PAGES

MISSING

The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Street Railway Permanent Track Construction

Description of Various Types in Service in Edmonton, Alberta—Review of Factors Determining Design of Rails, Rail Joints, Bonding, Track Drainage, Base and Paving — Maintenance and Special Work

By C. C. SUTHERLAND

Assistant Roadways Engineer, City Engineer's Department, Edmonton, Alberta

THROUGHOUT the rapidly changing conditions of the past thirty years, the street railway engineer has endeavored to keep pace with public desire for better and speedier transportation by constructing tracks capable of carrying the ever-increasing loads.

The advent of the popular "jitney" and the tendency of the older cities to make omnibus extensions to the present transportation equipment, leaves little doubt but that if the present street railway systems are to remain in existence, they must be developed along lines of speed combined with safety. It is not necessary that any change be made suddenly; in fact, that is improbable, as there are millions of dollars of capital invested in street railway equipment throughout this country, which must be worked off gradually before the system can be altered to a lighter and faster service.

Street railway tracks that will carry the present-day traffic and its heavy equipment without affecting the adjoining pavement must be carefully designed and well constructed, but there is every reason to believe that the maximum loading has been reached and that future designs will provide for lighter and speedier car traffic.

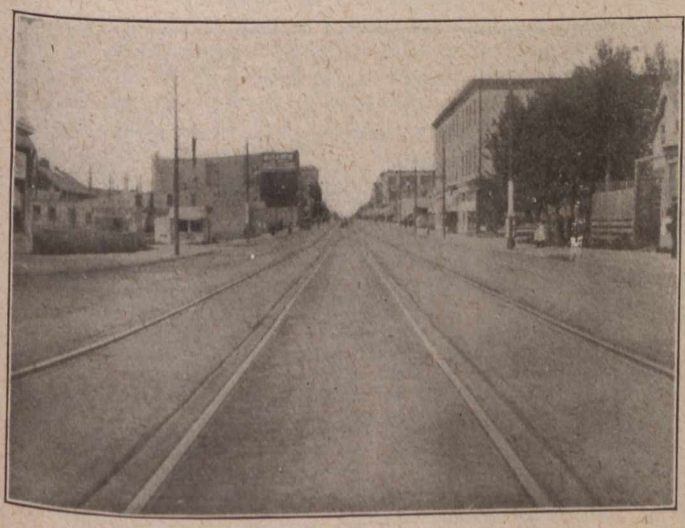


FIG. 1—NAMAYO AVE., EDMONTON, CONSTRUCTED IN 1908 (SEE FIG. 7)

The important feature of track design is to distribute the weight of the car and its load over an area which is capable of carrying that load without appreciable movement. Consideration will first be given to some factors governing the choice of rails, and methods of fastening and bonding them together.

The type of rail having been determined, the means of distributing the loads to the subsoil should then be considered. By describing the different types of construction in actual service in Edmonton, an idea may be obtained of the advantages and disadvantages of the various methods employed.

Rail

The choice of a rail for any particular location should be governed by its present and probable loading, and by the class of street over which it is to be laid. The first consideration should be to determine what part of the total traffic of the system this section of the road will probably carry in this way, classifying the loading into light, medium and heavy traffic.

FIG. 2—NAMAYO AVE., EDMONTON, CONSTRUCTED IN 1910 (SEE FIG. 8)

In Fig. 6 is shown a section of a 4¼-in. tee rail, weighing 60 lbs. to the yard. This section has been in use in the city of Edmonton in paved streets for several years, and from a carrying standpoint, may be considered satisfactory for light traffic, provided special attention be paid to the rail joints.

The difficulty of accommodating a pavement to a low section, and especially a tee section, makes the use of the latter doubtful, and in endeavoring to obtain sufficient height, considerably more metal is used than is actually required to carry the load, in order that the web will be stiff enough to hold the head to gauge. The temptation to use the low section is due to the fact that standard 4¼-in. 60-lb. and 5-in. 80-lb. A.S.C.E. sections may usually be obtained in quick shipments, and the costs are 10 to 15% less than some of the high tee or grooved rail sections.

The tracks on Jasper Avenue in Edmonton are laid with 7-in. tee rails, 80-lb. Lorain section, held together with tie rods. This rail has carried the medium traffic imposed upon it, and if a harder steel were used in this section, it would undoubtedly handle all medium traffic. For light traffic, 6-in. 60-lb. or 7-in. 70-lb. may be used in the Lorain tee section, or the 6-in. 74-lb. in the Lorain girder grooved section. Fig. 6 shows three sections of rails in general use, and tables 1, 2 and 3 quote the rail dimensions as given in the Lorain Steel Co.'s. catalogue.

There is no part of the Edmonton street railway system that can be classed as "heavy traffic." The Electric Railway Journal, dealing with "Characteristics of Track Construction in Paved Streets in 36 North American Cities," says that

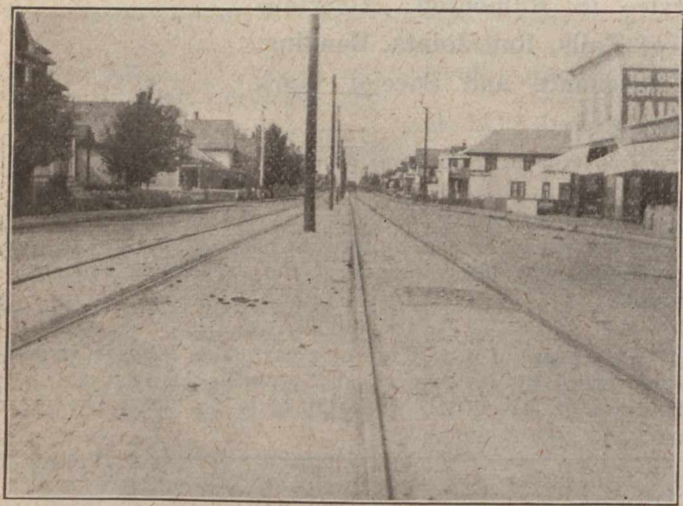


FIG. 3—SYNDICATE AVE., EDMONTON, CONSTRUCTED IN 1912 (SEE FIG. 9)

"where traffic is dense and the weight of the rolling stock increased, the 7-in. 91-lb. or 95-lb. high tee rail has been used in many cases." The weight of the 7-in. girder grooved section generally adopted varies from 100-lbs. to 116 lbs. per yard. A few cities use 9-in. girder grooved rails varying between 125 lbs. and 141 lbs. per yard. For heavy traffic the use of 7-in. 91-lb. to 95-lb. tee sections, or the 100-lb. to 116-lb. girder grooved sections is considered good practice.

The section of a rail for street railway track work is often governed by city ordnance, in order to reduce the great variety of sections which result when the choice is left entirely with the street railway companies. The first four sections in Fig. 6 show types in use on the Edmonton street railway system.

In the earlier days of track construction in paved streets, it was found that vehicular traffic usually preferred to use the railway allowance, because, by placing one wheel along the rail groove, less resistance was offered and vehicles were more easily guided. Not only did this cause considerable inconvenience by delaying car traffic, but it was found that the steel tires of the wagons soon wore the rail. To overcome this difficulty, the groove of the rail was pinched in, so that it was narrower than the narrowest wheel tire, and the top of the groove was brought up level with the pavement. With the advent of the automobile, some cities have found it necessary to regulate traffic, and by-laws have been passed requiring slow traffic to keep to the curb side of the roadway. As most of the fast traffic is rubber-tired, the old trouble from delays and rail wear is fast disappearing.

In adopting a pavement to the tee rail section, on the gauge side of the rail some form of rail block must be used which will allow for flange clearance as well as rail vibration. The rail was made monolithic with the concrete base and pavement in some of the older types of track construction, thus giving a very rigid track, but this type is being replaced by some other method where brick, granite, sandstone or concrete rail blocks are used. The heavy wear from car and vehicular traffic at intersections, however, soon cuts this rail block, giving it a rough appearance, and track maintenance is increased.

The pavement may be laid up to the lip of a girder grooved rail, which takes the wear of the traffic, retains its appearance and protects the adjoining pavement. From the pavement standpoint, there is little doubt but that the grooved section is much to be preferred.

Rail Joints

It has been said that an ideal joint should have the same strength, stiffness and elasticity as the rail which it joins. That is true of all joints used on rails laid in a pavement, and as far as strength is concerned, equally true in open track work, but in this case, expansion and contraction of the rails have to be considered. In open track work the duty of the joint is a peculiar one. It must have the supporting and stiffening power of the adjoining rail in order that the wave motion of the rail may be continued, and yet possess the capacity to move under contraction and expension. Provision is usually made for this movement by giving an elliptical shape to the bolt holes in the joint, making the long diameter ¼ in. greater than the diameter of the bolt. It is not necessary to consider the joint as a relief for stresses induced by temperature in rails laid in a pavement where they are protected from extreme changes of temperature.

Joints may be classified as mechanical or welded joints. The mechanical joint is made by bolting some form of plate on each side of the rail; welded joints are made by joining the ends of the two rails in a butt-joint.

Fig. 5 shows a number of common types of mechanical joints which are in use to-day. The fishplate is used in open track work, and with small rails such as are used in industrial railways or the light temporary tracks used by contractors.

The angle splice bar is being used in large quantities for both steam and electric railways. It is made in a great variety of sizes, varying from the 16⅛-in. 4-hole bar weighing 3.97 lbs. per ft., up to the 34-in. 6-hole bar, weighing 18.12 lbs. per ft. As a general rule, this bar is used on open track work, but the writer believes that a 34-in. 6-hole angle

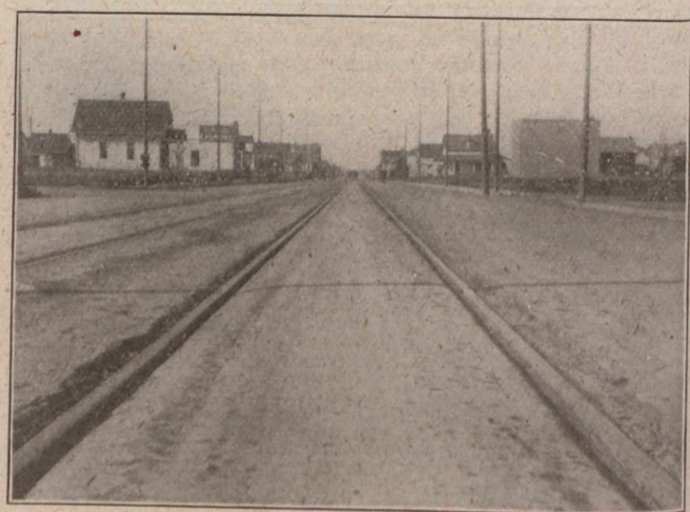


FIG. 4—KUBNESS ST., EDMONTON, CONSTRUCTED IN 1913 (SEE FIG. 10)

splice bar, supported by a centre tie and two end ties, will make a good joint in a paved street.

Fig. 5 also gives a section through the continuous joint, which is very popular with track engineers where a mechanical joint is to be used in a paved street. The flange of the rail fits so tightly into the base of the joint that it is usually necessary to drive the joint to place with a sledge.

The Nichols composite joint is made by riveting two loosely fitting plates to the rail and filling the open spaces with molten zinc, which enters into and fills out all irregularities of the rolled surfaces, thus giving a continuous bearing throughout the length and width of the flanges of the plates.

In a paved street where the rail is not exposed to any great change of temperature, it is a common practice to weld the joints. This class of joint has the advantage of being more permanent, costs less to maintain and makes a better conductor for the return current. It is made by three methods: (1) The Thermit process, which depends upon the heat from the chemical reaction of aluminum and oxide of iron; (2) the cast-iron joint, made by pouring molten cast iron around the joint; and (3) the electrically welded joint, made by welding two plates to the web of the rail.

The following tabulation of the different types of track joints in use in North American cities was compiled several years ago and as the total number of joints used in each city is not given, the comparison is only approximate:—

Riveted welded,	3.0%
Bonzano continuous,	5.8%
Nichols composite,	6.0%
Electric welded,	8.8%
Angle bars,	11.7%
Cast weld,	17.7%
Continuous,	47.0%
Total,	100.0%

Bonding

It is generally recognized that a good bond is important from the standpoint of operation, power economy and electrolysis migration. A poor bond lowers the voltage beyond the defect, thus making it more difficult for the motorman to make his run on time. Considering the bond from the standpoint of power economy, George H. Eveland, in a paper read before the American Electric Railway Association, states that he has measured drops around joints as high as 6 volts, and that one poor bond can waste $5 worth of energy in a year for every dollar that it would cost to rebond the joint. The resistance of a joint is usually expressed in terms of feet of rail, and a bond provided equal to the resistance of the rail being used. For instance, when a bond becomes so defective that its resistance is equivalent to 12 ft. of rail, then it should be rebonded. Many cities use a shorter length of rail as the maximum allowed before rebonding.

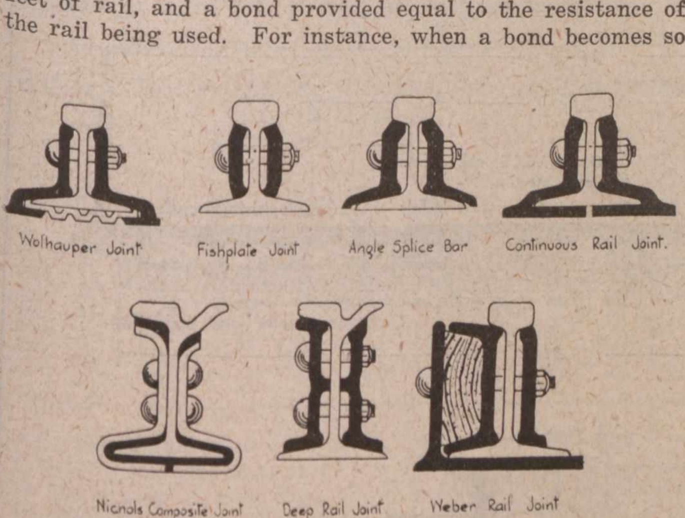


Fig. 5—Various Types of Rail Joints

The most common form of rail bond has terminals which are inserted in holes drilled through the web or flange of the rail, and the best results are obtained when the points of contact between the rails and terminal are perfectly clean. In order to insure that this will be the case, the rails are drilled for bonding 1/16 in. smaller than required, and reamed out immediately before the bond is to be made. The bonds most commonly used have round copper terminals with a flexible body made up of thin, narrow ribbons of sheet copper. After the bond hole has been reamed out, the terminal is riveted in place, either by hand or preferably by a mechanical compressor which ensures that the hole is completely filled.

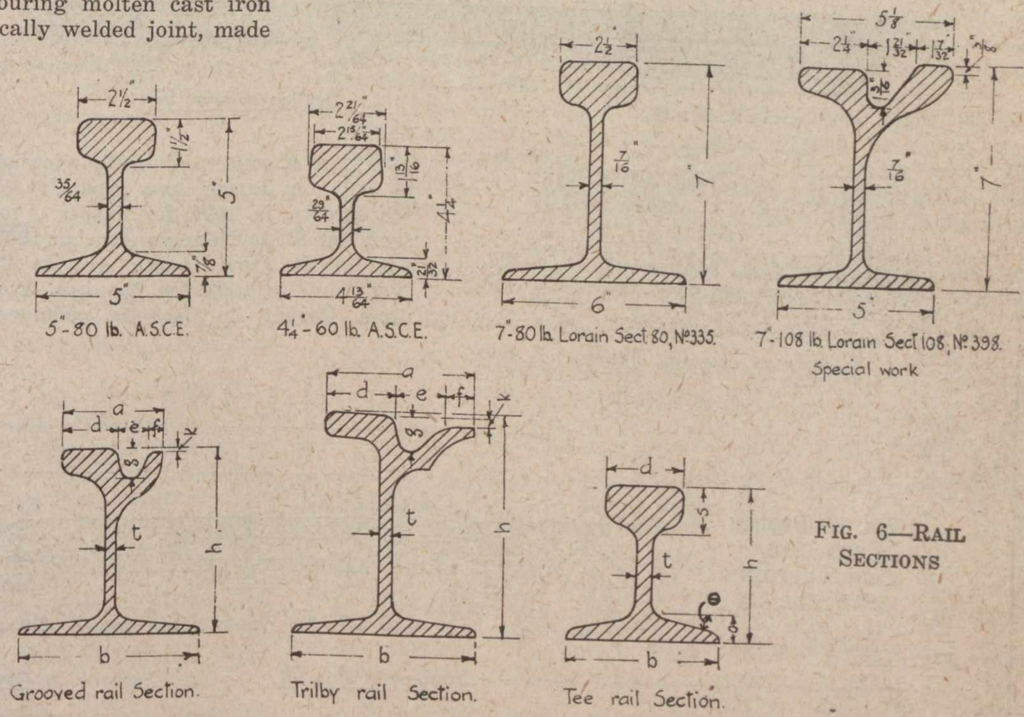


Fig. 6—Rail Sections

Bonds are sometimes made by soldering a short piece of cable to the web or flange, across the joint. This practice is not used extensively, because it is claimed to be a difficult matter to make this kind of joint "mechanically strong and electrically perfect." There are, however, cases reported where satisfaction has resulted from soldered bonding. E. J. McIlraith, superintendent of ways and structures, Puget Sound Traction, Light & Power Co., Seattle, Wash., in describing their twelve years' experience with soldered bonds, states that "of the 40,794 bonds on the 203 miles of track, less than one-quarter of one per cent. have proved defective or have been stolen. On most tracks a resistance per bond equivalent to 12 ft. of rail is the maximum allowed before rebonding, but on tracks of heavy current flow, 10 ft. is used."

In addition to bonding joints, it is practically essential that there should be "cross-bonding" between rails, as otherwise a break in one rail would deaden its side, and a break in both rails would cut off the return current altogether. This same principle may be applied to double track construction, and bonds carried across the devil strip to the nearest rail of the other track. The standard practice in Edmonton is to use 4/0 cross bond between the rails every 400 ft., and 4/0 cross bonds in the devil-strip every 500 ft.

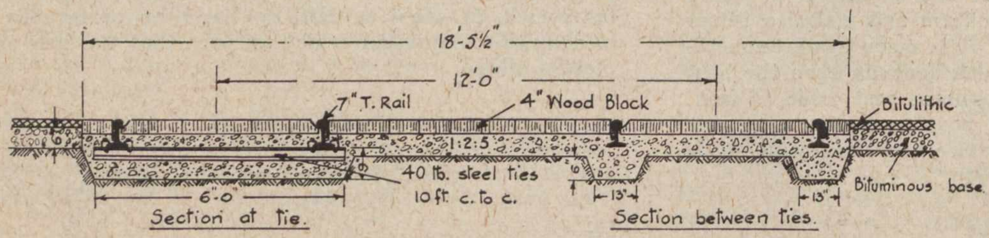
Track Drainage

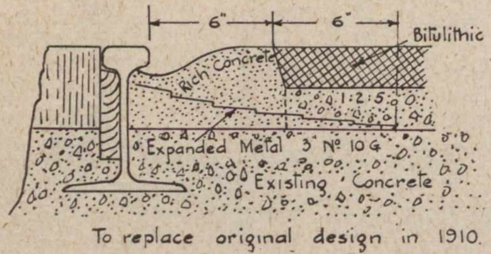
Track drains, which are provided to catch the rain and melting snow that runs along the track allowance and carry it into the sewer system, should be placed at least every 800 ft. on a long grade, and at the intersection of descending grades.

Fig. 12 shows the older type of track box built in Edmonton previous to 1915, in which the grill casting was made in two pieces, with the grills at right angles to the traffic. The water drops into a concrete box with an outlet pipe to the silt well, which is connected to the sewer.

The silt wells may be built of concrete blocks, brick or vitrified cull tile pipe. It has been found that excellent results may be obtained by using three pieces of 22-in. or 24-in. vitrified tile pipe standing on end in a concrete base.

Various Designs for Street Railway Construction in Edmonton





This type of construction was adopted in 1907 for Jasper Ave. from 1st to 9th streets, in 1908 for Jasper Ave. from 1st St. to Namayo Ave., in 1908 for 1st St. from Jasper Ave. to C. N.R., and in 1908 for Namayo Ave. from Jasper to Isabella avenues.

FIG. 7—DESIGN FOR 1907 CONSTRUCTION (SEE FIG. 1)

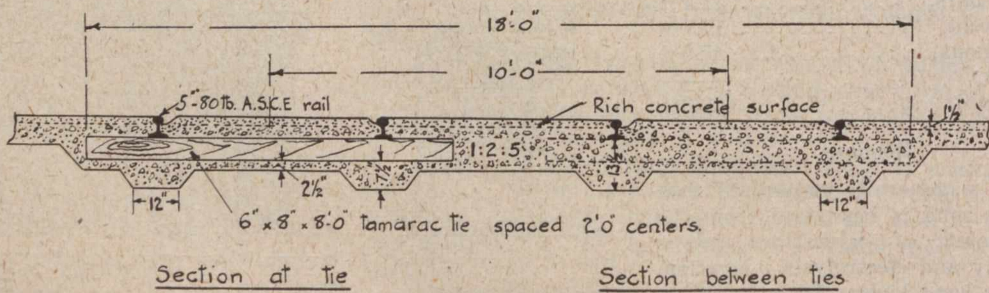


FIG. 8—DESIGN FOR 1910 CONSTRUCTION (SEE FIG. 2)

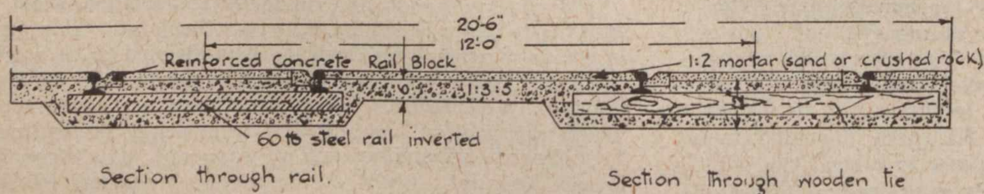


FIG. 9—DESIGN FOR 1912 CONSTRUCTION (SEE FIG. 3)

Steel and wooden ties alternately spaced at 5-ft. centres.

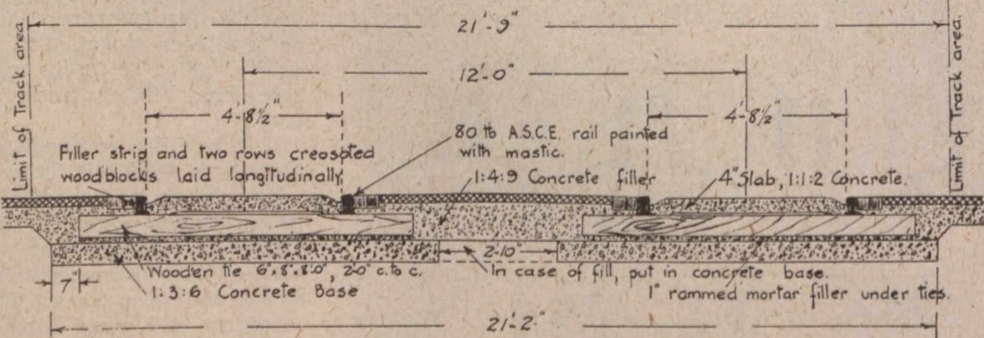


FIG. 10—DESIGN FOR 1916 CONSTRUCTION

This also represents 1913 construction (see Fig. 4) excepting that in 1913 no wood block was laid outside the rails, a sand cushion was placed under each tie instead of mortar, and the slab between gauge lines was reinforced.

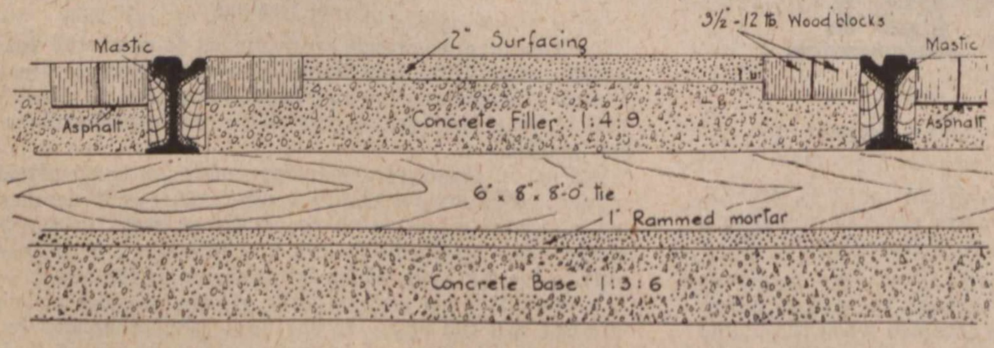


FIG. 11—ANOTHER DESIGN PREPARED IN 1916, FOR FUTURE CONSTRUCTION

The casting of the top is usually a standard manhole frame and cover made to fit on the tile by corbeling up with brick.

This type of track box has given satisfaction with the exception of the grill, of which a large number of the old type were found with one or more bars broken off by the traffic. In making a new design it was decided to lay the grill lengthwise along the rail, thus greatly increasing the inlet capacity. Fig. 13 shows a section of the new type in use since 1915.

Track Base

There are a great variety of methods of transmitting the loading of the rail to the subgrade below, but generally speaking they may be divided into: (1) Girder type; (2) slab construction; (3) ballast base construction; and (4) monolithic concrete construction.

The girder type of track work carries its load on a continuous concrete girder underneath the rail, with a cross girder under each tie. The pavement base is poured at the same time as the girders, but where the rails are 7 ins. or less, it cannot be expected that this thin slab will carry a part of the loading. Steel ties are invariably used with the girder construction, and placed from 6 to 10 ft. apart, serving only as tie rods in holding the rails to gauge, but taking very little part in supporting the load.

The slab construction carries its load on a 6 or 8-in. concrete base, extending the entire width of the track, which may be brought to grade by using a light sand cushion, or by shimming up the ties with wooden wedges and pouring a weak concrete filler or placing a 4 or 5-in. layer of rock ballast around and under the ties.

In the case of ballast base construction, the load is carried on a 6 to 10-in. gravel or crushed rock base which extends well out at each end of the ties. Some railway companies lay a ballast base but bring the concrete which supports the pavement down under the base of the rail, thus making a combination girder and ballast construction.

The monolithic concrete construction, as the name implies, is poured in one operation. It carries its load, however, in much the same way as the slab construction, the concrete under the slabs varying from 6 to 8 ins. in depth.

Track Pavement

In Alberta, where local clay does not make a paving brick, and where there is no granite to be obtained, the choice of a pavement is restricted to materials that may be shipped at a reasonable cost, or to local materials. The selection is limited to wood block, bituminous pavement, concrete, or some combination of two or more of these materials. A description of each class of pavement will be included in the following resumé of the different types of track work laid in Edmonton:—

TABLE 1—DIMENSIONS AND WEIGHTS, GROOVED RAIL SECTION (SEE FIG. 6)

h	b	d	a	e	f	g	k	t	Wt. per Yd., Lbs.	Tons per Mile, Single Track.
3 1/2"	4"	2 5/32"	3 13/16"	1 9/32"	3/8"	7/8"	0	3/8"	55	86.43
6"	6"	1 27/32"	3 3/8"	1 5/32"	3/8"	1"	1/8"	5/16"	74	116.29
6"	5 1/2"	1 59/64"	3 15/32"	1 1/32"	33/64"	1 7/32"	1/8"	3/8"	80	125.71
6"	6"	2 1/8"	3 15/16"	1 3/16"	5/8"	1 1/32"	3/16"	3/8"	85	133.57
6 1/2"	5 3/4"	1 7/8"	3 9/16"	1 1/16"	5/8"	1 1/8"	1/8"	15/32"	90	141.43
6 1/2"	6 1/2"	1 31/32"	3 7/8"	1 15/64"	39/64"	1 1/16"	1/8"	7/16"	95	149.29
6 1/2"	7"	1 15/16"	3 9/16"	1 1/8"	1/2"	1 1/8"	1/8"	14/32"	95	149.29
6 1/2"	7"	2"	3 11/16"	1 1/8"	9/16"	1 1/8"	1/8"	7/16"	100	157.14
7"	7"	2 1/8"	3 13/16"	1 1/8"	9/16"	1 1/8"	1/8"	9/16"	105	165.00
7"	7"	2 1/4"	3 31/32"	1 1/2"	19/32"	1 1/8"	1/8"	29/64"	110	172.86

Jasper Avenue Track Work

The first permanent street railway tracks in the city of Edmonton were laid on Jasper Avenue, between 101st Street and 109th Street, in 1907. Fig. 7 is a cross-section through this construction. The section is a girder type, having a 13-in. bearing at the bottom of the girder, with a depth of 9 ins. under the base of the rail. The rails are held together every 10 ft. with 40-lb. inverted steel ties, fastened to the flange of the rail with bolts and clips. Each cross-tie is supported by a cross-girder 6 ins. deep. Sixty-foot 7-in. 80-lb. Lorain section rails were used, and heavy Atlas joints, which were bolted to the web with sides well up under the head, and with the lower part of the joint carried under the flange, where it acts as a girder in supporting the joint.

Concrete was poured to within 4 ins. of the top of the rail and allowed to set. A wood block pavement was laid down between the gauge lines and in the devil strip, the blocks next to the rail on the outside being kept vertical by the use of a treated wooden filler strip laid against the web, while the blocks laid on the gauge side of the rail were notched to allow for the wheel flange clearance.

After two years of comparatively light traffic, it became apparent that the wood blocks between the gauge lines would not stay down. The flange of the wheels first split the blocks, and as dirt and water were forced into the cut, the blocks arched up until they caught on the fenders of the car.

During 1910, all wood blocks were removed from between the gauge lines and replaced by a reinforced concrete rail stretcher, with a 2-in. bituminous surface between the stretchers. Fig. 7 shows a detail of this reconstruction. The surface of the existing concrete was carefully cleaned off with steel brooms and a rich concrete rail block, 6-ins. wide and 4-ins. deep, was laid at the gauge side of each rail, and before the initial set had taken place the intervening space was poured with concrete mixed in the proportion of 1 part cement, 2 parts sand and 5 parts washed gravel or crushed rock. Strips of expanded metal were placed in the rail block, with one end embedded in the pavement base. After sufficient time had elapsed for the concrete to set, the 2-in. bituminous surface was laid.

TABLE 2—DIMENSIONS AND WEIGHTS, TRILBY RAIL SECTION (SEE FIG. 6)

h	b	d	a	e	f	g	k	t	Wt. per Yd., Lbs.	Tons per Mile, Single Track.
6 7/8"	6"	1 31/32"	4 1/8"	1 19/32"	9/16"	1 1/8"	1/4"	3/8"	87	136.71
7"	6"	2 1/4"	4 7/8"	1 5/16"	1 5/16"	1 1/8"	1/4"	3/8"	90	141.43
7"	6"	2 1/2"	4 11/16"	(e+f=2 3/16")		1 1/4"	1/8"	7/16"	102	160.29
7"	6"	2 1/2"	5 1/8"	2"	5/8"	1 3/16"	1/8"	7/16"	105	165.00
7"	5"	2 1/4"	5 1/4"	1 37/64"	1 27/64"	1 1/8"	1/8"	9/16"	110	172.86
8"	5 1/2"	2 1/8"	5 3/16"	1 9/16"	1"	1 1/8"	5/32"	7/16"	104	163.43
9"	5 1/2"	2 1/4"	5 1/4"	1 35/64"	1 29/64"	1 1/8"	5/32"	7/16"	109	171.29
9"	5 1/4"	2 1/4"	5 1/4"	1 37/64"	1 27/64"	1 1/8"	1/8"	1/2"	115	180.71
9"	5 1/2"	2 1/4"	5 7/8"	(e+f=2 7/8")		1 1/2"	13/32"	7/16"	125	196.43
9"	6 1/2"	2 3/8"	6"	2 7/16"	1 3/4"	1 5/16"	13/32"	9/16"	140	220.00

When the track on Jasper Avenue had been subjected to heavy traffic for 4 years, it became evident that the girder would not hold. The joints settled first, followed by other portions, and in 1915 it was found necessary to replace several hundred feet of the worst parts by a later design. In 1916 most of the pavement was removed and the joints blocked up.

From the fact that this kind of construction carried a fairly heavy traffic for 4 or 5 years on a partially saturated subgrade, it would seem reasonable to expect that for moderate traffic on a well drained subsoil such as gravel or coarse sand, this type would give satisfaction. In connection with the two rows of wood blocks, which insulated the bituminous pavement from the rail, it was a noticeable feature to see the block next to the soil follow the rail down 2 or 3 ins. as the girder sank, while the other block remained intact with the surface,—the two blocks sliding on each other.

Namayo Avenue Track Work

The next type to be constructed was on Namayo Ave. The loading was carried on two concrete girders, and the rails were held together by tamarac ties spaced at 2-ft. centres (see Fig. 8). The rails used were 5-in. 80-lb. A.S. C.E. sections, held together by continuous joints. After the trenches had been excavated, the skeleton track was blocked up and the base poured. In this case the track pavement was a two-course concrete slab, and it was possible to pour the track base and paving base in one operation. The top surface was added before the base had taken its initial set.

The track was constructed in 1910, but did not carry traffic until two years later. After eight years' service, the track is in good alignment and grade, but has a tendency towards ravelling on the inside and outside of the rail, and in one or two places the slab between the gauge lines has raised. It is thought that a great deal of the success of this type of construction lies in the fact that as operation did not commence until two years after construction, the concrete had every opportunity to develop considerable strength.

Type Designed in 1912

In 1912 a large program of street railway track construction was planned, and a new design was prepared, as shown in Fig. 9. The construction is somewhat similar to the Jasper Avenue type, but in order to decrease the unit pressure on the subsoil, cross-ties and cross-girders were placed at 5-ft. instead of 10-ft. centres. It was planned to use 60-lb. steel rails alternately with wooden ties, but as the steel rails were not obtainable, wooden ties were used throughout the construction. The specifications called for two bids, one for the completed 10 and 12-ft. centre tracks with a pavement wearing surface of 1:2 mortar, and a second bid for the completed tracks ready to receive a 2-in. bituminous surfacing between the gauge lines, in the devil strip and on the outside of the rails. In this latter construction, reinforced concrete rail blocks were to be constructed to form the flange clearance and act as a shoulder for the bituminous surface. On certain streets work was started late in the fall, with the result that the concrete rail blocks were caught by the frost and had to be removed. They were replaced by a concrete slab 4-ins. thick. Before this work had been down five years, the surface was badly cracked and broken up at a number of places, especially at the joints. A slight settlement in the girders was followed by a breaking up of the concrete pavement.

TABLE 3—DIMENSIONS AND WEIGHTS, TEE RAIL SECTION (SEE FIG. 6)

k	b	d	t	o	s	θ	Wt. per Yd., Lbs.	Tons per Mile, Single Track.	System.
4¼"	4¼"	2⅜"	31/64"	49/64"	17/32"	13°-00	60	94.29	A.S.C.E.
5"	5"	2½"	35/64"	⅞"	1½"	13°-00	80	125.71	A.S.C.E.
5 3/16"	5"	2 9/16"	9/16"	57/64"	1 35/64"	13°-00	85	133.57	A.S.C.E.
5⅜"	5"	2⅝"	9/16"	59/64"	1 19/32"	13°-00	90	141.43	A.S.C.E.
5¾"	5"	2⅜"	9/16"	31/32"	1 45/64"	13°-00	100	157.14	A.S.C.E.
6⅛"	6"	2⅞"	37/64"	1"	1 25/32"	13°-00	110	172.29	A.S.C.E.
6"	5"	2⅛"	11/32"	0.62"	1.2"	9°-10	60	94.29	Lorain
7"	5"	2⅛"	⅜"	0.67"	1.3"	9°-10	70	110.00	Lorain
7"	6"	2½"	7/16"	0.70"	1.3"	9°-10	80	125.71	Lorain
7"	6"	3"	17/32"	0.83"	1.4"	11°-20	95	149.29	Lorain

Track Work in 1913

In 1913 a radical change was made in the track design. It was thought that the track construction did not give sufficient bearing surface, and working towards that end, the old style of girder construction was abandoned and a 6-in. slab built completely across the track area. In case of a cut, a burm 2 ft. 10 ins. wide was usually left between the base slab in the 12-ft. centres construction, but in fill the difficulty of forming this burm offset the saving of concrete. After this base had set, the tracks were assembled and bonded. Fig 10 shows the general cross-section of the 1913 construction, with the difference that a 1-in. sand cushion was placed under each tie instead of the mortar as shown, the wood blocks were not laid on the outside of the rails, and the slab between the gauge lines was reinforced.

Some of this construction showed signs of failure after four years' usage, and the most noticeable failure occurred on Alberta Avenue where there had been constructed a double line of car-tracks, built at different times. On the south track the joints were made of ordinary 4-hole splice bars and with little or no attention paid to the spacing of the ties at the joints. On the north track, the joints were made with 4-hole continuous joints as shown in Fig. 5. Both tracks were subjected to the same traffic, yet the south track, gave way at the joints, while the north track remained in good condition.

On other streets the results were more satisfactory excepting that in some places the bituminous surfacing at the outside of the rail broke away, and in a number of places the concrete slab between the gauge lines raised, due to dirt and water finding their way under the slab, through a crack just inside the gauge lines, where the slab sheared.

The cause of failure of the slab was thought to have been partly due to the giving of the sand cushion under the tie. It would seem better practice to construct a good sound support for the ties and depend on wooden ties for resilience.

Standard for 1915-6

With the experience now obtained, the track design as shown in Fig. 10 was accepted as the standard construction for 1915 and 1916, when 2.8 miles were constructed. The 6-in. concrete base of the 1913 construction was retained, but the sand cushion was replaced by 1-inch of rammed mortar under the ties, which were shimmed up with wooden shims placed near the end of the ties. Before the filler had time to set, the concrete slab between the gauge lines was poured, precaution being taken to paint the rail with an asphaltic compound to prevent the bonding of the concrete to the rail. On the outside of the rail were placed two rows of treated wood blocks with a treated wood filler strip to fill the web. In forming a base for the two blocks, the rough filler was levelled with a mortar and painted with an asphaltic paint.

In this type of construction, the ties are supported on a rigid bearing, but the wood blocks and mastic joints leave the rail free to move up and down, to give a certain resilience to the track but without affecting the adjoining pavement.

To review the condition of the various types of track work under operation: The girder type has not held up under our conditions, especially at the joints and at street intersections. In the later designs, where the bituminous surfaces were laid against the rail, it usually ravelled, but this has been overcome by the wooden rail blocks. The biggest trouble has been caused by the flanges of the wheel cracking the concrete slab just inside the gauge line. These cracks soon became large and water found its way down under the slab, with the result that hundreds of feet of this slab had to be removed.

The results from operation on our various types of track construction have certainly demonstrated the fact that it is almost impossible to construct a permanent pavement around the tee-section of rail.

Excavation

In preparing the subgrade for a street railway track, ready to receive the concrete base, it may be possible under some conditions to take out most of the rough grade with drag scrapers but under most conditions this dirt must be hauled off the streets to some suitable dumping place in dump wagons. After the rough grade is taken out the subgrade is trimmed, leaving the loose dirt from ¾ to 1¼ ins. above the final grade, to allow for settling under the roller. All soft spots should be made firm with new material. This work may be paid for on a cubic yard basis, which will include "rough grade," "fine grading," rolling and carting of all surplus materials.

Concreting

In preparing to lay concrete, consideration should be given to the selection of material, methods of mixing, methods of placing and the care or "curing" of the green concrete.

The coarse aggregate may be obtained from well-graded gravel or a hard, tough material suitable for crushing and graded to pass a 2-in. ring. The fine aggregate may be any well-graded clean sand or crusher screenings from a durable material. Our experience has shown that "pit run" gravel—that is, a mixture of coarse and fine aggregate coming direct from the pit—has too great a variation between the percentage of fine and coarse aggregate to make good concrete, and our specifications require that "only segregated materials shall be used." The cement used should conform to the standard tests of the Engineering Institute of Canada, but may be released on passing the 7-day test.

The concrete should be mixed in some form of "batch" mixer where the materials are measured separately for each batch. It is not necessary to actually measure all the materials in a measure, but good results may be obtained by using small wheel-barrows. It is usually a good plan, however, to have a bottomless measure on hand to place over the wheel-barrow as an occasional guide to the laborer. Under no consideration should material be shovelled directly into the hopper. The mixing should continue long enough and with sufficient water to ensure that all the particles have been coated with a cement film. Excess water should be avoided so that the concrete will leave the mixer in as stiff a condition as it can be conveniently handled.

In placing concrete on the subgrade, some engineers recommend the use of "open chutes," or the "boom and bucket" method, but our experience on street railway work has shown that good concrete can be laid with dump carts, provided the concrete is raked or shovelled into place after it has been dumped. In placing the filler concrete between the tracks in the 1916 standard construction, a special gangway was built which enabled the carts to be backed out over the first track to fill in both tracks in one operation.

In hot weather the surface of the green concrete should be kept moist by sprinkling with a hose, and, after a day or so, covering with earth. The covering should be kept moist for at least two weeks. To get good concrete it must be protected from the drying out effect of the sun and wind, and more especially will this be true in countries of high altitude where the rate of evaporation is high.

Maintenance

The question of who should maintain the pavement on the street railway allowance has received a great deal of attention, and usually it is required that the street railway company should keep the pavement on the railway allowance in good repair. In the city of Strathcona, prior to its amalgamation with the city of Edmonton, the street railway department paved and maintained a strip 8 ft. wide over a single track, the remainder of the cost being assessed on the abutting property. In Edmonton the abutting property is assessed for the pavement on the street railway allowance.

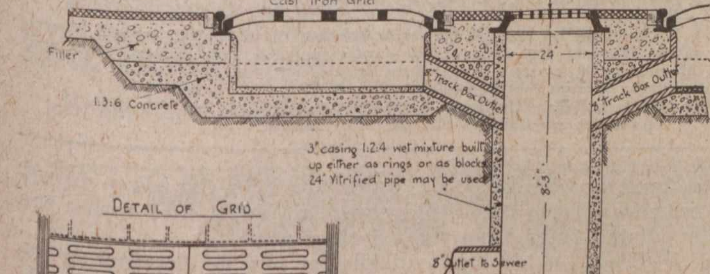


FIG. 12—TRACK BOX PREVIOUS TO 1915

The railway department usually constructs the completed permanent track and is reimbursed for the pavement at the same rate per square yard as the contract price of the adjoining pavement. The most common practice is to require the street railway company to construct and maintain a pavement equal to that on the adjoining roadway, the limits of the street railway allowance being defined by the area covered by the overhang of the cars or by some given distance, such as 18 ins. or 24 ins., outside the outer rail.

During 1913, when a large program of permanent track construction was carried out, several miles of track were constructed on streets where the adjacent roadways were not paved. Traffic kept to the paved strip, with the result that, from the mud and concentrated traffic, the bituminous surface in the devil-strip soon developed holes and ruts. In this case the city commissioners decided that the street railway department should pay one-third of the cost of maintenance, and the street department the other two-thirds.

Pavement replacements or repairs may usually be carried out without interruption to traffic, but when the track base gives way, considerable difficulty may be experienced in making repairs. The method that has been adopted in Edmonton is as follows:—

Where a track has settled, the pavement is first removed and piled in a convenient place, and the rails and ties are cut free from the concrete base and jacked up on runners

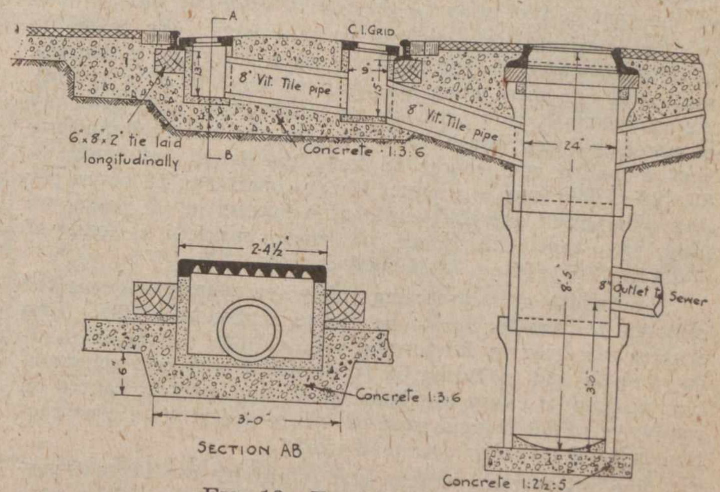


FIG. 13—TRACK BOX, 1915

made of 6 by 6-in. timber of various lengths. The subgrade, having been cleared of the old base, is then refilled and tamped with a suitable material, and the new concrete base is poured. When this has set sufficiently, the track is shimmed up onto the base, the runners removed and concrete filled up to the pavement line.

Edmonton has taken up a large area of bituminous pavement in recent years, and it has been found that by heating this on a plate of sheet-iron and mixing whilst hot, the retempered material gives satisfaction as a new surface.

Special Work

Special work is the specially designed parts of a system of tracks which will enable cars to turn corners, or cross over from one track to another. This is made possible by various combinations of switches, mates, frogs, crossings and curves arranged to make connection between the different tracks. In deciding a layout for any location, the points to be considered are: (1) The kind of car traffic (i.e., to make provision for regular and special car routing); (2) amount of car traffic; (3) width of roadway and location of curbs, poles, hydrants and man-holes with a view to clearance.

In addition to the regular curves at a corner, a second curve or cut-off taking the form of a Y-shaped combination is often installed, which, in addition to taking care of all possible car routings, may be used in turning single-end cars.

The amount of car traffic over a special, in most cases should be measured, and is used in deciding on the class of material that will be put into the special pieces.

In striking radii for a double-track curve, it is a very good practice to use radii which will throw the tracks apart on the curves, thus providing car clearance.

It is possible that the number of standard intersections in use in Edmonton could be reduced. By standardizing the sections throughout with standard switch pieces, mates and frogs, the cost of office work would be greatly reduced, and the accumulation of a large number of half-worn pieces of special work, ordered for some particular location, would be eliminated.

Pieces of special work are made by building up standard sections with cast-iron fillers, or cast-steel bodies with special inserts such as manganese steel, or all cast manganese steel.

A very common form of special work is made from rolled steel body with some hard, tough material (like manganese steel) inserts placed at the point of maximum work. These inserts are usually keyed in place with some form of spelter which may be easily removed from the surface without disturbing the pavement.

Special pieces of solid cast steel, or rail sections held in place with solid cast-steel joints, are often built. The solid cast pieces are made of open-hearth cast steel, and of manganese steel, and for important intersections it is good practice to use solid cast-manganese steel throughout. Pieces of the cast-in type may be considered only for light traffic.

In comparing the life of special work, car traffic is usually estimated in tons per hour when referring to density, and total car tons when speaking of the life of a special. As an example, cars crossing an intersection with headway of three minutes would mean 20 cars per hour. Supposing that a loaded car weighs 25 tons, the density of traffic is $25 \times 20 = 500$ tons per hour. If cars operating 18 hours per day will pound out the points of a special in 10 years, we may say that this piece of work carried a load of $500 \times 18 \times 365 \times 10 = 32{,}850{,}000$ car tons.

The width of intersecting roadways usually governs the distance the tracks are to be placed centre to centre. Two centres are used in Edmonton, viz., a 10-ft. centre on roadways up to and including 56 ft. or where side-pole construction is used to carry overhead work, and a 12-ft. centre on roadways of 56 ft. and over or where centre pole construction is used to carry overhead work.

The intersecting tracks are joined by the largest possible curve which will give sufficient clearance at the curb intersection, and at all poles, hydrants and man-holes. The simplest form would be a curve with one radius, but with the development of faster operation, it has been found desirable to work up to the central curve with a gradually increasing curve. A similar result may be obtained by compounding the curve, starting with a longer radius and working up to the shorter radius at the central curve.

In later special work it has become a common practice to pick up the wheel on its flange and ride it over the groove of the intersecting track, letting it down on the ball of the rail a few feet from the intersection. This is accomplished by gradually reducing the flange depth until the wheel rides clear at the intersection. The effect is to greatly reduce the pounding caused by the wheel bumping across the groove of the intersecting rail, adding to the comfort of the passengers and extending the life of the rolling stock and special work.

The United States government has not yet accepted any of the offers made for the large factory erected for it at Leaside, Ont., during the last few months of the war. Among offers that are being seriously considered is one from the Willys-Overland Motor Car Co. J. G. Perrin, assistant general manager of that company, states that should their offer be accepted, the building will be taken down and re-erected in West Toronto.

According to reports in the Montreal daily newspapers, the city of Montreal has agreed to pay a salary of $10,000 per annum to each of three engineers who are to serve on a board to supervise the completion of the Montreal aqueduct. The engineers appointed to this board are R. S. Lea, Walter J. Francis and A. E. Doucet. Mr. Doucet is city engineer of Montreal; Mr. Francis and Mr. Lea are prominent consulting engineers of that city. The aqueduct is to be finished in accordance with a report recently made by Mr. Lea to the Administrative Commission. It is understood that these three engineers will devote two-thirds of their time, or 200 days a year, to this work. The cost of building the aqueduct is estimated at $1,683,000; of the new pumping plant, $850,000; and of the addition to the filtration plant, $2,000,000.

DEVELOPMENT OF WATER-POWER

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

UTILIZATION of water-power in Canada is advancing even more rapidly than heretofore. During 1919, the installation of plants with a total of 64,400 h.p. was completed in various portions of the Dominion; the developments at present under construction or in process of installation aggregate over 470,000 h.p. Other projects definitely contemplated for the near future will add 750,000 h.p.

Among the more notable developments are the 300,000-h.p. Chippawa plant of the Ontario Hydro-Electric Power Commission, now under construction, to utilize the full head of Niagara power, and the impetus given by the Quebec government to the conservation of water by storage. Much activity is also to be noted in the Maritime Provinces.

This rapid progress, which represents industrial growth of the most valuable character, should be encouraged, yet most carefully guided. In the United States, electrical installations have doubled every five years while, in Canada, the present hydro-electric installation is about ten times that of 1900. The present hydraulic installation in the Dominion is nearly 2,400,000 h.p. If we assume for this country only one-half the rate of increase recorded for the United States, a total of 4,800,000 h.p. will have been developed 10 years hence, and 9,600,000 h.p. 20 years hence, if available.

The resources actually available to meet future demands are indicated in the accompanying table of the estimated developed and undeveloped water-power in Canada. An attempt has been made to separate available sites within the populated areas from those farther north.

Available Water-Powers in Canada.

Province or District.	Estimated total possible h.p.	Available in populated area, h.p.*
Maritime Provinces ..	403,000	354,300
Quebec	6,000,000†	2,600,000
Ontario	5,800,000	2,800,000
Prairie Provinces ...	3,379,000	653,860
British Columbia ...	3,000,000	990,000
Yukon and Territories	150,000	‡
Total	18,832,000	7,398,160

*Minimum all year power, with possible regulated flow where investigated. Figures for some of the rivers included may vary as additional information is secured from future detailed surveys, flow records and conservation storage investigations.
†Not including Ungava. 5,000,000 h.p. south of the 50th parallel.
‡Available possibilities not definitely known.

The 7,398,160 h.p. available for new development in the populated area is derived from an estimated total possible of 9,781,400 h.p., of which 2,383,240 h.p. has already been developed.

Under the rate of growth assumed, all the available water-powers within the populated portion would be developed in twenty years. It is self-evident, however, that, as new development becomes dependent on less accessible sites, it will proceed much more slowly.

F. M. Dawson read an interesting paper on "Some Investigations of Cement Under a Grant from the Advisory Council," at a recent meeting of the Engineering Institute's Montreal Branch. Discussing the paper, A. C. Tagge, general superintendent of the Canada Cement Co., Ltd., spoke of the interest that cement companies are taking in any development, such as super-cement, which might benefit their customers. A. D. Swan, consulting engineer, said that there is great need for improvement in cement for use in marine work. J. A. Jamieson, consulting engineer, stated that such researches such as those undertaken by Mr. Dawson are of great value to the engineering profession.

DRAINAGE OF EXHIBITION PARK, TORONTO

By Reginald B. Evans
Engineer, Parks Department, Toronto

EXHIBITION PARK, Toronto, comprises 235 acres of land extending along the north shore of Lake Ontario for a distance of 1½ miles, with an average width of 1,500 ft. The land rises abruptly from the water's edge for 15 ft., and then extends northward practically level for 500 ft.

This flat piece of land is of stiff clay, and for years was wet and covered with long, coarse grass. Level land is not the easiest land to drain, and although there was no marsh there, yet the grass held the water and it was always wet. This level area includes the Midway, the half-mile ring, the Manufacturers' building (the largest building on the grounds), and the Transportation building.

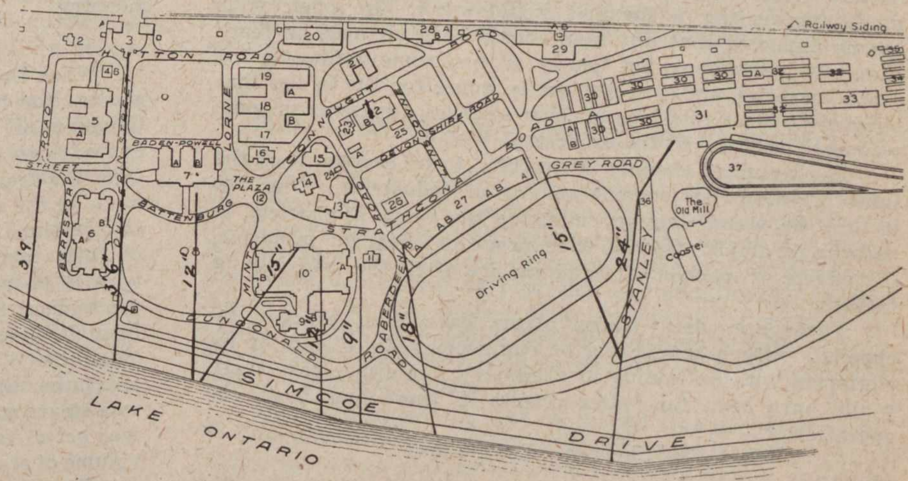
The writer well remembers staking out the Transportation building in water from 2 to 3 ins. deep, and grass at least 3 ft. high. The magnifying glass used in turning off the angles on the transit was dropped, and it was some work to find it in the long grass.

The whole exhibition grew like Topsy, as the march of events demanded, the Manufacturers' building being the first structure of any size on this badly drained land. The old plans show that a system of farm tile was laid over this site before commencing construction. The Transportation building was raised high and dry on an embankment, but shortly after this building was erected, roads were graded towards the lake and paved, catch basins and sewers were built, and no water was held on this flat.

Farther east, on the midway section, the same difficulty was encountered. A heavy rain simply flooded the area, and if this occurred during exhibition, tanbark had to be hauled to make paths, and even then it was a common sight to see people wading ankle-deep in water, tanbark and mud to see the attractions in the various shows. The half-mile ring and ball field are practically level, and up to the present have not been sufficiently drained.

Until about ten years ago drains were put in for each new building as required, but no general system was planned to take care of the grounds as a whole. At that time a 15-in. pipe was laid from the east end of the grandstand across the ring and connected up with all nearby drains. Only a few years passed before this drain was found to be quite inadequate, and a little farther east a 24-in. pipe was laid from the lake up, diverging and branching with smaller pipes to the stables and newly paved roads. At the west end of the grandstand an 18-in. pipe was also laid to the lake and found to be none too large on a day when 150,000 people are being cared for, to say nothing of storm water should there be rain. Immediately west of this, at the east end of the Manufacturers' building, is a 9-in. pipe; under the building, a 12-in. and a 15-in. pipe; and a little to the west, and going up to the Horticultural building, is a 12-in. pipe.

The main parts of the grounds being paved, and the roofs of buildings shedding water so quickly, necessitated large pipes being installed. The old city sewer on Dufferin St., 3 ft. 6 ins. by 2 ft. 6 ins., and a similar one on Dominion St., amply take care of the greenhouses as well as adjacent property not high enough to drain into the main city sewer on Springhurst Ave.

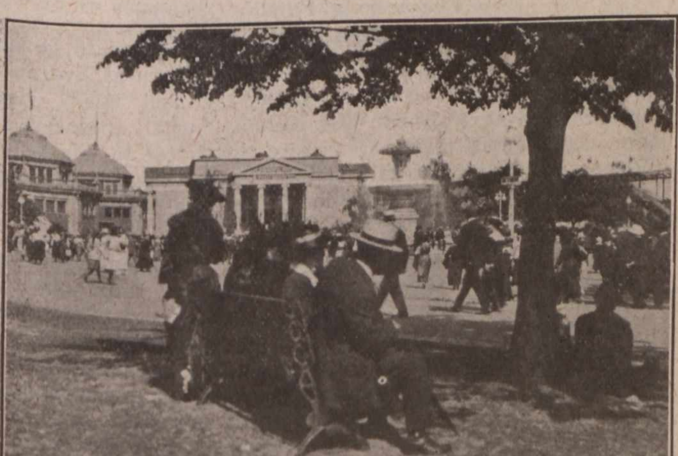


Plan of Grounds and Buildings, Exhibition Park, Toronto, Showing Location and Size of Drains

Key to Numbers of Principal Structures: (3) Dufferin Gate, (5) Government Bldg., (6) Transportation Bldg., (7) Horticultural Bldg., (9) Woman's Bldg., (10) Manufacturers' Bldg., (18) Industrial Bldg., (20) Machinery Hall, (27) Grandstand, (36) Midway, (A and B) Lavatories.

In designing a system of sewers, more care is needed to anticipate future growth than for most engineering undertakings, even water works or lighting, as duplicate sewers are very costly, and it is sometimes difficult to lay a second sewer on a narrow street already encumbered underground with many private drains and water pipes.

At a park like Exhibition Park, where a large number of people congregate for a short time, all supply pipes and drains should be built with large capacity. A few years ago the people living near this park found their gas supply cut off at noon, and nobody could account for it until it was discovered that the restaurants at the exhibition were using all that the main could supply. Fountains and lavatories work to their utmost capacity, and hose run all night for at least two weeks before the exhibition opens, to bring the grass and flowers to perfection. Care must be taken to have all commodities supplied to almost every corner of the grounds, and in convenient places. Plans and profiles must be kept of all underground wires, and of gas, water and sewer pipes, as rush orders are often received to drain a sink in a new tent, or to supply its users with light, heat and water.



Typical Scene, Exhibition Park, Toronto

Plans for the establishment of a national research institute were placed before the Scientific Research Committee of the House of Commons last Monday, with the recommendation that a site of at least 50 acres should be secured near Ottawa, and that a four-storey laboratory, costing $600,000, should be erected and equipped with scientific instruments costing at least $100,000. Salaries for staff would require an appropriation of about $100,000 per annum. This institute would be similar to the Bureau of Standards in Washington or the Mellon Institute in Pittsburgh.

CHEMISTRY AND ENGINEERING*

By T. Linsey Crossley
Consulting Chemist, Toronto

In the industrial applications of chemistry to-day a problem becomes a matter of engineering as soon as it leaves the laboratory, and even before that its engineering features must be studied. On the other hand, many things that appear to be purely matters of engineering depend for their success on due attention to the chemical composition of the materials used.

The question resolves itself somewhat into a discussion of how much chemistry an engineer should know, or how much engineering a chemist should know. In music it is hardly expected that any man should be a virtuoso on more than one instrument, but nearly all find some ability on the piano essential, and it might not be going too far to say that chemistry, in its relations to other sciences, functions in some ways as the piano to the orchestra.

The technical chemist is expected to be cognizant of the inner workings of a great variety of industries. One day it may be steam laundry trouble; the next, a problem in embalming fluids. In the wide range of chemical problems, the effects of mechanical handling are often the determining factors.

There are cases where plants have been erected by chemists with a smattering of engineering knowledge or by engineers with an inkling of chemistry. In either case there would have been far better results if there had been co-operation.

No Chemist,—Lost Client

In Canada, until quite recently, the engineer has not sought freely the co-operation of the chemist, and this is possibly a factor in the situation to-day in at least one of our great industries, whereby the financial backing for new mills of that industry has engaged engineering firms outside of Canada for their construction.

In an article entitled, "Lessons for Chemical Engineers in Other Industries," read at the Savannah Meeting of the American Institute of Chemical Engineers, December, 1919, by A. E. Marshall, there is a suggestive statement referring to war-time quantity production, as follows:—

"Some chemical plants built within the last five years will find it difficult to make extensions which permit of a lowered cost of production, or even a cost equal to the original plant, for reasons such as lack of strength in the building structure preventing the employment of monorail cranes or similar mechanism to convey supplies of raw materials from the original storage bins or piles to the new extensions. Time can more profitably be spent in designing the present to suit the future than in trying to add in the future to a completed unit which has no outlets for expansion."

The handling of raw materials for the chemical industry to-day is essentially an engineering problem. One little instance of this I noted recently was the handling of 4,000,000 case of soy-bean oil in one lot from ship to cars at a Pacific port. Perhaps some engineers don't know what soy-bean oil is. If we followed that oil to its various destinations we would find still more problems in chemistry and engineering. It is used in foodstuffs, soap, paints and varnishes.

Special Quebec Bridge Paint

Paints are to the engineer like the poor, in that he always has them to provide for. The life of great structures like the Quebec bridge depend on the protection of their members from the effects of weather. A special paint was made up for the Quebec bridge, and it would be interesting to have some report of its service.

Two outstanding feats of chemical engineering bear on the remark as to the amount of engineering knowledge a chemist should have. One of these was Gayley's accomplishment of the task of removing water from the air used in blast furnaces. The little problem he tackled was the removal of moisture from 40,000 cu. ft. of air per minute, and he did it. It took him 18 years, of which 5 years were spent in obtaining reliable data as to the moisture content of the air all day and every day for that time. He found that 40,000 cu. ft. of air per minute contained all the way from 73 gals. of water per hour in February, to 237 gals. per hour in June. Fourteen years after starting he asked for $100,000 to make an installation, and found that 9% more ore and flux could be handled with no more fuel, and in six months' time a regular economy of 15% was obtained, and 20% had been found possible. The outcome of Gayley's work was a saving of about $25,000,000 annually to the American iron and steel industry.

A 3,000-H.P. Experiment

When Dr. Frasch, chemist of the Standard Oil Co. (whose process for taking sulphur out of petroleum oils made the Canadian oil industry and raised the Standard Oil dividends from 7% to 40% on a $100,000,000 capital, and the value of Ohio Oil from 14c. to $1 per barrel), wanted to do a little work on the side, he took in the underground sulphur deposits of Louisiana. First he bought the property. That was act of faith number one. Then he drilled a well to the rock, with a 10-in. pipe, and continued through the sulphur deposit about 200 ft. with a 9-in. drill, and sunk a 6-in. pipe from the surface to the bottom, and put a 3-in. pipe inside the 6-in. pipe. After taking some precautionary measures, the well was ready for the melting fluid, which was steam superheated to 335 degs. F. Putting down the well was act of faith number two; and finally, to get the required volume of steam at 100 lbs., he installed twenty 150-h.p. boilers! Dr. Frasch notes that this was "experimentation on a ponderous scale." All this was done without any precedent, relying only on the fact that sulphur melts at about 250 degs. F. Dr. Frasch pumped sulphur so readily out of that well that he could have undersold Sicilian sulphur in Italy.

I have cited these two classic cases to illustrate the great posibilities of chemical engineering. Perhaps these men might be called engineering chemists instead of chemical engineers, but it only shows how little words mean. If we had union principles applied to engineering, it might have been contrary to regulations for those chemists to practice engineering.

Engineering and chemistry are so involved in all cosmic activities that there is scarcely any line of human endeavor that does not call for men who have given special attention to the particular case.

The Engineering Family Growing

The engineering family is growing. It used to be just civil and military. Now it is mechanical, electrical, hydraulic, sanitary, chemical and many other "ics" and "als." Soon there will be agricultural, and possibly burial, engineers. I once heard a mill manager dictate this letter to his tailor: "Please build another suit in navy serge, the same as the last one you constructed for me." So it is possible that we shall have tailoring engineers.

There is a need for co-operation between engineers and chemists in the inception of new plants, and throughout the consideration of layout. There is a pronounced tendency on the part of interests putting up new plant or extensions, to engage the contractor who erected their previous plant, who makes no corrections from experience of operation, and the frequent result is the perpetuation of unsatisfactory conditions. In the interests of conservation of labor and material, it seems advisable that no plant should be erected without co-operation of engineers and chemists, even in cases where processes are either essentially chemical or essentially engineering.

In large structural work such as bridges, where the life of the structure depends in large measure on its protection from weather, careful field tests of paints should be made in the actual locality, and the shop coats should be specified only after the field coat is decided upon.

*Excerpts from paper read recently before the Toronto branch of the Engineering Institute of Canada.

In the field of lubrication there may be interesting developments at any time as we study the relations between molecules and their physical effects. How great a part does viscosity play? or the chemical composition of lubricants? We have been accustomed to think that there should be no free fatty acids in lubricants, as they might tend to corrode the metal. We are now informed that small amounts of free fatty acids are much more effective than large amounts of the neutral oils from which they are separated. Roughly the coefficient of friction is lower with, say, 99% mineral oil and 1% fatty acid than with 40% mineral oil and 60% neutral vegetable oil. These figures are illustrative, not exact.

As an illustration of the importance of comparatively simple things, there is the case of flotation in the mineral industry. A recent writer has pointed out that 60,000,000 tons of ore are treated annually by the application of the forces in soap bubbles.

My attention has recently been called to a case where complaint was made that a mill effluent caused foaming in the water of a stream, and that this foam, becoming frozen, interfered with the generation of power at a plant downstream.

Frequently owners choose architects and contractors and leave the employment of engineers or chemists at their option, with no provision made for the latter in the estimates. In some cases an engineer is appointed, but I cannot recall any large piece of structural work for which a consulting chemist was appointed at the outset. I believe many cases in which the engineer's advice has been overridden by the better interests of the owner if the engineer had had a fellow-scientist to support him.

PRACTICAL TRAINING FOR ENGINEERING STUDENTS

CANADIAN engineers who are concerned with educational work will be much interested in the details of the new plan for industrial training that will be adopted next June at the Harvard Engineering School, in Cambridge, Mass. The first two years of any engineering course at Harvard will be substantially the same as at any other university excepting that there will be no differentiation between mechanical, civil and electrical engineers, and the students will not be segregated—either in their classes or in their social relations—from the other undergraduates at Harvard, thereby escaping the narrowing influence of an exclusive association with other engineering students. They will be required to take certain courses in mathematics and pure science but will have the opportunity of obtaining as broad an education as students of their class in any other course. The work of the senior year will also be carried out along the usual lines.

Combined engineering study and work in industries will start in June of the sophomore year and last until October at the beginning of the senior year. During those 16 months the class will be divided into two equal sections, which will alternate from study to industrial experience at two-month intervals, with one vacation period for which the ambitious student may substitute industrial work. Those students who take the regular offering will get eight months of study (which is the actual study time at present) and six months of experience in the industries; those who so desire may have eight months in the industries. There will be a continuous supply of students to the industries and continuous instruction in the school. Courses given within this period will have to be duplicated.

The scheme outlined above will be optional, but the present indications are that it will be elected by practically all students in the school. It adapts itself well to graduates in arts or sciences from Harvard or other colleges who enter the third year of the engineering school, even if they enter in August or as late as October.

The co-operation with the industries will be under a director who will arrange with the industries for placing the students at such work as will give them the best opportunities for experience. The students will receive the same pay as other workmen doing similar work, and will be treated by the industries like other workmen except that the director of co-operation will have freedom of access to each student at any time, and will be permitted to arrange the general character of his work. The director will meet groups of the students in the evenings during their industrial period to discuss with them their problems and experience.

Each student will be given a syllabus of questions relating to the type of work which he is doing, the answering of which will require him to observe closely not only the technical processes which he himself is carrying out, but also the whole system of management of the factory, and such general technical details as he may have opportunity to observe. The syllabus will also require him to apply to his observations the engineering theory acquired during his studies.

HAMILTON CONTROLLERS RECOMMEND FILL

ALTHOUGH E. R. Gray, city engineer of Hamilton, Ont., recommends the construction of a bridge instead of a fill to carry the Toronto-Hamilton highway across the Valley Inn ravine at the western entrance to the city of Hamilton, the Board of Control of that city has unanimously recommended to the city council that the ravine be spanned by means of a fill, at a cost of $280,000, compared with $1,226,590 estimated cost of a steel bridge or $1,419,100 estimated cost of a concrete bridge.

The estimate of the cost of the fill was prepared by E. H. Cummiford, chief engineer of the Toronto-Hamilton Highway Commission, and includes the following items: Grading, $100,000; bridge, $35,000; hand rail, $10,000; share of overhead bridge, $9,000; rip-rap, $5,000; tile in cut, $12,000; right of way, $45,000; pavement, $25,000; pavement from city line to high level bridge, $25,000; extra width of pavement from Waterdown to the high level bridge, $14,000; total $280,000.

In his report on the advisability of constructing a bridge, Mr. Gray discussed the fill proposition as follows:—

"Considerable support has been given a fill proposal, because it offers a less expensive and perhaps a more expeditious solution to the entrance problem.

"I desire merely to point out that while this suggestion in a measure reduces the sharp curvature and lessens the depth of the ravine; the rise to the high level from the level of the roadway on the fill is still approximately 50 ft., and the grade is improved something less than 2%.

"In addition, subsidence, and settlement of the fill for years would prevent the construction of a permanent pavement. It will be necessary also to reconstruct the bridge over the Grand Trunk and C.P.R., and the structure at the existing subway below the Grand Trunk, the estimated cost of which should be included in any estimate presented for comparison. I am of the opinion that the city of Hamilton is worthy of a more fitting entrance even at the expense of some delay, in order to secure what ultimately will be the best solution of this problem."

The nominating committee of the American Water Works Association has unaminously named the following candidates to hold office for the ensuing year: President, Beekman C. Little, superintendent of water works, Rochester, N.Y.; vice-president, Col. Edward Bartow, director of state water survey, Urbana, Ill.; treasurer, J. Water Ackerman, superintendent of the water board, Auburn, N.Y. By direct action of some of the members of the association, additional nominations have been filed, as follows: President, Capt. M. L. Worrell, Meridian, Miss.; vice-president, W. S. Cramer, chief engineer, Water Works Co., Lexington, Ky.; treasurer, J. M. Caird, chemist and bacteriologist, Troy, N.Y. Capt. Worrell is now vice-president of the association, Mr. Caird is treasurer, Messrs. Little and Cramer are trustees whose terms expire this year, and Mr. Ackerman is a member of the finance committee.

Recent Publications

CONCRETE HIGHWAY GRADE CROSSINGS.—Pamphlet issued by the Portland Cement Association, Chicago; 8 pages, 6 by 9 ins.

CONCRETE STREETS FOR YOUR TOWN.—Booklet, 24 pages, 6 by 9 ins., published by the Portland Cement Association, Chicago.

ONCE IN A BLUE MOON.—Pamphlet issued by the Barber Asphalt Paving Co., Philadelphia, Pa., descriptive of Iroquois road rollers.

CONCRETE CHIMNEYS.—Well illustrated booklet, 20 pages, 6 by 9 ins., published by the Portland Cement Association, Chicago.

CITY OF SASKATOON, ANNUAL REPORT.—For the year 1919; 72 pages and paper cover, 7 by 10¼ ins. C. J. Yorath, city commissioner.

HEAT INSULATION.—Catalogue, 78 pages and paper cover, 8 by 11 ins., published by the Franklin Manufacturing Co., Franklin, Pa.

TESTING OF TIMEPIECES AT THE LABORATORY OF THE DOMINION LAND SURVEYS.—Report, 16 pages and paper cover, 6½ by 9½ ins.

TIFFIN MOTOR TRUCKS.—Sixteen-page pamphlet, in two colors, published by the Tiffin Wagon Co., Tiffin, O., descriptive of Tiffin motor trucks.

PRACTICAL OIL GEOLOGY.—By Dorsey Hager; published by the McGraw-Hill Book Co., Inc., New York; 252 pages and flexible cover, 4¾ by 7¼ ins.

USEFUL DATA.—Catalogue issued by the Corrugated Bar Co., Inc., Mutual Life Bldg., Buffalo, N.Y.; 224 pages and limp leather cover, 5¼ by 7¾ ins.

PRECAUTIONS FOR CONCRETE PAVEMENT CONSTRUCTION IN COLD WEATHER.—Pamphlet issued by the Portland Cement Association Chicago; 8 pages, 6 by 9 ins.

ANNUAL REPORT, DEPARTMENT OF PUBLIC HIGHWAYS, ONTARIO.—For the year 1918; published by the King's Printer; 80 pages and paper cover, 6½ by 8¾ ins.

PAPER MAKING AND ITS MACHINERY.—By T. W. Chalmers; 180 pages and cloth cover, 7¼ by 11 ins.; published by Constable & Co., Ltd., London, Eng.; price, 26s.

PRACTICAL ELECTRIC WELDING.—By H. Bevan Swift; 104 pages and stiff cloth cover, 5¼ by 8½ ins., published by E. & F. N. Spon, Ltd., London, Eng.; 66 illustrations.

RIC-WIL SECTIONAL VITRIFIED TILE CONDUIT.—Bulletin No. 1 issued by the Ric-Wil Co., Cleveland, O.; 8 pages, 8 by 10¾ ins.; coated paper, well illustrated in two colors.

SEWAGE DISPOSAL FOR THE COUNTRY HOME.—By L. J. Smith, professor of agricultural engineering, Manitoba Agricultural College, Winnipeg; 24 pages, 6 by 8¾ ins.

COAL CONSUMPTION OF POWER PLANTS.—By R. H. Parsons. Published by the Electrical Review, Ltd., London, Eng.; 24 pages and paper cover, 5½ by 8½ ins.; price, 1s.

ANNUAL REPORT, EXPLOSIVES DIVISION, DEPARTMENT OF MINES.—By Lt.-Col. G. Ogilvie; 46 pages and paper cover, 6½ by 9¾ ins.; published by the King's Printer, Ottawa.

MANUAL OF HYDRAULIC ENGINEERING INSTRUMENTS.—Catalogue, 140 pages and cloth cover, 6 by 9 ins.; coated paper, well illustrated; issued by W. & L. E. Gurley, Troy, N.Y.

CORONA DISCHARGE.—By E. H. Warner and Jakob Kunz. Bulletin No. 114 of the Engineering Experiment Station, University of Illinois; 134 pages and paper cover; 6 by 9 ins.; price, 75c.

W-C-K CITY.—Pamphlet published by Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York, showing a mass photograph of over one hundred structures recently built by that firm.

THEORY AND PRACTICE OF AEROPLANE DESIGN.—By S. T. G. Andrews and S. F. Benson. Published by Chapman & Hall, Ltd., London, Eng.; 450 pages and cloth cover, 5½ by 8½ ins.; price, 15/6.

SAFE TRANSPORT.—Pamphlet describing boxes for transportation of tubed media for the bacterial analysis of water and sewage; issued by Wallace & Tiernan Co., Inc., 349 Broadway, New York.

MANUFACTURE OF ETHYL ALCOHOL FROM WOOD WASTE.—Bulletin No. 7 of the Honorary Advisory Council for Scientific and Industrial Research, Ottawa; 10 pages and paper cover, 6½ by 9¾ ins.

ANNUAL REPORT, DEPARTMENT OF HIGHWAYS, SASKATCHEWAN.—For the fiscal year ended April 30th, 1919; 92 pages and paper cover, 6¾ by 10 ins. Samuel J. Latta, Minister of Highways, Regina, Sask.

TESTS ON THE HOLDING POWER OF RAILROAD SPIKES.—By A. H. Beyer and W. J. Krefeld. Bulletin No. 1, Department of Civil Engineering, Columbia University, New York; 54 pages and paper cover, 6 by 9 ins.

ALL'S WELL.—Brochure, 16 pages, 3¼ by 6¼ ins., well illustrated, printed on coated paper in two colors. Describes Toncan metal roofing, shingles, sheets, etc.; issued by the Stark Rolling Mill Co., Canton, Ohio.

EFFECT OF VIBRATION, JIGGING AND PRESSURE ON FRESH CONCRETE.—By Duff A. Abrams, professor in charge of Structural Materials Research Laboratory, Lewis Institute, Chicago; 24 pages and paper cover, 6 by 9 ins.

WIRE ROPE AND FITTINGS.—Catalogue issued by the Canada Wire Iron Goods Co., Hamilton, Ont.; well illustrated; contains considerable information about wire rope of every description up to 2 ins. diameter.

TIDE TABLES.—For the eastern coasts of Canada for the year 1920; by Dr. W. Bell Dawson, superintendent, Tidal and Current Survey, Department of the Naval Service, Ottawa; 68 pages and paper cover, 6½ by 9½ ins.

EFFECT OF FINENESS OF CEMENT.—By Duff A. Abrams, professor in charge, Structural Materials Research Laboratory, Lewis Institute, Chicago. Bulletin No. 4, issued by the laboratory; 82 pages and paper cover, 6 by 9 ins.

CONCRETE PIPE.—Booklet, 8 pages and paper cover, two colors, 8½ by 11 ins., descriptive of culvert pipe, drain tile, pressure pipe and sewer pipe; issued by the American Concrete Pipe Association, 210 South Lasalle St., Chicago.

ANNUAL REPORT, ONTARIO DEPARTMENT OF PUBLIC HIGHWAYS.—For the year 1918; published by the King's Printer, Parliament Buildings, Toronto; 80 pages and paper cover; 6½ by 9⅝ ins.; coated paper; illustrated with several half tones.

HYDRA TOOL STEELS.—Catalogue, 46 pages and stiff cloth cover, 6 by 8 ins., printed on book paper in two colors and illustrated with original photographic prints pasted in place; published by Hall & Pickles, Ltd., 64 Port St., Manchester, Eng.

STANDARD PAVEMENT ASPHALT TIME TABLE.—Pamphlet issued by the Barber Asphalt Paving Co., Philadelphia, Pa., tabulating the kinds of asphalt in existence in Buffalo and New York from 1879 to 1919; also giving maintenance costs for Washington, D.C.

THE ORIFICE AS A MEANS FOR MEASURING THE FLOW OF WATER THROUGH A PIPE.—By R. E. Davis and Harvey H. Jordan. Bulletin No. 109 Engineering Experiment Station, University of Illinois, Urbana, Ill.; 56 pages and paper cover, 6 by 9 ins.; price, 25c.

JEFFREY 34-B ENTRY DRIVER.—Catalogue No. 269 published by the Jeffrey Manufacturing Co., Columbus, O.; 16 pages and cover, 7½ by 10½ ins., printed on coated paper, well illustrated; describing the Jeffrey entry-driving machine for mining and loading without the use of powder.

LIQUID CHLORINE.—Illustrated catalogue, 18 pages and embossed cover, 5 by 8 ins., published by the Electro-Bleaching Gas Co., 18 East 41st St., New York. Describes liquid chlorine, how it is shipped and its uses in water sterilization, textile bleaching, paper bleaching, etc.

MODULUS OF ELASTICITY OF CONCRETE.—By Stanton Walker, associate engineer, Structural Materials Research Laboratory, Lewis Institute, Chicago; 92 pages and paper cover, 6 by 9 ins.; with an appendix on the flexure of reinforced concrete beams.

POWER IN ALBERTA.—Booklet, 32 pages and paper cover, 6½ by 9¾ ins., published by the Commission of Conservation, Ottawa, descriptive of water, coal and natural gas resources of Alberta; by James White, assistant to the chairman, Commission of Conservation.

BOSS LABOR-SAVING CONSTRUCTION MACHINERY.—Catalogue, 64 pages and paper cover, 8½ by 11 ins., published by the American Cement Machine Co., Inc., Keokuk, Iowa; printed on coated paper, profusely illustrated; descriptive of concrete mixers, hoists back fillers, pumps, saw rigs and carts.

JEFFREY SHREDDERS.—Catalogue No. 259, published by the Jeffrey Mfg. Co., Columbus, O., and Montreal, Que., 36 pages and paper cover, 6 by 9 ins., printed on coated paper, well illustrated. Describes Jeffrey type "E" swing hammer shredder for reducing wood chips, bark and other fibrous materials.

CULVERT REFERENCE BOOK.—Engineering tables and other information relating to Pedlar's Toncan-Metal Culverts are contained in the "Culvert Reference Book No. 6C" issued by the Pedlar People, Ltd., Oshawa; 24 pages and cover, 6 by 9½ ins.; printed on coated paper; well illustrated.

AUTOMATIC DISCHARGE COUNTER.—Pamphlet describing apparatus for recording the number of fillings of any tank such as water tank, flush tank, syphon chamber, chemical solution tank, etc.; also for recording application of sewage from dosing chambers to sprinkling filters or contact beds. Published by Wallace & Tiernan Co., Inc., 349 Broadway, New York.

HIGH EFFICIENCY CENTRIFUGAL PUMPS.—Pamphlet, 8 pages and paper cover, 8¼ by 10¾ ins., published by the De Laval Steam Turbine Co., Trenton, N.J. Describes official tests made by the cities of Minneapolis and St. Paul upon De Laval centrifugal pumps. The Minneapolis pump showed a combined efficiency of motor and pump of about 82½%, and a pump efficiency of 86%.

PONT-A-MOUSSON.—Published by the Société Anonyme des Hauts Fourneaux et Finderies de Pont-a-Mousson, Paris, France. Published in French; 240 pages and leather cover, 3¼ by 5½ ins. This booklet is in two parts, the first being a catalogue of products, including flange pipe, bell and spigot pipe, drain pipe, bends, pipe fittings, manhole covers, etc. The second part of the booklet is a collection of useful formulae dealing with gas, water, etc. The book includes a brief French and English vocabulary and tables for the conversion of the metric system to English measure.

MONEL METAL.—Catalogue, 46 pages and paper cover, 4½ by 9 ins., coated paper, well illustrated in two colors, published by the Bayonne Casting Co., Bayonne, N.J. Describes Monel metal castings, sheets, rods, forgings, wire, wire cloth, wire rope, tubes, screws, ball bearings, chain, tie rods, etc. List of uses is given for Monel metal in power plants, marine installations, gas and oil engines, pickling and chemical works, dye house equipment, mining equipment, automobiles, dairy equipment, packing houses, and a score of miscellaneous uses. Monel metal is manufactured in Canada by the International Nickel Co. of Canada, Ltd., Toronto.

MODEL GR STERLING ENGINE.—Pamphlet issued by the Sterling Engine Co., 1252 Niagara St., Buffalo; 12 pages, 8¼ by 11 ins., coated paper, well illustrated. Describes 4, 6 and 8-cylinder engines up to 300 h.p. It is intended to construct these engines up to 450 h.p. This series of model GR Sterling engines has been developed from previous models which have been on the market for the past six years. The cylinder head is detachable and contains overhead dual inlet and dual exhaust valves, in addition to which various bearing surfaces have been increased. Exhaustive testing has proven the correctness of the design of the overhead valve-operating mechanism.

FOR THE GLORY OF AMERICA.—By G. B. Livinghood. Handsome book, 144 pages and cloth cover, 9 by 12 ins., published by the Traylor Engineering & Manufacturing Co., Allentown, Pa., describing that company's work during the war. The book is printed throughout on suede coated paper in three colors and is profusely illustrated. The typographical arrangement is admirable, and the illustrations are a triumph of art work, engraving and printing. Apparently no expense has been spared in producing a book that will be a lasting memorial of the strenuous efforts made by the company, beginning in 1915, to produce shells, marine boilers, engines and ships for the Allies. The book includes a review of the companies controlled by Traylor interests, including the Traylor Engineering & Manufacturing Co., Traylor Shipbuilding Corporation, Cement-Gun Co., Inc., and the Traylor-Dewey Contracting Co. The company intends soon to issue another volume dealing more particularly with the work in which it was engaged before the war, and to which it is now returning with renewed vigor and added efficiency as a result of its experience in war-time production.

THOMAS' REGISTER.—The eleventh edition of Thomas' Register of American Manufacturers, dated January, 1920, has just been published, comprising 4,500 pages in which there are listed 300,000 names of United States manufacturers, classified under 70,000 headings. It weighs 17 lbs. The page size is 9 by 12 ins. The register is divided into three main sections, with an index totalling 176 pages. The classified section (3,340 pages) furnishes a very complete list of manufacturers classified according to products, eleven pages being devoted to the single item of acids. A capital rating is also given for each manufacturer, showing the amount of capital invested, hence the approximate size of the concern. About 800 pages are devoted to a list of the trade names or brands of manufactured products, and to a continuous list of the names of manufacturers in alphabetical order, giving the addresses of head offices and branches, names of officers, etc. An international trade section lists exporters and importers, and there is a directory of banks, commercial organizations and trade papers in the United States and Canada. The Thomas Publishing Co., New York City, are represented in Canada by the Canadian Buyers' Register Co., 90 Constance St., Toronto, from whom specimen pages, etc., can be obtained. The price of the book in Canada is $17.50, all charges prepaid.

NOVA SCOTIA POWER COMMISSION AWARDS

TO consider tenders for general construction work and hydraulic and electrical equipment for the St. Margaret's Bay power development, which was described in the April 8th issue of *The Canadian Engineer*, a meeting of the Nova Scotia Power Commission was held April 15th in Halifax.

The contract for four generators was awarded to the Canadian General Electric Co., Toronto. The contract for wood-stave pipe, 6 and 10 ft. in diameter, was awarded to the Pacific Coast Pipe Co., Vancouver. About 200,000 lbs. of aluminum cable, for transmission line purposes, is to be supplied by the Northern Aluminum Co., Shawinigan Falls, Que.

The contract for general construction, involving dams, power-houess and intakes, grading of pipe lines and other miscellaneous work, was awarded to D. G. Loomis & Sons, general contractors, Montreal. A number of attractive proposals for this work were received.

Due to the fact that certain essential data had not yet been received from hydraulic manufacturers, a final award for the turbines could not be made.

The specifications for this development call for completion of one generating station by January 1st, 1921, and completion of the second generating station by June 1st, 1921. The total development at present under way is designed to deliver about 9,000 h.p. in Halifax.

EFFECT OF CAR TRACKS UPON TRAFFIC CAPACITY OF ROADWAYS*

By George W. Tillson
Consulting Engineer, La Grange, Ill.

THERE is probably no one thing that is the source of so much trouble and annoyance to the official in charge of the maintenance of street pavements or road surfaces as the existence of street car tracks in those surfaces. This is mainly true because he has no direct control over the repairs required to keep the tracks in good condition. As a general rule the street car companies must keep in good repair the tracks and pavements between same as well as for a short distance outside. It is generally provided also that, if the corporation does not do this, it may be done by the municipal authorities. But the procedure is such, and so much red tape is involved in carrying out the legal requirements, so that the cost of repairs may be collected from the company, that the provision is seldom resorted to and it is generally considered better policy to try and have the necessary work done by the corporation itself.

Regard for Public Rights

While, as has been said, the existence of car tracks in streets and roads is annoying, the public authorities accept the fact that they are necessary. Transportation is a very important factor in any community, be it large or small, whether a city or a state, and it does not seem proper that existing routes of travel should not be made use of wherever possible. It may be said, of course, that street car lines, especially if suburban, should secure their own rights of way. This may be true, as an abstract proposition. But it should be remembered that this involves a considerable increase in capital cost and to such an extent reduces the dividend to be paid from a certain fixed fare. This is exceedingly important at the present time when so many street car companies both urban and interurban are finding it impossible to meet their financial requirements with their franchise rates of fare.

The acceptance of this fact, however, does not mean that tracks are to be laid at any place or in any way as the company sees fit without regard to the public rights or needs; far from it; quite the reverse indeed.

A discussion of the subject of this paper must necessarily be academic to a great extent; but it is hoped that the presentation of one or two concrete cases will be sufficient to illustrate the general idea.

Location of Tracks

The principal items to be considered in this connection are the location of the track, their detailed construction, their degree of perfect maintenance, the character and amount of traffic on the tracks, and the character and amount of traffic on the street or road. The question of location is, perhaps, the one to be most considered, as upon the location depends the importance of the other items. Its discussion, too, involves the problem of what is the best location for car tracks when they must be laid within the lines of streets or roads. The common practise with streets is to place them in the centre, thus giving an opportunity for streams of traffic to move in either direction entirely independent of each other. With this arrangement it can easily be seen that the width between the cars and the curb will have much to do with the effect on traffic. In the Borough of Brooklyn, New York City, many streets with roadways only 34 ft. wide have two lines of car tracks; and some with a width of only 30 ft. In such cases the obstruction to traffic must be very great, as the distance from track to curb is only 9½ and 7½ ft. respectively and even these distances are reduced by the overhang of the car itself. It is on streets like these that the items of construction maintenance, amount of traffic, etc., are particularly important.

*Presented at the annual convention of the National Highway Traffic Association, January 29th, 1920, in the International Amphitheatre, Chicago, Ill.

The writer has always felt that a car track should be so constructed in a pavement that vehicular traffic could pass over it diagonally, squarely or in any direction without any real inconvenience, and that it should be so maintained that it would always meet this requirement. The heavy truck traffic that is so constantly increasing emphasizes this idea. With the present standard rails and latest construction there is no difficulty in meeting what is desired. Practically all electric roads in streets or highways are operated by overhead trolleys but in the Borough of Manhatten, New York City, where the underground trolley is used, it is necessary to have a slot half way between the rails of each track. This is also true of cable roads. Such construction makes it very difficult to properly maintain or lay the pavement. The space between the slot and rail is so narrow, and so shallow over the conduit that carries the power, that ordinary pavement methods are not successful. With the same amount of care in construction and maintenance, such tracks are more of an obstruction to traffic than those used with the overhead trolleys. The writer once saw both in Brussells and also in Vienna an underground trolley system where the slot was built in connection with one of the rails, leaving the entire space between the rails unbroken. This seemed much better work from a pavement standpoint, but the engineer in charge of the railways of Vienna said it was not good for operation. Why this was, he did not explain, but it was thought that possibly it would not permit so good an electrical connection with the car.

Some Unusual Locations

The Board of Estimate of the City of New York has made a rule that a double-track road shall not be laid in a street with a roadway of less than 40 ft. In Philadelphia, where the streets are narrow generally, but one track is laid in a roadway, the cars necessarily having different routes to and from the centre of the city.

In some cases where tracks are laid in the centre, an area is curbed especially for the tracks, vehicular crossings taking place only at cross streets or other especially provided places.. This is true in a few other cities but, almost generally so in New Orleans. Here the streets as a rule are wide, allowing plenty of room for this method as well as for the general traffic of the city. In such cases, of course, traffic is not impeded at all except as to general crossing from one side of the street to the other.

Rochester, N.Y., has one or two streets where the tracks are located just inside the curb line. On one of the streets leading out of Paris the writer once saw a similar location. In Rochester the instance noted was on a distinctly residential street but in France it was in a small retail section.

With such a location the general street traffic would not be affected but it has always seemed to the writer that it must be very inconvenient to the people along the line, especially if it were on a business street. Here, however, again comes in the question of how much traffic the car lines carry and how often the cars run.

Example of Serious Obstruction

Perhaps the best example of obstruction to traffic by car tracks of which the writer has any cognizance is in the Borough of Manhattan, New York City. Central Park West is that portion of Eighth Avenue lying directly west of Central Park. This avenue south of 58th Street is 100 ft. wide with a 60-ft. roadway with car tracks in the centre. Central Park West is also 100 ft. wide but the roadway is only 48 ft. wide and the tracks are laid on the easterly side, the nearest rail being 3 ft from the curb, leaving a free roadway of 29.9 ft., not taking into account the overhang of the car.

Central Park West is built up on the west side with business houses on its southern end and the remainder with large apartment houses. The cross streets, too, are well built up so that the local traffic is heavy. Previous to the introduction of the automobile the obstruction to travel was not so great. But it can easily be seen that, with it being necessary for all pedestrians to cross two lines of vehicular traffic in order to take or leave a car, a great deal of trouble must occur. So many accidents occured that in 1913 the Board of Estimate and Apportionment passed a resolution directing the railway company to relocate the easterly track at its own expense, with the intention of widening the roadway after this was done. It seems, however, that the tracks were located in their present position in 1897 at the request of the park commissioner of the city, and the corporation council advised that a court seeking to do equity might well deny the application to compel the company to again relocate its tracks entirely at its own expense. The estimated cost of the work was $352,000. Many communications passed between the city and the railway company in regard to the matter but no physical work was ever done and the tracks and roadway still remain as herein described. The police reports show that on this street 286 accidents occurred during the years 1910 to 1913 inclusive. In addition to the accidents to persons, the police records show that in 1913 there were 36 collisions between vehicles and eight collisions between vehicles and surface cars. It is also stated that probably only the most serious vehicle collisions are included in the police records. No doubt the number of accidents have increased in subsequent years. In any event, recently Central Park West has been made a one way street so as to reduce the number of accidents to a minimum. In order to understand just what this means it must be remembered that Central Park extends in width from 5th Avenue to 8th Avenue, a distance of half a mile, and that by making Central Park a street for south bound traffic only, this distance is increased by one long block so that all north bound traffic is cut off between 5th and Columbus (old 9th) Avenues. This, of course, increases the congestion on all north and south avenues. North bound automobile pleasure traffic, although permitted to go through Central Park, has but two outlets to the west, so that if not through traffic it must be seriously inconvenienced.

More Troublesome Locations

Compare for a moment the situation on Fifth Avenue south of 59th Street. This street is also 100 ft. wide and piror to 1908 had a roadway of 40 ft. with sidewalk spaces 30 ft. wide, but areas and stoops were allowed to encroach 15 ft. so that the free width of the street was only 70 ft. The Board of Estimate and Apportionment by resolution widened the roadway by setting the curb back 7½ ft. on each side and ordered the encroachments back to within 2½ ft. from the property line, thus giving a roadway 55 ft. in width with sidewalks 20 ft. wide free from obstruction. The old roadway permitted four lines of traffic while the additional 15 ft. in width furnished space for two more and even this is insufficient for the traffic requirements.

The large cars of the Brooklyn Rapid Transit Co. when passing occupy practically 19 ft. of space,—18.6 ft. to be exact. Supposing a double track line were laid in the centre of 5th Avenue; with the traffic it would certainly have, when two cars met there would be left on each side a distance of 18 ft. only, sufficient only for two lines of travel; in other words, nearly all of the benefits of the widening would be lost.

Prospect Park, Brooklyn, has five sides and on all of the adjacent streets there are street car tracks. With one exception the location is similar to that on Central Park West. But on only one street, Prospect Park West, has it been necessary to establish one way traffic. This is because both the local street car, passenger and also vehicular traffic are light. During the summer a large part of passengers carried by the car lines have the park itself as an objective and they, of course, are benefitted by having the tracks adjacent to the curb. The situation as a whole, however, well illustrates the bearing of both kinds of traffic upon the subject under consideration.

Effect Upon Repair Bills

In another, but perhaps indirect, way can be shown somewhat how traffic is diverted on street car streets, and that is by its effect upon the pavements.

In the Borough of Brooklyn careful records have been kept of the cost of repairs to all pavements for more than 15 years, by individual streets.

The cost of repairs to asphalt pavements on streets without car tracks for the years 1914 to 1918 inclusive has averaged 2c. per square yard; and with street car tracks the cost has been 3.4c. While these figures prove nothing directly they are at least indicative as they give results upon 31,645,000 and 3,884,000 square yards of pavement on streets without and with car tracks, respectively.

Location on Roads

The problem of track location on roads is somewhat different from that on streets as the local conditions are so different. Then too, a country road, even if paved, seldom has its pavement of greater width than will accommodate expected vehicular traffic, so that any interference with existing pavement will be serious. Fortunately, however, there are generally no very serious objections to a side location, the tracks being sufficiently far apart to provide for ample width of the pavement between them. The new National Highway bill proposes where feasible, a 66-ft. width of right of way and a pavement width of not less than 20 ft. This would give ample room for car tracks on both sides of the pavement. Whenever a wider roadway is required or any special local conditions arise, each case must be considered on its individual merits.

If the tracks are located in the pavement, whether in a city street or country road, the shape of rail and method of construction become very important. As has been previously stated, the mere existence of tracks in a pavement should not interfere with traffic. As a matter of fact, they do. The writer some 25 years ago saw a track on 14th St., Borough of Manhattan, laid with two centre bearing rails instead of one laid on longitudinal wooden stringers, the rails and tracks being so near and of such construction that traffic in the centre of the street was almost entirely cut off. Fortunately, such conditions do not now exist anywhere but they illustrate the importance of the principle.

No doubt the well known tee rail of the steam roads is the most economical type of rail for traffic. It does not, however, permit a smooth junction between the pavement and the rail, either between the tracks or outside. This type of rail also is liable to cause ruts alongside the rail if the tracks are much used by vehicles. With the present grooved rail in use in most cities, with a practically square edge on the outside and the flat lip on the inside, it is perfectly practicable to construct a track that *per se* will not interfere with traffic, especially if a 60-ft. rail be used. Specially burned brick or specially cut stone blocks are sometimes used in connection with the tee rail, the groove being really cut out of the blocks. This method often produces good results. On a country road where the tracks are laid outside of the pavement, the tee rail can, of course, be used to advantage.

Track Maintenance Good Policy

But whatever the style of construction, it should be designed with the idea of keeping both the track and pavement in good condition. Unfortunately, the track area of pavements in American city streets are not generally in good condition. Much improvement, however, has taken place during the last 20 years and most street railway companies realize that it is good policy to keep their plant well maintained. Again, unfortunately, soon after this realization, the world war came on, bringing with it financial changes to all, but which seemed to injure street car companies more than almost any corporations, bound as the most of them are by franchise obligations as to permissible fares, with costs of labor and materials mounting up with aeroplane-like rapidity.

If, then, car tracks are to exist in paved streets or roadways, they should be so constructed as to present as little interference as possible with the pavement.

Perhaps the most important item in construction is the type of rail to be used and this has previously been discussed.

The road bed and foundation, too, must be specially prepared. The rail must not give appreciably under car traffic as it is almost impossible to maintain any pavement against a rail that moves vertically under the passage of cars.

The joints too are a prolific source of trouble. Many times a hole in a pavement along the track has its origin at a defective joint. The use in the last few years of a 60-ft. rail has helped this situation very much.

Admitting the force of the arguments used herein, it follows that street car tracks do obstruct traffic very materially when in use in streets or roadways. Also that the extent of this obstruction depends upon the amount of existing traffic and location of tracks, being greatest where both tracks and roadway are used to their utmost capacity and the tracks laid in the pavement, and almost nil where traffic is light and the tracks located outside of the pavement proper. Probably no better illustration of the relative traffic capacity of street car and non-street car streets can be given than existing conditions on Jackson Boulevard and either Adams or Madison streets in the Chicago loop district in the rush hours.

In designing, then, a stret or road where provision must be made for street car lines, a study must be made of both street car and vehicular traffic, present and prospective, so that the relative importance of each may be determined. As a general proposition the centre of a paved street will be the correct location, but often special conditions may make a different one desirable. In the same way it might be said that on a country road the side location would be most logical, changing somewhat, possibly, when passing through small towns or villages.

Wherever the location the type of construction should be good, variations being permitted according to exact location and character and amount of traffic.

As careful provision should be made for the maintenance of the tracks and pavement to be kept in repair by the street car company, if any, as for the roadway pavement itself. The writer knows that this is often difficult but thinks that unless the company is operating under a franchise giving it special privileges, good results can be obtained by some arrangement. If a new franchise is to be issued, the car company might be obligated to pay a specified amount with the understanding that the highway authorities would keep the pavement in repair. The maintenance of the tracks and road bed must be left to the operating company.

The writer feels, therefore, that if these precautions are taken, that while some traffic obstruction must exist, it will in this way be reduced to a minimum and the general travelling public will be benefitted as much as possible.

GRAND VALLEY BOARD REQUESTS COMMISSION FOR FLOOD PREVENTION PROJECTS

At a meeting of the Grand River Valley Board of Trade held last Thursday in Galt, Ont., with representatives present from Brantford, Kitchener, Woodstock, Galt, Waterloo, Waterford, Preston, Hespeler and Paris, W. H. Breithaupt, consulting engineer, of Kitchener, Ont., again presented his scheme for flood prevention on the Grand River.

Mr. Breithaupt declared that disastrous floods such as have often occurred can be avoided by the construction of storage works; also power could be developed. He estimates that a basin with a capacity of three billion cubic feet is necessary. Such a basin has been found in Pilkington township, below Elora. It is 5 sq. mi. in area and would require a dam 1,200 ft. long and 80 ft. high. The provincial government, when approached in reference to the scheme, referred it to the Hydro-Electric Power Commission. While a partial investigation had been made, all necessary data had not been obtained, although 8 years had past. Mr. Breithaupt claimed that a separate commission should be appointed to carry on this flood prevention work. The Board of Trade decided to send a delegation to interview members of the provincial government, with the object of requesting that an independent commission be appointed.

The Soldiers' Settlement Board is laying out a townsite at Prairie River, Saskatchewan, in the centre of a large district which is being opened for soldiers' settlement.

METHODS OF INSPECTING RAILWAY BRIDGES

Present bridge inspection methods of railway companies were outlined in a committee report presented at the last annual convention of the American Railway Bridge and Building Association. The report dealt only with inspection as involved in current maintenance from year to year. It was based largely on replies to a questionnaire received from 40 railroads having a mileage of 90,000. An abstract of the report follows:—

Inspection of Metal Bridges

An annual inspection of metal structures is more generally in effect than that of any other periodicity, while the officer conducting it is more frequently chosen directly from the staff of the chief engineer than from any other group of officers. The motor car seems to be the most common means of locomotion for the inspection party, and the tools used for metal bridges consist generally of rivet hammers, calipers, rules and tape measures.

Regular forms for taking and recording notes in the field are used by the greater number of railways. These forms are diversified in character, ranging from ordinary mineograph forms to bound notebooks. Some roads require notes to be taken in detail, others contemplate the record being made in narrative form. Many of the forms seem to cover the matter very comprehensively, while others are painfully lacking in provision for adequately making the requisite notes.

By far the greater number of railways make inspection separately, for the various members of metal bridges, and it is probable that the general appearance of the structure and the judgment of the inspector are the criteria as to whether actual measurements are necessary. In most cases, recommendations as to repairs and renewals are made at the time of inspection and are recorded with the notes, but with metal bridges it is more than likely that such recommendations are appended to the inspector's report after mature consideration has been given to conditions reported at the office.

Generally the inspection notes are copied before being filed and the disposition of the notes is extremely diversified. In some cases careful calculations are reported as being the method of determining changes in the carrying capacity of the structure, but in other cases no such calculations or other investigations are customary. Almost all carriers report the practice of comparing records of previous inspections with conditions found, in an effort to determine the progress of deterioration.

Inspection of Wooden Bridges

Entirely different results are to be expected from the effects of climate on wooden bridges than with metal structures, but no definite statement can be formulated as to the general effect of climatic conditions in the periodic inspection of wooden bridges, for railroads in the same territory differ as to the frequency of inspection. A tabulation of returns shows the periodicity of inspection and the percentage of total mileage reporting under that periodicity as follows:—

Annually	41.55%	Four times annually	2.62%
Semi-annually	32.22%	Six times annually	13.11%
Three times annually	5.95%	Monthly	4.55%

Nearly 75% of the mileage represented in the replies to the committee's letter of inquiry customarily use the motor car as a means of conveying the inspection party over the line, while only about 21% use regular or special trains. The tools generally used for the inspection of wooden bridges consist of a special inspection bar and testing auger, although in some cases a chisel and brace and bit are added to the tool equipment.

Regular forms for recording inspection notes in the field are used by 85% of the mileage represented in the returns to the questionnaire. Actual measurements are reported as being taken by 52% of the reporting mileage, while general appearance and judgment are used by the remainder. By far the larger portion of the lines record in the notes recommendations as to repairs and renewals at the time the notes are taken. While 85% of the reporting mileage use regular forms for the reports, there is no uniformity in the manner of handling the notes when completed or the final disposition thereof.

General practice is about evenly divided as to giving authority to the inspector to order repairs or replacement in distinction from simply making recommendations as to these matters. The officer most often made responsible for bridge inspection is either the supervisor or the superintendent of bridges and buildings.

Conclusions of the Committee

A well organized plan of thorough and periodical bridge inspection should be in effect on all railroads. Inspection should preferably be made semi-annually and in any event not more infrequently than annually.

The inspector should be particularly fitted by training and experience for the work, technical training being requisite for metal bridges and both judgment and experience for wooden structures.

Motor cars afford the best means of conveying the inspection party over the line.

Such tools, either special or standard, as he may consider useful for his purpose should be furnished the inspector.

Special inspection forms for taking and recording notes are essential. Adequate provision should be made for reporting the conditions of bridge members individually or by groups and classes, dependent upon the facts disclosed by the examinations.

Sufficient assistance to insure thorough and comprehensive examination of a structure should be supplied.

Where necessary to determine the extent of deterioration, actual measurements of members should be made.

Recommendations of the inspector as to corrective measures which should be applied to observed conditions are not only desirable, but practically necessary. These recommendations should be recorded in the notes at the time of inspection and upon its completion should be followed up through proper channels for necessary action thereon.

The inspector should be vested with authority to order through proper channels the correction of any imminently unsafe condition discovered.

Prescribed limitations in stress should, if possible, be established, especially for metal bridges.

The general program of inspection can best be formulated by the individual railroad and must needs be developed by a consideration of the operating organization in vogue, methods of effecting repairs and renewals and the number, magnitude and character of bridges maintained.

At least one complete counterpart of all notes, recommendations, records and papers pertaining to the inspection and corrective measures applied as a result thereof should be kept in one file of ready access.

The annual report of the J. G. White Companies, of New York City, shows net profits for the year 1919 amounting to $479,935, before providing for federal taxes. The assets of the companies now amount to $6,412,216. The surplus or undivided profits amount to $820,090, and the liabilities to shareholders in regard to capital stock, $4,300,000.

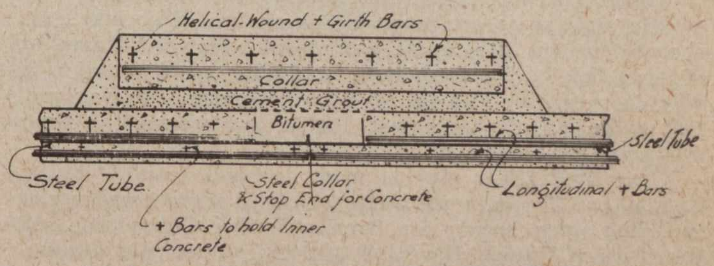
The Proprietors' League of Montreal has secured a report from independent engineers on the proposed completion of the Montreal aqueduct. As a result of the report, the league has written to the Administrative Commission calling attention to the fact that there is little assurance that the completion of the aqueduct will not seriously endanger the water supply conduit which in many places borders the aqueduct excavation. Attention is also called to a number of other objections which the league has in regard to the present scheme for completing the aqueduct, and it is stated that no solution is offered to the difficulty of getting sufficient water pressure in certain parts of the city.

PLAIN AND REINFORCED CONCRETE PIPE*

By H. P. Heywood
Assistant Engineer, Toronto Harbor Commission

One of the very few reinforced concrete pipes now made which can successfully withstand the higher pressures, and which is consequently becoming increasingly popular in England, is the Bonna pipe, invented by Aimee Bonna, of Paris, and at present controlled by Hughes & Lancaster, of London, Eng. Its chief features consists of a mild steel tube, 1 m.m. thick, built up from sheets of steel. These are rolled to the required diameter in lengths from 9 to 12 ft. The longitudinal joint is butt-welded by oxy-acetylene or electric processes. The ends of the steel tube thus formed are turned up and welded to the adjoining edge of the next tube, thus forming a flexible expansion joint. A collar of the same material is then welded on and this forms a receptacle for the bitumen covering of the joint. The reinforcing steel is wound around a mandril in helical form to the required diameter. A heavy section is passed over the steel tube to resist the internal pressure, and a lighter section inside the tube to hold the inner coating of cement in place.

The pipe is moulded vertically, using steel forms, and remains in this position four or five days, and is used after a month's duration. In laying the pipe the circumferential joints are welded, and bitumen is run over them and a collar of reinforced concrete placed over all, and the space between



Bonna Pipe Joint at Swansea, Eng.

this and the pipe is run with cement mortar. This joint necessitates jointing holes in the trench. In the case of high pressures the bends should be buttressed by concrete to resist the outward thrust of the water pressure.

This system was employed in Swansea, Eng., 15 years ago. The water main was 1,200 yds. long and 19.7 ins. diameter, and working head 185 ft. On completion it was tested to 382 ft. and proved satisfactory. The longitudinal butt welded joints were also tested, with the following results: Strength of steel in tube, 21.35 tons per sq. in.; strength of butt-welded joint, 21.5 tons per sq. in., the joint being slightly stronger than the sheet steel. Bends and specials are made by hand moulding instead of pouring. There has not been a single burst on this main since completion.

In 1909 Norwich City built 4,500 yds. of 36-in. sewage pumping main. The lowest tenders for delivering, laying, jointing and specials (excluding excavation) were: Bonna pipe, $3.50 per ft.; steel pipe, $4.50; cast-iron pipe, $6.50. The working head was 120 ft., and the city engineer, E. Collins, considers the main is quite safe now at 300 ft. head.

Several other types of joint are used and include a gasket-filled lead pipe driven into a corrugated steel ring. I will not go into any further details about this pipe as it is not yet manufactured in this country.

A plain concrete sewer pipe is manufactured at Woodstock by the Independent Pipe Co., Ltd., and is called the McCracken pipe. This pipe is different from most plain concrete pipes in that the outer surface is corrugated, giving it an extra crushing strength. It is cast vertically in a patent machine. A belt-driven vertical shaft revolves a number of packer wings slightly larger in diameter than the

*Excerpts from paper read April 15th, 1920, before the Toronto branch of the Engineering Institute of Canada.

required inside diameter of the pipe. Immediately below the packer wings is a kind of piston called a packer head, which, on revolving, produces the smooth inner surface of the pipe. The strong centrifugal force exerted by the packer wings packs the concrete hard against the corrugated outer mould or jacket. Below the packer head is the bell packer, which forms the bell of the pipe. All the packers revolve at the rate of 350 r.p.m.

The concrete is fed into the jacket of the pipe by passing through a chute from an endless chain of buckets. When more concrete is added, the packer head and wings are gradually raised until the top or spigot end of the pipe is completed. No inner form is used, as the concrete is so densely packed, and of a semi-dry mix, that it perfectly retains its true shape.

Table 1—Crushing Test on McCracken Pipe, by Canadian Inspection & Testing Co., Ltd.

Number of Samples Tested.	Diameter, Ins.	Length, Ins.	Thickness, Ins.	Capacity in Lbs. per Lin. Ft. (Average).	A.S.T.M. Requirements, Lbs. per Lin. Ft.
3	6	25	¾	2,477	1,430
2	6	30	⅞	2,570	1,430
3	10	30	1	2,440	1,570
2	12	30	1⅛ to 1¼	2,235	1,710
3	15	30	1½	2,338	1,960

When the pipe is made it is removed to a curing shed or kiln and the jacket removed. A system of sprinklers is operated in this kiln, and a mixture of water and steam, at 70 degs. F., in the form of a very fine spray or mist, is allowed to fill the kiln for 30 hours, thereby procuring perfect hydration of the cement. After two weeks, the pipes are ready for shipment.

The McCracken pipe is made in sizes from 6 ins. to 24 ins., and has been used extensively in many local works, including storm sewers for Toronto Harbor Commission and the cities of Guelph, Gault, Woodstock, Walkerville, London, etc. Also many English contracts have been supplied with this kind of pipe through McCracken machines installed there.

Table 1, giving some data of very recent tests made on these types by the Canadian Testing & Inspection Co., Ltd., show that the requirements of the American Society for Testing Materials are more than complied with. To obtain the crushing strength, divide the capacity in pounds per lineal foot by the barrel length, and multiply the result by ten-sevenths if a knife-edge test; if a sand test, multiply by one.

Table 2—Absorption Test on McCracken Pipe, by Canadian Inspection & Testing Co., Ltd.

Diameter, Ins.	Absorption.	A.S.T.M. Requirements.
6	4.6%	8%
8	4.6%	8%
10	3.9%	8%

In the absorption test, a square piece of the broken pipe is used, about 12 to 20 ins. square, and thoroughly dried in an oven at 230 degs. F., then weighed and soaked in water for 2 hours. The excess globules of water are wiped off and the piece again weighed. The difference in weight is expressed as a percentage. The tentative specification of 1918, of the American Society for Testing Materials, is practically the same as the specifications used for vitrified pipe for many years in the United States. (See Table 2.)

All the pipe manufactured by the Independent Pipe Co., Ltd., is carefully inspected, both during and after manufacture, by the Canadian Testing & Inspection Co., and each length must bear their official stamp before shipment. This is a long stride towards overcoming the prejudice that engineers have against the use of concrete products in general. This prejudice, in the past, I am bound to admit, has been to a certain extent justified, due to carelessness in manufacture and lack of adequate inspection.

Lock joint pipe was designed by Coleman Meriwether. The original design for sewer pipes was in 4-ft. lengths to overcome various obstacles and objections to the plain monolithic concrete sewer. This was at Wilmington, Del., in 1908. It was found that the work proceeded more rapidly and that the excavation cost was considerably reduced owing to the fact that the pipe could be layed right up to the excavation. This meant that quite a proportion of the lower and more expensively handled dirt could be thrown back on the pipe without damaging the joints. The sheet piling could be pulled and the trench back-filled at the end of the day's work, thereby considerably reducing that well known, and often abused item, "engineering contingencies."

Lock joint pipes are made in sizes from 15 to 90 ins., with variations of 3 ins. up to the 72-in. size. Above 72 ins. vary in 6-in. steps. They are moulded vertically in well-oiled steel forms, spigot end up. The reinforcement, usually triangular wire mesh, protrudes about 2 ins. from each end of the pipe, and when the pipes are laid in position, this reinforcement overlaps in a recess formed in the interior of the joint, which is V-shaped, and formed by the spigot and bell ends of the pipe. A sealing form is then placed inside the pipe over this recess and a 1:1 grout is poured through a hole broken in the crown of the bell. The steel and the grout form the "lock." Sewer pipes are usually made in 4-ft. lengths, and branch connections moulded where specified. The reinforcement is concentric, with a double ring for the larger diameters.

Lock-Joint Pressure Pipe

Two kinds of lock-joint pressure pipe are manufactured. For the smaller sizes, up to 54 ins. and 12-ft. lengths, cast-iron machined bell and spigot rings are cast in the ends. A slightly flattened lead pipe, filled with lampwick, and having its end soldered together to form a ring, is placed inside a groove and pressed against a shoulder of the casting, forming a reversed wedge inside the bell. When the tapered end of the spigot comes into contact with this lead gasket, it forces it radially against the shoulder of the bell and into the reverse wedge, with a pressure which increases as the tapered end increases. The pipe is forced home when the taper of the spigot has passed this gasket. This joint allows the spigot to move backwards and forwards on the lead gasket, through the extremes of expansion and contraction, without causing any leakage. The use of this joint was greatly appreciated by the American Reclamation Bureau. About 10% of the lead of the usual cast-iron pipe joint is required, and if necessary the pipes can be taken apart and the gasket used over again. The thickness of the walls vary from 3 ins. to 5½ ins. for the 54-in. diameter pipe.

For the larger pressure pipes, ordinarily 8 ft. long, a copper expansion joint, with a bead rolled into it, is used. The joint is similar to the sewer pipe joint except that the triangular mesh reinforcement projects from the bell end only, while the copper strip and its rolled bead project from the spigot end, half the width of the strip being previously moulded into the pipe. The mesh and copper, therefore, overlap in the recess of the joint. The grout is poured as in the sewer pipe, and adheres to the copper and mesh, but is prevented by paint from adhering to the concrete spigot of the other pipe.

When the temperature movement of the pipe occurs, the bead on the copper opens or closes without causing an opening in the joint.

Leakage from Winnipeg Aqueduct

This joint was recently used in 10 miles of 66-in. diameter pipe for the Greater Winnipeg Water District. The head varied from 45 to 95 ft. The leakage allowed was 118,000 gals per diem, and when tested it did not exceed 43,000 g.p.d. Incidentally, for the remainder of the 95 miles of aqueduct, built in 45-ft. sections of the inverted horse shoe shape, a beaded copper strip was used at the joints with good success.

A good type of subaqueous pipe, rigid and non rigid, is also made by the Lock Joint Pipe Co. A modified type of

(Concluded on page 412)

The Canadian Engineer

Established 1893

A Weekly Paper for Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

One Year	Six Months	Three Months	Single Copies
$3.00	$1.75	$1.00	10c.

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

President and General Manager JAMES J. SALMOND
Assistant General Manager ALBERT E. JENNINGS

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1206 McArthur Bldg., Winnipeg. G. W. Goodall, Mgr.

PRINCIPAL CONTENTS

ENGINEERING INSTITUTE COUNCIL DISCUSSES SALARIES AND UNIONIZATION

AT the invitation of the council of the Engineering Institute of Canada, delegates appointed by the executive committee of the Ontario provincial division met some of the members of the council in Montreal last week and discussed salaries of engineers in Ontario and elsewhere in Canada, and also legislation and other matters effecting their economic status and prestige.

After twelve hours' discussion the meeting reached no decision, but passed a resolution requesting the council to appoint a committee to investigate and recommend what action the institute should take to improve the financial position of many of its members, it being generally recognized that the institute owes an obligation to its individual members even though it is not in any sense a trade union. Although it was admitted that every possible means should be utilized in effecting an improvement in the material interests of the institute's members throughout Canada, it was agreed that no such steps should be taken without mature consideration.

During the meeting attention was drawn to the fact that the International Federation of Engineers', Architects' and Draughtsmen's Unions had established branches in Montreal and Toronto, and initial steps had been taken toward the formation of a branch in Hamilton. After very full discussion, the meeting came to the conclusion that the establishment of these branches was unnecessary and undesirable, and that the institute is doing everything possible in the way of furthering the interests of the profession in the Dominion.

One result of the conference will probably be the recommendation of a schedule of increased salaries and fees for engineering services.

Letter to the Editor

FAILURES IN CONCRETE CONSTRUCTION

Sir,—Each year brings its usual crop of additional reinforced concrete structures. Many of these are built according to the most approved methods of design and construction, and others stand the strain of the loads which they are called upon to resist owing to a fair share of good luck, while occasionally failures occur which temporarily disturb the public confidence in this type of construction.

The spectacular development of reinforced concrete during the past 15 or 20 years has created a very large number of so-called specialists; a mass of information, both practical and theoretical, has been produced, and certain standards have been evolved which have been more or less generally adopted. Building laws and specifications have been enlarged to include highly technical information pertaining to the design and inspection of reinforced concrete materials. But failures still occur!

A careful analysis of all the conditions surrounding concrete construction might result in the following conclusions as regards present-day failures:—

Probably the most dangerous element in concrete construction is the field "expert." I refer particularly to the type of man who claims to "know all about concrete." I believe that the over-confidence of this type of individual is probably responsible, partially at least, for many of the failures. The mistakes he makes are as follows:—

1.—Removal of forms before the concrete is sufficiently cured.

2.—The use of form supports or "uprights" without wedges.

3.—Insufficient lateral braces for "uprights."

4.—Insufficient mixing of concrete.

5.—Mixing of concrete too wet, thereby destroying the mix proportions before the concrete has reached the forms, and also causing the leakage and "flooding" of cement.

6.—The use of sand or gravel with loam or clay.

7.—The use of insufficient cement in the mix.

8.—Improper heating of concrete materials in cold weather, and not sufficiently protecting the poured concrete against frost.

9.—Lack of proper tamping.

10.—A general spirit of over-confidence and carelessness on the part of field foremen, which is dangerous.

On account of the factors of safety used in design, it is difficult to ascertain exactly to what extent design plays a part in the failure of reinforced concrete; but, undoubtedly, if the design is weak, it is a factor in failure, in conjunction with faulty or careless construction.

Generally speaking, current designing practice may be criticised as follows:—

(A) The use of flat slab design. The flat slab, if economically designed, is an unusual arrangement which tends to produce very high stress in both steel and concrete. This type of construction is nothing more or less than an optical illusion, and is probably the greatest piece of engineering camouflage which has ever been "put over" the innocent public.

(B) The general tendency of concrete design toward the use of too much steel and insufficient cement. The general uniformity in the quality of steel bars would seem to indicate that somewhat higher stress in the steel might be used with richer mixtures of cement.

With regard to the use of increased cement proportions, the following conclusions might be noted:—

(a) Practically all concrete failures indicate that the concrete and not the steel bars failed.

(b) The increased use of cement very materially increases the compressive strength and bonding power of concrete.

(c) The rich mix of cement permits the use of "anti-freeze" ingredients for winter concrete, and also creates an additional factor of safety against any possibility of the concrete being weakened by the addition of such mixtures.

(d) An additional general factor of safety is obtained against losses in strength of concrete due to any of the deficiencies of construction previously mentioned.

However, if reinforced concrete be used with the reasonable care which should characterize any type of engineering construction, it undoubtedly constitutes one of the most permanent, economical, safe and fireproof methods of building that the world has yet produced.

R. E. W. HAGERTY,
Toronto, Ont., April 19th, 1920. Consulting Engineer.

PERSONALS

P. M. Sauder, of Calgary, Alta., has been appointed divisional engineer of the Lethbridge Northern Irrigation District, with headquarters in Lethbridge, Alta.

Walter A. S. Melanson, of Moncton, N.B., has been appointed to succeed Joseph Theriault as district road engineer for the North Shore counties, New Brunswick.

E. J. Buegler, formerly consulting engineer of Westinghouse, Church, Kerr & Co., Inc., has been elected vice-president of the Foundation Co., in charge of engineering.

V. G. Younghusband, who superintended the work on the new Parliament Buildings at Ottawa, has left the Peter Lyall Construction Co. to enter the employ of the Foundation Co., Ltd., Montreal.

D. A. Molitor, consulting engineer, Detriot, Mich., formerly of Toronto, Ont., addressed the Windsor Branch of the Engineering Institute of Canada last Thursday evening, on "The Metric System."

Onisphore H. Cote, engineer, Montreal, has been appointed trade commissioner of Quebec City by the Board of Trade. Mr. Cote was previously connected with the Shawinigan Water & Power Co.

N. B. Wilson, civil engineer, of Guelph, Ont., has been appointed town foreman of Hespeler, Ont. Since his return from overseas, Mr. Wilson has been engaged as instructor in the Department of Soldiers' Civil Re-Establishment, at Guelph.

F. P. Moffat, who for several years was senior divisional engineer on the Hudson Bay Railway, has been appointed valuation engineer for the Department of Railways and Canals. Mr. Moffat will direct the valuation of the Grand Trunk system, which is being taken over by the Dominion government. His headquarters will be in Montreal.

David Mackay, who has been one of the construction superintendents of the Toronto Works Department for the past 14 years, has resigned in order to enter business on his own account as a general contractor. His office will be at 287 Ashdale Ave., Toronto, and he will specialize in reinforced concrete construction and tunnelled sewers. Mr. Mackay was brought to Canada from Glasgow, Scotland, by Toronto's former city engineer, C. H. Rust. In Glasgow Mr. Mackay had 10 years' experience in compressed air work in the construction of sewers and bridge piers, as foreman in the employ of the Glasgow Works Department. During the past 14 years he has directed construction on many of Toronto's prominent paving and sewer jobs, and on several special undertakings, such as the attempted cleaning of the tunnel under Toronto Bay.

OBITUARY

Angus J. MacDonald, railroad contractor, Vancouver, B.C., died April 11th at his home in Vancouver, following an accute attack of Bright's disease. Mr. MacDonald was born in 1876 in Kirkfield, Ont. He went to Vancouver in 1911 as superintendent of construction for the C.N.R. His most recent work was the erection of a large warehouse for the C.N.R. at False Creek.

Representatives of the highways departments of Manitoba, Alberta and Saskatchewan met last Thursday at Regina to discuss the correlation of the road programs of the three prairie provinces.

PLAIN AND REINFORCED CONCRETE PIPE

(Continued from page 410)

the rigid pipe is very suitable for high-class caisson work, and is made with a cast-iron cutting edge at the bottom of the caisson. Sections 20 ft. long, and joined together with cast-iron flanges bolted on the inside of the caisson, are used. These flanges are embedded in the concrete and held securely in position by bolts the length of the pipe, which also act as longitudinal reinforcement. If a watertight caisson is needed, a gasket is placed between the cast-iron flanges. A type similar to this, 30 ins. in diameter, is used very successfully by one of the largest contracting firms in New York City for underpinning work.

In most of the above-mentioned lock-joint pipes, the pouring is done with conical-shaped buckets fitted with a ball valve at the bottom. The pipes are then placed under canvas and steamed for about four hours under ordinary weather conditions, and allowed to set for twelve hours, then stripped and turned on their sides after three days, and shipped after two weeks of final setting.

Leakage tests made at Baltimore, Md., in 1913 on 5 miles of 84-in. and 11 miles of 108-in., gave an actual leakage of 13,000 g.p.d., against an allowable leakage of 38,000 g.p.d. The head was 80 ft. Another test in Dallas, Tex., in 1915 on 14,400 ft. of 36-in., gave 17,000 g.p.d. leakage, against an allowed leakage of 22,000 g.p.d. The heads were 30 and 80 ft. Another test in Fort Worth, Tex., the same year, with the same length of pipe, 48 ins. diameter gave 15,000 g.p.d. leakage against 36,000 g.p.d. allowed. The head was from 20 to 60 ft.

A test of the strength of the joint was made by placing 24,000 lbs. directly on the joint between two pipes supported on two bearings at 6 ft. centres. The deflection measured at the joint was only $\frac{1}{16}$ in.

In conclusion I may say that concrete has been used as a material for the construction of sewers for many years. Practically all cities have adopted it for the construction of the larger diameter sewers. Its use for smaller diameter sewers has not been adopted so extensively, undoubtedly owing to the fact that there has been more or less question connected with all concrete products which have been placed on the market. This is due to the fact that until recent years there has never been a recognized standard specification for the manufacture of cement concrete sewer pipe, and also to the tendency of cement product manufacturers to overlook the fundamental principles recognized in all concrete work.

Within the past few years the engineers have appreciated the value of concrete as a material for sewer pipe and have put forth every effort for the standardization of specifications and methods of manufacture. There are a number of instances on record where concrete sewer pipe has been in use for over 20 years. The city of Brooklyn, N.Y., laid its first concrete pipe about 1850, and since that time has laid over four hundred miles of this kind of sewer. Over 75% of all sewers laid in the city of Milwaukee during the past seven years have been concrete pipe. The specifications of many of the larger cities, including Chicago, Kansas City, Santiago and Oklohoma City, also permit its use.

The Maisonneuve Park Commission, Montreal, have accepted the tender of the Maisonneuve Quarry, Ltd., for quarrying stone from Maisonneuve Park for a term of five years at $1.15 per ton. The contractor undertakes to quarry 100,000 tons per annum.