areas is necessary. It is apparent that it is impossible to determine exactly the true surface area of the aggregate particles because of their irregularity and the uneven condition of their surfaces. However, it is not necessary to know the true surface area, for if a value can be determined for each case which has a constant relation to the true surface area, it is equally useful.

In the work of the Hydro-Electric Power Commission, the method employed to obtain this surface area variable is the same as that used by Mr. Edwards in his original investigations of the surface area method of proportioning. The aggregate is separated by means of testing sieves into its component sizes, and the number of particles per unit weight of each size obtained by count. The assumption is made that these particles are spheres. It is then possible from these counts and the specific gravity of the material to calculate for each size of separation the surface area of the average particle, and hence the total surface area in a pound of particles. This information is tabulated as in Table 1, or put into the form of charts (see Figs. 1 and 2).

In calculating the surface area of a particular aggregate, it is necessary to sieve it into the same sizes of separation as those used in obtaining the above data. While usually in reporting such a mechanical analysis, the percentages either passing or retained on each sieve are given, for this work the percentages lying between the adjacent sieves are

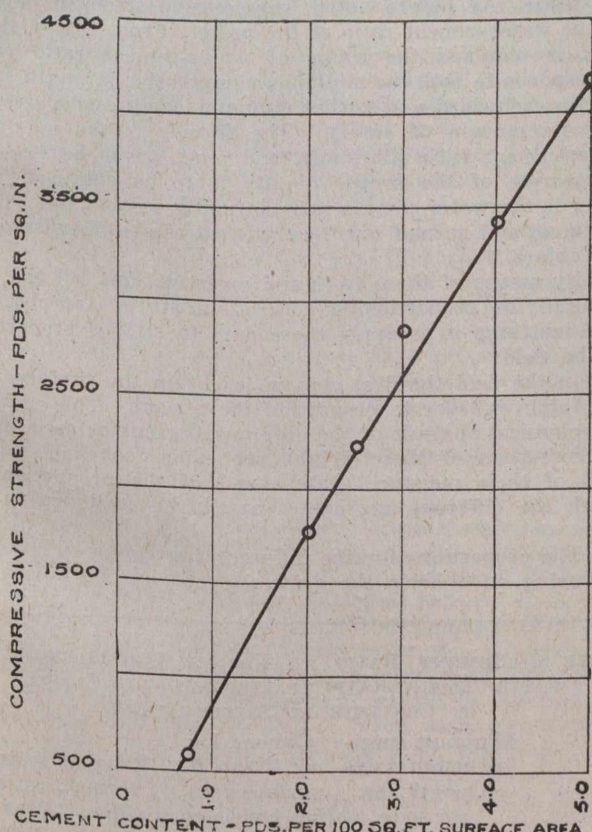

FIG. 3—RELATION BETWEEN COMPRESSIVE STRENGTH AND CEMENT CONTENT AT NORMAL CONSISTENCY

required. These percentages are translated as so many pounds of each size of material in 100 lbs. of aggregate. The surface area corresponding to the weight of each size is read from the surface area charts or calculated from the tabulated data. The sum of the different values thus obtained is the surface area per 100 lbs. of aggregate. This may be changed by simple calculation into the surface area per cubic foot or other unit as found desirable.

Our experience has shown that the finer portion of the aggregate, the silt or dust, must be treated differently than the coarser portion. This finer material is more comparable to the cement than to the aggregate. Investigations now under way indicate that it would be more correct to consider this dust as a dilutent or extender of the cement, and that where this dust does not exceed a few per cent. of the total aggregate, this could be done without affecting the strength of the mixtures. At the present time it is our practice to ignore entirely that portion of an aggregate finer than the No. 150 sieve. Our choice of this sieve is purely arbitrary, and it may be that the dividing point between dust and aggregate should be elsewhere. This method has, however, given good results. With fine aggregates the silt

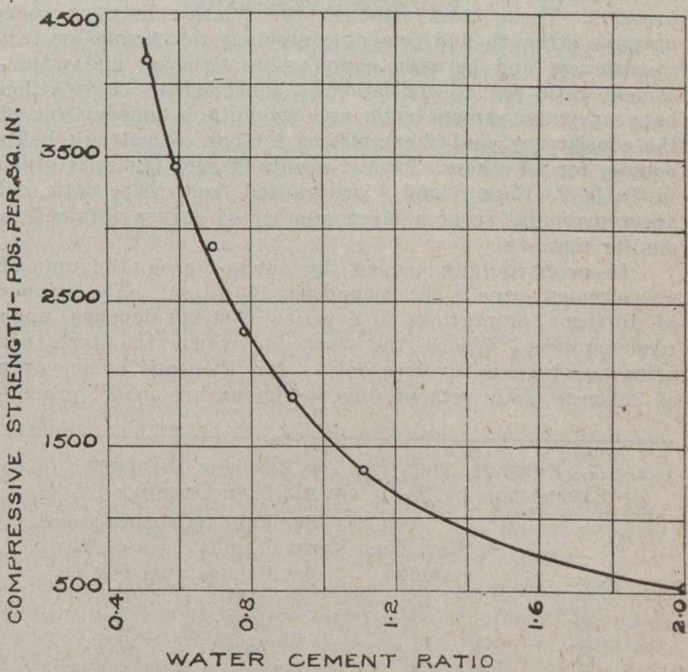

FIG. 4—RELATION BETWEEN COMPRESSIVE STRENGTH AND WATER-CEMENT RATIO

content of which is 5% and under, the above practice of ignoring the dust will be found satisfactory.

This brings us to the practical application of the foregoing and the system of judging and proportioning concrete aggregates based thereon now in use by the Hydro-Electric Power Commission of Ontario.

When a piece of construction involving concrete is contemplated, a combined field and laboratory investigation is first made to determine the most suitable and economical sources of supply for the necessary aggregates. The extent of this investigation depends on circumstances, but usually it consists of reports on deposits, samples from these deposits and field and laboratory tests of these samples to determine their quality. This work is undertaken as far as possible in advance of actual construction.

Once the source from which the aggregate is to be taken has been determined, a quantity of the material, usually from 3,000 to 5,000 lbs., is shipped to the laboratory for detailed investigations into its concrete-making properties. The first study undertaken is to determine the mechanical analysis of the combined fine and coarse aggregate which will give the most economical mixture, workability and economy of materials being balanced. The most economical mixture is one containing the lowest surface area per cubic foot of material which can be successfully handled and placed. These studies are checked in the laboratory by making concrete mixtures of different gradings and observing their mobility and flowing properties. However, the quantities of concrete handled in the laboratory are too small to allow of their exhibiting the same characteristics as do large masses of concrete, and the final determinations as to what is a workable mix must be made in the field.

Coincident with the laboratory work, the necessary grain counts and calculations are made to obtain the surface area per pound of each size of these materials, and these results are charted.