SOILS AND FOUNDATIONS Vol. 14, No. 1, Mar. 1974
Japanese Society of Soil Mechanics and Foundation Engineering

CLOSURE

INITIAL FABRICS AND THEIR RELATIONS TO MECHANICAL PROPERTIES OF GRANULAR MATERIAL*

Closure by MASANOBU ODA**

The author wishes to express his appreciation to El-Sohby, Arthur, Dunstan and Menzies for their interesting discussions.

According to the reasonable suggestion by Arthur, Dunstan and Menzies that "research on particle packing will be greatly helped if workers are as precise as possible in describing their sample preparation techniques", the author will describe the sample preparation techniques in more detail.

Tapping method : A cylindrical tube with internal diameter of 5 cm was attached to a split mold (5 cm internal diameter and 10 cm height) as shown in Fig. 14. After the cylinder-split mold assembly was sunk in water, sand which was divided into one to twenty parts was poured in it with a spoon. After each pouring of sand, the side wall of the split mold was tapped to obtain the desired density by a hand tamper with a rubber cover at its top (2 cm in diameter, 25 cm in length and 650 g in weight). The tappings of one to fifty, depending on the the desired density, were applied to rearrange the particle configuration of sand after each pouring of sand.

Test specimens to observe the granular fabric of sand were prepared as follows: Oven-dried sand, which was divided into five parts, was poured into a cylinder (5 cm in internal diameter and 10 cm in height) with a spoon. The side wall was tapped slowly about thirty times after each pouring procedure. It must be noticed that sand particles were settled in air, not in water.

The plunging method : The specimens prepared by this method were used only to observe the granular fabric. Oven-dried sand, which was divided into five parts, was poured into the cylinder with a spoon in air. A hand tamper (0.8 cm in diameter and 18 cm in length) was plunged directly into sand about twenty-five times after each pouring. The penetration of plunger was about 2 to 3 cm in depth at each time.

The specimens with the inclination angle $\varphi=0$ were prepared as follows : The mold shown in Fig. 23 was sunk in water and laid down on the horizontal table. Then, sand was poured slowly into the mold through an opening having a dimension 10×0.5cm. After the mold was filled up by the sand saturated with water, the mold whose opening was closed by a cap was frozen at -27°C.

The most serious problem in preparing the inclined specimens ($\varphi=60°$, 30° and 0°) is non-uniform deposition of sand particles which may easily introduce the non-uniform deformation of sand. In fact, the non-uniform fabric in the inclined specimens was observed, especially at their corners. However, the corner-and/or wall-effects on the granular

* Vol. 12, No. 1, Mar., 1972, pp. 17-36.
** Research Assistant, Department of Foundation Engineering, Faculty of Science and Engineering, Saitama University, Urawa, Saitama.

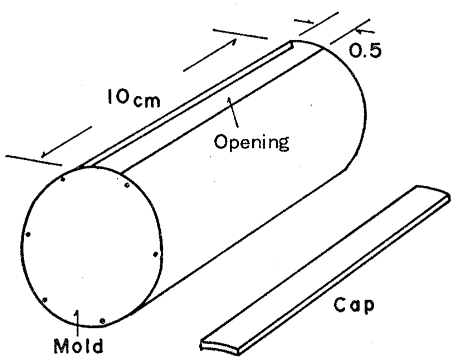

Fig. 23. Mold to prepare the specimens with $\varphi=0$

fabric such as dimensional orientation and void ratio are restricted in relatively narrow zones (Kallstenius and Bergau, 1961). Consequently, even if we neglect the effect of non-uniform fabric and the restraining effect of radial frictional forces at the end plates on the deformation behaviour of sand, it may be regarded that the triaxial tests on these specimens are not affected very much.

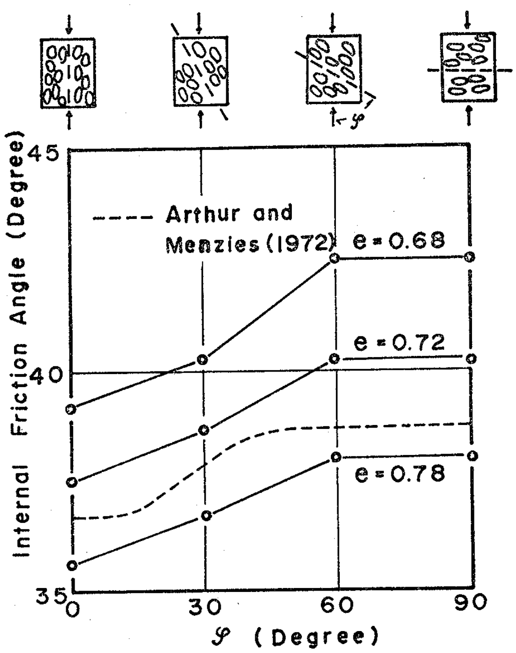

Fig. 24. Variation of internal friction angle with the value of φ for given initial void ratios

The results of fabric analyses (Figs. 15 and 16) show that the sample preparation technique used is adequate to determine the anisotropic behaviours of sand deformed when the maximum principal stress axis is inclined to the vertical direction at various angles. The distributions of $E(\beta)$ for $\varphi=90°$ and $\varphi=0°$ is not mirror images of each other in these figures, because the distribution of N_t shows an axial symmetry with the symmetry axis which is parallel to the vertical.

Arthur and Menzies (1972) have shown the variation of internal friction angle in the drained triaxial test with the angle of tilt $(=\varphi)$, as shown by a broken line in Fig. 24. Solid lines in the same figure show the same variations of sand B for the various void ratios. Solid lines and a broken line show the same tendency ; the decrease of mobilized stress ratio at failure with the decrease of inclination angle of specimens. It is worthy of note, however, that the relation between ϕ and φ depends not only on the shape of grains but also on the manner of their deposition.

The author agrees with the El-Sohby's statement that "as the material becomes loose the decrease in the co-ordination number will be more likely on the expense of the side contacts rather than the under contacts of particles". In fact, there are some evidences to show that the specimens loosely deposited have more anisotropic fabric than the specimens densely compacted by the tapping method. However, this is not always true, because the density of sand assembly and the distribution of N_t are basically independent fabric elements of the assembly. Therefore, we cannot always conclude that the initial fabric becomes more anisotropic with the increase of void ratio. Contrary to El-Sohby's expectation, there is no evidence to consider that the distribution of N_t becomes isotropic when the initial void ratio decreases and the material becomes more dense.

References

11) Kallstenius, T. and Bergau, W. (1961): "Research on the texture of granular masses," Proc. 5th Int. Conf. Soil Mech. Found. Eng., Vol. 1, pp. 165-170.
12) Arthur, J. R. F. and Menzies, B. K. (1972): "Inherent anisotropy in a sand," Geotechnique, Vol. 22, No. 1, pp. 115-128.