PAGES

MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Pape Avenue Storm Sewer, Toronto

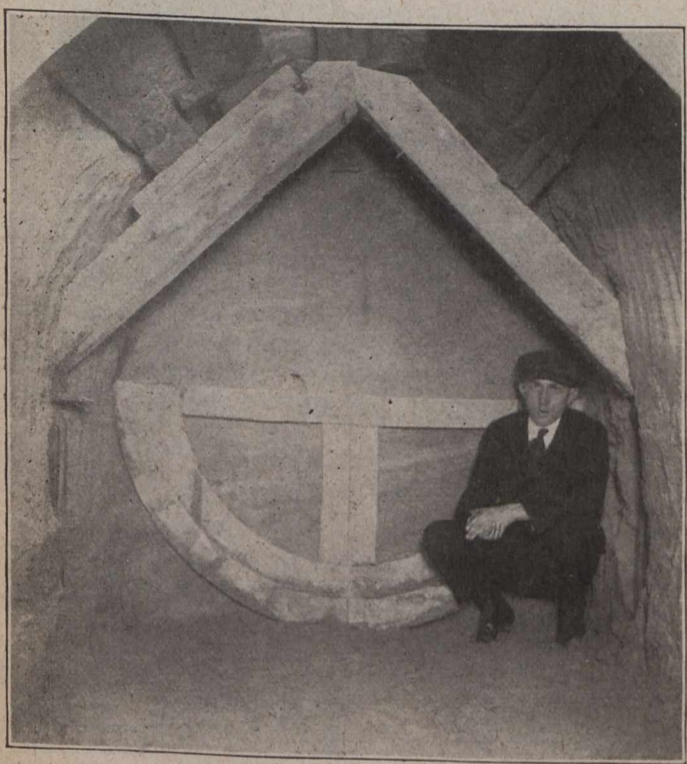
Circular Brick Sewer, 1,446 Ft. Long By 4 Ft. Diameter, With Grade of 1 in 200, Constructed in Tunnel 22 Ft. Below Street Level, With Aid of 8 to 10 Lbs. Air Pressure

By R. T. GRANT JACK

Resident Engineer, Sewer Section, Works Department, Toronto

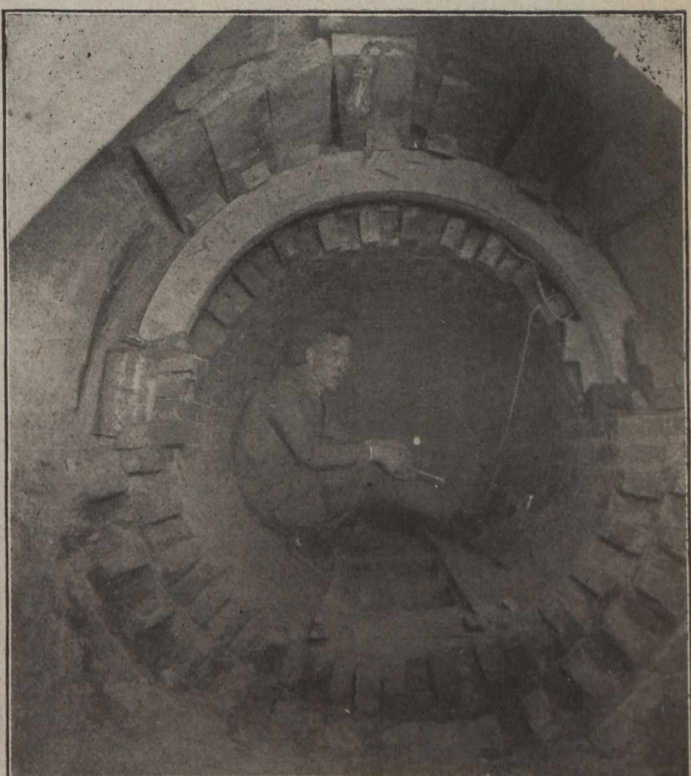
PAPE AVENUE Storm Sewer, Toronto, is located to the east of the centre line of Pape Avenue and extends from Danforth Avenue to the northern city limit, a distance of 1,446 feet. It was constructed to relieve that portion of Pape Avenue and vicinity and also with the idea of later extending it northward as a combined sewer, constructing laterals where necessary, as the county develops north of the city limits.

Fig. 1 shows the drainage area of the sewer within the city limits and in the County of York. An old water-course drains a large portion of the county area and runs to the city limits at Pape Avenue in an open ditch, thence southward on Pape Avenue and diagonally across Gertrude Place to Danforth Avenue, where it is admitted to the storm sewer. The portion between Danforth Avenue and the city limit is carried in a box culvert. It is intended to divert this ditch so that it will discharge into the new storm sewer at the city limits, as shown in Fig. 1 (see next page).



View of Heading, Showing Finished Excavation. Note the Square Base

The area in the County of York is 155 acres, the natural outlet for which is Pape Avenue. The estimated storm flow from this area is 81 c.f.s., for the accommodation of which there was designed a 4-ft. circular brick sewer with a grade of 1 in 200. The dry-weather flow from the county area is 1.7 c.f.s., calculated on the basis of 35 persons per acre and a water consumption of 120 gallons per head. Assuming that half of this quantity is run off in 8 hours, the resulting flow per acre is .011 c.f.s.



View of Heading Showing Finished Brickwork

Fig. 2 shows the overflow chamber at Gertrude Place which allows 3.25 c.f.s. to pass to the storm sewer, and three times the dry-weather flow to enter the existing 18-in. tile pipe sewer on Pape Avenue.

Fig. 3 shows the connection of the Pape Avenue Storm Sewer with the Danforth Avenue Storm Sewer. Fig. 4 shows cross-sections of the new Pape Avenue sewer.

The usual borings were taken along the line of sewer, and very hard blue clay was found at the elevation of the sewer, up to a point about 500 feet north of Danforth Avenue (north being toward Bee Avenue; see Fig. 1). North of this point, wet sand was found; therefore, two designs were adopted, one with circular base for good ground and the other with a square base to be used where soft ground was encountered.

Construction

Work was commenced at the corner of Pape and Lipton Avenues, station 3+00, where shaft No. 1 was sunk and tunnels carried north and south. The excavated

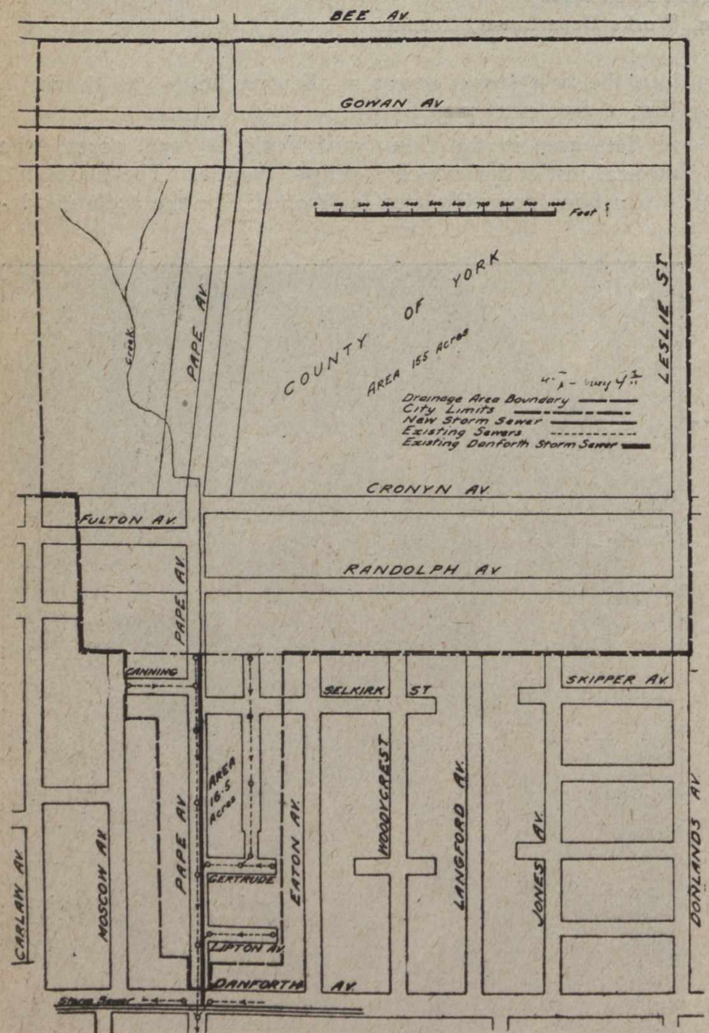
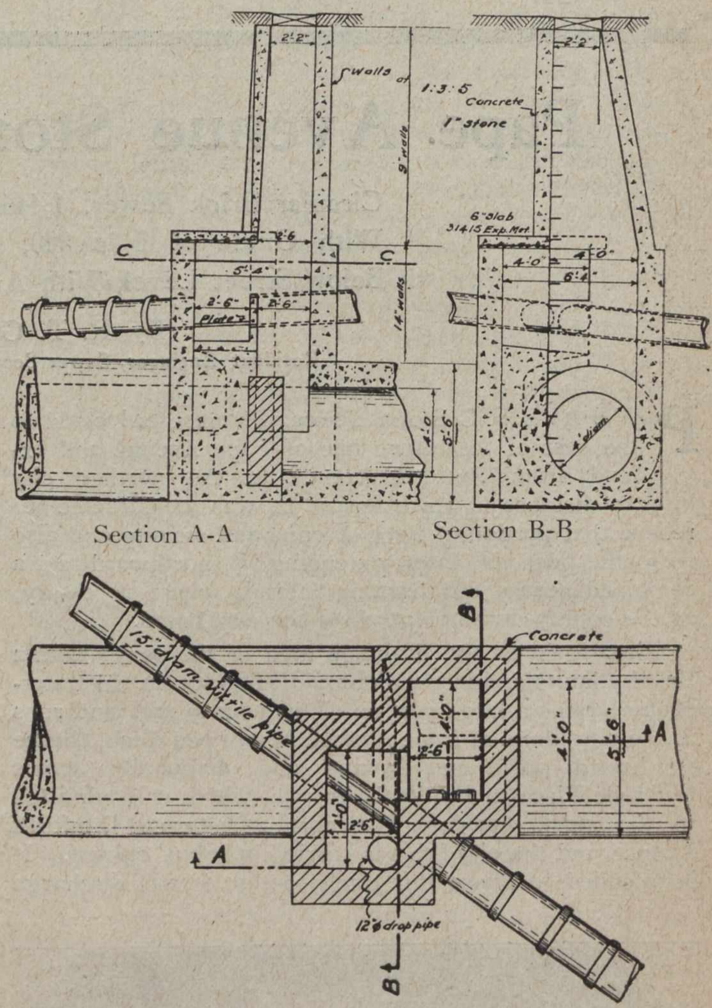


Fig. 1—Plan of Drainage Area

material was conveyed to the shaft in cars, hoisted by a derrick, dumped into wagons and carted to a city dump for use as "fill." The construction material was carried into the heading on the same cars. The clay was so hard that it necessitated the use of dynamite. Very little timbering was required, but if the clay was exposed to air for any length of time, it would shell off in large pieces, so two or three crown planks were used for protection of the workmen.

After the south heading had been driven to the end, a drop connection was made in tunnel with the existing storm sewer on Danforth Avenue.

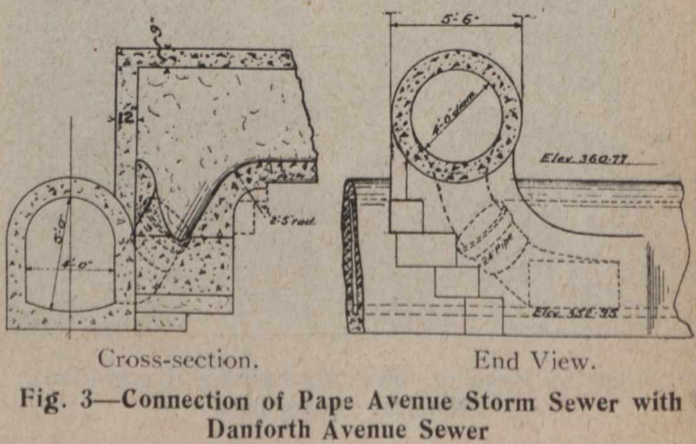
In the north heading it was found to be too expensive to continue operation after station 4+95 was reached, as the ground changed very rapidly from the hard clay to wet sand. It is said that at one time a creek ran southeasterly across Pape Avenue at that point. The remainder of the work, 950 lineal feet, was carried on from



Section Plan C-C

Fig. 2—Overflow Chamber on Gertrude Place

station 8+85 where shaft No. 2, 12 ft. x 10 ft., was sunk; but on reaching the elevation of the arch of sewer, it was found that the sand was very wet and that it would be almost impossible to do any tunnelling without the aid of compressed air. It was decided to install an air compressor, and the shaft was enlarged to 65 ft. x 10 ft., to allow for the construction of locks. In the last seven feet of excavation, tongued and grooved sheeting was used,



Cross-section. End View.

Fig. 3—Connection of Pape Avenue Storm Sewer with Danforth Avenue Sewer

driven down one foot below subgrade. This facilitated excavation and reduced the amount of water.

In constructing the locks, a concrete slab was placed and braced down; when this concrete was well set the invert forms were placed and more concrete poured. When this had set sufficiently to allow the removal of forms, they were reversed and used for the arch. Prior to placing concrete in the arch, all the pipes for the air lines and the iron frames for the lock doors were put in place, so that a bond would be obtained between the iron

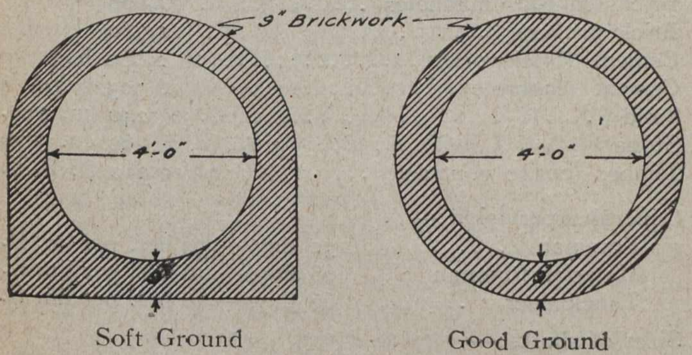


Fig. 4—Cross-sections of Pape Avenue Sewer

and concrete, thereby eliminating any loss of air at such points.

After the locks were completed, the trench was backfilled, care being taken that it was tamped and watered well, so that the least possible amount of air would be lost.

Two compressors were put in place, so that if one was not able to supply sufficient air, the second could be used. It was found necessary to use the two nearly all the time owing to loss of air through private drains which connected the houses on the east side of the street to the local sewer.

With the aid of the compressed air, very good headway was made and the 888 feet of sewer were completed in less than seven weeks. Three of the five manholes were partly constructed from below and afterwards excavated from the surface and finished.

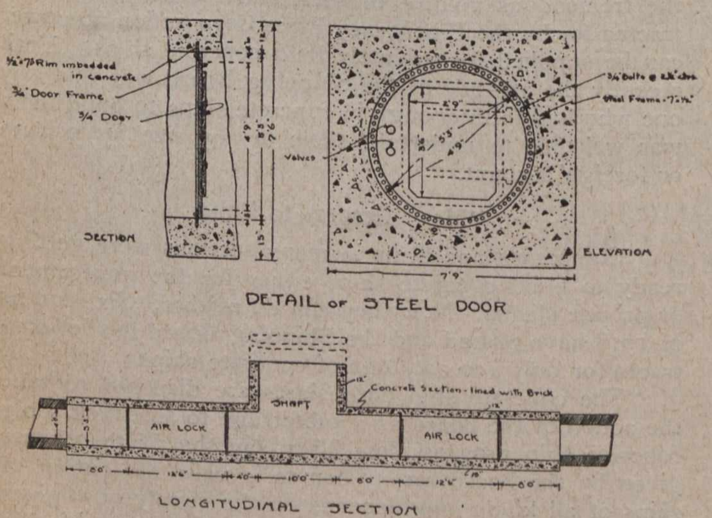


Fig. 5—Detail of Design of Locks

The method of construction was practically the same as in the first section. As material excavated was sand, sheeting of the crown was required throughout. The square base design was used so that when the compressed air was removed there would be a good bearing surface for the sewer, with less danger of settlement of the sewer after the water returned.

The entire contract was executed by the Fussell and McReynolds Co., Limited, Toronto, and was completed in 4½ months. The work was under the direction of the Works Department of the city of Toronto, of which R. C. Harris is Works Commissioner and George Powell, Principal Deputy City Engineer. W. R. Worthington is engineer of sewers; W. G. Cameron, engineer of maintenance and construction; and W. S. Harvey, engineer in charge of design. The writer was resident engineer for the city.

Unit Costs

In the following unit costs, for convenience a "key" is used in reference to the distribution of labor, as follows:—

A—Sinking and timbering shafts.
C—Backfilling.
E—Placing forms and concreting.
J—Pumping water.
K—Brickwork.
N—Mining.
P—Material handling.
Q—Plant.
Z—Miscellaneous labor (cleaning out sewer).
S—Compressor operators (mining).
T—Compressor operators (brickwork).
U—Compressor oilers (mining).
V—Compressor oilers (brickwork).
CP—Setting up compressor plant.
TD—Taking down compressor plant.
D—Handling surplus excavation.

Quantities, Shaft No. 1

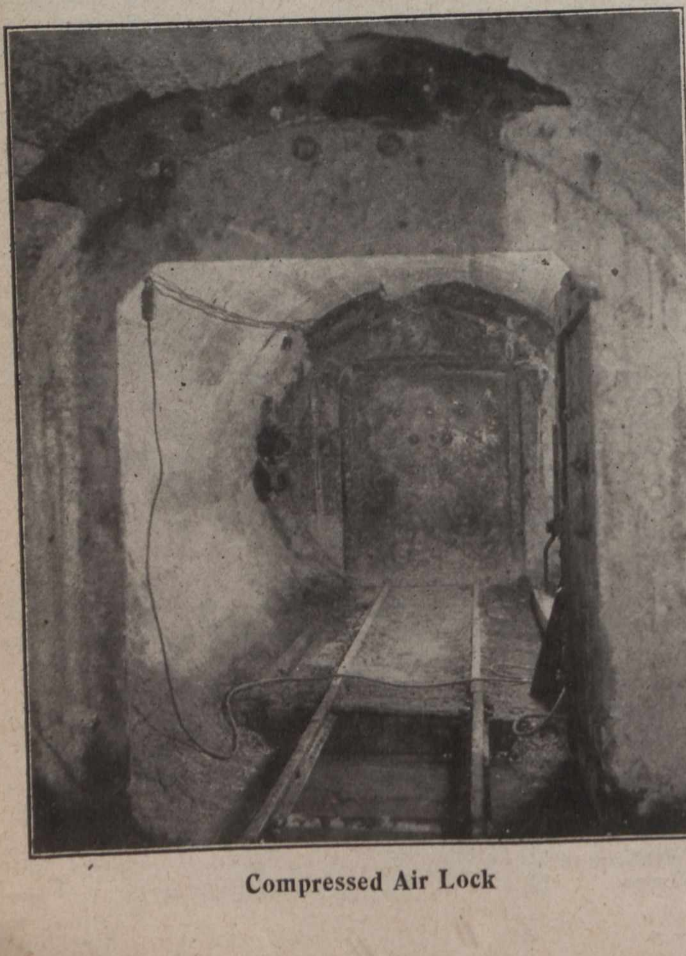
4-ft. two-ring brick sewer	495	lin. ft.
Excavation in tunnel	425	cu. yds.
Excavation in shaft	58.5	cu. yds.
Surplus excavation	425	cu. yds.
Brickwork	205	cu. yds.
Concrete in chamber	7.0	cu. yds.
Bricks in tunnel	93,725	
Bricks in manhole	3,275	
Brick packers	5,625	
Cement	1,150	bags
Sand	115	cu. yds.
24-in. tile pipe (chamber)	16	ft.

Unit Costs in Hours, Shaft No. 1

Item	Distribution	Time in Hrs.	Hours per Cu. Yd.	Hours per Lin. Ft.
Foreman	A	60	1.03	1.2
Engineer	A	45	.77	.08
Teams	A	45	.77	.08
Labor	A	288	4.75	.58
Teams	D	310	.73	.63
Teams	P	239	—	.50
Labor	P	180	—	.40
Labor	Z	230	—	.47
Foreman	N	300	.75	.60
Miners	N	1,140	2.45	2.30
Labor	N	1,155	2.50	2.33
Engineer	N	300	.75	.60
Bricklayer	K	336	1.60	.68
Engineer	K	231	1.12	.47
Labor	K	1,432	7.00	2.90
Engineer	Q	54	—	.11
Labor	Q	85	—	.18
Teams	Q	85	—	.18

Unit Costs in Hours, Shaft No. 2

Item	Distribution	Time in Hrs.	Hours per Cu. Yd.	Hours per Lin. Ft.
Foreman	A.....	200	.43	—
Teams	A.....	70	.15	—
Labor	A.....	1,760	3.80	—
Engineer	A.....	105	.23	—
Foreman	E.....	40	.65	—
Engineer	E.....	15	.25	—
Labor	E.....	470	7.70	—
Foreman	N.....	580	.64	.65
Engineer	N.....	512	.57	.58
Miners	N.....	1,620	1.80	1.84
Labor	N.....	2,457	2.73	2.75
Teams	D.....	488	.54	.55
Bricklayers	K.....	816	1.56	.86
Labor	K.....	3,860	7.40	4.06
Engineer	K.....	488	.93	.51
Operators	S.....	522	.58	.60
Operators	T.....	546	1.04	.63
Oilers	U.....	212	.24	.24
Oilers	V.....	200	.40	.22
Engineers	J.....	201	—	.21
Labor	J.....	90	—	.10
Foreman	Z.....	40	—	.04
Labor	Z.....	500	—	.50
Labor	P.....	390	—	.42
Teams	P.....	410	—	.44
Labor	C.....	560	1.30	—
Teams	C.....	36	.09	—
Engineers	Q.....	144n	—	.15
Labor	Q.....	435	—	.46
Teams	Q.....	81	—	.09
Engineers	CP.....	410	—	.46
Labor	CP.....	667	—	.76
Teams	CP.....	114	—	.13
Engineer	TD.....	70	—	.08
Labor	TD.....	35	—	.04



Compressed Air Lock

Quantities, Shaft No. 2

4-ft. 2-ring brick sewer with square base	951 lin. ft.
Air locks	63 lin. ft.
Excavation in tunnel	900 cu. yds.
Excavation in shaft	462 cu. yds.
Surplus excavation	900 cu. yds.
Backfilling shafts and manholes	427 cu. yds.
Brickwork	523 cu. yds.
Concrete in locks	61 cu. yds.
Bricks in tunnel	156,750
Bricks in square base	28,500
Bricks in four manholes	14,200
Brick packers	11,780
Cement (brickwork)	2,080 bags
Cement (concrete)	305 bags
Sand	240 cu. yds.
Stone	60 cu. yds.
Timber (entire contract)	10,930 ft. B.M.

General supervision:—

Foreman	132 days—.92 hrs. per lin. ft.
Material foreman	66 days—.46 hrs. per lin. ft.
Timekeeper	66 days—.46 hrs. per lin. ft.

Sizes of shafts:—

Shaft No. 1—7′ 3″ x 9′ 10″ x 22′ deep.
Shaft No. 2—10′ x 65′ x 22′ deep.

NO POWER FOR CONCRETE SHIPS

IN a special dispatch from Washington, D.C., dated June 20th, 1918, the New York Tribune of June 22nd says:—

"The concrete ship idea is now apparently 'cabined, cribbed and confined' to the complete satisfaction of its opponents. The Shipping Board has decided to refuse to permit any private building of concrete ships, even small ones. Everything concrete except barges of 1,000 tons or less is banned. The output of concrete ships is thus confined to the five small yards already established, which five are now practically government yards, with the contractors acting as agents.

"The explanation given for this course is that the supply of engines and boilers is so limited that in view of the tremendous volume of steel and wooden ships contracted for by the Emergency Fleet Corporation no power can be supplied for privately built concrete ships. Until recently the attitude of the Shipping Board was that any one who had faith enough in concrete ships to build them was welcome to undertake them in any size for private or foreign account.

"Many Prepare to Build

"Companies and firms in many sections were getting ready to build concrete ships either for the government or private clients. Now they can do neither. Six months of 1918 have passed and the Shipping Board has let contracts for only 200,000 tons of concrete ships.

"The concrete ship enthusiasts are disposed to take the action of the board as a subterfuge to sidetrack a big concrete ship programme. They say that if the excuse given by the board for its course is valid the output of ships of all kinds now depends on the supply of engines and boilers. It is conceded that the production of ship propelling power is much less than it should be, but critics of the board say that it has never made any adequate effort to mobilize the manufacturing potentialities of the country in this line, that it has never even

(Concluded on page 48)

PROPORTIONING THE MATERIALS OF MORTARS AND CONCRETES BY SURFACE AREAS OF AGGREGATES

By Capt. Llewellyn N. Edwards
Supervising Engineer of Bridges, City of Toronto

(Continued from last week's issue.)

HAVING determined the means of securing a "normal," uniform mix, little difficulty was encountered in the preparation of test mortars intended to establish the efficiency of the primary theory of this method, namely: "The strength of mortar is primarily dependent upon the character of the bond existng between the individual particles of the sand aggregate. Upon the total surface area of these particles depends the quantity of cementing material."

Test mortars were prepared as follows:—

1. A series of nine mortars, composed of sands varying widely in their granulometric composition, combined in each case with a quantity of cement proportioned in the relation: 1 g. cement to 13 sq. in. sand area.

2. A series of four mortars, composed of a sand of uniform granulometric composition, combined in each case with quantities of cement proportioned in the relation: 1 g. cement to 10, 15, 20 and 25 sq. in. sand area, respectively.

3. A series of two mortars, composed of the sands used in two of the concrete tests, combined in each case with a quantity of cement proportioned in the relation: 1 g. cement to 15 sq. in. sand area.

It is evident that, if the primary theory of this method of proportioning is correct, the ultimate strengths obtained from the first series of tests will be uniform and equal. It is equally evident that the relation of the ultimate strength to the cement content of the mortar is securable from the results of the second series. However, it must be borne in mind that the strengths obtained in each series are not necessarily the same as those which might be obtained from the use of a sand having its origin in a different rock material. The third series of tests provides a means of comparing the ultimate strengths obtained from mortars of normal consistency with those obtained from the mortar content of concretes forming a part of the general tests herein described.

Table VII.—Strength Tests: Composition of Mortars

Sand Letter.	Surface Area per 1000 g., sq. in.	Cement, g.	Water, cc.	Ratio of Cement to Aggregate by Weight.
TEST SERIES No. 1 — CEMENT CONTENT—1 G. : 13 SQ. IN.				
A	5 856.6	450.5	128.0	1 : 2.22
B	5 106.1	392.0	111.5	1 : 2.55
C	7 683.7	591.0	134.5	1 : 1.69
D	6 758.4	520.0	148.0	1 : 1.92
E	12 816.4	986.0	280.5	1 : 1.12
F	6 769.1	521.0	148.0	1 : 1.92
G	4 182.0	321.5	91.5	1 : 3.11
H	6 564.6	505.0	143.5	1 : 1.98
I	6 564.6	505.0	143.5	1 : 1.98
TEST SERIES No. 2 — CEMENT CONTENT—1 G. : 10, 15, 20 AND 25 SQ. IN.				
F	6769	677.0	183.0	1 : 1.47
	6769	451.0	132.5	1 : 2.21
	6769	338.5	105.5	1 : 2.95
	6769	270.5	92.5	1 : 3.61
TEST SERIES No. 3 — CEMENT CONTENT—1 G. : 15 SQ. IN.				
O	7353.4	490.0	144.0	1 : 2.41
Q	6391.0	426.0	126.0	1 : 2.35

Table VII. shows the composition of the test mortars of the three series described above. It also shows for each mortar the ratio existing between the cement content and the sand aggregate, by weight.

Fig. 8 shows the average ultimate compressive and tensile strengths obtained from test specimens of the first and third series while Fig. 9 shows the results obtained from the specimens of the second series.

Fig. 10 was deduced from the information contained in Tables VI. and VII. It shows by percentages the relation between the surface area of sand *E* and that of each of the other sands described

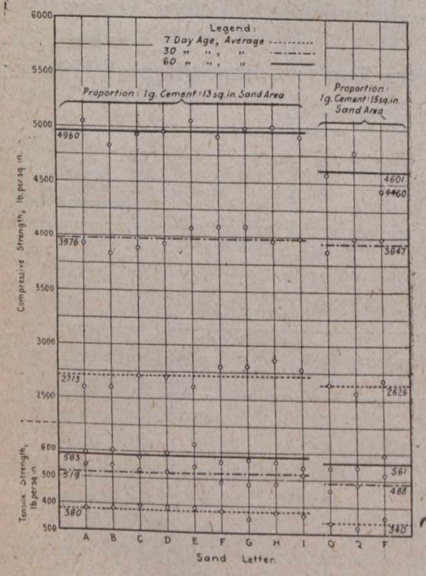


Fig. 8—Strength Tests—Compressive Strengths of 2-in. Mortar Cylinders and Tensile Strengths of Mortar Briquettes

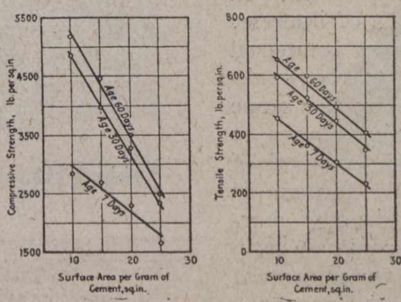


Fig. 9—Strength Test—Compressive Strengths of 2-in. Mortar Cylinders and Tensile Strengths of Mortar Briquettes; 1 g. Cement: 10, 15, 20 and 25 sq. in. Sand Area

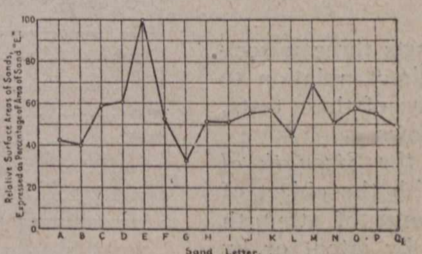


Fig. 10—Relative Surface Areas of Sands (Deduced from Tables VI. and VII.)

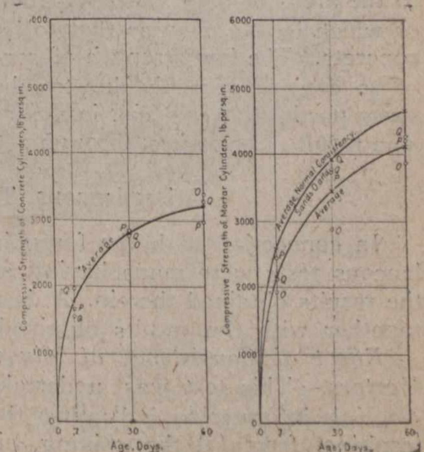


Fig. 11—Compressive Strengths of Mortar and of Concrete Test Cylinders

in Table V. The economy of the surface-area method of proportioning is here apparent.

Concrete Strength Tests

Fig. 11 shows the average strengths obtained from the tests of concretes and from the tests of mortars secured from the mortar portions of these concretes. For purposes of direct comparison, the average of strengths obtained from normal consistency mortars, sands O and Q, are also shown. In this connection a comparison with Fig. 13 is of interest.

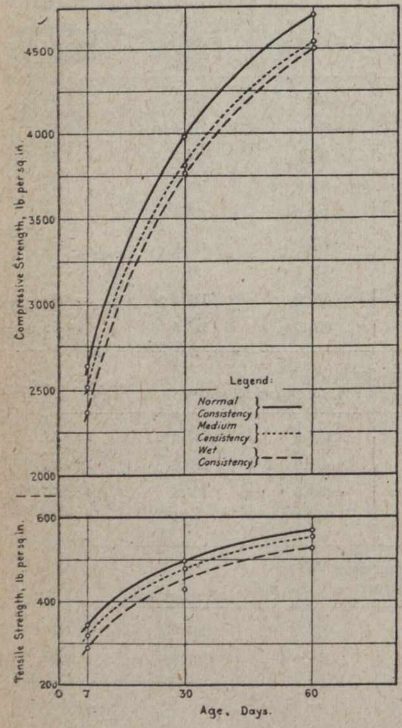


Fig. 12—Strength of Mortars of Different Consistencies and Ages; Sand Q; 1 g. Cement: 15 sq. in. Sand Area

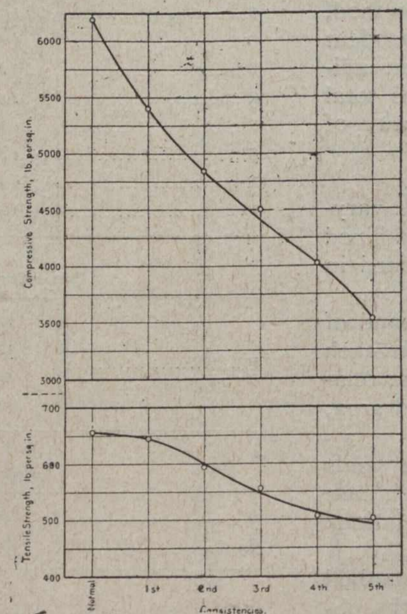


Fig. 13—Strengths of Mortars of Different Consistencies, Age 60 Days; Sand F; 1 g. Cement : 10 sq. in. Sand Area

The weaker strength of the concretes as compared with the mortars is doubtless due in part to the weakening effect of cleavage planes produced by the stone aggregate. A comparison of the strengths shown in Fig. 11 indicates a probability that by this method of proportioning, the relative values of sands for use in concretes can be determined from a comparison of mortars, the cement content of which bears a common ratio to the areas of the sands compared and the water content of which is the same as that to be used in the proposed concrete. The low strength of sand O mortar at an age of 30 days is probably due to the weakening effect of stone particles over ¼ in. in size contained in the mortar as a result of screening through a ⅜-in. screen.

Miscellaneous Tests

In connection with the foregoing tests three miscellaneous tests were made having an indirect relation to the results obtained therein. A description of these tests, together with the results obtained, follows.

Effect of Consistency of Mix upon the Strength of Mortars.—This test was undertaken with the object of securing information indicating the change of strength resulting from (1) the mixing, either by intent or by accident, of test mortars of too wet consistency, and (2) a variation of the water content of the mix from that required to produce a "normal" consistency mortar to that producing a "sloppy" mix, such as is frequently found in concretes of too wet consistency.

In each of these tests the relation of the cement content of the mix to the surface area of the sand aggregate was constant for each series; that is, for the first series a proportion 1 g. cement to 15 sq. in. sand area, and for the second series a proportion 1 g. cement to 10 sq. in. sand area. Sand Q was used in the first series and sand F in the second series.

Table VIII. shows the compositions of the mortars and Figs. 12 and 13 show the average strengths obtained from test specimens for each series of tests.

Weight-Volume, Cement Paste Test.—This test was made as a check upon the common assumption that 110 lbs. of dry cement produces 1 cu. ft. of cement paste. It was found that 2,000 g. of cement when thoroughly mixed with 445 cc. of water (normal consistency) produces 1,140 cc. of paste, corresponding to 109.52 lbs. of dry cement to produce 1 cu. ft. of paste.

An increase of 35 cc. in the volume of water used produced an increase of 20 cc. in the volume of paste, which corresponds to a decrease of 2.11 lbs. in the weight of dry cement required.

Bulking Effect of Cement Content of Mortars.—The bulking effect of the cement was especially noticeable in test mortars in which the granulometric composition or grading of the sands was such as to give comparatively large computed surface areas. Its variation with the proportion of cement used in relation to the surface area was also noted. Both conditions are in full accord with the primary principle of this method of proportioning.

Fig. 14 shows a series of mortar cylinders in each of which 1,200 g. of sand F were used and the cement content was successively decreased in the proportions: 1 g. cement to (a) 5, (b) 10, (c) 15, (d) 20, (e) 25, (f) 30, (g) 35 and (h) 40 sq. in. sand area. The cylinder (i) at the extreme right-hand end of the series contains only a sufficient quantity of cement (15 g.) to retain the 1,200 g. of sand in a cylindrical form, thus permitting a close comparison with the compacted bulk of the sand alone. Fig. 15 shows the relative percentages of volume in relation to the volume of the "sand" cylinder above described.

Table VIII.—Consistency Tests: Composition of Mortars

Test Series No. 1c.
Cement Content—1 g.: 15 sq. in.—Sand Q.

Consistency.	Surface Area per 1000 g., sq. in.	Cement, g.	Water, cc.	Percentage of Water to Cement and Sand.
Normal	6391	426	124	8.69
Medium	6391	426	136	9.54
Wet	6391	426	147	10.31

Test Series No. 2c.
Cement Content—1 g.: 10 sq. in.—Sand F.

Consistency.	Surface Area per 1000 g., sq. in.	Cement, g.	Water, cc.	Percentage of Water to Cement and Sand.
Normal	6769	677	183	10.91
First	6769	677	217	12.94
Second	6769	677	251	14.97
Third	6769	677	285	16.99
Fourth	6769	677	319	19.02
Fifth	6769	677	353	21.05

In this connection it is of interest to note that the void in sand *F* was found to be 31.3 per cent. By the void method of proportioning the quantity of cement paste necessary to fill the void in 1,200 g. of sand bulking 41.29 cu. in. would be 12.92 cu. in., requiring 374.3 g. of dry cement. With no allowance for the separating of the sand particles, this corresponds approximately to a cement content, 1 g. cement to 22 sq. in. sand area by the surface area method.

Figs. 14 and 15 give no evidence of a marked change in the increment of increase of volume due to the cement content exceeding that of the void.

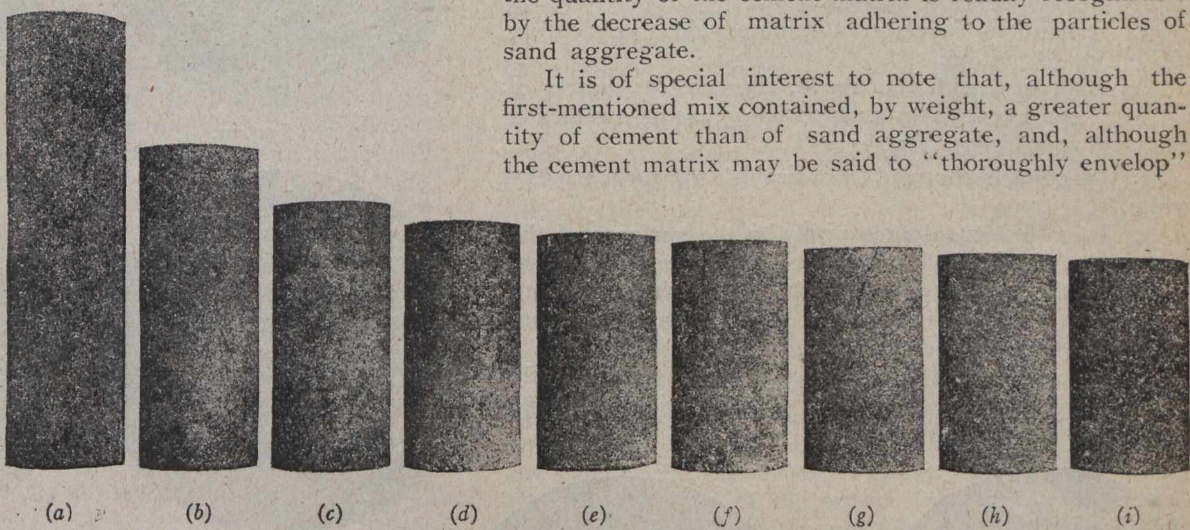


Fig. 14—Mortar Cylinders in which the Cement Content was Decreased

Observed Phenomena of Tests

Voids in Mortar. — Mortars produced under ordinary conditions invariably contain voids having two general sources of origin, namely: (1) Those due to globule-like accumulations of water which evaporate, leaving so-called water voids, and (2) those due to air adhering to the surfaces of the sand particles or to air entrained during the mixing of the component materials, producing air voids.

Fig. 16 shows a photomicrograph (× 75) of neat cement as it exists in standard briquettes. The effect of the surface tension of water is shown here by the great number of voids. This well-known attribute of water renders it impossible to secure, even in the richest mortars, an unbroken film of cementing material surrounding the particles of sand aggregate.

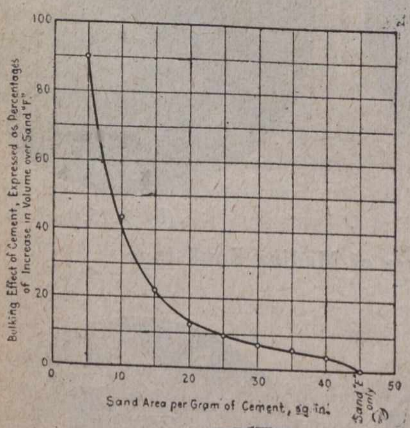


Fig. 15—Relation of Cement Content to Bulk of Mortars—Sand F.

Resistance to Impact. — Hardness, toughness, etc., were roughly tested under the impact of hammer blows, "knob" ends of briquettes and fragments of broken cylinders being used for this purpose. Mortars having an equal cement content in relation to the surface area of the sand aggregate showed a most remarkable uniformity when tested in this rather crude way.

Texture of Mortars.—A careful microscopic examination of the cement matrix of the mortars containing test sands *A* to *I*, inclusive, proportioned as indicated in Table VII., showed, in all cases, an equal uniformity of distribution. In a comparison of mortars containing a less proportion of cement in relation to the surface area of the aggregate this condition was found to be equally true.

Fig. 17 shows photomicrographs (× 20) of the fractured surfaces of mortars, proportioned 1 g. cement to 13 sq. in. sand area, in which the sands are of distinctly different granulometric composition.

Fig. 18 shows four photomicrographs (× 20) of fractured surfaces of mortars varying in their cement content as follows: 1 g. cement to 5, 15, 25 and 35 sq. in sand area. The specimens for photographing were taken from the mortar cylinders shown in Fig. 14. The decrease in the quantity of the cement matrix is readily recognizable by the decrease of matrix adhering to the particles of sand aggregate.

It is of special interest to note that, although the first-mentioned mix contained, by weight, a greater quantity of cement than of sand aggregate, and, although the cement matrix may be said to "thoroughly envelop" the particles of the aggregate, it nevertheless contains myriads of minute voids which are probably of water origin.

Fig. 19 shows photomicrographs (× 20, × 75) of Medina sandstone. The comparatively small amount of cementing material holding the particles of sand in place is of special interest.

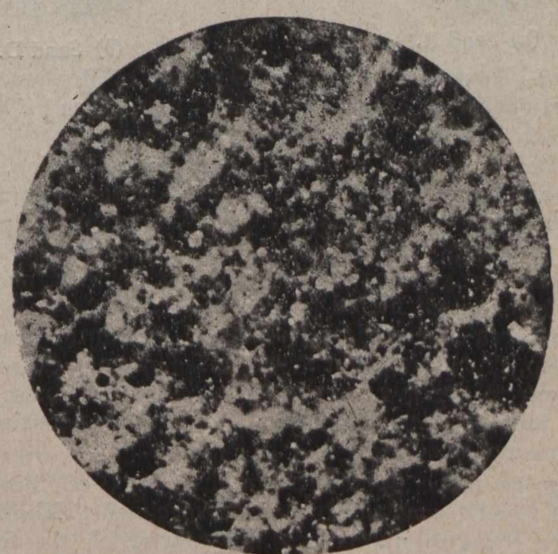


Fig. 16—Texture of Fractured Surface of Neat Cement Briquette (× 75)

Effect of Excess Water.—The proper function of the water content of a mortar mix is to combine with the cement in producing the pasty matrix which, when set, binds the particles of the aggregate into a uniformly strong, stone-like material. The addition of a comparatively small quantity of water in excess of that required for the fulfillment of its proper function produces a very marked effect upon the structure of the cement matrix.

This change in the structure of the cement matrix can be readily seen by the aid of a microscope; but, like sunlight, it is far easier seen than described. However, in the microscopic examination of the fractured surface of a "normal" consistency specimen, say, at 50 to 75 diameters magnification, the observer takes special note of three conditions of the matrix, namely:—

1. It is grayish in color.

2. It adheres to the particles of agregate in amorphous pasty-appearing masses.

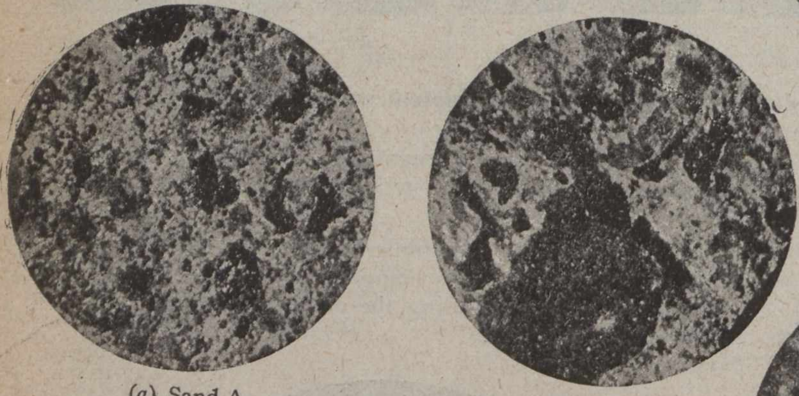
3. It contains myriads of minute voids, permeating the entire formation.

As compared with the above, the cement matrix of a "wet" consistency mortar specimen presents a radically changed appearance, that is:—

1. Its color is changed from grayish to nearly a milky white.

2. It no longer adheres firmly to the surfaces of the aggregate, but instead appears as a comparatively loose, semi-crystallin formation, which, although containing few, if any, real crystal forms, may be compared to rather loosely massed snow crystals.

3. It contains, when closely examined, comparatively few of the well-defined globular-shaped voids observed in a "normal" specimen.



(a) Sand A. (b) Sand D.

Fig. 17—Texture of Fractured Surfaces of Mortars, Proportioned 1 g. Cement: 13 sq. in. Sand Area (× 20)

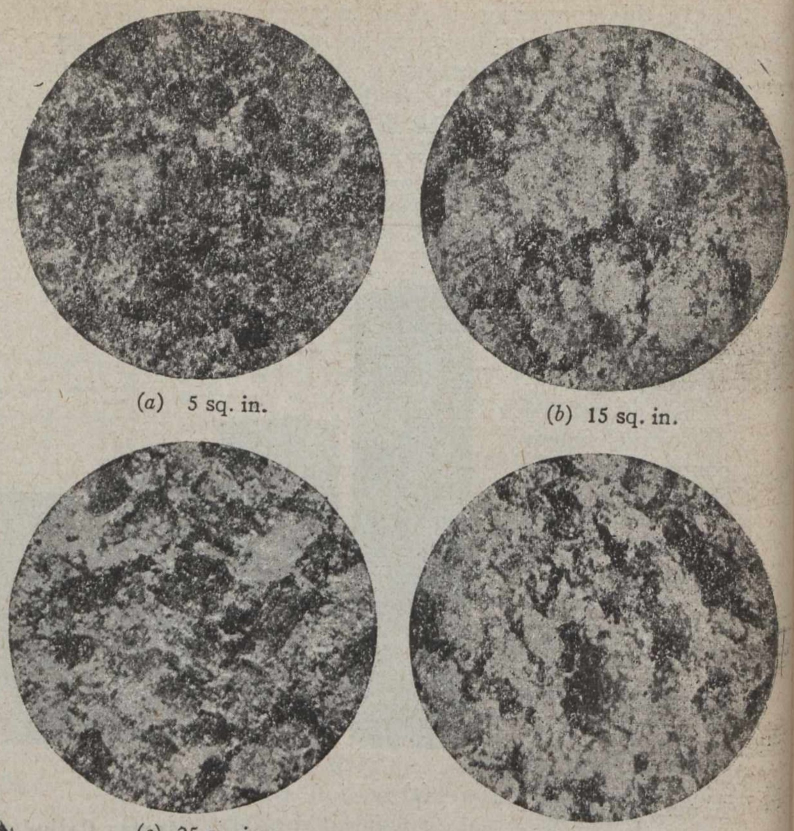
When examined under a lower magnification, say, 16 to 25 diameters, the matrix of wet-consistency mortar specimens presents a loose "sugary" or granular appearance. Doubtless this change in the physical structure of the matrix from a comparatively dense, compact material to an attenuated, fluffed up, skeleton-like mass, lacking cohesiveness and other attributes of strength, discloses the deep, underlying, but nevertheless primary cause contributing to the low strength, friability, shortness and other undesirable properties found in wet-consistency mortars and concretes.

Fig. 20 shows photomicrographs (× 75) of "normal" and of "wet" consistency mortar specimens. The latter specimen was produced from the mortar of the former by the addition of sufficient water to render it of a "mushy" rather than of a liquid consistency.

Design vs. Construction

Whether a structure be composed of mortar or of concrete, the ideal of its construction is that it shall fulfil the predetermined requirements of strength, durability, utility, etc., at the lowest cost; that is, other things being equal, economy and efficiency demand the development of the full value of the cement and of the aggregate. A

(Continued on page 41)

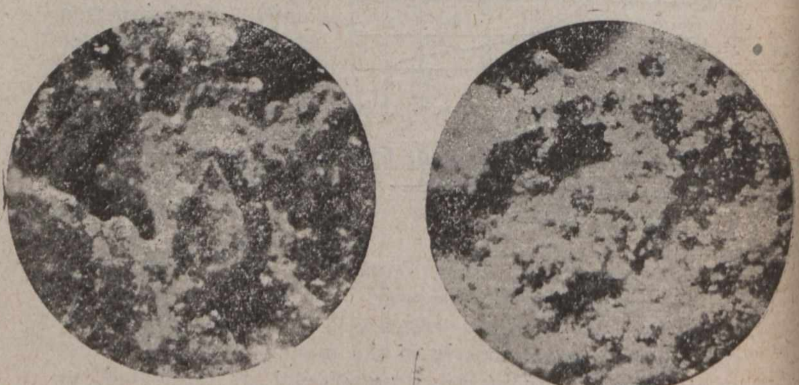


(a) 5 sq. in. (b) 15 sq. in. (c) 25 sq. in. (d) 35 sq. in.

Fig. 18—Texture of Fractured Surfaces of Mortars Proportioned 1 g. Cement: 5, 15, 25 and 35 sq. in. Sand Area (× 20)

(a) ×20. (b) ×75.

Fig. 19—Texture of Medina Sandstone



(a) "Normal" Consistency. (b) "Wet" Consistency.

Fig. 20—Texture of Cement Matrix in Mortars of Different Consistencies (× 75)

THE PAY OF THE ENGINEER*

IN his presidential address at the last annual meeting of the Canadian Mining Institute, Arthur A. Cole commented on the meagre and altogether inadequate salaries which are offered, particularly by our government departments, to technical men; and in the course of a subsequent discussion, much was said about the necessity of adopting some means of generally improving the status of the profession. This should not end in mere talk. Mr. Cole pointed his remarks by citing a recent specific case, where the Civil Service Commission of Canada had advertised for a legal officer at an initial salary of $3,300 per annum, and for a chemist in the Mines Branch at an initial salary of $1,600 per annum. The advertisement detailed very fully the qualifications which were required of applicants for each position, and a comparison of these was justly summed up by Mr. Cole as follows: "The qualifications required by the chemist are such as would entitle him to a Ph.D. degree at any of the best universities on the continent. The absurdity of the discrimination thus instanced is further emphasized when we know that in the Mines Branch only the director receives a higher salary than that mentioned in the above advertisement as the amount to be paid at the start to the legal officer, whose duties could quite readily be performed by any mediocre country lawyer, or even by a clerk who had a few years' experience in a lawyer's office."

Engineer, $1,500; Camera Man, $2,400

The contrast presented in these two advertisements is so pronounced that anyone not familiar with the real conditions might well be pardoned if they harbored the suspicion that Mr. Cole had deliberately selected some unusual isolated example to support his case. Unfortunately, it is only one instance of the invariable practice; it is typical of the government's estimation of the value of the services of a man with high technical training, and one has only to consult the advertisements of the Civil Service Commission, which appear from time to time in "The Canada Gazette," to appreciate the truth of this assertion. During the month of May, for example, a technical clerk was temporarily required in the Topographical Surveys Branch of the Department of the Interior at a salary at the rate of $1,300 per annum, and it is stated that "applications will be considered from graduates in Applied Science, honor mathematics, or physics, of some recognized university." Qualified draughtsmen, competent to perform engineering and architectural work, are offered $125 per month. By way of contrast, a "motion-picture camera man" required by the Department of Trade and Commerce is to be given an initial salary of $2,400 per annum, and a law clerk an initial salary of $2,100.

Serious Reproach Against All Engineers

However, it is hardly necessary to multiply examples. The fact is self-evident that, as compared with other professions, the government sets a very low value on the services of men of the engineering profession, and the possibility for the existence of this state of affairs constitutes a serious reproach against all engineers. The training of a properly qualified technical man is a protracted and expensive business, necessitating as it does a long course of special study at a university or technical college, followed by a further period spent acquiring knowledge in the school of practical experience or in conducting original research. Before he can attain proficiency such as is required of applicants for positions similar to those for which the Civil Service Commission offers a salary of from $1,200 to $1,600 per annum, the engineer must have spent some of the best years of his life and a very substantial sum of money acquiring the necessary knowledge. His knowledge has not been obtained at a lesser cost, either in time or money, than has that of the lawyer or doctor, and to be successful he must possess at least an equal measure of intelligence and ability. Why, then, is it that the lawyer and the doctor are everywhere remunerated at a fair cash value, while the engineer is expected to do work which calls for an equal degree of training, skill, intelligence, and efficiency, at a wage which would be refused with scorn by a mine mucker? Can it be that the salaries offered do actually represent the full worth of the engineer; or, if not, how does it come about that they are accepted, apparently with complete satisfaction? These questions need to be seriously considered and answered before there can be any improvement in the status of the technical man.

The Doctors' and Lawyers' "Unions"

With regard to medicine and law, it is well to remind ourselves that those following these professions have certain natural advantages over members of the scientific and engineering professions. Everyone, at some time or another, has need of the services of a doctor, and in a lesser degree, the same may be said regarding the lawyer. Moreover, these professions do not, as a rule, necessitate extensive or frequent travelling from one part of the country to another. As a consequence, both doctors and lawyers are usually able to settle more or less permanently in one place, generally a large centre of population. They have better opportunities for meeting together, and one result of this is that both these professions are extremely well organized. It is true that there is no *actual* "union" of doctors or of lawyers, but it is none the less indisputable that there exists in each of these professions a very strict *latent* union. There is a well-maintained, if unwritten, etiquette, amounting practically to a taut agreement, whereby certain fees are charged for certain services, and the government or any corporation requiring the services of a doctor or lawyer is well aware that it would be useless to try and undercut these "union" wages. The wage they demand and receive serves to maintain the dignity of their professions, but, broadly speaking, it is not exhorbitantly high.

Remedy in Engineers' Own Hands?

If, then, the salaries paid to men of these professions are not excessive, why is it that the government is able to secure highly trained technical men for the wretched pittances offered by the Civil Service Commission? Mr. Cole calls it absurd discrimination, but is it absurd discrimination? Or have our technical men so much false modesty, or, rather, such a lack of self-respect and proper dignity, both for themselves and for their professions, that they themselves set this low value on their services? No doubt the great weight of opinion will endorse Mr. Cole's summing up, but is it quite fair for the technical men to blame the government for discriminating? Let them rather face the position squarely and honestly, and then place the blame where it rightly belongs. Is not the remedy entirely in their own hands?

After all, it is only human for an employer to get the best man he can at the lowest salary he will accept. This attitude may not be admirable, but it is, none the less, practically universal, and will remain so long as the ex-

*From Bulletin of the Canadian Mining Institute, July, 1918.

isting economic system endures. So far as the Geological Survey Branch of the Department of Mines is concerned, it must be admitted that serious efforts are made to secure the best men, and recent practice has been that no field officer can obtain an appointment on the permanent staff unless he holds a doctor's degree from some recognized university. Possibly the same rule holds in other government technical departments, but the writer cannot speak with certainty on this point. That men with such qualifications are willing to accept the inadequate salaries offered is a reproach against themselves rather than against their employers. Past experience has shown very conclusively, however, that in consequence of its parsimonious policy, the government is unable to retain the services of many of these men for any considerable period, and most of the prominent consulting geologists and mining engineers in the country to-day, and in recent years, were formerly officers of the Geological Survey; in some cases, the services of such men have been lost to the country. Surely the work with which our technical departments is entrusted is of the very first national importance, and if it is worth doing at all, the best brains available in the country are required for its most efficient prosecution. In this respect, the policy of the government, in under-paying its technical employees, is culpable in the extreme.

Lower Wages Than Unskilled Laborers

However, it is not the government alone which holds the technical professions in such low esteem: this is, unfortunately, more or less universal. Provincial departments and municipalities have followed the lead of the federal technical departments. Corporations and companies are little better in this respect, and it would be very exceptional to find their technical advisers receiving salaries on the same scale as their law advisers, while the mass of their technically trained employees are often paid the same, or even lower, wages than their unskilled laborers. In some of the western coal mines to-day, mine managers are actually working at the face, because they can earn considerably more money using their muscles than using their brains.

This is really the crux of the whole matter. Ordinary labor, requiring little or no special training or skill, and only average intelligence, has become so highly organized throughout the world that it is in a position to enforce its demands for a fair wage; and like the doctor and the lawyer, labor displays no false modesty in estimating the value of its services. On the other hand, the technically trained man, whose knowledge has been acquired only at considerable expense, both in time and money, and who must possess a fair modicum of ability and intelligence, is at a discount, and this is entirely owing to his lack of organization, and lack of professional etiquette.

Engineers the Life Blood of Industry

This state of affairs is a very unhealthy one, and it is of the utmost seriousness, not only to members of the technical professions, but to the whole country and to the whole world. Wages have reached their present high scale partly as a result of the war, but it would be most unwise to assume that they will be materially lowered during the present generation, if ever. All experience is against this assumption. The wages or salaries of technically trained men have not advanced, or certainly they have not advanced to anything like the same extent. If conditions are to be allowed to remain on this unsatisfactory basis, the outlook for future technical and industrial progress is indeed pessimistic. What incentive is there for parents to go to the expense of sending their sons to the technical colleges or to the universities to learn an unremunerative profession? What encouragement is there for the boys themselves to take up with diligence or keenness the arduous courses of study which are necessary before they can qualify as efficient technical men or engineers, when they realize that they can, with their hands alone, command an immediate independence and very respectable pay? There is something radically wrong with a system under which a university graduate, after four or more years of special study, is only too glad to obtain a position at a salary of $100 or so per month, whereas a man with only one or two months' training can easily obtain work, which is almost purely manual labor, at $5, $10, or even more, per day. Education for its own sake is a fine ideal, but there are few men so altruistic or so affluent that they do not look upon their education as a means to an end, as an investment which will yield dividends in the shape of a future salary. Moreover, it is well that this should be so; a rapidly growing industrial nation, such as ours, has need of all the trained technical men it can obtain; they are the life blood, without which its industries must soon decline and die. Any policy or condition which tends to discourage the production of such men is suicidal to the growth of all industry, and it is becoming increasingly evident that this condition already exists.

Complete Lack of Professional Etiquette

It cannot be emphasized too often, however, that technical men are themselves mainly to blame for this condition, and that their salvation rests entirely with themselves. There is evident among them an almost complete lack of professional etiquette. A case which recently came under the writer's notice may be cited in illustration of this. A surveyor in a western town was asked by his council if he would accept a lower salary, and refused. Thereupon he was asked to resign, but was informed that he might, if he wished, send in his application for the position at the lower salary. This invitation was also declined, but the council had no difficulty in securing another man at the lower salary. It is not necessary here to go into the merits of this particular case, but scores of similar instances might be mentioned where technical men have been willing and anxious to underbid one another in the matter of fees or salary, and the present low status of these professions is the direct outcome of this procedure. This sort of thing would be impossible among men who had any regard for the dignity of their profession, or a proper sense of what was due to themselves, and it can easily be avoided by some form of organization.

Engineers Are Laborers, Not Capitalists

There seems no obvious reason why professional engineers and technical men in this country should not form a union as highly organized as any of the so-called labor unions. There is not, or should not be, any reproach or stigma attaching to the words "labor" and "laborer." Labor is defined as "the toilsome exertion of either body or mind," and surely the men of the technical professions have as much claim to the title "laborer" as anyone. For some obscure reason, however, men of the engineering professions have been popularly classed rather with the capitalist than with the labor man, though goodness knows they number very few capitalists among their company.

Labor unions have admittedly done much to improve the condition of men working in skilled and unskilled trades, and they are likely to play an even more important rôle in the future when further readjustments are made between capital and labor. A union of technical men would certainly have the effect of similarly improving the condition and raising the status of those following these professions. That such a union is practicable is shown by the fact that chemists in England have already organized in this way. The fact that technical men follow a great variety of more or less distinct professions, and that the qualifications of individuals are equally diverse, ranging from the consulting man who has had extensive experience to the recent graduate only commencing to practise his profession, need form no barrier to the introduction of a proper scale of fees and salaries. There is the same range of ability and experience among men of the medical and law professions, and the etiquette prevailing in these professions suffices to maintain fees on a well recognized and adequate scale. Even in these professions there are, of course, some who indulge in the practice of under-bidding, but they find themselves severely ostracized. There is no reason why this practice should not be similarly eliminated from the technical professions, and so soon as this is done, the apparent discrimination against technical men will automatically disappear. Those who are at the head of these professions have every reason to know, from their own experience, the hard road their juniors have to travel, especially at the commencement of their career, and the initiation for bringing about the organization which is necessary before present conditions can be rectified or ameliorated, would most appropriately come from them.

U.S. ENGINEERING COUNCIL ACTIVITIES

By Alfred Douglas Flinn
Secretary, Engineering Council

At the regular meeting of Engineering Council of the United States, held June 20th, a special report by the Public Affairs Committee on the licensing of engineers was debated at length. It was decided to create a small special committee, with very carefully selected membership, to study this important question thoroughly with a country-wide view. It is intended that through the work of this committee, Engineering Council shall in due time be prepared to advise engineering organizations in any of the states upon this much-discussed matter. Engineers who have knowledge of proposed legislation are requested to communicate with the secretary of Engineering Council. Information or rumor has already been received of possible action by the legislatures of Iowa, Ohio, Indiana and Michigan. As is well-known, a few states have passed laws.

Assistance rendered by the committee of Engineering Council known as American Engineering Service, has been of increasing importance to the war, navy and other governmental departments in securing men for both civilian and uniformed services in connection with the war. American Engineering Service has come to be officially recognized as the channel of communication between governmental departments and engineers in personnel matters, in the United States.

The Fuel Conservation Committee has been working with the Fuel Administration and the Bureau of Mines, particularly in consultation on questions of policy. At the spring meeting of the American Society of Mechanical Engineers, in Worcester, an important special session arranged largely by this committee was devoted to fuel. Many valuable papers and discussions were presented which are to be printed by the American Society of Mechanical Engineers in a separate pamphlet.

A committee on Americanization activities was authorized for the purpose of co-operating with the National Americanization Committee and the Bureau of Education of the Department of the Interior. Council was requested by Miss Frances A. Kellor, special adviser to the Bureau of Education, to appoint such a committee to co-operate in the war work extension in an advisory capacity, especially in educational propaganda among mechanics and laborers with whom engineers come in contact through their industrial and professional work.

Ask for Engineers on Commission

Upon receiving a telegram from Boston engineers that the legislature of Massachusetts was expected to pass a bill abolishing the public service and the gas and electric commissions, substituting a Public Utilities Board of seven members appointed by the governor for five years, at five thousand dollars annual salary, Engineering Council passed resolutions and directed its secretary to send the following letter to Governor McCall:—

"Engineering Council, an organization of national technical societies of America, created to provide for consideration of matters of common concern to engineers, as well as those of public welfare, in which the profession is interested, representing the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, known as the Founder Societies, and having a membership of thirty-three thousand, at a regular meeting held June 20th, 1918, adopted the following preambles and resolution:—

"Whereas, it has been brought to the attention of Engineering Council that a Public Utilities Board of seven members will probably be appointed by you in the near future, and

"Whereas, experience has shown that engineering training, combined with special knowledge of organization and experience therein, is of great advantage to the public and should be associated with business capacity and tact for the efficient discharge of the duties of a Public Utilities Board, be it, therefore,

"Resolved that Engineering Council suggests the advisability of the appointment to membership on your board of at least one engineer who is qualified by training and experience for such duties as may be required of the members of such a board."

The organization meeting of Engineering Council was held June 27th, 1917, and so the recent meeting completes the first year of the Council's activities. During the year the Council has done much to perfect its organization, to strengthen its relationships with the societies and the government and has accomplished much useful work.

About 325 acres of devastated area in Halifax are to be rebuilt. The commission will undertake to construct the work on modern town-planning principles, and this will call forth the best art of engineers and architects. Provision is being made for the better location of streets, and public and private buildings of first-class construction.

At a recent joint meeting of the Point Grey, Richmond and South Vancouver boards of trade, the subject was joint action for the encouragement and development of industries in the Fraser District of British Columbia. A resolution was passed to the effect that every encouragement should be given to the building of wooden, iron and concrete ships and to new firms of a substantial character, when it was clear that such shipbuilding was in harmony with the best interests of the country and did not conflict with the intentions of the government.

SAMPLING DEPOSITS OF ROAD STONE AND GRAVEL IN THE FIELD

FOR a knowledge of the roadmaking values of natural deposits of stone and gravel, the engineer is depenuent very largely upon the results of laboratory tests. The tests are made upon small samples taken from much larger deposits and the value of the laboratory tests, therefore, depends directly upon the degree to which the samples represent the deposits. A series of studies is being made by L. Reinecke and K. A. Clark, of the Geological Survey of Canada, upon variations in the roadmaking qualities of deposits of bedrock, boulder aggregates and gravel. In *The Canadian Engineer* for May 3rd, 1917, was published an illustrated article by Mr. Reinecke on "Methods of Determining the Roadmaking Qualities of Deposits of Stone and Gravel." Messrs. Reinecke and Clark have now prepared for the American Society for Testing Materials a brief paper giving the results of a number of tests in respect to the sampling of deposits of road stone and gravel. The authors say that the field is very wide and that their paper covers only a small part of it. In regard to bedrock, they came to the following conclusions:—

Bedrock

1. The results of an abrasion test is liable to an error of 0.2 per cent. due to variations caused by laboratory procedure.

2. No additional error is introduced into the results of abrasion tests by the process of sampling when samples are collected in the manner outlined below.

3. Results of abrasion tests on rock in place in a deposit represent, within a probable difference of 0.4 per cent., the percentage of wear that will be shown by a crushed product produced from the deposit.

4. In the case of deposits consisting of stone of a very uniform character and appearance, the results of abrasion tests on samples taken at one point in the deposit can be regarded as representing within the probable error due to laboratory manipulation, the percentage of wear of the stone over quite a considerable area, at least a quarter of a square mile.

5. It is possible to assign average values and fairly narrow limits of variation of this value for the percentage of wear and the toughness of the material occurring in a limestone formation covering areas up to 50 and 60 square miles, and with thicknesses up to 500 ft., even though stone of quite different character is included in the formation. These values and limits will apply to the majority of results of tests made on samples collected throughout the formation and its various horizons. These limits should define the maximum variation of the results of abrasion and toughness tests made on samples collected from a quarry in a limestone formation to represent the material produced from the quarry as operations are extended from year to year. They should assist in determining at what intervals apart vertically and horizontally it is necessary to sample formations consisting mainly of limestone or dolomite in order to arrive at their average percentage of wear and toughness values, and variations from such values.

6. The results of abrasion and toughness tests over a series of diabase dykes of the same age and structure reveal very uniform results in deposits of the same grain. A change in grain affects the toughness value slightly. The number of samples taken in dykes of this character need therefore not be great even though they cover large areas, if structural conditions and the texture and degree of alteration of the stone remain the same.

Boulder Aggregates or Field Stone

The authors state that the following conclusions may be drawn from their investigation of boulder aggregates:

1. Boulder deposits in any one area consist of many combinations of three or four rock types of fairly uniform durability, and the percentage of wear of any combination of the rock types found in deposits of boulder aggregates can be calculated by the following formula if the percentages of wear of each of the rock types are known:

$$W_m = \frac{\Sigma C W}{100},$$

in which W_1, W_2 . . . . Wn = percentages of wear of the various rock types, and C_1, C_2 . . . . Cn = percentage proportions in which the rock types are present in the combinations.

2. A large variation was found between the results of duplicate granulometric laboratory analyses on the same sack of gravel. The variation in texture over one deposit of gravel of 80 acres was found to be large.

Method of Collecting Samples

In collecting samples of bedrock for the abrasion test, care was taken to secure samples which fairly represented the entire face of the deposit being sampled. Equal numbers of pieces were broken from equal units of height of face. Fifty-five pieces, the right size or a little larger, for the abrasion test constituted a sample. In a good many cases 110 pieces were uniformly collected from the face and separated in the laboratory by quartering into duplicate samples. In other cases two samples of 55 pieces were separately collected over the same face and at the same place. If there was reason to suspect that any definite section of a deposit contained material that possessed somewhat different qualities than stone from the other parts of the deposit, samples were taken to detect any such difference. Corresponding to each abrasion sample, toughness blocks representing each important lithological phase of the stone in the deposit were collected. In sampling crushed stone, material was taken from the stock pile of large sizes so that pieces with fresh edges could be prepared for the abrasion test.

At a joint meeting of the Point Grey, Richmond and South Vancouver boards of trade, held recently, a desire was expressed by one of the members from Point Grey to obtain a site for an up-to-date smelter for the purpose of making grey pig iron from British Columbia ores. It was agreed that the committees should see what sites are available.

The new policy of concentrating the work of the engineering department of the city of Montreal has led to the assignment of defined positions to divisional engineers. F. E. Field, engineer of the filtration plant, has been appointed assistant to the head of the waterworks department. E. Blanchard, of the Eastern division, has been appointed assistant engineer of the road department. T. Langlois is assistant engineer of the sewers department. J. H. Valiquette, of the Western division, is now assistant designer in the sewers department.

It has been definitely determined by laboratory tests that the maximum safe working internal temperature of an 11,000-volt cable is 150 deg. Fah. 65.6 deg. Cent.), says the "Electrical World." Beyond that temperature a peculiar phenomenon is manifested. By reason of the high voltage, a hysteresis effect occurs in the insulation that generates heat. Up to 150 deg. Fah. this loss increases directly with the temperature, but after 150 deg. Fah. is reached the curve takes a very sharp upward turn and quickly reaches the failure point. Safe operation depends, therefore, upon the ability to keep the internal cable temperature below 150 deg. Fah.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto

CHEMICAL ANALYSIS OF IRON

Reviewed by Prof. L. J. Rogers
University of Toronto

By *A. A. Blair.* Published by the J. B. Lippincott Co., Philadelphia. 318 pages, 100 illustrations, 6¼ x 9 ins., cloth. Price, $5.00 net.

The last edition of Blair covers the field in the same comprehensive manner as the previous editions. There are several points, however, where the author has apparently not kept abreast of the improvements made in the past few years. The chapter on carbon determinations gives no elaboration of the electric furnace now universal in application. All cuts show gas furnaces. There is no mention made of the rapid type of absorption tower after the Fleming model, although these have in many instances supplanted the color carbon in practice in making the snap test.

The chapter giving methods for chronium has ignored Tusker's persulfate method as well as Low's bismuthate procedure, and no mention is made whatever of the barium carbonate precipitate method for small quantities, as given in A.S.T.M.

The chapters on alloy steels give some excellent methods, but unfortunately, do not deal in a manner to classify such, and the type of steel where they best apply.

The book on the whole, while giving much that is standard and valuable, cannot be said to be up-to-date on these points wherein advances have been made during the past decade.

MINING ENGINEERS' POCKET BOOK

Edited by *Robert Peele,* Professor of Mining Engineering, School of Mines, Columbia University, New York City, assisted by forty-three associate editors. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Limited, London; Canadian selling agents, Renouf Publishing Co., Montreal. 2,385 pages, 4¼ x 7, nearly 2,000 illustrations, flexible imitation leather binding. Price, $5.00 net.

The first edition of this monumental hand-book will undoubtedly be hailed with considerable pleasure by the engineers concerned with the development and management of mines, and also by those who have to do with construction detail involved in the installation of plant. It is also a valuable text book on mining subjects.

The size of the work, nearly 3,000 pages, is caused by the great variety of subjects that must be treated The editors claim that the two other mining engineers' hand-books which are already in existence either omit or treat too briefly many subjects which constitute important parts of the professional equipment of the present-day mining engineer. A hand-book on mining must include a greater variety of subject-matter than hand-books on other branches of engineering, and the publishers felt that the field was too wide to be covered satisfactorily by a single writer, so they followed the precedent set in their American Civil Engineers' Pocket-Book and invited a large number of authorities to contribute to Prof. Peele sections on their respective specialties. Besides sections dealing with mineralogy, ore deposits, methods of prospecting, exploration in mining and mining plant of all kinds, there are others on certain branches of civil, electrical and mechanical engineering. It may be thought by some that this collateral material occupies too much space in a book on mining, but in view of the important part played by the allied branches of engineering in equipping and operating modern mines, we believe the allotment of space is reasonable. The book includes such data on machinery, power plant, electrical transmission and structural design as the mining engineer may need when in the field and out of reach of his personal notes and technical library. For office use there is at the end of each section a bibliography of the more important books and papers on the subjects dealt with.

No serious attempt is made in the hand-book to exhaust metallurgical subjects, as it is recognized that a companion hand-book on metallurgy must soon be supplied. Condensed summaries are included, however, of those processes of treatment which are frequently carried on by mining companies themselves. Relatively small space is allotted to coal mining, due somewhat to the fact that a coal mining pocket-book is already in existence.

It was planned to publish this book in 1916, but the outbreak of war about one year after the work was begun was responsible in a large measure for the delay.

The list of associate editors is a formidable one, including some of the leading consulting mining engineers and professors in the United States.

HANDBOOK ON PIPING*

Reviewed by George A. Orrok
Consulting Engineer, New York City

By *Carl L. Svensen,* B.S., Assistant Professor of Engineering Drawing in the Ohio State University. New York: D. Van Nostrand Co. Cloth; 6 x 9 ins.; 352 pages; illustrated. Price, $3.00 net.

Professor Svensen has produced a text-book on piping which both in range of contents and in size greatly exceeds the three books on the subject previously available. Although the present volume appears to be a combination of lecture notes and material from manufacturers' catalogues and seems to show lack of knowledge of actual practice, yet within such limitations the work of preparation seems to have been well done, and as a text-book it will doubtless prove useful—though, of course, not as useful and as safe a guide for students as is desirable.

The first three chapters relate to the history of pipe and pipe threads and contain data as to the sizes and use of pipe. The next four chapters deal with fittings, joints

*From Engineering News-Record, of New York.

and valves. Steam exhaust, water and gas systems are covered in Chapters VIII. to XIV. To erection, insulating pipe covering, drawings and specifications is allotted a chapter each.

In general, the text and tables are very good and the illustrations well drawn. A few specific faults may be mentioned. Although the plates in the chapter on "Specifications" are valuable as examples of high-class engineering, the tables need to be corrected so as to cover the later work of the committee on pipe standards of the American Society of Mechanical Engineers. Going back to page 3, a serious error may be noted. Here the author advises the use of extra-heavy pipes for pressure above 125 lbs. per square inch. He also says that standard pipes are sometimes used up to about 200 lbs. per square inch, but that this is not advisable. As a matter of fact, full-weight pipe is in nearly universal use for pressures up to 225 lbs. per square inch, while extra heavy pipe is rarely used except in small sizes or for special reasons.

It is unfortunate that the author does not use the term "Van Stone" as applied to pipe joints until he reaches Chapter VIII. and then not again until Chapter XVIII., although he has illustrated the type, on p. 83, as the "Walmanco" and "Cranelap," both trade names for variations of the nearly universal Van Stone joint. The welded joint and nozzle (pp. 75-76) are somewhat cavalierly treated, although they have been known for 20 years at least and at the present are undergoing considerable change while their use is widening. The reviewer fails to find any mention of the use of the Van Stone joint with welded edges on high-pressure work (350 pounds).

Fig. 152 appears to be a violation of the American Society of Mechanical Engineers' boiler code (now the official standard of many states) in that a steam connection is made to the safety valve nozzle. Machine banded wood-stave pipe, so common at the present time, is not mentioned and continuous-stave wood pipe might well have received more space.

Some of these criticisms relate to what may be considered relatively minor points, but they will serve to illustrate opportunities for improvement in the next edition. It is to be hoped that when a revision is made the errors of omission and commission, which smack of the study and the classroom, rather than of the engineering office, the power house and the field, will be eliminated. The volume would then become more useful not only in the classroom but also in engineering practice.

PUBLICATIONS RECEIVED

Temiskaming County, Quebec, Memoir 103.—Issued by the Geological Survey, Ottawa. Illustrated. By M. E. Wilson. 200 pages.

Weights of Various Coals, by S. B. Flagg. Technical Paper 184 issued by the Bureau of Mines, Department of the Interior, Washington, D.C.

Onaping Map Area.—By W. H. Collins. Memoir No. 77 of the Geological Series. Issued by the Department of Mines, Ottawa. Contains 162 pages.

Tarvia A.—An illustrated booklet describing the character and use of this road preservative. Published by the Barrett Co., Ltd., Toronto, Montreal, etc.

Tarvia K.P.—A handy vest-pocket reference booklet showing each step in patching a road with Tarvia K.P. Issued by the Barrett Co., Ltd., Montreal, Toronto, etc.

Johnson Well Screens.—Bulletin No. 18, describing Johnson brass well screens and Johnson pipe base well screens. Eight pages, 6 x 9 ins., coated paper, illustrated.

Cutters.—Catalogue "A" issued by The Cleveland Milling Machine Co., Cleveland, Ohio, being a reference book of milling cutters, etc. Contains 223 pages and is well illustrated.

Polyphase Induction Motors.—Bulletin in which is described this type of motor, which has a very wide field of application. Issued by the Canadian General Electric Co., Ltd., Toronto.

Gardner Duplex Pumps.—Forty-eight-page catalogue in two colors on coated paper, 6" x 9", issued by the Gardner Governor Company, Quincy, Ill. Canadian representatives, O. W. Meissner, Ltd.

Lillie Evaporators.—Describes the Lillie evaporators for waste for use in connection with tank waters, run-away waters, distillery slop, etc. Issued by the Wheeler Condenser and Engineering Co., Carteret, N.J.

Museum Bulletin No. 27.—Issued by the Department of Mines, Ottawa. Contains information concerning the mineralogy of Black Lake Area, Quebec. By Eugene Poitevin and R. P. D. Graham. Illustrated; 108 pages.

Centrifugal Boiler Feed Pumps.—Bulletin N, published by the De Laval Steam Turbine Co. Describes the De Laval combined steam turbine and centrifugal boiler feed pump. Issued by the De Laval Steam Turbine Co.

Air Compressors.—This is a 32-page bulletin printed on coated paper and illustrated. It describes Ingersoll-Rogler air compressors and points out their special features. Issued by Canadian Ingersoll-Rand Co., Ltd., general offices, Montreal.

Coaling Towers.—A 28-page pamphlet devoted to the description of Wheeler-Balcke coaling towers. Various designs of these towers are shown with capacities varying from a few thousand gallons per hour to nearly a million gallons per hour. Issued by the Wheeler Condenser and Engineering Co., Carteret, N.J.

Direct Lift Vertical Air Hoists.—The Canadian Ingersoll-Rand Co. have just issued a new catalogue of their direct lift vertical air hoists. The booklet is well illustrated, and gives complete details of the different types of valves used for various classes of work up to five tons capacity—the dust-proof single acting, the dust-proof air balance, the dust-proof double acting. Complete tables are given, including a useful table of the free air consumption of the hoists.

Petroleum, Asphalt and Natural Gas.—This is a 210-page handbook issued by the Kansas City Testing Laboratory, Kansas City, Mo., and contains a great deal of useful information to all who are interested in the production, refining, selling, uses and technology of petroleum, asphalt and natural gas. Some exceedingly valuable statistics, intelligently arranged and carefully classified, are included, as well as many useful tables and data, making a compact handbook on the subject.

Empire Municipal Directory and Year Book, 1918.—Contains among other matter specially contributed articles on highway engineering, sewage disposal, public lighting, water supply and purification. An interesting section of the book is the list of municipal officials in the various British colonies. The list of names of municipal officials in Canada takes up twenty-two pages and covers every province. The book contains 260 pages exclusive of diary pages for 1918 and memoranda pages at end of book. This is the 36th year of publication. Published by "Municipal Engineering and The Sanitary Record," 8 Breams Buildings, London, England. Price, 5s. 6d.

NOTES ON THE PRESUMPTIVE TEST FOR B. COLI*

By Max Levine

EXAMINATIONS of waters for B. coli constitute an important part of the tests employed for the control of water supplies. Isolation and complete identification of the organisms is too laborious and costly for routine work and it is therefore desirable to have some simple test by which the probable presence of B. coli may be quickly determined with a sufficiently high degree of reliability to give a reasonably accurate idea of the existence of pollution.

The ideal medium for such a presumptive test would be one in which B. coli flourishes while other forms are inhibited, but this ideal has not as yet been attained. The requirements of a reliable presumptive test may be briefly stated as follows:

Requirements of Reliable Test

1. The medium employed must be one in which a test characteristic of B. coli is quickly obtained and easily recognized.

2. The medium should not inhibit the growth of B. coli nor permit its overgrowth by such forms as B. aerogenes.

3. Anaerobic spore-forming gas producers should be inhibited or some simple supplementary test provided by which errors due to their presence may be eliminated.

4. It is desirable that the test should also differentiate between true B. coli and B. aerogenes.

Until 1906, the most commonly employed presumptive test was gas production in dextrose broth. The formation of 25 to 70 per cent. gas, of which approximately one-third was CO_2 was regarded as an excellent indication of the presence of B. coli and dangerous pollution. This criterion has been conclusively discredited. The variability of the gas ratio as determined in routine analysis, the many bacterial forms which ferment dextrose but not laxtose, coupled with the relatively greater incidence of such forms in treated and partially purified sources than in polluted waters, makes the old dextrose broth presumptive test an unreliable index of pollution. This is particularly true in warm weather.

Since 1906 the most commonly employed presumptive test has been lactose peptone bile. The advantages over dextrose broth are many, but recently there has been a tendency to use lactose broth in order to eliminate the inhibitory action of bile.

Recent Work by U.S. Department of Agriculture

Where pollution has been recent, the lactose bile or lactose broth presumptive tests are very reliable, but with relatively pure or treated waters, a positive presumptive test is not infrequently obtained when no B. coli are present. This confusion is due to the presence of spore-bearing anaerobic lactose fermenters. The error may be easily eliminated by plating from the positive lactose bile or broth tubes to some solid medium in petri dishes, as recommended by the U.S. Treasury Department Standard for drinking waters on common carriers.

The recent work of Rogers and his associates of the United States Department of Agriculture, which has been confirmed by many other investigators, has demonstrated conclusively that there is a marked correlation between certain types of coli-like bacteria and their sources. Two types may be easily distinguished: the B. coli which is constantly found in feces of man and in sewage but rarely in unpolluted soil, and the B. aerogenes which is rarely obtained from feces, but commonly found in cropped soil, on grains, etc. That these two types are very different in their sanitary significance is evident, since B. coli is characteristically of fecal origin whereas B. aerogenes is not. It is therefore desirable that they be differentiated in routine water analysis.

The following procedure is suggested as routine:

1. Plant portions of the sample in 0.5 per cent. lactose peptone broth. Incubate at 37° C. for forty-eight hours.

2. After twenty-four hours incubation smear onto eosine methylene blue agar plates described below, from the highest dilution showing any gas (preferably also from the next highest dilution) and incubate at 37° C. for twenty-four hours.

If gas production is due to B. coli, characteristic black colonies with a metallic lustre will develop on the eosine-methylene blue agar in fifteen to twenty-four hours. B. aerogenes also grows well on this medium but its colonies are so distinctly different from B. coli as to be easily distinguished. Anaerobic spore-forming gas producers will, of course, not develop, thus eliminating the error introduced by their presence in the fermentation tubes.

Lactose Broth

The new Standard Methods of Water Analysis of the American Public Health Association recommend 0.5 per cent. peptone and 1 per cent. lactose for the lactose broth medium, and incubation for forty-eight hours before any confirmatory tests are applied. With 1 per cent. lactose, this period of incubation is too prolonged and detrimental to the successful isolation of B. coli. In a private communication Dr. Joseph Race, of Ottawa, Canada, points out that begining with equal quantities of B. coli and B. aerogenes there are found many times as many B. aerogenes as B. coli in 1 per cent. lactose peptone bile-salt broth after forty-eight hours. The ratio may be as high as 18 to 1. The probability of obtaining B. coli from such a mixture by plating on litmus lactose agar is evidently slight.

In some unpublished studies in this laboratory it has been observed that with pure cultures of B. coli a maximum count is obtained in about twelve hours. In a medium with 1 per cent. lactose B. coli begins to die off after twenty-four hours, some strains disappearing very rapidly whereas many B. aerogenes-like forms do not. If the quantity of lactose is reduced to 0.5 per cent. the death of B. coli is retarded considerably, and the probability of its detection thereby increased. One-half of one-per cent. lactose is sufficient for rapid and characteristic fermentation and this quantity therefore seems more desirable than the standard 1 per cent.

Eosine Methylene Blue Agar

The agar medium recommended is a modification of that employed by Holt-Harris and Teague for the isolation of B. typhi, and is prepared as follows: Distilled water, 1,000 c.c.: agar, 15 grams: peptone (Difco), 10 grams: K_2HPO_4, 2 grams.

Boil until dissolved. Make up loss due to evaporation, and place measured quantities in flasks or bottles. Sterilize in autoclave for fifteen minutes at 15 pounds pressure.

Neither adjustment of the reaction nor filtration is necessary.

*Read before the Iowa Section of the American Water Works Association.

For use the following materials are added to each 100 c.c. of the melted agar as prepared above: 1 gram or 5 c.c. of the sterile 20 per cent. lactose solution, 2 c.c. of 2 per cent. aqueous yellowish eosine, and 2 c.c. of 0.5 per cent. aqueous methylene blue. The aqueous solutions of the dies will keep in the ice box several months.

Differentiation of B. Coli and B. Aerogenes

On the eosine methylene blue agar as prepared above, B. coli forms characteristic button-like colonies 2 to 4 mm. in diameter with large black centres. There is also a greenish metallic lustre and they are only slightly raised above the surface of the medium. B. aerogenes forms colonies which are much larger, considerably raised obove the surface of the medium: characteristically show a relatively small brown centre and the metallic lustre is rarely observed.

Of 122 colonies tentatively diagnosed as B. coli from their appearance on the agar, 97 per cent. were B. coli, while of 102 colonies of supposed B. aerogenes, 83 per cent. were confirmed. The differentiation on this medium therefore seems reasonably reliable.

Conclusions

In the lactose broth presumptive test, 1 per cent. lactose is detrimental to the successful isolation of B. coli, as many strains die off rapidly after twenty-four hours. A reduction of the lactose to 0.5 per cent. reduces this error and is therefore recommended for routine tests.

For a rapid confirmatory test, the modified eosine methylene blue agar, because of its simplicity, ease of preparation, and the differentiation which it permits between B. coli and B. aerogenes, may advantageously be substituted for litmus lactose agar or the Endo medium, in routine water analysis.

The necessity for confirming the presumptive test and differentiating between the objectionable B. coli and the more widely distributed B. aerogenes and anaerobic gas-formers is not only of theoretical interest but of considerable practical significance when dealing with surface waters which are purified by sedimentation or chlorination. Where the positive presumptive test is due to spore formers, the amount of chlorine necessary to remove them is far in excess of that required to make the water safe. B. aerogenes also seems to be more resistant to treatment than B. coli. A knowledge of the type of bacteria responsible for a positive presumptive test thus becomes of practical significance.

J. E. Ray, Canadian trade commissioner, Manchester, England, reports that the British Government is considering a scheme to erect at least 300,000 houses under state and municipal rate aid. This prospective demand for building materials, etc., should be closely followed by Canadians, as this country will probably be the largest source of structural supplies.

The Continental Pipe Manufacturing Co., organized under the laws of the State of Washington, has purchased the plants of the following concerns: The Pacific Coast Pipe Co., Seattle, Wash.; the Washington Pipe Foundry Co., Tacoma, Wash.; the National Tank Pipe Co. (pipe department only), Portland, Ore., and the Portland Wood Pipe Co., Portland, Oregon.

The new building of the Sun Life of Canada in Montreal has been almost completed. It occupies a corner overlooking Dominion Square, and is seven stories high, but is so constructed that ten more stories could be added. The exterior is of grey granite on a frame of structural steel. A fireproof vault, built on separate foundations, runs upward through all floors. The building includes a dining-room and lounge-rooms.

NEW INCORPORATIONS

Unity, Sask.—Standard Machinists, Ltd., $20,000.

Mazenod, Sask.—Mazenod Farmers Elevator Co., Ltd., $15,000.

Hamilton, Ont.—Monarch Metal Co., Ltd., $250,000; G. A. Young, A. B. Turner, A. H. Johnson.

Woodstock, Ont.—Fig-Lax Laboratories, Ltd., $50,000; L. Goodyear, B. Goodyear, W. Goodyear.

Winnipeg, Man.—Gray Tractor Co. of Canada, Ltd., $1,000,000; J. W. Gray, A. Prugh, E. R. Chapman.

Midland, Ont.—Midland Iron and Steel Co., Ltd., $1,000,000; D. S. Pratt, D. L. White, J. W. Benson.

Hamilton, Ont.—Dominion Sheet Metal Corporation, Ltd., $500,000. J. R. Marshall, H. A. Burbidge, A. B. Turner.

Windsor, Ont.—Saxon Motors Corporation of Canada, Limited, $50,000. Alexander Robert Bartlet, Harvey Leroy Barnes.

Brantford, Ont.—Canada Plaster Board Co., Ltd., $100,000. Frederick Chalcraft, William Edward Long, Robert Edwin Haire.

Welland, Ont.—Dillon Crucible Alloys, Limited, $100,000. Lynn Bristol Spencer, Lorenzo Clarke Raymond, Charles Henderson.

Vancouver, B.C.—North Wellington Collieries, Ltd., $25,000; Point Hydraulic Mining Co., Ltd., $25,000; Delia Mines, Ltd., $25,000.

East Broughton, Que.—Dominion Asbestos Spinning Co., Ltd., $149,000. Aurel Pare, James Edward Murphy, Arthur Morisset.

Calgary, Alta.—Branham Dredging Co., Ltd., $500,000. William Wilfred Wadleigh, Alexander Cameron Galbraith, Charles Saunders.

Saint-Amedee-de Peribonka, Que.—Quebec-Saguenay Pulp & Paper Company, Limited, $799,999. M. M. Joseph-Philias Galibois, Hector Godbout.

Vancouver, B.C.—Frank Waterhouse & Company of Canada, Limited, $50,000. Frank Waterhouse, Neal Harold Begley, John Richard Lane.

Vancouver, B.C.—Vickers Contracting Co., Ltd., $10,000. Burnaby Oil Wells, Ltd., $65,000. Barons Motors, Ltd., $15,000. Quadra Steamship Co., Ltd., $100,000.

Montreal, Que.—Fairfax Forgings, Limited, $1,500,000. Louis Athanase David, Louis Phillippe Crepeau; L. H. Cantin & Compagnie, Limitée, $10,000. Frank Pauze, J. Arthur Beaudoin.

Vancouver, B.C.—Beaver Cove Lumber and Pulp Co., Ltd., $1,000,000. Point Hydraulic Mining Co., Ltd., $25,000; North Wellington Collieries, Limited, $25,000; Spartan Oil Co., Ltd., $250,000.

Toronto, Ont.—King Construction Co., Ltd., $100,000. John Alexander Hart, John William Gooch, Edwin George Long; Kirkland-Munroe Gold Mines, Ltd., $2,000,000. Alexander Gordon, Sydney Charles Parker, Daniel Sheriff.

Toronto, Ont.—Paving and Mastic Co., Ltd., $40,000; R. E. Grass, R. Lierberman. Wilberforce Molybdenite, Ltd., $250,000; L. Adams, V. M. Gray, B. M. Gray. Superior Mines, Ltd., $500,000; J. H. Spence, G. Cooper, L M. Heal.

Toronto, Ont.—Sunbeam Chemical Company of Canada, Limited. George Harold Gilday, Martha Pearl Procter, Loretta Flynn. Petroleum and Gas Products, Limited, $1,000,000. George Joseph Valin, Fred. Woods, Fred. Wilson Rogers.

Winnipeg, Man.—Northern Implement Company, Limited, $25,000. William John Leaney, Frank Nilan, Norman Wesley Stowell; Flaxlinum Sales Company, Limited, $25,000. James Douglas Armstrong, Albert Preston Hendrickson, Frank Evans.

Quebec, Que.—Corporation d'Energie de Montmagny, $400,000. Ernest Roy, Hew R. Wood, Maurice Rousseau; Steamer Muriel W., Limited, $10,000. Wm. Quarrier Stobo, Herbert Cecil Thorn, Cyril St. John Griffis; Canadian Ferro Alloys, Limited, $250,000. Lawrence Macfarlane, Gordon-Walters MacDougall, William-Bridges Scott.

Montreal, Que.—Halifax Shipyards, Ltd., $6,000,000; C. Pringle, N. G. Guthrie, R. Blake. Clyde Engineering Co., Ltd., $100,000; F. T. Peacock, H. Kennedy, J. Bryson. Motor Services, Ltd., $250,000; R. T. Heneker, H. N. Chauvin, H. Wylie. Electric Welding and Shipbuilding Co. of Canada, Ltd., $50,000; J. J. Meagher, H. N. Chauvin, J. E. Coulin. Troja Steamship Co., Ltd., $1,000,000; E. F. Surveyor, W. L. Bond.

PROPORTIONING THE MATERIALS OF MORTARS AND CONCRETES

(Continued from page 32)

large proportion of the structures now existing fall short of the ideal mainly for two reasons:—

1. Not all of the factors influencing the strength, hardness, durability and other physical properties of mortars and concretes are known and have not, therefore, been given due consideration.

2. Infallibility is not an attribute of the human mind, and, in consequence, defective structures are built, which, like chains, are no stronger than their weakest parts.

As regards strength alone, there is a most remarkable lack of "team play" between the designer on the one hand and the construction superintendent on the other. This lack of co-ordination arises most commonly from the restricted field over which each may claim, "I am monarch of all I survey." The average designer thinks in terms of pounds of compressive or of tensile stress rather than in terms of the materials to be used in the actual construction. Too frequently he clings tenaciously to the notion that a given mix will develop a given strength at an age of 28 days. For example, he assumes that a 1 : 2 : 4 mix, proportioned by the commonly used volume method, will develop a compressive strength of 2,000 lbs. per sq. in., while, as a matter of fact, the 1 : 2 : 4 mix actually used in the work he designs may attain a strength of from 1,200 to 3,000 lbs. per sq. in. or over. He rarely realizes that in ordinary concretes of, say, 1 : 2 : 4 mix the actual cement content per cubic yard of finished concrete varies widely, due to the character and quality of the aggregates, to the consistency of the mix and to field methods and operations of mixing and placing. The average field superintendent commonly thinks in terms of bags and barrows, batches and bulks. He measures strength by the "ring" of the concrete under the blows of a hammer, which indicates that the form work can safely be removed. To him efficiency and excellence are gauged and measured not by ultimate results, but by a day-to-day standard involving an intimate combination of time, volume and payroll rather than by standards of strength, reliability and permanence.

The securing of greater uniformity in results approaching more closely the ideal, demands that a great amount of work be done—work not only of an educational, but also of an experimental and creative kind—involving the training of the workman and of his foreman to a different conception of their duties, that they may become more expert and efficient; the consigning to a merited oblivion of time-honored practices and methods, unproductive of desired results; and the development and adoption of new methods and practices founded upon rational and scientific principles. This is, indeed, no menial task.

The maximum economy consistent with strength and durability will be realized when the designer can so proportion the several parts of a structure that all will theoretically be worked to equal efficiencies, and those the maximum safe ones; and the superintendent of construction can so erect the structure as to conform to the conditions assumed in the design.

There is ample evidence that in order to bring mortars and concretes to the highest standards of excellence as structural materials our efforts must be directed more specifically toward the development of a more thorough knowledge of their component materials and the improvement of field methods and practices. The suggested investigation of available aggregates with a view to determining their values as materials for the making of mortars and concretes, preliminary to the designing of a proposed structure, properly deserves further consideration.

Extended examinations cannot economically be made in connection with structures of minor importance involving comparatively small total expense. In such cases a liberal use of cement is doubtless more economical. However, there should be a certain amount of investigation. The justification of expense in connection with structures of greater magnitude, involving large quan-

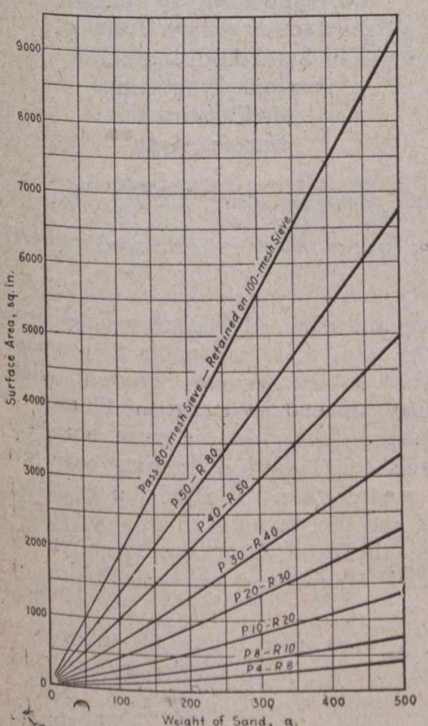


Fig. 21—Surface Areas (sq. in.) Corresponding to Various Weights of Sand Aggregate (g.)

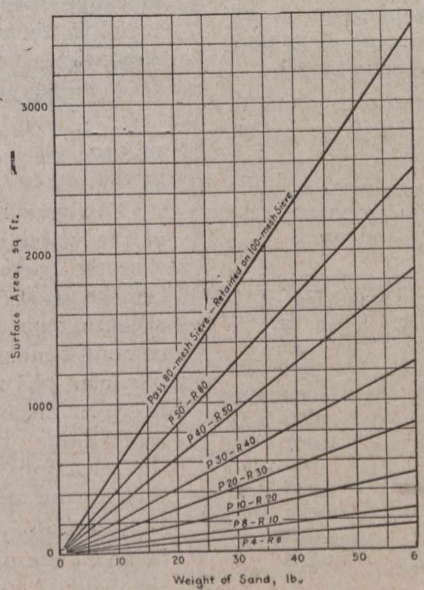


Fig. 22—Surface Area (sq. ft.) Corresponding to Various Weights of Sand Aggregate (lb.)

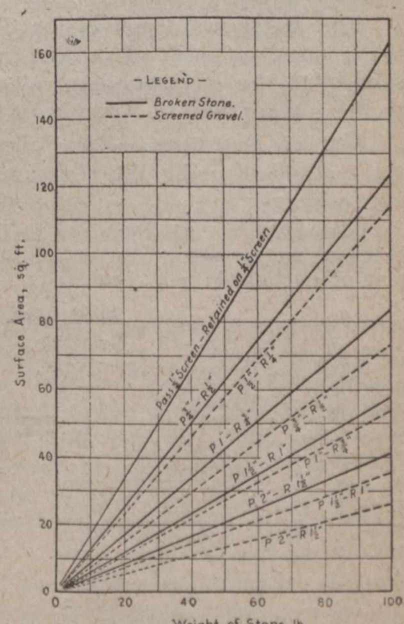


Fig. 23—Surface Area (sq. ft.) Corresponding to Various Weights of Stone Aggregate (lb.)

tities of mortar or of concrete materials, is a quite different proposition when considered from an economic viewpo.nt. The results of the tests herein described give ample evidence of the economy of well-graded sands when used as aggregate for mortars and concretes proportioned in accordance with the surface-area method. It will frequently happen that such an investigation will involve only the collecting and testing of sample aggregates secured from commercial companies dealing in these materials. In other cases an investigation might involve a search for satisfactory sand and gravel deposits or for quarry sites.

It is an encouraging fact, and worthy of note in passing, that tests of aggregates are being regarded of much greater importance and are receiving correspondingly greater attention than formerly.

Practical Application of the Method

The adaptation of the surface-area method of proportioning mortars and concretes to both laboratory investigations and to field construction operations presents no serious difficulties. The outstanding feature of this method, in so far as its practical application is concerned, is the importance of knowing the granulometric composition of the aggregates. It must be admitted that the securing of this all-important information involves a comparatively small amount of labor, and by way of equipment the use of only the necessary scales, standard sieves and screens. The time element involved is comparatively negligible, since, as described more fully herein, the computation work of determining areas and quantities of cement can be largely reduced to the most simple mathematical operations by the use of tables and diagrams. For use in the laboratory and in the field, diagrams drawn to a large scale increase accuracy and reduce labor.

Figs. 21 and 22 are designed for use in determining the surface areas of sand aggregate. The former is intended for laboratory use and the latter for both laboratory and field use. These diagrams are derived from information contained in Table III.

Fig. 23 is designed for use in determining the surface area of stone aggregate and is intended for both field and laboratory use.

Fig. 24 shows a conversion diagram for determining the relative quantity of cement in pounds per 100 lb. of sand from the corresponding relation of cement in grams to the surface area of 1,000 g. of sand and vice versâ.

Use of Diagrams.—The following examples explain the method of using the diagrams shown in Figs. 21 to 24, inclusive:

Example No. 1.—Required to find the composition of a batch of mortar using 1000 g. of sand A and a cement content proportioned: 1 g. cement to 15 sq. in. sand area.

Sand Area.

Sieve.	Grading, per cent.	Weight, g.	Area (Fig. 21), sq. in.
P 4 -R 8	15.0	150	142
P 8 -R 10	5.0	50	75
P 10-R 20	25.0	250	694
P 20-R 30	15.0	150	676
P 30-R 40	15.0	150	997
P 40-R 50	10.0	100	992
P 50-R 80	10.0	100	1,348
P 80-R 100	5.0	50	932
Totals	100.0	1,000	5,856

$$\text{Cement (g.)} = \frac{5856}{15} = 390.5.$$

$$\text{Water (cc.)} = 390.5 \times 22.25 \text{ per cent. (normal consistency)} + \frac{5856}{210} = 115.$$

Example No. 2.—Required to find the composition of a batch of concrete using 100 lbs. of sand A, 200 lbs. of broken stone graded as shown below, and a cement content proportioned: 1 g. cement to 15 sq. in. aggregate area.

The area of the sand aggregate is determined as shown in Example No. 1 except that Fig. 22 is used, therefore: Sand area (sq. ft.) = 1,845 sq. ft. per 100 lbs.

Stone Area.

Screen.	Grading, per cent.	Weight, lbs.	Area (Fig. 23), sq. ft.
P $1\frac{1}{2}$ in.-R 1 in.	60.0	120	69.0
P 1 in.-R $\frac{3}{4}$ in.	25.0	50	41.5
P $\frac{3}{4}$ in.-R $\frac{1}{2}$ in.	10.0	20	24.5
P $\frac{1}{2}$ in.-R $\frac{1}{4}$ in.	5.0	10	16.0
Totals	100.0	200	151.0

Total area of aggregates = 1,996 sq. ft.

Cement (lb.) = 19.96 × 2.11 (Fig. 24) = 42.12 lbs.

Practical Limitations

It is especially important to note that in its application the surface-area method of proportioning admits of certain physical limitations. The more important of these are here discussed briefly.

Effect of Dust.—The effect upon the physical properties of mortars and concretes of a sandy "dust" passing a No. 100 sieve is not definitely known. The main feature to be considered in this connection is the relation of the sizes of the "dust" particles to the sizes of the cement particles. A microscopic examination of the cement used in the tests described in this paper showed the sizes of the greater portion of the cement particles to range from 1.5 to 3.3 μ[1] in their largest dimensions with an average dimension of approximately 2.2 μ, that is $\frac{1}{11,540}$ in. Some of the larger particles measured ranged in size up to 6.7 μ.

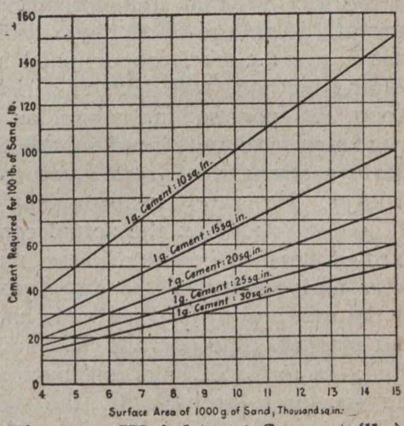


Fig. 24—Weights of Cement (lb.) per 100 lb. of Sand Aggregate Corresponding to Various Surface Areas per 1,000 g. of Sand Aggregate and Various Proportions of Cement to Surface Area

Disregarding entirely the effect of the surface tension of the water used in the mix, it is reasonable to assume that the particles of dust do not become "coated" with cement paste, but that instead they become linked to adjoining particles of aggregate by one or more separate cement bonds. Doubtless the cohesion existing between particles of cement is greater than the adhesion existing between these particles and the particles of dust or other aggregate. It follows, therefore, that the strength of the mass must be somewhat weakened by the inclusion of dust in the aggregate.

Laboratory vs. Field.—The most important difference between the preparation of mortars in the laboratory and the field is found in the methods of mixing. In the laboratory the operator submits the mix to a thorough

[1] One micron (μ) = $\frac{1}{25390}$ in.

kneading and squeezing which forces the component materials into the closest possible contact with each other. In the field the mixing and frequently much of the work of transporting and placing tends to separate and break up rather than to knead and compact the mortar mass.

Field construction conditions are never ideal, even when carried on under the most careful supervision. In consequence, the strengths and other physical properties of field-made mortars and concretes frequently differ widely from the results obtained by tests made in the laboratory, in accordance with standard laboratory practice, with the object of obtaining a measure of the constructive value of the materials.

Coarse vs. Fine Sands.—Mortars in which the sand aggregate contains a comparatively large proportion of coarse particles are subject, during mixing and placing operations in the field, to an intensified movement of the water content which tends to produce an improper distribution of the cement. This condition is most noticeable in concreting operations.

When mixed to "normal" consistency, so-called well-graded sands do not produce mortars which are as "workable" as those in which the sand aggregate contains larger percentages of smaller sized particles.

As compared with mortars containing well-graded sand aggregate, mortars containing aggregates composed entirely of fine particles must be subjected to a greater amount of mixing in order to secure a uniform distribution of the cement by a thorough abrasion which will separate the fine particles of aggregate tending to cling together.

Wet vs. Dry Sand.—The amount of moisture existing in the sand aggregate constitutes one of the most commonly disregarded sources of variation in the strength of field-made mortars and concretes. Various tests have shown that the surface tension of the water film enveloping the sand particles holds the particles apart, thus producing a decided increase in the gross volume. Sands made up of fine particles, and in consequence having greater surface area, increase more in volume than coarse sands. It is evident that a disregard for this important factor may produce materials the ultimate strengths of which are quite different from those contemplated in the design.

Acknowledgments.—The writer takes sincere pleasure in here giving due credit to J. S. Burgoyne, A. S. Goss, R. G. Goss, W. G. Howse, H. W. McAll, F. G. Marriott, and C. E. Stilson, who have rendered worthy assistance in the making of test specimens, chemical and physical tests and photographs, and in the tabulation of data.

JOINT MEETING AT TORONTO

TWO addresses were delivered on Wednesday evening, July 3rd, at a joint meeting of the Ontario Section of the American Society of Mechanical Engineers and the Toronto Branch of the Engineering Institute of Canada. The meeting was held in the lecture room of the Engineers' Club, Toronto. Edward Maybee, a well-known patent attorney of Toronto, read a paper on "Patents of Invention," covering particularly the part of the patent field which is of interest to engineers. The second address was by Mr. Holmes, of the Invalid Soldiers' Commission, on "Training of Disabled Soldiers in the Industries."

ABRASION TEST FOR STONE, GRAVEL AND SIMILAR AGGREGATES*

By H. H. Scofield
Purdue University

IT has been found that the standard Deval test for road materials is somewhat misleading in its results due to the retention within the abrasion chamber of the dust worn from the charge. This dust cushion would obviously decrease the rate of loss during the later stages of the test and would be more noticeable in tests of the softer materials than in those materials which yield little dust. The test described in this paper is devised to do away with this objection, and also to furnish a more rapid and practical test as well as a simpler machine.

The resistance of stone and gravel or other road materials to the abrasive action of service must be recognized as an important quality. The careful and wise selection of such materials would be considerably aided by a rapid and efficient laboratory test. The results of such a test should, of course, be studied in connection with the important test, that of service.

In 1916 the writer called attention to a seeming weakness in the standard Deval abrasion test for rock, in that the dust resulting from the abrasion is retained in the container and acts as a cushion to cut down loss in the later stages of the test. This is illustrated by the tests given in Table I., in which a medium stone and an extra soft stone were tested by the standard Deval machine.

Table I.—Tests to Show Effect of Dust in Deval Abrasion Apparatus

Kind of Test.	Wear, per cent.		Ratio of Soft to Medium.
	Medi m Stone.	Extra Soft Stone.	
Deval Test, regular (10,000 revolutions)	5.28	10.3	1.95
Deval Test with all dust removed after every 1000 revolutions	10.7	25.8	2 41

It is evident that the ratio in Table I. would be considerably larger if the container were so arranged as to remove the dust as fast as formed. This has been done with success in one or two laboratories.

A simple abrasion machine has been devised to do away with the objection. The machine is a small type rattler in which the dust and chips abraded from the sample escape between the staves as fast as formed. The opening between staves is 1/16 in. The abrasion chamber is octagonal in shape with a volume equivalent to that of the Deval cylinder.

Recent tests with this apparatus upon twelve Indiana limestones in the Laboratory for Testing Materials, Purdue University, are shown in Table II. In general, the new test gives a greater range of results and a consequent better differentiation of quality. The effect of the dust cushion in the Deval test is apparent in the more or less regular increase in the ratio of the results of the new test to those of the Deval test as the stones tested vary from hard to soft.

It became apparent from these tests that to shorten the time to a practical limit, it would be necessary to use an abrasive agent and to cut down the size of sample from 5,000 to 2,500 g. It also appeared from further

*Abstracted from paper presented to the Atlantic City convention of the Amerian Society for Testing Materials.

tests that the sample for the tests could be made more practical and useful if one-half were ½ to 1 in. in size and one-half were 1 to 2 ins. in size. The standardized test, as operated at the present time, is as follows:

The sample of stone or gravel or other road material consists of 2,500 g., of which 1,250 g. are from ½ to 1 in. and 1,250 g. are from 1 to 2 ins. in size. The abrasive agent consists of six cast-iron spheres 1⅞ ins.

Table II.—Tests of 12 Typical Indiana Limestones with the Standard Deval and New Abrasion Test Apparatus

SAMPLES 5000 G. EACH. TOTAL NUMBER OF REVOLUTIONS, 10,000; 30.5 R. P. M.

Sample No.	Wear, per cent.		Ratio of New to Deval Test.
	Deval Test.	New Test.	
1	3.5	8.1	2.3
2	4.15	9.1	2.19
3	3.9	9.6	2.46
4	3.76	9.7	2.58
5	3.6	10.3	2.86 (one test only)
6	3.0	10.5	3.5 (" " ")
7	4.1	11.8	2.9 (" " ")
8	5.56	14.1	2.54
9	6.0	14.7	2.45
10	6.05	16.3	2.70
11	6.00	20.2	3.36
12	10.3	35.2	3.42

in diameter as used in the rattler test for paving brick The charge is given 2,000 revolutions in the case of broken stone and 4,000 revolutions in the case of gravel, at the rate of 30 revolutions per minute. The losses for

Table III.—Tests of Broken Stone with the New Apparatus Under Varying Conditions as to Charge and Number of Revolutions

Sample.	Abrasive Charge.	Number of Revolutions.	Wear, per cent.	
			Medium Stone.	Soft Stone
DEVAL TEST. 50 pieces, 5 kg	None	10 000	5.28	10.3
NEW TEST. 50 pieces, 5 kg	None	10 000	12.3	35.2
25 " 2.5 "	None	2 000	5.3	14.9
25 " 2.5 "	6, 1⅞-in. Shot	2 000	6.0	17.1
25 " 2.5 "	" " "	4 000	10.0	27.1
25 " 2.5 "	" " "	6 000	13.4	35.1
25 " 2 5 "	" " "	8 000	16.6	42.5
25 " 2.5 "	" " "	10 000	19.3	48.2
1 to 2-in. sizes, 2.5 kg	" " "	2 000	7.3	19.3
1 to 2 " " 1.25 " / ½ to 1 " " 1.25 "	" " "	2 000	9.7	24.6
½ to 1 " " 2.5 "	" " "	2 000	9.9	23.0

both stone and gravel for this shortened test are approximately the same as for a full 5,000 g. sample for 10,000 revolutions, without an abrasive charge.

Results of Tests

Table III. gives the results of tests upon broken stone under different conditions as to charge and number of revolutions. The next to the last item gives the results of the standardized test with the new apparatus as arranged at present.

Table IV. shows the results of the standardized test with the new apparatus upon gravels. For the purpose of comparison and study, the gravels were selected particles from the local gravel deposits synthetically grouped as shown. Except where otherwise stated the results are the average of at least three tests.

The apparatus here described has been devised at the Laboratory for Testing Materials, Purdue University, to fill the need of a rapid and practical abrasion test for road materials of all kinds. The machine is simple in construction and acts upon the right principle by allowing the dust of abrasion to escape.

Table IV.—Results of the Standardized Test with the New Apparatus on Various Gravels

Gravel Content, percentage by Weight.					Wear, per cent.	
Trap.	Granite.	Quartz.	Limestone.	Sandstone.	2000 Revolutions.	4000 Revolutions.
100	0	0	0	0	0 4	1 08
0	100	0	0	0	1 48	2 60
0	0	100	0	0	2.04	3 48
0	0	0	100	0	2 24	4.52
0	0	0	0	100	15.52	23 04
50	5	5	40	0	1 5	2 5
50	5	5	35	5	3 2	4 5
50	5	5	30	10	4 0	5 9
50	5	5	20	20	5 2	9 0
50	5	5	10	30	7 0	10.5
50	5	5	0	40	10.0	14.0
40	5	5	50	0	1.5	2.9
35	5	5	50	5	3 0	5 5
30	5	5	50	10	4 5	7.5
20	5	5	50	20	6 0	9 7
10	5	5	50	30	9.4	14.0
0	5	5	50	40	12.0	17 2
15	5	5	75	0	2.1	3.8
10	5	5	75	5	3.3	5.6
5	5	5	75	10	5.0	8.4
0	5	5	75	15	6.0	9.3
2	2	2	75	19	8.0	10.8

The tests of stone and gravel reported are given as representing certain local conditions. It is hoped that others will continue abrasion tests with this or a similar apparatus, especially in the field of gravels where very little testing has as yet been done.

"Progressive men on both sides of the Niagara frontier are agreed that even before the war a greater diversion of water from the Niagara River was justifiable, and that the present emergency merely changes the word justifiable into obligatory," says "The Engineer," of London, Eng., in a recent issue. "In round numbers, according to the 'Electrical World,' the flow of water and the head at Niagara Falls represent 5,000,000 continuous horsepower. Even at the low price of $10 a horsepower year, the spectacle has a potential value of $50,000,000 per annum. Can any nature lover contend that the view is worth any such sum, and would any government be justified in appropriating $50,000,000 yearly to reproduce the attraction? With these self-evident facts in mind, it is difficult to understand why this profligacy continues, especially when there is such urgent need of the power, a willingness to use more water on both sides of the border, and apparently nothing to stop it except the inertia of governmental bodies."

DESIGN AND OPERATION OF SEWAGE TREATMENT PLANTS*

By H. A. Whittaker
Director of Sanitation, State Board of Health, Minnesota

BEFORE designing a treatment plant, a careful study should be made to determine the volume and character of sewage to be treated. When the sewers are already in use, actual measurements of the sewage flow should be made, covering a considerable period. A census of the actual number of sewer connections should be taken and a record made of the character and amount of sewage discharged from manufacturing plants, such as creameries, tanneries, gas plants, etc. The ground water flow should be measured or carefully estimated. The plant should be designed in accordance with the above data and with reasonable allowance for future growth. Where a new sewerage system is to be constructed, care should be taken to obtain good grades, whenever possible. Flush tanks should be installed wherever the grade of the sewer is such that it will not be self-cleansing at all times. The sewerage system should be so designed that the sewage will be delivered to the treatment plant in as fresh a condition as possible.

Grit and Screen Chambers

For small plants, where the sewerage system is of the separate type, removing house sewage only, grit and screen chambers may often be omitted to advantage. Grit and screen chambers are necessary where the sewerage system is of the combined type, and, when used, these chambers should be made easily accessible for cleaning.

Imhoff Tanks

(a) Settling Chambers: The settling chambers should be designed to hold the average flow of sewage for a period of two hours. Where the settling chambers are too small, the efficiency of the tank is decreased, and where these chambers are too large, fresh sewage may become septic before leaving the tank. The sloping walls of the settling chamber should be constructed as steep as possible; never less than 1.2 vertical to 1.0 horizontal, and, better still, 1.5 vertical to 1.0 horizontal. The walls should be smooth, with no projections. A baffle should be installed at the inlet end and a scum board at the outlet. These should be located approximately 1 to 2 feet from the inlet and outlet ends of the tank, respectively. They should extend across the tank and to a depth of about 12 inches below the surface of the sewage. The invert of the inlet pipe or pipes should be at an elevation of a few inches above the surface of the sewage. The inlets and outlets should be so located as to distribute the flow as much as possible across the entire section of the settling chamber. Outlet weirs should be relatively narrow. Very wide weirs are not desirable, since it is difficult to keep them clean.

(b) Sludge Compartments: The sludge compartment should be of generous size. For Minnesota conditions, where the winters are long and severe, a part of the sludge must remain in the tank for nearly a year. It is the opinion of the Division of Sanitation of the Minnesota State Board of Health that sludge compartments should have a capacity of at least two cubic feet per capita. In computing the size of the sludge compartment, only that portion should be considered that is below a horizontal plane two feet below the slot or slots in the bottom of the settling chamber. The sludge will not flow a great distance horizontally to the sludge removal pipe. In large tanks, two or more sludge removal pipes should be provided.

(c) Covering: Tanks should be uncovered. Light, easily handled, wooden covers should be provided for winter use. The entire plant should be surrounded by a tight, high ornamental fence, to keep out animals and unauthorized persons.

(d) Operation: The operation of a sewage treatment plant is a very important feature and one which is seldom given sufficient attention. A poorly designed plant under conscientious management will often produce better results than a well designed plant with indifferent management. Plants should be constructed so that all parts are easily accessible to the operator. It is frequently necessary to break up the scum which will collect on the sewage in the vents and to scrape down the walls of the settling chamber and push through the slots material which will adhere to the walls. Readings should be taken frequently to determine the surface of the sludge in the sludge chamber so as to know when and how much to remove. The sludge should be examined occasionally to determine whether or not it is acid or alkaline. An acid sludge is sour and foul-smelling and generally requires a long period for drying. Such a sludge should be treated with lime.

The operator should be provided with necessary tools and apparatus to care for his plant. The tools usually consist of a sludge scraper, used for the purpose of scraping down the walls of the settling chamber; a scum breaker, used for the purpose of breaking up the scum which may collect on the surface of the sewage in the vents; a skimmer, used for the purpose of removing to the vents scum which sometimes collects on the sewage in the settling chamber; and a sludge sampling apparatus, in order to determine the position of the surface of the sludge, and a set of Imhoff tubes with which the operator can determine roughly how the plant is operating. Each plant should be provided with a house of generous size in which the tools can be kept and in which the necessary analytical work can be performed.

Pumping Machinery

Where it is necessary to pump the sewage or the sludge by pumps driven by electric motors, the motors, switch boards, or starting rheostats should be located in a building not directly connected with any part of the sewage treatment plant, since the condensation and moisture in the winter months is very heavy on all parts of the plant directly connected with the settling or vent chambers.

Sludge-Drying Beds

Sludge-drying beds should be located as close as possible to the Imhoff tank. Where it is necessary to conduct the sludge a distance of ten or fifteen feet horizontally to the drying bed, it should be allowed to flow in open channels rather than in pipes, since long sludge pipes are likely to become clogged with dried sludge. Where the sludge is removed from the tank by gravity, the sludge pipe outlet should be at an elevation at least six feet below the sewage in the tank. The sludge should be discharged on to the bed from an elevation at least two feet above the surface of the bed so that the sludge removal pipe can be drained after each removal of sludge. The sludge drying beds should be of generous size, having an area of not less than one square foot per capita.

*Abstracted from recommendations made in a report submitted to the Minnesota State Board of Health.

Percolating Filters

Percolating filters, where necessary, should be of ample size, so as to prevent overworking. It should be remembered that in the colder climates the bacterial action in the filters is much slower than in milder climates. Therefore, to produce the same results, filters must be considerably larger than would be necessary in a southern climate. Certain tests at Milwaukee, Wisconsin, indicated that, on very hot days, percolating filters could be operated efficiently at the rate of 4,000,000 gallons per acre per day, whereas, in colder weather, only 400,000 gallons per acre per day could be applied to obtain the same results. The Division of Sanitation recommends that percolating filters in Minnesota be designed to operate at a rate of 1,200,000 gallons per acre per day, where the average depth of stone is at least six feet.

Resettling Tanks

A resettling tank, having an average holding period of about one hour, shall be installed wherever percolating filters are used. This tank shall be provided with cross baffles. The bottom shall be hopper-shaped. Adequate provision for sludge removal shall be provided. The sludge-drying bed shall be constructed in a manner similar to the bed for drying the sludge from Imhoff tanks. This bed shall have a net area equal to at least one-half a square foot per capita.

Sand Filters

Sand filters have not been entirely successful under Minnesota conditions, due to freezing in cold weather. They cannot be operated at rates much exceeding 100,000 gallons per acre per day, and require a great deal of attention.

With the exception of a very few cases, not much attention has been given to the appearance of sewage treatment plants. It is the opinion of the Division of Sanitation that some of the litigation brought on by alleged nuisances at sewage treatment plants could have been avoided had a little care been exercised in designing the plant so that it would have a pleasing appearance. A small amount of money expended in parking and landscape work at sewage treatment plants will do away with a great deal of the objection to them.

There are many phases of the sewage treatment plant problem which need investigation, such as the treatment of dairy and other trade wastes before admitting them to the sewage system; the disinfection of sewage, if necessary, to prevent its being the cause of injury to cattle pasturing along streams which receive sewage; and the question of installing mechanical apparatus for the purpose of breaking up scum, stirring the sludge, etc.

Rules for Operation of Imhoff Tanks

Any material, other than sand and grit, which may collect in the inlet chamber, should be forced through the opening into the settling chamber. Sand and grit should be removed and deposited upon the surface of the ground. The inlet chamber should be kept clean at all times. Any material which rises to the surface of the sewage in the settling chamber which does not sink readily when broken up should be removed to the vents. Any sludge which deposits on the walls of the settling chamber should be forced through the slots into the sludge chamber. The walls of this chamber can be kept clean by daily scraping and forcing any adhering deposit through the slots.

Any scum which collects on the surface of the sewage in the vents should be thoroughly stirred up *daily*, so as to liberate the entrained gases and facilitate the settling of the solid material. If the scum in the vents should reach a thickness of over 6 inches, a portion of it should be removed. The surface of the sludge in the sludge chamber should never be allowed to reach a point higher than 2 feet below the slots, equivalent to a point about 9 feet below the surface of the sewage. The level of the sludge in the sludge chamber should be lowered about 2 feet each time the sludge is removed, except in the late fall, when about 4 feet should be removed to allow for the winter's accumulation. The operator should be provided with a sampling outfit by means of which bottle samples of sewage in the sludge chamber can be collected at various depths and the exact location of the surface of the sludge determined.

The surface of the sludge should be determined at least once every two weeks.

Ice which may collect on the surface of the sewage in the settling and vent chambers should be removed immediately.

When the sludge on the drying bed reaches a depth of about 1 foot, it should be removed. Since a portion of the sand will adhere to the sludge removed from the bed, it will be necessary to replace the top layer of sand on the bed from time to time.

Escher Wyss & Co., Montreal, have moved their offices from 211 Coristine Bldg., to 112 Coristine Bldg.

The weight of steel in a reinforced concrete ship 205 ft. by 32 ft. by 19½ ft. has been found to be about 42½ per cent. of that in a steel ship.

Economy in using oil fuel is recognized on the Southern Pacific Railway system by a distinctive mark on the locomotive of each class which makes the best record on its division. This decoration consists of bright red paint on the circular number-plate on the front of the boiler.

The "Commonwealth Statistician" states that the 444 strikes in Australia last year affected 1,941 establishments, representing 173,970 workpeople, who had 4,689,316 workless days and a loss of over $13,000,000 in wages. Industrial disputes in New South Wales totalled 296—in Victoria, 52.

A very simple test which may be applied to determine whether a coal is likely to ignite spontaneously is given in an article by J. F. Springer, in "Power." Take a convenient quantity of the coal and weigh it pretty accurately. Heat the sample to 250 deg. Fah., hold it at that temperature for three hours, and then weigh it. If the weight has gone up 2 per cent. or more, the coal is a dangerous one from the point of view of spontaneous combustion. The sample must be dry coal, the drying being done at about 100 deg. Fah.

"Among those who came to Canada in 1913 to attend the 12th International Geological Congress was a certain German, Geheimerat Bergrat Professor Doctor Fritz Frech, of Breslau," says a recent issue of "The Canadian Mining Bulletin." "This Prussian professor has recently published a work ('Die Kohlenvorrate der Welt; Stuttgart, 1917') which contains a statisticall review of the coal resources of the world. The statistics appearing in this work are taken mainly from the well-known report issued under the auspices of the congress, but they have been wonderfully distorted for German consumption. With regard to the coal resources of Canada, the author of this work remarks: 'The impression is gained that the classification of coal of the Canadian Commission had only been adopted in order to conceal the inferior quality of the Western lignite under the veil of unintelligible formulas'; and he further suggests that the small output of Canadian coals is evidence of their poor quality. In short, Professor Frech has juggled with the statistics until he has apparently mesmerized himself into believing the conclusions he desires to impress upon his readers, which are to the effect that England has coal for two, or at the outside three, centuries, Germany for fifteen centuries, and that, from the point of view of a German coal policy, the possession of Belgium is indispensable to Germany."

The Canadian Engineer

Established 1893

A Weekly Paper for Canadian Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

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

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

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

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

DEVELOPMENT COMMITTEE APPOINTED BY AMERICAN SOCIETY OF CIVIL ENGINEERS

ALTHOUGH it has reached a very high standard of service, both to its members and to the profession generally, as well as to its country, those who direct the American Society of Civil Engineers are evidently uncertain as to whether or not the society might be still further improved so that it "may take its proper place in the larger sphere of usefulness now opening to the profession." At a meeting of the Board of Direction held June 18th, the following preamble and resolutions were adopted:—

"The development and application of the sciences in recent decades have caused profound changes in the social and industrial relationships of all peoples. The engineer has been a leader in this progress. Sociological and economic conditions are in a state of flux and are leading to new alignments of the elements of society. These new conditions are affecting deeply the profession of engineering in its services to society, in its varied relationships to communities and nations, and in its internal organization.

"A broad survey of the functions and purposes of the American Society of Civil Engineers is needed in order that an intelligent and effective readjustment may be accomplished so that the society may take its proper place in the larger sphere of influence and usefulness now opening to the profession. Such a survey and readjustment can be accomplished successfully only with the aid of the membership throughout the country.

"Any steps toward changes in organization must lead to a revision of the constitution of the society, which has not been materially modified for many years, during which the society has grown rapidly and has established twenty-two local associations of members. The constitution should be revised only after securing the views of the membership of the society as to what its purposes and activities should be and as to the instrumentalities through which these purposes and activities should be carried out.

"Any changes in organization must take into account all the conditions above indicated, and also the relationship of the American Society of Civil Engineers to other engineering organizations and to the public. Therefore:

"Resolved, that a committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the committee to consist of one member chosen by each local association of members, and seven members at large appointed by the president.

"Resolved, that the president be instructed to select from this committee an executive committee of not less than five nor more than nine members and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.

"Resolved, that the president be instructed to prepare a precept for the general guidance of this committee.

"Resolved, that this committee be requested to present to the Board of Direction a preliminary report, not later than November 1st, 1918, so that it may be printed and distributed to the membership in advance of the annual meeting in January, 1919, at which meeting it will be presented for discussion."

PUBLIC UTILITIES AND RISING COSTS

PUBLIC utility companies throughout Canada are everywhere meeting the difficulty of advancing costs of operation, while their gross earnings remain practically stable. During the earlier days of the war, in Canada and in the United States, the situation was not felt very acutely, but, while other industries have been adjusting themselves gradually to the changed conditions, this class of industry has been feeling continually increased pressure.

There have been very few businesses which have advanced so rapidly during the past few decades as have utility enterprises. Street railway transportation; gas and electricity for lighting, heating and power; and telephones, have almost become necessities with the great majority of people. It has been this characteristic of near-necessity which has helped to maintain the favor of investors for public utility securities as compared with ordinary manufacturing industries which were, it was supposed, more subject to competition and to changes in public tastes. Now, however, manufacturing companies have been able to take part, and frequently a leading part, in the general programme of raising prices, and their income and profits have benefited accordingly. The utility companies, on the contrary, must nearly always secure the consent of public or semi-public bodies before raising rates, and utility companies have, therefore, greater difficulty in increasing their income in proportion to the increased cost of labor and materials.

This condition of affairs cannot be permanent. While, generally speaking, the return from bonds and stocks of utility companies has been maintained, it has been only with great difficulty, and conditions have become such that it is practically impossible for utilities to raise funds for additional capital outlay. The majority of them have, of course, been able to get along without new capital expenditures, but in the case of some of our cities, which have increased considerably in population through war industries, etc., the need for these funds has been felt with considerable urgency. Evidently, before more capital can be attracted to the public utilities, a reasonable return must be assured.

Bodies which have control of the rates of utility enterprises must recognize these facts and permit rates to be fixed at such levels as will assure sufficient return upon bona fide investments.

PERSONALS

W. A. James has been appointed assistant chief engineer of the Canadian Pacific Railway western lines. Mr. James had charge of the double tracking operations west of Winnipeg.

R. G. Black, who for four and a half years has been a member of the Toronto Hydro-Electric Commission, has resigned from the board. Mr. Black was for ten years with the Toronto Electric Light Company.

Henry Japp, president of S. Pearson, Son & Partners, Canada, Limited, Montreal, has been made a Knight of the newly established Order of the British Empire. His name was included in the King's birthday list.

Thomas Linsey Crossley has joined the staff of the Wayagamack Pulp and Paper Company, where he will be in the chemical section. Mr. Crossley was formerly connected with the laboratory of Dr. J. T. Donald, Montreal and Toronto.

T. P. Howard, general manager of the Phœnix Bridge and Iron Works, Montreal, has been elected vice-president of the Canadian Manufacturers' Association. At the present time he is at Washington acting on the staff of the British War Commission.

J. B. Woodworth, of Vancouver, went recently to Nelson to reopen the Athabasca Mine, but finding the workings full of water, postponed proposed operations for the present. Mr. Woodworth returned to Vancouver and is conducting an investigation into the oil prospects at Burnaby Lake.

A. W. Campbell, who recently retired as deputy minister of railways and canals, will be appointed by the government to a position in connection with a federal scheme for the improvement of highways. Mr. Campbell had some years ago been head of the "Good Roads" movement in Ontario.

E. P. Mathewson, who recently resigned the general managership of the British American Nickel Corporation, has been appointed consulting metallurgist of the American Smelting and Refining Co., with headquarters at New York. His successor, W. A. Carlyle, has established offices in the Citizen Building, Ottawa.

R. T. Grant Jack, resident engineer, Sewer Section, Department of Works, Toronto, has resigned to accept a position on construction work with the Leaside Munitions Co. Mr. Jack is a graduate of the University of Toronto, class of 1909, in civil engineering, and has been with the city ever since his graduation.

Stanley H. Frame has resigned as district hydrometric engineer of the Irrigation Branch, Department of the Interior, Calgary, in order to become assistant engineer of the Department of Natural Resources, Canadian Pacific Railway, with headquarters at Brooks, Alta. Mr. Frame has been with the Irrigation Branch for over two years.

J. W. Archibald, formerly secretary-treasurer of the Warren Bituminous Paving Co. of Ontario, Limited, has been appointed Canadian representative of the Pioneer Asphalt Co., of Chicago. Mr. Archibald will make his headquarters at 1 Toronto Street, Toronto, and intends to tender on contracts for asphalt paving work in various parts of Canada, as his firm owns three portable asphalt paving plants in this country.

Chester G. Wigley has resigned as chief of the Bureau of Engineering of the New Jersey State Department of Health, in order to become affiliated with the engineering staff of Wallace & Tiernan Co., Inc., New York City. After graduating from Cornell University, Mr. Wigley performed various engineering work connected with the construction of water purification plants and sewage disposal works, and in 1910 became associated with the New Jersey Board, being chief of the department for the last three years.

William J. Roberts, formerly vice-president and general manager of the Traylor Engineering and Manufacturing Co., Allentown, Pa., has been elected president of the company to succeed Samuel W. Traylor, who becomes chairman of the board of directors. H. Battersby, formerly treasurer of the company, has been elected vice-president and treasurer. Besides being very large manufacturers of crushers and mining and other machinery, the Traylor Co. are understood to hold the controlling interest in the Cement-Gun Co., Inc., and also in a big shipbuilding plant at Philadelphia.

OBITUARY

Lieut. Harold L. Scully, of Owen Sound, Ont., is reported to have died of wounds in France. Before enlisting he was on the staff of the Dominion Construction Co., Toronto. Lieut. Scully was a brother of A. A. Scully, who is a well-known representative for a number of machinery and supply firms.

NO POWER FOR CONCRETE SHIPS

(Continued from page 28)

made a reliable survey of the country's power resources and that large engine plants are actually without orders to-day.

"It is argued that it is incredible that the makers of boilers and engines, if properly mobilized, cannot make them faster than we can build ships.

"In the meantime the shipping situation gets worse and worse. The army transport service is reported to be almost frantic. It will need 500 ships more than are in sight owing to the scrapping of all plans on account of the unexpected rushing of vast armies to France this spring and summer, and is said to be contemplating building ships itself. The only field open to it, however, is concrete ships and the action of the Shipping Board makes it impossible for the army to contract for them.

"Summed up, this is the concrete ship situation:—

"When nobody wanted to build them every encouragement was offered to private ventures; when everybody wants to build them, nobody is permitted to do so.

"The two attitudes seem contradictory, but they are not. Either way we get no concrete ship effort that is worth while."