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Effect of Time of Mixing on the Strength of Concrete

Exhaustive Series of Tests on Machine-Mixed Materials Shows That Inferior Concrete is Produced By Undermixing, But Excess of Water is By Far the Greater Evil—Paper Read Before the Atlantic City Convention of the American Concrete Institute

By Prof. DUFF A. ABRAMS

Structural Materials Research Laboratory, Lewis Institute, Chicago

MACHINE-MIXING has almost entirely replaced hand-mixing of concrete on work requiring the use of large quantities of material. While it is generally recognized that good results can be secured by hand-mixing, it is also well known that this result can be accomplished only at the cost of conscientious effort and much hard work. It has long been known that the thoroughness of mixing, whether by machine or hand, has an important influence on the quality of the finished concrete. Reference may be found in engineering literature to several series of tests in which the effect of duration of mixing was studied. So far as hand-mixing is concerned such studies have been generally confined to briquet tests made on cement mortars. The tests on machine-mixed concrete which have been reported, covered such a narrow range that no quantitative measure of the effect of continued mixing has been developed. No sustained effort has been made, so far as the writer is aware, to analyze the factors which enter into the beneficial effects of continued mixing. Due to a more or less vague impression of the value of longer mixing time, there has been a marked tendency during the past year or two on the part of specification writers toward lengthening the time the batch should remain in the mixer.

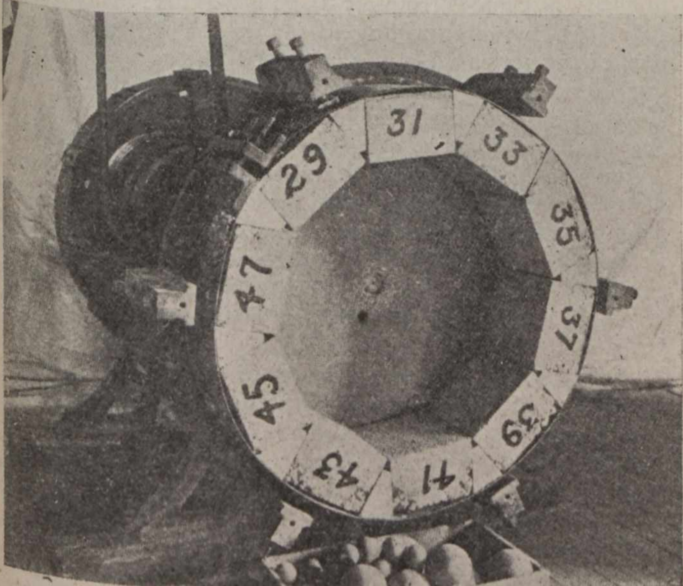


Fig. 1—Talbot-Jones Rattler with Concrete Wear Blocks in Place

Wear tests were made on blocks 8-in. square, 5-in. thick.

There can be no question of the importance of thorough mixing of concrete. Undoubtedly much inferior concrete is produced by undermixing. Undermixing, coupled with the excess of mixing water which is too frequently used, forms a combination which is very conducive to defective concrete or concrete of low strength and wearing resistance. Of the two evils, excess water is by far the greater.

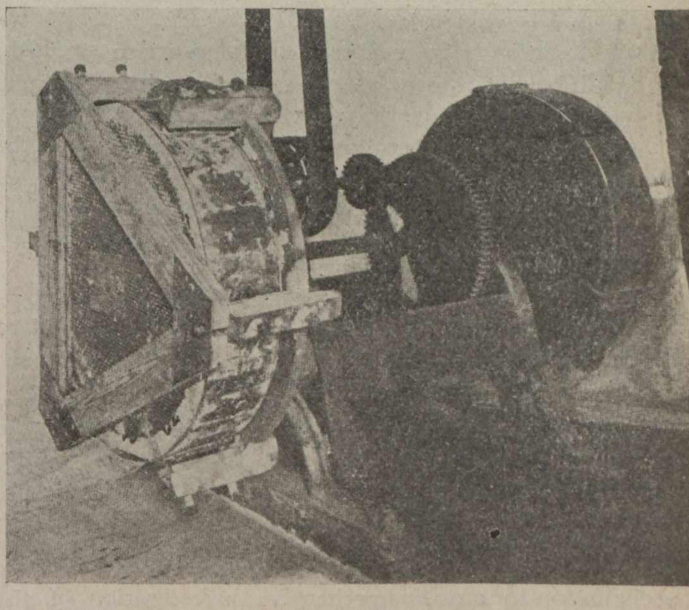


Fig. 2—Talbot-Jones Rattler with Head Closed Ready for Test

The machine was operated for 1,800 revolutions at 30 r.p.m.

Due to the multiplicity of sizes and designs of batch mixers, the exact basis for the mixing period has not been clear. Should a minimum time limit be specified? Or should a minimum number of revolutions of the drum be required? If a minimum time limit for mixing is specified, what is a proper basis for mixers of different capacities, or mixers operating at different rates? Whatever basis is used for fixing the minimum amount of mixing which would be acceptable, several other questions of equal importance are immediately raised. What is the effect of the time of mixing if the proportions of the concrete are changed? The change of proportions would involve varying the relative quantities of cement, water and aggregate, the size and grading of the aggregates, etc.

It was with a view to securing definite information on some of these problems that the tests covered in this report were carried out. Two forms of test were used:

(1) Compression tests of 6 by 12-in. concrete cylinders.

(2) Wear tests of concrete blocks, 8 ins. square and 5 ins. in thickness.

The wearing resistance of concrete is of great interest in view of the widespread use of concrete for the construction of roads, pavements, floors, walks, etc. The wear tests were made in the Talbot-Jones rattler.

Over 3,800 specimens were made in the experiments covered in this report. The 1-year compression test cylinders have not been made. For the conditions of the tests, definite results were secured on the following topics:

(1) Influence of quantity of mixing water on the strength and wear.

(2) Effect of time of mixing (15 sec. to 10 min.) on the compressive strength.

- (*a*) Concrete of different consistencies.
- (*b*) Concrete of different cement content.
- (*c*) Concrete made of aggregates of widely different size.

(3) Effect of time of mixing on the wear of concrete of different consistencies.

(4) Relation between wear and compressive strength.

(5) Effect of rate of rotation of mixer drum on the strength of concrete.

(6) Effect of temperature of mixing water on the strength of concrete.

(7) Effect of age on the strength of concrete.

- (*a*) For different times of mixing.
- (*b*) For different mixes and consistencies.
- (*c*) For different sizes of aggregates.

(8) Comparison of machine-mixing with method of hand-mixing used in the laboratory.

(9) Uniformity of mixer tests.

These experiments form a part of the researches in the properties of concrete and concrete materials being carried out through the co-operation of the Portland Cement Association and Lewis Institute at the Structural Materials Research Laboratory, located at Lewis Institute, Chicago. The tests must be considered as merely preliminary to any comprehensive investigation of the performance of concrete mixers. Such an investigation would include machines of many types and capacities and numerous other factors which have not been studied. It is hoped that an opportunity will be found for extending these mixer investigations beyond their present limits.

Acknowledgment is due to the Chicago Gravel Company, Chicago, for their courtesy in supplying the aggregates used in these tests and to the T. L. Smith Company, of Milwaukee, who donated one of their 3½-cu. ft. "Mascot" concrete mixers for use in the laboratory.

Outline of Tests

For convenience, each group of experiments is given a series number. It is believed that confusion will be avoided by referring to the tests by the series numbers. Table 1 gives the titles of the series and the number of tests of each kind.

The tests on effect of time of mixing covered in this article were made on concrete mixed in a tilting mixer with a double-cone drum, capacity 3½ cu. ft., manufactured by the T. L. Smith Company. In all these tests the mixer was loaded to capacity and the entire batch was made into test pieces.

Table 1—Outline of Test Series

Series No.	Title.	Total Number of Tests, Compression.	Wear.	Miscellaneous.
81	Uniformity of Machine-Mixed Concrete	44	...	70
89	A Study of the Time of Mixing Concrete (Effect of Consistency)	612	...	70
93	A Study of the Time of Mixing Concrete (Effect of Mix and Size of Aggregate)	1,344	240	82
96	Study of Rate of Rotation of Mixer Drum	576	...	70
97	Effect of Temperature of Mixing Water on the Strength of Concrete..	660	...	70
	Total	3,236	240	362

Series 81 was preliminary in nature, carried out for the purpose of studying the variation in the compressive strength of specimens made from different parts of the same batch of machine-mixed concrete. Three batches of different consistencies were mixed. Compression tests on 6 by 12-in. cylinders were made at 7 and 28 days.

Series 89 included a study of the effect of time of mixing, using concretes of consistencies varying from a fairly stiff to a wet mix, the proportion of cement and the grading of aggregates being the same in all tests. Batches of each consistency were mixed for periods ranging from 15 seconds to 10 minutes. Compression tests were made at ages of 7 and 28 days and 2 months, and year tests at 2 months. This is the only series in which wear tests were made.

In series 93 a study was made of the effect of time of mixing, varying both the mix and the size of aggregate. The first part of the series consisted of variations in the quantity of cement from a 1-15 to a 1-2 mix, using aggregates of the same grading (0-1¼ ins.). In the second part of the series a 1-5 mix was used, the aggregate ranging in size from sand all of which passed the 14-mesh sieve to a sand and pebble mixture graded up to 2 ins. Batches of each mix, etc., were mixed for periods of 15 seconds to 10 minutes. Parallel sets of tests on hand-mixed concrete were made for comparison with the machine-mixed specimens in both of the groups mentioned above. In the hand-mixed concrete only one mixing period was used. Compression tests were made at ages of 7 and 28 days and 3 months. The 1-year tests are not yet due.

Series 96, "Effect of Rate of Rotation of Mixer Drum," concrete of 1-5 mix, aggregate graded to 1¼ ins. in size was mixed for 1 minute at six different rates, ranging from 8 to 30 r.p.m. The rate recommended by the manufacturers for this mixer is 18 r.p.m. Concrete of four different consistencies was used for each rate. Compression tests were made at ages of 7 and 28 days and 3 months. The 1-year tests are not yet due.

Series 97, on effect of temperature of mixing water on the strength of concrete is somewhat foreign to the subject-matter of this article, but since the tests were made at the same time, using the same materials and under similar conditions, it is considered desirable to include the results here.

The temperature of the mixing water was varied at intervals of 10° C. from 0 to 100° C. Four different consistencies were used. Duplicate batches were mixed for

Table 2—Miscellaneous Tests of Cement

Cement Lot No.	Used in Series No.	Fineness Test Residue on 200.	Normal Consistency Per Cent.	Time of Setting: Vicat Needle Initial. h. m.	Vicat Needle Final. h. m.	Gillmore Needle Initial. h. m.	Gillmore Needle Final. h. m.	Soundness Test (over boiling water).
3,768	81	18.0	24.5	5 40	8 40	6 20	8 50	OK.
3,965	89, 93	18.8	23.0	3 40	7 36	5 15	8 32	"
4,035	96, 97	17.5	23.0	3 45	9 00	6 00	9 30	"

Table 3—Strength Tests of Cement

Cement Lot No.	Water Used Per Cent.	Tensile Strength (Briquets) 7 days.	28 days.	3 months.	Compressive Strength (2 by 4-in. Cylinders) 7 days.	28 days.	3 months.
3,768	10.5	292	368	419	2,120	3,580	4,320
3,965	10.3	242	378	462	1,770	3,360	4,380
4,035	10.3	246	386	402	1,700	2,640	3,750

1-3 Standard Sand Mortar.
Values for strength tests are expressed in pounds per square inch.
Each value is the average of 5 tests made on different days.

each condition on different days. Compression tests were made at ages of 7 and 28 days and 3 months.

Materials

The cement used consisted of a mixture of equal parts of four brands purchased in the Chicago market. The brands were thoroughly mixed by placing one sack of each in the mixer and running for about 1 minute. Complete tests of the different lots of mixed cements are given in Tables 2 and 3.

The aggregates consisted of sand and pebbles from the Chicago Gravel Company's plant near Elgin, Ill. This material was received in carload lots in the form of coarse torpedo sand, graded up to 3/8 in. in diameter, and pebbles graded from 1/4 to 1 1/4 ins. Before using, the sand was screened through a No. 4 sieve. All material retained on this sieve was added to the pebbles. The pebbles were all from the same shipment. The material was shovelled over several times and stored for use in a shallow bin. In most of the tests the aggregate was graded up to 1 1/4 ins. by mixing a certain percentage of sand with the pebbles. In Series 93 the aggregates of the smaller sizes were prepared by using the sand which was finer than No. 14, No. 8 and No. 4 sieves respectively.

The sieves used in all of these tests were what are known as the Tyler standard sieves, manufactured by the W. S. Tyler Company, Cleveland, Ohio. The dimensions of the sieves used are given in Table 4. Table 5 gives the grading and other properties of the aggregates. The sieve analyses are the average from samples taken at intervals throughout the period covered by the tests.

Table 4—Sizes of Sieves Used in Sieve Analysis of Aggregates

Sieve No. or Size.	Size of Clear Opening in.	mm.	Diameter of of Wire in.
100	.0058	.147	.0042
48	.0116	.295	.0092
28	.023	.59	.0125
14	.046	1.18	.025
8	.093	2.36	.032
4	.185	4.70	.065
3/8 in.	.37	9.40	.092
3/4 in.	.74	18.8	.135
1 1/2 in	1.5	38.0	....

Brass wire cloth sieves with square openings.

The weight per cubic foot of the aggregate was determined by means of machined cast-iron measures, having capacities of 1/5 and 1/2 cu. ft. The 1/2 cu. ft. measure was used for the larger sizes; the 1/5 for the smaller sizes. The inside diameter of each measure is equal to the depth. The test was made by filling the measure about 1/3 full and puddling with a small steel bar pointed at the lower end. Filling and puddling was continued in like manner till the measure was full. After striking off with a straight-edge, the weight was determined.

Table 5—Notes on Aggregates

Ref. No. in Series.	Range in Size.	Amount Finer than Each Sieve Per Cent. by Weight, 100	48	28	14	8	4	3/8	3/4	1 1/4	2	Weight lb. per cu. ft.	Density.	Voids.
SERIES 81														
All	0-1 1/4 in.	0	2	11	18	28	40	50	80	100		130	.781	.219
SERIES 89														
All	0-1 1/4 in.	0	3	11	16	21	44	50	82	100		130	.781	.219
SERIES 93														
49-54, 249	0-14	2	11	58	100	...	...	...	...	...	...	104	.626	.376
55-60, 255	0- 8	1	8	42	72	100	...	...	...	...	...	110	.660	.340
61-66, 261	0- 4	1	6	30	52	72	100	...	...	...	...	115	.691	.309
67-72, 267	0- 3/8 in.	1	5	23	40	56	77	100	...	...	...	124	.746	.254
73-78, 273	0- 3/4 in.	0	4	21	25	35	49	69	100	...	...	126	.756	.244
1-48, 201, 243	0-1 1/4 in.	0	2	10	18	24	34	51	84	100	...	130	.781	.219
79-84, 279	0-2 in.	0	1	6	10	14	20	40	60	80	100	128	.770	.230
SERIES 96														
All	0-1 1/4 in.	0	2	10	18	24	34	51	84	100	...	130	.781	.219
SERIES 97														
All	0-1 1/4 in.	0	2	10	18	24	34	51	84	100	...	130	.781	.219

The density of the aggregate was computed from the specific gravity and the unit weight. The density refers to the total volume of solids in the mass. The voids in the aggregate is the complement of the density.

Mixing Concrete

The studies of the effect of time of mixing covered periods of ¼ to 10 minutes. The cement, water and aggregate for the batch were all weighed or measured and placed in the mixing drum before the mixer was started. The mixing period was measured from the time the mixer was started to the beginning of discharge.

In series 93 a parallel set of compression cylinders was made, using hand-mixed concrete made in the manner

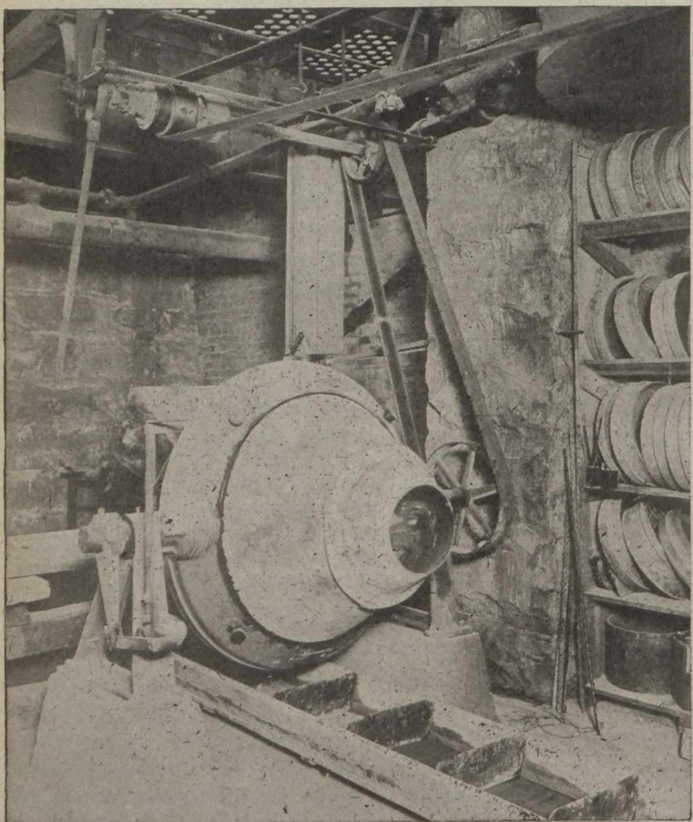


Fig. 3—3½-Cu. Ft. Concrete Mixer Used in Tests
The trough shown in the foreground was used to receive the concrete as the batch was discharged.

regularly followed in concrete tests made in this laboratory. In these tests a batch of concrete was proportioned of the size required for one cylinder (about 1/5 cu. ft.); each batch was mixed by hand with a trowel in a shallow metal pan. The methods of molding, etc., were the same for all specimens. These tests were carried out for the purpose of securing a direct comparison between the strength of hand-mixed and machine-mixed concrete.

The different rates of rotation of the mixer drum used in Series 96 were secured by shifting the driving belt to pulleys of different size or by varying the speed of the motor.

The water tank which supplied the concrete mixer was calibrated in such a way that accurate readings of the quantity of water could be secured. Both hot and cold water were available for mixing purposes. The variations in temperature of mixing water in Series 97 were secured by this means. The extremely low temperatures were reached by placing ice in the water tank. The temperatures near the boiling point were obtained by heating the water tank by means of gas jets.

Fig. 3 shows the mixer used in these tests. The water tank can be seen in the background. In the foreground is shown a trough which was used for receiving the batch as it was discharged from the mixer. The trough is about 5 by 14 ins. in section, 15 ft. long; the bottom is lined with galvanized sheet steel; partitions of ⅛-in. steel plates are provided at intervals of about 15 ins. The sides are sloped slightly to facilitate placing the partitions. It is mounted on castors in such a way that it can be pulled over the floor so as to distribute the concrete throughout its length as the mixer is discharged. The partitions prevent the concrete from flowing from one point to another in the batches mixed to very wet consistencies.

Test Pieces

Most of the tests covered in this report consist of compression tests of 6 by 12-in. concrete cylinders. The wear tests in Series 89 were made on concrete blocks 8 ins. square and 5 ins. in thickness. The hand-mixed specimens in Series 93 were each mixed and proportioned separately. All proportions are expressed in terms of the volume of cement and mixed aggregate. For instance, a 1:4 mix would be made up of 1 cu. ft. of cement (equivalent to 1 sack) and 4 cu. ft. of aggregate, without regard to the size of grading of the aggregate. A 1:4 mix was used in most of the tests; this corresponds to the usual 1:2:3 or 1:1½:3 mix. The exact equivalent of the 1:4 mix expressed in the customary manner would vary with the size and grading of the aggregates.

The consistency of concrete was varied in most of the series. In the tables and diagrams we have used the term "relative consistency." What we have called "100 per cent. consistency" is a plastic mix which when molded in the form of a 6 by 12-in. cylinder will show a shortening of about ¼ to ½ in. if the steel form is slipped off immediately after molding. The quantity of water required to produce this condition varies, of course, with the proportions of the mix, the grading and absorption of the aggregate, etc. Other consistencies for the same mix are expressed in terms of the quantity of water required to produce "normal consistency," *e.g.*, 90% or 150%. It should not be assumed that this "normal consistency" gives concrete of the highest strength. Highest strength has generally been found at consistencies around 90% of normal.

While the method of expressing the consistency by reference to a certain "normal" is most convenient, it should be stated that the method of testing for this consistency described above is not entirely satisfactory. For lean or very rich mixes or for aggregates of unusual or fineness or coarseness, the test does not give concordant results. A penetration test for consistency was used in Series 97. In this test a bar ¾ in. in diameter, 24 ins long, weighing 800 g. was used. The bar was made of thin brass tubing with a pointed steel shoe at one end. The steel point was tapered from 1/16 in. to ¾ in. in a length of 2 ins. It was held in a vertical position over the top of the cylinder with the pointed end in contact with the fresh concrete. Upon being released the bar falling of its own weight penetrated the concrete a certain distance depending on the viscosity of the mass. This test was repeated several times, the depth of penetration in inches measured and the average recorded. If the point struck a large piece of aggregate and did not penetrate, that trial was not considered.

This method gave fair results in Series 97. However, it should be borne in mind that only one mix was used and there was no variation in the character or grading of the aggregate. The method is not satisfactory for wide ranges of mixes or grading of aggregates, but appears to be promising for use where only a limited range in the character of the concrete will be encountered.

The amount of water used in the batch exerts such a controlling influence that the quality of the concrete depends very largely on this factor. The quantity of water to be used depends on the following factors:

(1) The quantity of cement (mix).
(2) The normal consistency of the cement.
(3) The size and grading of the aggregate.
(4) The absorption of the aggregate.
(5) The moisture already present in the aggregate.
(6) The nature of the work; that is, the size of the members, the methods of handling, placing, finishing, etc.

The term "consistency" as used in this article refers to the physical condition of the fresh concrete with reference to viscosity or plasticity and not to the quantity of water. It has been found convenient to express the quantity of water used in the concrete in terms of the volume of the cement. This ratio has been found to be the best criterion of the strength of the concrete. The whole question of consistency has been studied, but it is not feasible to take up a detailed discussion of these studies in the present article.

The 6 by 12-in. compression cylinders were molded in metal forms made of 12-in. lengths of 6-in. inside diameter cold drawn steel tubing which had been split along one element by means of a thin slotter. The form was closed by a circumferential band. Each form stood on a machined, cast-iron base plate. A sheet of paraffined tissue paper was placed between the base plate and the cylinder form.

The concrete for the machine-mixed batches was taken from the receiving trough by means of a large scoop. In molding the cylinder the form was filled about one-third full and the concrete puddled with a ¾-in. steel bar about 21 ins. long. This process was continued until the form was filled. The top was levelled off with a bricklayer's trowel. About three to six hours after molding, a thin layer of neat cement paste (which was mixed at the same time or before the concrete) was spread over the top of the cylinder. A piece of plate glass and a sheet of paraffined paper was used to form a cap which made a smooth, square end for loading. The glass remained in place until the form was removed. This method of capping is much better than setting the specimens in plaster of paris or cement-plaster caps immediately before testing. It has the following advantages:

(1) The cap is just as strong and stiff as the concrete and forms an integral part of the specimen.

(2) The time and labor required is a small part of that necessary with the plaster method.

(3) The plate glass prevents evaporation of water during the period the concrete is in the form.

(4) The cylinder is ready for test at any time without further preparation.

The forms for the wear blocks were made in gangs of three. The forms were set on a sheet of building paper laid directly on the concrete floor. Each form was filled before puddling. The top was levelled off with a trowel. After a period of one to two hours the tops of the blocks were finished by hand with a wood float. Instead of capping, the blocks were covered with a sheet of wet building paper and about 3 ins. of damp sand. This method prevented loss of water while the blocks were in the forms.

All test pieces were allowed to remain in the metal forms over night. Upon removal of the forms they were stored in damp sand in the basement. The compression cylinders were not removed from the damp sand until immediately preceding their test. The wear blocks, however, were allowed to dry out in an open room for two days prior to testing.

The machine-mixed batches consisted of 15 to 17 specimens. The specimens were made and numbered in the same order in all cases. The material which was first discharged from the mixer was used to make Specimen 1; the material last discharged forms the last specimen from the batch. In assigning the test pieces to be tested at each age, the specimens were distributed throughout the batch. The exact distribution is stated in the tables giving the results of the tests in each series.

Methods of Testing

The compression tests of concrete were made in a 200,000-lb. Olsen universal testing machine. A spherical bearing block was used on top of the specimen. Stress-deformation measurements were made from which the modulus of elasticity of the concrete can be computed. These values are omitted from the present article.

Wear tests of concrete were made in the Talbot-Jones rattler. The test pieces consist of blocks 8 ins. square and 5 ins. in thickness. The blocks are arranged around the perimeter of the drum of the rattler, as shown in Fig. 1. Ten blocks constitute a test set. The ten-side polygon formed by the test blocks presents a nearly continuous surface. The outside diameter of the polygon thus formed is 36 ins. and the inside diameter 26 ins. During the test the front of the chamber is closed by means of a light steel plate. The abrasive charge consists of 200 lbs. of cast-iron balls (about 133 1⅞ ins. and 10 3¾ ins. in diameter). These balls conform to the requirements of the standard rattler test of paving brick of the American Society for Testing Materials.

The test consists of exposing the inner faces of the concrete blocks to the wearing action of the charge for 1,800 revolutions at the rate of 30 r.p.m. The machine was run for 90 revolutions in one direction, then reversed. Two sets of blocks are tested at once in the machine now in use. Each block was weighed upon removal from the form, upon removal from the damp sand, immediately before and after testing. The loss in weight during the test is used as a measure of the wear. This loss is reduced to an equivalent depth of wear in inches.

This method of making wear tests of concrete is believed to have the following advantages as compared with other methods which have been used or proposed for this purpose:

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

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

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

(4) The cost of tests is not excessive.

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

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

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

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

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

A comprehensive series of tests on the effect of size and grading of aggregates, using gravel, crushed limestone, granite and slag is now under way. Tests have also been made on a large number of wear blocks molded in the field on concrete road construction.

(Continued in our next issue)

ENGINEERING INSTITUTE OF CANADA ELECTIONS AND TRANSFERS

At a meeting of the council of the Engineering Institute of Canada held July 23rd, 1918, in Montreal, the following elections and transfers were announced:—

AYARS, WM. STEWART, of Halifax, N.S., was elected Member. He was born at Wilkes-Barre, Pa., and educated at Lehigh University. He was for a time sea-going engineer, and during the Spanish-American war was chief machinist and acting assistant engineer. He is a professor at the Nova Scotia Technical College, but since 1917 has been chiefly engaged in re-educational work for the Military Hospitals Commission.

BERTRAND, HENRI, of Montreal, has been transferred from the class of Student to that of Junior Member. He was born at Isle Verte, P.Q., and received his education at Laval University and has, since that time, been acting engineer for the St. Lawrence Pulp Company, and also for the Phœnix Bridge and Iron Works Co. Mr. Bertrand is at present in charge of lining of the G.T. Ry. tunnel through White Mountains, 1st Dist.

BROWNE, ERNEST FRANK, of Ottawa, Ont., has been transferred from the class of student to that of Associate Member. After taking his degree of B.Sc. at Queen's University, Mr. Browne was for a time assistant surveyor on D.L.S., and is at present a Corporal with the Engineering Field Company, C.E.F., France.

BRUNTON, ROBERT, of Victoria, B.C., has been transferred to Associate Member. He was born at Glasgow, Scotland, and educated at the Technical College in his native city. After completing several engineering engagements, Mr. Brunton became resident engineer on location for the C.N. Ry., and is at present time Commissioned Officer, Intelligence Staff, Military District No. 11, Victoria, B.C.

CHARLESWORTH, LIONEL CLAN, of Edmonton, Alta., has been elected Member. Born at Windsor, Ont., and educated at S.P.S., Toronto, he has since served in various engineering capacities in Ontario and elsewhere. Since 1915 Mr. Charlesworth has been Deputy Minister and chief engineer, Department Public Works, Alberta.

CORBETT, ALBERT HAROLD, of Winnipeg, Man., was born at Springfield, Man. He has been transferred from Member to Associate Member. After completing his education at the University of Manitoba, Mr. Corbett became for a time resident engineer in various districts of Manitoba during which time he superintended the construction of bridges, roads, etc. He is at present in charge of general municipal drainage and roadwork in Northern Manitoba.

DAVIS, WILLIAM EDGAR, of Winnipeg, Man., elected an Associate Member. Mr. Davis was born at Guernsey County, Ohio, in 1877, and was educated at Ohio State University, taking all elective branches in engineering and science. From 1906 to 1910 Mr. Davis was resident and assistant engineer on the G.T.P. Railway on location, grading and substructures, North Saskatchewan River crossings and on Division Engineer's staff, Edmonton; 1910-13, assistant engineer in chief engineer's office, G.T.P. Railway; 1913-15, contracting for railway structures under firm names of Davis & Barienbrock, and W. E. Davis; at the present time Major, O.C. 11th Battalion, C.R.T., France.

DICKINSON, JOHN ARTHUR, of Hawkesbury, Ont., elected a Junior Member. Mr. Dickinson was born at Liverpool, England, in 1888. From 1912 to 1917 he was engaged as a draftsman on the head office staff, Welland Ship Canal, St. Catharines, Ont.; 1917 to date, with Riordon Pulp and Paper Co., Ltd., Hawkesbury, Ont.

DYER, ARTHUR FREDERICK, of Halifax, N.S., elected an Associate Member. Mr. Dyer was born at Giridih, India, in 1885, and was educated at Edinburgh University and Heriot Watt College, taking a course in civil engineering. In 1910 Mr. Dyer was for five months employed as a draftsman with the Dominion Bridge Co., Lachine, P.Q.; 1910-12, manager, Clinton Fireproofing Co., Montreal; 1912-15, resident engineer for Sir John Kennedy on construction of new pier at Halifax; 1915 to date, in charge of construction and general consulting work for Furness, Withy & Co., Halifax.

GORDON, JAMES MacKENDRICK, of Toronto, Ont., elected a Junior Member. Mr. Gordon was born at Toronto in 1884, and took a two-year course in mechanical and electrical engineering, School of Practical Science, Toronto. 1910-17, paving superintendent with the Warren Paving Company, in full charge of bitulithic paving construction, in Port Arthur, Fort William, St. John, N.B., New Glasgow, Halifax and Moncton.

GREATREX, WILLIAM KERR, of Toronto, Ont., has been transferred from the class of student to that of Junior Member. He was born at Peterborough, Ont., and took his B.Sc. degree at the University of Toronto in 1917. Mr. Greatrex was for a time instrument man in the Department of Roadways, Toronto, and later assistant engineer of tests with the Toronto Hamilton Highway Commission. At the present time he is engineer for the Imperial Ministry of Munitions.

HACKNER, JOSEPH WESLEY, of Toronto, Ont., elected an Associate Member. Mr. Hackner was born at Uxbridge, Ont., in 1882, and received his degree of B.A.Sc., School of Practical Science, Toronto, in 1909. He has since been employed by the Department of Public Works, Ontario.

HALFORD, ABRAHAM, of Toronto, Ont., has been elected Member. He was born at Maidstone, Ont., and educated at the University of Toronto, in a special science course. Mr. Halford is with the Ontario Public Works Department as chief engineer, and is general superintendent of construction of bridges, locks, etc.

HAYWARD, CHARLES, of Sault Ste. Marie, Ont., elected an Associate Member. Mr. Hayward was born at Rochester, England, and received his degree of B.A.Sc., Toronto University, in 1915. Mr. Hayward is at present with the Algoma Construction & Engineering Co., Ltd., on concrete designs, also preliminary work on a power development scheme, etc.

HORSFALL, HERBERT, of Leaside, Ont., elected an Associate Member. Mr. Horsfall was born at Sheffield, England, in 1880. From 1900 to 1910 he was assistant superintendent and later general superintendent of the Dominion Wire Mfg. Co., Lachine, P.Q.; 1910-18, works manager, Canada Wire & Cable Co., Ltd.; at the present time works manager of the latter company, Leaside Munitions Co., Toronto; also St. Catharines Steel & Metal Co., St. Catharines, Ont.

MACKAY, ROBERT, of Calgary, Alta., elected an Associate Member. Mr. Mackay was born at Duntocher, Scotland, in 1880. From 1910 to date he has been engaged as superintendent and electrical inspector, city of Calgary, Alta.

MACKENZIE, CHARTERS GORDON, of Moose Jaw, Sask., elected an Associate Member. Mr. Mackenzie was born at Lucknow, Ont., in 1887. From 1910 to 1911 he was engaged by the Dominion Government as inspecting engineer on the construction of the Saskatchewan River bridge on the Hudson Bay Railway. At present Mr. Mackenzie is assistant engineer, bridge department, C.N.R.

McCULLY, ROBERT CHESLEY, of Winnipeg, Man., was born at Shediac, N.B., and has been transferred from student to Junior Member. After receiving his degree at Mt. Allison University, Mr. McCully became clerk of the Topographical Survey Branch Department of the Interior and later draftsman with the G.T.P. Ry. He is at present in charge of construction for the Imperial Oil Co., of Winnipeg.

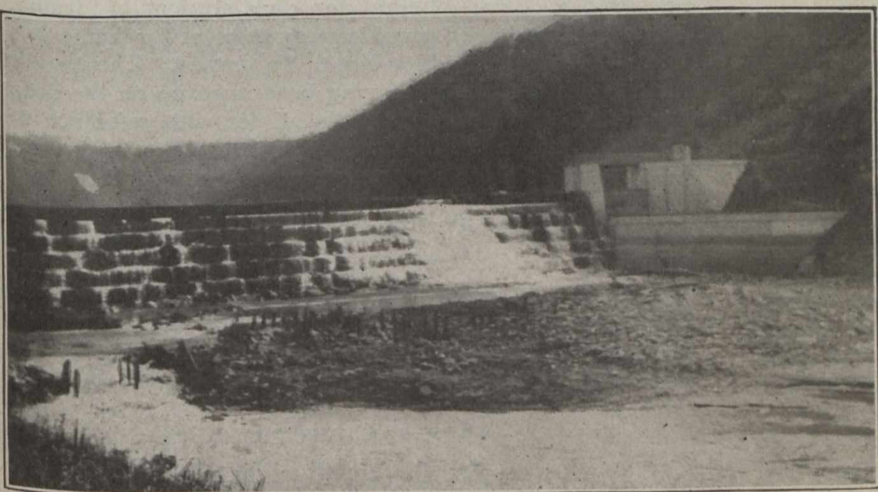
McHUGH, JOHN, of New Westminster, B.C., elected an Associate Member. Mr. McHugh was born at Liverpool, England, in 1879. For several years he was with the C.P.R., G.T.P. Ry. and N.T. Ry. In 1913 he was for eight months municipal engineer, district of Surrey, B.C., and since then resident engineer, Department of Naval Service, Fisheries Branch, New Westminster, B.C.

(Concluded on page 91)

DESIGN OF A TILTING DAM*

By V. Bernard Siems
Pitometer Engineer, Baltimore City Water Department

THE water supply of Baltimore, Md., is taken from the Gunpowder River, the headwaters of which lie in York County, Pa., near the Maryland line. The river then flows through Baltimore County, Md., in a southeasterly direction, emptying into the Chesapeake Bay about ten miles northeast of Baltimore city. The river, though small, has steep slopes, with a drainage area of 308 square miles. Its main tributary below the fall line is the Little Gunpowder Falls, which has the same general characteristics as the larger river. There are several small power developments along its course, of which the Warren and Phœnix Mills are the largest. The condition of water supply in this river and others in the vicinity is different from that of all rivers of the north because of the fact that its location is south of the limits of glacial action. The water is muddy immediately after rains, and subsequently, after the rain is over and the streams are supplied wholly by water coming from the ground, the water becomes clear. It frequently takes two or three days for the water of the Gunpowder River to clear, which clearing up is due mainly to the fact that the clear water following the muddy water forces the latter over the dams, and it is not due to the subsidence of the finer suspended particles which the water is passing through the impounding reservoir. The mineral constituents of the water are fairly low, hardness being about 40 parts per million.



Loch Raven Tilting Dam, Showing One Section Held in Open Position by an Obstruction at the Toe. Water Surface Elevation, 191.5 Ft.

Annual Yield of Gunpowder River

The annual yield of the Gunpowder River, according to the records kept for 35 years past by the water department, has averaged about 280,000,000 gallons daily, much of which runs off in floods, and by suitable storage this flow could be conserved. Previous to 1913 the city of Baltimore received part of its water supply from an impounding reservoir in the Gunpowder Valley, this supply having first been used in 1881. The works for taking this water consist of a stone dam about 25 feet high across the river, about seven miles northeasterly from the city limits, creating a small reservoir, known as Loch Raven, with an original capacity of 510,000,000 gallons, and an area of water surface of 105 acres. Elevation of crest of dam 171.2 ft. A.M.T. At this time the city possessed the right to divert 170,000,000 gallons per day from the Gunpowder River. This capacity became largely reduced by the deposit of silt, until, in 1900, it was reduced to 178,000,000 gallons. At this time dredging was begun, and continued until 1909, with an average cost per year of $25,000.

Plans for Increased Capacity

Starting in 1906, the water department made plans for increased storage capacity. Because of the fact that only $5,000,000 was available for the construction of a new dam and purification plant, the water department decided to build a dam designed for a width of base at foundation line (approximately elevation 140.0 A.M.T.) to elevation 153.0 A.M.T., for a head at elevation 305.0 ft. A.M.T., this being the maximum height at which an impounding reservoir would be practicable. The area of water surface at this elevation would be approximately 9,500 acres, and a total capacity of reservoir of 142,300,000 gallons. This base to serve for dam at elevation of crest (spillway section) of 270.0 ft. A.M.T. Area of water surface at this elevation, 4,928 acres, and a total capacity of 58,871,000,000 gallons. From elevation 155.0 ft. A.M.T. to elevation 164.0 ft. A.M.T. base for dam (spillway section) was designed for a head at elevation 240.0 ft. A.M.T. The area of water surface at elevation 240.0 ft. A.M.T. is approximately 2,391 acres, and has a total capacity of reservoir of 23,660,000,000 gallons. From elevation 164.0 ft. A.M.T., starting with width at this elevation of 29.79 ft., the dam was made of stepped section on down-stream side with a rise of 5.0 feet and a tread of 5.0 feet successively to elevation 184.0 feet A.M.T., and at elevation 188.0 ft. a width of 9.59 ft. The reason for making dam of stepped section on the down-stream side was because of the fact that no excavation or cofferdam construction will be necessary at the time of the raising of dam to any future height.

Warren Company Files Injunction

In 1911 the Warren Manufacturing Co. filed an injunction prohibiting the city of Baltimore from building the low dam, their reason for filing same being the probability of injury to their water power at the Warren Mills by the raising of the dam to the height as proposed by the city of Baltimore. In order not to affect the Warren Mills it was decided to build a masonry dam at elevation 188.0 ft. A.M.T. and then an automatic superdam or tilting dam from 188.0 ft. to 192.0 ft. A.M.T. The masonry dam, at elevation 188.0 ft. A.M.T., was completed on November 1st, 1913, and in 1917 the tilting dam was installed.

Dimensions of Spillway

The present spillway has a length of 321.0 ft. at elevation 188.0 ft. A.M.T., and as this crest has keyways affecting future raising of dam, the centre one was utilized for the location of anchor block, which in turn acts as pivot for tilting dam. To provide a tilting or otherwise movable superdam in this spillway, in one unit, was impracticable, for structural reasons. More so, how-

*Abstracted from paper read before the American Water Works Association.

ever, was this undesirable from the standpoint of waste of water. The tilting dam was arranged so that a portion would tilt when the water reached an elevation of 193.5 ft. A.M.T., a depth of 1.5 feet of water on crest of movable dam. If the flood continued to rise, other portions tilt in turn at different elevations.

The width of spillway was divided into 27 units or separate dams, numbered from 1 to 6. Each numbered section is arranged to tilt at a different height of water over crest. The summary below shows the number of each kind of unit and head under which they are designed to tilt:—

No.	Units.	Designed to tilt at elevation	Elev. of water at crest line (basin's curve)
1	 5	194.0 ft. A.M.T.	193.64 ft. A.M.T.
2	 6	193.5 ft. A.M.T.	193.27 ft. A.M.T.
3	 4	194.0 ft. A.M.T.	193.69 ft. A.M.T.
4	 4	194.5 ft. A.M.T.	
5	 4	195.0 ft. A.M.T.	
6	 4	195.5 ft. A.M.T.	

It should be noted that all sections are four feet high (top of spillway to crest of movable dam) except section No. 1, which is 3 ft. 9 ins. in height. The reason for making section No. 1 (composed of four 12-ft. and one of 9-ft. sections, a total length of spillway of 57 ft., all at elevation 191.75 ft. A.M.T.) lower than the others was because of the desire to confine the normal water flow up to 192.0 ft. A.M.T., also logs, etc., to centre of stream. Section No. 2 was designed to tilt under the minimum head of 1.5 ft. because the intake channel, having an approximate elevation of 170.0 ft. A.M.T. at the gate house, starts opposite this location (Sec. No. 2), and therefore by an increased velocity, due to the water being confined to this location, the deposit of silt at end of tilting dam will be kept away from this channel, also channel to 48-in. sluice gate, whereas if section No. 1 was made to tilt at the minimum head the deposit of silt would fill the entrance to channel.

Form of Dam Chosen

The original topography of the river necessitated the excavation of a channel from original stream bed in order to bring the water to gate house at the lowest elevation. The form of dam chosen was that of an obtuse triangle, pivoted at the obtuse angle, and forming a typical hollow or framed dam. As the water rises on a section its centre of pressure on the inclined dam surface also rises, and eventually the pressure normal to the back will strike through the hinges. At this time neglecting the weight of dam, the structure will be in neutral equilibrium. As the pressure rises still further, the normal strikes above the hinge, and tilting takes place, the dam falling to its second or open position.

Under High Water Conditions

It is significant that since these dams were installed they have been subjected to high water conditions, and sections No. 1, No. 2 and part of No. 3 have tilted. Upon subsidence of the water these dams returned to their normal positions. In many cases the elevation varied from 0.3 ft. to 0.6 ft. lower than that for which they were designed. There can be numerous reasons for this, *i.e.*, as the water subsides and reaches near elevation 188.0 ft. A.M.T. foreign matter lodges at the toe, and when dam drops back it sets on this obstruction, thereby throwing it forward. This is also the case when warping of timber decking at toe and at ends of section takes place. In both cases the tendency is to decrease the head necessary for tilting. The friction and corrosion at pin also offer resistance to tilting. It is interesting to note that, as dams tilt, I-beams and timber decking offer some obstruction to stream. This is especially true as the water subsides. The free waterway from bottom of lower I-beam to concrete top of dam (elevation 188.0 ft. A.M.T.) is 1 ft. 2¾ ins., giving an opening of 1.2 ft. x 321 ft., or 385 sq. ft., obstructed only by upright framing of dam. The tilting dam usually drops back when water reaches an elevation of 188.75 ft. A.M.T. or slightly lower. This proves conclusively that the dams are entirely automatic in their action.

Form of Casting Used as Bearings

The casting used as bearings for the dams has several unique features. The centre keyway on top dam was utilized for the anchoring of castings. It was necessary to cut groove to 14-in. width at anchor blocks, as the 12-in. original groove was irregular in alignment and did not give room for lining up casting. The castings for anchor blocks are different for each section of frame. Distance from back face of keyway to pivot for frame No. 1 is 4 5/16 inches, and for No. 6, 8½ inches. The groove for a width of 6 inches having been lined up on the deep stream side, the castings were all set with reference to this edge. The castings are three in number—a centre block with hole for pin, and two side-setting pieces and wedges. The centre block was first set to position, then the side pieces slid in and tightened against the sides of groove by wedges. After aligning and wedging in position space under castings were filled with 1:2 grout, and spaces between side pieces and block were filled with lead. This gives absolutely rigid construction, limited only by the strength of the concrete in grooves of present masonry dam.

Cost of Construction

Tht total cost of the construction of these tilting dams amounted to approximately $3,700. This work was originally let for contract, two bids being filed, one for $5,275 and the other $9,280. Since the estimate made by the water department amounted to $3,200, the bids were rejected, and the work done by the department's forces at the above-mentioned figure.

By the construction of this tilting dam and the consequent raising of the water surface from elevation 188.0 ft. A.M.T., a considerable saving in electric power consumption at the low-lift pumping station was realized, *e.g.*, with an assumed pumpage of 90,000,000 gallons per day the saving was approximately 1,500 kilowatts per day, or 547,520 kilowatts per year, and at a cost of 0.8 of a cent per kw. we have a saving of $4,380 per year. These assumptions do not allow for water surface lower than 188.0 ft. A.M.T. nor higher than 192.0 ft. A.M.T., and therefore I would say that the tilting dam paid for itself in at least a year and a half.

The Course of the Water

The water impounded behind the new Loch Raven Dam flows through a 10-ft. circular steel conduit, paralleling the Loch Raven drive, until it intersects the 12-ft. circular tunnel at the old Loch Raven gate house; thence through 12-ft. circular tunnel to the low-lift pumping station at the Montebello filter, a distance of seven miles. It is of interest to note that, although the 12-ft. circular tunnel was built in 1881, when the amount of water consumed by the city was very small in proportion to the present consumption, it was designed and built of such liberal dimensions that it will be capable of supplying water to a population of at least 1,500,000, and is therefore a valuable asset to the city. The 12-ft. circular tunnel is intercepted at the centre of the pumping station by a concrete shaft 16 ft. in diameter. This shaft extends vertically from the tunnel at elevation 145.94 ft. A.M.T. to the floor of pumping station at 206.25 A.M.T. The water level in shaft reaches a maximum elevation of 190.0 ft. A.M.T. and varies, of course, according to the elevation of reservoir at the new Loch Raven Dam, the discharge through the tunnel and loss of head. The shaft acts as a suction chamber for four centrifugal pumps, which are arranged around it in radial lines. The water, after passing through one 30-million, two 40-million and one 50-million gallons single stage centrifugal pumps, with a centre line elevation of approximately 198.5 ft. A.M.T., is discharged into a 6.5-ft. circular conduit, having a centre line elevation of 201.5 ft. A.M.T.; thence through an 8.0-ft. circular conduit to head house, through mixing basin, coagulating basin, filters and filtered water reservoir to city distribution system. When the dam at Loch Raven is raised to a crest elevation of 237.0 ft. A.M.T. the centrifugal pumps will be abandoned and water from shaft will pass directly through six 42-in. cast iron pipes arranged radially at centre line at an elevation of 201.5 ft. A.M.T. to 6½-ft. circular conduit.

LEAD PIPE COUPLINGS*

By J. Arthur Jensen
Minneapolis Water Department

THE object of this paper is to discuss the joints commonly used in service pipe connections and the development that has taken place from time to time under the guiding light of experience, for the purpose of improvement and prolonging the life of the service and its various appurtenances.

Description of a Service Pipe

A service pipe, as discussed here, consists of a corporation cock at the water main, a run of lead pipe to the curb or walk, where a stop cock is placed and covered with a box extending to the surface of the ground and galvanized iron pipe continued to the premises. Lead pipe is selected because of its durability and necessary physical properties for conditions generally met with in most localities. Galvanized iron pipe is suitable for the remaining portion of the run from the stop cock to the building. The cocks are made of bronze or noncorrodible metal for the purpose of resisting deterioration and, as a consequence, to permit ease of operation. The principal object in the selection of materials and fittings is to make up a suitable and durable structure that will insure the owner minimum repairs and troubles from leakage. Aside from corrosion of materials, consideration should be given to the various kinds of joints used for connecting the several parts of the service pipe.

The Use of Lead Pipe

"The use of lead pipe probably originated the so-called "wiped joint" or soldered connection to the cocks. There were originally in use the fixed soldering nipples. These later gave way, for obvious reasons, to the separate nipples and tail pieces, with their necessary couplings, all of which are now commonly used. For the iron pipe, the common threaded fittings are convenient and apparently suitable for all purposes. Any improvement in the various parts of a service pipe is naturally based upon the troubles arising from leakage. The leak is the alarm that calls attention to the condition of the service. These leaks require considerable attention by water departments, *viz.*, to locate the trouble, to serve notice upon the owner and to see that prompt repairs are made.

The Practice in Minneapolis

For some time the City of Minneapolis has given consideration to the matter of service leaks that occur between the water main and the meter. These leaks not only give trouble and expense to the owner, but also cause a considerable loss of water to the municipality. This loss has been variously estimated at from 15,000,000 to 20,000,000 gallons per year. These services are owned by the consumers, but the city supervises their maintenance to prevent loss of water. The number of leaks referred to is an increase of 19 per cent. over the previous year. With an increasing number of services approaching the age of trouble and replacement, further increase in the number of leaks must be expected.

Looking to the Future

There are no practicable means for the reduction of leaks occurring in existing services, but in order to prolong the life and lessen troubles on services that will be installed in the future, a study was made to discover the precise nature of existing troubles so that the proper remedy could be applied. At present the service connections are made up of a corporation cock at the main, tail piece with wiped joint to lead pipe leading to the stop cock at the curb where it is again wiped to a soldering nipple. From this point to the meter, galvanized iron pipe is used. All of the wiped joints are made by licensed plumbers who install all services under city inspection. A classification of service leaks was made and some interesting data has been obtained which indicate clearly the various kinds of trouble encountered. The classification was as follows:—

		Per cent.
1. Defective curb cock	6	1.0
2. Iron pipe, corroded	302	47.0
3. Lead pipe, corroded or burst	96	15.0
4. Wiped lead joints	238	37.0
	642	100.0

In considering only the serious leaks in this table, those that occur in iron pipe might be set aside, since such pipes are accessible for repairs without disturbing walks or pavements to any serious extent. The portion of the service that should be most secure and durable is the lead pipe and its connections which are located under the roadway and in the majority of cases—under pavements. The street leaks may then be separated and reclassified as follows:—

		Per cent.
1. Defective curb cock	6	2.0
2. Lead pipe, corroded or burst	96	28.0
3. Wiped lead joints	238	70.0
	340	100.0

Apparent Facts in Street Leaks

An examination of these street leaks shows the following facts to be apparent:—

1. The curb cocks enumerated were found to be defective. They were all old-style cocks which have since been replaced by an improved type by the use of which a

*Extracts from paper read before American Water Works Association.

minimum amount of trouble will be experienced in the future.

2. The table shows 28 per cent. of street leaks to be in the lead pipe itself. About one-sixth of these were due to bursts by swelling of the pipe from repeated water hammer caused by defective faucets. Inspection of these showed all such pipe to be of lighter weight than that used at present. One-fourth of lead pipe troubles were found under car tracks and the pitting and corrosion clearly indicate electrolysis. The remaining leaks were due to other causes though many of them also appear to be from the effects of electrolytic action. Since heavy lead pipe is now used and means are employed to eliminate electrolysis these troubles are already reduced to a minimum, so far as the future is concerned, and justification found for the continued use of lead pipe.

3. The wiped joint leaks made up 70 per cent. of the street leaks and troubles. These leaks are due chiefly to inferior workmanship. In most cases there has been failure to secure proper bonding in the joint. A number were "lop-sided"; others barely covered the end of the tail piece and in several cases the solder had run inside and partially closed the water opening. One joint had an opening left no longer than a pencil and after a remarkable record of patience covering a period of 24 years, the owner had the service dug up and the trouble was discovered and corrected. Many of these joints stood up for many years but finally gave way prematurely.

Trouble Experienced With Wiped Joints

Several years ago lead pipe was used extensively in all plumbing appliances and fittings made of other materials than lead so that the art of wiping lead joints has passed into the hands of pipe fitters rather than the plumbers of former days. In many shops the wiped joints on service pipes form the only work of this nature that is encountered and it must be undertaken as a special task. The work is attempted by unqualified and incompetent persons not familiar with, nor skilled in the art. The result is that present-day wiped joints, under these conditions, do not measure up to the standard of former times, and more trouble may be expected in the future than in the past if such joints continue to be installed.

A Superior Connection

It appears from a consideration of this matter that these facts have been recognized in various cities. Efforts to secure protection against joints have resulted in the development of a connection that is superior to the wiped joint. This joint is a mechanical connection in the form of a coupling in which the lead pipe is shaped to form its own gasket. The lead flange should undergo slight reaming to make true parallel surface for close contact. The couplings should have plane faces, at least in part, to insure a good joint, and must not be permitted to cut the lead flange. The coupling should have a sleeve to cover a short portion of the lead pipe close up to the flange to prevent any movement or deformation of the lead at the joint. The shaping of the lead flange may be conical or at right angles to the axis of the pipe. There are several types of this joint on the market, all having desirable features of design, but the principle is similar in all cases. The coupling is made a part of the corporation or curb cock and is of composition metal. The joint develops the full strength of the lead pipe and is equally as strong as the best wiped joint and superior to it in results because it can eliminate defective workmanship. Tests made in the presence of waterworks men have demonstrated conclusively that rupturing stresses applied as internal pressures and tension on lead pipe secured at both ends by flanged curb cocks, have failed to break the joint or injure the coupling. In all cases the lead pipe burst or parted.

Initial Cost Offset by Improvement

The initial cost of the material for this joint is slightly greater than for the wiped joint but when the necessary labor is added, this cost is more than offset. The cost to the property owner ought at least to be practically the same. An intelligent man can make a flange coupling joint with simple tools and a pair of wrenches in a very short time, and on the ground where required. The comparative cost of the wiped joints and flange couplings in an ordinary service, at recent prices and labor costs, is as follows:—

⅝ in. wiped joint corporation cock	$1.05
¾ in. wiped joint curb cock	2.40
2 lbs. solder, two wiped joints	.80
Plumber's time, 1 hour	.90
Total cost wiped joints	$5.15
⅝ in. flange coupling corporation cock	$1.30
¾ in. flange coupling curb cock	3.15
Time making joints, 1 hour	.40
Total cost flange joints	$4.85

This shows a balance of $0.30 on each service in favor of the flanged joints which can be considered as a margin for fluctuation in cost of materials and labor.

Longer Life of Service Connections

In considering the data given, the use of lead flange joints promises longer life to service connections as a whole, and a consequent reduction of leakage troubles and expense to both the city and property owner. The street service department of Minneapolis has used lead flange couplings of different types for repair work for several years and they have been satisfactory and successful in every way. They have not only proven more convenient than the wiped joint for the department, but their use has also resulted in the saving of time and money in every case.

In reporting upon the fire which recently occurred at the plant of the Thor Iron Works, Toronto, Deputy Fire Marshal Geo. F. Lewis recommends that a practical and comprehensive readjustment of the fire protection system be worked out by engineers, so as to properly protect the city's growing and important industries.

"The British Science Guild is organizing a comprehensive exhibition of products and appliances of scientific and industrial interest which, prior to the war, were obtained chiefly from enemy countries, but are now produced in the United Kingdom. The exhibition, which will be held at King's College from about the first week in August until the first week in September, will show, in the first place, products chiefly imported from Germany before the war, but now made in this country; but it will also illustrate the remarkable developments that have taken place generally in our scientific industries. In many of these, as a matter of fact, Great Britain always excelled, and it is only our national quality of self depreciation which has prevented the public from appreciating the fact that we were able to export to Germany apparatus and products embodying the highest scientific knowledge and technical skill. The exhibits will include: Chemical products; thermal, electrical and optical appliances; glass, quartz and refractory materials; photographic apparatus and material, surgical and medical appliances; and papers and textile products. Further particulars may be obtained from the Organizing Secretary, 82 Victoria Street, S.W. 1, London, Eng."—The Engineer, of London, Eng.

WHO PAYS FOR RESURFACING PAVEMENTS?

An investigation was recently carried out by the American Society of Municipal Improvements which gives some valuable information regarding methods of securing the resurfacing of worn pavements and meeting the cost of same. In sending out the questionnaire three general questions were asked: First, as to the method of meeting the cost of the original pavement; second, as to payment by the city of cost of repairs and maintenance; third, as to the methods used to secure resurfacing or reconstruction of pavement and how funds were raised to pay for the same.

Many cities make careful distinctions between maintenance, repairs, resurfacing and reconstruction, and secure the funds for these different kinds of work from different sources. It is believed that these distinctions, where made, are shown in the following tabular statements of the answers to the questions asked in the questionnaire sent to members.

The responses were quite widely distributed, coming from about 70 cities in 33 states and Canadian provinces.

The meanings of the letters and numbers are given in the foot notes at the end of the tables. They are in three groups.

Capital letters stand for the principal word in the answer to the question.

Small letters refer to the boards or officials involved in the operations.

Numbers refer to notes giving special methods which must be explained, the table not being large enough to contain them.

In the first table, A, are given the answers to the questions regarding the method of meeting the cost of the original pavement.

Column 1 gives the answers to the question, Do the funds come from assessment on the property benefited? It will be noted that in the great majority of cities this is the method. The proportions assessed on the property and raised in other ways are given in a few instances. Special methods of distributing the cost are explained in the foot notes.

Column 2 states whether the cost of original construction is met from general city funds. It will be noted that in many cities the city pays the cost of paving intersections, being considered a property owner to this extent. The proportion definitely fixed for the city to pay is shown in other instances. In Ohio, cities pay for the intersections and two per cent. of the remainder also. In Tennessee the city pays for the grading of the street, for the intersections, and for one-third of the remainder. Other special provisions are explained in the foot notes.

Column 3 states kinds of bonds issued, if any, and what area ultimately pays the bonds. Thus C A denotes that city bonds are issued to pay the cost and these bonds are paid from assessments made on the property benefited; D T that bonds of the paving district are issued which are paid from taxes levied on the district; P A that bonds on the property itself are issued, which are paid from assessments; etc.

The fourth column shows, together with the other columns and the foot notes, how the funds are raised in case there are two or more sources for them.

City bonds (C) are issued by the city and are a charge against the city. They may be paid by general taxes or by assessments on the property improved as stated in each case. District bonds (D) may be issued on the responsibility of the improvement district and paid from proceeds of assessments or taxes on the property in the district; or they may be issued by the city and paid by assessments on the property benefited, not being a lien on the general funds but on the property assessed. Abutting property bonds (P) are issued for the amounts of the deferred payments on each piece of property assessed and are a lien on such property alone. Tax or assessment bills (B) are liens on the property assessed, issued for the amounts of the assessment and sold or given to the contractors in payment for their work.

A. How Cost of Original Pavement is Met

City.	1	2	3	4
ALABAMA				
Birmingham	y	—	CA(1)	—
ARKANSAS				
Pine Bluff	y	—	DT(2)	—
CALIFORNIA				
Pasadena	y	I(3)	PA(4)	—
San Francisco	y	—	—	—
COLORADO				
Denver	y	—	—	—
CONNECTICUT				
Hartford	⅔	⅓	—	(5)
FLORIDA				
West Palm Beach	y	—	—	—
GEORGIA				
Savannah	y	y	—	(6)
ILLINOIS (49)				
Evanston	y	—	PA(4)	—
Moline	y	—	PA(4)	—
Oak Park	y(7)	—	DA	—
Waukegan	y	—	—	—
INDIANA				
Indianapolis	y	I(8)	PA(4)	y
Richmond	4-5	2-5	PA(4)	(5)
South Bend	y	I(3)	PA(4)	y
IOWA				
Sioux City	y	—	—	—
KANSAS				
McPherson	y(7)	I	DA(26)	y
Pittsburg	y	I	DA	y
Wichita	y	I	PA	y
KENTUCKY				
Louisville	y	—	—	—
Owensboro	y	I	DA	y
LOUISIANA				
New Orleans	—	y	—	—
MARYLAND				
Baltimore	—	y	CT	—
MASSACHUSETTS				
Boston	y	—	—	—
Brookline	—	y	C(9)	—
Fitchburg	—	y	CT	—
Springfield	½(10)	y	—	—
MICHIGAN				
Ann Arbor	1-5	I 4-5 (3)	y	(5)
MINNESOTA				
Minneapolis	y	I(11)	—	y
MISSOURI				
Kansas City	y	(12)	BP	—
St. Louis	y	(13)	BP	—
NEW JERSEY				
Atlantic City	y	y	CTA	(14)
East Orange	y	—	—	—
Essex County	—	—	CT	—
Roosevelt	—	y	—	—

City.	1	2	3	4
NEW YORK				
Albany	y	—	CA	—
Buffalo	y	—	—	—
Elmira	2-5	3-5	CT(15)	(5)
New York	y	—	—	—
Oswego	y	I (16)	—	y
Rochester	y	(17)	—	—
Syracuse	y	—	—	—
Utica	⅓	⅔	TCA	(24)
OHIO				
Cleveland	y(19)	12%	CTA(20)	(18)
Columbus	y	12%	CTA(20)	(18)
Lakewood	y	12%	CTA(20)	(18)
OREGON				
Portland	—	y	BCA	(25)
PENNSYLVANIA				
Bradford	y	—	—	—
Butler	y	—	—	—
Erie	y	I	CA (1)	(5)
Farrell	⅔	⅓	—	(5)
Harrisburg	y	I	—	(5)
Oil City	y	I	CA (1)	(5)
Pittsburg	y	—	—	—
Wilkes-Barre	y	—	—	—
RHODE ISLAND				
Pawtucket	—	y	—	—
SOUTH CAROLINA				
Columbia	½	½	—	(5)
TENNESSEE				
Greenville	⅔	GI ⅓	CTA	(21)
TEXAS				
San Antonio	⅔	I ⅓	CT (3)	(5)
VIRGINIA				
Danville	—	y	(15)	—
WASHINGTON				
Everett	y	—	—	—
WISCONSIN				
Beloit	y	I	CT (3)	(22)
Madison	y	—	CA (1)	—
Milwaukee	y	I	—	(22)
CANADA				
Victoria, B.C.	y	—	CA (1)	—
Ottawa, Ont.	y	—	—	—
Toronto, Ont.	y	—	CA (1)	—
Montreal, Que.	y	I (23)	—	(5)

In Table B the first column shows by the small letter, explained in the second group of foot notes, what authority determines when the street shall be resurfaced or reconstructed.

The second column shows whether the procedure followed in resurfacing is the same as that given in Table A or not.

The third column shows whether the procedure followed in reconstruction is the same as that given in Table A or not.

The fourth column shows who pays for resurfacing or reconstruction and method of meeting cost if different from that shown in Table A.

B. How Cost of Repaving is Met

City.	1	2	3	4
ALABAMA				
Birmingham	c	y	y	p
ARKANSAS				
Pine Bluff	p	y	y	p
CALIFORNIA				
Pasadena	cc	y	y	(28)
San Francisco	c	n	—	c
COLORADO				
Denver	m	n	n	c
CONNECTICUT				
Hartford	sc	n	n	c
FLORIDA				
West Palm Beach	co	y	y	P
GEORGIA				
Savannah	co	(29)	y	(29)
ILLINOIS				
Evanston	c	(30)	y	(30)
Moline	b	y	y	cp
Oak Park	b	y	y	(7)
Waukegan	b	y	y	p
INDIANA				
Indianapolis	b	y	y	(4)
Richmond	c	(31)	y	p
South Bend	b	y	y	p
IOWA				
Sioux City	co	y	y	p
KANSAS				
McPherson	—	y	y	p
Pittsburg	p	y	y	(32) (28)
Wichita	p	y	y	(33)
KENTUCKY				
Louisville	b	n	n	c
Owensboro	co	y	y	p
LOUISIANA				
New Orleans	co	n	n	(34)
MARYLAND				
Baltimore	e	y	y	c
MASSACHUSETTS				
Boston	—	—	—	c
Brookline	ss	n	y	(35) c
Fitchburg	co	y	y	c
Springfield	ss	y	y	c
MICHIGAN				
Ann Arbor	co	—	—	c
MINNESOTA				
Minneapolis	co	y	y	p
MISSOURI				
Kansas City	e	y	y	p
St. Louis	b	(36)	y	(36)
NEW JERSEY				
Atlantic City	cc	y	y	c
East Orange	co	n	y	(37)
Essex County	e	—	n	C
Roosevelt	e	y	y	c
NEW YORK				
Albany	co	(38)	(38)	c
Buffalo	cp	y	y	(39)
Elmira	b	y	y	(40)
New York	bp	n	y	c
Oswego	cp	y	y	(41)
Rochester	co	y	y	(42)
Syracuse	co	—	—	(43)
Utica	—	y	y	(24)
OHIO				
Cleveland	co	y	y	(44)
Columbus	co	y	y	(45)
Lakewood	c	y	y	(46)
PENNSYLVANIA				
Bradford	co	—	—	c
Butler	co	—	—	c
Erie	cp	—	—	c
Farrell	c	—	—	c
Harrisburg	—	—	—	c
Oil City	co	n	n	c
Pittsburg	b	n	n	c
Wilkes-Barre	co	—	—	c

City.	1	2	3	4
RHODE ISLAND				
Pawtucket	co	y	y	c
SOUTH CAROLINA				
Columbia	co	none yet repaved		
TENNESSEE				
Greenville	—	y	y	(21)
TEXAS				
San Antonio	ss	y	y	(47)
VIRGINIA				
Danville	co	y	y	(15)
WASHINGTON				
Everett	—	y	y	n
WISCONSIN				
Beloit	co	y	y	(22)
Madison	b	y	y	n
Milwaukee	cp	y	y	(48)
CANADA				
Victoria, B.C.	e	y	y	n
Ottawa, Ont.	cp	y	y	—
Toronto, Ont.	e	y	y	n
Montreal, P.Q.	—	y	y	y

A—Funds raised by assessments on property.

B—Tax or assessment bills issued as direct liens on property.

C—City or county bonds issued to pay cost.

D—Bonds on paving district issued to pay cost.

G—Grading (different procedure from paving).

I—Street intersections separated from street abutting on private property in procedure.

P—Assessment made on abutting property.

T—General municipal taxes are source of funds.

b—Board of Local or Public Works or Improvements, or like body; official titles are various.

bp—Boro president.

c—City.

cc—City Commission.

co—City Council.

cp—Commissioner of Public Works.

e—Engineer of Highways.

m—Manager of Improvements and Parks.

n—No.

p—Property owners.

sc—Board of Street Commissioners.

ss—Superintendent of Streets.

y—Yes.

(1) City bonds are paid from proceeds of assessments on the property benefited.

(2) Bonds issued by improvement districts are paid by taxes on the districts.

(3) Cost of street intersections is paid from city funds.

(4) Bonds issued against the property benefited are paid by assessments upon the property.

(5) Portions indicated are paid by assessment on property benefited and from general funds or paving bond issues.

(6) Part of cost of pavement is paid by assessment on property abutting, and part from general city lands. In the special case of the street improved under the ordinances sent as samples, one-third the total cost was paid from the city treasury and two thirds was paid by a single assessment on the abutting property, the city being considered a property owner to the extent of the width of intersecting streets and lanes.

(7) The property benefited includes property one-half block each way from the street paved. Bonds are issued and paid by tax on the improved district so defined.

(8) Cost of paving street intersections is paid in cash by the city if possible. If necessary, the cost of intersections may be assessed on valuation of all lands and lots in the city, which is made a special assessment district for the purpose. This assessment is made annually, large enough to pay the cost of all work done during the year.

(9) Cost of street paving is usually paid from the general funds, but is occasionally paid from proceeds of paving bond issues.

(10) Assessment of one-half of cost on property benefited is made if the street is a new one. Nearly all street construction is done by municipal labor, only three small contracts have been let in five years.

(11) City pays also the assessments which would be made on property exempt from assessment.

(12) Tax bills payable in four annual instalments are given contractors for work, for each piece of property assessed. Improvements are paid for practically always by assessment on property benefited. Very rarely the improvement of traffic ways is paid for from general funds.

(13) Tax bills are given contractor, which are liens on the particular pieces of property covered by them. It is proposed in case of certain boulevards to assess on the property benefited the cost of an ordinary street, the excess of cost to be paid from general funds of the city.

(14) Ordinances provide that a just and equitable assessment of benefits shall be made on the property benefited and that any excess of cost shall be paid from city funds. Paving bonds are issued and are paid from proceeds of assessments and general taxes.

(15) City's share is sometimes raised by issuing bonds, which are paid from proceeds of city taxes.

(16) Property benefited is assessed bid price for pavement, curb, etc., in front of it plus for inspection, contingencies, etc., 5 per cent. on long block, 10 per cent. on short block or 15 per cent. if there is a single-track car line. This practically seems to leave the city to pay a part or all of the cost of paving street and alley intersections.

(17) The city council has power to assess a part or all of the cost of paving a street against the city, but actually this is limited to assessing on the city 25 per cent. of cost of resurfacing street if it is extensive, but not if it is an entire reconstruction.

(18) The city pays the cost of paving street intersections and 2 per cent. of the remaining cost.

(19) Special assessments are made (a) as a percentage of the tax value of the property assessed; (b) in proportion to the benefits which may result from the improvement; (c) by the foot frontage of the property bounding or abutting upon the improvement. Street improvements are made by (b), which is usually assumed to be (c).

(20) City's portion is paid from proceeds of bond issues, met from general city taxes. City bonds or notes may be issued in anticipation of collection of assessments, interest to be included in the assessment.

(21) Town pays for grading, draining, other preliminary work, one-third of paving, street and alley intersections, pavement abutting public buildings. Abutting property pays two-thirds of cost of paving, one-third on each side of street. City bonds paid from general taxes and serial 1-10 year bonds paid from proceeds of assessments on paving districts are sold to pay costs of improvement.

(22) City pays for street intersections. If cost of pavement is more than $3 a square yard city pays the excess in Beloit and one-half the excess in Milwaukee.

(23) Cost of paving street intersections is paid by the city, also the cost of any excess in width of street over 50 feet.

(24) City pays one-third of cost of pavement and two-thirds is assessed on abutting property, which is paid in cash, or bonds of city are issued, which are paid from deferred payments of assessments with interest.

(25) Tax bills are issued for each piece of property assessed and taken by the contractor. If unpaid in thirty days they are collected as other delinquent taxes unless property owner elects to pay in instalments. Tax bills are then replaced by city bonds, which are paid by the proceeds of the deferred payments of assessments. City bonds draw 1 per cent. less interest than deferred payments of assessments, thus giving a fund for expenses.

(26) The bonds issued in anticipation of collection of assessments are first offered to the state school fund commission and if it does not have funds to invest they are readily sold at 4½ per cent., non-taxable.

(27) Paid from proceeds of wheel tax and auto licenses, as long as the fund is large enough, then streets on which repairs are too heavy are resurfaced by assessment.

(28) City pays for resurfacing or reconstructing street intersections, property is assessed for remainder.

(29) City council decides whether street should be resurfaced or reconstructed. If reconstructed, the cost is met by assessment. If resurfaced, city pays cost in some instances. In case of ordinances filed with report, city was assessed one-third of cost, street railroad cost of paving track space, and property owners two-thirds of cost of plain pavement. Procedure was same as for original construction after old pavement was condemned as unsanitary and worn out. City's share is paid from general city revenues.

(30) A pavement may be resurfaced by the city and the abutting property owners or by special assessment, in the latter case the procedure being the same as for reconstruction or for original construction by this method as outlined in Note 7 above.

(31) City pays cost of resurfacing. If street is reconstructed procedure is same as for new construction as under Table A.

(32) The district for paving or repaving a street extends to the centre of the alley in rear of abutting property, or, if none, 300 feet back from street line.

(33) If property owners petition for resurfacing or reconstruction of street procedure is same as for new construction. If city resurfaces or reconstructs without petition, the city pays the bill out of general funds.

(34) City pays for resurfacing streets from general fund. Cost of reconstruction is divided between city and property owners, proportion not given.

(35) Procedure for reconstruction is same as for new construction and is paid for from general funds or bond issues raised by general taxation.

(36) City does a small amount of resurfacing by the general maintenance force, but most of resurfacing is done, the same as reconstruction, by same procedure as new construction.

(37) City pays for resurfacing, the need for which is determined by the road committee of the city council. Part of cost of reconstruction is paid by city and part by property owners, the necessity of reconstruction being decided by the city council. The city's share of the cost is met by improvement bonds which are paid by general tax.

(38) As city pays for resurfacing, no petition is required and the need for it is determined by the city council on advice of the commissioner of public works and the city engineer. Fifteen-year bonds are issued, which are paid from general taxes. Reconstruction is authorized by ordinance of the city council and paid for by city, same as resurfacing.

(39) The city pays one-third the cost of resurfacing and reconstruction and two-thirds is assessed on property.

(40) The city pays three-fifths the cost of resurfacing and reconstruction and two-fifths is assessed on property. The city's share is paid from the general funds or proceeds of paving bonds, met by tax on city.

(41) Procedure is same as for new construction except that usually about one-half the cost of reconstruction is paid by city from funds of department of works. The city has issued no paving bonds for twenty years.

(42) For some years city council has assessed one-fourth of cost of resurfacing asphalt or brick on the city, and three-fourths on abutting property. Reconstruction is treated same as new construction.

(43) One-tenth of cost of resurfacing and reconstruction is paid from the budget of the year and nine-tenths from the proceeds of ten-year local improvement bonds, which are paid by taxes on entire city.

(44) The city council, on advice of the commissioner of engineering, decides when a street shall be resurfaced or reconstructed. The procedure and method of payment are the same as in the case of new construction except that the city usually pays 50 per cent. of the cost from bond issues met by general taxes.

(45) Same procedure as for new construction except that city pays 50 per cent. of cost plus cost of intersections from general taxes, the other 50 per cent. being assessed as benefits on the abutting property.

(46) The state law for repaving pays 50 per cent. by general tax and 50 per cent. by assessment on frontage, but the city charter provides that for any replacement made within twenty years after the original construction the city shall pay two-thirds from general taxes and assess one-third on the abutting property.

(47) Payment same as for new construction except in case of partial resurfacing.

(48) Fifty per cent. of all cost of resurfacing or reconstruction above $3 a square yard is paid by the city from general funds and 50 per cent. by assessment on abutting property.

(49) Funds may be raised by general tax, frontage tax or by assessment of private and public benefits.

A steamer made from a 40-gal. tank mounted on a portable wood-burning furnace was used very successfully during the past winter by the Interstate Water Co., Danville, Ill., for thawing frozen hydrants. The tank had a safety valve set at low pressure and carried enough ½-in. hose to reach from the boiler to the bottom of the hydrant. It took from 5 to 25 minutes to thaw the worst cases.

"The outstanding feature of the water powers of Canada is their fortunate situation with respect to existing commercial centres," says "The Engineer," of London, Eng. "Within economic transmission range of practically every important city from the Atlantic to the Pacific, except those in the central western prairies, there are clustered water-power sites, which will meet the probable demands for hydro power for generations."

One result of the war is likely to be the forcing of Spain into the ranks of producers of ferro-manganese. By a recent Anglo-Spanish agreement, it was stipulated that Great Britain should supply to Spain ferro-manganese to the extent of 120 tons per month, which was shared among the various producers of steel. Deliveries have been interrupted by the war, and in consequence at least six electro-metallurgical companies have taken steps to produce the article themselves.

CAMP SANITATION*

By Dr. W. P. Mason,
Professor of Chemistry, Rensselaer Polytechnic Institute.

In these days of military activity, with soldiers widely scattered throughout the land, a camp is naturally conceived of as having to do with war, and relatively little thought is given to those gatherings of men who are occupied with the activities of peace.

Certain well-defined differences must be recognized between labor camps and those of soldiers, the most notable of which is the existence of military authority in the one and its entire absence in the other. When provision is being made for a group of men accustomed to obey orders, who are equipped in all particulars with uniformity, who are subject to military authority, and who are protected thereby from the dangers of irregular and vicious living, the camp problem assumes a simplicity of solution quite in contrast with that presented when arrangements have to be made for a collection of persons gathered from many sources, frequently of many nationalities and different languages, often very ignorant, and all imbued with a spirit of independence that causes them to resent what they believe to be an interference with their personal liberty.

Camps are Potentially Dangerous

In perhaps no other way is their resentment so likely to be aroused as by attempts to control their movements during off-hours. Any approach toward making prisoners of camp employees is bound to produce resistance on the part of a majority of them, even though the more intelligent few may be persuaded of the advantage accruing from stopping a too free passage to and from the general enclosure. A man-proof fence with single gateway has its advantages, even though no physical interference be attempted with an inmate passing the guard.

Camps are sources of potential damage not only to their own people, but also to the inhabitants of the district wherein they are located, particularly to those who dwell down stream in the same valley. Pollution of a public water supply, either direct or through injury to its general water-shed, may become serious unless guarded against by competent sanitary supervision.

This supervision may be undertaken by those in responsible charge of the camp or else by the sanitary authorities of the municipality threatened. It would be better if it were carefully looked after by both, although it often fails to receive the attention of either.

"Unnecessary Expense"

There is abundance of law upon the statute books wherefrom the local health officer can draw all the power needed to meet the situation, but it too frequently happens that the power is not evoked until the threatening menace has developed into an actual disaster. The public itself should not be required to look into matters of health protection, for the sufficient reasons that they do not possess the skill, and have, moreover, delegated a presumed expert to do that sort of work for them; consequently, many sanitary sins will be overlooked, particularly if rectification should call for heavy demand upon the treasury.

When something serious does happen, however, the public energy will act with great vigor to abate an existing and manifest evil, even though the ounce of prevention that could have saved the day was at an earlier period considered an unnecessary expense.

Of all the forms of danger which may accompany camp life, that arising from the presence of human dejecta is the one requiring the most serious consideration. How shall this material be handled so as to deprive it of power to become a menace to health? Even when the number of men employed upon a job is small, it will never be wise to allow them free license to act as they see fit in the matter of disposing of their bowel discharges. This is particularly true if the job be one involving the possible pollution of a public water supply.

Burial of Dejecta

So simple a device as a "straddle trench" is quickly made and easily cared for, and, if well located, possesses the advantage of placing the material collected in a portion of the soil where pathogenic bacteria will find conditions least likely to favor their longevity.

As illustrating the great difference in numbers of ordinary bacteria found at sundry depths, the following counts are given per gramme of dry meadow soil:—

Immediately under the sod	114,000
1 foot below	47,800
2 feet below	39,000
3 feet below	9,500
4 feet below	6,700

A straddle trench should be dug twelve inches wide, twelve inches deep, and as long as circumstances demand. Dejecta placed therein and covered at once with the excavated earth will be quickly destroyed, in contrast with what happens to it when deposited in pits many feet deep. In the latter case the action is one of imprisonment rather than destruction.

Anyone who has had occasion to uncover very old and large privy pits will recall the exceedingly foul condition in which the contents were found, even after the lapse of many years, while, on the other hand, the appearance of the soil turned by the plough in any field which has been repeatedly manured will furnish illustration of how quickly animal droppings will disappear after shallow burial.

Easy to Start Much Trouble

It would seem scarcely necessary to urge attention to the selection of a proper site for a straddle trench, and yet it was lack of good judgment in such a matter that caused an outbreak of typhoid fever in a New England community through the washing out by heavy rainfall of dejecta carelessly buried on a steep hillside.

It takes but little infected material to produce great damage if the point of its introduction be a vital one. This was instanced at Plymouth, Pa., when the dejecta of a single typhoid patient caused the illness of over twelve hundred people. Nevertheless, it is manifestly wiser to take chances on a little rather than on much of a dangerous article, particularly if that little be so distributed as to encounter conditions favorable to its destruction.

If the dejecta in the Plymouth case, instead of being accumulated upon a steep and rocky hillside during a northern winter, had been scattered upon a flat and sandy southern soil, the polluting material would have been easily and safely disposed of and no disaster would have occurred.

No more safe method of disposal for small amounts of night soil can be secured than placing it in small lots just under the surface of the ground in a level sandy loam. It is the privy system at its best.

*Paper presented to the Annual Meeting of the Franklin Institute.

How the ancient Hebrews looked upon this matter may be judged from the following: "Thou shalt have a place also without the camp, whither thou shalt go forth abroad: And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee" (Deut. 23: 13).

New Railroad Device

Perhaps it may be not generally known that a device has been under trial by one or more railroads whereby a certain speed has to be attained by the car before the toilet pans can be dumped. While the train is standing at stations or while it is slowly approaching or leaving them the pans are automatically locked. The advantage, so far as cleanliness of the stations is concerned, is apparent, but benefit reaches further than that, for the reason that the material discharged at a high rate of train speed is spread over much ground, which increases the opportunity for natural purifying agencies to do their work.

A simple, old-fashioned privy system is often the only one which will fit camp conditions, but deep pits are then usually a necessity. Flies must be absolutely excluded from the possibility of reaching the excreta, seat-covers must always be provided, and must be so constructed as to be self-closing when the seat is vacated, and the ventilating window must be screened. The seat-box should be movable to allow of the pit being burned out with straw and oil three times a week, if not oftener.

As camps grow in size, the labor of properly caring for them increases. Men have to be employed whose entire time is devoted to sanitary work. Proper water carriage of sewage, night-soil removal, and incineration of garbage are matters that fall under the care of such men.

A complete water-closet system contemplates sewers and also a disposal plant, unless there be available either some large body of water into which raw sewage can safely be discharged, or else an almost unlimited area of suitable sandy soil for disposal by irrigation. At one of our cantonments where some thousands of men are collected, the raw sewage, after coarse screening, is run into a blind ditch in the sand, which ditch is simply extended as its side slopes and bottom becomes clogged. Clogging is delayed by suitable use of a rake. Nothing could be simpler, but the character of the soil requisite for such a solution of the sewage problem is rarely found, and when found cannot be unduly overworked.

Artesian Wells to Scatter Sewage!

The most novel proposition, involving a serious overload, that the writer ever encountered had to do with sewage disposal in a town in the Far West where deep wells were available which delivered much water under heavy pressure. The proposition was to use this artesian water to shoot the sewage into the air and thereby so distribute it over the country as to render it unobjectionable. One can imagine the state of things that would have resulted had such an odd plan been adopted.

A sewage disposal layout of a municipal type cannot be considered for a camp except under circumstances of decided permanency, and when provision is to be made for a large body of men. At a number of our present military establishments we possess such systems of treatment, but labor camps are nearly always in quite another class.

Night-soil removal, or the can system, involves burying the can contents or else burning them, and the decision is sometimes in favor of employing both methods, although burying is the more common. There is an often-expressed objection to the burning of this sort of material because of a fancied unpleasant smell resulting, and yet it is really hard to detect any real difference between the odor so produced and that evolved by the combustion of almost any kind of organic material. Major Lelean quotes an interesting letter from a lady, who wrote as follows: "The odor of burning peat, so delightfully reminiscent of the cotter's hearth, becomes the intolerable effluvium of burning matter of an indescribably objectionable nature" when excreta are being burned. Inasmuch as the letter of objection was received when a wood fire was employed to try out the furnace, and before any excreta had been added, the Major was induced to seriously discount subsequent objections.

Use of Incinerators

Many types of incinerators are in use, some of which are decidedly complex and expensive. For a simple device, calculated to provide for a reasonable number of men, and especially suitable for garbage destruction, the Woodruff pit is worthy of attention. It is merely a circular hole in the ground, ten feet in diameter and about four feet deep, with the sides lined up with field stones. In the centre is a conical pile of the same stones to act as a sort of draft chimney. This pile can be advantageously supplemented by a couple of lengths of tile pipe, or even old stovepipe. A good fire of wood having been started in this pit, a very considerable amount of camp refuse can be disposed of by judicious firing. Liquids should be slowly poured down the hot side stones so as to encourage rapid evaporation. If liquids be added in too great bulk or thrown on too quickly they are likely to pass the fire zone and reach a lower level where they may start a nuisance.

One disadvantage of the Woodruff pit or of any other type of open fire is that when the wind is high, light materials will often be blown about the camp; this is especially objectionable if the said materials chance to be what are known as "camp butterflies," or toilet paper.

Urine can be well disposed of by the stone-filled soakage pits, adopted by the British Army, into which long funnels of wood or tin are extended. Fouling of the ground with consequent fly infection is thus avoided.

At one large New York camp a non-portable furnace was built which worked successfully. It consisted of three levels, of which the bottom one held the fire. The top level was a shelf extending from the front half-way or more toward the back wall, and upon this shelf was thrown the material to be destroyed. The middle level was also a shelf of about the size of the top one, but it extended from the back wall out toward the front. Thus the hot products of combustion followed a curved course under and over the materials on the two shelves. When the charge on the top shelf had become thoroughly dried it was pushed back so as to fall on the middle shelf, and when it had thoroughly charred in that position it was pulled forward and fell upon the fire.

The Plattsburg Furnace

A military furnace may be seen at Plattsburg which is operated without drying shelves. Its length is greater than its height, and the garbage charge is dumped directly upon the fire through a trap-door. The fuel is cordwood. Around the sides of the combustion chamber run iron water pipes that act like the water-back of a kitchen range and supply hot water with which to wash the cans in which the garbage is collected. The process is not continuous, and a new fire has to be started every morning.

While garbage is usually incinerated in a furnace such as this or in a Woodruff pit or in some still simpler arrangement burning either wood or coal, yet it generally contains so much combustible material that a device less costly in the matter of fuel consumption is to be preferred.

The Canadian camps, or at least some of them, are using a furnace which is designed to operate continuously without any other fuel than that contained in the garbage itself after an initial fire of wood has been built as a starter.

Col. Nasmith's Experiences

Colonel Nasmith, of Toronto, advises the writer that while at the front in France, excellent results were secured by constructing incinerator walls out of old oil cans filled with puddled clay. After a wall built in such a manner had been fired it proved very stable. Similar cans used empty produced a reliable chimney, and old railroad iron thrust irregularly through the furnace walls supplied supports for the garbage charge and permitted air to reach scattered points throughout the mass.

Doctor Nasmith found it of advantage to follow the introduction of old tin cans of every description into the furnace with the garbage, as thereby a desirable "porosity" was given to the material being burned.

Horse manure can be burned by arrangement such as just described, but the destruction of valuable fertilizing material savors of decided waste, and, moreover, a labor camp rarely contains enough horses to demand military measures.

Fifty horses will make about a wagonload of manure daily, but, however small the volume may be, provision must be made to prevent its becoming a breeding place for flies. Usually, although not always, farmers are found willing to cart manure away for use upon their crops, in which case it is of interest to be certain that it is hauled to a sufficient distance before it is piled; otherwise, as a large camp presents many attractions for flies, the insects are likely to find it if the haul should be a short one. Major J. M. Phalan, U.S.A., believes that the only safe haul is one by railroad, for the reason that a distance likely to be covered by ordinary wagon hauling would probably prove much too short to prevent the flies reaching camp.

Swat the Fly!

However much the average farmer may value good manure which is given to him, the labor camp is frequently so placed as to make the use of its horse droppings for fertilizer unprofitable because of the expense of removal. A small amount of manure can be made "fly-proof" by a liberal wetting down with solution of copperas, but a much better treatment is that of destruction by fire. Windrows less than two feet high can be successfully burned if sprinkled with crude oil.

Before leaving the question of flies we should remember that a single insect can produce nearly a million descendants during a season. They feed to a large measure upon fæces, and their bodies and legs are covered with hairs, so that they can act as distributors of pathogenic organisms by vomiting upon human food, by defecating over it, and by wiping their filthy feet upon it.

So much has been written upon the necessity of protection against flies and mosquitoes that it is simply needed here to insert a reminder that the development period, from egg to mature form, of each of these insects is practically the same, namely, about two weeks. Precautions in the way of thorough screening of quarters, removal or destruction of horse manure, and oiling or draining of water pools, however small, must be faithfully practised throughout the breeding season.

Only a word can properly be said here upon the general subject of "housing," because upon that topic there are far too many variables to allow of a fair standardization of labor camps. Five hundred cubic feet of air space per man should be supplied in the sleeping quarters, and mosquitoes should be excluded by careful screening.

Each camp must be treated upon a plan of its own and local conditions must govern. The construction of proper ditches to receive roof drip and the use of the material excavated from these for "banking" the outer walls against drafts along the floor naturally suggest themselves as suitable procedures.

Two-Story Barracks, With Bunks

Sleeping accommodations of the "bunk" form are more compact and are cheaper than cots placed side by side. They have the disadvantage of being more difficult to keep clean than the open arrangement, but, on the other hand, communicable diseases are not so easily transmitted under crowded conditions.

Both one-story and two-story barracks have their advocates. The two-storied forms are certainly cheaper to heat per capita, and they are also less expensive in the matter of cost of roof construction, calculating upon the same basis.

The following description by Meriwether of prison barracks may be inserted here:—

"They occupy what are called Adrian barracks, which are built of wood, in sections one hundred feet long by twenty-five feet wide. The necessary parts are standardized and can be quickly assembled. After each big battle a quantity of the parts is rushed to the desired point, and within a few hours accommodations are ready for the captured men. On the day of our visit the camp contained eleven hundred and ninety-eight prisoners, but three hundred and sixty more were to arrive the next day, and quarters for the newcomers were being assembled.

"Each barrack contains two rows of two-story bunks, the upper bunk being placed four feet above the lower. In the centre between the two rows of bunks is an aisle provided with long tables and benches. Electric lamps light this centre aisle, and the prisoners use the tables as dining-tables and for playing games and writing letters.

"In another the grounds of the camp were drained by subsoil pipes. The wooden barracks, heated by stoves and lighted by electricity, contained bunks raised eighteen inches above the wood floors. Each bunk was provided with a straw mattress and two woolen blankets."

Carelessness Not All In Camp

Camps being but temporary in character, a due consideration of the "economic period" for which they are built naturally controls to a large degree the design of the quarters.

In localities of special danger, as when new construction or repairs are in progress in the immediate vicinity of some public water supply, the care exercised in the camp itself must be extended to the site of the work as well. The thoughtlessness that a labor gang can exhibit upon occasion is simply amazing.

It would seem sufficiently careless to deposit fecal matter upon the steep bank of a stream a short distance above a city intake, but the writer has seen the same material dropped in the open end of a cast-iron water main as it lay in the ditch. Nothing but careful sanitary supervision can meet such abuse.

Naturally the officer in charge of formulating the rules governing the camp, if worthy of his responsibility, would see to it that the regulations were suited to the local conditions, and, while strict enough to safeguard health, were not so loaded with unnecessary caution as to become a burden. No hard-and-fast rule can be laid down which will state, for instance, the exact point beyond which pollution will become dangerous and short of which one can count upon safety. The writer had upon one occasion testified that five thousand head of cattle would seriously damage the water of a certain stream upon the banks of which they were corralled. The cross-examiner asked if twenty-five hundred would likewise cause serious pollution, and the answer was "Yes." The next question was, "Would twelve hundred cattle produce serious pollution?" To this the reply had to be made that, "while willing to halve the number of cattle actually covered by the facts in the case at issue, it would be unwise to attempt further division for fear of finding a single cow polluting the entire valley."

Protection of the Watershed

The prominence usually given to what may be termed the auto-intoxication of a camp may well mask the equally important matter of the danger a camp may be to the well-being of those whose homes are in the same drainage area. Camps are, of course, of all sizes, depending upon the magnitude of the job, but it is no error to assume that for the same quantity of proposed work a larger number of laborers must now be provided than were needed for the same work a few years ago. As an instance, it was formerly common on railroad construction to find four men carrying a hundred-pound rail, where now twelve are demanded; and, while one man could in the past shoulder a railroad tie, it now must be lifted by two men, one at each end, except in those cases where the tie is creosoted, when four men using lifting tongs are required.

Of course, such circumstances increase not only the expense of construction, but they also call for greater vigilance to provide against sanitary risks arising from enlarged camp population.

Nothing short of conscientious sanitary inspection, followed by promptness in necessary action, can meet the difficulties that confront those in charge of water-shed protection.

It is of the utmost importance that engineers and foremen should remember that in a very real sense they are health officers and sanitary instructors as well. The men under their care are likely to be largely ignorant of elementary sanitation and need both instruction and advice. If the camp be sufficiently large to support a meeting hall, great good will follow the inauguration of lectures and instructional moving pictures. Not only needed information is thereby supplied, but entertainment also.

It goes without saying that the camp water supply is a matter of major importance, and it is the manifest duty of the parties in charge to so arrange matters that a suitable volume shall be always available, and that its quality shall be suitable as well. Small groups of men can usually be safely supplied locally, but large camps may demand the exercise of considerable skill of a special character to meet their needs. No haphazard guessing nor the application of household tests should be employed to determine the suitability of a water for use in a large camp. At this point we are reminded of a quaint old book by John Smith, printed in 1712. Its title is "The Curiosities of Common Water, or the Advantages Thereof in Curing Cholera, Intemperance, and Other Maladies." In it we note: "How to distinguish water." "The way to do this is by the taste and scent—for if it have no taste nor small, being purely fresh, nor salt, nor sweetish, nor ill-scented, it is good, provided it be pure and clear." "All water that will make good lather with soap is wholesome to drink without boiling, but none else."

It may be that no little difficulty will be encountered in persuading the men to avoid the attractive water from some polluted well and use the safer camp supply, as the latter may have been carried some distance in slightly buried pipes, and consequently be lacking in coolness. If the camp water should have a taste due to algæ, there would be still greater difficulty in securing its use. Algal taste can be successfully removed by a small dose of potassium permanganate, as first proposed by Houston. Removal of the means of raising the water from an open and polluted well is the best plan for stopping its use if such a procedure be permissible. Deep or driven wells furnish supplies that may be nearly always accepted with confidence.

Bathing should be encouraged, and, unless the camp be very small, showers of simple construction should be built. In the absence of showers, abundant provision should be made for the washing of both body and clothes, and no charge should be made for soap.

To insist upon and secure periodical bathing is rather more than those in charge of labor camps can accomplish; all they can do is to see to it that provision is made for maintaining cleanliness and leave the rest to the discretion of the men. Fifty gallons of water per day per capita should be supplied to large camps; this will very liberally suffice for all purposes.

Using Same Water Repeatedly

It is interesting to observe the economies that have to be practised during the present war in localities where water is scarce. Thus we note in the "Journal of the Royal Army Medical Corps," 27:363: "Baths at the front where water is scarce. Add lime to the water after use and mix by hand-power. Insoluble lime soap separates, settles, and carries down impurities. Settlement is effected in three successive concrete tanks. Sodium carbonate is added to the water in the third tank, whereby calcium carbonate is precipitated and oils are caused to float. The latter are absorbed by sacking on frames. After settling in this third tank, the water is passed through a charcoal bed four inches thick." The water treated as above is described as quite clear and "free from dirt, soap, lime and soapy oils." The same water is used indefinitely.

As to the character of the pipe for camp plumbing and the possibility of its being acted upon by the water carried, there is not the same necessity for careful selection as when more permanent construction is being undertaken. "Red water," due to an attack upon iron by a soft surface supply, is not likely to appear immediately, so that even an inferior galvanized pipe will probably last long enough to outlive the purposes of the camp, and we know that action upon the protecting coating, whereby zinc is carried into solution, will cause no injury to those drinking the water. Large amounts of zinc have been swallowed by sundry communities over long periods of time without ill effects. Thus Hazen reports that at Brisbane, Queensland, the water, which is stored in tanks built of galvanized iron, contains over seventeen parts per million of zinc, yet no harmful effects have been observed after years of use. A number of city water supplies of Massachusetts have been reported by the State Board of Health as containing zinc, but no evil results due to its presence have been reported.

In the State of New York certain rules are formulated by the Commissioner of Health which work hardship to no one and which materially aid in conserving the health both of the camp and of the neighboring communities. Among the requirements we observe that even for so small a labor camp as one holding ten people a permit must be secured if the camp site is to be occupied for over six days.

If there be twenty people in the camp, then a camp caretaker must be appointed.

No camp building of any kind shall be erected within fifty feet of a stream or lake furnishing public water supply.

Any privy located within from fifty to two hundred feet of said stream or lake shall be built without a vault and its dejecta shall be removed daily to a distance of at least two hundred feet from the water's edge before being buried or incinerated. A number of states have similar sanitary rules, but unfortunately others do not.

Engineers in charge of even large labor camps could scarcely be expected to have the camp cooks examined to determine if they were "typhoid carriers" or to provide "typhoid vaccination" for the men; neither could it be expected that they should look after the cleanliness of their employees to the extent of ridding them of body vermin, nor is it likely that the latter attention would be acceptable to the employees if it were offered.

A feeling of thankfulness should develop upon the thought that supervision does not have to extend so far, for the thorough accomplishment of that kind of an undertaking is a task indeed. One has but to note the almost endless detail and yet perfect smoothness of running in the matter of managing that disagreeable job among the troops now in France in order to appreciate how much the commander in civil life is spared. To quote from a prominent military authority: "It takes from 8 a.m. to 4.40 p.m. to attend to the thorough 'delousing' of 1,400 men. This includes washing of the bodies and the washing, steaming and drying of their clothes."

To conclude, we see that the proper management of a labor camp is largely founded upon common-sense and good judgment, with an additional allowance of that extra sense called "tact," which enables one to get along efficiently and smoothly with other men.

ENGINEERING INSTITUTE OF CANADA

(Continued from page 78)

O'KELLY, EDWARD GEORGE, of Toronto, Ont., elected an Associate Member. Mr. O'Kelly was born at Cooloo, Ireland, in 1879. From 1907 to 1910 he was a member of the firm of Hamer and O'Kelly, engineers and contractors, in full charge of construction of five large concrete substructures for bridges N.T. Ry.; 1912 to the present time assistant engineer Public Works of Canada.

ROGERS, GEORGE WYON, St. James, Man., elected an Associate Member. Mr. Rogers was born near London, England, in 1869, and was educated at King's College, London, and also passed College of Preceptors C.E. course, Crystal Palace School of Engineering. He was assistant on the main drainage works, West Ham, London, E.; assistant to late Sir F. Bramwell, Westminster, London, on civil engineering works; assistant to late Roger Field on engineering works and underground work, London and county; engineer with King, Norton and Birmingham, sewage disposal and refuse destructor; 1909-11, engineer to the Manitoba Government; since 1911 engineer to the municipality of Assiniboia.

ROSS, ROBERT WILLIAM, of Melville, Sask., has been transferred from the class of Junior to that of Associate Member. After completing his education at Queen's University, Mr. Ross was for several years acting instrument man with the G.T.P. Ry. He later became resident engineer for construction of branch lines and is, at the present time, instrument man on maintenance with the G.T.P. Ry.

SCOTT, CECIL R., of Toronto, Ont., has been elected a Junior Member. He was born at Richmond, Ont., and educated at the University of Toronto. Mr. Scott is at the present time designing for the firm of James, Loudon and Hertzberg, Ltd., Toronto.

WALSHAW, JOHN HENRY, of Calgary, Alta., elected an Associate Member. Mr. Walshaw was born in Auckland, N.Z., in 1880. In 1910 he was assistant building inspector, city of Calgary, and from 1915 to date, building inspector.

WRIGHT, CHARLES HARVEY, of Halifax, N.S., has been elected Member. Born at Renfrew, Ont., and educated at McGill University, he became construction and installing engineer for Canadian General Electric Co., of Toronto. Mr. Wright is at present district manager and engineer for the same firm.

NEW YORK STATE NEEDS POWER

THE two American hydro-electric plants at Niagara Falls were taken over by the United States Government in December, 1917, and their power distributed under Federal order to essential industries, says a recent report to the U.S. Secretary of War by Gen. C. Keller and R. J. Bulkley, who have been supervising the supply of electrical power in western New York State for the U.S. Government. One of the plants, during the past winter, devoted 74 per cent. of its power to direct war industries and 12 per cent. to transportation; of the remaining 14 per cent. only 2 per cent. went to really nonessential interests. The other company had 97 per cent. in direct war industry. In some cases power users deprived of power changed their product to one essential to the war and received power.

Regarding shortage in this district the report says:—

"Under war conditions the power supply falls short of the demand by about 200,000 h.p. This estimate is not based on new industries coming into the district, but is determined as the amount of power which could be absorbed by the industries now operating, were such a supply available. A large part of this amount would be absorbed without the addition of new industrial equipment by the users.

"Some of this shortage will be relieved next fall by the proposed enlargements of the steam plants of the steam plants of the Buffalo General Electric Co. and the Niagara, Lockport and Ontario Power Co. These two companies are now making additions to their plants aggregating 62,000 h.p. By means of a further development by the American hydro-electric power companies at Niagara Falls, their existing supply of power, amounting to about 250,000 h.p. will be increased by about 160,000 h.p."

Work has already been started on the 66,000-h.p. addition to the Hydraulic Power Co., on the American side of the fall. Two 33,000-h.p. units are to be installed at present, and in future, if permission for use of more water can be had, this will be increased to ten such units, making a total capacity, with the present units, of 450,000 horsepower.

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HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

Principal Contents of this Issue

MILITARY STATUS FOR STUDENTS

CO-OPERATING with the presidents of all the universities and colleges in the United States, Secretary of War Newton D. Baker has announced that military training shall at once be instituted in all such institutions, to the end that students, being thus offered by the government a definite and immediate military status, may recognize the duty to continue their education rather than to enlist prematurely in active service.

The details of the plan remain to be worked out, but the War Department has announced that it will be comprehensive and that it will begin with the next college year, September, 1918.

Military instruction under officers and non-commissioned officers of the army will be provided in every institution of college grade which enrolls for the instruction 100 or more able-bodied students over the age of eighteen. The necessary military equipment will, so far as possible, be provided by the government. There will be created a military training unit in each institution. Enlistment will be purely voluntary, but all students over the age of eighteen will be encouraged to enlist. The enlistment will constitute the student a member of the army of the United States, liable to active duty at the call of the president. It will, however, be the policy of the government not to call the members of the training units to active duty until they have reached the age of twenty-one, unless urgent military necessity compels an earlier call. Students under eighteen and, therefore, not legally eligible for enlistment, will be encouraged to enroll in the training units. Provision will be made for co-ordinating the Reserve Officers' Training Corps system, which exists in about one-third of the collegiate institutions, with this broader plan.

This new policy aims to accomplish a two-fold object: first, to develop as a great military asset the large body of young men in the colleges; and second, to prevent unnecessary and wasteful depletion of the colleges through indiscriminate volunteering, by offering to the students a definite and immediate military status.

Should not a similar program be evolved for all Canadian colleges, especially those devoted to the education of engineers, chemists, physicians and other professional men whose services are essential to the welfare of the country?

OUTPUT AND CONSUMPTION OF COAL

IN 1913 there was mined throughout the world about 1,400 million tons of coal, according to statistics compiled by Prof. F. B. Burstall, of Birmingham University. Of this total, about 600 million tons were used for metallurgical purposes and 300 million tons for the production of power, says Prof. Burstall.

Mr. Geo. S. Rice, of Washington, D.C., in a paper read last year before the American Institute of Mining Engineers, estimated the world's coal production in 1913 at 1,330 million tons, as follows:—

	Tons.
United States	513,000,000
Great Britain	290,000,000
Germany	275,000,000
Austria-Hungary	54,000,000
France	40,000,000
Russia	32,000,000
Belgium	22,000,000
Asia	47,000,000
Africa	6,000,000
Other countries	50,000,000
	1,330,000,000

Mr. Rice estimates that the world's gross coal resources amount to approximately seven million-million tons, consisting of:—

Anthracite and semi-anthracite	495,000,000,000
Bituminous coal	3,960,000,000,000
Sub-bituminous and lignite coal	2,970,000,000,000

The above figures include all coal down to 1 ft. in thickness and 4,000 ft. in depth. The estimates are as follows:—

	Tons.
United States	3,960,000,000,000
Canada	1,240,000,000,000
China	990,000,000,000
Germany	416,000,000,000
Great Britain	187,000,000,000
Russia	59,000,000,000
Austria	53,000,000,000
Belgium	10,800,000,000

It must be borne in mind that in the above estimated tonnages, as regards the United States about one-half is lignite coal, and in the case of Canada four-fifths is lignite coal.

The coal consumption per head in the United States for the year 1915 varied from 0.35 to 6.52 tons per capita, and by the various industries was as follows:—

	Tons.
Domestic	47,000,000
Steam	32,000,000
Railroads	128,000,000
Industrial steam trade	144,000,000
Domestic & small steam trade	71,000,000
Beehive coke	42,000,000
By-product coke	20,000,000
Exported	23,000,000
Steamship bunker fuel	11,000,000
Steam and heat at mines	10,000,000
Coal gas	5,000,000

The total production of anthracite and bituminous coal in the United States from 1807 to 1915 was as follows:—

	Tons.
1807-1825	500,000
1826-1835	4,000,000
1836-1845	23,000,000
1846-1855	84,000,000
1856-1865	174,000,000
1866-1875	419,000,000
1876-1885	848,000,000
1886-1895	1,586,000,000
1896-1905	2,832,000,000
1906-1915	4,919,000,000
	10,890,000,000

Anthracite coal is a luxury, and only possessed by the United States in very large quantities, but even there it is limited, being probably only sufficient to last about a hundred years longer. Canada cannot depend upon the United States for a continued supply of anthracite coal. She must proceed with the earnest development of her own lignite, peat and other fuel resources, comparatively inferior as they may be.

OBITUARIES

HENRY CARRE, B.A., D.L.S., O.L.S., died on July 11th at Belleville, Ont. Mr. Carre was 85 years old at the time of his death; he was formerly well-known in railway engineering circles.

E. P. QUIRK, C.E., who retired from practice about 15 years ago, died last week in Montreal. Mr. Quirk was a graduate of Trinity College, Dublin, and came to Canada in 1874. He was engaged in harbor and railroad work.

PERSONALS

JOSEPH LAFOREST, formerly chief city engineer at Hull, P.Q., has joined the staff of the Braden Copper Company in Chili.

E. W. PATTISON, who was recently appointed municipal engineer of Langley, B.C., has resigned to accept a position in eastern Canada.

E. J. ALBERT has resigned as manager of the mining and power branch of the Canadian Allis-Chalmers, Ltd., Toronto, to become sales manager of the Thwing Instrument Co., Philadelphia.

J. E. LONG, of Moncton, N.B., safety engineer, who has been in charge of the "Safety First" department of the C.G.R., has resigned to join the Delaware and Hudson Railway. He will be stationed at Albany under F. P. Gutelius, formerly general manager of the Canadian Government Railways.

Captain RALPH B. GIBSON, of Toronto, has recently been promoted to adjutant of the Fifth Battalion, Canadian Engineers, with rank of captain. After graduating from the University of Toronto, Captain Gibson enlisted with the 83rd Battalion and went to France from England with the 123rd Battalion, and later transferred to the Engineers.

DONALD HUGH MCDOUGALL has resigned as general manager of the Dominion Steel Corporation, Limited, to accept the presidency of the Nova Scotia Steel and Coal Co., Limited, succeeding Frank H. Crockard, who decided to return to the Tennessee Coal, Iron and Railroad Co. Mr. McDougall was born in Cape Breton in September, 1879, and has been connected with coal and steel interests in the maritime provinces ever since he became of age. He was educated at the Government Mining School, Glace Bay, N.S., and at Dalhousie College, where he studied mining engineering. In 1900 he joined the Dominion Iron and Steel Co., holding various engineering positions until 1902, when he resigned to become assistant resident engineer of the New York Central Railway. In 1904 he returned to the maritime provinces as manager of the Wabana Mines, Newfoundland, and in 1907 was appointed superintendent of mines and quarries of the Dominion Iron and Steel Co. In 1910 Mr. McDougall was appointed assistant general manager of the Dominion Coal Co., Limited, being promoted to general manager two years later. On February 29th, 1916, he received the appointment as general manager of the Dominion Steel Corporation. Under his direction the company has made excellent progress. It is stated that Mr. McDougall has been particularly successful in handling the employees of the steel company. He is a member of the Canadian Mining Institute, Mining Institute of Scotland, Nova Scotia Society of Engineers, Royal Astronomical Society of Canada, Mining Society of Nova Scotia, Engineering Institute of Canada, Canadian Forestry Association, American Iron and Steel Institute and a number of other scientific, industrial and social organizations.

Construction News Section

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand or projected, contracts awarded, changes in staffs, etc.

▲—Denotes an item regarding work advertised in *The Canadian Engineer*.
+—Denotes contract awarded. The names of successful contractors are printed in CAPITALS.

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

Further information may be had from the issues of *The Canadian Engineer* to which reference is made.

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Cornwall, Ont., construction of concrete culverts	July 29.	July 18.	48
Loverna, Sask., erection of frame school	Aug. 22.	July 18.	50
Ottawa, Ont., coal and ash handling equipment	Aug. 2.	July 18.	54
Ottawa, Ont., construction of heating plant	Aug. 8.	July 18.	48
Ottawa, Ont., installation of water tanks and pumps	July 30.	July 18.	48
Ottawa, Ont., marble lavatories, etc.	Aug. 2.	July 18.	54
St. James, Man., all trades in erection of school	July 27.	July 18.	50
Weston, Ont., extension to pump and filter house	July 30.	July 18.	50

BRIDGES, ROADS AND STREETS

Blenheim, Ont.—A special committee of Kent County Council favors the project of building a good highway to the village of Erieau. Letson Pardo, county road superintendent.

▲—**Brantford, Ont.**—Tenders addressed to the undersigned will be received up to noon, August 4, 1918, for construction of reinforced concrete culvert and steel bridge in the Tuscarora Indian Reserve, counties of Brant and Haldimand, Ont. Duncan C. Scott, Deputy Superintendent-General of Indian Affairs, Department of Indian Affairs, Ottawa.

Chippawa, Ont.—The canal running from Chippawa Creek to a point below Queenston Heights will be hurried to completion. Operations were commenced recently. It is expected that 300,000 horse-power will be developed.

Gould, Que.—Tenders will be received by the undersigned for the building of a portion of the Sherbrooke-Beauceville Rd., from the town line of Bury to the town line of Winslow, a distance of about 11 miles. Arthur B. McDonald, secretary-treasurer, Gould, Que.

Hamilton, Ont.—The construction of asphalt pavements costing $9,000 is contemplated by the City Council. E. R. Gray, engineer.

Laterriere, Que.—Gravel roads are being constructed by the Town Council at a cost of $16,000.

Medicine Hat, Alta.—Grading, preparatory to the construction of a railroad running from the south via Dunmore to the Saskatchewan boundary, will commence in the near future.

North Hatley, Que.—The construction of roadwork costing $15,000 is contemplated by the Town Council. J. B. LeBaron, Mayor.

Regina, Sask.—Tenders will be received by the undersigned up to 1 o'clock p.m., Saturday, July 27, 1918, for the construction of earth grade across flat at the east end of Eyebrow Lake, in section 31, township 22, range 1, west of the third meridian. H. S. Carpenter, deputy minister, Regina.

St. Vincent de Paul, Que.—Tenders will be received at the office of the secretary-treasurer at the municipality of St. Vincent de Paul for the paving with bituminous macadam, of Masson Rd., within the limits of the village of the municipality of St. Vincent de Paul. Joseph Auclair, secretary-treasurer.

Victoria, B.C.—Hon. J. D. Reid, Minister of Railways and Canals, has notified the C.N. Railway Co. to proceed with the terminals of the C.N.P. Railway at Victoria at once, and also with the laying of the 70 miles of rails on the road between Victoria and Sooke and Nitina Lake as soon as the steel is available.

West Vancouver, B.C.—The erection of a $30,000 bridge is contemplated by the City Council at Marine Drive, over the Capilano River. Mr. Sharpe, engineer.

Woodstock, Ont.—Tenders are being called by the undersigned for the construction of concrete boulevards for the City Council. J. Morrison, clerk.

WATER, SEWAGE AND REFUSE

Brantford, Ont.—The installation of a mechanical filtering plant at the waterworks station is proposed by W. S. Lea, of Montreal.

Edmonton, Alta.—The Edmonton Cement Co. have asked for the diversion of North White Mud Lake for a new water system to be installed at their plant. The company has also asked for the right to construct the necessary works in connection with this diversion.

Hamilton, Ont.—The construction of water main costing $5,000 is contemplated by the City Council. E. R. Gray, engineer.

Kaslo, B.C.—At a cost of $10,000 the Gibson Mining Company, Limited, will shortly construct waterworks. C. D. Empfield, secretary-treasurer.

▲—**Montreal South, P.Q.**—Tenders will be received until 6 p.m., August 1st, by E. Drinkwater, 66 Lafayette Ave., Montreal South, P.Q., for the erection of pumping station, filters, etc. For plans, specifications, etc., apply to Mr. Drinkwater.

Pembroke, Ont.—Tenders will shortly be called for the construction of waterworks for the Town Council. J. B. McRae, engineer, Boothe Building, Sparks St., Ottawa.

West Vancouver, B.C.—West Vancouver is considering the extension of its water system by building a flume from Cypress Creek to the intake. City engineer, A. H. Clucas.

+—**Woodstock, Ont.**—WM. STRUTHERS has been given the general contract for tile sewers costing $92,700 for the City Council.

LIGHT, HEAT AND POWER

+—**Fort William, Ont.**—The DOMINION PLUMBING CO., LTD., have the plumbing and heating contract for $70,000 collegiate for Board of Education.

Fredericton, N.B.—Tenders will be received until Tuesday, July 30th, for the installation of a heating system for the City Hall here. Tenders to be addressed to Ald. F. L. Cooper, Chairman, City Hall Committee, care City Clerk's office. G. R. Perkins, City Clerk.

Keddleston, Sask.—Tenders wanted for small extension to system of Keddleston Rural Telephone Co. Tenders wanted by August 1st. W. G. Palmer, Keddleston, Sask.