Hydrometer Analysis

Analyse par hydromètre

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Summary

To make the hydrometer method more rapid the Geological Division of the Swedish State Road Institute has worked out a time-saving apparatus, nomogram and way of analysis.

If no other preparations of the soil are necessary, except dispersion, one man is able to do ten analyses per day and besides will have time to spare. This is possible because:—

(1) The weighed soil sample will never leave the sedimentation cylinder during analysis.

(2) The soil sample is dispersed in the sedimentation cylinder by a shaker apparatus for ten cylinders (Fig. 1).

(3) The hydrometer readings in the ten cylinders are coordinated.

(4) The hydrometer readings are corrected by aid of a nomogram (Fig. 4).

(5) The grading curve is easily obtained by using a special graphing paper and a nomogram (Figs. 2 and 3).

Sommaire

Pour rendre la méthode hydrométrique plus rapide, la Section Géologique de l'Institut Routier Suédois a mis au point un appareil permettant de gagner du temps, de même qu'un nomogramme et la marche d'analyse correspondant à cet appareil.

Si aucune préparation du sol n'est nécessaire, la dispersion exceptée, un homme seul peut faire dix analyses par jour et avoir encore du temps à sa disposition. Ceci est possible pour les raisons suivantes:

1° L'échantillon de sol pesé ne quitte jamais le tube de sédimentation pendant l'analyse.

2° L'échantillon de sol est dispersé dans le tube de sédimentation par un appareil à secousses aménagé pour dix tubes (Fig. 1).

3° La lecture hydrométrique dans les dix tubes est coordonnée.

4° La lecture hydrométrique est corrigée à l'aide d'un nomogramme (Fig. 4).

5° La courbe graduée est facile à obtenir par l'emploi d'un papier graphique spécial et d'un nomogramme (Figs. 2 et 3).

Apparatus

The apparatus is standardized for ten analyses and consists of an hydrometer graded in gram particles per litre of soil suspension from —2 g/l to 60 g/l, ten sedimentation cylinders of equal length and of equal inner diameter, and a shaker apparatus which is used in order to disperse the suspension in the ten cylinders (Fig. 1).

Particle Size Nomogram (Fig. 4)

This consists of lines of concentrations on a double-log paper (modulus 50), with the particle diameter on the ordinate and the time of sedimentation on the abscissa. The monogram is based on *Stokes*' law, and it is possible to obtain the particle diameters for each value of the hydrometer readings at any time from 0.2 to 2,000 minutes.

When constructing the nomogram the following form of *Stokes*' law is used:—

$$d = \sqrt{\frac{18 \cdot \mu}{(s_1 - s_2) \cdot g}} \cdot \sqrt{\frac{h_R - \frac{V}{2A}}{t}}$$

d = particle diameter

μ = coefficient of viscosity of the suspending medium

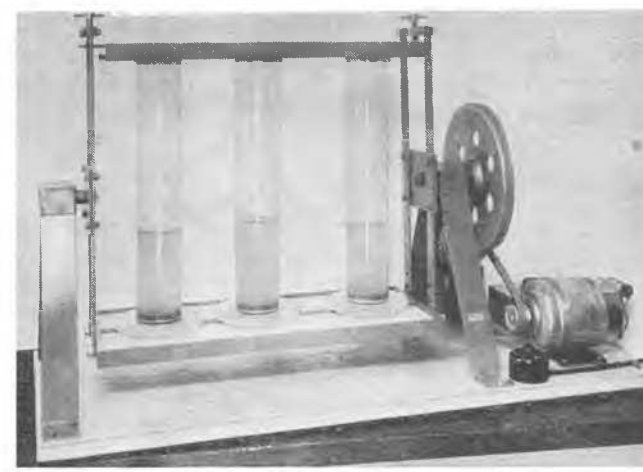

Fig. 1 Shaker Apparatus with three Sedimentation Cylinders
Appareil à secousses avec trois cylindres de sédimentation

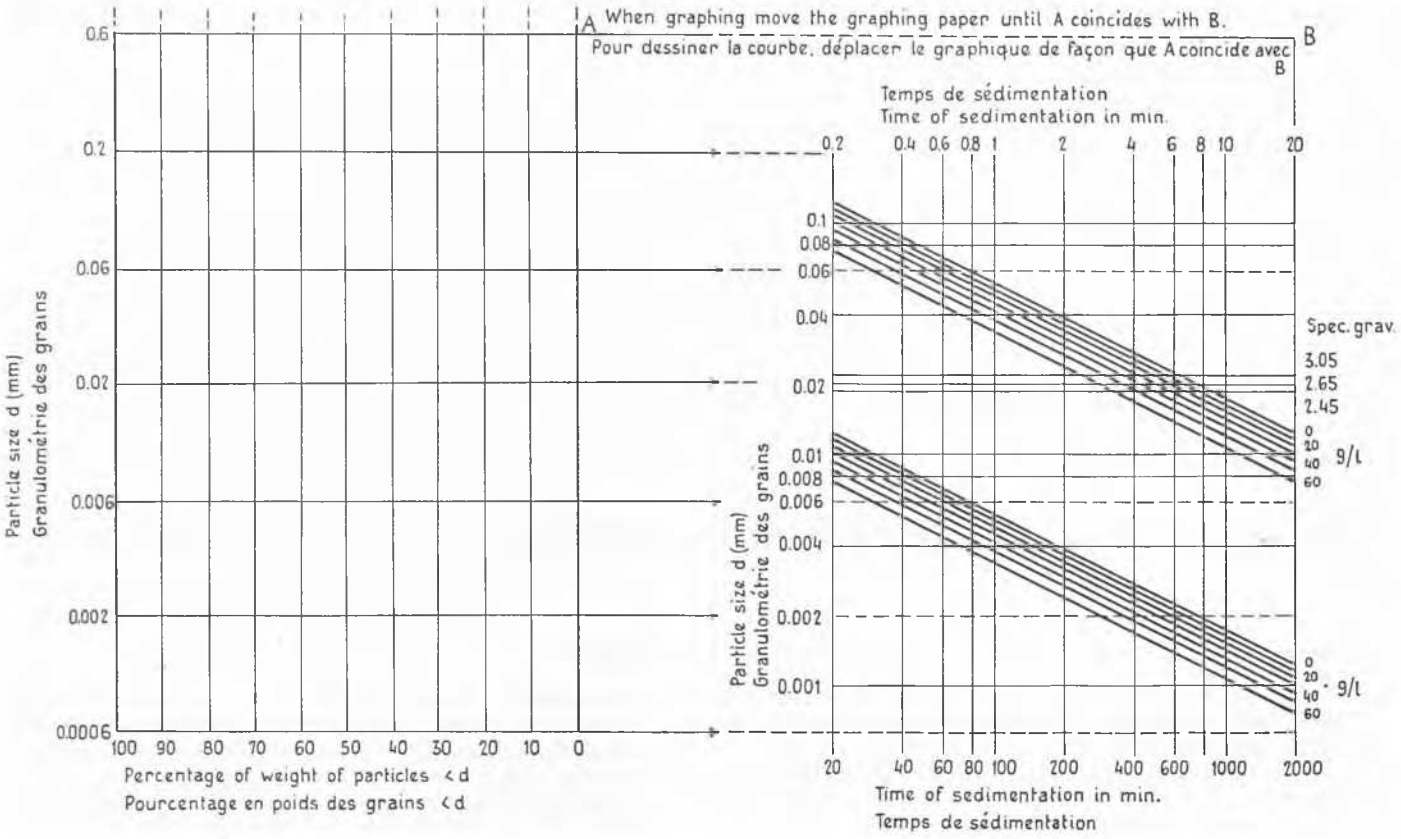

Fig. 2 Graphing Paper
Papier graphique

Fig. 3 Particle Size Nomogram
Nomogramme de granulométrie

s_1 = density of the soil particles
s_2 = density of the suspending medium
g = gravity acceleration
h_R = distance between the surface of the suspension and the volume centre of the hydrometer
V = volume of the hydrometer
A = the cross-sectional area of the sedimentation cylinder
t = time of sedimentation.

The nomogram is constructed for one special hydrometer and sedimentation cylinder.

Graphing

A transparent single-log paper (modulus 50) is being used (Fig. 2). When graphing, this paper is placed over the particle size nomogram in such a way that lines of the same particle sizes coincide on the two papers.

Corrections

Temperature corrections are not necessary if the analysis is being carried out in a room with a constant temperature (20 °C). When the specific gravity of the soil particles diverges from 2.65 the hydrometer readings have to be corrected. The corrections can be obtained by means of a nomogram (Fig. 4), where the corrections are computed for some specific gravities.

With this correction nomogram it is also possible to determine with sufficient accuracy the specific gravity of the soil particles. By weighing a certain amount of soil, i.e. 50 g, dispersing it, and then undertaking a hydrometer reading at the sedimentation time 0, a correction value can be obtained. Thus, if the hydrometer shows i.e. 52 g/l, the correction for this reading is 2 g/l, and the specific gravity 2.85.

Correction of particle size for specific gravity can be made merely by moving the graphing paper a certain distance along the nomogram before plotting. When the specific gravity is 2.65, the lines 0.02 mm—also marked 2.65 on the particle size nomogram—on both the nomogram and the graphing paper

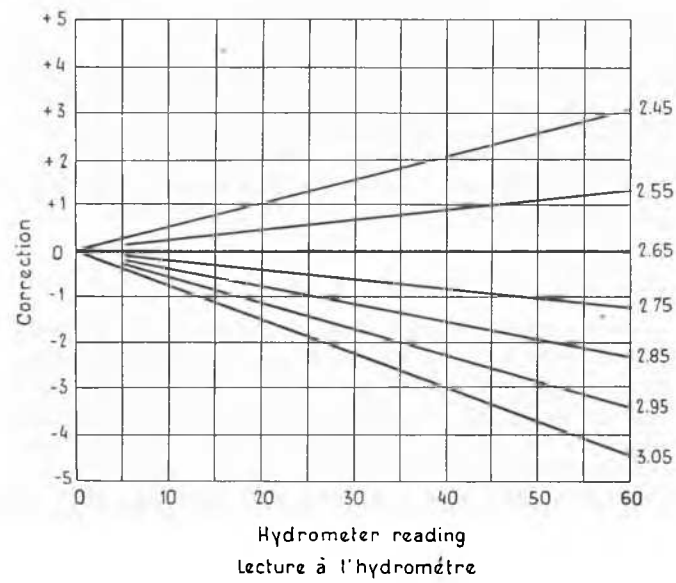

Fig. 4 Correction Nomogram
Nomogramme de correction

coincide. If the specific gravity of the particles is i.e. 3.05, the line 0.02 mm on the graphing paper is brought to coincide with the line marked 3.05 on the nomogram. The distance between the two lines 2.65 and 3.05 is calculated according to *Stokes'* law.

Stages of Analysis

If necessary, the soil has to be purified from salts and humus. Thus we obtain the following stages of analysis:—

(1) 100–25 g dry soil (particles passing sieve 2 mm) is weighed. The amount of soil depends on the content of clay (particles $<$0,002 mm). The soil is placed in the cylinder, which it does not leave during the analysis.

(2) By means of a solution of sodium pyrophosphate (100 ml 0.05-m $Na_4P_2O_7$, 10 H_2O + 300 ml dest. H_2O) the soil is dispersed in the shaker apparatus during 15 minutes. Ten cylinders can be shaked at the same time.

(3) After shaking, the suspension is diluted with dest. H_2O to exact 1,000 ml. The pyrophosfate solution is now 0.005-m.

(4) The suspension is thouroughly stirred with a stirring rod in order to make it homogeneous, and the hydrometer readings can now take place. The readings are undertaken at 1, 2, 5, 10, 20, 50, 100, 200, 400 and 800 to 2,000 minutes' sedimentation. From the 10 minutes' reading, the readings are coordinated. If the stirring in the first cylinder is stopped at 9.00, in the second at 9.01, in the third at 9.02, etc., the first reading in the first cylinder will be at 9.10, the second reading in the second cylinder at 9.11, etc. The readings for 1, 2 and 5 minutes' sedimentation have to be done separately in each cylinder.

(5) After corrections have been made, the grading curve is constructed by means of the particle size nomogram.