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EFFECTS OF AGING AND FINE CONTENT ON UNDRAINED BEHAVIOR OF SAND

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1.- INTRODUCTION

The undrained behavior of sand is largely dependent on the void ratio or relative density, grain size distribution (Castro, 1969), fine content (Troncoso and Verdugo, 1985) and aging (Ishihara, Troncoso and Verdugo, 1988) among other factors. This paper presents a results of an experimental program using triaxial compression test, showing the effect of the above mentioned factors in the undrained response of sand. Sand from Kiyosu area, located near Nagoya city, was used. The samples were taken from an archaeological excavation where evidence of boiling sands were found. According to archaeological studies the liquefaction of this sand likely took place during a big earthquake 400 years ago.

2.- TESTING PROGRAM AND SOIL PROPERTIES

Lubricated ends with silicone grease and two layers of pieces of membranes were used, which gave a good result avoiding non-homogeneities in the deformation of the samples tested. The standard procedure for triaxial test was used. The dimension of the samples were 10 cm in height and 5 cm in diameter. Saturation of the samples were considered enough when the B-value measured before consolidation was greater than 0.95. The void ratio of the samples were calculated after the test, measuring the water content of the samples.

Three different sets of samples from Kiyosu sand were tested:
(k1): Undisturbed samples taken using tubes 15 cm in height and 7.8 cm in diameter.
(k2): Reconstituted samples using the remaining sand after the undisturbed samples were trimmed.
(k3): Reconstituted samples using Kiyosu sand free of fine by washing through #200 mesh.

The grain size distribution for these three sets of samples are shown in Fig.1. The specific density of Kiyosu sand is 2.67.

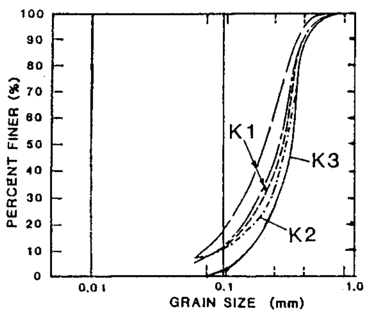

Fig.1. Grain Size Distribution of Kiyosu Sand.

3.- TEST RESULTS AND DISCUSSIONS

Fig.2 shows the stress path for the three undisturbed samples tested at 0.5 , 3.0 and 6.0 Kgf/cm2 of effective confining pressure. It is clear that the response of the soil under small initial confining pressure is dilative. This means that the sand should be stable against a new cyclic loading. It is believed

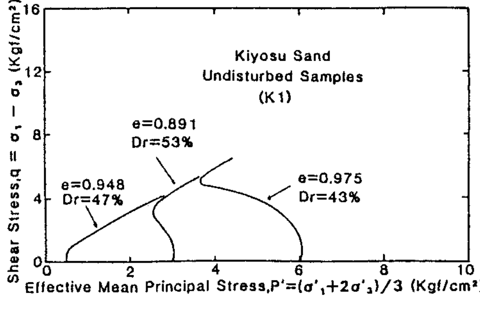

Fig.2. Effective Stress Path, Undisturbed Samples.

that the mass of soils increased its resistance due to aging. This conclusion can be confirmed by the peak stress ratio vs. axial strain curve, for small confining pressure shown in Fig.3. The reconstituted samples do not present any peak, which may indicate the development of certain degree of cementation due to aging in the undisturbed soil.

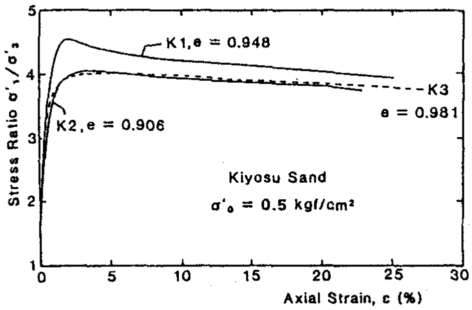

Fig.3. Stress Ratio vs. Axial Strain.

The phase transformation condition defined by the elbow in the effective stress path (Ishihara et. al.,1975) and the ultimate stage or "Steady State" are shown in the p'-q plane in Fig.4. It can be seen that the phase trans. line is a little below to the steady state line. Furthermore both stages in the p'-q plane are practically unaffected by the aging, fine content and void ratio (the range of the void ratio can be seen in fig.5) .

Fig.5 shows the state diagram in terms of void ratio and effective

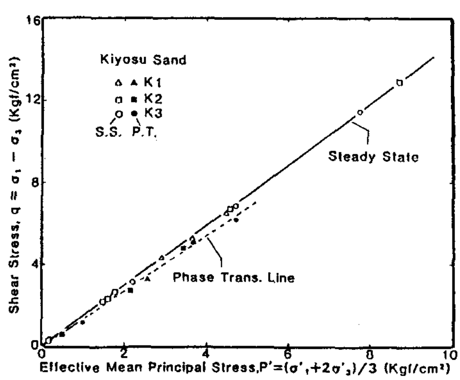

Fig.4. Steady State and Phase Transformation Condition in the p'-q Plane.

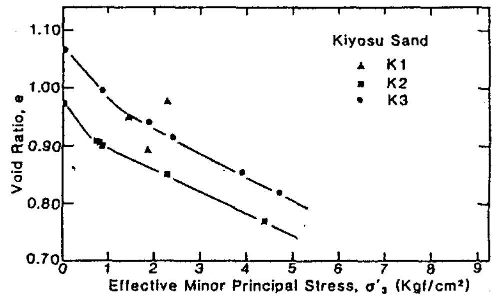

Fig.5. State Diagram for the Steady State Condition.

minor principal stress at the steady state condition for the three sets of tests. For the reconstituted samples in the range of void ratio used, the fine content moves the steady state relationship to the left. This means that for the same void ratio and initial effective confining pressure the clean sand is more dilative (or less contractive) than the silty sand. On the other hand the undisturbed samples do not present a clear pattern. The grain size distribution in the undisturbed samples is not uniform throughout the samples. This original structure can not be erased even at large deformation. This may explain the differences between the sands K1 and K2 showed in fig.5.

5.- REFERENCES

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