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 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.

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

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.