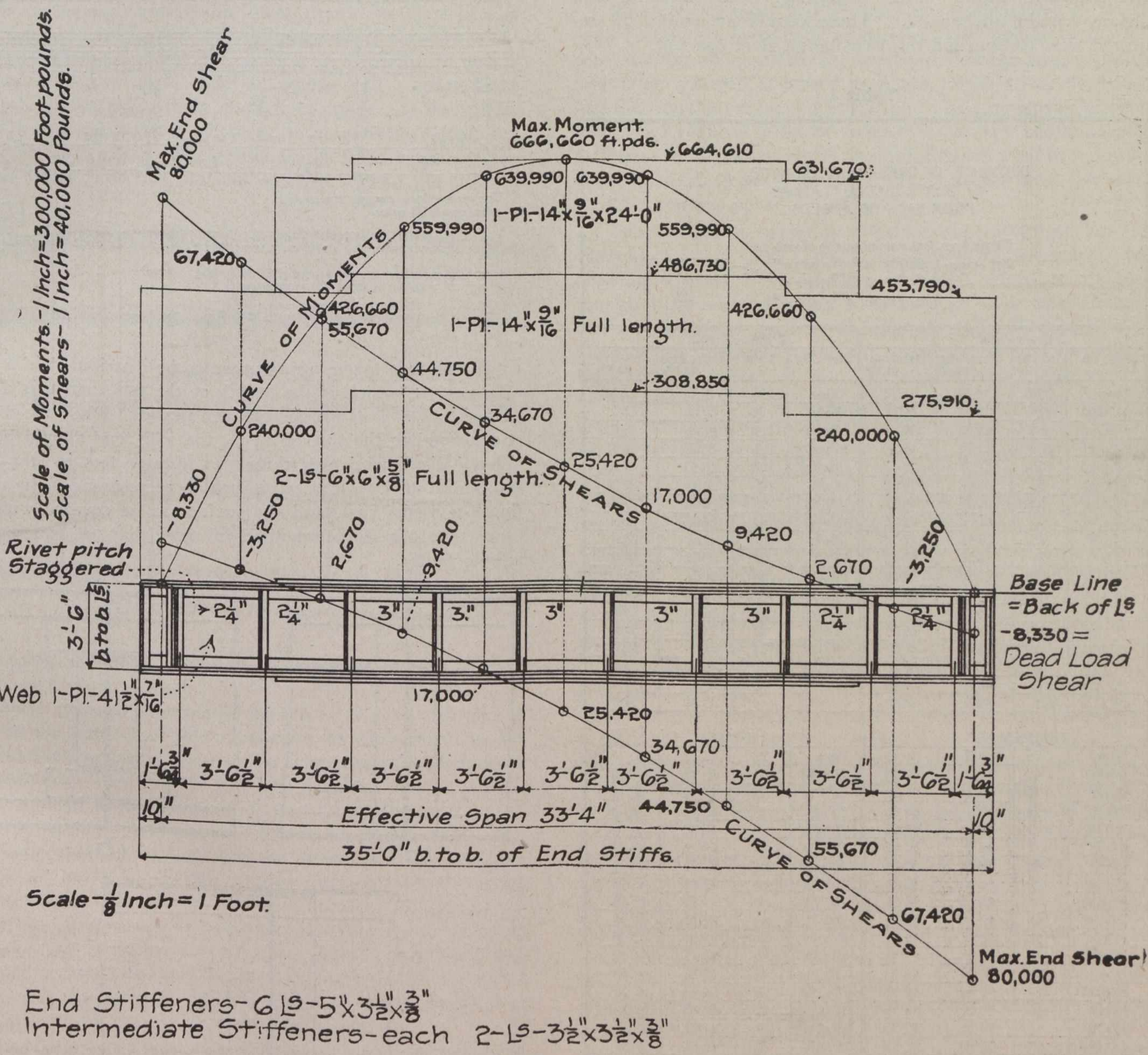

Fig. 4.—Stress and Section Diagram for Deck Plate Girder.

Lateral Angles.—Usually these are made heavier than the stresses require, to ensure stiffness of the bridge. In deck spans the entire lateral forces are considered to be carried by the top laterals, through the end brace frames to the anchors, while the bottom laterals are merely considered to stiffen the bottom flanges against wind. The latter are often omitted in deck spans under 50 feet long, as the interior brace frames give sufficient stiffness to the bottom flange.

In through plate girder spans there is only one system of bracing, which necessarily carries all the lateral stresses, and the traction stresses in addition.

When rods are used as laterals, an initial stress of 10,000 pounds should be added to the other stresses to take care of the tension induced in the rods by tightening the nuts or turnbuckles.

With four lines of stringers, the common method is to assume that the inner and outer stringers take their share of the wheel loads inversely in proportion to the distance they are spaced from the rail. As a matter of fact, when the rail is midway, the inner stringer gets a greater proportion of the wheel load, because the ties are continuous beams over four supports. Some account should be taken of this.

Floor beams should also be made as deep as practicable. When the top flange is of moderate width it should be about one inch below the base of rail, so that it will support derailed trains; but when the top flange is 18 in. or 20 in. wide, it is good practice to drop it three inches below the base of rail, so that a wood strip can be placed on it to support the rail, as well as to be useful in the event of wheels passing over it.

Stress and Section Diagrams.—Such diagrams are convenient for reference on bridge plans, indicating graphically the bending moments and shears along the length of the span, and the flange and web sections which correspond. Fig. 4 shows a complete form, and needs little explanation. The two shear diagrams represent the change in web shear as the train passes over the bridge in either direction, the live load and impact shear changing, while the dead load shears remain unchanged. These curves determine the required web section and the web flange rivet spacing.

Table I.

DISTANCE OF CENTRES OF GRAVITY OF PLATE GIRDER FLANGES FROM BACK OF ANGLES

Flange Area does not include 1/8 of web
Net Area – 2-6"x6" Ls 4-7/8"⌀ rivets off
2-8"x8" Ls 6-7/8"⌀ rivets off
Cover Pls. 2-7/8"⌀ rivets off

2-Ls-6"x6"x5/8"				2-Ls-6"x6"x11/16"			
Cover Pls.	x (ins.)	Gross Area sq. ins.	Net Area sq. ins.	Cover Pls.	x (ins.)	Gross Area sq. ins.	Net Area sq. ins.
None	1·73	14·22	11·72	None	1·75	15·56	12·81
14"x3/8"	1·21	19·47	16·22	14"x3/8"	1·26	20·81	17·31
14"x7/16"	114	20·35	16·97	14"x7/16"	1·19	21·69	18·07
14"x1/2"	1·07	21·22	17·72	14"x1/2"	1·13	22·56	18·81
14"x9/16"	1·01	22·10	18·47	14"x9/16"	1·07	23·43	19·56
14"x5/8"	·95	22·97	19·22	14"x5/8"	1·01	24·31	20·31
14"x11/16"	·89	23·85	19·97	14"x11/16"	·95	25·18	21·06
14"x3/4"	·83	24·72	20·72	14"x3/4"	·89	26·06	21·81
14"x7/8"	·73	26·47	22·22	14"x7/8"	·79	27·81	23·31
14"x1"	·63	28·22	23·72	14"x1"	·68	29·56	24·81
14"x1 1/8"	·53	29·97	25·22	14"x1 1/8"	·59	31·31	26·31
14"x1 1/4"	·43	31·72	26·72	14"x1 1/4"	·49	33·06	27·81
14"x1 3/8"	·34	33·47	28·22	14"x1 3/8"	·40	34·81	29·31
14"x1 1/2"	·25	35·22	29·72	14"x1 1/2"	·31	36·56	30·81
14"x1 5/8"	·16	36·97	31·22	14"x1 5/8"	·23	38·31	32·31
14"x1 3/4"	·08	38·72	32·72	14"x1 3/4"	·14	40·06	33·81
14"x1 7/8"	b. of Ls	40·47	34·20	14"x1 7/8"	·06	41·81	35·31
14"x2"	out	42·22	35·72	14"x2"	out	43·56	36·81
2-Ls-8"x8"x11/16"				2-Ls-8"x8"x3/4"			
None	2·25	21·06	16·93	None	2·28	22·88	18·38
18"x3/8"	1 66	27·81	22·93	20"x1 3/4"	·37	57·88	49·88
18"x1/2"	1 50	30·06	24·93	20"x1 7/8"	·28	60·38	52·13
18"x5/8"	1 36	32·31	26·93	20"x2"	·19	62·88	54·38
18"x3/4"	1 23	34·56	28·93	20"x2 1/8"	·11	65·38	56·63
18"x7/8"	1·10	36·81	30·93	20"x2 1/4"	·03	67·88	58·88
18"x1"	·98	39·06	32·93	20"x2 3/8"	out	70·38	61·13
18"x1 1/8"	87	41·31	34·93	20"x2 1/2"	out	72·88	63·38
18"x1 1/4"	76	43·56	36·93	20"x2 3/4"	out	77·88	67·88
18"x1 3/8"	·66	45·81	38·93	20"x3"	out	82·88	72·38
18"x1 1/2"	56	48·06	40·93	18"x1 1/2"	·64	49·88	42·38
18"x1 5/8"	·47	50·31	42·93	18"x1 5/8"	·55	52·13	44·38
18"x1 3/4"	38	52·56	44·93	18"x1 3/4"	·46	54·38	46·38
18"x1 7/8"	·29	54·81	46·93	18"x1 7/8"	·37	56·63	48·38
18"x2"	20	57·06	48·93	18"x2"	·28	58·88	50·38
18"x2 1/8"	11	59·31	50·93	18"x2 1/8"	·19	61·13	52·38
18"x2 1/4"	·03	61·56	52·93	18"x2 1/4"	·10	63·38	54·38
18"x2 3/8"	out	63·81	54·93	18"x2 3/8"	·02	65·63	56·38
18"x2 1/2"	out	66·06	56·93	18"x2 1/2"	out	67·88	58·38
18"x2 3/4"	out	70·56	60·93	18"x2 3/4"	out	72·38	62·38
18"x3"	out	75·06	64·93	18"x3"	out	76·88	66·38

The bending moment diagram determines the required flange areas and the length of cover plates. These plates are made to pass beyond the curve far enough to develop the strength of the plate in rivet connections. When the flange rivet spacing is less than 2½ inches, staggered, it is considered that two extra rivet holes are deducted from the net flange area, which explains the drop in the area lines shown in the diagram. Where web and flange splices are necessary this diagram is convenient for reference in getting out detail drawings.

The Design of Trough Floors.—The computation is different from that of regular plate girders, as the section is determined by their net moment of inertia, as in the case of a solid beam. When the troughs run parallel to the line of

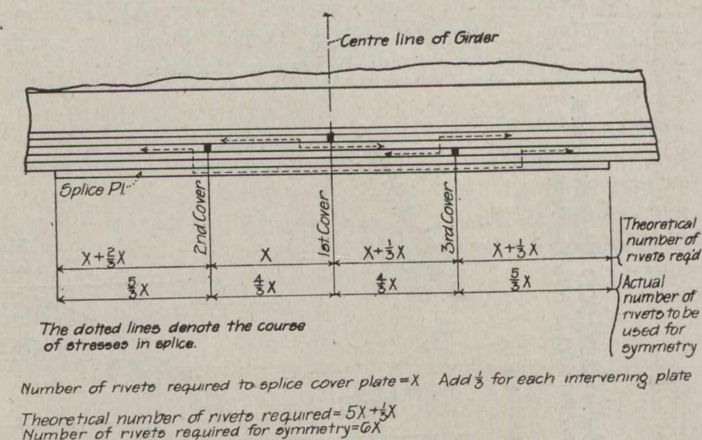

Fig. 5.—Flange Splice.

track, the axle loads are assumed to be distributed in a width of nine feet, which is the length of the ties, and this decides the amount of load carried on each trough. When the troughs run normal to the line of track, the axle load should be considered distributed over three ties of nine feet in length. A minimum thickness of 7/16 inch is recommended in trough floors to resist rust, and the surface to be covered with concrete should be left unpainted in order that the concrete will adhere better.

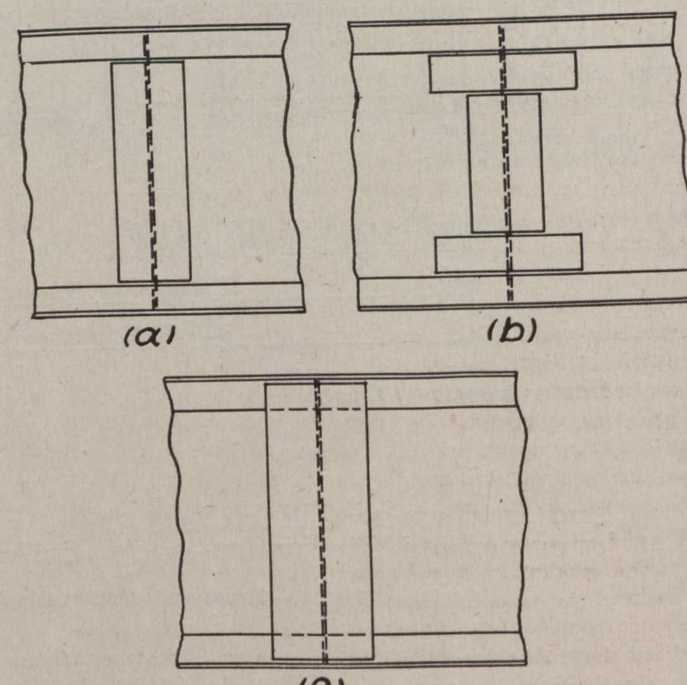

Fig. 6.—Plate Girder Web Splices.

Fabrication of Sections.—The details in connection with the framing of the various sections of a bridge may be the cause of its failure, as the strength of a structure is measured by the strength of its weakest point. It is necessary for the detailer to have an intelligent grasp of the action of stress through rivets and sections and he must keep in mind the sizes and maximum lengths of material that can be procured from the mills. He must be familiar with shop practices and erection methods, and must also consider the conditions of exposure of the bridge in actual service.

Splices should be avoided where possible, by the use of the longest angles and plates that can be obtained. Flange splices should alternate except in special field splices where it is necessary to have a compact joint. The theory connected with flange splices can be best explained by an example and the reasoning used in it can be applied in all cases. In the example shown in Fig. 5 the flange consists of two angles and four cover plates, and it is required to splice the two angles and three plates. The first cover plate breaks at the centre of the girder, and the second and third at equal distances each side of the centre. For convenience, consider the cover plates to be of equal thickness, and a splice plate added on the outside., thick enough to splice any one plate. Let X denote the number of rivets, in single shear, required to develop each plate, and let the arrow lines represent the lines of stress from one plate to another. When the stresses

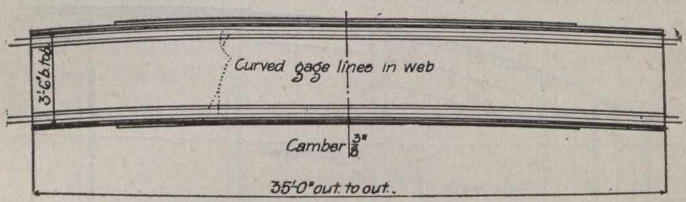

Fig. 7.—Plate Girder Without Web Splices Showing Camber.

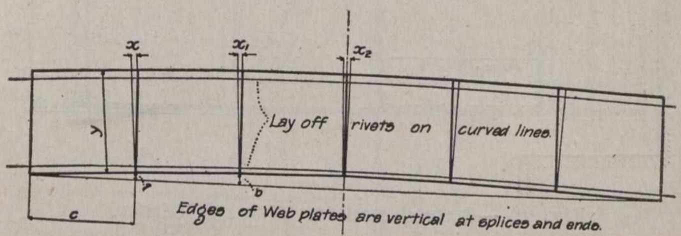

Fig. 8.—Plate Girder With Five Web Splices.

must pass through intervening plates, it is good practice to increase the number of rivets required by 33⅓ per cent. for each intervening plate, because the rivets are less efficient on that account. The number of rivets required theoretically is then obtained, as explained in the example, and in order to make the girders symmetrical about the centre line, extra rivets are added. To complete the splice the best arrangement is to break the flange angles just beyond the cover plate splices. They should alternate, one on each side of the centre line of girder. The number of rivets are obtained in the same way as for the cover plates. Where space is limited, the angles could be spliced in conjunction with the cover plates, but the method outlined above is better, because it does not require the use of such long rivets.

The Splicing of Web Plates.—This is a difficult detail and a subject of disagreement among engineers. If the web is considered to transfer shear only, the best solution for the splice, it to use a pair of splice plates of a depth equal to the clear distance between the flange angles, and attached with the necessary number of rivets, to properly develop the splice. This arrangement is indicated in Fig. 6 (a). If it is desirable to have the web carry its due proportion of the bending moment, this form of splice can also be used, but it is necessary to have a sufficient number of rivets in the connection to resist the web shears and also the amount of bending moment attributable to the web plates. This requires a large number of rivets and their value varies directly with the distance from the centre of the web plates.

A common form of splice is shown in Fig. 6 (b), in which the horizontal plates adjacent to the flange angles are considered to resist the bending moment, and the vertical plates to resist the shear. This is perhaps the cheapest arrangement, but not the best, for it concentrates the bending stresses at two points, whereas, in reality they occur over the entire depth of the girder; and it splices the web for shear, in a depth which is considerably less than the web, and thereby introduces unknown internal stresses. The horizontal plates are sometimes made to overlap the flange angles, but this arrangement has the same objections.

The splice shown in Fig. 6 (c) is recommended by some engineers as the best form of detail. It is similar to (a) except that the splice plates are extended over the flange angles and either crimped or placed on fillers. In this way the splice has the same depth as the web itself. This is expensive shop work, and requires a lot of rivets. It has the additional objection that the flange rivets in the splice are used in a double capacity, as they act with the splice and also have the same work to perform as all flange rivets.

Since there is evidently considerable uncertainty in the efficiency of web splices, where the web is considered to take bending stresses, it seems safer, as stated before, to consider that the web takes shearing stresses only. The best method, and one which is used by the Pennsylvania Railroad, is to use a splice which is considered sufficiently strong to develop the bending stresses, if ⅛ of the web acts as flange section, but to disregard the web in figuring the flange, by using sufficient flange section to resist the entire flange stress. In this way the factor of safety of the bridge is increased at very small cost, and this provides for future excessive loading.

Rivet Spacing.—The rivet spacing in flange angles is dependent upon the assumption that the shear at any cross section is transmitted into the flanges in a length equal to the depth of the girder. This depth should be considered the distance, centre to centre, of web flange rivets.

In the top flange of deck girders, there is also the direct load from the track to be considered, which makes the calculation more complicated. Some engineers consider that the axle load plus impact is supported by only two ties, but it is more common practice to consider that it is distributed over three ties. For an example, consider the case where none of the bending stresses is carried by the web plate, and assume that the direct load is distributed over 36 inches. As this distance is very short, the impact should be counted 100 per cent. of the live load. If W represents the combined wheel load plus impact, then W/36 will equal the vertical load per lineal inch on the flange rivets; and if S represents the shear in the girder at any cross section, S/h will equal the horizontal shear per lineal inch, where h is the depth.

The resultant stress on the rivets per lineal inch of flange will be $\sqrt{\left(\frac{W}{36}\right)^2 + \left(\frac{S}{h}\right)^2} = K$. The working value of one rivet in bearing on the web, divided by k, will give the required pitch of rivets in the web flange. This spacing is slightly less where ⅛ of the web acts as flange section because the entire shear does not have to be transmitted through the flange rivets.

The rivets in cover plates are spaced so that there will be a sufficient number between the ends of two successive plates to develop the strength of the longer one. This, however, usually gives too great a pitch, as practical reasons require a maximum allowable spacing in order that the surfaces will be held in even contact.

Camber in Girders.—As stated before, this is often specified, but it is only obtained by proper details. Where there are no web splices in the girder, it is necessary to punch the flange holes in the web plate in the form of a circle, as shown in Fig. 7, and the flange angles are pulled down to suit, when the girders are assembled in the shop.

When the web plate has splices at various points there are two methods of camber commonly used. In the first method, which is the cheaper and more common, the top and bottom flanges are considered as circles about a common centre. This is accomplished by adding the extra length required in the upper flange, at the points of web splice. This extra length is the same at each splice, and the web splice plates are detailed to suit.

The other method, which is used by the Pennsylvania and other railroads, is more to be commended, and is shown in Fig. 8. Here the upper and lower flanges have an equal radius and are of equal length, the ends of the girders being vertical. This arrangement has a big advantage in details and shop work. In the example given, the girder is 88 feet long over all, and requires a camber of 1 1/16 inches when figured at 1/1000 of the span. This would be increased by ⅛ of an inch for each web splice to allow for shop play, which makes a total required camber of 1 11/16 inches. For even figures 1¾ inches is considered.

The ordinates, a and b, are then figured at the various splice plates. By proportioning similar triangles, $X = \frac{a}{c} \times y$, and similarly X1 and X_2 are obtained. They diminish in value towards the centre of the girder. The web plates should be planed to these figured bevels, so that they will bear along the splice, and the splice plates are also detailed to suit. If the last method is used, and properly followed in the shop, good results should be obtained.

Many engineers put the same camber in the deck as in the girders, by using the same dap in the ties along the length of the span. The better practice is to take all camber out of the track for spans up to 75 feet, and to take out only one-half the camber for greater spans. This for the reason that the bridge looks better to have the track level under dead load only, and moreover, as there is always an excessive camber over that required to balance actual deflection from the ordinary fast trains, these trains would only produce a very slight dip in the track in passing; whereas, if the track had excessive camber, there would always be a bump which would be very objectionable in trains at high speed. With the heavier trains passing there might be a noticeable deflection, which would cause a dip in the track, but the heavy trains would be moving comparatively slowly, and this would not be a bad feature.

The ends of girders in deck spans are necessarily square at the top, in order to support the ties, but in through spans it is customary to curve the top flange for appearance. One method, as indicated in Fig. 9, is to round the corners in the form of a circle with a radius equal to ⅓ the depth of the girder. This is commonly done, and is a good detail as the web plate is not weakened, but the shop work is expensive as the angles must be bent hot and spliced.

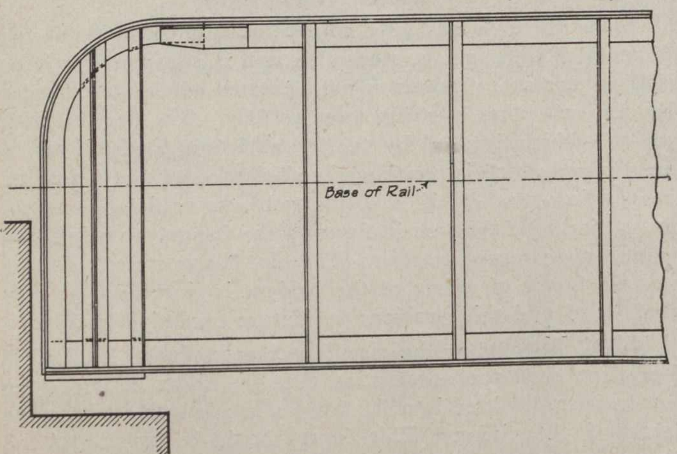

Fig. 9.—Curved End for Through Girder.

Fig. 10 represents a detail which is a cheaper curve to make, as the radius is about 1½ times the depth of the girder. It is also more suitable to resist derailed trains, and cases are actually known where trains have hit the ends of such girders and skidded back on the ties. The main objection to this type of end is, that the web is shallow where the shearing stresses are greatest and it is necessary to reinforce the web by side plates, as indicated by "A" in the sketch. In this construction, and also in the case of girders where the bottom chord is bellied, an error is often made by detailers, as they neglect to add the horizontal plates marked "B" in the diagram. In other words, they reinforce the web against rupture from shear in a vertical plane, and forget that, in order to transmit the shear into the flanges in a length equal to the depth of the web, it is necessary to reinforce the web also against rupture in horizontal lines at the toes of the flange angles.

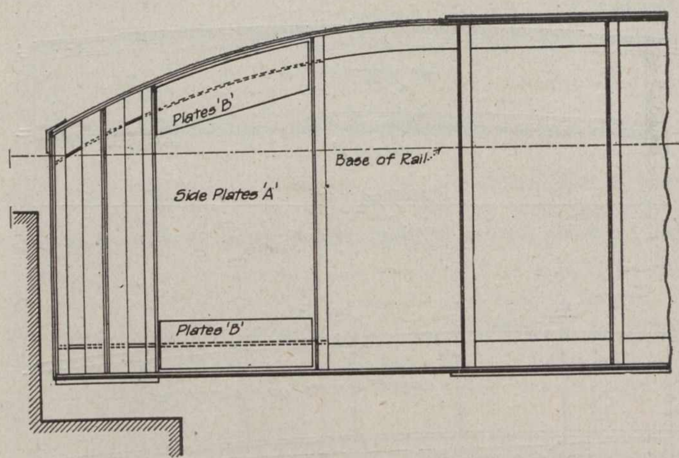

Fig. 10.—Curved End for Through Girder.

The grade of a track does not affect details of plate girder spans, except the sliding bearing plates of smaller spans, in which case either the upper shoe plate or the loose masonry plate must be planed on the bevel. Where the loose plate is bevelled the sliding plane is in the same direction as the expansion, which is an advantage where the grade is steep and the span is long; because if the upper shoe were bevelled there might be considerable rise and fall in the elevation of the track, when the bridge expands.

For smaller spans and light grades the best arrangement is to bevel the upper shoe, and thus keep the sliding surfaces horizontal, as shown in Fig. 1. Thus any tendency for the span to creep on a sloping surface is avoided.

Modern Methods in Shop Practice.—Shop methods, as well as the action of stresses and the strength of connections, should be well understood by the designer and detailer. Rivets should be spaced to suit the requirements of the spacing tables and multiple punches in common use, and which are specially adapted to plate girder construction. In this way the necessity for templates is reduced to a minimum and the shop costs are lowered.

Bridges should be so made that there is easy access for painting of all parts and no openings or pockets should be left where dirt and water might lodge.

In shipment, plate girders are sometimes troublesome and more expensive than other forms of lading. Where the girders are short and shallow and can be loaded on one car, the method of loading is not very different from any form of heavy material. Where the girders are over sixty feet long and extend over two or more cars, it is necessary to adopt special pivoted bolsters in order that the cars will pass freely around curves. The bolster adopted by the Master Car Builders' Association, is recommended in practice and is explained in Figs. 11 and 12. The sizes of material given, are for girders weighing between 30,000 and 70,000 pounds, and vary slightly for other weights.

The weight of loading that can be placed on each car, where the load rests on one bearing point per car, varies from ½ to ⅔ of the capacity of car, depending on whether it is located at the centre or whether it is located midway between the centre and the position of the truck, and also depending on the construction of the car. The height of an ordinary flat car above the top of rail, is four feet and two inches, and this, in conjunction with the bolster, should be deducted from the minimum allowable overhead clearance along the line of shipment, in order to find the maximum depth of girder that can be shipped to various sites.

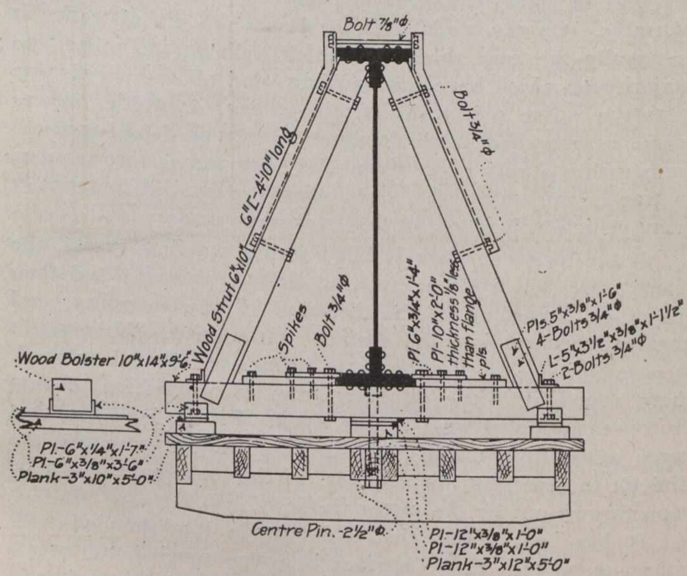

Fig. 11.—Method of Loading Girder on Flat Car.

The Erection of Plate Girder Spans.—This is accomplished with less expense and in shorter time than in the case of any other form of bridge. As it is an inestimable advantage in railroad construction to replace existing spans with no interference with traffic, the simplicity in erection of plate girder spans by modern methods is most important.

The old methods of erecting girders, where there was no falsework, was to place a gin pole in the centre of the span and gradually work the girders from the bank into position. Where there was falsework in place, which had been necessary for further construction of the road, there were several familiar methods employed. One was skidding the girders on the falsework and lowering by jacks. Another method was placing gantries at the abutments, or on cars, and from these gantries a set of falls was suspended which raised the girders off the cars, after they had been run out on the falsework, and which then lowered the girders into position. Lever cars and wood travellers were also used to lift the girders upon the falsework, after which they were pulled over into position.

The above-mentioned methods were dangerous and slow, and the modern erection car completely equipped, and properly manned, will take a plate girder span which is all riveted up, and drop it into position in less than one-half hour. Some companies use travellers which run on special wide-gauge tracks, but they require special provision in the design of the bridge to provide for this. The Hamilton Bridge Works Company, Limited, have eight erection cars in operation, which run on regular gauge tracks and, therefore, require little delay in rigging up at the site, requiring no provision in the design of the bridge, except that it is necessary to consider the load on the front trucks of the car. This very rarely affects the design, however.

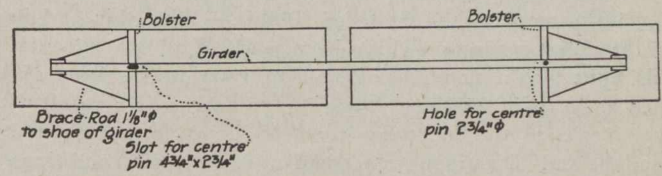

Fig. 12.—Plan of Loading.

Another advantage in the erection of plate girder bridges is that there are very few field rivets to be driven owing to the fact that the girders can be shipped completely riveted up. This is a big saving in costs, and is stronger construction, since rivets can be driven better in the shops, where machines are power-driven.

The evolution in plate girder bridges has been very pronounced since the year 1850, when they were first built of iron, and the principles of economy in design have changed to a great extent. It is impossible to foresee what changes will develop in the future, in regard to the limiting sizes that will be practicable; the composition and strength of metal that may be used, and the facilities for fabrication and erection that may be invented. For these reasons, the engineer in practice should be daily reminded that no set of specifications can cover all the questions he will have to decide, and that "The most perfect system of rules to insure success must be interpreted upon the broad grounds of professional intelligence and common sense."

THE PRODUCTION OF LIMESTONE IN CANADA.

The statistics given in the annual report of the mineral production of Canada, by John McLeish, B.A., do not include the value of the stone burned into lime by the quarry operators nor that of the stone used in the manufacture of cement, a record of lime and cement production being separately given. With these exceptions, the total value of the production of limestone in Canada in 1911 was $2,594,926, as compared with a value of $2,249,576 in 1910, or an increase of about 15 per cent.

There was a decrease in the production of limestone for building and monumental purposes and for curbstone and paving, but an increased production of crushed stone and rubble. The production of furnace flux was slightly less in tonnage, but of increased value.

The production during 1911 of limestone for building purposes was valued at $664,148, as against $695,729 in 1910. The value of crushed stone in 1911 was $1,066,559, as against $701,556 in the previous year. Curbstone and paving blocks were produced to the value of $36,902 in 1911, as compared with $125,637 in 1910. The value of rubble in 1911 was $374,327, as against $295,168 in 1910. The production of furnace flux in 1911 was 874,224 tons, valued at $452,990, as compared with 896,677 tons, valued at $431,486 in 1910.

CONCLUSIONS REGARDING MACADAM ROAD CONSTRUCTION.

Of the 1,001,823 square yards of experimental roads constructed by the Illinois Highway Commission, of which Mr. A. N. Johnson is engineer, 651,123 square yards were water bound macadam and 288,971 were bituminous macadam. A recently-issued report of the commission explains the construction of these experimental roads as an endeavor to determine the modifications necessary to adapt the usual methods of macadam construction to the particular conditions of soil, etc., encountered in the State of Illinois. With this end in view, frequent inspections have been made of all experimental roads built by the commission and information has been obtained as to their condition from year to year. As a result of this experience the following conclusions as to waterbound macadam and bituminous macadam under Illinois conditions are given.

Thickness and Width.—Roads have been constructed of varying thicknesses, sometimes because the local officials felt that on account of the cheapness of the stone, it would be as well to use plenty of it, and sometimes it was desired to demonstrate the possibility of economical construction by reducing the thickness of the stone where local conditions would warrant. The thickness has varied from 5 ins. to 12 ins., after being thoroughly compacted. Inspections made on these various roads from time to time show conclusively that there is no soil encountered in Illinois upon which it is necessary to use a thickness of crushed stone greater than 8 ins. after being rolled and have also shown there are many types of sandy soil in the State upon which a layer of stone 6 ins. thick will serve all purposes of traffic.

The width of roadway has also been varied considerably on the various sections of the road, the widths built being from 10 ft. to 30 ft. Observations of these roads under traffic indicates that there are very few places in the State where a roadway 10 ft. wide is sufficient. A road which does not have any large amount of traffic before improvement will, after improvement, attract a great deal of traffic, and consequently require a wider road than seems necessary from the traffic observed before improvement.

It is also apparent that roads constructed in the vicinity of cities of from 10,000 population upwards, should be wider than 12 ft. This is particularly true if the road will be subjected to any considerable amount of motor traffic, as is often the case in the vicinity of a city. These roads should be at least 16 or 18 ft. wide in order to accommodate both the motor and horse drawn traffic. While it may not seem desirable to build roads merely for motor traffic, yet it is evident that the motor traffic is here and must be taken into account in any comprehensive system of road improvement.

In general it can be said that in most communities where it is worth while to construct and improve roadways at all, a width of 12 ft. is desirable. And in many communities the roadways must necessarily be 16 to 18 ft. wide in order properly to accommodate the traffic which will use them. Moreover, the traffic census which has been taken by the Illinois Highway Commission during the past six years, shows that there is a large increase in motor traffic on these improved roads from year to year, and consequently a road which might be wide enough upon completion will be too narrow to accommodate the traffic in a few years.

Waterbound Macadam.—In regard to waterbound macadam construction, it may be remarked in general that there has been no difficulty, if reasonable precautions are taken for proper drainage, to support this form of construction on any of the soil conditions usually encountered in the State. Wherever isolated sections of macadam roads are exposed to mud marks tracked on at the ends and from adjoining roads, a disproportionate amount of damage is done, to that done on a larger mileage of road. The most serious damage to any of the macadam roads has resulted from tracking on of sticky mud, particularly the first year, before the road has become thoroughly seasoned and consolidated. The mud will pick out the binder and loosen the stone which will be carried with the mud on the wheels and deposited upon the road, which, when dry leaves the surface very uneven. Such action will be in evidence for 100 to 300 ft. from either end of the road.

It has been found, however, that if sand or gravel is placed on the earth roads adjacent to the macadam for 100 or 200 ft., that it will render the mud non-sticky and no damage is done to the macadam surface. If precautions of this nature are taken for the first and second winters, there does not seem to be much further difficulty experienced from this source, as the road in the meantime will have become thoroughly compacted and does not pick up.

Some roads have been much more affected by traffic than others, although it is a fact that the roads that have worn the best in some instances have carried the largest amount of traffic. On the roads with the lesser amount of traffic, it is usually the case that one vehicle follows the other, the majority of which have narrow tires, and all the wheels use a narrow space practically within 10 ins. in width. Where traffic uses a road in this manner, a rut or depression will form within a very short time after the road is thrown open to travel, and unless this depression is removed, practically every vehicle will follow in the track thus made.

If the incipient track is filled with a bonding gravel, the team traffic will avoid it, turning first to one side and then the other, according to the direction it may be going, and eventually consolidate the surface of the road. Wherever it is possible once to distribute the traffic over the whole road, there seems but little difficulty from the formation of ruts or concentration of wear in one track. Roads, however, that carry automobile traffic even in very limited amounts are difficult to repair in this manner, as the loose gravel will be soon thrown out by the motor traffic.

It has been found that a limestone road bonded with gravel to make a gravel surface is a very much better wearing road and will carry with less damage to the surface a very considerable amount more of motor traffic than a limestone road bonded with limestone screenings alone. It is to be noted that the damage done to a macadam road the first year is much more than during subsequent years. In general, if a small amount of gravel is distributed over the surface early in the first spring, the amount required being about one carload to the mile, and a drag is used on the road occasionally as wet weather permits, it is found that the road will pass through the next two or three seasons with little or no attention, save the occasional use of the drag during late fall or early spring.

With the majority of the roads built by the Commission, however, the general impression has been that such construction is permanent in a strict sense of the word, and once a road is built that nothing further needs be done. Thus very few of the roads have had any proper attention, so that their condition in many instances is much poorer than would have been the case under proper and systematic maintenance. As a result, when maintenance repairs have been made, the condition of the road is such that a very considerable amount of work is necessary to restore the surface, so that when this cost is distributed over the years which the road has been in use, the cost per year is often greater than would have been the case had a small amount of work been done more frequently, and the road surface in the meantime maintained in a much higher state of preservation.

In general, it may be said that waterbound macadam construction, particularly where gravel is used for the surface dressing, is a practical form of road construction for many miles of moderately traveled roads in the State; roads that carry a sufficient amount of traffic to make their improvement in this manner worth while at the same time have not developed an amount of motor traffic to prevent the maintenance of this form of construction at a reasonable cost. This applies particularly on those roads which eventually would become feeders to main roads where it is believed that this form of construction will prove serviceable for many years to come. But waterbound macadam is not advised on roads carrying a considerable amount of motor traffic or roads which will eventually become the main roads of a county or State system.

Table I.

Item.	Cost per sq. yd.	Cost per cu. yd.
Shaping roadbed, trimming shoulders and side roads	$0.03	....
Applying bituminous binder	0.023	....
Superintendence, watchmen, etc.	0.037	$0.12
Loading stone on wagons	.....	0.107
Spreading stone	0.028	0.093
Rolling and sprinkling	0.027	0.071

Bituminous Macadam.—The comparatively short experience that has been had with this form of construction with the work under the supervision of the Illinois Highway Commission and elsewhere, makes is impossible to draw any final conclusions. The results, however, of the experience so far gained, seem to show:—

1. The necessity in this form of construction for as stable a foundation course as possible, and that probably the best method would be to lay the first course of the road as waterbound macadam, applying the bituminous top about 3 ins. thick the following season when the foundation course had become thoroughly well compacted.

2. The necessity for using durable material in the bituminous top, and where under the conditions that exist in Illinois, limestone alone is available, the material used for filling the voids and dressing the surface of the bituminous layers as they are applied, should be of washed gravel and torpedo sand. The particles of the gravel are made up for the most part of silicious material, which is the hardest material available, but where the rock of which the road is made is tough and hard, then rock chips could be substituted.

3. It is necessary that the bituminous binder be spread so as to present as uniform a service as possible. This may not necessarily mean the uniform distribution of the binder as the texture of the surface of the macadam before the application of the binder may itself not be quite uniform. Therefore, the more finely divided form in which the asphalt can be applied, the better the control of its distribution. The form of the application whereby the material is spread by a jet of steam has given excellent results.

4. Too much binder should not be used as it will result in a less stable layer of bituminous concrete than if sufficient binder is used only to fill the voids in the stone.

5. It is essential that the surface of the road have very close texture and that usually this cannot be secured in less than three applications except by an excessive amount of binder. The most economical and best results can be secured when the binder is put on in three applications.

6. The bitumens which do not possess some ductility at freezing temperature have not been satisfactory.

7. There is some evidence to show that certain bitumens of low ductility at ordinary temperature are seriously injured by mud that may be tracked upon the road, particularly if the soil is of highly alkaline character. There does not appear to be an equal amount of injury done by mud from soils of slightly acid character, though in either case the results are not as satisfactory as with bitumens possessing higher ductility. It is important that bitumens be applied at high temperatures, and if possible, during hot weather, as some unsatisfactory results obtained can be attributed to the cold weather prevailing at the time of con-

Table II.—Estimated Cost of One Mile of Macadam Road.

Width ft.	Cu. yds. stone per mile	Sq. yds. per mile	Average haul ½ mile		Average haul 1 mile		Average haul 2 miles		Average haul 3 miles	
			Waterbound	Bituminous	Waterbound	Bituminous	Waterbound	Bituminous	Waterbound	Bituminous
12	2,200	7,040	$4,572	$ 5,859	$4,836	$ 6,123	$5,298	$ 6,585	$ 5,870	$ 7,157
16	2,637	9,387	5,659	7,375	5,875	7,591	6,429	8,145	7,115	8,831
18	2,805	10,560	5,960	7,892	6,297	8,229	6,886	8,818	7,615	9,547
20	3,116	11,733	6,624	8,770	6,995	9,141	7,649	9,795	8,459	10,605
24	3,740	14,080	7,948	10,524	8,397	10,973	9,182	11,758	10,154	12,730

struction. The roads constructed with tar binder under ordinary traffic conditions seem to require a paint coat at the end of the second, or at the latest, during the third season, by which time the tar near the surface of the road seems to have lost most of its adhesive qualities.

8. A tar with approximately the following analysis has proved most satisfactory:—

Specific Gravity.—The specific gravity at 25° C shall not be more than 1.26.

Free Carbon.—The free carbon shall not exceed 20 per cent. by weight.

Consistency.—The consistency as determined by the Howard and Morse float appartus at a temperature of 50° C shall not be less than 1½ mins. nor more than 2½ mins.

Distillation.—Fractional distillation shall give results within the following limits, all measurements being by volume.

Up to 110° C the distillate shall not exceed 2 per cent. and shall be free from ammoniacal water.

Up to 170° C there shall be not to exceed 5 per cent. distillate, of which not more than one-fourth shall be naphthalene.

The total distillate up to 315° C. shall be at least 18 per cent.

Brittleness.—A cylindrical prism of the tar binder 1 cm. in diameter, after being maintained at a temperature of 0° C for 20 mins., shall bend into a semi-circle of 3 cm. diameter without checking or breaking.

9. A surface constructed with an asphalt binder apparently requires a paint coat during the third or fourth season. While the asphalt binders do not seem to lose their adhesiveness, the mat forming the close texture of the surface under ordinary traffic conditions will have become worn so as to make the application of a paint coat desirable as a protection against further wear of the road. The most satisfactory results with asphalt binders were obtained with those having closely the following analysis:

Class A.—Bituminous binders shall conform to the following specifications, the various properties described being determined by the methods proposed by the American Society for Testing Materials:

1. The material shall be free from water.

2. **Specific Gravity.**—The specific gravity at 25° C./25° C. (77° F.) shall not be less than unity.

3. **Total Bitumen.**—The bituminous material shall be soluble in chemically pure carbon bisulphide at air temperature to the extent of at least 99.5 per cent. for residuums and gilsonite products, 95 per cent. for Bermudez products, 80 per cent. for Cuban products, and 65 per cent. for Trinidad products.

4. **Naphtha Insoluble Bitumen.**—Of the total bitumen not less than 15 nor more than 28 per cent. by weight shall be insoluble in 86° B paraffine naphtha at air temperature. On evaporation of the naphtha solution the residue obtained shall be sticky and not merely oily.

5. **Fixed Carbon.**—The fixed carbon shall be not less than 8 nor more than 14 per cent.

6. **Penetration.**—The penetration as determined with the Dow penetration machine, using a No. 2 needle, 100 grams weight, 5 sec. time, and a temperature of 25° C (77° F) shall not be less than 12 mm., nor more than 16 mm.

7. **Loss on Evaporation.**—When 20 grams (in a tin dish 2⅜ ins. in diameter and ¾ in. deep with vertical sides) are maintained at a temperature of 170° C (338° F) for 5 hours in a New York testing laboratory oven, the loss shall not exceed 6 per cent. by weight. The surface of the residue at air temperature shall be smooth and show no sign of blistering or cracking, and when tested with the Dow penetration machine for 5 secs. at 25° C (77° F) with a No. 2 needle, and 100 grams weight, it should have a penetration of at least 5 mm.

8. **Ductility Test.**—The ductility at 25° C (77° F) shall not exceed 85 cm., according to the district of Columbia standard.

9. **Flash Test.**—The flash point in an open cup shall not be less than 163° C (325° F).

10. **Paraffine Scale.**—The asphaltic binder shall not contain more than 2 per cent. by weight of paraffine scale.

Class B bituminous binders shall conform to the following specifications, the various properties described being determined by the methods proposed by the American Society for Testing Materials:—

1. The bituminous material shall be free from water.

2. **Specific Gravity.**—The specific gravity at 25° C / 25° C (77° F) shall not be less than 0.965 nor more than unity.

3. **Total Bitumen.**—The bituminous material shall be soluble in chemically pure carbon-bisulphide to the extent of at least 99.5 per cent. by weight at air temperature.

4. **Naphtha Insoluble Bitumen.**—Of the total bitumen not less than 20 nor more than 26 per cent. by weight shall be insoluble in 86/ B paraffine naphtha at air temperature. On evaporation of the naphtha solution, the residue obtained should be sticky and not merely oily.

5. **Loss on Evaporation.**—With 20 grams (in a tin dish 2⅜ in. in diameter and ¾ in. deep, with vertical sides) and maintained at a temperature of 163° C. (325° F.) for 5 hours in a New York testing laboratory oven, the loss shall not exceed 2 per cent. by weight. The surface of the residue at air temperature shall be smooth and shall present no greasy spots nor any sign of blistering or cracking. The penetration in the residue shall not be decreased more than 40 per cent. from the original consistency.

6. **Fixed Carbon.**—The fixed carbon shall not be less than 7 nor more than 13 per cent.

7. **Penetration.**—The penetration as determined with the Dow penetration machine, using a No. 2 needle, 100 grams weight, 5 secs. time, and a temperature of 25° C. (77° F.) shall not be less than 7 nor more than 12 mm.

8. **Paraffine Scale.**—The bituminous binder shall not contain more than 6 per cent. by weight of paraffine scale.

9. **Carbon-Tetrachloride Insoluble Bitumen.**—Of the total bitumen not more than 0.5 per cent. by weight shall be insoluble in chemically pure carbon-tetrachloride at air tempertature.

10. **Brittleness Test.**—A cylindrical prism of the bituminous binder 1 cm. in diameter, after being maintained at a temperature of 5° C for 20 mins., shall bend in a semicircle of 3 cm. diameter without checking or breaking.

11. **Flash Test.**—The flash test in open cup shall not be less than 200° C (392° F).

12. **Melting Point.**—The melting point shall not be less than 60° C (140° F).

13. **Ductility.**—The ductility at 25° C shall not be less than 25 mm., according to the District of Columbia standard.

These binders are of two general classes, and it was found in practice that excellent results were obtained by using a mixture of three parts of low price blown oil or residual asphalt of class B combined with one part of a natural asphalt of class A.

10. The size of stone in the bituminous layer should range from 2½ ins. to ¾ ins. where limestone is used. When trap rock or other equally hard material is available, stone should not exceed 2 ins. in size; the chips for filling the stone not to exceed ¾ in. and the grit for the top dressing not to exceed ¼ in. and all of the materials to be free from dust.

11. The use of laboratory is absolutely necessary for making tests on materials and mixtures as construction proceeds.

12. Experience indicates that this form of construction is adapted to moderate traffic roads, that is, where there is no large amount of extra heavy hauling. Where the traffic is composed of automobiles and farm loads not to exceed two tons, this form of construction will prove satisfactory, although possibly not as durable as either concrete or brick. Where traffic consists of heavier loads, wholesale trucks, heavy coal hauling and loads reaching to five and six tons, it is believed this form of construction is not at all suitable.

It presents a pleasing appearance and is well adapted to horse drawn traffic, but requires close attention for maintenance, and there is some evidence that during warm weather, when the bitumen is least stable there is a tendency for the surface to creep and undulations develop.

The cost of this form of construction over that of first class waterbound macadam is approximately 20 cents per square yard, but there has not been had sufficient experience to determine definitely the maintenance cost and its final economy. The construction requires the utmost care in every detail, and owing to the small experience contractors have had with it, appreciation of this fact has not been realized, with the result that nearly everywhere work done under contract has not been as satisfactory as that done by day labor under the immediate supervision of skilled men. Where attention is given to the construction and where the services of a laboratory are available, to insure the character of the materials, there is no difficulty in duplicating results. Bituminous macadam is of doubtful value on those sections of road so situated that considerable quantities of mud will be tracked on them from adjoining roads.

Construction Cost of Macadam.—At the close of the season of 1912 there were available cost data obtained from the construction of about 150 separate pieces of road, involving the handling of 286,494 cu. yards of stone. A study of these data shows that the various unit costs are constant, regardless of the distance to the road from the tracks from which stone is hauled, except the cost per cubic yard for hauling stone. The costs of the various parts of the work shown in Table I., are the averages of these items for all of the roads constructed.

A study of the data on the cost of hauling stone shows that this cost increases constantly and almost uniformly from a distance of ¼ mile upwards. This variation is most readily shown by means of a curve which is given as Fig. 1. It is possible, with these data available, to make an estimate of the cost of the construction of a mile of macadam road for any length of haul for stone not exceeding three miles. When the width of a road and the thickness of the material have been decided, the fixed items of cost in the road can be immediately determined by use of the unit costs from Table I.

In this manner the estimates of cost of one mile of road, as given in Table II., have been made up. In the table, the cost of crushed stone is assumed to be $1.25 per cubic yard f.o.b., cars at the siding from which it is to be hauled. In bituminous macadam roads the cost of the bituminous binder is assumed to be 8 cents per gallon f.o.b., the siding from which it will be hauled, and it is also assumed that 2 gals. of binder per square yard of surface will be used. This table is based on the actual cost of the work which has been done by the Illinois Highway Commission, and makes no provisions for contractors' profits. It does, however, include cost of maintenance of equipment under the item of rolling and sprinkling.

It should be noted that the allowance for shaping the road bed, and trimming shoulders and side roads, while covering the ordinary earth work necessary on the average road encountered in Illinois, would not be a large enough allowance if the road to be improved included heavy earth work to reduce grades, or construct embankments.

The cost of labor on the various pieces of work varied from 30 cents to 50 cents per hour for teams and from 15 cents to 25 cents per hour for men, and the number of pieces of work where the lower price was paid was about as large as where the higher price was paid. It would probably be fair to assume that these costs are substantially correct where teams received 40 cents per hour, and men 20 cents per hour.

In Table II. the quantity of stone per mile is given and it will be noted that the quantity does not increase in proportion to the width. This is due to the fact that a road 12 ft. wide is made of uniform thickness, while the wider roads are made somewhat thinner at the edge than at the middle. The 12-ft road is estimated on a basis of thickness of 10 ins. of loose stone, while the 16-ft. road is assumed to be 10 ins. thick at the middle and 8 ins. thick at the edge, making the average thickness 9 ins. For roads wider than 16 ft., the average thickness has been taken as 8½ ins.

The cost of bituminous macadam roads exceeds the cost of waterbound macadam roads by the cost of the binder, plus the cost of application, and the experience of the Commission in the construction of bituminous macadam roads by the penetration method indicates that 2 gals. of binder per square yard of macadam is required.

MAINE HIGHWAY LAW.

Maine motorists are regarding the new highway law with mingled pleasure and pain. The pleasure part is experienced when it is considered that the bill provides that all trees must be removed from dangerous turns and at railroad crossings, and that no advertising signs can be erected within 500 feet of crossings. All state roads must be furnished with signposts of a uniform size and height, by the various towns. Part of the bill legislates against the motor truck, providing that trucks having a total weight of over nine tons must obtain a special license. Speed limits are set for all machines, ranging from fifteen miles an hour for light trucks to six for the heavy ones.

STONE PRODUCTION IN CANADA.

Statistics of stone production given in the annual report on the mineral production of Canada, by John McLeish, B.Sc., include the sales of all classes of stone used for building, monumental, and ornamental purposes, stone for paving purposes, curbstone, and flag-stone, rubble, rip-rap, and crushed stone, limestone for furnace flux, sugar factories, etc., but stone used for burning lime or the manufacture of cement is not included.

The kinds of stone quarried have been classed as granite, limestone, sandstone, and marble.

The records are practically confined to quarry operations or the production of sawn or polished stone when these operations are carried on by the quarry operators. In addition to this production of stone by regular operators, there is no doubt a large stone production by individuals, such as farmers and others, for house or barn foundations, concrete work, etc., of which it would be impracticable to obtain any satisfactory record. Much stone is probably also used in railway construction work and in road-building, of which no record has yet been obtained.

It is impossible, except in a few cases, to show the quantity of stone production, so that the value only of the shipment can be given.

The total value of the production of stone in 1911, according to returns received, was $4,328,757, as compared with a value of $3,650,019 in 1910, showing an increased production of $678,738, or 18.6 per cent.

The number of active firms reporting in 1911 was 191, the total number of men employed 5,437, and the total wages paid, $2,500,005. In 1910 the number of active firms reporting was 166, the number of men employed 5,105, and wages paid, $2,225,791.

Of the total value of the 1911 production, limestone contributed $2,594,926, or nearly 60 per cent.; granite, $1,119,865, or nearly 26 per cent.; sandstone, $451,183, or 10.4 per cent.; and marble, $162,783, or 3.8 per cent.

Stone was used for building purposes to the value of $1,368,693, or 31.6 per cent. of the total; monumental and ornamental stone, a value of $303,050, or 7 per cent.; curb, paving, and flagstone, $233,723, or 5.4 per cent.; rubble, $460,803, or 10.6 per cent.; crushed stone, $1,509,498, or 34.9 per cent.; and furnace flux, 874,224 tons, valued at $542,990, or 10.5 per cent.

By provinces, Quebec again shows the largest output, having a value of $1,894,892, or 43.8 per cent. of the total, being made up of limestone to the value of $1,296,577, granite valued at $462,678, marble, $135,187, and sandstone, $450. Ontario takes second place with a production of $892,305, or 20.6 per cent. of the total, of which limestone is credited with $680,461; granite, $131,816; sandstone, $54,032, and marble, $25,996. British Columbia ranked third in order of importance, with a total of $698,811, including granite, $460,851; sandstone, $179,580; limestone, $56,780, and marble, $1,600. The production in Manitoba was valued at $318,050, made up of limestone, $315,782, and granite, $2,268. The Nova Scotia production was valued at $292,914, comprising limestone, $245,216; granite, $24,258, and sandstone, $23,440. The Alberta production was reported as $158,344, all sandstone. New Brunswick is credited with $73,441, made up chiefly of sandstone and granite.

Official figures, recently compiled, place the cement production of the United States last year at 83,351,191 barrels, which is a new high record and an increase of more than 3,800,000 barrels in a year.

ALLOWABLE HEIGHTS AND AREAS FOR FACTORY BUILDINGS.*

By Ira H. Woolson, Mem. Am. Soc. M.E.

In the design of factory buildings, one of the vital features tending to control the spread of fire is a judicious limitation of height and area. It is self-evident that whatever restricts a fire reduces the life hazard. Owing to the supreme importance of these two subjects, a person contemplating the erection of a building of this class should give careful consideration to the history of fires in such buildings, and the experience gained in fighting them. The question is more acute in this class of buildings than in any other because of the fire hazard which exists in them, and the economic advantages due to reduced costs in construction and supervision, when several large areas are housed under a single roof. Just where to draw the line so as to produce reasonable safety without prejudice to building investments is the problem.

Factory buildings of excessive heights or areas have long been recognized by underwriting organizations as a grave danger to life and property, owing to the difficulty of controlling fires in them. They have for years urged limitations which have been freely ignored by ambitious architects and factory owners, because the suggested restrictions were considered unreasonably drastic. The evidence produced in this paper strongly supports the limitations which were advocated.

It is logical to assume that the men best fitted to determine safe limits of heights and areas are the men who have made a life work of combatting fires under all conditions of weather and hazard. With this idea in mind, the writer communicated with all the fire marshals and fire chiefs in the United States representing cities of over 20,000 population. A set of eight questions and a letter of explanation were sent to each. Fire chiefs as a class are not good technical correspondents, therefore it was not surprising that only one-third of the men addressed responded to the appeal. However, replies were received from 117 representative cities well distributed as to size and geographical location. These have been summarized and form the basis of this paper. A few of the replies indicated a misunderstanding of the questions, and these were discarded. The questions were as follows:—

1. What should be the greatest height allowed for manufacturing or warehouse buildings **without sprinkler equipment?**

Brick and joist construction—
Height in ft. ...... or No. of Stories ......
Fireproof construction—
Height in ft. ...... or No. of Stories ......

2. Take the same question as No. 1, but assume the buildings to be fully equipped **with automatic sprinklers.** What height would you approve?

Brick and joist construction—
Height in ft. ...... or No. of Stories ......
Fireproof construction—
Height in ft. ...... or No. of Stories ......

3. What should be the greatest flo r area allowed in the same class of building **without sprinkler equipment?**

Brick and joist construction—
Area in sq. ft. ...... or Width ...... ft. Length ...... ft.
Fireproof construction—
Area in sq. ft. ...... or Width ...... ft. Length ...... ft.

4. If the same buildings were fully equipped **with automatic sprinklers** what area would you approve?

Brick and joist construction—
Area in sq. ft. ...... or Width ...... ft. Length ...... ft.
Fireproof construction—
Area in sq. ft. ...... or Width ...... ft. Length ...... ft.

Each building was assumed as a good one of its class, with enclosed stairways and elevator shafts; and the chiefs were requested to base their answers upon experience in fighting fires in the class of buildings described, and to assume restrictions which would afford a reasonable chance of controlling a fire on any floor.

Naturally, and quite properly, the replies reflect the local conditions, such as the efficiency of the fire department, the water pressure, the combustibility of the goods being manufactured, the number of sprinkler equipments in service, and the degree of congestion among the buildings. However, all conditions were represented, and the summary of so large a number of opinions should indicate fairly well the average condition throughout the country. (See Table I.).

Table I.—General Average of 99 to 111 Replies Received From All Classes of Cities.[1]

Type of Building.	Stories in Height.	Area between Fire Walls in Sq. Ft.
Non-Fireproof, not Sprinklered..	3.1	6,300
Fireproof, not Sprinklered	4.9	12,300
Non-Fireproof, Sprinklered	4.6	12,800
Fireproof, Sprinklered	7.0	27,100

Average story height was 12 to 13 ft.

The answers regarding allowable heights were much more uniform than those relative to area. It is significant that 83 per cent. of the replies would limit the height of a fireproof sprinklered factory building to less than ten stories. The opinions in reference to height of the other classes of buildings were exceedingly uniform, and consistently low.

Replies as to permissible areas in sprinklered buildings were widely divergent, but for the unsprinklered classes they were more uniform than would naturally be expected considering the great diversity of conditions under which they were prepared.

It is evident from the figures given, that the fire chiefs have no settled policy among themselves as to the credit that should be given to an automatic sprinkler equipment as a fire extinguishing device. A few enthusiasts would permit unlimited area in a sprinklered building, while on the other hand a considerable number would give very little or no increase when sprinklers are installed. Two chiefs stated that their unfortunate experiences with sprinklers had caused them to lose faith in their reliability. As a whole, however, they are strongly in favor of sprinklers and are inclined to permit over generous areas in buildings so equipped.

In order that the replies may be intelligently interpreted they have been separated into three groups, Tables 2, 3, 4, according to size of the city represented, and each group has been analyzed to show the character of the answers given to each question.

In the cases referred to by an asterisk, where no limits to areas were given, they were not included in the averages, but were counted in the columns giving the number of answers above the average. In each group it will be noted that about the same number of men gave high answers to all questions, the proportion being one-quarter to one-half of the number in the group. The uniformity of height limits,

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* From a paper read before the American Society of Mechanical Engineers in Baltimore, May 22nd, 1913.

[1] The variation in the number of replies (averaged) resulted from some incomplete answers.

and the lack of it in the area limits, is very apparent in all groups. It will be noted that the largest area values are given in Groups I. and II., comprising the smaller cities. This is significant, and needs explanation.

Table 2.—Group I. Summary of Answers from 52 Cities With a Population of 20,000 to 50,000.

Type of Building	Stories in Height Average	Stories in Height Max.	Stories in Height Min.	Answers above Average	Area in Square Ft. Average	Area in Square Ft. Max.	Area in Square Ft. Min.	Answers above Average
Non-Fireproof, not Sprinklered......	2.8	6	1	13	6,000	20,000	1,150	15
Fireproof, not Sprinklered......	4.4	10	2	24	12,600	60,000	1,150	15
Non-Fireproof, Sprinklered......	4.1	8	2	17	12,300	*60,000	3,000	17
Fireproof, Sprinklered......	6.3	12	3	18	27,300	*180,000	5,000	20

* Four votes received in favour of "no limit to area" in this class.

Table 3.—Group II. Summary of Answers from 23 Cities With a Population of 50,000 to 100,000.

Type of Building	Stories in Height Average	Stories in Height Max.	Stories in Height Min.	Answers above Average	Area in Square Ft. Average	Area in Square Ft. Max.	Area in Square Ft. Min.	Answers above Average
Non-Fireproof, not Sprinklered......	3.2	6	1	8	8,300	40,000	2,500	5
Fireproof, not Sprinklered......	5.2	10	1	6	14,800	60,000	2,400	4
Non-Fireproof, Sprinklered......	4.8	10	3	5	16,300	75,000	1,500	5
Fireproof, Sprinklered......	7.7	20	4	5	36,300	200 000	4,000	5

Table 4.—Group III. Summary of Answers from 36 Cities With a Population of 100,000 and Over.

Type of Building	Stories in Height Average	Stories in Height Max.	Stories in Height Min.	Answers above Average	Area in Square Ft. Average	Area in Square Ft. Max.	Area in Square Ft. Min.	Answers above Average
Non-Fireproof, not Sprinklered......	3.5	7	1	17	5,400	10,000	900	15
Fireproof, not Sprinklered......	5.3	9	2	18	9,800	22 500	2,400	10
Non-Fireproof, Sprinklered......	5.0	10	3	15	11,300	22,500	900	13
Fireproof, Sprinklered......	7.5	12	4	16	19,400	*80,000	2,500	9

* Two votes received in favour of "no limit to area" in this class.

Occasionally the fire chief of a small city has experience which would abundantly qualify him to estimate properly the merits of fireproof construction and sprinkler equipment; more often, however, his city has meagre protection of this kind, and consequently he has little opportunity to judge of their efficiency, and it is not strange that he should be a bit extravagant in the credit he would give them.

The most rigid restrictions on area are found in Group III embracing the large cities. As fireproof construction and sprinkler equipments are common in most of our larger cities, it is reasonable to assume that the fire chiefs of such cities would have had much more experience with such methods of protection, and be better able to decide what increase should b given in the size of a building when such protection is provided, than their less experienced fellow officers in smaller towns. It is thought quite proper to assume that their figures are more nearly correct and should be given the most weight.

Significant evidence in support of this argument is found in the fact that four chiefs who give no limit to areas in non-fireproof and fireproof sprinklered buildings are located in cities having a population of less than 50,000 in which there are few fireproof factory buildings or sprinkler equipments. On the other hand only two chiefs, in cities over 100,000 population, suggest a "no limit area" in a fireproof sprinklered building, and none approves such areas for non-fireproof buildings.

With these thoughts in view, Table 1 has been changed somewhat to be more in accord with the weight of evidence. It is believed, therefore, that Table 5 represents more correctly the consensus of opinion among the fire chiefs of the country best qualified to judge as to what should be the proper limits of height and area for factory buildings.

Table 5.—Allowable Heights and Areas in Factory Buildings.

Type of Building	Stories in Height	Area between Fire Walls in Sq. Ft.
Brick and joist construction, not sprinklered	3	6,000
Fireproof construction, not sprinklered.....	5	10,000
Brick and joist construction, sprinklered	5	13,000
Fireproof construction, sprinklered	7	20,000

These values might be increased somewhat under the influence of especially favorable local conditions, as previously explained, but the writer submits that as they represent the average deliberate judgment of such a large body of men, so well qualified to estimate the hazard which the values involve, they should be given careful consideration, and should be increased only with the utmost caution.

Extracts From Fire Chiefs' Letters.—The following extracts from letters received from different fire chiefs in connection with this investigation may be of interest as indicating their attitude of mind in relation to the questions asked:—

"In my opinion, from a fire-fighting standpoint, **no building** should be built over eight stories."

"In our city there is room to grow on the ground without building high in the air. It is almost impossible for a public fire department to fight a fire from the outside above 75 ft."

"The figures given mean that every 66 ft. by 66 ft. should have a brick wall through length of building with Underwriters' doors; same to be double. As for width, in no case over 66 ft. wide; with solid wall, same to reach above roof at least 6 ft. **Build on ground not in air.**"

"A building 8 or 10 stories high, out in the open where it can be attacked from all sides should be handled very readily by a modern equipped fire department."

"I think that a factory should never be more than four stories high. I almost feel that there is no such thing as fireproof construction from my own experience. I know that it is possible to store enough material in any building to burn it. I am very much in favor of dividing rooms in factories with fire-resisting walls, provided with automatic fire doors."

"While fireproof construction is the best, it is the contents placed therein that is the hazard to life and property. Buildings should not be constructed to a greater height than can be reached by fire department ladders; 85 ft. to upper windows."

"In my opinion no warehouse building ought to be over one story in height. In regard to manufacturing buildings, I will say that I do not approve of any of these buildings being over three stories in height. If they want room, let them build in length and not so high; that is just what makes such bad fires. These buildings have all kinds of combustible material in them and they are sure to jump to another building if they are four or five stories in height."

"It is my opinion that all buildings for manufacturing and warehouses should be sprinklered, and not built higher than what the water supply will furnish and cover."

"Do you think any fire department can successfully fight a large fire over six stories high, and ten stories allowed only when there are two sources of water supply with good pressure."

"Area of sprinklered and unsprinklered buildings should be about the same, on account of increase in height allowed for fireproof buildings."

"All buildings of character named should be sprinklered."

"Joisted brick construction should not be allowed without sprinklers."

"I think a good sprinkler system is one of the best fire preventions that has been invented in a great many years, and if kept up properly, it is pretty hard for fires to get away."

"If I had my way I would not allow any manufacturing plant to do business until it were properly sprinklered. It does things when they should be done."

"My experience with the 28 factories in this city has been that the sprinkler systems are out of order much of the time. Not looked after properly.

"This department has had no unfortunate experience with the sprinkler system, but, I do not feel inclined to depend upon them."

"The reason for not showing more favor to sprinklered risks, is because our experience with sprinkler systems in this city has shown them to be unsatisfactory, and not to be depended on."

"Stairs should be of steel without any wood sides; if any wood in the construction then there should be sprinklers. Should be sprinklers in all elevators even if they are enclosed, for an elevator is a bad air shaft. Brick factories cut up with wooden partitions are generally hard fires to fight."

"I do not approve of small rooms in factories, they make it very hard for a fireman to fight his way through smoke trying to find a fire when a building of this kind is partitioned off so much."

"In considering the limiting of height and area of a building, the question of accessibility should play an important part."

OUTPUT OF LIME IN 1911.

The production of lime in Canada in 1911, as contained in the annual report of the Mineral Production of Canada, by J. McLeish, B.A., and according to returns received from the producers, was 7,533,525 bushels, this being the amount sold or used (equivalent to about 263,673 tons), and valued at $1,517,599, or an average of 20 cents per bushel, or $5.75 per ton.

The production in 1910 was reported as 5,848,146 bushels (204,685 tons), valued at $1,137,079, an average of 19 cents per bushel, thus showing an increased production in 1911 of 1,685,579 bushels, or 22 per cent.

Returns were received from seventy-five active firms in 1911, as compared with seventy firms in 1910. The average number of men employed was 1,056, and wages paid, $523,518, during the past year, as against 976 men employed and $466,876 paid in wages in 1910. Statistics of labor and wages should be used with discrimination, however, as many firms producing lime are also engaged in quarrying stone for purposes other than lime making, and are unable to make separate reports as to labor employed. This is particularly evident in the record for Nova Scotia and New Brunswick, since for the first mentioned the record includes only the labor employed at the kilns, while for the latter the quarry costs are also included.

The average price per bushel varied from a minimum of 16 cents in Ontario to a maximum of 34 cents in British Columbia.

Hydrated lime was produced by three firms only, the sales being 5,023 tons.

A small quantity of lime is annually made in Prince Edward Island. The production is separately shown for 1911, but for previous years is included in the Nova Scotia figures.

THE ELIMINATION OF TASTE IN TREATED DRINKING WATER.

Dr. Arthur Lederer, a chemist and bacteriologist in connection with the Sanitary District of Chicago, and Mr. Frank Bachmann, assistant chemist, in commenting upon the abundant use of chlorinated lime in the treatment of water supplies, refer, in a paper read at the fifth annual meeting of the Illinois Water Supply Association, last March, to the surprisingly little which has been done towards meeting with compliance the frequent complaints about the resulting taste.

The first experiments on the removal of taste due to chlorinated lime were made almost twenty years ago by Traube, who also was the first one to recommend it for the disinfection of water supplies, although its germicidal action was known before. Traube applied 4.26 mg. of chlorinated lime containing 1.06 mg. of available chlorine to one liter of the water, and added after two hours' contact 2.09 mg. of sodium sulphite ($Na_2SO_3.7H_2O$). He claimed that an excess of sulphite up to 50% over the required quantity does no harm; for the reason that the salt is quickly oxidized in the water to sodium sulphate, which cannot be tasted in such low concentrations. For one million gallons of water Traube recommended 35.7 pounds of chlorinated lime and 16.8 pounds of sodium sulphite. The quantity of chlorinated lime applied may seem abnormally high in the light of more recent observations and experiences in this country, but it explains why the early observers were forced to look for means to remove the repugnant aftertaste in water thus overdosed. The need for remedial measures grew still more pronounced when later observers were led by laboratory tests to employ still larger quantities of chlorine in the form of chlorinated lime or sodium hypochlorite. Sickenberger and Kaufmann disinfected the turbid Nile water at Cairo with sodium hypochlorite equivalent to 2 mg. of available chlorine per liter, which corresponds to about 50 pounds of chlorinated lime per million gallons of water. Bassenge recommended for disinfection on a large scale the enormous quantities of 2,445 pounds of chlorinated lime for a ten-minute contact period down to 270 pounds of chlorinated lime for two hours' contact. To eliminate the taste a quantity of calcium bisulphite, $Ca(HSO_3)_2$, somewhat larger than the quantity of chlorinated lime employed had to be added. Bassenge decided on the use of calcium bisulphite for the neutralization of the excess of chlorine with the advice of Dr. B. Proskauer. Calcium bisulphite is a saturated solution of calcium sulphite in sulphurous acid. It has the strong odor of that acid. On standing it decomposes, forming calcium sulphite and water. The reason Bassenge did not make use of sodium sulphite as did Traube, was that it forms sodium sulphite in sufficiently large quantities to have a marked therapeutic effect which would not be the case with calcium bisulphite. An additional reason was that the free acid present would more readily combine with the chlorine than would the neutral sulphite. No definite quantity of bisulphite was recommended since it rapidly changes on storage. The quantity had to be determined each time by actual trial. Lode likewise used excessive quantities of chlorinated lime and advised the use of either sodium or calcium sulphite for the neutralization of the chlorine after 5 to 10 minutes' contact. Later he went quite thoroughly into the question of removing the taste by various chemicals, of which he preferred the neutral sodium sulphite, but also recommended for disinfection quantities of chlorinated lime as high as 1,250 pounds per million gallons of water.

It is also interesting to note in connection with the early disinfection experiments, that acids were brought into contact with the water after the chlorinated lime has been added, in order to liberate the active chlorine which otherwise would not enter into the reaction. Lode adds for each pound of chlorinated lime about 1.2 pounds of concentrated hydrochlorite acid. Citric acid likewise has been used in quantities of approximately 15 grains per gallon of chlorinated water for the same purpose. It is said that the taste was not influenced by the addition of the citric acid.

From the foregoing it must be apparent that even if the taste was effectively removed by the addition of various chemicals, the treatment of water supplies at that time must have proven too expensive to be considered anything more than a temporary relief measure in times of epidemics. As such the Traube-Lode process was employed during a typhoid epidemic at the Austrian city, Pola, in the fall of 1896 and the winter of 1896-97, by Dr. Meerans on the recommendation of V. Kusy. A total of 450,000 gallons of treated water was supplied during that period and sodium thiosulphate ($Na_2S_2O_3 \cdot 5H_2O$) served for the elimination of the taste. The consumers became eventually used to the water in spite of its high turbidity resulting from the chlorinated lime treatment. Lode criticized the use of sodium hyposulphite in Pola and assumed that it had been used by mistake, since in his earlier writings, he called the sodium sulphite "Antichlor," which as a matter of fact is the trade name for sodium thiosulphate.

The uncertainty of the quantity of chlorinated lime to be added to different waters and the almost general introduction of safer ground water supplies led the Germans to abandon altogether this treatment as a permanent procedure.

There are, however, industrial regions in Germany where similar conditions exist in regard to water supplies as in this country, which have caused renewed interest in the hypochlorite treatment. Such conditions are met with in the coal mining region of the Ruhr watershed and the disinfection of more than a dozen waterworks supplies carried on by H. Bruns with quantities somewhat smaller than those originally employed by Traube, gave with two exceptions very satisfactory results. The quantities of chlorinated lime varied between 12.5 and 25 pounds, (containing approximately 33% of available chlorine) per million gallons. While complaints were frequent when the treated water was used by the consumers, the complaints ceased as soon as sodium thiosulphate was added as a routine measure. The compound was added 15 to 30 minutes after disinfection in quantities equivalent to 50 to 70% of the weight of the chlorinated lime. As spoken of above, the disinfection was a failure in two cases. In one case the organic contents of the water expressed as "oxygen consumed" reached as high as 30 p.p.m. and in the other case the water contained 2 p.p.m. of iron.

The good results obtained on adding taste removing chemicals induced us to believe that like results could be obtained in our "hypo" plants where the amount of chlorinated lime approaches the limit of recognizable taste. In some of our own observations we found that 0.6 p.p.m. of available chlorine (equivalent to 15 pounds of chlorinated lime per million gallons) was about the smallest quantity which could be readily tasted but it is a fact that even smaller quantities are discerned by sensitive non-smoking consumers, particularly when the temperature of the water is high. We should remember that in plants where smaller quantities, such as 6 to 8 pounds of chlorinated lime per million gallons, are employed, accidental overdosing followed by a flood of complaints, is frequent. W. H. Dittoe and R. F. MacDowell, in reporting on the result of an inquiry among a large number of cities in United States and Canada, in which "Hypo" treatment is installed, state that a taste is not often noticed when chlorinated lime is applied in quantities of 7 pounds per million gallons or less, but that there is often complaint on using larger quantities. However, with certain waters even smaller quantities may produce tastes and odors. It would then seem an advantage to apply a "sure cure" remedy if this can be done without materially influencing the cost of the treatment. Our tests have been made on Lake Michigan water and, while the relation of the chlorine to the chemicals applied theoretically remains the same, it is possible that the actual quantities would require adjustment with different water supplies.

We know that storage of chlorinated waters by itself is a simple method by which to rid the water of the taste, depending on the time allowed for this purpose. The chlorine taste in lake water treated with 12.5 pounds per million gallons disappeared, at room temperature, in a little over 3 hours. Simple aeration will hasten the disappearance, reducing the time to something like 2 hours with the same quantity of bleach. The amount of air applied was 0.3 cubic feet per gallon of water. It may also be stated here that the elimination of the taste coincides well with the disappearance of the potassium iodide-starch reaction. There is no definite chemical reaction taking place on aeration which would account for the speedier elimination of the taste; the chlorine seems to be carried off by the air bubbles passing through the liquid. On a large scale a prolonged storage period or storage with additional aeration would be in most cases not a practicable procedure.

Contact of chlorinated water with wood charcoal will quickly do away with the chlorine taste but the water in our experiments absorbed certain ingredients from the charcoal which, by themselves, resulted in a pronounced taste. Whether other carbonaceous material will give like results we do not know, but it is probable that sedimentation or filtration would be subsequently required to rid the water of the matter in suspension.

The chemicals which seem of value for the purpose of removing the chlorine taste from waters are sodium sulphite and sodium thiosulphate, both of which are strong reducing agents and form tasteless compounds when brought into contact with chlorine. The calcium sulphite and calcium bisulphite which have been employed by some early observers have not been utilized by us for the reason that they are not readily obtainable and too expensive for practical application even when bought in bulk. The calcium sulphite, $CaSO_3 \cdot 2H_2O$, is only sparingly soluble in water; the calcium bisulphite, $Ca(HSO_3)_2$, is very unstable on account of the presence of free sulphurous acid and it is not a commercial preparation. When coming into contact with chlorinated lime the reaction is analogous to the one taking place with sodium sulphite:—

$$CaSO_3 + CaOCl_2 = CaSO_4 + CaCI_2$$

$$Na_2SO_3 + CaOCl_2 = Na_2SO_4 + CaCl_2$$

Our experiments on the neutralization with sodium sulphite were made on late water treated with chlorinated lime as well as free freshly generated chlorine and practical tests coincided well with the theoretical quantities of chemical as determined by calculation. For 0.01569 gm. of bleach containing approximately 33% of available chlorine 0.01815 gm. of crystalline sodium sulphite were required, or 1.2 pounds of sulphite for each pound of chlorinated lime. When free chlorine is employed the reaction taking place is:

$$Na_2SO_3 + 7\ H_2O + Cl_2 = 2HCl + Na_2SO_4 + 6H_2O$$

One pound of liquid 100% chlorine would necessitate the addition of approximately 3.6 pounds of crystalline sodium sulphite for neutralization. An important point to keep in mind is that it takes as much sulphite for the free chlorine as for the total available chlorine in chlorinated lime to remove the taste of treated waters. The reaction between the sulphite and the chlorine takes place instantaneously, thus removing the taste as well as the odor at the same time. No harm can be done with a reasonable overdose since the sulphite could not be detected in such low concentrations. Furthermore, it would take but a very short time for the dissolved oxygen in the water to convert the sulphites into sulphates. Medicinally the sulphites are of low toxicity and fairly strong antiseptics on account of their ability to withdraw oxygen from organic matter, but they are rarely used nowadays for that purpose. The average medicinal dose is 15 grains. Supposing we overdose a treated water containing 10 pounds of chlorinated lime per million gallons with 50% of the quantity of sulphite required, which would be an excess of 6 pounds, one would have to drink about 370 gallons of the water to get a single medicinal dose, not considering any oxidation into sulphates at all. Since the medical dose of sodium sulphate, which is formed in the reaction, is 240 grains, its therapeutic effect is surely negligible. The wholesale price of crystalline sodium sulphite is approximately 4 cents per pound when bought in 100 pound lots. This would add about 125% to the cost of the chlorinated lime, assuming that the market price of chlorinated lime containing 33% of available chlorine is 2⅛ cents per pound. Considering the benefit to be derived in many cases from the use of the sulphite, the additional cost would not seem unreasonable. There are, however, serious drawbacks to the continued use of sodium sulphite, one of which is the fact that it deteriorates readily, forming sulphates, which of course are completely inert as far as the taste-removing property is concerned. Weak solutions in particular will change from day to day. We have noted N/40 sodium sulphite solutions to weaken over 50% in less than a day. The aqueous solution of the sulphite is neutral or feebly alkaline and has a cooling, saline, sulphurous taste.

The sodium thiosulphate, $Na_2S_2O_3.5H_2O$, as first applied in Pola and recently recommended by Burns, has striking advantages over the sodium sulphite. It is commercially used very extensively as "Antichlor." When sodium sulphite comes into contact with chlorine the reaction taking place is the same as with iodine. With thiosulphate the oxidation is more complete, and this therefore alters materially the proportions of chlorinated lime and thiosulphate necessary to do away with the taste and odor. The reaction is as follows:

$$Na_2S_2O_3 + 8Cl + 5H_2O = Na_2SO_4 + H_2SO_4 + 8HCl$$

The acids formed in the neutralization process immediately combine with bases to form neutral salts. Lode stated that in his experiments he found it impossible to establish quantitatively corresponding values of chlorine and thiosulphate, and he recommended 0.8 to 0.9 of the quantity of chlorinated lime for the purpose of taste removal. Bruns recommends values of 50% to 70% of the quantity of chlorinated lime applied. As a matter of fact, it seemed impossible in our experiments to obtain checks when a chlorinated lime solution was titrated with a thiosulphate solution under addition of potassium iodide and starch in the absence of acid. Of course, when acid was added and all of the available chlorine became liberated, checks were readily obtainable. This was likewise the case when the same definite quantity of potassium iodide was added, each time without acid, and the solution immediately titrated. We have found, however, that the theoretical quantity of thiosulphate necessary to complete the reaction and remove the taste as well as odor coincide always with the amount necessary to satisfy the total available chlorine in the chlorinated lime employed. For one pound of chlorinated lime containing approximately 33% of available chlorine, the theoretical quantity would be 0.28 pounds of crystalline thiosulphate, or approximately 30% of the weight of the chlorinated lime. One need not be afraid to add an excess, since even 100 pounds of thiosulphate in one million gallons of pure water cannot be tasted. As a matter of fact, we should strongly recommend the application of thiosulphate in quantities of one-half of the quantity of the chlorinated lime to be on the safe side at all times and to take care of all reasonable overdosing with chlorine.

The commercial sodium thiosulphate is about 98% pure; it is a colorless, odorless salt possessing a cooling taste, afterwards bitter. It is very stable in air below 92° F., but loses moisture above that temperature. It greatly exceeds the chlorinated lime in stability. The salt is readily soluble in water and neutral or faintly alkaline in reaction. The medical dose of thiosulphate is the same as that of the sodium sulphite. Formerly it has been used to a limited extent as a weak antiseptic. The price of the commercial preparation is about 1.85 cents per pound when bought in 100 pound lots; it is therefore cheaper than chlorinated lime.

To summarize the advantages of the sodium thiosulphate over the sodium sulphite, we would say that it is much more stable, much cheaper, and that it requires less in actual weight to accomplish the same result. The combined cost of the treatment is within easy reach of a community, since it adds but 40% to the cost of the chlorinated lime, and the advantage of its application will best be appreciated in places where taste troubles are frequent. Even when less than the theoretical quantity of thiosulphate is added, it is bound to lessen the frequency of complaints. A very important point to keep in mind when such treatment is resorted to is that the thiosulphate stops the germicidal action of chlorine the moment it comes into contact with the treated water. This is not of serious consequences, however, since we know positively that the destruction of bacteria by the chlorine is extremely rapid and in most cases practically completed in the first five minutes. We should recommend, however, at least 10 to 15 minutes as a safe margin, or even more when conditions warrant. When the chlorinated water is stored, the simple addition of the thiosulphate in solution will suffice, care only being required to obtain a fair distribution. There is not much chance for the thiosulphate to unite with substances other than chlorine, since those compounds have a pronounced chemical affinity. Where the treated water is directly discharged into the mains, without previous storage, provisions will have to be made to dose the treated water continuously with thiosulphate at a point where disinfection has been practically completed. The thiosulphate does not attack metals, and therefore would not cause trouble in the dosing chamber, as does the chlorine. Where quantities like 2 to 5 pounds of chlorinated lime are applied and the dosing can be made reasonably automatic, the application of thiosulphate will hardly seem necessary. However, where larger quantities are required and taste troubles ensue, our observations would lead us to recommend the application of sodium thiosulphate as a permanent procedure.

Argentina owes a great part of her present prosperity to the excellence and extent of her railways, and in this connection a tribute is due to the courage and persistence of British railway men and investors, who were the pioneers of construction. As more and more the necessities and advantages of railways are being realized, so it may be expected that development will be even more rapid in the future than it has been in recent years.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of the CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MARINE AND MINING ENGINEER, THE SURVEYOR, THE MANUFACTURER, AND THE CONTRACTOR.

Present Terms of Subscription, payable in advance
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	**$1.75** (7s.)	**$1.00** (4s.)

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HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main **7404, 7405** or **7406**, branch exchange connecting all departments. Cable Address: "ENGINEER, Toronto."

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820 Union Bank Building. Phone M. 2914. G. W Goodall, Western Manager.

London Office: Grand Trunk Building, Cockspur Street, Trafalgar Square, T. R. Clougher, Business and Editorial Representative. Telephone 527 Central.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

NOTICE TO ADVERTISERS.

Changes of advertisement copy should reach the Head Office two weeks before the date of publication, except in cases where proofs are to be submitted, for which the necessary extra time should be allowed.

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Printed at the Office of The Monetary Times Printing Company Limited, Toronto, Canada

Vol. 25. TORONTO, CANADA, JULY 3, 1913. No. 1

CONTENTS OF THIS ISSUE.

TO RAISE THE LEVEL OF LAKE ERIE.

Canada and the United States are equally interested in the recent finding of the International Waterways Commission as a result of its investigation into the possibilities of raising the level of the water in the upper Niagara River and Lake Erie. The problem has been under the Commission's examination for a number of years, and the recent recommendation is but one of a number of suggestions towards its solution.

Briefly, the International Waterways Commission, a body representative of both countries, has just recommended to their respective governments, the building of a submerged weir in the Niagara River at Hog Island, just above the Welland River, on the Canadian side, to extend toward the New York shore to a point opposite Gill Creek. If carried out, the restriction to flow will raise the level of the upper waters of the Niagara through a height of three feet for a distance of approximately one and a half miles. The effect opposite Buffalo would be an increased level at low water of 1.08 feet, and at flood of .19 feet. The level of Lake Erie would be raised .31 feet at low, .39 feet at mean, and .11 feet at extreme flood levels. Extending into the upper lakes, the mean level of Lake St. Clair would be influenced to an extent of .23 feet increase, and that of Lake Huron by .09 feet. The cost of the weir, including the levees necessary to protect adjoining shore properties, is estimated at $3,500,000.

Of particular importance, as it would be to the towns and cities on Lake Erie, whose docks and harbors will be rendered more usable, and whose water transportation facilities will thus be considerably enhanced, the proposed dam would have no appreciable effect, it is claimed, upon the waters below it. Lake Ontario and the St. Lawrence would not suffer from any perceptible decrease in flow from the Niagara. The only precaution necessary, below the weir, would be the construction of a guard-lock in the barge canal at Tonawanda, N.Y., to remedy the effect the new weir would have upon its level.

The Commission pointed out that the weir would be of further value in eliminating any injurious effect upon the level of Lake Erie, due to the diversion of water at Niagara Falls for the generation of hydro-electric power, and also that it would reduce the degree of variation in the Lake Erie water level by four and a half per cent.

Several years ago the Commission submitted a report on the advisability of constructing an ordinary dam across the Niagara for the purpose of controlling the Lake Erie level. The scheme did not meet with favor, the Commission considering as too great the possibility of consequent damage to property below the dam, and, although the present recommendation aims at only partial control, the disadvantageous possibility of detriment to property is largely eliminated. Surveys had also been made for a proposed site immediately below the mouth of the Welland River, but the probability of resulting floods from a weir built at that point defeated any advantages the location presented.

In connection with this scheme, it is of interest to recall the suggestions made some years ago by the United States War Department, that a weir be built along the crest of the Falls, having for its purpose the distribution of flow over the brink, and resulting, it was predicted, in increased grandeur of appearance. According to the report, however, this would have had no effect upon the level of the water in Lake Erie.

THE ENGINEER AND THE LANGUAGE.

In an address delivered in 1909 to one of the university engineering societies in the United States, Mr. Onward Bates, C.E., then the president of the American Society of Civil Engineers, states that engineers' opinions should be expressed with a regard for accuracy equal to that used in their mathematical computations, and that precision in written and spoken expressions of fact and opinion is most essential in a profession that is so exacting in its nature as that of engineering. Just how far the average engineer's command of the English language falls short of such accomplishment has its solution in the frequently aired criticism that engineering is a narrow and extremely one-sided profession. The engineer is prone to leave to the followers of other professions the copious use of language. Other people do the talking while he works—the drawing up of contracts and the writing of specifications and reports are the literary works of the average practising engineer. It is true that in these examples of literary ability one does not always find clear and distinct thoughts and correct representations. Serious complications frequently arise as a result of the derivation of divers meanings from expressions failing to convey a simple idea. This is a practical example, showing that the criticism is not without foundation.

Justly considered, the engineering profession is not inferior to the legal, ministerial, or medical professions, but, compared with them, it has a remarkably small amount of necessary writing associated with it. To this fact is attributable the impression among engineers that the careful attainment of facility of language is not as necessary in his profession as in the others. Experience has taught severe lessons in a manner mentioned above, in dislodging this erroneous idea.

Accuracy in engineering demands accuracy of expression, and has a severe handicap in lack of facility of language. According to Mr. Bates, and others, this shortcoming, and it is quite general among engineers, has its rising at the universities, from which men graduate insufficiently equipped in the matter of knowledge of the English language, a most important requirement. In these days of specialties in technical courses, one cannot expect to master all, and to the student, as to the instructor, the essentials of mathematics, the use of engineering instruments, and the general principles upon which engineering is based, leave little or no time for studying English. A man thus graduates with a university degree backed by a preparatory school certificate in English, which is not enough. It only requires such an address as that of Professor Swain, appearing in this and the last issue of *The Canadian Engineer*, to illustrate how important an instrument in the hand of the practical engineer is a thorough knowledge of language. Be a man's training what it will, in the literature at his disposal, and in the writing, for the benefit of others, of his own ideas, the engineer of to-day need anticipate no better opportunity for elevating himself in his profession, than by adding to his equipment, more of this necessary part.

One thing is certain, an engineer of all men requires such knowledge of the technique of the language that he can use it with accuracy and facility at all times. The bad construction of a sentence or the erroneous use of a word may result in costly litigation and heavy loss; therefore, the language merits far more study than the best technical courses provide.

EDITORIAL COMMENT.

The recent awards by the Hydro-Electric Power Commission of Ontario of contracts in connection with the construction and equipment of a hydro-electric power plant at Wasdell's Falls, on the Severn River, denotes an important event in the history of the Commission. The opening of the headgates of this power plant should be observed with ceremony, as it is an epoch-making event, announcing the entrance of Ontario into a period of extensive generation of hydro-electric power from its many inland waters, and the accompanying distribution of it throughout the Province by the Hydro-Electric Power Commission. It is likely that the plant at Wasdell's Falls will be followed closely by several others, and that at the close of present season plants will be in operation.

* * * *

The Canadian Pacific Railway Company will electrify a section of their line in the mountain division, it is announced, and if the results obtained warrant it, the electrification of many of their mountain branch lines will follow. The replacement of steam locomotives by electric tractive power, even in this small degree, marks a new period in Canadian transportation development. When the Canadian Pacific will realize, by this innovation between Rossland and Castlegar, the advantages of electricity over steam for mountainous traffic, other electrification units will follow in rapid succession. A 2,400 volt, direct current, trolley-system is the service that has been decided upon for the new project.

* * * *

In his report to the Minister of Lands, Forests and Mines, Ontario, Roads Commissioner J. F. Whitson recommends an expenditure of $1,000,000 in the construction in main and trunk roads and in the improvement of existing roads in the districts of Northern Ontario. The report, which covers the work accomplished in 1912, contains information concerning the construction of some thirty roads up to the end of the season in November. A statement of the expenditure on this road construction in Northern Ontario, which is carried on under the Northern Development Branch of the Department of Lands, Forests and Mines, is as follows:—

Wages of Workmen		$112,155 76
Amount paid on road construction under contract		32,633 64
Salaries of office staff, including assistant engineers and inspectors		7,726 48
Camp equipment—tools, implements, road machinery, tents, blankets, utensils, etc.		13,035 90
Supplies, provisions, freight and express charges, etc.		39,594 35
Insurance on warehouse and contents, Cochrane		380 00
Office expenses—		
Stationery and printing	$269 35	
Travelling, railway and hotel expenses	986 64	
Postage and telegrams	97 48	
Furniture, rent of offices, equipment and incidental expenses	897 31	
		2,250 78
Medical and surgical expenses for workmen		248 05
Other expenses, made up of small accounts, livery, etc.		421 35
		$208,446 31

THE ENGINEER AND THE SOCIAL PROBLEMS

THEY ARE WITHIN HIS PROVINCE — HIS CAPABILITIES FOR SOLVING THEM—THE POSSESSION OF CONSERVATISM AN ESSENTIAL SAFEGUARD — MORE RECOGNITION FOR EXPERIENCE, KNOWLEDGE AND SPECIALIZED TRAINING

By DR. GEORGE FILLMORE SWAIN, Pres. Am. Soc. C.E.

(Continued from last issue.)

[NOTE.—As stated at the beginning of this article in the issue of June 26th, *The Canadian Engineer* is preparing a forty-page pamphlet containing the entire address of Prof. Swain. A limited supply of them will be ready in a few days and will be mailed upon request.—ED.]

TWO of the most important requisites for authority in matters of opinion, seem to be a spirit of conservatism. and the possession of good judgment. The man who is slow to advocate a change, who adheres instinctively to old ideas and practices until there is reasonable ground for the belief that a change will be beneficial, is clearly a safer guide than he who rushes into all sorts of new schemes and is ever ready to throw aside the results of years, because perfection has not been attained. Conservatism is the brake which prevents our rushing to destruction. The possession of grasp and of good judgment is also essential. By these are meant the ability to see all the elements entering into a problem and to see them in their proper proportion. The narrow-minded man does not see all the elements in a problem; such a man lacks grasp. The unbalanced man, while he may see all the elements, exaggerates some and minimizes others; such a man has poor judgment. The advice of either is unreliable.

It is worthy of fuller inquiry what the reasons are, reduced to their elements, which cause men to differ in their opinions. Take almost any subject, except one dealing with abstract relations, and opinions may be cited which are diametrically opposite. Take such a subject, for instance, as the relation of forests to stream flow. Here we have a scientific subject, regarding which it might be supposed that experiments or observations might be made, scientific principles applied, and opinions reached which would be agreed upon by all intelligent men conversant with the subject. And yet, on this subject, and still more so on even more speculative subjects, men of equal authority or experience will be found holding diametrically opposite views. Why is it?

It seems to me that if intelligent men differ on any subject, it must be due to one or more of the following causes:

1. One or the other is not in possession of all the facts or principles involved.

2. One of the other may use facts or principles which are incorrect.

3. One or the other may reason incorrectly.

4. One or the other may see the facts out of proportion, attributing too great importance to some and too little to others.

5. One or the other may illustrate the natural stubbornness or imperviousness of the human mind.

It is not always clearly recognized that facts cannot always be compared directly, because they cannot be expressed except in incommensurable terms. For instance, if we ask which is the greater, six feet or two meters, there will be no disagreement in the answer; but if we ask which is the more important, 10 feet or $5, or which is more important, truthfulness of beef steak, the reply is not entirely obvious. These are not fanciful illustrations. We are continually obliged to make comparisons between things which have to do with our physical well-being and those which have to do with our moral or spiritual well-being. They are incommensurable, yet they must be compared and an opinion formed from the comparison. In planning a railroad station, for instance, a certain design requires the passengers to walk a certain number of feet, while another design costs more but requires less walking. Here is a comparison which must be made between feet and dollars. In such a case, some will endeavor to express the comparison in commensurable terms. They will compute, perhaps, the value of the shoe leather that would be saved in a year if all the passengers using the station have to walk the given distance less, and compare it with the interest on the additional expenditure. Similarly, the expenditure of millions of dollars is asked for electrification, the advantage urged being the saving of a certain number of minutes each day for each passenger and because the aggregate saving of time in a year, valued at the average annual wage of an individual, amounts to a sum greater than the interest on the cost. Such comparisons are generally made by those who find their judgment unable to deal with the subject in any other way, who cannot compare except by measuring or weighing, as they have been trained or accustomed to do. Yet, such persons do not realize that the comparisons they make may be entirely deceptive. Although more rapid transit may render a journey quicker, it does not follow that the time is saved. It may be usefully employed in reading, or in conversation, or in sleep, or in meditation. An additional fifteen minutes spent in going from one's house to one's office, is not necessarily lost; it may be utilized like any other fifteen minutes in the day. Even if spent solely in meditation, it would be most beneficial, for, as Arnold Bennett says, the great defect of the age is the absence of meditation. In such arguments as that for electrification the mistake is also made of not considering whether the individuals who would make the saving claimed are the same individuals who would bear the increased cost.

Referring to the classification above, it is evident that an ability to observe correctly, the faculty of getting at all the facts, and of knowing when all the pertinent facts have been collected, the ability to reason from those facts, the possession of conservatism, the absence of stubborn persistence in holding a previously formed opinion in the face of proof of its error, and, above all, the faculty of seeing things in proper proportion, or good judgment, are essential in forming an authoritative opinion.

How can the absence of these qualities be detected? To discuss this would lead us too far, but there are one or two points to which I wish to refer. For one thing, dogmatism, or intellectual arrogance, in speculative or uncertain matters, is an almost certain indication of disqualification. The man who in such matters shows intolerance of opinion, may generally be disregarded. He who in matters of opinion is cocksure, who terms all men who disagree with him knaves or fools, who resorts to epithets and extreme statements, who asserts that all honest men should believe as he does, or who makes similar assertions, is either wilfully trying to mislead, or is unworthy of credence. This is a fault which is observable particularly in the immature, whether old or young in years.

If, therefore, we find an author proposing changes in political or social conditions, who, referring to eminent men at least as honest and intelligent as himself, and more learned and experienced than he is, in terms of disrespect, we may be pardoned if we surmise that the temper and judgment of the author are not such as to entitle his words to be received with authority. So, also, if we detect what we believe to be frequent gross errors in reasoning, or a temperamental lack of the power to see things in what is clearly their proper perspective, we may save ourselves the trouble of pursuing such an author farther, even though his sentences are adorned with flowers of rhetoric or by Biblical quotations.

The Disregard of Experience.—One of the most serious tendencies of the present day, particularly in the United States, a tendency which, like the disregard of authority, seems to result from that to regard men as equal, is the disregard for experience. It is a tendency fraught with great possibilities for evil, which must be recognized by every serious thinker.

In any occupation, except those which have to do with the study of purely abstract relations, which, as above explained, may be arrived at correctly in the seclusion of the study, it is almost self-evident that experience is of great value. In any occupations having to do with pure and applied science, and particularly in those having to do with man and his relations to society—that is to say in politics, economics and government, as well as in engineering—experience is a necessary qualification for arriving at correct judgments. A person having a power of perception of mathematical relations may become a profound mathematician at an early age; indeed, the perception of mathematical truths is essentially a subjective faculty, and may be most correct and powerful when the mind is removed from the objective state. Some mathematical prodigies have reached their greatest power when mere boys, and have lost it with increasing age and contact with the objective world. But, in business affairs, no amount of reading of books or of closet meditation can take the place of actual experience. But, if all men are equal, then the boy's opinion is as good as the man's, and experience is a mere useless drag.

It seems to be an inherent tendency of our form of government, to disregard the value of experience; any man is considered good for any job; all he has to do is to get the votes, by one means or another. Men who have made little or no study of government, and who have had no experience in it, are considered capable of judging of and administering laws and of occupying any elective or appointive position. The butcher, the baker, the candlestick maker, are all eligible for the state legislature, for congress, for the senate, for the mayoralty, or the presidency. This condition necessarily results in gross inefficiency and waste, not always through evil intent, but perhaps more often through stubbornness, ignorance, conceit, or the unwillingness or inability to select and take good advice. We talk much of graft and rightly condemn it. But, as Lecky has pointed out, corrupt governments are not necessarily extravagant. Graft is injurious mainly to those who practice it. Inefficiency and inexperience are much worse for society in general; and laws which hamper industry, which harass property, or which—through unwise taxation, or extravagant state expenditures for the benefit of particular classes—plunder large portions of the community, are much more injurious to the general good than the pilfering of a few thousands of dollars a year. Sir Henry Maine remarks that the form of bribery which is most to be feared in a democracy, is that of "legislating away the property of one class, and transferring it to another."

Only in one department do we recognize experience, knowledge and specialized training as necessary, and that department is the administration of justice. No one but a trained lawyer is considered eligible for the position of judge, and in most instances, judges are appointed and not elected, and are, therefore, not driven to seek the votes of the mob, or subject to popular whim, or the arts of the demagogue. For this reason, our courts have been rightly deemed the safeguard of our liberties. Not until our legislators and our administrators of public affairs are chosen from men trained and experienced, and who have ascended from the bottom step by step, will efficiency, economy and wisdom be attained in our government. Whether this time will ever be reached may well be doubted. We are much less advanced in this respect than some of the countries in Europe, where the expert is more recognized and has a higher standing, and where knowledge, and particularly experience, are valued higher than here. If financial measures are under consideration, men experienced in finance should be sought and their advice followed. In our country, experience in finance seems to be to-day looked upon as a disqualification for giving sound financial advice, and the same in railway and other affairs. Under such conditions, satisfactory results cannot be attained. Either, as a people, we are more dishonest or more unwise than the people of Europe.

In these days, when higher education is a fad, there is an increasing tendency, in my opinion very pernicious, to regard book knowledge as the equivalent of experience. We are more and more inclined to regard those as able to speak with authority, whose knowledge is derived simply from books, who perhaps have spent their lives in a professorial chair, with no actual experience in the subjects they teach or write about. We shall in time learn the fallacy and danger of this; but, in my opinion, at the present time great harm is being done by talking too seriously, in questions of politics, government, economics, finance and business, and sometimes in engineering, the opinions of theoretical men and closet reformers, whose advice we would not think of following in the conduct of our own private affairs. Some of these men will come within the class of those who, to use the phrase of Mr. E. P. Ripley, president of the A. T. & S. F. Railroad, have "zeal without knowledge, and enthusiasm without sanity."

Of course, it must not be supposed that experience is everything. In some cases, experience only confirms a man in rule-of-thumb practice, works him deeper and deeper into a rut, and destroys his power of vision. Probably all of us have seen instances of men, whose long experience in doing a particular thing in a partcular way has only destroyed their power to see that there is another and a better way, and whose only reason for doing that thing in that way is that they have always done it in that way. Such men, however, would never, under any circumstances, be leaders. They are the soldiers in the ranks, whose only function should be to obey orders. It not infrequently happens, in the administration of some business affair, that a new man with a fresh mind, without experience in that line, but with a power of selecting good advisers, of grasping a new situation quickly, of seeing all the elements involved and of judging them correctly, will arrive at a truer decision than another man of less grasp and judgment, though experienced in the matter in question. This, however, is no argument against experience, but simply illustrates that experience must be combined with grasp and judgment; for the new man, before he becomes really proficient, must either gain his experience, or must be able to select his advisers well and to rely on them.

Not only is experience discredited to-day, but we actually find inexperience put forward as a virtue by men who should know better. One candidate for an important elective office, in an address to the electors just previous to the election, urged his qualification for election, on the ground that he had had no business experience which would prejudice his judgment in the matters which would come before him. Is not this a serious disqualification—an admission that his temperament is such that experience would prejudice him, and not teach him? Do we not want men in office experienced in the affairs they are to deal with, but fair-minded and of good judgment, whose experience, instead of warping their judgment, aids and matures it? Woe be to us as a nation when we place inexperienced men in office for fear that experience would warp their judgment.

It is, nevertheless, true that men differ greatly in the amount of experience which they need in order to perfect their powers. This will depend upon the rapidity with which they can assimilate it, and the philosophical character of their minds. It has been said that the wisest man is he who can do with the least experience; that is to say, the one who does not need to have an experience repeated again and again before he learns the lesson which it teaches, but who only needs one experience to learn its lesson, and who can extend that lesson to cover other possible experiences, thus rendering the latter unnecessary.

When we are asked, therefore, to believe and advocate any proposed policies, let us train ourselves to apply certain touch-stones before we commit ourselves. If the subject is one within our experience, knowledge and reasoning powers, let us endeavor earnestly to think the matter out for ourselves and arrive at our own conclusions. In the many cases in which we cannot do this, let us carefully scrutinize the policies and their proposers, to determine how much credence we can give. Let us observe whether the author asserts them dogmatically or modestly; let us note whether he makes assertions without proof, and by incessant repetition endeavors to make us believe that assertion constitutes demonstration; let us ask whether he speaks from experience or simply from book knowledge; let us remember that he is not free from the frailties of human nature, and let us, therefore, inquire whether he has any personal interest at stake; let us assume an attitude of doubt and distrust toward all human opinions until that doubt and distrust are effectually removed. It is said that it is better to be deceived than to distrust; but, after we have been deceived, we shall be more inclined to reverse this saying, and to consider that, in the reversed form, it will be, upon the whole, safer and more conducive to our happiness. Let us be on our guard against assuming that good intentions are a guarantee of authority, and when we find ourselves in danger of being influenced by flowers of rhetoric, let us remember that "no man is more dangerous in a state than he who possesses in an eminent degree the power of moving, dazzling and fascinating his contemporaries, while in soundness of judgment he ranks considerably below the average of educated men"; and let us further bear in mind that "an excessive love and admiration of rhetoric is one of the diseases to which democratic communities are most liable."

The Tendency to Relax Discipline.—Another of the demoralizing tendencies of the equality of man is that which has led in recent years, it seems to me, to the gradual but steady relaxation of discipline. It will probably be denied by few that for the proper training and full development of the human being, discipline is necessary. Life itself is little more than discipline; it is not for pleasure; it is for work, accomplishment, development; without discipline there will be no proper development. He who is born with a golden spoon in his mouth and whose life is a continual round of pleasure, is likely to go out of the world less developed than when he entered it. "The beginning of wisdom," says Solomon, "is the desire of discipline." Work, which is itself an end, and rather to be sought than what it brings, consists largely in doing things which in themselves are uninteresting and perhaps distasteful, and we must accustom and train ourselves to be able to do this kind of work cheerfully and well. This ability will be attained only through discipline. Moreover, the man who attains a position of responsibility must be able to direct and command the work of others, and no one can command wisely until he has first learned how to obey. For this, too, discipline is necessary. Yet the tendency of recent years seems to me to have been toward a steady relaxation of the discipline imposed by law and custom upon the growing individual.

Dr. Swain then referred to the tendency toward the relaxation of discipline in educational institutions, and likewise in the application of our laws, whereby offences are condoned, and sympathy instead of sternness administered, thus encouraging a spirit of lawlessness and an unwillingness to submit to proper restraint.

The Spirit of Innovation.

Another of the tendencies very marked at the present time, is the spirit of innovation, which seems to pervade all things; whatever is, is wrong: the social custom must be changed in order to keep up with the time. This spirit is particularly observable among the young and the immature, especially if it has been preceded or accompanied by a lack of discipline in early training. It is an instance of what Ferrero terms "that youthful spirit of innovation which is in all ages the main source both of perversion and of progress." Many of our young men "all aflame with an enthusiasm unquenched as yet by any continuous contact with affairs," set out to reform the world, not so much because it needs reform as because they wish to justify their existence. This spirit of innovation is at all times a spirit to be expected and reckoned with. Every generation as it comes along, will endeavor to change the condition in which it finds itself, and will designate that change with the name of progress even though it be perversion.

This spirit of innovation which pervades all things seems to be largely a result of scientific progress; the rapid advances made in inventions of all kinds, the improvements in the arts and manufactures, have resulted in a complete revolution of the methods in many branches of industry within a comparatively few years. Men are now living who were born before there were any railroads, and almost all of us can remember the time when the applications of electricity were just beginning. An industrial plant but a few years old may be out of date and unable to compete with newer and more economical installations. We are accustomed in engineering matters to see things completely remodelled within a short time.

This familiarity with industrial change and the recognition if its benefits has naturally led to the idea that everything must be reconstructed, or it is old-fashioned and out of date, even though it be a thing in which there have been no new discoveries, warranting any change whatever; music painting, dancing, education—everything, in fact—must be completely reorganized. This willingness and desire for change affords the opportunity for unsuccessful mediocrity and for ambitious and unscrupulous failure to foist upon the public, which eagerly accepts it, forms of change which discerning men must characterize as gross, ridiculous, and demoralizing. The result, in many cases, is a deterioration pitiable to behold. Let any one compare, for instance, the modern painting, dancing and music, with that in vogue fifty or one hundred years ago, and he will find abundant proof of this. In politics and government too, the same tendency, the same recklessness, the same demoralization, are equally observable.

Now, of course, an existing condition is not necessarily the best because it is old; neither is a proposed change advisable because it is new. In many cases, however, suggested changes, ignorantly proposed by those unacquainted with history, have been tried and have been found wanting centuries ago. History repeats itself. Nations, like individuals, will only learn by costly experience. Away with the old, make way for the new! We will not profit by the lessons of our forefathers, we must experiment and learn for ourselves. In all matters, then, let us try to cultivate the breadth of view, the tolerance of opinion, which will lead us neither to adhere to that which is old from extreme conservatism, nor to indulge in rash experiments; but let us study history, cultivate a sound and deliberate judgment, and endeavor to guide the inevitable spirit of innovation into proper channels; and let us remember, as Lecky well says, that "an appetite for organic change is one of the worst diseases that can affect a nation."

Improper Use of Wealth.

Advancing civilization and increase of wealth inevitably lead to increased luxury and extravagance; and, with our advancing civilization, this tendency is not wanting. If the experience of the past is of any value, however, it is a serious symptom of degeneration. The sudden accession of great wealth, particularly to those who are incompetent to use it wisely, engenders luxury and ostentation, and a contempt for those less fortunate; thus stimulating, to a certain extent, an attempt of the latter, particularly if endowed with the ballot, to recoup themselves and gain what they conceive to be their rights at the expense of wealth, by various forms of unjust taxation and other well-known expedients. If it is our duty to preach the gospel of content and the inequality of man, it is equally our duty to preach the proper use of wealth, and the proper attitude of the wealthy toward those less fortunate; and while believing that individual initiative should be stimulated to the utmost, and allowed to enjoy the fruits of it's success, it may, nevertheless, fairly be questioned whether some of the rewards under present conditions are not too large, and whether men would not exert themselves as well for the prospect of a more reasonable recompense as for the prospect of unreasonable and excessive riches. But again history repeats itself, and things move in cycles. Peace causes prosperity, prosperity gives rise to wealth, wealth gives rise to luxury and extravagance, luxury and extravagance are the source of contention, contention results in war or social revolution, these result in poverty, poverty results in peace, and so the cycle is completed.

The Part for the Engineer.

And now you may very likely have asked what has all this to do with engineering, or with the engineering profession; what is the appropriateness of a discussion of social conditions before a society of engineers? My answer is that the engineer is primarily a member of the social body; that its problems are his problems; and that he cannot avoid the responsibility of taking a share in their solution. The problem of the twentieth century, it seems to me, will be pre-eminently, a social problem, and upon its solution will depend the happiness of mankind for years to come. Moreover, this social problem is largely, as I have shown, the outcome of the work of the engineer who, as the advance agent of civilization, has been the main factor in creating the conditions which give birth to this problem. It will be evident, therefore, that I differ from one of my predecessors who, in his annual address, intimated that social problems were out of the province of the engineer and that he should not meddle with them. On the other hand, I maintain that it is his duty to exert himself in their solution. Moreover, I consider this duty the more necessary because I believe the engineer to be well fitted—possibly better fitted than any one else—to solve these problems wisely. Let me briefly give you my reasons for this opinion.

The engineer is by training a scientific man. If his education is what I conceive it should be, and what it will be more and more in the future, it will consist of a training in mathematics, logic, science and in the technical branches of his profession, together with a sufficient amount of study of the humanities—history, economics, language, literature—to give him a clear view of the relations of things. He will be pre-eminently by training a scientific man, but with a power of understanding and grasping social questions. Now, a scientific training has this great virtue, that its end and aim is constantly the discovery of the truth. The truth for its own sake, independent of everything else, is the object of the scientific man and therefore of the engineer. In this respect, it is, in my opinion, the noblest as well as the most widely useful of the professions. The lawyer is not always concerned in arriving at the truth; he is too frequently tempted to make the worse appear the better reason. As one of that profession has expressed it, his object is not to get at the truth but to win cases. He is constantly under the temptation to pervert the truth, or to suppress it, if the exigencies of his case demand.

Furthermore, the engineer is exposed to a very direct personal responsibility which cannot but steady his character and increase his self-reliance and self-control. While he does not always receive the credit of his success, he cannot succeed in throwing the responsibility for his failures upon others. If a lawyer loses his case, as Mr. Choate once remarked, it is never his fault; he can always charge it to the prejudice of the judge, or the ignorance of the jury, or the untruthfulness of witnesses. He goes on and obtains new clients and new fame. If the doctor loses his patient, it is never his fault; he can always charge it to the disobedience or delay of the patient, or maintain that a cure was impossible. But if an engineer builds a structure which fails or a machine which will not work, the responsibility is his and he is held accountable.

Again, the engineer is a business man, for engineering is business and business is engineerig; he deals with men, he has to do with financial affairs, he learns the characteristics of human nature, and his training, therefore, tends to teach him tact, moderation and conservatism.

Of course, any sweeping eulogy or disparagement of any class of men cannot be truthfully made. Engineers will differ on questions of opinion, as other men will. there are dishonest, untruthful, unreliable engineers, as there are men of this type in every class. No doubt the ranks of our society include men who will widely disagree with me on the questions which I have discussed; there are men who will hold extreme views in one direction or in the other; men who will be dogmatic, intemperate in language and in thought, inaccurate in reasoning, insincere in opinion. No class of men has a monopoly of virtue or of error. Neither are these excesses confined to men of weak minds or deficient training. As Lecky says: "Strange veins of insanity and capacities for enthusiastic folly sometimes flaw the strongest brains, and the impetuous ebullitions of youth which impel some men into extravagances of vice, develop in other natures into not less wild extravagances of thought."

Nevertheless, on the whole, if there is anything in training and experience, may we not believe that engineers, as a class, have the training, temper, and experience which will best enable men to judge sanely and solve wisely the social problems which confront us?

What, then, may the engineer do to aid in the solution of the social problems of the 20th century?

In the first place, he should consider it his duty not to retire into the technical recesses of his professional work and content himself with being the servant of other men, but should actively exert himself and take the initiative in the great problems of the day. He will find that these problems in their details are largely of an engineering character.

What, for instance, is involved in the problem of administering the affairs of a great city? Do they not involve, in the main, the preservation of the health, safety, property and order of the community? and are they not, therefore, predominantly of an engineering character? Financial and legal questions of great importance are, of course, involved, but why should the engineering problems be considered secondary to these? Engineers can employ financiers and lawyers, as well as be employed by the latter. I see no reason why the position of mayor of a city could not be filled at least as satisfactorily by an engineer with proper breadth of view, training and experience, as by a man of any other profession. Yet, I doubt if the mayor of any city in the United States is or has been an engineer.

The same holds true of other administrative positions. The management of our great corporations involves problems largely of an engineering nature, and high administrative positions in these concerns are being more and more given to engineers. Even such a position as that of president of a republic is not one which the engineer should necessarily consider himself excluded from. Why is he not as well qualified to fill it as a soldier, a lawyer, or a college professor, provided his training and experience, judgment and breadth of view warrant. Two of our greatest presidents, Washington and Lincoln, while not engineers, did have some little practice in what was then termed engineering, and one president of the French Republic has been a professional government engineer.

There is perhaps a tendency to-day towards better recognizing the qualifications of the engineer in the administration of municipalities and larger political units. The position of commissioner of public works in a city is perhaps the most important municipal position next to that of mayor. Formerly, this position was monopolized in most cities by men who were mere politicians. Nowadays, it is quite common to appoint engineers to such posts. In Boston, Philadelphia, Cincinnati, and very likely other cities, these positions are now held by trained and educated engineers, and this recognition I consider significant and deserved. Engineers, however, will not and should not be recognized in this way unless they show their interest in public questions, unless they inform themselves about them, unless they study the economic and social, as well as the engineering problems involved, and unless they assert themselves before the public. This, I trust, they will do more and more as years go by. "The fault, dear Brutus, is not in our stars, but in ourselves, that we are underlings."

A question which is much before us at the present day is that of conservation. Conservation, as I understand it, consists in a wise economy and proper use of the materials and resources that are afforded us by Nature. It is essentially the avoidance of waste; it does not mean that natural resources shall be withdrawn from use, but that they shall be used wisely and economically. It does not mean that the present generation shall suffer for the benefit of future generations, but that the present generation shall not rob future generations. Now, the technical problem of the avoidance of waste and the proper use of natural resources, is a problem already solved. Applied scientists can tell just what to do and how to do it. They know how to utilize the power of falling water and how to transmit it; they know how to utilize coal most economically, they know how to utilize forest products without waste, how to prevent the erosion of the soil, how to conserve health. The unsolved problem of conservation—the problem which now concerns us most—is not an engineering problem, but a social one. It is to alter the public state of mind, to make people thrifty and economical instead of extravagant and wasteful. It is thus an attitude of mind that we have to deal with. If the attitude of mind of the public toward this problem could be made the correct one, if the individual man could be made thrifty, frugal, careful, thoughtful of the future, the problem of conservation would be solved. Why should not applied scientists, who know how to solve the problem technically, lead in educating the people to perceive the necessity for its solution? Should not mere self-interest, not to speak of public spirit, prompt us to do this? In education, too, where, as I view it, the tendencies I have referred to are plainly evident, we may as a profession exert a good influence. I have often expressed the opinion that an engineering education is the best possible education for any vocation, because it combines, or should combine in the best proportions, the study of abstract relations with that of natural science and of the humanities. These, combined with training and experience in the profession itself, should make the engineer as well educated as any class of men. He should be sane and sensible, not likely to be carried away by fallacious economic theories; conservative, and yet safely progressive. Engineers should, I think, exert more influence than they do in education, by actively interesting themselves in it, serving on school committees, and insisting on the maintenance of rigorous discipline and the scientific method. Above all, they should aid in maintaining the standard of engineering education, and prevent it from succumbing to the prevailing tendency to relaxation of discipline. The best students do not really seek such relaxation, and schools which make students work hard and which insist on a high standard of accomplishment, will attract strong men. The tendency of the times shows this, and proves that one movement to-day is towards utilitarian and vocational training. Some of the tendencies I have referred to may be in large measure only surface currents, and a strong undercurrent may perhaps be generated in another direction if the proper means are employed. This is indicated by the growth of the engineering department of our state universities within the last thirty years, and by the surprising development of such a school as the Massachusetts Institute of Technology from its first small beginnings to its position of recognized leadership in less than a third of a century. Let us make the engineering schools the place of refuge for those who are disgusted with the relaxation of discipline which prevails so largely elsewhere.

Finally, let us inquire what this society, representing the engineering profession, may do in the directions which have been suggested. We have been criticized in the past as being inactive, as taking no part as a society in the large public questions. I must frankly confess that the criticism has seemed to me in some measure deserved. Our society is large, rich, influential, but we have been too content to sit down in dignified ease, taking little or no initiative, and allowing other and younger societies to outstrip us in actual work performed and in real influence exercised. We have had some committees which have done good work in unifying practice in relation to technical matters. In these respects, however, we have been far surpassed by two or three of the newer societies, whose committees after long and conscientious labor, have exercised far greater influence that we have in the solution of even professional problems. It is true that this is largely due to the fact that those societies are more specialized than ours, that they are composed of men all engaged in one line of work, who could co-operate and lay down the results of experiment, experience and opinion more easily than we could. This society, however, is the American Society of Civil Engineers, it includes engineers in all branches; there is no reason why the engineers in the different branches should not associate themselves together in sections, or why we could not do more committee work along the various engineering lines than we have done in the past.

I believe, therefore, that we should favor the establishment of branches of the society in various parts of the country, and of student branches in the several technical schools; and that we should urge our committees to activity, supply them with funds, and perhaps pay the mileage of members who attend meetings. The society is rich, and it is not a philanthropic institution. If members give their time to committee work, I see no reason why they should be expected to give money, and the expense of attending many meetings may not seldom be considerable.

Moreover, we have been very loath to take any steps in formulating answers to questions which are largely matters of opinion; and we have done, thus far, little or nothing to influence public opinion in regard to questions of the day. I believe that we could and should go much further in these directions; that we should step forward, take the initiative and become a moving force in the community. Let me make some more definite suggestions.

In the first place, I believe we should have a standing Committee of Public Relation, its province being to keep track of all public affairs involving engineering questions directly or indirectly, in all the states in the Union, and to take such action as may be deemed desirable to insure a wise treatment of such questions. This committee might perhaps consist of president and secretary of the society ex-officio, of a certain number of members of the Board of Direction to be appointed each year by the president, and of a certain number of members of the society not members of the Board of Direction, to be nominated by the Board of Direction. These outside members might be in considerable number, perhaps one or more from each state or group of states, so that the committee could keep in touch with public affairs affecting the profession in all parts of the Union.

Further, our Committee on Engineering Education should, in my opinion, be enlarged, supplied with funds, and encouraged to active and exhaustive work. If we could lay down the principles which we believe should govern in engineering education, the general curriculum which should be adopted, the proportion of the humanities which should be included, and similar matters, we might, I believe, do much good and, while still leaving ample room for individual initiative and divergencies in practice in different institutions, render effective aid to those teachers who are striving to resist some prevailing tendencies.

In the next place, I believe it will be wise to have more committees of the society, dealing with specific problems, than we have had in the past. You have before you at this meeting, I am glad to state, a report from the Board of Direction stating that, as provided in the Constitution, it has voted to appoint two special committees to deal respectively with the regulation of streams and with uniform water legislation. I believe that still other committees could be appointed to advantage. We have no reason to be afraid of having too many committees. We should, rather, be sure that we lose no opportunity to exercise legitimate influence on public opinion or to aid in the solution of large problems. We might well, I believe, have a standing committee on conservation, another perhaps on corporation legislation, another on the history of American engineering. Let us give our earnest attention to this matter and let us not hesitate to suggest any and every means that may occur to us to promote the welfare of the society, of the profession, and of the public. The Board of Direction will be always ready, I am sure, to act promptly with such members of the society who can show a proper field for all legitimate action.

Reviewing then, the points which I have brought to your attention, I have endeavored to show that the problem of the times is pre-eminently a social problem. I have outlined some of the tendencies of the day, as they appear to me. I have given the reasons for my belief that it is the duty of engineers to aid in the solution of these problems and that by training and experience they are well qualified to do so. If my tone has appeared to indicate a pessimistic attitude toward the tendencies of the day, I fear I must plead guilty in some degree to the imputation; whether wisely or not, as the years have gone by, I have grown more conservative and I find myself having little sympathy with many of the tendencies which I seem to see about me. I believe that this age will be looked upon by future generations, not as an age of progress, but more distinctively as an age of deterioration, an age of fads, frivolities, fancies and follies; of much reading and little thought; an age of impulse rather than an age of reason. I am not alone, however, in a feeling of dissatisfaction. M. P. Leroy Beaulieu, writing in 1890, expressed himself as follows:—

"Every age is characterized by its particular craze. The present craze is for education, unlimited and injudicious, and for philanthropy equally unlimited and injudicious, both absolutely superficial. By their aid we have succeeded in producing a mental condition and in creating certain social circumstances which are most unfavorable to the growth of the population."

But, after all, it is only an epoch in the history of man. It will pass away, and others will solve the problems that we leave to them. May we do our part, as members of one of the greatest professions, to help direct the tendencies of the day in such manner that our successors may look back upon us with approval and not with blame, and that we may aid in forwarding the true progress of mankind.

WIRELESS IN AUSTRALIA.

The acting Australian Postmaster-General states that the wireless station at Darwin (Northern Territory) now being built will cost about £90,000. The station will have a radius of 2,000 miles, touching Singapore on one hand, and Sydney on the other. It will form the apex of a wireless triangle, of which Sydney and Perth will be the other points. The surplus electric energy at Port Darwin, it is expected, will be supplied to consumers at a low rate. The Darwin stations will be capable of communicating with any system which may be established by the British Government. Already wireless stations have been provided at Perth, Adelaide, Melbourne, Hobart, Sydney, Brisbane and Port Moresby (Papua). At Townsville and Cooktown masts for new stations are already up, and at Rockhampton arrangements are well advanced for completing the equipment. At Geraldton, Esperance, Roebourn, Broome and Wyndham construction work is being pushed ahead, and it is expected that the chain will be completed before the end of the year.

PRESSURE FILTRATION PLANT AT HAILEYBURY, ONTARIO.

The town of Haileybury, Ontario, has been the first to follow the British practice in regard to the use of British pressure filters for the purification of its domestic water supply.

The installation of a chlorination plant did not satisfy all the requirements for a potable and safe water supply, on account chiefly of the large amount of vegetable matter present in their raw water.

In April the filtration plant which last year's council and the present mayor, Mr. N. J. MacAulay, decided to have installed was turned on, and has since been operating with considerable success.

The source of the water supply is Lake Temiskaming, at the head of the Ottawa River. It is very highly colored, and is frequently very turbid with fine clay, while containing bacteria varying from 100 to 10,000 per cubic centimeter.

The alkalinity is also very variable owing to the rise and fall in the water level at different seasons, and most of the sewage of New Liskeard and Haileybury is discharged into the lake.

These conditions made the success of any filter plant very doubtful, but since the operation of that installed there has been a clear and sparkling water turned into the mains, without the slightest trace of color, or any turbidity, and according to the last bacterial analysis a reduction from 1,040 bacteria per cubic centimeter to 10 per cent. per cubic centimeter without the use of chlorine or any other disinfectant or sterilizer, or 99 per cent.

The cuts show a view of the plant and the platform for operating the cleaning mechanism, plans of the complete plant, there being no sedimentation basins or clear water reservoir, and a sectional view of one of the filters.

The inlet to the filter house is connected with the supply main, which was cut and had a branch inserted. The outlet end is connected in the same manner, except that a by-pass valve was placed in front of the branch to allow of the filters being cut out if necessary, or to diverge the raw water into the inlet to the filters.

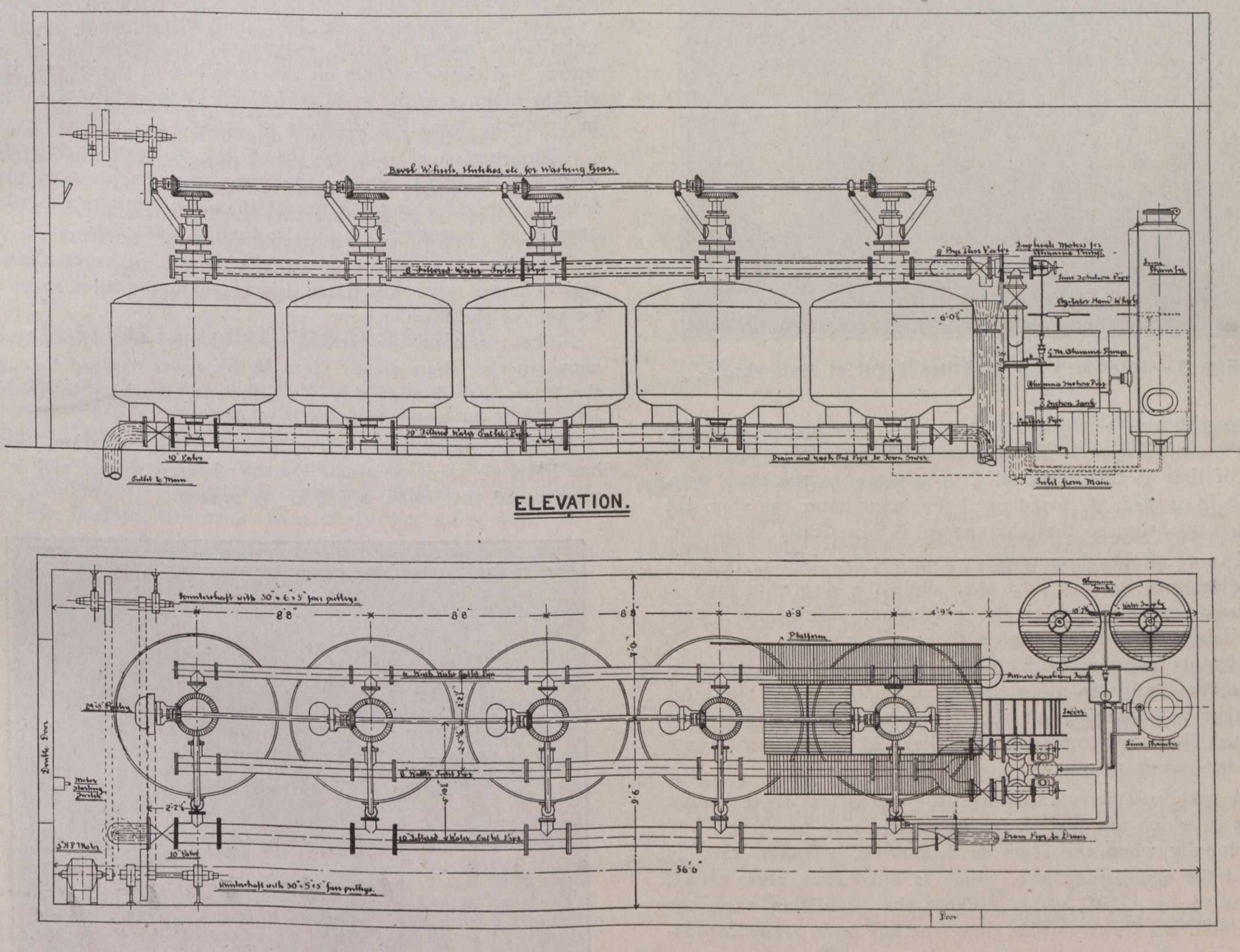

Fig. 1.—General Arrangement of Haileybury Plant.

The plant has a capacity of one million Imperial gallons per day as a maximum, and operates under a working pressure of 100 lbs. per square inch. It is housed in a brick building 60 feet long by 18 feet wide, situated just above the pump house, which is placed alongside the lake. The water is delivered through the pump into the filters, through to the main, and thence on to the distribution system, and the town reservoir. The reservoir is placed on the hill above the town, so that a pressure of 85 lbs. per square inch is available at the lowest points when the pumps are not in use, and is filled while pumping by the excess over the town's requirements in the five hours' pumping.

Inside the filter house is located a lime chamber, and duplicate alumina tanks constructed of steel, five Bell patent vertical type pressure filters, and the necessary piping, valves, washing motor and alum pumps.

As the raw water enters it passes through a venturi pipe into the throat of which is connected the down pipe from the lime chamber, while before entering the construction a pipe is led into the foot of the lime chamber. Lime is filled from

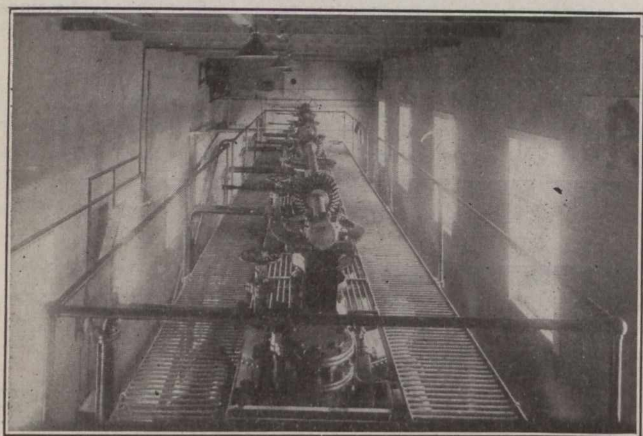

Fig. 2.—Interior View of Filter Plant at Haileybury.

a wrought iron platform on the top of the lime chamber in pails after being well slaked and the top closed. The addition of lime is then controlled by a valve on the town pipe, which is opened or closed until the manometer registers the desired quantity, so that the control is practically automatic.

In one of the alum tanks a solution for the day is made up, dissolved and put into use, while the duplicate tank is prepared for the following day's solution. Each tank is connected into the delivery pipe with a valve on each branch, so that by opening or closing either tank can be used at will. There are also drain pipes connected to the foot of tanks for cleaning and running off the liquor when it is required to do so. These are connected to a tile field drain running into the town sewer system.

A steel platform facilitates the operation of the alum tanks in which are placed agitators requiring to be revolved occasionally when the alum is dissolving. Under this is placed the equalizing tank, which is filled from alum tanks, controlled by a ball valve. From the equalizing tank the alum solution flows to the alum suction tank ready for delivery into the raw water, all the alum pipes being constructed of copper pipe with gunmetal fittings.

The raw water rises to the supply pipe to the filters, and revolves a turbine in proportion to its velocity situated inside the supply pipe. This turbine, by means of a worm gear, operates the gunmetal alum pumps also in proportion to the volume of water passing through the pipe, which pump up alum solution from the suction tank and deliver it into the raw water before it reaches the turbines. In this way the turbines can mix it intimately with the water and ensure absolute homogeneity in the distribution of the alum.

The supply pipe is brought by means of branches into the filter supply pipe. On each branch a valve is placed, and a turbine is connected. Only one of the branches is put into use at a time, and one of the alum pumps, the other being used as a duplicate in case repairing or overhauling is required.

Now that the raw water has received a definite proportion of lime and alum, it is in a 10-inch pipe delivering through branches into each of the filters, through which it passes into the collecting pipes out into the 10-inch outlet pipe in the town main.

In this plant and all others constructed by the same company the action of the chemicals added is to prepare the sand bed for effective operation in extracting the chemicals and impurities rather than to drug the impurities and then remove them, so that the minimum of chemical is required. Hence, the reason for the careful control of lime and alum, the latter being controlled by the strength of the solution and an ingenious arrangement on the alum pumps, whereby the length of the stroke can be shortened or lengthened at will, simply by turning a hand wheel while in operation.

The lime reacts on the alum and precipitates a sticky gelatinous matter which entangles the impurities in the water, and deposits them on the sand bed in the filters, in a similar manner to the work performed by the white of an egg in bringing down the grounds of coffee.

The section of one of the filters will explain fully the workings of these, while a wrought iron marine type platform is erected along the top of them to facilitate the other operations necessary, as will be further described.

Inside the filter house are placed two pressure gauges and two test taps, which are connected to the inlet and outlet side of the filters.

The test taps are tested periodically for alkalinity to show whether there is any alum in the water passing through the filters, or whether there is sufficient alkalinity to decompose the alum which is being added.

So far, since the plant commenced its operation, there has been no trace of alum in the filtered water, and it is guaranteed that none will ever be present.

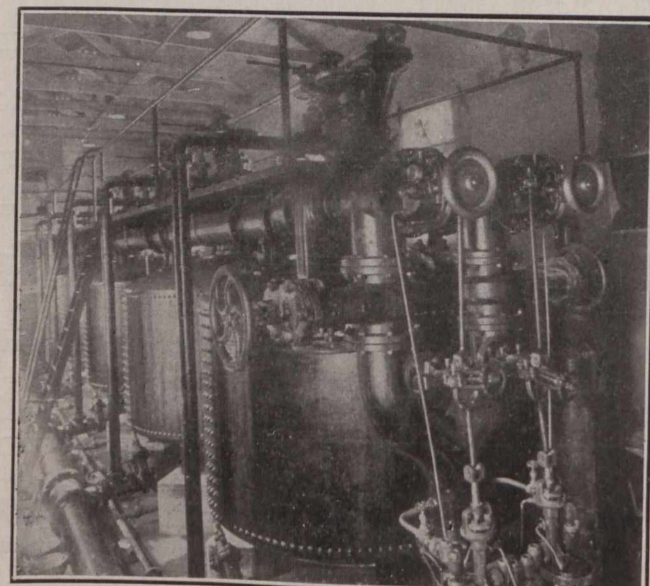

Fig. 3.—Installation at Haileybury, Ont.

When the pressure gauges indicate a loss of five pounds pressure between the inlet and the outlet side of the filters, the operator washes them out, as they are clogged up with the sediment which has been extracted from the raw water.

The wash-out is accomplished with less than one per cent. of wash water, occupies about twenty minutes of time, and is done by closing the inlet valve on the filter to be washed and opening the wash-out valve. The washing motor of 2½ horse power is switched on to revolve the washing gear shaft, and the clutch on the filter thrown in to allow of agitation. Then the agitator valve is opened which directs high pressure jets of water through the hollow agitator arms into the sand in a lateral direction, forcing all sediment out so that the reverse flow raises it up and out to wash out the drain.

The wash-out water, when settled in a cylinder, is composed by bulk of one-third sludge and the remainder water. Each filter is washed in turn without any interruption taking place in the filtering action.

If it is desired to drain out any one filter all valves on that filter are closed, and the filter is then drained by means of a small drain pipe into the field drain.

The plant was erected and put in operation by the Bell Filtration Company of Canada, Limited, 305 Kent Building, Toronto, to the design and supervision of Mr. H. W. Cowan, C.E., their consulting engineer, and is very highly spoken of by all the residents of Haileybury, and those who have inspected it.

It is the first municipal plant of Bell patent filters to be installed in Canada, although every other country in the world, excepting the United States, have many installations. Several other plants are under way, and judging by the operation of the Haileybury plant, promise to solve the difficulty of treating water under conditions hitherto deemed untreatable.

AUSTRALIA'S RADIUM INDUSTRY.

In view of the cost and increasing use of radium, information as to radium mining in South Australia, contained in a review of mining operations in the state during the latter half of 1912, compiled by the chief registrar of the department of mines, is of more than ordinary interest.

At the Radium Hill mine, near Olary, 257 miles north of Adelaide, a considerable quantity of ore has been raised. This is concentrated at the magnetic separator plant in the mine, and shipments of the concentrate forwarded regularly to the company's works at Woolwich, on the Paramatta River, near Sydney. These works, which can now treat about ten tons per week, have, it is stated, cost over £15,000.

The directors report that "pure radium bromide has been produced. Although only 2½ milligrams were fully prepared, it proves that radium bromide of a purity of between 1,800,000 and 2,000,000 radio-activity can be procured from the company's ore, and there are, approximately, 350 milligrams of radium in the laboratory in various stages of purity, which will receive its final preparation and be available for sale automatically week by week henceforth. One hundred and twenty tons of concentrates have been smeltered, of which 95 tons have been treated for about 350 milligrams of radium, which is equivalent to an extraction of 32.3 milligrams per ton of concentrates." The company also proposes to utilize the various by-products contained in the ore.

The South Australian Radium Proprietary holds leases adjoining and to the northeast of the Radium Hill Company's property. Four shafts have been sunk, and a considerable amount of development work has been done. The Rare Metals proprietary, working on claims about three miles northeast of the Radium Hill mine, has done a considerable amount of prospecting work, and raised about seven tons of lode material, analyses from which are satisfactory.

At the property of the Radium Extraction Company of South Australia, Mt. Painter, no work was done during the period under review. The directors' report states that some good ore was picked out and despatched before work ceased, and one shipment of about 2¼ tons realized very satisfactory prices.

THE SCIENTIFIC SELECTION OF PAVEMENTS.

By W. W. Crosby, D.Sc., M. Am. Soc. C.E.*

The following article has received a good deal of press comment recently, especially from engineers in Great Britain. The writer is of the opinion that the science underlying the development of good roads is in need of careful study for the purpose of mathematically comparing the many kinds of road materials and construction methods with which highway engineers have become fairly familiar during the past few seasons. He claims that the problem of proper selection is most pressing, considering the fact that knowledge of road materials, new and old, is rapidly advancing, and that the demand for efficiency is making strides of even greater proportion. It would seem possible that a large amount of the personal element could be eliminated and that the practice of basing the selection on opinion alone could be replaced by scientific methods.

The suggestions which have been presented in various forms on previous occasions in the engineering press are called to the attention of highway engineers by Major Crosby in "The Municipal Journal." He further suggests the immediate commencement of steps for the standardization of the scientific method of selection. The importance to the roadway movement in Canada of the suggestions contained, and the value of impressing upon road builders the superiority of proper selection over methods of more or less personal nature, are factors which indicate that "The Scientific Selection of Pavements" is a paper which will be of great interest.

For convenience, in this paper any artificial road crust will be referred to as a "pavement," and "road" will be considered synonymous with "street" or "alley."

On a road requiring a pavement for reasons of economy and satisfaction, conditions are seldom duplicated. A pavement ideal in one instance may or may not be so in another. It has been suggested that, in general, the requirements for being ideal will be the same in all cases, but the various classifications may have decidedly different importance in different cases. That is, in one case low first cost and low maintenance cost may be most important. In another case, ease of hauling and lack of slipperiness may govern; while in another, sanitariness and noiselessness may overbalance all other considerations.

The main classifications suggested for consideration in the selection of an ideal pavement for any case are given as follows:—

First cost (on a basis of dollars and cents).

Maintenance cost (on a basis of dollars and cents plus interest on first cost).

Durability (ease and infrequency of repairs).

Resistence to traction (self-explanatory).

Non-slipperiness (self-explanatory).

Sanitariness, cleanliness and noiselessness (self-explanatory).

Acceptability or agreeableness (æsthetic or personal).

In assigning values to these qualities, it will be found in the interests of accuracy and convenience to subdivide them somewhat further, and in order to assist in getting farther away from the personal factor, the writer suggests for consideration the following table, with the values opposite the classifications as assigned by various authorities:—

*Chief Engineer, Maryland Geological and Economic Survey, Baltimore, Maryland.

Table I.—Showing Relative Values of the Various Qualities of an Ideal Pavement.

Qualities.	Baker.	Tillson.	U.S. Bulletin.
First cost—cheapness	15	14	14
Maintenance cost—cheapness	—	—	—
Durability	—	21	20
Ease of maintenance	20	10	10
Ease of cleaning	10	15	14
Low tractive resistance	10	15	14
Non-slipperiness	5	7	7
Sanitariness	25	13	13
Noiselessness	—	—	—
Acceptability	15	—	4
Favorableness to travel	—	5	4
Total	100	100	100

While the authorities quoted have not done so, the writer would suggest the sub-division of the items on the following bases:—

"Maintenance cost" into "maintenance cost" (i.e., on a basis of dollars and cents), and "durability" (i.e., on the basis of ease and frequency of repairs required). "Acceptability" into "noiselessness" (which explains itself), "acceptability" (i.e., on a basis of personal or local preferences of abuttors and æsthetic considerations), and "favorableness to travel" (i.e., on the basis of absence of bad effects on animals and vehicles using the pavement).

He would then base his values for "ease of maintenance" in the list on the ease of actually making the repairs necessary (i.e., whether or not special outfits, such as asphalt plants, were required or not), and "ease of cleaning" on the requirement for unusual machines, the frequency of cleaning required, and the actual cost in dollars and cents.

It will be noted that, while the values assigned by Tillson and the U.S. Bulletin are practically identical, a considerable variation exists between them and those given by Baker, and it has been suggested that this variation results from consideration of different conditions. Apparently Tillson and the U.S. authorities had in mind pavements subjected to heavy hauling, while Baker was considering a type of pavement for residential streets. This illustrates the former reference to differences in ideals or to the relative importance of the classifications composing the ideal.

Hence, it seems to the writer that the standardization of a table for the selection of pavementts covering all conditions, character of traffic and with positive values assigned to each kind of pavement is impracticable. Rather, on the other hand, should the effort be made for the standardization of a set of tables—one for use with each class (not amount) of traffic under each class of circumstantial conditions. That is, the writer would suggest a set of tables as follows:—

Table A.—For use on streets in a commercial district where heavy hauling is prevalent or likely to be so; such, for instance, as along the docks or freight depots.

Table B.—For use on streets in a commercial district where heavy hauling is not preponderant nor likely to be so; such, for instance, as about the retail stores of a city.

Table C.—For use on streets carrying occasional heavy loads, occasional pleasure vehicles, and a large proportion of vehicles of moderate weight; such, for instance, as the main thoroughfares of the "down town" portions of a city.

Table D.—For use on streets of the residential portions of a city and where street railway tracks do not exist. (Where street railway tracks exist, use for the width occupied by the rails plus 4 ft., Table C.)

Table E.—For use on city streets where special conditions exist; such as around hospitals, court-rooms, etc.

Table F.—For use on boulevards and on places where æsthetic conditions are preponderant.

Table V.—For use on main country roads, such as "State roads" carrying fairly heavy mixed travel.

Table W.—For use on secondary country roads carrying moderate travel.

Table X.—For use on minor country roads carrying farm travel almost wholly.

Note that the classification is based on the kind of travel known to require support by the pavement, or likely, from the situation of the road, to so require, and not the amount of travel. Consideration of the latter factor will enter when, for any particular case, comes the entering of figures of value for each kind of pavement.

Assuming that the main classifications of travel are given in the above list (though, of course, it is possible to extend the latter), a set of values for the components of the ideal in each case can be made, as shown in Table II.

Table II.—Showing Values for Components of Ideal for Different Tables.

Components	Tables A	B	C	D	E	F	V	W	X
First cost—cheapness	10	10	10	12	10	8	15	15	15
Maintenance—cheapness	20	20	20	15	10	10	25	25	20
Durability	5	5	5	5	5	7	7	7	7
Ease of maintenance	5	5	5	5	5	5	8	10	10
Cleanliness	5	5	7	10	10	12	5	5	5
Low tractive resistance	20	15	10	5	5	5	10	5	5
Non-slipperiness	15	15	12	10	10	10	10	10	10
Sanitariness	5	8	10	13	15	10	5	5	5
Noiselessness	5	7	8	10	20	8	5	5	5
Acceptability	5	5	8	10	5	20	5	5	8
Favorableness to travel	5	5	5	5	5	5	5	8	10
	100	106	100	100	100	100	100	100	100

The application of the tables to the selection of a pavement would be as follows:—

If the case of a street along the freight station is taken, Table A may be applied thus:—

Example I.

Qualities	Ideal (Table A)	Values for Vit. brick	Grouted stone block	Pitched stone block	Grouted Durax	Sheet asphalt
First cost	10	10	8	8	7	10
Maintenance cost	20	8	18	15	20	6
Durability	5	2	5	4	5	3
Ease of maintenance	5	5	5	4	5	2
Cleanliness	5	5	4	3	4	5
Low tractive resistance	20	20	15	10	18	19
Non-slipperiness	15	3	8	13	15	2
Sanitariness	5	5	4	3	4	5
Noiselessness	5	4	1	2	3	5
Acceptability	5	4	4	4	5	4
Favorableness to travel	5	2	2	3	5	4
Totals	100	68	74	69	91	65

Or, in the case of a residential street without street railway tracks:—

Example II.

Qualities	Ideal (Table D)	Values for Vit. brick	Durax	Sheet asphalt	Water-bound macadam
First cost	12	6	3	7	12
Maintenance cost	15	12	15	10	8
Durability	5	4	5	3	2
Ease of maintenance	5	4	4	2	5
Cleanliness	10	10	8	10	4
Low tractive resistance	5	5	4	5	4
Non-slipperiness	10	3	8	2	10
Sanitariness	13	12	8	13	6
Noiselessness	10	6	4	10	8
Acceptability	10	8	6	10	8
Favorableness to travel	5	3	2	4	5
	100	73	67	76	72

And in the case of a secondary country road, we have:—

Example III.

Qualities	Ideal (Table W)	Vit. brick	Values for Plain con-crete	Pitch macadam	Water-bound macadam
First cost	15	8	10	10	15
Maintenance cost	25	25	20	20	10
Durability	7	7	5	5	3
Ease of maintenance ..	10	7	8	8	10
Cleanliness	5	3	3	5	2
Low tractive resistance	5	5	4	4	4
Non-slipperiness	10	4	7	5	10
Sanitariness	5	4	4	5	3
Noiselessness	5	3	3	5	4
Acceptability	5	2	3	4	5
Favorableness to travel	8	3	5	6	8
	100	71	72	77	74

The foregoing will perhaps serve to illustrate the idea the writer has in mind that mathematics can aid the highway engineer and help to reduce the personal equation in the important matter of selecting the proper pavement for any particular case. Of course, the tables suggested may be amplified or altered at the discretion of the individual. The principle remains the same.

For general cases and in order to furnish proper starting points to modifications for particular instances, it seems to the writer that the attention of the profession, the discussion of the question and the standardization of a set of tables as suggested above, and of their components and their values for an ideal pavement in each case, would be well worth while.

When this shall have been done, there will next be needed accurate information from records, uniformly kept, as to the cost of maintenance of the various kinds of pavements, and as to their behavior as to the other items or components of the tables under stated conditions of travel, so that values can be properly assigned, with as little "guessing" as practicable, to such components for the comparison of different pavements under any particular travel which is known to be expected in a specific case. Such records are now being collected and will probably soon be available.

NEW BRITISH CABLE SERVICE.

The new cable direct from Land's End (England) to Hongkong by way of Suez, Aden, Colombo, Penang, and Singapore, is to be laid during the present year. The Malta section to Alexandria is already finished, so that about 9,000 miles remain to be completed out of a total distance of 12,000 miles. The section from Colombo to Penang is expected to be ready by July, and the work on the other sections is to begin shortly. With the exception of a small land cable from Alexandria to Suez, the whole line will be under sea. It is said to be the largest ever laid, and is estimated to cost about $7,500,000. At present the time taken to transmit a 20-word message from Bombay to London in 2½ hours, while the distance from Colombo to Bombay occupies another hour or hour and a half. By the new cable it will take only ten minutes to transmit a message from Colombo to London, while the cost of cabling will be greatly reduced. By means of the "slot" system the message is mechanically transmitted from section to section, and is not touched by hand till it reaches its ultimate destination, thus reducing to a minimum any chances of mutilation in retransmission. The cable will be under European management, and will be worked entirely by European operators.

COAST TO COAST.

Toronto, Ont.—C. A. Magrath, former member for Medicine Hat, Alta., in the Dominion House, and a member of the Canadian section of the International Waterways Commission, has been named as the probable choice of the Ontario Government for the chairmanship of the Provincial Highways Commission, through which the Government will carry out the vast road development scheme promised last session. It is generally understood that W. A. McLean, present provincial highways engineer, will be a member of the commission, with supervision over the engineering and construction end of the scheme. Just now Mr. McLean is abroad, where he went partly to attend the International Roads Congress, but chiefly to journey about and study advanced road construction methods of Britain and Europe. Upon his return, and after the appointment of a commission, it is probable the commissioner will visit the United States and study methods there. The government's third choice is somewhat in doubt, but the name of Reeve Henry, of the York Highways Commission, has been spoken of. Reeve Henry is a road enthusiast, and would represent the farming interests of the province on the board.

Victoria, B.C.—A meeting of leading state highway commissioners and the manufacturers of horse-drawn wagons and motor-driven trucks is the suggestion of Chairman George C. Diehl, of the American Automobile Association national good roads board, who contends that the time has arrived when those interests can advantageously discuss the drafting of suitable legislation governing the width of tires and the weight of loads. After an interchange of views he holds a committee could prepare laws, the passage of which would be practically assured when put forward by the chief highway officers of the various states. "Many states have enacted laws which endeavor to regulate the width of tires of vehicles, but unfortunately there has not been strict enforcement of these regulations," says Mr. Diehl. "The width of tires is one of the important factors in highway construction and maintenance. Narrow tires, especially during the wet season, form ruts in improved roads, and in many instances, where the roads are weak, break through the surface, causing subsequent rapid destruction of the highway. One great difficulty in enforcing wide tire ordinances with horse-drawn vehicles has been that while less traction is required, with wide tires, on slippery clay or hilly roads it is very difficult in wet weather to manage a horse-drawn vehicle with wide tires, owing to its tendency to skid and slide into the ditches. Instances are frequent where in a journey a farmer must drive over miles of slippery road and only have a few miles of improved highway, in which case he would naturally prefer to use narrow tires for the entire distance, rather than to attempt the use of wide tires over the slippery section of the road. There is no question that protection and economica. maintenance of improved highways require that narrow tires should be discarded, and ordinances must be enforced which will prevent their use on main travelled highways which have been improved at great expense. If a vehicle owner desires to use narrow-tired wagons on slippery roads, he must be absolutely prevented from using the same tires on improved roads. Equal, if not greater, damage can be done to the highway with tires of insufficient width on motor trucks.

Victoria, B.C.—Preparations for more active work on the Sooke Lake waterworks system are being made by Water Commissioner Rust, and a few more men have been added to the force on the ground, about fifty being now engaged. A camp is being established at the lake, and supplies and materials required for the same are now being shipped out. The city has made a satisfactory arrangement with the receiver of the Westholme Lumber Company whereby the plant required by the city can be secured on a valuation to be decided by independent valuators. This plant consists of tents, light rails, tools of all sorts, and other necessary apparatus, which, unless its use was permitted by the receiver, the city would have to purchase. Water Commissioner Rust stated that as soon as work actively commences the force of men will be increased to about 150. Mr. Wynn Meredith, the city's consulting engineer on the work, has prepared the specifications for the tenders for which the city is now calling for the supply of cement pipe and steel plate for the pipe line. Cement pipe for about twenty-seven miles will be secured for the flow line from Sooke Lake to Humpback Reservoir, and the steel pipe will be required for the pressure line from that reservoir to the city. The estimated cost of this part of the work is between $700,000 and $800,000. With the recent sale of debentures the city has on hand ample funds wherewith to permit of active prosecution of the work, and as soon as the preliminaries are fully settled the undertaking will be proceeded with as fast as possible.

Toronto, Ont.—It is understood that the plan of the Ontario Government for establishing a good roads commission to supervise construction in the older parts of the province embraces several features. There is likely to be a joint chairmanship, one official to be in charge of the practical administration, and the other will deal with financial and the general outline of the scheme. In addition, there will be a complete reorganization of the co-operative system, in which the government advances to counties desiring it a grant of one-third the amount to be expended in the good roads movement. A change in the percentage has long been considered by the cabinet, and legislation will in all probability appear at the next session to change the rate from one-third to one-half. The fact that the maintenance of roads by the counties is not popular has been instrumental in resolving the government to assume the upkeep in future. The actual means have not yet, however, been decided on, but it has been suggested that the government grant be reserved in large part for that purpose. Premier Whitney recently stated that the personnel of the commission had not yet been decided upon. It is understood, however, that Provincial Engineer W. A. McLean will occupy a place, probably as administrative chairman. The interests of Eastern Ontario may be regarded in choosing a commissioner from that district.

Victoria, B.C.—A prominent automobile man, in discussing the relative merits of the telephone and motor car, made the following interesting statements: "The telephone and the motor car have done more for the farmer than any other invention, with the possible exception of the reaper. We have heard a great deal of late about the necessity of a return to the farm. That is, various social and economic conditions of modern life have prompted a movement to turn the tide which has been running cityward back to the farm. Farmers' sons for a while were irresistibly lured to the city, and the reason was that farm life was too sordid, uninteresting, too limited in its opportunities for rational enjoyment for the young man who had argued that the high cost of living, the congestion in cities, the bitterness of competition in all walks of life could be reduced and alleviated if farming as a profession was made more attractive. The telephone and the motor car have been doing a great work in solving this problem by doing just what the students of sociology and economics have asserted must be done. That is, they have revolutionized farm life by modernizing it, keeping it in close touch with the outside world and bringing the city almost to the isolated farm. Nowadays the farmer without a telephone is an exception. This great convenience keeps him in instant touch with his neighbors and with the city. It has had an untold effect in making the life of the farmer more bearable and attractive. No less important in achieving a revolution in living conditions is the motor car. Beyond all that it has proved of economic value because a machine is serviceable for many tasks that can be accomplished far more efficiently and expeditiously than with the horse and wagon. Any one who doubts that the farmer has taken kindly to the automobile should visit the country churches, the country fairs and the county seats, and see the machines parked. The number of automobiles in evidence will certainly prove illuminating."

Ottawa, Ont.—There will not likely be any opposition to the city co-operating with the Dominion Government in preparing plans for the enlargement and beautification of the Capital and its development along proper lines. The board of control in its report to the city council will recommend that the city concur in the suggestion which was made by the minister of finance for the appointment of a commission to prepare plans covering Ottawa, Hull and their environs and dealing with parks, transportation and other features that are serious problems in the development of the Capital. The proposition made by the government was that half the cost of the commission should be borne by the government and the other half by Ottawa and Hull. The board of control is recommending to the city council that Hull be asked to bear one-fifth of half the cost and that Ottawa bear the remaining four-fifths of half. The city council seems unanimously in favor of co-operation and it is not likely that any opposition will be raised. It is understood that as soon as the cities agree to the proposal the government is prepared to name its commissioners, the mayors of the two cities also being members.

Toronto, Ont.—An important conference between the city of Toronto and the townships of Etobicoke, York and Scarboro' was held recently. City planning beyond the limits of Greater Toronto was discussed, a plan for diagonal roads in Etobicoke, York and Scarboro' engaging the attention of the delegates. It was decided to adopt the principle that no road must be less than 66 feet wide, and that through roads must be 86 feet wide. The townships interested in the schemes will have to obtain legislation before they can establish building lines to prevent people from building up to the street line as at present. Ald. Sam. McBride presided, and promised that the city would do everything that could be done to help the townships secure the necessary legislation. Assessment Commissioner Forman explained the principles of the homologated line and its power to fix street building lines indefinitely. As a result of the conference each township will prepare a map showing which of the proposed diagonal streets will be 66 feet wide and which will be 86 feet wide. Then a general map will be prepared to conform with the smaller maps, the township maps being submitted first at another meeting of the city and township officials.

Ottawa, Ont.—Canada will have the longest and loneliest motor road in the world, according to the recent decision of the government to build a motor road into Dawson City. Fifty thousand dollars has been voted for the purposes of this road, and a couple of other such votes will be necessary to finish it. At the present time Dawson is only reached by stage in winter, when there is a deep coating of snow on the ground. It is the intention of the government to build a road for motors 400 miles in length, from White-horse at the head of Yukon's two thousand miles of navigation, right into Dawson City. Dr. Alfred Thompson, M.P. for Yukon, who obtained this grant, will take surveyors with him into the territory to start the work on his return to his constituency. At the present time the motor has penetrated into the heart of Africa, and almost everywhere else. Tourists go thousands of miles in order to travel over some road, hitherto unknown to the power car. And thus, when this motor road is finished into Dawson, it will not only open that Canadian city to the tourist traffic of the world, but attract tourists from many lands.

Ottawa, Ont.—The improvement works and storage reservoirs on the Upper Ottawa by dams at Temiskaming and Quinze are dealt with in the annual progress report just published by the public works department. The storage of the surplus water of the Ottawa River has been demanded by various interests for a great number of years. In 1902 and 1903, the matter was particularly brought to the attention of the government, memorials being presented asking that this work be undertaken as a national enterprise. During periods of low water in the river, navigation is rendered difficult, and the power developments supplying energy for industries and public utilities suffer severely. To remedy these conditions, it was represented that the best scheme would be to establish some system of storage reservoirs at the head waters of the Ottawa River, by which some of the surplus waters of the spring could be collected and conserved, to be released gradually during the low period and thus augment the low flow. The total appropriation in 1912 for construction work was $353,000, and the total expenditure since storage commenced is $609,347. The principal feature of the report is that by C. R. Coutlee, engineer in charge, who tells in detail of the work accomplished by the department by day labor on the storage dams at Quinze and Temiskaming, and who makes some interesting general comment. He says in part: "The full benefits of the great storage system now nearing completion, will not be felt until subsidiary reservoirs are created all the way down stream. The Mississippi, for instance, is not benefited by its reservoirs much below St. Paul, say 150 miles down stream. Now, if private capital begins building dams in the river, there will be no general system observed and chaos will result. Owing to the great cost and the divided control of the river between Ontario and Quebec, companies would often pen up only one side of the stream. This would ruin the river for navigation and an attempt to use the other side for power would be met with law suits and great construction difficulties. Private dams take no heed of power possibilities above and below their immediate site and the money is not always available to make them strong beyond chance of accident. Inspection would be lacking both as to upkeep and as to the control of the water flow and riparian rights." The dams now are practically finished and their benefits are already apparent in low water seasons.

Ottawa, Ont.—That the government is fully alive to Canada's greatest problem, that of transportation and its allied facilities, is indicated in the more than generous appropriation for the purpose made this year. The engineering staff of the public works department is applying itself to the preliminary arrangements for calling of tenders on several new and very expensive works and of proceeding with other undertakings already in progress. After session there is always a demand by members of parliament to have works in their respective constituencies started immediately. This cannot always be done, as time is required for the preparation of plans. However, the intention is to have all the works comprised in the forty-five million dollars appropriations under way before the year terminates. All parts of the country have been looked after in what may be described the big national works. Halifax is to have new terminals and docks for the I.C.R. costing eight or ten millions, while a big dry dock is also to be built. St. John has the extensive Courtenay Bay improvements in full swing including also a dry dock. In a few days a contract will be awarded for the largest dry dock in America at St. Joseph de Levis, opposite Quebec, while the River St. Charles is being deepened and many new terminal facilities added for railway and steamship services. At Montreal the harbor board is proceeding on the strength of government advances with the yearly stage of improvements to aggregate in cost $18,000,000. Tenders will be called this week for the Toronto harbor works to cost $6,000,000, while a good start has been made and bigger plans are in view for similar works at Hamilton. On July 17, the tenders for the first section of the Welland Canal will be in and those for other sections will be called in a month or so. On Georgian Bay extensive dredging works are in progress and work being rushed on the Trent Canal, while at the Soo, with its abnormal shipping, a subsidized dry dock is under construction. Port Arthur and Fort William improvements consist of new docks and warehouses, grain elevators and harbor improvements. A system of internal elevators will be built on the prairies, those at Saskatoon and Moosejaw being already decided on. Out at the coast Vancouver is to have big docks and harbor facilities and a dry dock, while the similar works and breakwater at Victoria are well started. Esquimalt, in the extreme west, gets a first-class dry dock. Departmental expenditures in two years have doubled with the growth of the country and its coincident demands for up-to-date facilities for handling traffic have both necessitated and justified the extensive outlays now being started.

PERSONAL.

MR. F. W. PETERS, general superintendent of the British Columbia division of the Canadian Pacific Railway, who has been in Europe since April, has just returned.

MR. J. D. CRAIG, of the Department of the Interior at Ottawa, is in charge of the boundary survey from Mount St. Elias to the Arctic Ocean, and arrived in Skagway recently, expecting to complete the work before the end of the summer. The survey has been in progrss during the past four years.

MR. J. DARLINGTON WHITMORE, A. M. Can. Soc. C.E., has been appointed boro' engineer at Whangareé, New Zealand, and is taking up his duties at once. Mr. Whitmore was city engineer at Moose Jaw, Sask., for five years, until, in 1910, he opened offices as consulting, municipal and sanitary engineer.

MR. ALBERT NUTTALL, formerly erection superintendent, Structural Steel Company, and for the last two years superintendent of construction for Canada of the Cleveland Bridge Company, has been appointed superintendent of erection, bridge department, Canada Foundry Company, Limited, with headquarters at Toronto.

MR. P. W. WARD, who for the past two years has occupied the position of eastern manager for E. R. Watts & Son, Canada, Limited, and who resigned a short time ago, has accepted an appointment to the position of eastern sales manager for the Eugene Dietzgen Company, Limited. Mr. Ward will manage the eastern business of the firm in engineering and architectural instruments and supplies from the company's headquarters at 432 St. Catherines Street West, Montreal.

MR. COLLINGWOOD B. BROWN has been appointed to the position of chief engineer of the government railways in Canada. Mr. Brown is a graduate of Cornell University and has been with the Canadian Pacific Railway for the last fourteen years, for the past two years of which he has been principal assistant engineer. Previous to that time he was division engineer at St. John, N.B., and at Montreal, and assistant division engineer at Calgary. He is a Canadian by birth with Kingston as his native city.

PACIFIC COAST CONVENTION OF THE A.I.E.E.

The Pacific Coast Branch of the American Institute of Electrical Engineers will be in convention in Vancouver, September 9, 10 and 11. The convention is in charge of a committee of prominent members, of which Mr. R. F. Hayward, of Vancouver, B.C., is chairman. A number of papers have been arranged for by the committee. The proposal is to present one paper at each session, giving ample opportunity for comprehensive discussions. Several interesting trips are also being arranged.

COMING MEETINGS.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—The Twelfth Annual Meeting to be held in Canada during July and August. Opening day of the Toronto Session, Thursday, August 7th. Secretary, W. S. Lecky, Victoria Memorial Museum, Ottawa

CANADIAN PUBLIC HEALTH ASSOCIATION.—Annual Meeting in Regina September 16. 17 and 18. General Secretary, Major Drum, Ottawa; Local Secretary, Dr. Murray, Regina.

THE INTERNATIONAL ENGINEERING CONGRESS.—Convention will be held in San Francisco in connection with the International Exposition, 1915.

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

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—176 Mansfield Avenue, Montreal. President, Phelps Johnson: Secretary. Professor C. H. McLeod.

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

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

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

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

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

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

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

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

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

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

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

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

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

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

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

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

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

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

CANADIAN TECHNICAL SOCIETIES

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

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

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

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

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

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

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

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

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

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

INSTITUTION OF MINING AND METALLURGY.—President, Bedford McNeill; Secretary, C. McDermid, London, England, Canadian members of Council:—Prof. J. B. Porter, H. E. T. Haultain and W. N. Miller and Messrs. H. W. Claudet, S. S. Fowler, R. W. Leonard and J. B. Tyrrell.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

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

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

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