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Bulking Measurement of Surface Area

New Method of Determining Surface Area of Sands or Mixtures of Sand and Gravel is Based on Volume-Moisture Relation—Requires No Mechanical Analyses—Paper Presented to American Society for Testing Materials

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WE are all more or less familiar with the fact that the space occupied by a given weight of fine aggregate is related in some way to the moisture contained by that aggregate. A sand ordinarily occupies more space when moist than when dry. In the course of an investigation undertaken to ascertain the bearing that this might have on the problems of proportioning concrete mixtures, it was discovered that this phenomenon was related to the "surface area" of the aggregates involved.

Perhaps it would be well to define the terms, "surface area," "bulking," "sand" and "silt," as used in this paper. The "surface area" of an aggregate is the summation of the surface areas of its individual particles—these particles

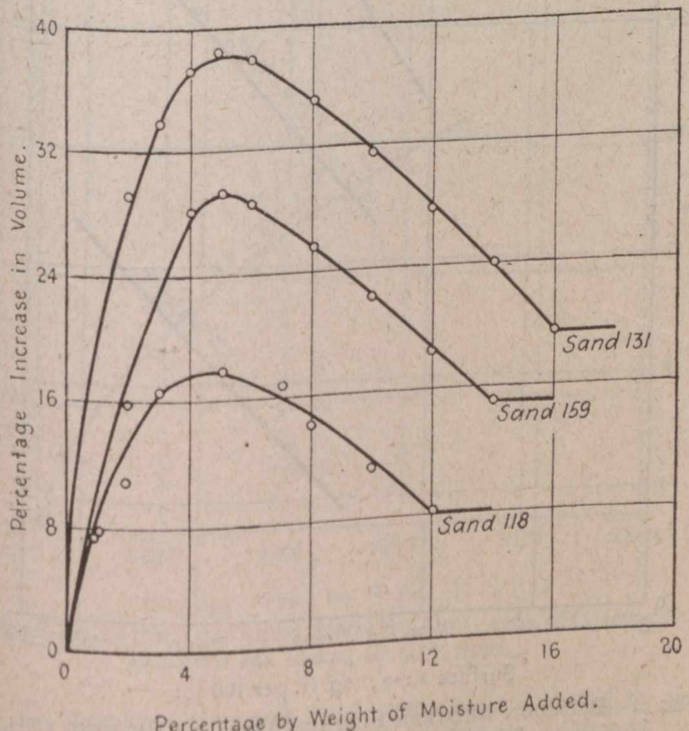

FIG. 1—RELATION BETWEEN MOISTURE CONTENT AND BULKING IN SAND

being considered spheres equal in volume to that of the actual particles. The investigations of Edwards* and others have shown that both the strength and water requirements of a concrete mixture are related rather definitely to the "surface area" of the aggregates used. Surface area is, therefore, used in proportioning concrete mixtures as a measure of the cement requirement of an aggregate.

When a sand increases in volume because of an increase in its moisture content, it may be said to "bulk." Bulking is expressed quantitatively as a percentage or ratio.

"Sand" is used in its commonly accepted sense: namely, a fine aggregate derived from a natural source, all of which

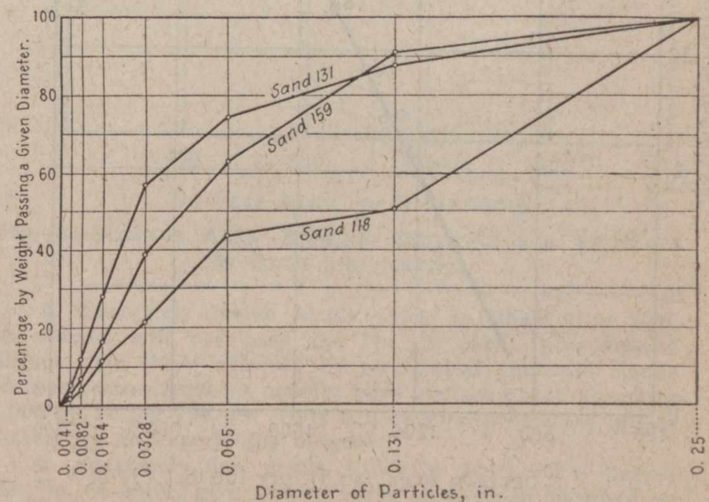

FIG. 2—MECHANICAL ANALYSES SHOWING RANGE OF SAND USED IN THE INVESTIGATION

will pass, when dry, a screen having circular openings ¼ in. in diameter.

"Silt" as here used means that very fine material in a sand which will pass a No. 150 sieve.

The tests described in this paper were carried out by the authors in the laboratory of the Hydro-Electric Power Commission of Ontario as a part of an extended research being conducted there into the problem of concrete proportioning.

The materials used in these tests were sands which had been submitted to the laboratory in the course of its routine examination of aggregates. They came from sundry localities in Ontario and elsewhere—localities quite dissimilar geologically. Most, though not all, would be classed as good concrete sands.

Mechanical analyses were made of each sand from carefully prepared samples taken by the method of quartering. The sieves used were a perforated plate having ¼-in.-diameter openings and Tyler's Nos. 6, 10, 20, 35, 65 and 150. Grain counts were carried out on each size of separation for a representative sand from each locality, and from these

*The Canadian Engineer, Nov. 27th, 1919, pp. 487-90.

counts and the specific gravity, the surface area was obtained, using the formula

$$A = 236.1\ (n/s^2)^{1/3} \quad (1)$$

where A=surface area in square feet per 100 lbs., s=specific gravity of the sand, and n = number of grains per gram in any size of separation.

This method of obtaining surface area is essentially the same as that described by Edwards and uses the basic

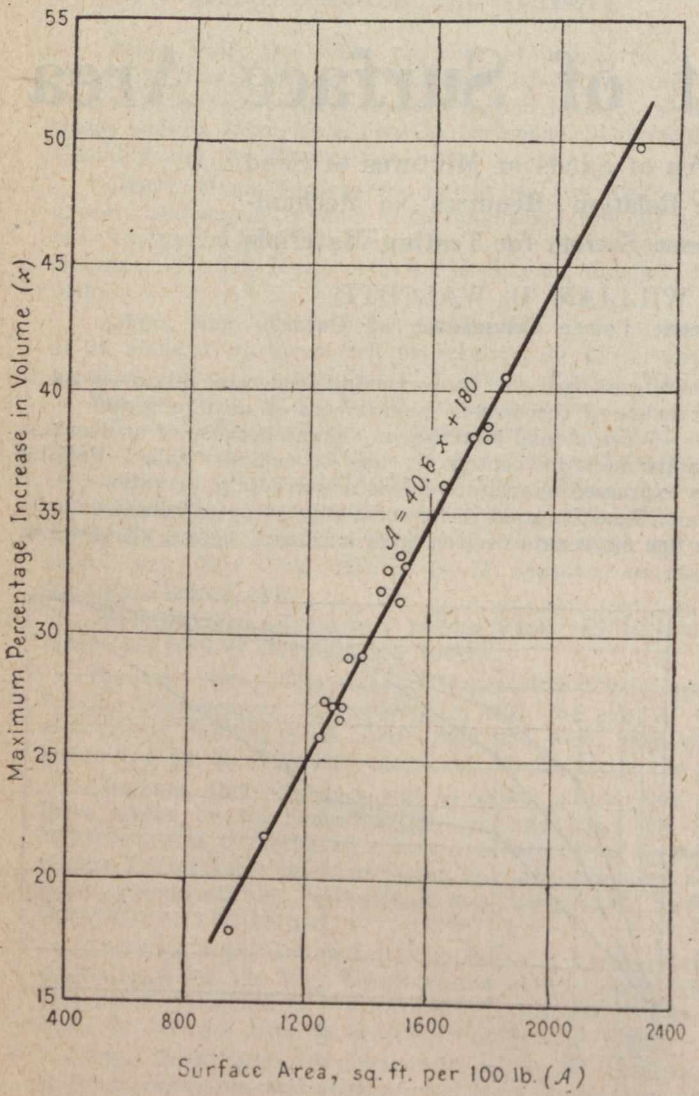

FIG. 3—RELATION BETWEEN SURFACE AREA AND MAXIMUM BULKING FOR GRADED SANDS EMBODYING RESULTS SHOWN IN TABLE 1

assumption, before noted, that the individual particles of sand are spheres. The surface area for any size as determined by the above formula is called the "unit area" for that size.

The increase in volume resulting from additions of moisture was obtained indirectly by determining the weight per cubic foot of the material, first dry and then moist. Both ⅛ and ¼-cu.-ft.-capacity cubical measures were used at different times. The measure was filled by means of a cylindrical shell, open at both ends. This was placed in the measure, filled with the sand under test and slowly withdrawn. The capacity of the cylinder being slightly greater than that of the measure, an excess of material remained in the latter when the cylinder was removed. This excess was struck off with a straight edge. Several determinations were made on each sand and the results averaged. It was found that the method gave concordant results.

To obtain sands of different degrees of moisture, a predetermined amount of water was added to the dry sand and thoroughly worked into it by kneading.

Knowing the weight per cubic foot of the sand, both dry and moist, the percentage increase in volume due to the added moisture was calculated from:—

$$P = 100\ [W_1 (1 + r) - W_2] \div W_2 \quad (2)$$

where P = per cent. increase in volume, r = ratio of water added to weight of dry material, W_1 = weight per cubic foot of dry material, and W_2 = weight per cubic foot of moist material.

Fig. 1 shows the percentage increase in volume obtained in this manner for three sands: a fine, a medium and a coarse. The mechanical analyses of the same sands are shown in Fig. 2. These curves are representative of those obtained throughout this investigation.

A study of these tests revealed the interesting fact that the maximum percentage increase in volume, or bulking, is related to surface area. When plotted against surface area the points fall approximately on a straight line (Fig. 3). The equation of this straight line is

$$A = 40.6\ x + 180 \quad (3)$$

in which A = surface area in square feet per 100 lbs. and x = maximum increase in volume in per cent.

It may seem odd that the relation between bulking and surface area is independent of the percentage of water used to cause it. This would not be so were it not for the varying

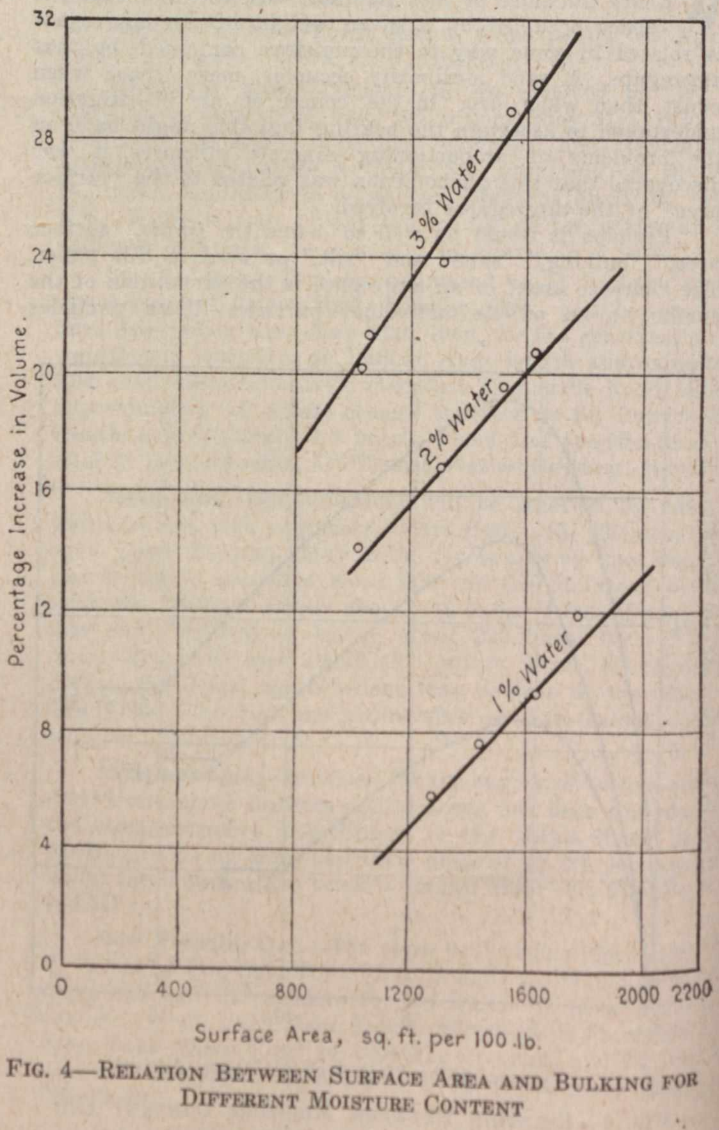

FIG. 4—RELATION BETWEEN SURFACE AREA AND BULKING FOR DIFFERENT MOISTURE CONTENT

silt contents of the sands. Fig. 4 shows a relation between bulking and surface area for one, two and three per cent. additions of water. However, to show this relationship it was necessary to plot only results from sands having approximately equal silt content. Other sands of different silt content would not conform to these curves.

Any silt contained in a sand will commence to absorb moisture as soon as water is added. This absorbed water takes little or no part in the bulking phenomenon. It is the moisture in excess of that absorbed by the silt that causes changes in volume. Sands of equal surface area but containing different percentages of silt will bulk differently for the same percentage additions of water up to nearly the point of maximum bulking. At that point the variable effect of different silt contents is compensated for.

Experiments were also carried out upon sands having particles of uniform size. These sands were all prepared from one material by sieving it into its different sizes. Volume-moisture studies were then made on each size. These experiments also showed maximum bulking to be related to surface area. But it was found that this relation did not follow the same law as with graded aggregates. It was found that sands coarser than that passing the No. 6 sieve did not increase in volume with additions of moisture. It is thought that the reason for this is that the weight of the particles in these large sizes is sufficient to overcome the separating effect of the film of water surrounding the moistened particle. This explanation has not as yet been tested out experimentally.

Fig. 5 shows the relation between maximum bulking and surface area for these "one-size" sands. This relation is expressed by the equation

$$x = 0.30\ A^{0.612} \quad \text{.......................} \quad (4)$$

where x = increase in volume in per cent. and A = surface area in square feet per 100 lbs.

A few experiments were made with mixtures of sand and gravel. Only one sand and one gravel were used, but these were mixed in different proportions. Here also a relation between bulking and surface area was found. Successive additions of gravel decreased the percentage of maximum bulking in the same ratio as it decreased the surface area. Fig. 6 illustrates the results of these few tests.

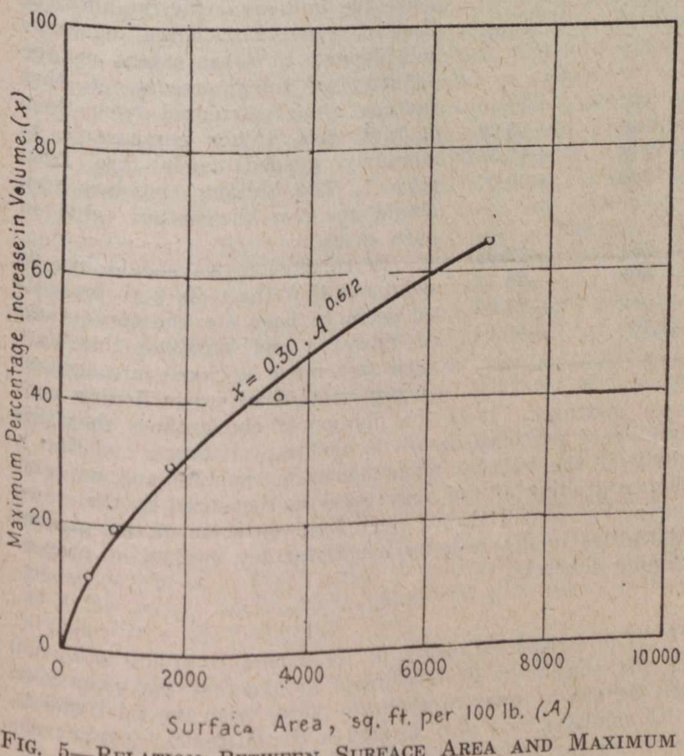

FIG. 5—RELATION BETWEEN SURFACE AREA AND MAXIMUM BULKING FOR SANDS OF ONE SIZE

It is at once apparent that if the laws indicated by Figs. 3 to 6 inclusive are general, the maximum bulking of sand or of a sand-gravel mixture could be determined if its surface area was known; conversely, its surface area could be determined if its percentage of maximum bulking was known. It is evident, however, by the behavior of "one-size" materials that these relationships are not perfectly general, since the large-size particles take no part in the bulking phenomenon.

An experimental study of the limitations within which the conclusions hold have shown that the following is approximately true:—

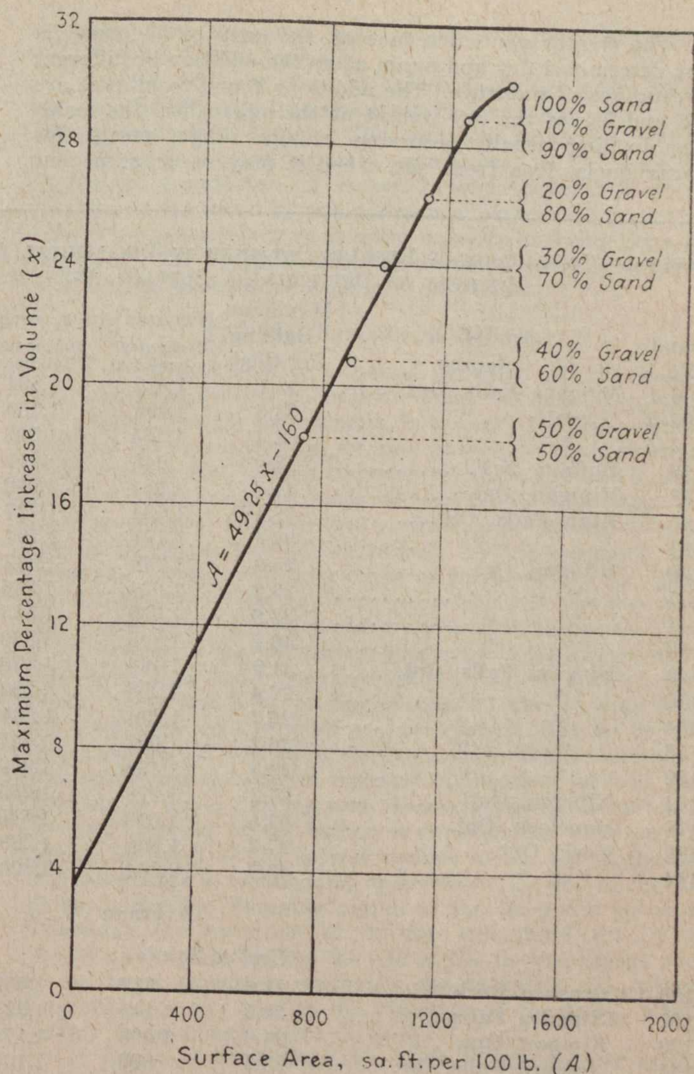

FIG. 6—SURFACE AREA - BULKING RELATION FOR MIXTURES OF SAND AND GRAVEL

1. Extremely coarse sands, sands in which over 60% by weight will not pass the No. 10 sieve, give results higher than those obtained by mechanical analysis. Sands of these characteristics usually have surface areas less than 1,000 sq. ft. per 100 lbs. They will usually be detected immediately by an experienced observer.

2. Extremely fine sands, sands in which 50% passes the No. 65 sieve, give results lower than those obtained by mechanical analysis. The sands are really "one-size" materials, and usually contain a high percentage of silt. They have surface areas in excess of 2,000 sq. ft. per 100 lbs. As in the case of the coarse sands, they can usually be detected by examination.

Silt, when present in excess of 7 or 8%, affects the accuracy of the results to some extent. For percentages lower than this, the effect of the silt is compensated for by the adoption of the point of maximum bulking.

Most sands acceptable for concreting purposes fall within the limits stated. This being so, the relationship between bulking and surface area has two very valuable applications in the science of concrete proportioning:—

(*a*) Knowing the surface area and the moisture content, the changes in volume in the aggregate can be determined and proportions corrected accordingly.

(*b*) Knowing the maximum increase in volume of a sand due to contained moisture, the surface area of that sand is at once obtainable.

While the first of these is important, it is not the subject of this paper and will not be elaborated upon. The second will be taken up at some length.

A method of obtaining the surface area of an aggregate which is both simple and rapid can be based on this relationship between the maximum bulking and surface area.

The weight per cubic foot of the sand to be tested is first determined dry and again after the addition of different percentages of moisture. The additions found to be best are 4, 5 and 6% of the dry weight of the aggregate; the maximum bulking usually occurring in this range, except for coarse sands, free from silt, when it may occur at as low

TABLE 1—COMPARISON OF RESULTS OBTAINED BY MECHANICAL ANALYSES AND BULKING METHODS OF DETERMINING SURFACE AREA OF SANDS

Sand No.	Source.	Maximum Bulking, Per Cent.	*Surface Area, sq. ft.* Mechanical Analysis.	Maximum Bulking.	Difference. Sq. Ft.	Per Cent.
106–1	Niagara Falls, Ont.	33.1	1,515	1,524	+ 9	+ 0.59
106–2	" "	31.5	1,494	1,460	— 34	— 2.28
106–5	" "	32.7	1,454	1,508	+ 54	+ 3.71
118	Buffalo, N.Y.	18.0	945	911	— 34	— 3.60
128	Nipigon, Ont.	21.7	1,054	1,062	+ 8	+ 0.75
130	High Falls, Ont........	38.1	1,734	1,727	— 7	— 0.40
131	" "	38.5	1,777	1,734	— 43	— 2.42
136	Nipigon, Ont.	25.9	1,238	1,232	— 6	— 0.48
137	" "	29.2	1,324	1,366	+ 42	+ 3.17
141	" "	33.6	1,500	1,545	+ 45	+ 3.00
143	" "	40.7	1,805	1,830	+ 25	+ 1.39
149	Niagara Falls, Ont.	31.9	1,436	1,476	+ 40	+ 2.79
150	" "	27.4	1,256	1,292	+ 36	+ 2.86
154	" "	26.7	1,299	1,264	— 35	— 2.70
155	" "	36.1	1,631	1,647	+ 16	+ 0.98
159	" "	29.3	1,368	1,370	+ 2	+ 0.14
161	Nipigon, Ont.	27.2	1,273	1,285	+ 12	+ 0.94
178	Havelock, Ont.	33.5	1,513	1,540	+ 27	+ 1.78
183	York, Ont.	27.3	1,304	1,289	— 15	— 1.15
184	" "	49.7	2,264	2,200	— 64	— 2.83
		Average				1.798
		Coarse Sands				
106–L1	Crushed Rock	21.6	717	1,057	+ 340	+47.40
107	Niagara Falls, Ont.	28.2	1,145	1,325	+ 180	+15.72
129	Nipigon, Ont.	24.6	1,003	1,179	+ 176	+17.55
151	Niagara Falls, Ont.	23.3	866	1,126	+ 260	+30.07
		Fine Sands				
106–4	Niagara Falls, Ont.	40.6	2,079	1,828	— 251	—12.05
134	Nipigon, Ont.	40.2	2,420	1,812	— 608	—25.12
144	Nipigon, Ont.	41.3	2,446	1,857	— 589	—24.05
157	Niagara Falls, Ont.	37.9	2,888	1,719	—1,169	—40.04

as 3%. The weight per cubic foot with the lowest percentage of moisture is first obtained; the last two percentages of moisture are then obtained by adding in each case the necessary extra water. The loss of moisture by this procedure has been found to be negligible. Applying successively Eqs. 2 and 3 to these results gives the surface area per 100 lbs.

The equipment required is simple. That used by the writers consisted of a ⅛-cu.-ft.-capacity cubical measure, a ¼-in. sieve to separate the fine and coarse aggregates, a small platform scales and minor incidentals, such as scoop, straight edge, glass graduate, etc. This apparatus may be varied somewhat to suit circumstances or the whims of the user without affecting the results.

Compared with the combined mechanical analysis and surface area calculations, the method is the acme of simplicity. It is rapid, inexpensive, requires a minimum of equipment and skill to carry out, and can be made to give accurate results.

Table I. shows results obtained by both methods. Here are tabulated concrete sands having, as is evident from their surface areas, a wide variation in grading. The maximum difference between their surface areas as determined by sieve analysis and grain counts and as determined by the bulking test is approximately 3.7%, while the average difference is only 1.77%. This degree of accuracy is within the probable error of the sieve-analysis method.

The bulking test does not agree with the standard method for obtaining surface area with very coarse sands, very fine sands or with sands high in silt. This has already been touched upon. Table I. shows a number of such sands and the results obtained using both methods. It is thought by the authors to be extremely likely that the surface area determined by the bulking test may be a better measure of the concrete-making properties of the sand than the values obtained from the sieve analysis.

The bulking method has one weak point, and that lies in its basic test—the one for the weight per cubic foot. This test is more subject to the personal equation of the operator than is the sieve analysis. It is believed that the rodding method of determining the weight per cubic foot—the method that is now being considered for adoption as standard—would to a large extent overcome this drawback. Before the rodding test could be used it would be necessary to establish the proper equations linking surface area and maximum bulking; the equations given in this paper only hold for the methods described.

The presence of mica in a sand introduces an interesting problem. Any considerable quantity alters the specific gravity of the material (the number of grains per gram), and hence the unit areas for the different sizes of separation. These unit areas will depend to some extent on the quantity of mica present, so that surface areas calculated from them do not give values comparable to similarly graded sands free from mica. The bulking test has been found to give the better value in such cases.

In conclusion, we should like to point out that the tests here presented seem to bear out the contentions of Edwards and ourselves that surface area must be taken into account in any method of proportioning concrete mixtures. It is the opinion of the authors that this bulking of particles occurs in concrete mixtures, and that a study of the bulking phenomenon in concrete and its relation to grading of the aggregates as measured by their own surface area will throw much light on some of our present difficulties in determining a satisfactory method of proportioning concrete.

The British Ministry of Transport is giving attention to the possibility of building a dam across the estuary of the Severn in order to generate power from the tidal waters. The ministry has also formed a committee to examine the schemes for railway electrification.

George T. Clark, designing engineer of the Toronto Harbor Commission; J. M. Gibson, assistant engineer on the staff of B. H. Prack, consulting engineer, Toronto; A. M. Mackenzie, engineering department, Bell Telephone Co., Toronto; A. P. Marshall, assistant engineer, Ontario Highways Department; Wm. Snaith, assistant engineer on the staff of Frank Barber, consulting engineer, Toronto; J. E. Underwood, of Murphy & Underwood, consulting engineers, Saskatoon; and William D. Walcott, assistant engineer, Engineering Materials Laboratory, Hydro-Electric Power Commission of Ontario, received the C.E. degree last week from the University of Toronto. Chester B. Hamilton, of the Hamilton Gear & Machine Co., Toronto, received the M.E. degree.

STRESSES IN RAILROAD TRACK

IN the second progress report of the American Society of Civil Engineers' Committee on Stresses in Railroad Track (Prof. Arthur N. Talbot, of the University of Illinois, chairman), which was recently published in the Proceedings of that society and which comprised 164 pages of most valuable analytical discussion and reports of field tests and laboratory experiments, there appears the following summary of some of the committee's tests and analyses, bringing out in part the phenomena attending the transmission of pressure from the tie through the ballast:—

The bearing pressure of the tie varies in intensity from its edge to its middle line; the maximum intensity is dependent upon the intensity of pressure developed at the edge. A variation in intensity exists also along the length of the tie.

The pressures which react from the lower face of the tie act in other than vertical lines, the greatest variation from the vertical direction being at the edge of the tie.

There is a concentration of pressure a short distance below the tie, say, at 3 to 4 ins., and the intensity of pressure in the ballast at such a depth is greater than exists at the bottom of the tie.

Distribution of Pressure

For the tie of ordinary width, the intensity of pressure at a depth of 6 ins. and the distribution of vertical pressure over a horizontal plane at this depth do not differ greatly from those existing immediately under the tie. The directions of the pressures are not the same. At or below this depth the distribution of pressure laterally begins, with a consequent decrease in maximum intensity of pressure, and the change becomes more apparent as the depth increases.

The foregoing relates to the transmission of pressure from a single tie. For a number of ties, with the ordinary tie spacing, the effect of the combination of pressures transmitted is readily found by superposing the values of the pressures from the several ties as obtained for a plane at the same depth. For the ordinary width of tie, the effect of the pressure transmitted from the adjacent tie to points midway between ties (overlapping lines of pressure) is noticeable at a depth equal to about half of the usual tie spacing. At a depth of three-fourths of the ordinary tie spacing, the pressure immediately under the centre of the tie is about one and one-half times that resulting from a uniform distribution over the horizontal plane. At a depth equal to the ordinary tie spacing, the lateral distribution has become such that the variation in intensity of pressure from tie to tie is small.

The variation in intensity of pressure in the ballast lengthwise of the tie (which is dependent upon size and stiffness of tie, quality of tamping, and condition of the bed on which the tie rests) becomes less and less with increase in depth, and it may be expected that the variations will be smoothed out at a depth equal to the ordinary tie spacing, or a few inches below, where there will be a fairly uniform pressure over the horizontal plane.

The tests were made on a rigid base, and the results may be expected to apply to a firm roadbed capable of carrying the loads transmitted. A depth of ballast greater than that named would be found useful when the roadbed is of uneven character or yields under the load or is subjected to unusually heavy load.

Effect of Different Ballasts

The tests show that for quiescent loading there is little difference in the manner and rate of transmission and distribution of pressure for broken stone, pebble and sand ballasts; that is, at a given depth the intensities of pressure will be approximately the same, provided, of course, the ultimate carrying capacity of the ballast is not exceeded, and this conclusion may properly be extended to other non-cohesive materials. It will require less load to force the tie into sand ballast than into broken stone; the ultimate carrying capacity of the broken stone ballast under tie pressure is much greater than that of the sand ballast,—the particles of sand ballast are more easily moved and rearrange themselves under lighter loads.

For the different kinds of ballast there are great differences in the ultimate load which can be carried on a tie before ballast movement begins. The ultimate carrying capacity depends upon size of particle, smoothness of surface and degree of angularity. A material whose mobility under pressure is increased by the addition of water or by mixture with other materials may thereby have its carrying capacity decreased. For heavy loading the ultimate carrying capacity of a ballast material is especially important.

Principal Function of Ballast

It is evident that a principal function of the ballast immediately under the tie and for some distance down, aside from such functions as drainage, is to carry the load without material lateral movement of the ballast to that depth at which lateral distribution becomes effective. An advantage of the coarser, rougher kinds of ballast is that they will carry a greater ultimate load—which is of special importance in the upper part of the ballast. This is especially true under the jarring, vibrating loads of track service for which the ultimate carrying capacity naturally will be less than that found under the quiescent loads used in the tests.

The tests in the laboratory indicate, as would be expected also from analytical considerations, that the presence of ballast above the level of the bottom of the tie may have little influence on the quiescent load which will be carried before the ballast will work out from under the tie and allow it to settle, but that under repeated applications of load, and particularly under jarring and vibratory loads, the ultimate carrying capacity of the ballast is considerably increased by raising the level of the ballast surface to the top of the tie. This advantage is particularly apparent at the end of the tie, where, under the whipping action of the tie under repeated deflections, the particles of ballast will more readily be pushed away, since beyond the end of the tie there is no part of the track structure available for resisting the lateral pressure as is the case in the direction of the track, where another tie is always near at hand.

It seems probable that the effect of the jarring action of train loads will be to decrease the lateral distribution of pressure. It seems possible also that this tendency is counteracted in some degree by the cohesion which develops in ballast after it has been in place for some time.

At a recent meeting of the St. John, N.B., branch of the Engineering Institute of Canada, a paper was read by F. G. Goodspeed, on "The Improvement of Navigation in River Estuaries." It was announced that the Committee on Concrete in Sea Water has compiled a complete bibliography on this subject, and that it is planning numerous tests of cement and super-cement concretes in sea water.

George H. Duggan, president of the Dominion Bridge Co., Ltd., has been elected president of the newly incorporated Dominion Engineering Works, Ltd. A. J. Brown and Julian C. Smith have been elected vice-presidents and R. Montague Davy secretary-treasurer. The board of directors will include the officers and W. F. Angus, George Cahoon, jr., Sir Herbert Holt, Phelps Johnson, J. M. McIntyre, Howard Murray, H. Birchard Taylor and F. L. Wanklyn.

The two 60-cycle turbine-generators which will be installed in the new Hell Gate station of the United Electric Light & Power Co., New York, will be of the tandem-compound type each rated at 43,750 kv.-a. at 80% power factor. They will be designed to carry peak loads of 40,000 kw. for short periods. These units, which will be built by the Westinghouse Electric & Mfg. Co., will be similar to the 60-cycle units installed in the Northwest station of the Commonwealth Edison Co., with the exception that the newer units will have a rating of 43,750 kv.-a. as compared with 35,300 kv.-a. for the Chicago units. The generators will be designed for 13,200 volts, and the units will operate at 1,200 r.p.m. The turbines will be designed to operate at 220 lbs. steam pressure, 200 degs. F. superheat and 29 ins. vacuum.

NEW METHOD OF GUNITE WALL CONSTRUCTION REDUCES COST TO FIFTY CENTS PER SQUARE FOOT

By R. H. Gillespie
Chief Engineer, Traylor-Dewey Cont'g Co., Allentown, Pa.

ONE of the most interesting of the many new types of houses that are being developed to lighten the burden of the present shortage of lumber and brick, is that referred to in the report of the "Cement-Gun" Committee of the National Concrete Housing Association, which convened re-

Fig. 1—One Man Can Raise Panels—Note That Floor Beams Extend Beyond 2 by 6-in. Plank

cently in Chicago. The advantages that this house offers are:—

1. Rapidity and ease of construction.
2. Fireproof qualities.
3. Absolutely perfect insulation and protection against heat and cold.
4. Permanency.
5. Economy.

This house as finally developed is the evolution of several methods of construction that have met more or less favorable comment in the technical press for the past three or

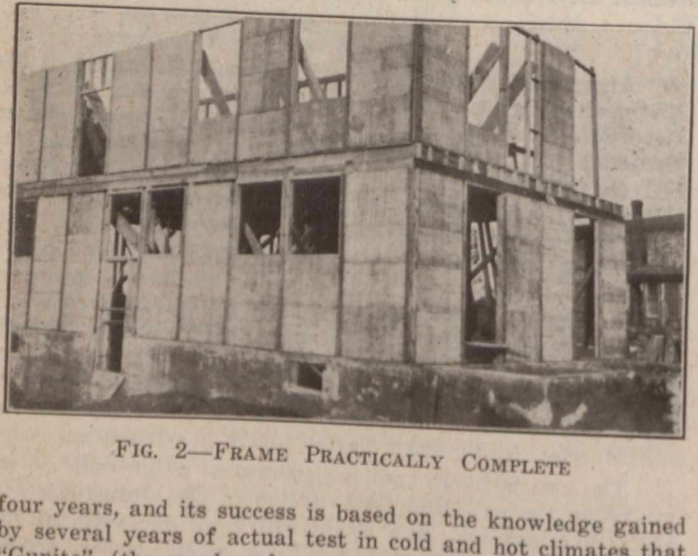

Fig. 2—Frame Practically Complete

four years, and its success is based on the knowledge gained by several years of actual test in cold and hot climates that "Gunite" (the sand and cement product of the "Cement-Gun") is a concrete which is impervious to moisture, and when placed in thin wall slabs is permanent. Being impervious to water and air, it is possible to develop the absolute dead air pockets which are a feature of this construction.

The intent of this mode of construction is to build up as a monolith a light, reinforced concrete frame of columns and girders, with the outer walls hung as a reinforced concrete curtain between them, all tied together in such way as to form not only the supports for the floors and roof, but also so that the girders act as ribbon bands around the house, binding it together much as the hoops bind a barrel.

The methods employed are as follows:—

While the foundations are being poured in the usual manner, short pieces of steel are left projecting at spaced intervals, preferably 4 ft., which later serve as dowel pins, to which are attached the steel reinforcing rods of the columns or studs. On top of the foundation is fastened a 2 by 6-in., laid flat and with the outer edge at 5½ ins. back from the outer face of the wall. This timber in this way serves as a level support for the floor beams, and at the same time prevents the further necessity of lining up the forms when the floor beams are placed, and the ends extend from 2 to 4 ins. beyond the outer face of this timber. Fig. 1 shows this, and also shows the forms or panels, which are so light as to be easily handled by one man.

The details as shown in Fig. 5 will make it apparent that the form frames used are built up of the very lightest lumber (1 by 4-in. and 1 by 5-in.), and that their purpose when covered with the two-ply tar paper is only to act as a light backing against which the "Gunite" is to be shot,

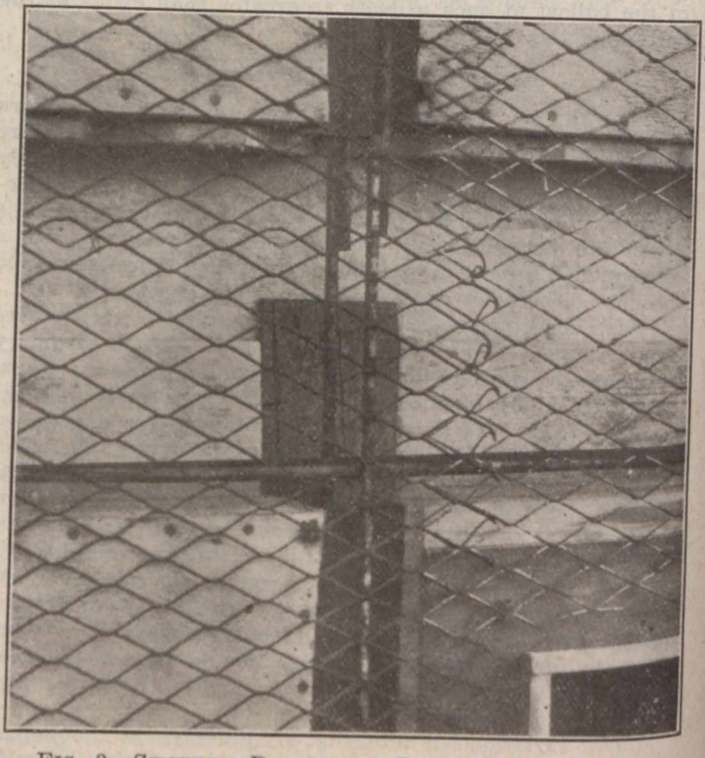

Fig. 3—Showing Details of Connection Between Column and Girder

and not as carrying members. They are usually made 3 ft. 8 ins. wide, so that when spaced with a 4-in. recess between them, the columns built up in these recesses will be 4 ft. on centres.

It is, of course, not always possible to follow this definite spacing, as the architectural details may not always so adapt themselves, but the intent and great advantage of this type of construction is that the panels shall be laid out and built up in advance to save field measuring and framing. In case of a number of houses of even different designs, it is possible to use only a few sizes of panels.

These panels are of such a height as to reach from the top of the foundation to 6 ins. below the bottom of the second floor joists, or from the top of these floor joists to 6 ins. below the bottom of the roof or ceiling rafters.

After having slipped the bottom planks of the form frame underneath the first floor beams until it is heeled against the outer edge of the 2 by 6-in., the frame is then plumbed and toe-nailed to the floor joists, insuring their permanency in location and stability. A 1 by 6-in. plank is then nailed to each frame across the back of the recess, thereby acting as

(a) A tie between the frames.

(b) A backing against which the concrete column is built up.

(c) A method of lining up the frames, as this plank extends several inches beyond the top of the frames.

(d) An insulation against condensation marks on the inside of the building.

On top of the frames a 1¼ by 6-in. plank is laid on edge and nailed to the backing planks referred to above, thereby acting as

(a) A means of lining up.

(b) A backing against which a reinforced concrete girder is built up.

(c) A temporary support to which the floor beams of the second floor are nailed. These floor beams are supported on the other end of the studding of the interior partitions, thereby making use of these floor beams as the temporary

FIG. 4—FRAMES AND REINFORCEMENT IN PLACE

cross-bracing and supports for the building. The ends of the floor beams are shown in Fig. 2.

The above methods of form-placing are continued on the floors above, with the exception that the panels of the upper floors are set on top of the floor beams instead of underneath as on the top of the foundation.

Having completed the erection of the form panels as shown in Fig. 2, the next step is to place the reinforcing rods in the columns, and in spacing these a rather ingenious method is employed.

Before the backing board is placed, a piece of ⅛ by 1-in. strap iron, bent to an L shape, with two holes in the

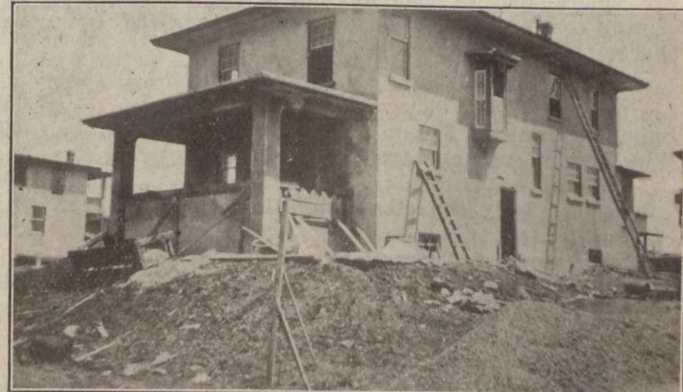

FIG. 6—COMPLETED HOUSE

longer leg, is fastened to this board, and through these holes the rods are dropped. The two rods forming the bottom reinforcing for the girders are then placed, and to the vertical and horizontal rods is tied the reinforcing mesh used in the outer curtains. This is plainly illustrated in Fig. 3.

The reinforcing mesh used must be sufficiently heavy to reinforce properly a slab of this spacing, as the entire outer wall is carried by the concrete columns, but it is nailed lightly, as a temporary support, to the vertical members of the form panels. The concrete columns, girders and walls are shot monolithically with a "Cement-Gun." After it is built to its required thickness, the panels are not withdrawn, but are left in place as a support for the interior lath and plaster. It is for this reason that the exterior vertical members of the frames are made one inch narrower than those between, for it will be apparent that when the backing board at the columns is placed, the inner edge becomes a true plane, immediately ready for this interior plaster, which is usually applied by hand.

Having completed this interior plaster, it is apparent at once that there has been created a wall with dead air pockets 5 ins. thick, about 8 ft. high and 4 ft. wide, with absolutely no chance for air circulation, which is always existent in the furring of brick houses. Without this absolute freedom from circulation the insulation is nil.

The horizontal girders, in addition to their carrying and binding-together characteristics, act as an absolute fire-stop to prevent the flue effect from floor to floor. It will be seen from the photographs that these girders have been extended to the top of the floor beams as a further prevention against fire passage, as well as to act as bridging between the beams.

The photographs shown herewith are for a more expensive house than would be erected in extended building developments, but it will be apparent that if this type of construction is flexible enough to lend itself to the construction of a house of so many details, it can easily be adapted for simpler type.

Attention is called to the window details shown in Fig. 5, as well as the photograph of the completed house. It is seen that the frames for these windows are so set that there is

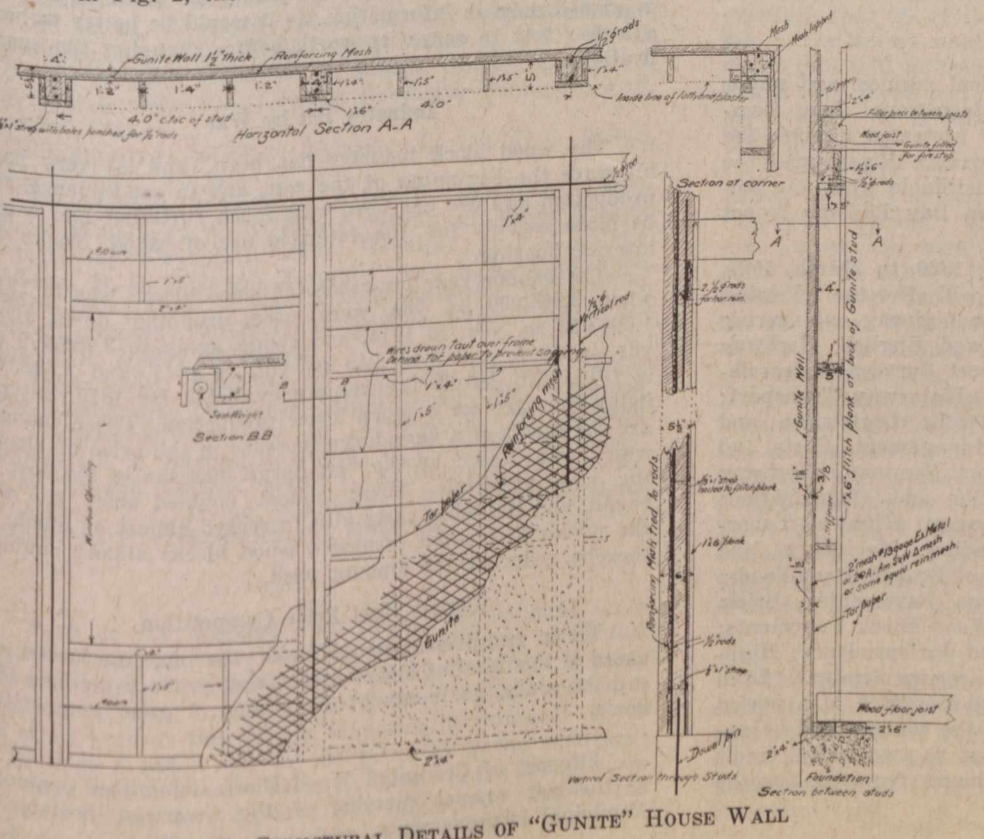

FIG. 5—STRUCTURAL DETAILS OF "GUNITE" HOUSE WALL

no possibility of air leakage within the house around this frame, a condition which is almost impossible to obtain in even the very best-constructed brick or frame houses.

Regarding the costs of such construction, the following figures seem to represent a fair statement of the actual cost per square foot for building up a wall of this type, excepting cost of setting window frames, overhead, equipment charges and contractor's profit:—

Lumber in panels, 60 ft. BM in 72 sq. ft., 0.9 ft. BM per sq. ft. at $70,	$.063
Building forms at $40,	.036
Wire (No. 8 gauge) over frames before placing tar paper,	.005
Tar paper (2-ply Barrett specification)	.019
Placing tar paper,	.005
Setting forms (two men at $6 per day each averaged ten panels per day, or 320 sq. ft.),	.040
Placing floor beams and inner partitions, which must be done at time of form erection, but should not be chargeable against outer walls, as this would have to be done in any house,	.075
Rods, ½ lb. per sq. ft. at 12c. in place,	.060
Reinforcing mesh,	.050
Placing reinforcing mesh,	.025
"Gunite" material, average 2 ins. thick— One bag cement,— $ .75; Three cu. ft. sand,— .25; $1.00	
Covering 10 sq. ft.,	.100
Labor, $42 per day, will cover an average of 600 sq. ft., including all time lost in moving from house to house,	.070
Power, $10 per day,	.025
	.573
From which deduct the cost of placing the floor beams,	.075
Resulting cost	$.498

In addition to the advantages that this type of construction offers, as above indicated, is its great adaptability to architectural treatment. By adding coloring matter to the cement, or by the use of white Portland cement with marble dust or colored sands, very beautiful and permanent decorative effects may be obtained.

Charles F. Gray, consulting electrical engineer and mayor of Winnipeg, appeared before the International Joint Commission last week, in Winnipeg, and protested against the proposed canalization of the St.. Lawrence River upon the ground that the expenditure is not justifiable while the $4,000,000 asked to complete the Hudson Bay Railway is not forthcoming.

During the months of December, 1920, to March, 1921, inclusive, the University of Michigan will offer the following 17 graduate short period courses in highway engineering and highway transport: American and English Highway Transport Methods; Highway Transport Surveys; Interrelationship of Highway, Railway and Waterway Transport; American and English Highway Traffic Legislation and Regulations; Highway Transport Management, Costs and Record Systems; Highway Transport Seminar; Highway Engineering Financing, Administration and Organization; Highway Engineering Theory and Design; Highway Laboratory; Bituminous Materials; Grading Machinery and Operation; Earth, Sand-Clay, Gravel and Broken-Stone Roads; Bituminous Surfaces and Bituminous Pavements; Brick, Cement-Concrete, Stone Block and Wood Block Pavements; Highway Specifications, Contracts and Jurisprudence; Highway Structures; and Highway Engineering Seminar. Each course will consist of 30 lectures and be given in a period of two weeks. The time schedule of the courses will be announced later. Each course will count as two hours' credit towards the total of twenty-four hours required for the Master of Science degree.

STATUS OF CREOSOTED BLOCK INDUSTRY*

SINCE the last meeting of the American Society for Municipal Improvements and the slight changes made at that time in the specifications for creosoted wood block, there has been very little desire or wish expressed for further changes. It seems as though the specifications for the oil and treatment were satisfactory, and would insure a good, substantial, lasting block, one that would be satisfactory in every way, and which would not bleed.

This bleeding, which has been cited as one of the principal objections to creosoted wood block paving under the latest specifications, has been shown to be caused by the filler left on top of the blocks, and that which was forced out by expansion, and not caused by the exudation of oil from the blocks themselves. In some cases, where another oil and treatment has been used, it perhaps has been partly caused at least by such exudation of oil from the blocks, but from our experiences it is not the case upon proper treatment, according to the present specifications.

New Specifications For Filler

Under the latest revised specifications, providing for a smooth top concrete and bituminous cushion, and using the ordinary filler, some trouble has arisen with bleeding. Changes in the character of the filler have been made in Minneapolis the past summer—and used on about 50,000 sq. yds. of paving on the downtown streets—with excellent results. During the hottest weather, the streets were almost entirely free from bleeding, although the paving had only been laid a short time. The specifications for this filler are as follows:—

Specific gravity at 38–15.5 degs. C.,	1.24
Specific viscosity at 82.3 degs. C.,	35
Distillate up to 355 degs. C.,	20%
Specific gravity at 38–15.5 degs. C. of distillate,	1.015
Melting point of residue, cube method,	95 degs. C.
Insoluble in chloroform,	25%

It will be seen by comparison with the usual specifications that the filler is much lighter and has more volatile material, and it is more like the fillers used some years ago when the ordinary filler was very much lighter than at present.

This specification, on analysis, and the observed results, is offered only as information, as it would be better to have a longer test to serve its worth before changing the specifications.

Industry Hit by War

The wood block industry has been (and is) very hard hit since the beginning of the war, and in consequence, the production and use has been very much curtailed, and would be more so only for the extended use of wood blocks for interior flooring.

The banner year for creosoted wood blocks was in 1911, when 3,865,000 sq. yds. were used, dropping down about 1,000,000 sq. yds. in 1914, and rising again to 3,788,400 sq. yds. in 1916, and 3,461,040 sq. yds. in 1917, and 2,398,969 in 1918. No definite figures are available for 1919, but the indications are for a much lower production. These changes are the result of a very large increase in the price of blocks, which was caused by the very large increase in the cost of the raw materials. These almost doubled since the war began, and the labor costs also increased almost as much, so the prices of treated creosoted wood blocks almost doubled, thereby reducing the amount used.

Cannot Meet Price Competition

These conditions should make the manufacturers and users of this kind of blocks and paving produce the best that can be made, as it cannot be sold on a price competition basis.

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*Report of Creosoted Wood Block Committee presented at the last annual meeting of the American Society for Municipal Improvements.

ENGINEERING INSTITUTE ELECTIONS

AT a meeting of the Engineering Institute of Canada held April 20th in Montreal, the following elections and transfers were announced:—

Members.—R. N. Blackburn, Regina; J. O. Boving, London, Eng.; W. L. Dethloff, Coniston, Ont.; W. P. Dobson, Toronto; R. T. Gent, Niagara Falls; H. V. Haight, Sherbrooke; J. D. Hathaway, Westmount; G. P. Hawley, Cedars, Que.; W. G. Hewson, Toronto; T. D. LeMay, Toronto; Maj.-Gen. W. B. Lindsay, Strathroy, Ont.; Wills Maclachlan, Toronto; L. D. Magie, Peterboro; James McEvoy, Toronto; G. E. Newill, Montreal; G. W. Rayner, Toronto; H. M. Scott, Montreal; P. F. Sise, Montreal.

Associate Members.—N. T. Binks, Montreal; W. M. Cruthers, Peterboro; F. L. Darrell, Kenogami, Que.; A. L. Dickieson, Peterboro; D. A. Duffy, St. John, N.B.; K. A. Dunphy, Souris, Man.; R. H. Findlay, Westmount; V. S. Foster, Peterboro; L. F. Fyles, Calgary; A. MacD. Grant, Ottawa; R. L. Hearn, Toronto; V. J. Hvidt, Princeton, B.C.; C. J. Jeffery, Armstrong, B.C.; Lieut. F. B. James, Walkerton, Ont.; B. F. Lamson, St. Catharines; C. J. LeBlanc, Montreal; W. S. Lockhart, Montreal; W. MacK. MacAndrew, Vancouver; J. P. Mackenzie, Vancouver; M. S. Madden, Keewatin, Ont.; W. F. McKnight, Montreal; Robert Morham, Toronto; Lieut. R. R. Murray, Halifax; Capt. B. T. O'Grady, Nelson, B.C.; F. O. Orr, Alfred, Ont.; G. H. Patterson, Quebec; H. C. F. Poste, Cornwall; William Ramsay, Nelson, B.C.; J. I. Richardson, Quebec; Major G. L. Ridout, Toronto; H. S. Rimmington, Winnipeg; Capt. F. A. Ritchie, Sault Ste. Marie; A. R. Robertson, Toronto; S. G. Smith, Toronto; R. D. Sutherland, Montreal; F. E. Umphrey, Winnipeg; James Veitch, Winnipeg; W. C. Way, Ottawa; H. M. White, Winnipeg; J. M. F. Wilson, Winnipeg; John Young, Winnipeg; Francis Hankin, Montreal.

Juniors.—Pierre Danais, Baie Saint Paul, Que.; Major N. H. Daniel, Toronto; D. C. M. Davies, Regina; R. C. Eastman, Capreol, Ont.; J. W. D. Farrell, Regina, Sask.; H. E. Miller, Charlottetown, P.E.I.; V. C. Moulton, Westmount; Lieut. Alexander Pirie, Vancouver; J. R. Ross Winnipeg; J. H. Russell, Peterboro; Capt. W. J. Rutherford, Westmount; Lieut. A. B. Rutherford, Westmount; Lieut. W. B. Scott, Montreal; N. H. F. Smith, Ottawa; A. R. Whittier, Ottawa; E. P. Wilson, Montreal; J. K. Wilson, Montreal.

Transferred, Associate Members to Members.—Major W. E. Davis, Winnipeg; Major E. P. Fetherstonhaugh, Winnipeg; Lieut. J. D. McDeath, Moncton, N.B.; P. H. Mitchell, Toronto; Major W. H. Munro, London, Eng.; J. J. Newman, Windsor, Ont.; Joseph Rocchetti, Winnipeg; J. S. Tempest, Ottawa.

Transferred, Junior to Member.—Lt.-Col. J. C. Brown, Constantinople, Turkey.

Transferred, Juniors to Associate Members.—Garnet Affleck, Winnipeg; W. W. Dynes, Winnipeg; Major Erskine Duncan, Galt; Capt. L. I. Easton, Winnipeg; H. F. J. Estrup, Welland; H. P. Heywood, Toronto; Capt. K. R. MacKinnon, Omaha, Neb.; K. W. Morton, New Westminster, B.C.; W. H. Norrish, Ottawa; Major G. R. Turner, Fredericton, N.B.; Capt. C. S. Walley, Winnipeg.

Transferred, Students to Associate Members.—Capt. Yves Lamontagne, Montreal; Major H. R. Urie, Winnipeg.

Transferred, Students to Juniors.—A. M. Alberga, Montreal; L. F. Barnes, Hamilton; W. S. Collins, Winnipeg; W. W. Crough, Selkirk, Man.; L. A. Dubreuil, St. Placide, Que.; Lieut. J. C. Irving, Winnipeg; Hector MacNeil, Montreal; Lieut. F. C. Rounthwaite, Montreal.

Work on the Welland Ship Canal was resumed on a small scale last Thursday morning, when dredging on Section 5 recommenced. The Dominion Dredging Co.'s fleet is being prepared for work in the harbor at Port Weller, Section 1, and other work on that section may soon be resumed. Work on Sections 2 and 3 may be hampered by power shortage; also there may be labor troubles, as these are the two sections in which strikes were declared last fall shortly before the work was shut down by the Dominion government.

NOVA SCOTIA BILL PASSED

BOTH houses of the Nova Scotia legislature have passed the bill incorporating the "Association of Professional Engineers of the Province of Nova Scotia," and it now requires only the formality of the lieutenant-governor's signature for the bill to take its place upon the statute books of the province. Nova Scotia is the sixth province to pass legislation dealing with the registration and licensing of engineers, as similar bills were recently adopted by the legislatures of British Columbia, Alberta, Manitoba, Quebec and New Brunswick. Saskatchewan, Ontario and Prince Edward Island are the only provinces that have not yet adopted such legislation. No bill has been introduced in Ontario or Prince Edward Island. In Saskatchewan a bill was prepared, but upon advice of the provincial premier, who requested a number of changes, it was withdrawn but will most likely be introduced next fall. On account of the comparatively few engineers in Prince Edward Island, there has been no concerted action towards legislation in that province. In Ontario a joint committee of two members from each of seven technical organizations is at work drafting a bill which it is hoped will meet with the approval of all engineers in that province.

EXTENSOMETER TESTS OF CONCRETE BEAMS

AT the last spring meeting of the Toronto branch of the Engineering Institute of Canada, held last Thursday evening in the Mining Building of the University of Toronto, Prof. W. A. Slater, engineer-physicist of the U.S. Bureau of Standards, delivered a lecture on "The Extensometer Tests of Reinforced Concrete Beams for the Emergency Fleet Corporation." These tests were made by the Structural Research Unit, Concrete Ship Section, Emergency Fleet Corporation, and Prof. Slater and A. R. Lord were jointly in charge of the work of that unit.

The meeting was well attended, and great interest was shown in Prof. Slater's remarks and in his slides and moving pictures. His lecture was divided into four parts: (1) General discussion, (2) slides and diagrams, (3) moving pictures of the tests, and (4) mathematical demonstration.

The lecture was followed by considerable discussion, during the course of which Prof. Slater stated, in reply to a question, that all of the slides, diagrams and data given by him in the lecture would soon be published in a technological paper that will be issued by the Bureau of Standards, and that a very great deal of the data will also be contained in a paper which he is presenting to the American Society of Civil Engineers.

Prof. Slater was formerly first assistant to Prof. A. N. Talbot in the Engineering Experiment Station of the University of Illinois. When the United States entered the war, his services were secured by the Emergency Fleet Corporation. In 1919 he took charge of the reinforced concrete research work conducted by the Bureau of Standards. He has presented a number of important papers to various societies in the United States, and is a member of several concrete committees.

Prof. Slater's lecture terminates a most successful season for the Toronto branch of the Engineering Institute. Under the able leadership of this year's chairman, R. O. Wynne-Roberts, the branch has shown more active interest in its weekly meetings than has been the case for many years past. There has been a meeting every Thursday evening throughout the winter and spring, and it is to be noted that the program as arranged last fall was carried out without any deviation, as every speaker kept his appointment.

The Hydro-Electric Power Commission of Ontario has completed the High Falls plant on the Mississippi River, 22 miles northwest of Perth, Ont. The formal opening of the plant took place last week, Sir Adam Beck officiating. The plant consists of three 1,200 h.p. units of the double-runner, horizontal type.

RECOMMENDATION FOR PRACTICE IN TESTING FLOORS OF CONCRETE BUILDINGS*

By W. A. Slater
Engineer-Physicist, U.S. Bureau of Standards

The purpose for which a test is to be made will have an important bearing upon the form which the test should take. In the following recommendations, tests for research purposes are considered first, and from the procedure to be followed in making research tests the features applicable to inspection for acceptance purposes may be selected. In few respects will the methods be entirely divergent.

Location of Test Area

For a test in which the main consideration is the securing of scientific data, the important considerations may be such as to require that the test be made on an upper floor, where the columns are small, or even upon a roof, where the columns end at the under surface of the test slab. On the other hand, if the attempt is to simulate the conditions where a large number of panels are loaded, a lower floor, where the larger columns assist in giving restraint to the slab at positions of negative moment, may best serve the purpose. Generally it will be desirable to select a position between the two extremes.

The area selected for testing should be free from irregularities of construction which would prevent the behavior of a slab in a typical manner.

Secondary considerations in selecting the test area are cost and convenience of access to loading material.

In general, tests should be made upon as large an area as possible. This permits a study of the results for the condition of uniform loading over a large area, and a comparison with the conditions for panels at the edge of th loaded area. With nine panels loaded, the conditions of strain for the four central columns and for all points within the central panel probably will not vary greatly from the conditions which exist for columns and corresponding points in the slabs when an area indefinite in extent is loaded. The outer panels represent conditions less severe at certain points and more severe at others than are found in the centre panel.

With only four panels loaded, it is believed that the conditions of moment around the central column will be as severe as those for negative moment in a loaded slab of indefinite extent. It is recommended that an area not less than two panels square be loaded, in order to develop representatively high stresses under a given uniform load.

Loading and Removal of Load

Where there is opportunity for selection of loading materials, the use of the heaviest material available will usually offer advantages, because danger of accident due to the high piling up of loading material is reduced, and because arch action is generally less likely with a low load than with a high load of the same intensity.

Generally, the only practical method of preventing arching is the dividing up of the load into small isolated stacks, or piers, usually rectangular. However, even under the most favorable circumstances it is difficult to cover more than 75 or 80% of the test area and still to leave room for access to the gauge lines for measurement of stress. This may necessitate the use of large piers in order to avoid too high piling up of load.

In such cases an important consideration is the securing of an arrangement, which, regardless of the amount of arching, will cause the resultant load to produce the same amount of moment as though no arching were present. A close approximation to this condition will be obtained if the panel is divided into areas such that a beam element in any direction through the panel will have the centres of gravity of the applied loads on the two half spans fall on the one-quarter points of the span. Such a condition is obtained when the panel is divided into four equal rectangular areas with aisles on the centre lines and edges of the panel. This condition is illustrated in the loading plan for the Schulze Bakery Co.'s Building, Bulletin 84, University of Illinois Engineering Experiment Station, page 66. The principle upon which this statement is based is illustrated in Bulletin 64., University of Illinois Engineering Experiment Station, page 24. In the illustration used, a simple beam was considered. The conditions will not be the same for the continuous beam elements under consideration, but the relations between moments, due to the varying distributions of the load, will be not far different.

The load distribution for tests is generally assumed to be uniform, though it is never possible to attain this condition with exactness. Frequently, where areas of the test floor are left exposed for the purpose of giving access to the gauge lines, deficiency of the load thus produced is made up by piling the load higher on other portions of the panel. Where this is done, special attention should be given to the securing of the same magnitude of moment and of shear as would be obtained with uniform load. No exact rules can be laid down for the procedure in this connection, but all cases require careful attention to these features. A satisfactory method is the use of a platform over the unloaded areas, high enough above the floor to permit access to the gauge lines and supported at intervals sufficiently frequent to approximate the conditions of moment and shear caused by uniform load. This platform is loaded with an intensity of load equal to that of the uniform load required.

The amount of deformation found in the concrete has been found to be markedly dependent upon the rate of application of load.*

Due to the plastic yielding of the concrete, the stresses in the steel will also be affected by the rate of loading. It is important that uniformity in this respect be observed in all tests to as great an extent as possible. If the loading be too hurried, the concrete will not have assumed its full deformation by the time strain gauge readings are taken. In order to facilitate the interpretation of test data, it is recommended that loading increments should be made not more frequently than once in twenty-four hours, and that the length of time elapsing after completion of one increment of load before beginning the application of the next increment should be not less than twelve hours. The maximum load should remain in place not less than twenty-four hours before beginning to remove it. The rate of removal of load may vary under different conditons, which will be determined by the circumstances and purposes of the tests.

Observations Required

The purpose of the test will fix the kind and amount of data required and will, therefore, in general define the observations necessary to secure these data. However, in any test, either for acceptance purposes or for objects of research, there are certain observations which experience has found to be necessary for the satisfactory interpretation of the test data. These observations involve a determination of the quality of the concrete used in the structure; of the conditions of support of the structure; the method, extent and duration of loads applied; the weather conditions during the period of testing; calibration of all measuring instruments used in the test. There are also certain methods of manipulation of the instruments by the observer which should be followed. The above points will be discussed separately.

Auxiliary Specimens

It is essential when making tests upon a concrete structure that an accurate knowledge be had of the quality of concrete used in the structure. Sample specimens should be prepared for the purpose of supplying this information. Specimens for the determination of the compressive strength and deformation of the concrete should be in the form of

*Excerpts from report of chairman of Committee on Tests of Reinforced Concrete Floors, American Concrete Institute.

*University of Minnesota Studies in Engineering No. 3, F. R. MacMillan; also Trans. A. S. C. E., 1916, p. 1,743.

cylinders whose height is twice the diameter and whose diameter is not less than 6 ins. The cylinders should be cast from samples of concrete taken from batches actually used in the concreting structure to be tested. Sampling should be sufficiently distributed over the period of concreting to give fair representation of possible variations occurring in the quality of concrete. There should be a sufficient number of these cylinders to establish fairly accurately the gain in strength and other properties due to aging of the structure. In arriving at a determination of the strength of the concrete at a given age, the results of tests of not less than three cylinders should be used.

It is difficult in testing concrete members in biaxial bending, or in some other complex state of stress, to determine the extent to which the resisting forces may be divided between concrete and steel. Thus in the testing of a flat slab floor, measurement of the strain in the slab reinforcement will not give directly the magnitude of the external moment applied at the sections under measurement because of the indeterminate part played by the concrete. One means of approximating the external moment is by testing a slab under monaxial loading in such a manner that at a section under measurement the external moment may be known. The resisting moment of the steel stresses may then be computed as a percentage of the external moment. If this percentage is then applied to the more complicated structure, it should assist in determining the value of the external moment at sections under measurement.

Other forms of auxiliary specimens may be required, dependent upon the nature of the information desired in connection with the test.

It is obviously necessary that the auxiliary specimens should be made up of concrete similar to that used in the test structure. The concreting of these specimens and of the test structure should be carried on simultaneously with the same concrete and by the same construction forces for the control specimens as for the test structure.

The curing of all auxiliary specimens or other concrete specimens necessary to the interpretation of the test data should follow as closely as possible the condition of curing the test structure. It is the customary practice to cure these specimens right at the structure up to the time of testing of the specimens.

Corrections in Changes in Length of Strain Gauge

It is desirable that the strain gauge have invar steel side pieces in order that the change in the instrument due to change in temperature may be negligible. However, it is possible to use successfully a strain gauge whose length is not constant, if very frequent reference is had to a constant length standard bar, say, an invar steel bar or an iced bar.

A gauge line in an unstressed portion of the structure or in a bar embedded in concrete to maintain temperature conditions the same as those in the test structure may be used as a standard of reference. Such a standard serves to correct for the changes in the instrument and for those in the structure simultaneously.

Probably one-half the routine work of reducing the strain gauge data can be avoided by the use of an invar steel strain gauge. However, even then a standard bar should be used to correct for accidental changes in the instrument. The usefulness of a standard bar in correcting for changes in the structure is discussed in another paragraph.

Preparation of Gauge Lines

The gauge line consists of two small holes drilled in the member or in metal plugs embedded in the member whose strain is to be measured and in the desired direction and so spaced that by the insertion of the two points of the strain gauge into these holes their movement with respect to each other may be readily determined. A countersunk hole has not been found to be satisfactory for general use. A cylindrical hole formed by a number 54 drill is recommended. The objectionable burr at the surface may be removed by tapping very lightly with a punch having the same conical form as the leg of the strain gauge, thus forcing the burr back away from the axis of the hole. This tapping must be extremely light.

Gauge holes on deformed bars should not occur on any portion of the bar which is a protrusion from the main shaft of the bar.

Gauge lines on concrete may be set by inserting small metal plugs in the concrete. These plugs may be embedded in plaster of Paris or some other cementing medium. Care should be taken if this medium is hydroscopic that a coat of shellac or other waterproofing material should be applied over the exterior.

Procedure of Making Strain Gauge Observations

In taking any set of strain gauge readings, check observations should be made. The preferable method is to make observations on all gauge lines to be read in the given series and then to repeat the reading of these same gauge lines in the order first read. Particular care should be used in taking the series of "zero" observations on the unloaded structure.

The observer should take readings on a standard bar at frequent intervals. If an invar strain gauge is not used, these standard bar readings should be not less frequently than once every 16 to 20 gauge lines. With an invar strain gauge the frequency of standard bar observations may be reduced materially, but they never should be less frequent than at the beginning and end of each series of readings.

Calibration of Strain Gauges

The strain gauges should be calibrated to determine the relation between readings on the gauge and deformation of the gauge line. Instruments in which the multiplication ratio of the mechanism is affected by the length of the movable leg of the gauge should be calibrated in operating position in holes of the size and form to be used on the test structure.

Data of Control Specimens

With the strain gauge and other data from the test panels and control specimens collected, there remains the important step of considering these in relation to each other so that the results of strain observations on the slab may be expressed in terms of stresses and their true significance understood.

The data from the control or auxiliary specimens should include: (1) Stress deformation relation in direct compression of specimens representative, in both quality and curing, of the concrete in the structure (this should show how much plastic effect there is under sustained loads as well as the usual relation when loaded continuously to failure); (2) load deflection and load-deformation relations, when tested as simple beams, of coupon slabs typical of sections of the test panels; these also should show the plastic behavior of the concrete. These data together with the temperature observations before and after, as well as during the test, are essential to the proper interpretation of the strain data in terms of stresses.

Adjustment for Temperature Changes in Structure

Concrete structures are subject to temperature deformation. The importance of the consideration of this deformation may be appreciated from the fact that in some flat slab structures it has been observed that a 20 degs. change in temperature has produced stresses and deflections equal to those observable on the structure when the load for which the structure was designed has been placed upon it. Deformations produced by changes of temperature during the test should be eliminated from the observed deformation as far as possible before attempting the reduction to stress-equivalent. At best it is very difficult to make these corrections and under unfavorable conditions, such as with exposed structures or with large temperature changes, it may not be possible to make satisfactory corrections by any practicable method.

One method uses as standards of reference gauge lines established in the concrete and on the steel of a small auxiliary slab similar, in all details, to a typical portion of the test panels. With this method it is necessary to assume that the auxiliary slab has the same coefficient of expansion as the structure under test. If this standard has the same coefficient of expension and can be kept in such a way as to be at the same temperature as the test panels throughout the period of the test, the temperature deformations observed in the auxiliary slab will constitute corrections which when applied to the deformations observed in the test panel will eliminate the temperature deformations from the test data.

A modification of this method uses as a standard of reference a common steel bar buried loosely in a slab of concrete, the slab to be cared for during the test in such a way as to maintain as nearly as possible the same temperature as the test panels.

Objections to Previous Methods

Objection to either of these methods arises from the fact that: (1) It is very difficult to maintain the same temperature in the two slabs; and (2) the coupon slab is practically free to expand or contract in any direction while the test structure is restrained somewhat by the presence of columns and by the variation in expansion and contraction of different parts, due to slower temperature changes where there are concentrations in the mass of concrete than elsewhere. Wherever possible the deformations and temperatures in the test panels should be observed for periods before and after the test. With this information, corrections may be arrived at for effect of temperature changes during the applications of load.

For this method a convenient form of standard of reference is one of invar steel. Another form would be a common steel bar, excepting for the fact that owing to its high degree of hardness, it is difficult to obtain satisfactory gauge holes.

The objection to this method is that it is very difficult to determine the mean temperature of the slab. In some tests in the past, observations for temperature both at the surface and within the slab itself, have shown rather wide discrepancies.

Other methods of collecting data relative to the effect of temperature change upon the steel deformations are described in the Proceedings of the American Concrete Institute for 1919, page 127. Until more data are obtained on this subject a combination of the two methods is recommended, using both auxiliary specimens typical of the slab and an invar or other standard of known coefficient. Extensive observations should be made for temperature both within and adjacent to the test panels and the standards of reference, together with strain gauge readings on the standards and representative gauge lines on the test panels. These should be begun several days before the test and continued a like period ofter the test.

A careful study of these temperature data should be made to determine the most consistent correction for the temperature changes during the test period.

Temperature correction for deflection data may be obtained by observing changes in deflection during the periods before and after the test. If the observations are carefully made, a comparison of these corrections with those determined upon for deformations will aid in judging of the corrections of the former.

Reduction of Strain Gauge Data to Equivalent Stress

Nominally the stress in a gauge line is the product of the unit deformation and the modulus of elasticity. Actually, the relation is not so simple. In the case of gauge lines placed to give deformations in the concrete at points of critical stress, the relation is complicated by the continued deformation under sustained loads, a phenomenon generally spoken of as plastic effect. In the case of gauge lines on the reinforcement the condition frequently arises in which the maximum unit deformation in a gauge line may be considerably in excess of the average obtained by dividing the observed total deformation by the length of the gauge line. Shrinkage in the concrete of the structure may also affect the stresses in steel gauge lines.

The determination of the stress under these conditions is discussed in the following paragraphs:—

Concrete Stresses

Under the conditions of loading recommended in another portion of this report, it will usually be found that concrete deformation at critical sections will increase considerably during the period between the successive applications of the load. Except for a small increase shortly after the application of the load, this continued deformation is likely to be due to the plastic effect noted above. If observations are made within an hour or so after the application of a load, and again immediately before the application of the next increment, it will generally be fair to deduct the entire amount occurring within these periods from the total deformation, basing the stress on the resulting net deformation.

The test of the compression specimen for plastic effect has been referred to. It will be well that some of these specimens be held until the data from the panel test have been examined, so that rate of loading and the intervals between increments of load may be made to correspond to the loading of the test panels. The successive increments of load should be chosen to give the same unit deformation as was obtained in critical gauge lines of the test panels for the corresponding load stage. Specimens should be tested in this manner to correspond to the results from a number of the important gauge lines, especially for those in which large plastic yields have been found.

The foregoing procedure is recommended largely as a check to insure safe interpretation of the stress in critical gauge lines. For in general it will be found that the portions of the stress-deformation curve representing the successive loading periods will be about parallel to corresponding portions of a stress-deformation curve for specimen tested so rapidly as to eliminate the plastic effect. When this is true all that is necessary is to deduct from the total deformation that part found to be due to the plastic effect and determine from the regular stress-deformation curve the stress corresponding to the resulting net deformation.

Control Specimens Require Great Care

In the foregoing discussion it is assumed that the auxiliary specimens for these modulus tests are representative of the concrete in the structure. It is recognized that even with the greatest care, rather wide difference in quality may result. Probably the greatest difference will arise from the necessarily different curing conditions between the isolated specimens and the slab of the test panels.

As reliance must be placed on the control specimens, at least for the present, it is recommended that the greatest care be taken in controlling the making and curing of these specimens.

The test of the coupon slabs offers opportunity for corroborative data on the modulus of elasticity. If these are tested as simple beams rather accurate values of the modulus of elasticity in flexure may be obtained by careful deflection measurement at loads up to the point where the concrete first develops cracks. During this stage of loading the specimens will behave as homogeneous beams, and calculations for modulus are simple and reliable. Since the deflections are very small, it will be necessary to have the measurements accurate to one one-thousandth of an inch.

In the tests of these coupon slabs it is also recommended that further check on the plastic deformation be obtained by loading at least one in a manner similar to that described for the compression specimens.

A. B. Connell, barrister, of Woodstock, N.B., has been appointed chairman of the Public Utilities Commission of New Brunswick, succeeding G. O. D. Otty, whose term of office has expired. J. D. P. Lewin, barrister, of St. John, has been appointed as a member of the commission for a term of ten years.

CONCRETE: ITS USE AND ABUSE*

By Irving K. Pond

Past-President of the American Institute of Architects

CONCRETE is a material which lends itself to many kinds of manipulation. It can be cast, poured, pressed, assembled in the shop or on the job; it can be applied in liquid or in solid form to the work immediately in hand. So many are the possible methods of its application—such a diversity of means may be employed towards its legitimate ends—that some of its enthusiastic sponsors see in it a panacea for structural ills, and possibly for æsthetic building ills, a substitute for all previously employed building materials—excepting, possibly, door hinges—and a perfect end in itself. Therefore it behoves those who can impartially survey the entire field to offer both warning and encouragement—encouragement in its legitimate use, warning against its too free employment, especially where other materials may better serve the conditions.

The economics of the general situation favor concrete, and through this factor alone, there may arise a tendency toward its too general employment, toward its substitution for other materials which, though, perhaps, costing more in mere money, satisfy the senses and better fulfil geographic and climatic conditions.

The cheapness and ease of casting a flat slab of concrete has led certain enthusiasts to advocate the general adoption of a flat-slab type of roof in any and all parts of the country (and ultimately of the world). It is advocated for a northern climate because it can very cheaply be made strong enough to hold a load of snow and ice. But that is not what a roof is for; it is to shed snow and ice. The flat-slab roof is advocated for a southern climate because the overhang for shade is so cheaply procured. The shade is desired, but not at the expense of ugliness, which results from unembellished overhangs—and concrete embellishments are expensive.

Simplicity Which Begets Ugliness

The factors of ease and economy in manufacturing concrete slabs, whether to be applied vertically or horizontally, contribute to a "simplicity" which tends towards stupidity, and to a barrenness which begets ugliness. Where the general form is stupid and ugly, not much in the way of reclamation can be effected by proportioning of windows or application of superficial ornament. If the mass is interesting and appropriately conditioned, geographically and climatically, slight defects in details will not too seriously challenge the taste; but an ugly mass is fatal.

In spite of the manifold and varied means, methods, processes, applications, manipulations, textures, surfaces and colors appertaining to the use and employment of concrete as a medium of architectural expression and embodiment, I am not certain that I should advise its sole and unlimited agency in housing the activities of any one neighborhood or community. Indeed, I am quite certain that I should not so advise, and this not altogether on the ground of a needed variety, but that there are other materials which transcend even concrete as a medium of certain desired expressions of the human spirit in the art of architecture. And I should desire to see no community curtailed of, or denied, the right and power to express the best that is in it in the materials best adapted to that expression.

Thus marble, granite, iron, bronze, brick, slate—each one possesses inherent qualities or characteristics not translatable into concrete even through the agency of base and artificial imitation. In the matter of brick, for example, there is scale to the unit which relates the mass to human desires and experience in an intimacy possible with no other material, while in natural color and texture the range is boundless. But even with all that, brick needs other materials in its neighborhood for contrast and variety—purple-green of slate, soft white of stucco, weathered grey of timbers, with carvings and turnings, and craftsmanship which cannot be imparted by a mold, however exquisitely the surface be wrought by the modeller's hand.

*From an address delivered in Chicago at the Conference on Concrete Housing.

Æsthetic Expression in Concrete

I assume that, as an architect, I am expected to say that the only way to make concrete an accredited and acceptable building material adapted to all human material and æsthetic needs is to have its essence filtered through the alembic of the architectural profession or its representatives.

If you wish me to say it, of course I will—with reservations. Now the most stupid of anachronisms are perpetrated by so-called architects (they really are untutored archæologists, or, rather, grave robbers), and the most blatant of modernisms, cut off from all context of history, have emanated from, again, so-called architects (they really are unlettered sentimentalists). But I will say that the possibilities of concrete as a medium of æsthetic, expression in building may best be apprehended by a sincere architect, with knowledge of modern social conditions and tendencies, working in co-operation with those who know the material at first hand, and who also are sincerely working to exploit nothing, but to develop the latent and inherent possibilities of a worthy material. Such architects exist; such material and men exist. They should come together.

AMERICAN WATER WORKS ASSOCIATION

AT a meeting of the committee that has charge of the arrangements for the convention of the American Water Works Association, which will be held next month in Montreal, it was announced that arrangements had been completed with the Beaconsfield Golf Club whereby the members of the association who play golf may use that club during their stay in Montreal. An afternoon tea will be given June 24th at the club house for the ladies attending the convention.

The personnel of the entertainment committee was increased by the addition of Messrs. Pitcher, Sutherland, Leclerce and Stephen, all of Montreal. The chairman of the committee is H. G. Hunter, resident engineer at Montreal for the New York Continental Jewell Filtration Co.

The committee decided to request the mayor of Montreal to open the convention with an address of welcome, and to ask R. A. Ross, city commissioner, of Montreal, who is president of the Engineering Institute of Canada, to welcome the delegates to Canada and to extend to them the courtesies of the institute. It was decided that the informal reception and dance to be held during the evening of June 21st should consist of a concert in Windsor Hall, dancing in the Ladies' Ordinary at the Windsor Hotel, and refreshments to be served at 11 p.m. Messrs. Lesage and Hunter were appointed as a sub-committee to make arrangements for the Lachine Rapids trip. Messrs. Stephen and Hunter were appointed a sub-committee to arrange for the smoker.

A member of the entertainment committee will be in attendance at the convention at all times to advise out-of-town delegates regarding places of interest in Montreal, and to furnish whatever other information may be of service to the visitors. A photograph of the convention will be taken by William Nottman & Sons. Mr. Hunter was appointed as a committee of one to make arrangements with Charles Wood, of Philadelphia, for the golf tournament which is held annually in connection with the convention of the association. Messrs. Pitcher, Sutherland, Lesage and Hunter were appointed as a sub-committee to arrange the visit to the filtration plants of Montreal, Friday, June 25th.

At a recent meeting of the St. John, N.B., branch of the Engineering Institute of Canada, G. G. Murdoch was elected chairman; H. F. Bennett, secretary-treasurer; E. P. Vaughan and A. Gray, members of the executive committee. The other members of the executive committee are the retiring chairman, C. C. Kirby, and C. O. Foss and G. G. Hare.

ST. LAWRENCE NAVIGATION AND POWER INVESTIGATION

FOLLOWING is the International Joint Commission's schedule of summer hearings in the St. Lawrence navigation and power investigation:—

Thursday, May 20—Hearing at Regina.
Friday, May 21—En route to Calgary.
Saturday, May 22—Hearing at Calgary.
Sunday, May 23—At Calgary.
Monday, May 24—Hearing at Calgary.
Tuesday, May 25—En route to Helena, Montana.
Wednesday, May 26—Hearings at Helena.
Thursday, May 27—Hearing at Helena.
Friday, May 28—En route.
Saturday, May 29—En route.
Sunday, May 30—At Boise.
Monday, May 31—Hearing at Boise.
Tuesday, June 1—En route to Cheyenne, Wyo.
Wednesday, June 2—Hearing at Cheyenne, Wyo.
Thursday, June 3—Hearing at Denver.
Friday, June 4—En route to Omaha.
Saturday, June 5—Hearing at Omaha.
Sunday, June 6—At Omaha.
Monday, June 7—Hearing at Omaha.
Tuesday, June 8—Hearing at Des Moines, Iowa.
Wednesday, June 9—Hearing at Sioux Falls, S. D.
Thursday, June 10—En route, Sioux Falls to Minneapolis.
Friday, June 11—Hearing at Minneapolis.
Saturday, June 12—Hearing at Minneapolis.
Sunday, June 13—At Duluth, Minn.
Monday, June 14—Hearing at Duluth.
Tuesday, June 15—Hearing at Duluth.
Wednesday, June 16—Hearing at Superior, Wis.
Thursday, June 17—Hearing at Ashland, Wis.
Friday, June 18—Hearing at Milwaukee, Wis.
Saturday, June 19—Hearing at Milwaukee, Wis.
Sunday, June 20—En route to Toledo, O.
Monday, June 21—Hearing at Toledo.
Tuesday, June 22—Hearing at Lansing, Mich.
Wednesday, June 23—Hearing at Windsor, Ont.
Thursday, June 24—Hearing at London, Ont.
Friday, June 25—Hearing at St. Catharines, Ont.
Saturday, June 26—Hearing at Hamilton, Ont.
Sunday, June 27—At Buffalo, N.Y.
Monday, June 28—Hearing at Buffalo.
Tuesday, June 29—Hearing at Buffalo.

ST. LAWRENCE DEEP WATERWAY PROJECT

IN an article, "From the Great Lakes to the Sea," by C. Birkett, secretary of the Fort William and Port Arthur Grain Exchange, published in a recent issue of "The Monetary Times," there appeared the following terse summary of the project to deepen the St. Lawrence waterway from Lake Ontario to Montreal:—

The plan: To remove obstructions in the St. Lawrence River between Lake Ontario and Montreal by joint action of the United States and Canada.

What are the present limits of navigation? Through the lakes, 20 ft. in all main channels; at Niagara and down the St. Lawrence, 14 ft.

What is being done to raise the limit? At the Soo, new locks, 24 ft.; projected locks, 30 ft. At Niagara, the new Welland 25-ft. channel, with 30-ft. locks; projected channel, 30 ft.

What remains to be done? Only to overcome a series of rapids in the St. Lawrence.

How formidable a job is it? Total fall to be overcome, 221 ft., strung over a hundred miles or more—forty odd miles of artificial channel—compared with 326 ft. in 25 miles at the Welland.

How serious is the cost? The United States spent about $50,000,000 to get from the upper to the lower lakes. Canada is spending more than $65,000,000 to get from Lake Erie to Lake Ontario. Both countries are to spend something over $100,000,000 to link the great lakes with the ocean. Compare with $450,000,000 for Panama project.

What dividends are promised? It will save its cost in three years in transportation bills. It will take the crushing load off railroads and terminals. It will develop coastwise traffic along the new coast line. Finally, it costs nothing; the power it develops will pay for it.

What will the channel carry? All lake vessels can deliver their cargoes at an ocean port. Any lake carrier may continue its voyage coastwise or overseas. Two-thirds of the ocean-going fleet can make the lake ports at will. Any coasting vessel can come up the lakes as they choose.

What traffic will develop? Free movement of western products to the seaboard by all-water. Lake cargoes delivered at any Atlantic port wherever convenient. Lake cargoes delivered at destination overseas whenever profitable. Direct imports to the heart of the continent whenever conditions favor.

The St. Lawrence improvements fall in two sections: First, international,—113 miles long, the boundary between the United States and Canada from Lake Ontario to St. Regis; second, Canadian,—67 miles from St. Regis, where the river leaves the boundary line, to deep water in Montreal.

ASSOCIATION C. B. & C. I. LABOR COMMITTEE

AT the first meeting of the standing committee on labor appointed recently by the executive committee of the Association of Canadian Building and Construction Industries, there were present: J. P. Anglin (chairman) and D. K. Church, Montreal; R. J. Fuller, Toronto; F. W. Dakin, Sherbrooke; Geo. A. Crain and H. J. Graham, Ottawa; and J. C. Reilly, secretary. The meeting was held May 13th, in Ottawa.

The secretary reported that the Winnipeg Builders' Exchange has appointed Joseph A. Bonnett as its representative on the committee, and read letters from the Minister of Labor and the president and secretary of the Trades and Labor Congress, expressing their desire to co-operate with the committee in its work. A general discussion followed, covering labor conditions in the various cities represented, and dealing with the various clauses of the report of the Labor Committee submitted at the last Ottawa Conference. Responsibility of labor unions, dating of agreements and apprenticeship were fully discussed.

It was decided to have a further meeting of the committee on May 25th, in Hamilton, at which the secretary is to submit data on several of the above matters so that more definite action can be taken. The committee would appreciate it if any builders' exchange, firm or individual having special information on any of the foregoing topics would submit same to the secretary or to the nearest committee member, or give any other assistance in the committee's work.

Announcement has been made by Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, that the 50,000 h.p. steam reserve plant which will be built during the coming year, will, upon its completion, be enlarged to 100,000 h.p. Sir Adam says that the first 50,000 h.p. will be ready by September, 1921, when the city of Toronto is to take over the Toronto street railway. He states that a steam reserve plant was not built previously because the commission had plenty of power, but now it is constantly using its maximum supply of power and there is need for a steam plant to carry the peak. Also conditions at the existing power plants at Niagara Falls at times during the winter and spring are not very satisfactory, due to ice troubles. The Canadian Niagara Power Co., at times last winter developed only a fraction of the capacity of the plant, said Sir Adam, resulting in a great shortage of power on the commission's system, as the Canadian Niagara Power Co. is under contract to supply the commission with 60,000 h.p.

ELECTRICAL PUMPING FOR KINGSTON WATER WORKS*

UNTIL August, 1918, the city of Kingston, Ont., depended for its water on two steam pumps, each having a capacity of about 3,000,000 gals. per day. Kingston has a population of about 22,000, and the average daily consumption of water in 1918 was roughly 3,300,000 gallons. A standpipe 80 ft. high, having a capacity of 628,000 gallons, is situated about 1½ miles from the pumping station. The bottom of this standpipe is about 106 ft. above normal lake level. The pumping station is situated at the dock, the intake crib being located in Lake Ontario, about 2,500 ft. from shore. The intake is mostly 30 and 24-in. steel pipe.

Normal growth and the condition of the steam pumps, which have been in use many years, necessitated additional pumping capacity. After careful investigation, it was decided to install an electrically-driven centrifugal pump having a capacity of 3,500 Imperial gallons per minute (5,040,000 gals. in 24 hours) against a total head of 210 ft., the pump to be connected through a jaw-clutch to a 320 h.p., 3-phase, 60-cycle, 2,200-volt, 1,200-r.p.m., self-starting and self-synchronizing synchronous motor, complete with a direct-connected exciter and the necessary starting apparatus. This pump also has a capacity of 3,050 gals. per min. against a head of 240 ft. (104 lbs.), under which condition it can be used for fire purposes. The motor is capable of operating continuously as a synchronous motor at 380 kv.-a. at any power factor between 100 and 70% leading when carrying a mechanical load of 325 b.h.p.

Two More Units Contemplated

The electric pump is located in a new brick annex, 50 by 20 ft., to the old pumping station. Future provision has been made for two more pumping units in this building.

Sketches have been prepared and connections provided by which a new intake may be constructed, and the present one, which has been in service for many years, may be abandoned, or held in reserve. This new intake will be carried to a new suction well from which low-lift electric pumps will deliver the water to rapid sand filter beds, which in turn will discharge to a clear-water reservoir, from which the main electric pumps will deliver to the city mains. All the water pumped is measured by means of a Venturi meter.

Statements available covering operating costs during 9 months in 1917 and 9 months in 1919 indicate that there was a daily average pumpage of 3,520,000 gals. in 1917 and 3,800,000 during 1919; the first figure being based on the revolution counter of the old steam pump, with allowance for slippage, and the second on Venturi meter records.

Operating Costs

The operating costs for the above periods were:—

	Per million Imp. gals.
Coal at $6.89 per ton	$ 6.51
Oil, waste, supplies, etc.	1.55
Labor	3.74
Total 1917 operating costs	$11.80
Banked fires, coal at $7.48 per ton	$ 1.07
Electric power	4.77
Oil, waste, supplies, etc.	1.88
Labor	2.73
Total 1919 operating costs	$10.45

These figures indicate a saving of 10 to 12%, or about $1,500 per annum, exclusive of the 300 to 380 kv.-a. corrective capacity, which is extensively used in correcting the power factor.

This saving will be increased when the operators have had experience with banked fires for steam reserve, and when operating conditions have settled down so that the item of $1,936.80 for oils, waste, supplies, etc., can be reduced.

The two steam pumps have been retained for emergency use, and boilers are bank-fired; consideration may be given in the near future to the installation of sufficient gasoline-driven pumps to provide an immediately available reserve.

The installation was made by C. C. Folger, general manager of the Public Utilities of Kingston, with the assistance of the Hydro-Electric Power Commission of Ontario.

The De Laval pump was supplied by the Turbine Equipment Co., Toronto; the motor by the Canadian General Electric Co., Toronto; and the Venturi meter by Allen General Supplies, Ltd., Toronto.

*From the Bulletin of the Hydro-Electric Power Commission of Ontario.

THE RURAL WATER SUPPLY AN INTEGRAL PART OF THE MUNICIPAL SUPPLY*

By Dr. E. G. Birge
State Epidemiologist, University of Iowa, Iowa City

THAT Farmer Jones' well, located 5 miles northwest of Rock Rapids, may at any time become an integral part of the municipal supply of Keokuk sounds, on the face of it, a foolish statement, yet the author hopes to prove that such may be the case, and that the water works official should be as vitally interested in that well as in his own municipal supply. Not only is it to his interest to see and to know that Farmer Jones has a pure water supply, but it is to his interest to see that it is kept pure.

To follow out our original premise more fully, let us suppose that one of the citizens of Keokuk drifts up into the northwestern part of the state and lives for a while on the farm in question, returning to Keokuk in apparent good health. Let us furthermore suppose that there has been a typhoid epidemic, a small one, to be sure, merely one of those local flareups that don't get into the paper, that has been traced to the use of a contaminated well existing on our farm. In due time the citizen in question develops a case of typhoid fever. Potentially he is dangerous to the rest of the community, and it is up to the water works superintendent to see that no more case of typhoid fever develop in Keokuk through the medium of the water. To all intents and purposes that well, situated miles away, has become an integral part of the Keokuk supply and the water in Keokuk must be treated as though it were contaminated.

While that is a concrete case, merely a supposition in this instance, yet the underlying idea is the one which governs the treatment of water in the country at the present time. Were it not for the fact that water supplies, city as well as rural, are in constant danger of being contaminated by the excreta of human beings, the necessity of chemical treatment, of sand filtration and the constant expense of so safe-guarding the watershed as to reduce the danger to a minimum would be largely reduced. Do not get the idea that it would be absolutely done away with in any community. If it could, it would simply mean that the human beings residing in that community would be perfect, a thing unheard of, yet all will agree that if all water supplies could be kept from being contaminated the problems of the water works manager would be solved to a large extent.

Another reason why the water supply must be more carefully watched when there is a case of typhoid in the town, is the fact that the public throws suspicion first on the water supply and should an epidemic arise from that first case, the public always jumps to the conclusion that the water is at fault, and it may lead to serious difficulties for the water company. In some instances, even when the water company was not at fault and the water was not contaminated, although the analysis of the water showed the possibility of its being so contaminated, the cities have revoked the franchise of the water company. It is for this reason as much as any other that the water company should be inter-

*Read before the Iowa section, American Water Works Association.

ested in the rural supply, not only of the surrounding country, but of the entire state.

Can that condition be brought about? The first answer to that question is usually, "no." Possibly that is the correct answer; personally, the author is optimistic enough to think otherwise. Certainly it cannot be brought about in a short time, nor without a great deal of effort on the part of those most vitally interested, nor can it to a large extent ever be brought to a point of perfection, but that the conditions can to a large extent be improved, and should be improved, goes without saying. What forces are there at our command to tackle this problem and to keep the matter agitated to a point where the public will think about it and see that it is done? Without the public back of the movement, it is doomed to failure at the start.

Follow-Up Work Required

The State Board of Health is the first force we have to deal with, and no board of health worthy the name neglects this important thing for a minute, yet it is a deplorable fact that in most parts of the country the improvement goes on with surprising slowness due no doubt to the multiple activities of the State Board of Health and to the fact that the public looks to them to decrease disease, and this matter of improving water supplies, either municipal or rural, is merely a coincident step in the reduction of disease. As such, it receives its greatest attention at times of epidemics, and usually only in proportion as the danger lies to the community immediately interested. Usually, too, there is little follow-up work done, and the rural supply, once put into shape, in a short time relapses into its former condition. This is not always the fault of the State Boards of Health; if it were, it would be an awful indictment against men who are giving the best they have towards the betterment of the communities in which they live. Usually it is largely due to apathy on the part of the public and a lack of definite co-operation on the part of other forces working towards the same end. This lack of co-operation is enormous in our public life; various boards and societies, instead of co-operating, overlap on their work, each jealous and afraid that the other fellow is going to spring something new and get the lead.

Can a society such as the American Water Works Association do anything of value along this line? Most assuredly it can and it does; not only that, but its members are those who, from a monetary standpoint, are most vitally interested. The association has always stood for the best in water works practice, and it is largely to its efforts that we have the present laws governing municipal water supplies. There is no question but that it would do more work with the rural supplies if it were definitely realized that they may become at any time an integral part of the municipal supply, even if it is only in an indirect manner.

Community's General Health Improved

The thing which we would all like to see, not only as professional men but as citizens, is the betterment of the community. That good water tends towards that betterment is unquestioned. In order to keep that water good the general sanitation of the community must be improved. We are all familiar with the Mill-Reincke phenomenon, in which the death rate due to all causes shows a reduction greater than can be accounted for by the drop in deaths from typhoid fever alone, when reduced by the use of filtered water. If that drop in the death rate holds for cities with proper municipal water supplies, think of the reduction in deaths to a state which could say that the biggest proportion of its rural supplies was above suspicion.

The task is a great one; just what the plans of such a campaign would have to be is a question. The present laws concerning the pollution of water in this, as in many other states, relate to the water supplies of cities and incorporated towns. So far as they go they are adequate, but they do not go far enough. The time has passed when any city can clean up its own yard and say, "sufficient." In the past these conditions undoubtedly held good, in which the rural district was isolated to a greater or less extent, and the pollution of a rural water supply affected only those persons who used it. However, with the coming of the automobile and the advent of good roads, no part of a state, or of the surrounding states, can in any sense of the word be termed isolated. There is altogether too much travelling back and forth and it is too easy for the persons living in remote districts to come into the town, to say that any district, no matter how remote, is isolated from the city. It is those outlying districts in which the water supply is not so carefully watched that are dangerous to the municipalities.

On account of the present laws, the strictly rural supplies, and by that is meant the well that supplies the farmer's family and possibly a neighbor or two, are not brought to the attention of the health authorities, either local or state, until disease appears in the neighborhood and suspicion points towards the supply. For the reasons set forth above, it is as necessary to safeguard the strictly rural water supply as it is to safeguard the water supply of the municipality and state. Another benefit which is bound to come from the constant supervision of the individual country water supply, is the fact that the surrounding conditions will necessarily be put into better sanitary condition and will be kept in better sanitary condition. Not only will that benefit the water supply itself, but it will benefit the entire catchment area in which that supply is situated. To put it briefly, it will make the sanitary supervision of the municipal water supply more efficient than is possible at the present time.

District Officers and Laboratories

Such a plan would probably necessitate the establishment of either a district or county health officer, of necessity a full-time man. It might, and probably would, necessitate the establishment of a laboratory centrally located in the district or county. While that would at first seem to put an undue burden of expense on the community, as a matter of fact such a laboratory, designed for examination of water, milk and chemical material, can be made to be nearly, if not quite, self-supporting through private investigations for physicians, investigations not along strictly public health lines. Co-operation in meeting the expense of public health service has worked in other places and it is unreasonable to suppose that it would not work in this state. That the state, county and municipality could not co-operate in obtaining full-time men of ability is unthinkable. That they might not, is at present probable; but if the demand were great enough, it would in all probability be done.

It is only through such a demand that any improvement is possible. Undoubtedly, when it is realized that when proper sanitary conditions obtain in rural districts many of the health problems in urban communities will be materially lessened, that demand will be made. Certainly improved rural sanitation will materially lessen the problems of the city water works manager, both technically and financially, and it would seem reasonable to suppose that the water works engineer should be vitally interested in seeing some such plan established.

Along this same line it appears that the time is fast approaching for other states to follow in the steps of the New Jersey State Board of Health in the licensing of the water works operators and operators of sewage disposal plants. It is unnecessary to give at this time the exact wording of that law. New Jersey grants four grades of licenses, upon examination. The highest grade is that of the superintendent. The superintendent must be familiar with the operation and chemical treatment of water as well as with the chemical and bacteriological analysis of water. The other grades are for operatives and depend entirely upon the amount of knowledge which the man shows in his line of work. Such a law assures the highest efficiency in the operation of these plants and to a large extent assures the operation of the plants by a proved expert. That such efficiency is desirable, will no doubt be unquestioned, and that it will work for the general betterment of sanitary conditions, as related to water supplies, is also obvious.

U. S. ENGINEERS TO DISCUSS FORMATION OF SINGLE NATIONAL ASSOCIATION

DELEGATES from scores of the most prominent national, state and local engineering and allied technical organizations in the United States will meet June 3rd and 4th in Washington, D.C., to form a single association through which united action can be secured in matters of common interest. The meeting has been called by the Joint Conference Committee of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Every organization, whether natural or local, is entitled to one delegate for every thousand members or major fraction thereof. Following are some of the objects which the above-mentioned Joint Conference Committee believe can be attained by such an organization:—

1. To render the maximum of service to the nation through unity of action.
2. To give the engineers of the country a more potent voice in public affairs.
3. To secure greater recognition of the services of the engineer, and to provide for his advancement.
4. To promote *esprit de corps* among the members of the profession.
5. To provide the machinery for prompt and united action on matters affecting the profession, among which are licensing and registration of engineers, National Service Committee, National Department of Public Works, conservation of national resources, publicity, classification and compensation of engineers, general employment bureau, engineering education, international affiliation of engineers and industrial relations.

In calling the meeting for the formation of a new national organization, the members of the Joint Conference Committee, state that they recognize "that there exists in 'Engineering Council' a tool which is engraving an honorable record on the pages of professional history, but its limitations are well known and its poverty is chronic. If desired, 'Engineering Council' can be moulded into this organization by making it more democratic and founding it on direct representation of all engineers, rather than appointment as at present. The great object is to provide an effective body, widely and truly representative, modestly yet adequately financed, which will be neither autocratic nor aristocratic, which will at all times stand as the representative and defender of the profession in matters affecting its honour, welfare and common interest. The mandate for a vehicle to provide for co-operation and solidarity among engineers has been unmistakably expressed by the membership of of the four societies, through their several development committees. In obedience thereto the Joint Conference Committee has constructed a plan for an organization designed to perform this function by providing an opportunity to use the strength of every existing technical organization in the country, but without taking from them any of their present privileges, or in any way interfering with their respective spheres of usefulness."

R. H. Parsons, city engineer of Peterborough, Ont., has returned to that city after a trip to New Orleans and Houston, Tex., where he was sent by the city council to investigate the operation of sewage disposal plants.

At last Thursday's meeting of the Toronto branch of the Engineering Institute of Canada, Dr. W. H. Ellis, formerly dean of the Faculty of Applied Science and Engineering, University of Toronto, was presented with the badge of honorary membership in the institute. Prof. H. E. T. Haultain introduced Dr. Ellis, and paid a tribute to his long and distinguished service in technical education. C. H. Rust, a former chairman of the Toronto branch, and R. O. Wynne-Roberts, who is chairman this year, also spoke. Dr. Ellis in his reply, stated that while he is not an engineer, he has long worked and associated with engineers, and he appreciated greatly the honor that they had bestowed upon him.

PROGRAM FOR ROADS CONVENTION

FOLLOWING is the program for the "Seventh Canadian Good Roads Convention and Exhibition," which will be held June 1st-3rd in the Royal Alexandra Hotel, Winnipeg:—

Tuesday, June 1st

10.30 a.m.—Congress called to order by the president, S. L. Squire.

12 a.m.—Particulars of the demonstration of road work by the Canada Ingot Iron Co., Kelly-Powell, Ltd., and the United Grain Growers, Ltd., will be announced.

2.30 p.m.—"Federal Aid," by C. A. Magrath, chairman of the Highways Commission, Dominion government. Discussion led by E. O. Hathaway, District Engineer, U. S. Bureau of Public Roads, Minneapolis, Minn.

"Gravel Roads," by B. M. Hill, provincial highway engineer, New Brunswick.

"Surface and Subsoil Drainage," by A. Fraser, Highways Department, province of Quebec.

"Road Machinery," by Arthur H. Blanchard, professor of Highway Engineering, University of Michigan.

7.30 p.m.—Annual dinner and entertainment tendered by the city of Winnipeg, complimentary to visitors.

Wednesday, June 2nd

10.00 a.m.—"Roads as an Aid to Agriculture," by T. P. Regan.

"Economical Methods of Transporting Road Materials," by A. P. Sandles, secertary of the National Crushed Stone Association, Columbus, O.

"How to Improve and Maintain Earth, Clay and Sand Roads," by A. R. Hirst, state highway engineer, Wisconsin.

"Broken Stone Roads," by Geo. Hogarth, chief engineer, Ontario Highways Department.

12 a.m.—Annual meeting, Canadian Automobile Association.

2.30 p.m.—"Suggestions for Financing a Provincial Highway System," by A. W. Campbell, Commissioner of Highways, Dominion government.

"Bituminous Treatment of Sand Roads," by Col. W. D. Sohier, ex-chairman, Massachusetts Highways Commission, Boston.

"Road Dragging and Maintenance Competition."

"Organization of Provincial Highways Departments to Obtain and Maintain High Standards of Efficiency," by A. E. Foreman, chief engineer, Public Works Department, province of British Columbia.

8.30 p.m.—Annual general meeting, Canadian Good Roads Association, for election of directors and officers and reception of annual report and financial statement.

Thursday, June 3rd

10.00 a.m.—"School for Highway Engineering," by Brig.-Gen. C. H. Mitchell, dean of the Faculty of Applied Science and Engineering, University of Toronto.

"Highway Bridges and Culverts," by M. A. Lyons, chief engineer, Good Roads Board, province of Manitoba.

"Asphaltic Concrete Pavements," by W. H. Connell, consulting engineer, Philadelphia, Pa.

"Cement Concrete Roads," by W. P. Near, city engineer, St. Catharines, Ont.

12 a.m.—Luncheon and drive.

2.30 p.m.—"The Value of the Local Association in a Nation-Wide Highways Movement," by W. Findlay, business manager, "The Globe," Toronto.

"The Importance of Keeping a Traffic Census," by W. A. McLean, deputy minister of highways, province of Ontario.

"Refined Tar in Construction and Maintenance," by Andrew F. Macallum, commissioner of works, city of Ottawa.

"Road Oils and Carpet Coats," by J. A. Duchastel de Montrouge, city manager, Outremont, Que.

The following moving pictures prepared by the Ontario Highways Department will be shown during the various sessions: Construction of Waterbound Macadam, Earth, Cement Concrete, Asphaltic Concrete and Tar Macadam Roads; Road Construction in Ontario; The Gravel Road. Road models will also be shown.

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PRINCIPAL CONTENTS

LABOR TROUBLE AT QUEENSTON

LAST Saturday evening the laborers on the Queenston-Chippawa power canal met to take a strike vote because the Hydro-Electric Power Commision of Ontario had refused to grant all of their demands for increased wages. Labor leaders and members of the provincial parliament pointed out the urgency of the completion of the Queenston development, and requested the men not to strike. They promised that the provincial government would appoint a commission to investigate the dispute. The men decided to leave the matter in the hands of the provincial government, but despite this decision, about half of the unskilled labor on the job is said to have quit work during the past few days, thus forcing out of employment a large number of skilled workmen.

Statistics compiled by the Hydro-Electric Power Commission show that the wages now asked by the workmen mean an increase of 223% over those paid in 1914, while the cost of living in the same time has advanced 110%. The increase in wages demanded is, therefore, entirely out of proportion to the increase in the cost of living.

The commission states that the wages now asked are as high as $14.70 a day for cableway and dragline operators and other skilled mechanics, $14 a day for pump-runners, $13.20 for blacksmiths on heavy work, and $12 a day for watchmen. The men who are now asking $14.70 a day received $4.80 a day in 1914; those who are asking $13.20, then received $3.50.

Consideration of these figures will cause the reader to ask two questions: First, is labor utterly demented? and, second, Has the Hydro-Electric Power Commission or any other public body any right to pay wages at all approximating these figures? It would appear questionable whether the Hydro-Electric Power Commission has not already paid entirely too high wages. It is high time that the commission called a halt in their work when demands such as these are made by comparatively ignorant laborers.

What appears to be needed at Niagara Falls are a few free soup kitchens and a bread line. The general public, even including many trade unionists, will support the Hydro-Electric Power Commission in a stand against demands such as those above outlined. Ontario needs power, and needs it urgently, but the people will do without the power and make considerable sacrifices rather than be "held up" in this manner by unskilled labor.

The Queenston-Chippawa development is a great undertaking, but it cannot be economically completed upon the basis of $14 or $15 per 8-hour day for labor. Publicity regarding labor conditions at Niagara Falls will serve to reduce the load on the Niagara system until the proposed 50,000 h.p. steam reserve plant is placed in commission, and, if necessary, the completion of the Queenston-Chippawa development can be left until labor gives some evidence of sanity. Street lighting can be reduced; electric heaters, irons, washing machines and other similar appliances can be temporarily stored away; the power requirements of factories can be curtailed or other sources of power used; and economy can be shown in domestic lighting.

BULKING AND SURFACE AREA

EXPERIMENTS described in the article by R. B. Young and W. D. Walcott, published in this issue, have shown that the maximum bulking—or increase in volume resulting from the addition of water—of any sand is, within certain limits, a direct function of the surface area of that sand as determined by the methods used by Llewellyn N. Edwards in his original surface area studies. The limits within which this relation holds are approximately the limits of surface area encountered in commercial concrete sands. This relation between bulking and surface area exists both for sands the particles of which are of uniform size, and for mixtures of sand and gravel.

Since maximum bulking and surface area are related, Messrs. Young and Walcott claim that it is possible to determine the surface area of a sand by determining its maximum bulking, and *vice versa*. They describe and discuss a method of test based on this theory.

Results obtained by using their method are given in their article and indicate that this method of determining surface areas gives, within the limits of grading for which it is applicable, results in close agreement with those obtained for the same sands by the method of mechanical analyses and grain counts.

CONCRETE PROPORTIONING AT QUEENSTON

THE article, "Bulking Measurement of Surface Area," published in this issue, is another of several noteworthy contributions that Roderick B. Young and his assistants have made to the subject of the proportioning of concrete materials. The Hydro-Electric Power Commission of Ontario was the first organization that put Mr. Edwards' surface area ideas and Prof. Abrams' water-cement ratio law into actual practice in the field on construction work of any considerable magnitude. Under Mr. Young's direction the commission's laboratory perfected its own method for making use of both of these ideas in a practical manner. The success that has attended their efforts has been shown in several articles that have appeared in *The Canadian Engineer* during the past twelve months.

As a result of this success, nearly all of the concrete on the great Queenston-Chippawa development will be proportioned by the new methods. The plans for this concrete work include more scientific inspection and a greater amount of testing than has ever before been seen in connection with similar engineering undertakings. The laboratory control will be close and constant, and will be enforced to the letter by the entire engineering staff.

Nearly all of the canal will be lined with concrete, and the layout of the concreting plant and metal formwork, which will cost over $250,000, has been specially arranged with just two points in view: First, speed of concreting; and second, adaptability to the latest ideas in the scientific proportioning of materials.

RURAL WATER SUPPLIES

IN a paper presented to the American Water Works Association and republished in this issue, Dr. E. G. Birge, state epidemiologist of Iowa, makes the claim that the rural water supply is an integral part of the municipal supply, and that the citizens of any community as well as those officials to whom they look for better health conditions, should be as vitally interested in the remote well as they are in their neighbor's sanitary conveniences. Dr. Birge's line of thought is not new, nor does he claim any originality for it, but the the angle from which he discusses the subject may be new to some readers, and will prove interesting even to those to whom it is an old story. There can no longer be any doubt that any campaign looking toward better sanitary conditions must take into account the remote country districts, if we can still call them remote. Under present living conditions, all communities are so closely bound together that a campaign for better health conditions in one corner of a province loses a large share of its effect unless that campaign can be taken up throughout the entire province at the same time.

STANDARDIZATION OF RESEARCH TESTS

RESEARCH tests are difficult to standardize, because research can be made successful only by the use of a great deal of initiative. It is, therefore, possible to standardize research tests only to the extent of standardizing the methods of securing the test data, and even these methods are likely to vary according to the objects of the tests.

One can readily appreciate, therefore, the difficulties experienced by Prof. Slater and his committee on tests of reinforced concrete floors in attempting to standardize such tests. Prof. Slater's report to the American Concrete Institute, which is published in this issue, was prepared by only three members of his committee, and Prof. Slater frankly admits that even these three members do not fully agree with the proposals set forth in his report.

The subject of tests of concrete floors is very comprehensive, and, as Prof. Slater points out, it would be very difficult to develop standards likely to be of value in all cases; nevertheless, the general advice contained in Prof. Slater's report is well worth close study by any engineer who may be called upon to conduct tests of this nature.

PERSONALS

ALEXANDER PEDEN has been appointed engineer in charge of the structural drafting office of the Dominion Bridge Co., Ltd., Lachine, Que.

HOWARD J. MCLEAN, of Calgary, Alta., has been appointed junior hydro-electric engineer, Reclamation Service, Department of the Interior, at Calgary.

F. N. SMAIL, formerly assistant engineer in the provincial highways department, Regina, Sask., has joined the city engineer's staff in Moose Jaw, Sask.

G. J. STEPHENSON, of Paynton, Sask., has been appointed resident architect in the province of Saskatchewan for the Department of Public Works of Canada.

D. C. COLEMAN, vice-president and general manager of western lines, Canadian Pacific Railway Co., has been appointed president of the Kettle Valley Railway, British Columbia.

J. A. DUCHASTEL, city manager of Outremont, Que., has been presented by the Greek government with the Silver Cross of the Savior for services renderd during the war to Greeks in Canada.

J. A. TOM, who has been city engineer of Guelph, Ont., for the past 18 months, has resigned in order to accept a position as resident engineer on the staff of the Ontario Highways Department.

THOS. ADAMS, town planning adviser to the Housing Committee of the Dominion Cabinet, has sailed for England, where he will represent the City Improvement League at the International Conference on Housing.

R. R. BEEBEE, formerly assistant city engineer of Fredericton, N.B., has been re-appointed to that position. Mr. Beebee will assist City Engineer McDowell in the paving work that is being planned for this summer.

WILLIAM J. GRANT has been appointed assistant superintendent of the Department of Highways, province of Saskatchewan. As district superintendent, Mr. Grant has been in charge of the department's work in the vicinity of Saskatoon.

W. S. LEA, consulting engineer, Montreal, and J. A. DUCHASTEL, city manager of Outremont, Que., have been appointed consulting engineers to the Quebec Public Utilities Commission "at a remuneration to be approved by the commission."

L. A. ST. MARIE and ERNEST DRINKWATER have been appointed resident water works engineers for the South Shore municipalities (St. Lambert, Montreal South, Longueuil, etc.), by the Quebec Public Utilities Commission, at a remuneration "to be fixed by an intermunicipal committee."

W. A. SIBBETT, of Bracebridge, Ont., has returned to Canada from Barranquilla, Colombia, where he was engaged for six months on a survey of the harbor for the national government. Mr. Sibbett has now undertaken some survey work along the northern shore of Lake Superior for the Algoma Steel Corporation, of Sault Ste. Marie, Ont.

G. C. MCKAY, engineer on the staff of the Public Works Department of Canada, who has been in charge of the department's office in Merritt, B.C., has been promoted to the position of district engineer for the Cariboo-Lillooet district, with headquarters in Quesnel. G. B. Whitehead, district engineer of Kamloops, will temporarily have charge of the office at Merritt, pending the appointment of a successor to Mr. McKay.

W. J. STEWART, consulting engineer of the Department of External Affairs of Canada, has been appointed by the Dominion government as its representative on the International Committee of Inquiry which is meeting in Paris to draft general conventions on freedom of transit, international ports and international railways in order to facilitate the work of the League of Nations in regard to transportation problems. The British Empire has two representatives on this committee, of which Mr. Stewart is one. Mr. Stewart is now in Paris, studying the vast amount of data which must be considered in the work of the committee.

OBITUARY

HON. R. B. GLENN, one of the three members of the United States section of the International Joint Commission, was found dead in bed in the Royal Alexandra Hotel, Winnipeg, last Sunday night. All members of the commission were in Winnipeg to attend a hearing in the St. Lawrence navigation and power investigation. Mr. Glenn was formerly governor of North Carolina. He was born August 11th, 1854, in North Carolina, and graduated from the University of Virginia, where he and Woodrow Wilson were class-mates. Mr. Glenn was a lawyer, and at various times occupied the positions of state solicitor, United States district attorney and state senator. He was elected governor of North Carolina in 1904, and received his appointment on the International Joint Commission in 1913.

CONSTRUCTION NEWS SECTION

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

ADDITIONAL TENDERS PENDING

Not Including Those Reported in This Issue

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

PLACE OF WORK	TENDERS CLOSE	ISSUE OF	PAGE
Albert, Man., grading	May 24.	May 13.	474
Albert, Man., road-making machinery	May 24.	May 13.	474
Charlottetown, P.E.I., supply of cement, sand, gravel or broken stone, reinforcing steel and tile pipe	May 31.	May 13.	58
Courtenay, B.C., construction of water works system	June 10.	May 13.	50
East Whitby Tp., Ont., work on highway	May 22.	May 6.	58
Edwardsburg Tp., Ont., road work	May 31.	May 13.	54
Ellice R.M., Man., grading	May 29.	May 13.	474
Gleichen, Alta., erection of cottages and stables	May 31.	May 13.	52
Harrington Tp., Que., bridge construction	May 31.	Apr. 15.	49
Kingsville, Ont., construction of sewers and pavements	May 31.	May 13.	474
Lasalle, Que., construction of pavements	May 21.	May 13.	474
Leamington, Ont., labor and materials for erection of school	May 21.	May 6.	54
Newmarket, Ont., construction of sewage disposal plant and trunk sewers	May 25.	May 13.	58
Newmarket, Ont., installation of heating system, power-house and radial brick chimney, and electric wiring, York County Industrial Home	June 4.	May 13.	58
Portage la Prairie, Man., road grading	May 24.	Apr. 22.	48
St. Andrews, Man., grading and brushing of roads	June 5.	May 13.	49
St. Lambert, Que., construction of pavement	May 31.	May 13.	49
Stuart Lake, B.C., erection of school	May 25.	May 6.	56
Swan River, Man., grading roads	May 22.	May 6.	456
Sydney Mines, N.S., erection of school	May 24.	May 13.	54
Wallace R.M., Man., material and labor for construction of concrete culverts	May 21.	May 6.	54
Weedon, Que., construction of concrete dam and power-house	May 25.	May 13.	50
Welland, Ont., construction of roads	June 1.	May 13.	50
Whitby, Ont., culverts	May 31.	May 13.	58
Winnipeg, Man., water meter	May 21.	May 13.	50

BRIDGES, ROADS AND STREETS

Ancaster Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, until 12 o'clock noon on Monday, June 14th, 1920, for the construction of a concrete pavement, etc. (See official advertisement in this issue.)

Bedford Tp., Que.—Tenders will shortly be called by the township council for the building of the Philipsburg Rd., Dutch St. Rd. and the road to Farnham. Mayor, A. J. Bouchard, Bedford, Que.

Beinfait, Sask.—Tenders for roadwork, addressed to A. J. Milligan, Secretary-treasurer, Beinfait, Sask., will be received until 12 o'clock noon, May 24th, 1920, Work consists of approximately 22,000 cubic yards grading, 20 miles turnpike, 500 feet of pipe (hauling and placing). Plans and specifications may be seen at the office of the Parsons Engineering Co., Regina, and at the office of the Secretary-treasurer.

Brantford, Ont.—Contract let to Johnson Bros., of this city, for the construction of three miles of permanent roadway on the provincial route between Brantford and Cainsville-Hamilton Rd.

Cedar Rapids, Que.—It is announced that the Cedar Rapids Manufacturing and Power Co. is applying to the Minister of Public Works, at Ottawa, for permission to build a wing dam in the St. Lawrence River at Cedar Rapids.

Charlottenburg Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, until twelve o'clock noon on Wednesday, June 9th, 1920, for crushed stone. (See official advertisement in this issue.)

Charlottetown, P.E.I.—Tenders for grading and concrete structures will be received by L. B. McMillan, Secretary, Department of Public Works, until noon on Monday, June 7th, 1920. (See official advertisement in this issue.)

Chatham, Ont.—Tenders will be received by L. A. Pardo, County Roads Superintendent, Chatham, Ont., up till six o'clock p.m. on Friday, May 21st, 1920, for the construction of eight reinforced concrete culverts. Plans and specifications may be seen at the office of W. G. McGeorge, C.E., Chatham, Ont.

East Gwillimbury Tp., Ont.—Tenders will be received by W. A. McLean, Deputy Minister of Provincial Highways, Toronto, until twelve o'clock noon on Friday, June 11th, 1920, for the construction of a bituminous pavement. (See official advertisement in this issue.)

Edmonton, Alta.—Provincial government plans construction of 50 miles of highways through the Rockies this year.

Esquimalt, B.C.—The Gorge Bridge will be repaired immediately. Clerk, G. H. Pullen.

Farnham East, Que.—Tenders will be received by J. W. Peloir, Secretary-treasurer, Adamsville, Que., up to Tuesday, June 3rd, 1920, for the construction of a concrete bridge in the municipality of the district of Farnham East.

Fredericton, N.B.—Tenders will shortly be called by the Canadian National Rly. for the erection of new bridge across the St. John River.

Fredericton, N.B.—Tenders are being called by the Provincial Department of Public Works for rebuilding the Godin Dam bridge over the Pokemouche River, Gloucester county, and the Lockes Mouth bridge, parish of Lepreau, Charlotte county. Minister of Public Works, Hon. Peter J. Veniot.

Hamilton, Ont.—Tenders for the building of a concrete bridge on Barton St. will be received up to 12 oclock, May 20th, 1920, addressed to T. J. Mahoney, chairman of the Suburban Area Commission, Court House. Plans and specifications may be seen at the office of J. F. Vance, County Clerk, Court House, Hamilton.

Hamilton, Ont.—Wentworth county council appropriated $60,000 for roadwork this year, $40,000 for construction and