A SIMPLE RAPID METHOD OF DETERMINING THE APPARENT DENSITY OF SOIL AGGREGATES

Esther P. Perry

METHODS of measuring accurately the apparent density of soils are rather tedious and time consuming. For routine work it was felt desirable to develop a method that would require only a small amount of the analyst's time. Opportunity to undertake a search for such a method came when the Agricultural Extension Division of the University of California wished to make a study of plow soles, and offered to finance the project. A senior student was thus made available for the actual work in the laboratory.

Probably the simplest way of determining the density of a solid, nonabsorptive body is to suspend it successively in liquids of varying densities and to observe in which liquid it is at equilibrium. Soil aggregates in their natural state do not lend themselves to this treatment, since they are permeable to the immersion liquids. However, a waterproof coating around the blocks would render the soils impermeable and allow them to be immersed without absorbing the liquid. The paraffin immersion method of determining the apparent density suggested a method of waterproofing the lumps of soil, which was tried and which proved satisfactory.

With soils, it is customary to use the water-free weight of soil as the basis for apparent density measurements (oven-dried to constant weight at 100°C to 110°C). The usual procedure is to determine the amount of moisture in the sample and to convert the weight of the aggregate to its equivalent water-free weight. If, however, the apparent density is to be determined by suspending the sample in a liquid of known density, the sample must not contain any water at the time the measurements are made. So this method is applicable only where it is the apparent density of the dry soil aggregate which is desired. In our western area, with its long rainless summers when the soils become hard and dry, the apparent density of the naturally occurring shrunken aggregates does become of great importance. To eliminate the error from the contained water, the following procedure was adopted.

Since natural soil aggregates vary in apparent density from about 1.0 to 2.0, it became necessary to find liquids that covered the same range. After diligent search in chemical tables, it was decided to try zinc chloride solutions for the standard liquids. Zinc chloride has the advantage of being easily curable and of being nonvolatile. It can be used in solutions that cover the entire range needed. In dilute solutions zinc hydroxide is precipitated. This was overcome by the addition of small amounts of hydrochloric acid. The solutions must be kept in tightly closed containers when not in use. Wide-mouthed glass-topped jars were used for the solutions in order to have containers suitable both for storage and for dipping of the soil blocks. The zinc chloride proved to be eminently satisfactory. A saturated solution has a density of 2.0, so a quantity of this strength was made up and dilutions were made, using a hydrometer, to give a series of 10 solutions in order to have containers suitable for storage and for dipping of the soil blocks. A jar of distilled water was added to the set to give a density of 1.0. (As noted above, a small amount of hydrochloric acid was added to the more dilute solutions to prevent the precipitation of hydroxide.)

For comparison, a set of samples was run by the paraffin immersion method and by the zinc chloride method. Since both methods require the samples be dipped in melted paraffin, the blocks of soil could be used for both determinations. When the paraffin-coated blocks are used in the paraffin immersion method they are weighed before and after dipping in the paraffin, and the data are corrected for the weight and density of paraffin. In the zinc chloride method no correction is made for the density of the paraffin, which being 0.9 gives data that are slightly low. Great care must therefore be taken to get as thin a waterproof coating as possible. The samples used varied in diameter between 1 and 2 inches and gave results a little lower than the results obtained by actually weighing the samples in air and in water (regular paraffin immersion method).