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Soil Particle Size by Time-Weight Accumulations of Sedimentation[1]

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ABRIDGMENT

• A FURTHER investigation was conducted at South Dakota State University of the method developed by Oden in 1916 for measuring the amount of material that settles out of a suspension in various time intervals. This method of weighing increments of the sediment for a determination of particle size is more promising now in view of the developments in weighing and automatic recording equipment.

The tests for soil particle size by sedimentation are based on Stokes' law for the velocity of falling particles. This law established the principle that small spherical particles that are allowed to fall freely in a viscous liquid soon reach a velocity where the downward acceleration is balanced by the friction between the particles and the liquid. The velocity of falling particles may be determined from the use of the following equation, known as Stokes' law:

$$V = \frac{2g\,(d - d')\,r^2}{9n} \qquad (1a)$$

or

$$V = \frac{9\,(d - d')\,D^2}{18\,n} \qquad (1b)$$

where

V = velocity of fall,
g = acceleration of gravity,
d = density of falling substance,
d′ = density of fluid medium
n = viscosity of fluid medium,
r = radius of particles, and
D = diameter of particles.

Since the objective is to determine the diameter of falling particles, the equation may be rewritten as follows:

$$D = \sqrt{\frac{18\,nv}{(d - d')\,g}} \qquad (2a)$$

or

$$D = \sqrt{\frac{18\,n}{(d - d')\,g}}\ \sqrt{\frac{H}{T}} \qquad (2b)$$

[1] A copy of the full text of this paper is available from the Highway Research Board at cost of Xerox reproduction and handling—Supplement XS-4 (Highway Research Record 91), 15 pages.

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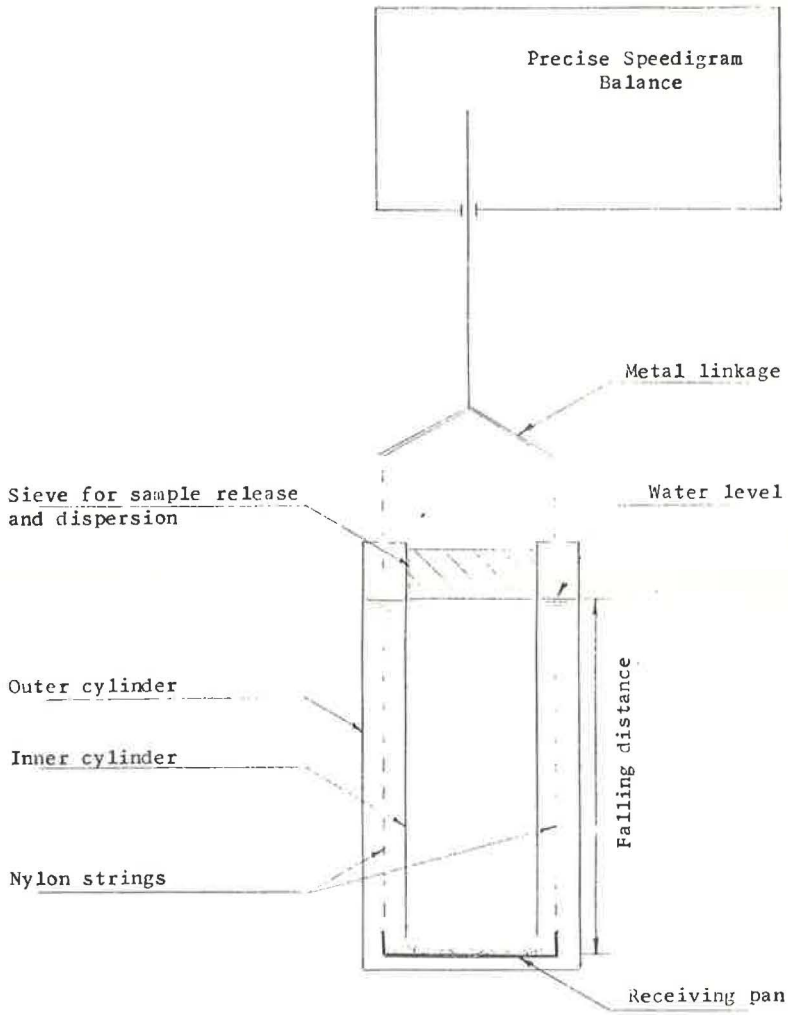

Figure 1. Sedimentation apparatus for time-weight accumulation.

where T is time of fall, and H is height of fall. If the height of fall, viscosity, and densities are held constant the equation may be simplified as follows:

$$D = \frac{K}{\sqrt{T}} \tag{3}$$

where K is a constant:

$$K = \sqrt{\frac{18\,nH}{(d - d')\,g}} \tag{4}$$

The developments in weighing equipment were taken advantage of to determine more accurately the time-weight accumulations of sedimentation. A precise speedigram balance was used for an accurate measurement of the rate of sedimentation. Figure 1 shows a schematic diagram of the testing equipment.

The height H of the free-fall cylinder was 41.90 cm for this testing equipment. This value may be substituted in Eq. 4 for the determination of the value of K. Eq. 3 may be used to determine the diameter of the particle size by dividing K by the square

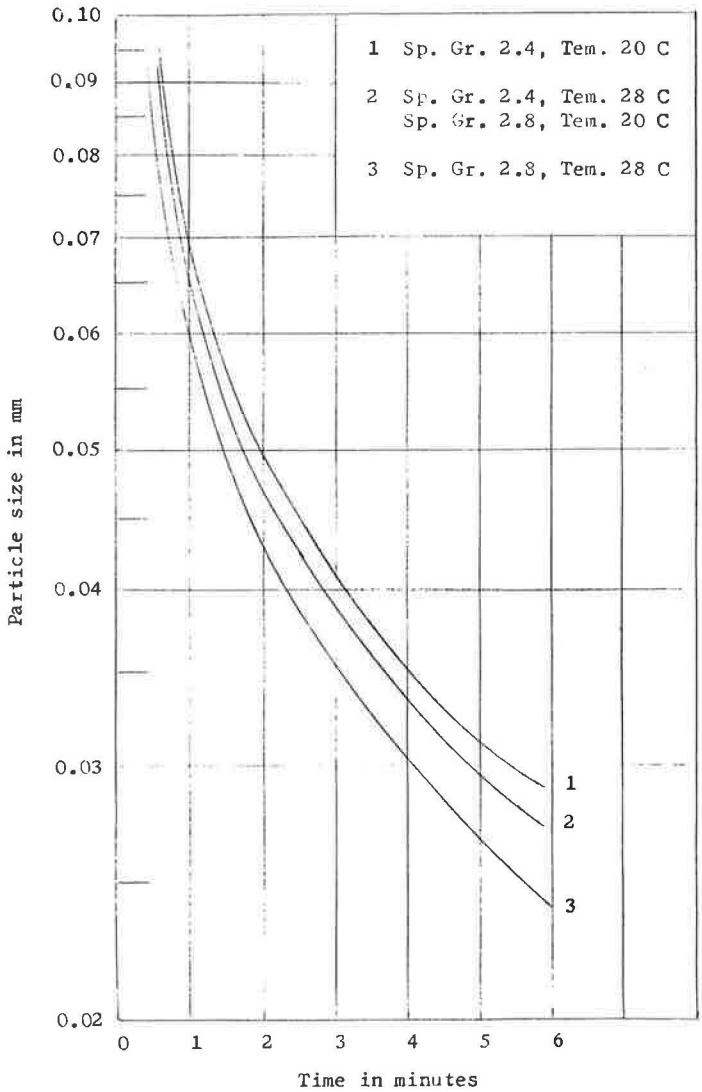

Figure 2. Particle size vs falling time (15 sec to 6 minutes).

root of the free-fall time. Curves may be prepared for the determination of particle size from free-fall time as shown in Figure 2. Gradation curves may be found by determining time intervals of sedimentation for various percentages of the total sample.

Further improvements can be made in the testing procedure by using automatic recording equipment.