New proportions for the 55, 75 and 95-per-cent. mixtures were computed in the same way.

This theory is approximate, not rigorous, for when the concrete is actually made, the density d will be affected a small amount. The result obtained, however, is within the probable range of accuracy in making the concrete.

The proportions thus derived are by absolute volumes. To make these proportions usable it is necessary to convert them to a loose volume basis, which requires the weight per

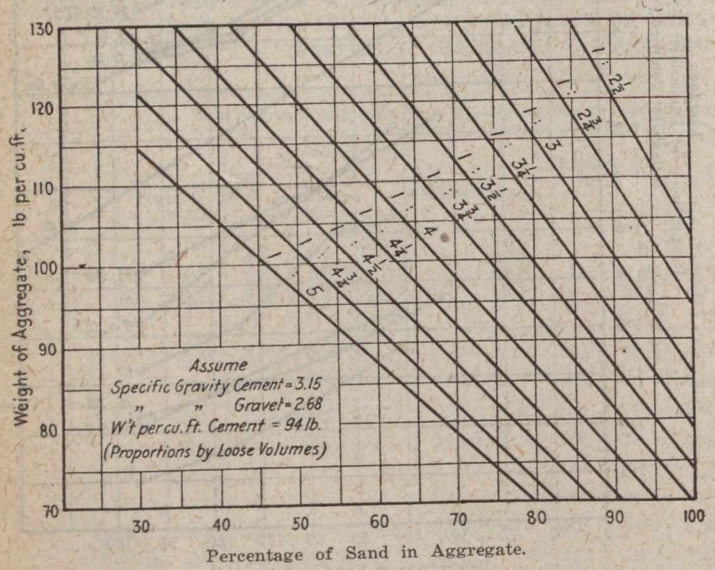

FIG. 4—DIAGRAM FOR USE IN PROPORTIONING PIT-RUN GRAVEL FOR CLASS I. CONCRETE

cubic foot of cement and loose aggregate. Assuming cement to weigh 94 lbs. per cu. ft., its specific gravity = 3.14, and that of the aggregate = 2.68, absolute volume proportion of aggregate (cement = 1) may be changed to loose volume proportion by the following equation: Aggregate (loose) equals aggregate (absolute) multiplied by 80 and divided by the weight per cu. ft. of aggregate (loose).

In this way the absolute proportions and loose volume proportions of materials to yield concrete equivalent in strength to the one in each series whose aggregate contained 42 per cent. of sand, was determined for aggregates containing 33, 55, 75 and 95 per cent. of sand.

In Fig. 2 the relation between the proportions for equivalent strength by absolute volume and percentage of

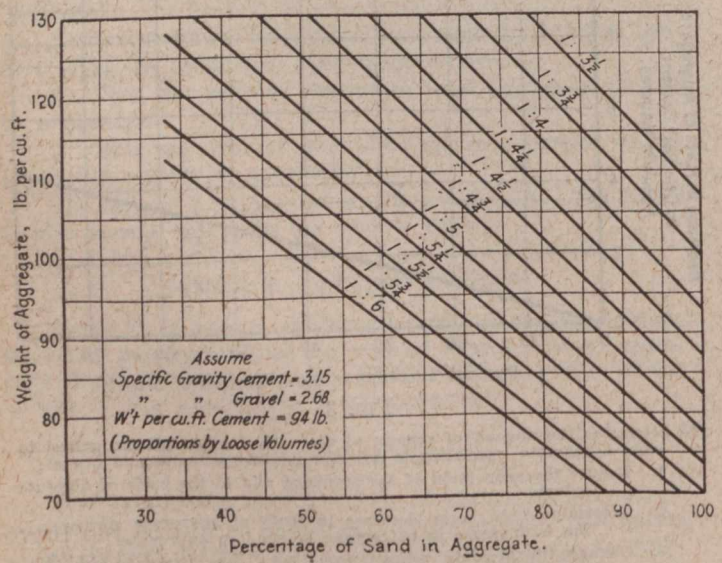

FIG. 5—DIAGRAM FOR USE IN PROPORTIONING PIT-RUN GRAVEL FOR CLASS II. CONCRETE

sand in aggregate is shown for all of the specimens tested. Each line is the average of results from 3 or 4 different sands, and, therefore, represents the conclusion drawn from 3 or 4 series of tests. Each point is the average of from 75 to 100 individual specimens.

The conclusion drawn from a study of this diagram is this: The relation between proportions by absolute volumes to give equivalent strength, and sand content of the aggregate, varies uniformly and at approximately the same rate for all degrees of quality of concrete. The line AB in the diagram is established to indicate this rate of variation as an average.

To make use of this diagram to determine the proportions to use with a given material having a certain sand content, it is necessary first to assume an aggregate and proportion known to be satisfactory. Locate the point representing this known condition and draw a line through it parallel to AB. Then pick from this line of proportions the proportion corresponding to the given aggregate.

To make a single line diagram of general application, the line AB (Fig. 2) is plotted on Fig. 3, using for ordinates the decrease in parts of aggregate, and for abscissas the increase in percentage of sand in the aggregate. This diagram can be used for determining proportions in a case when the proper data are at hand, or for writing a table of proportions for equivalent mixtures of cement and pit-run gravels in general. Such a table could not be exact for all materials, but it would give a very reasonable set of proportions to use with Iowa gravels.

Example: Assume that an aggregate containing 42 per cent. of sand, and weighing 112 lbs. per cu. ft., makes a satisfactory concrete in the proportion 1:4½ loose volume.

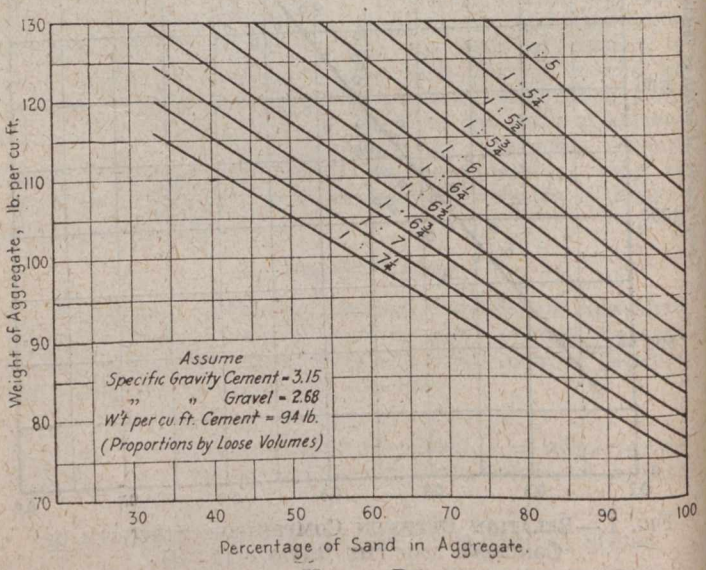

FIG. 6—DIAGRAM FOR USE IN PROPORTIONING PIT-RUN GRAVEL FOR CLASS III. CONCRETE

What proportion should be used with a similar gravel containing 75 per cent. of sand and weighing 107.1 lb. per cu. ft?

Change the proportion 1:4½ to a proportion by absolute volume, thus:—

$4.5 \times 112/80 = 6.3$. Proportion (absolute) = 1: 6.3.

The increase in percentage of sand is 33. From Fig. 3 the corresponding decrease in parts of aggregate is 1.9. 6.3 − 1.9 = 4.4. Therefore, the proportion for the aggregate containing 75 per cent. sand should be 1: 4.4, absolute volumes, or 1: 3.3 loose volumes.

Fig. 3 is perfectly general and can be used for designing mixtures equivalent to any assumed base.

The diagrams in Figs 4, 5 and 6 have been arranged for convenience in proportioning pit-run gravels for three classes of concrete:—

Class I., suitable for reinforced concrete in general, water-tight concrete, and base course of concrete pavement. It should range in strength from 2,400 to 3,000 lbs. per sq. in.