COMMENTARY ON REPORT NO. 9

Density of Sediments Deposited in Reservoirs

By Lane and Koelzer

1. The terms "density" and "unit weight" are used interchangeably throughout the report for the dry weight per unit volume of sediment in place. Specific weight might be a better term to use.

   Except for the silt and clay of Table 10, the data can be considered as specific weight when given in weight per cu ft in the report.

2. Apparently percent by volume and by weight were used interchangeably in that percentages shown are generally by weight and are used in computations as percentages by volume.

3. On page 50, percentages of sand, silt, and clay are given as 20, 40, and 40. These seem to be percentages by weight because the separate percentages by volume could not be obtained for a mixed sample and percentages by volume change with time of consolidation of the sediment.

4. If the data of Table 10 is in "density" or "unit weight", the illustration on page 50 is mathematically incorrect for it uses percentages by weight as percentages by volume. For sediment always submerged, the Lane and Koelzer method shows 74.0 lbs/cu ft after 100 years, and 56.6 lbs/cu ft after 1 year of consolidation.

   Correct computation of the volume for 20 lbs sand, 40 lbs silt, and 40 lbs clay at the end of 100 years would be:

   $20/93 + 40/76.4 + 40/62.0 = 1.383$ cu ft.

   Then $100/1.383 = 72.3$ lbs/cu ft for the specific weight. At the end of 1 year the specific weight would be 46.2 lbs/cu ft.

5. Because of its derivation, the 93 lbs/cu ft for sand in Table 10 is in specific weight and the usage in the illustration on page 50 is incorrect.

6. For silts and clays the derivation of the "densities" in Table 10 is somewhat obscure. If they were derived from samples composed predominantly of the size in question the "densities" are essentially specific weights and they may be used with volume percentages (or weight percentages converted to volume). Then the report is essentially correct except for the illustration on page 50 and the ambiguous terminology.

7. Concerning the derivation of Table 10 the report states, "The data were not of a nature which would permit a rigid mathematical solution of the problem, and the values given were rather derived by a cut and try synthesizing process starting with sand at 93 lbs per cu ft as derived independently on Figs. 1 and 2 and obtaining values for the other materials which best agreed with the available data and among themselves."

Suppose a sample with a specific weight of 60 lbs per cu ft has been deposited for 1 year under complete submergence and the sample consists of 30, 40, and 30 percent by weight of sand, silt, and clay. Proper application of a cut and try mathod to 1 cu ft of sediment would be:

18, 24, and 18 lbs are the weights of sand, silt, and clay, respectively.

1.00 - (18/93 + 24/65) = 0.437 cu ft volume of clay, assuming the weight of silt is 65 lbs/cu ft.

18/0.437 = 41.2 lbs/cu ft or the specific weight of the clay.

The Lane and Koelzer approach would be:

60 - (0.30x93 + 0.40x65) = 6.1 lbs of clay.

6.1/0.30 = 20.3 lbs/cu ft.

The Lane and Koelzer method determines lower specific weights for silt and clay in a given sample. Also starting from given specific weights for sand, silt, and clay they would compute too high a weight per cu ft of sediment mixture; or starting from their lower specific weights for the size fractions they would come back to the proper weight per cu ft for an original sample from which the specific weights of the fractions was derived.

If a sample actually possessed the Table 10 specific weights and the 30, 40, 30 percentages by weight of sand, silt, and clay, the weight per cu ft would be:

100/(30/93 + 40/65 + 30/30) = 51.6 lbs/cu ft.

But synthesizing using weight percentages as volumes would show

30x93 + 40x65 = 53.9 lbs of sand and silt in the sample and the weight of the clay would be negative.

8. Table 10 data for silts and clays probably has no definable statistical significance. Presumably the "densities" shown for silt and clay are somewhat too low for use with volume percentages and they may be too high for use of weight percentages as substitutes for volume percentages.

9. So far this discussion has assumed that the use of volume percentages with specific weights is mathematically correct, but that is true only if the sand, silt, and clay maintain their separate fractional identities and do not mix. A mixture of sizes probably has a greater specific weight than that computed for individual fractions of various sizes.

10. The use of weight percentages as multipliers for the "densities" of Table 10 is not mathematically justified. However, such use results in a rational increase in computed weights per cu ft of sediment mixtures over that for separate fractions of each size of sediment.

11. The presentation in Report 9 is not fundamentally sound and probably will not be trustworthy for use in situations that are extreme. For example, the Table 10 data for clay is perhaps not applicable to a sample that is all clay. To avoid confusion, one should keep basic sedimentation concepts clearly in mind when using Report 9.

12. No matter what approach had been used a single specific weight for clay could not be accurate for all conditions. The rapid change in specific weight with size as shown by the data of Table 10 indicates that the specific weight will differ for different clays because of the size range within those clays. Flocculation and other factors also change the specific weight.

13. Therefore Report 9 and Table 10 in particular should be recognized as an empirical approach to a difficult problem, but an approach that has shown merit over the years. The data can be used for engineering estimates under many conditions.

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