III-83 LIQUEFACTION POTENTIALS WITH DIFFERENT ANISOTROPIC SPECIMENS BY DISCRETE ELEMENT MODEL

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INTRODUCTION

The effect of anisotropy of granular materials on various engineering parameters has been recognized as a very important one. A dramatic example of such effect is significantly different liquefaction potentials observed for saturated sand specimens even with same void ratio but with different sample preparation techniques. In this research the authors use a discrete element model "TRUBAL" to numerically create different degree of anisotropic specimens and to evaluate liquefaction potentials of those specimens under cyclic loadings. The result clearly demonstrates the significant effect of the initial anisotropy on the liquefaction potential of granular materials.

NUMERICAL EXPERIMENTS

Loose glass beads assemblies were numerically prepared as shown in Table 1. Five different sample preparation techniques were employed to create different levels of the anisotropy as shown in Table 2. Method 1 (M1) specimen is isotropic and Methods 2 through 5 (M2 to M5) specimens have an anisotropic axis in the vertical direction. The variation of the directional rigidities of each specimen has been discussed previously (Ishibashi and Kiku, 1992). For dry specimens cyclic simple shear tests under constant volume were performed. That is, cyclic uniform shear strains γ_{cyclic} in horizontal-vertical plane were applied to the specimens while keeping the lateral normal stress constant. Under such conditions measured changes in the vertical normal stress is equivalent to the changes in the pore water pressure in saturated specimens. $(\sigma_{vo}-\sigma_v)/\sigma_{vo}$ is defined as the equivalent pore pressure ratio, where σ_{vo} is the initial vertical normal stress and σ_v is the changed vertical normal stress.

TABLE 1. GLASS BEADS ASSEMBLY

Relative Density	38.8 %	
Particle Dia.(mm)	0.215	0.256
No. of Particles	216	216
Weight Ratio	1	1.688
Properties of Glass Material: Shear Modulus = 2.9 x 10^{10} Pa; Poisson's Ratio = 0.2; Contact Friction Coeff. = 0.35		

PORE PRESSURE RATIO AND LIQUEFACTION POTENTIALS

Figs.1 and 2 show a typical cyclic shear stress and strain relation and a stress path in p-q diagram, respectively. Note again that those numerical experiments were conducted under uniform cyclic shear strain applications. Fig. 3 shows the relationship between the equivalent pore water pressure ratio and the number of cyclic strains for different initial anisotropic specimens under γ_{cyclic} = 0.15 %. Fig.4 shows resulted liquefaction potential curves. From those figures it is obvious that the initial anisotropy of the granular materials causes significant effect on the liquefaction potential. Those different behaviors may be related to the difference in sample preparation techniques as previously observed in many literatures though the quantitative correlation was not done this time.

TABLE 2. SAMPLE PREPARATION TECHNIQUES

Method	Stage of Porosity Dense 0.90 0.43 0.367 Loose 0.967 0.473 0.380	Preshearing
M1	isotropic compression → Δe_h-Δe_v	none
M2	isotropic → Δe_h-Δe_v ¦ anisotropic → Δe_h-0	none
M3	isotropic compression → Δe_h-Δe_v	γ_{max}=0.3 % in θ=0 direc. $\sigma_1+\sigma_2+\sigma_3$=60psi
M4	isotropic compression → Δe_h-Δe_v	γ_{max}=0.9 % in θ=0 direc. $\sigma_1+\sigma_2+\sigma_3$=60psi
M5	isotropic compression → Δe_h-Δe_v	6 cycles of Δe_v=0.0024 % and Δe_h = 0

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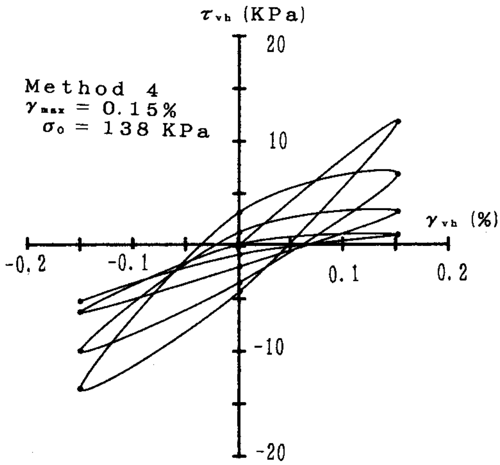

FIG.1 CYCLIC SHEAR STRESS-STRAIN RELATION

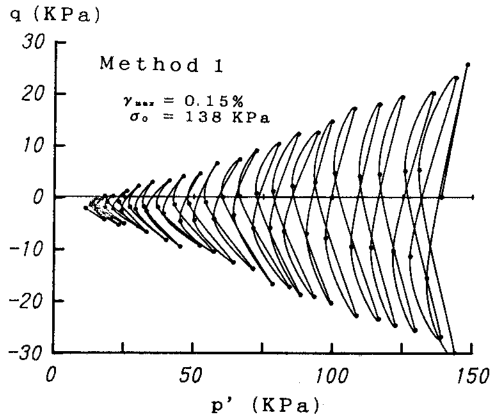

FIG.2 EFFECTIVE STRESS PATH

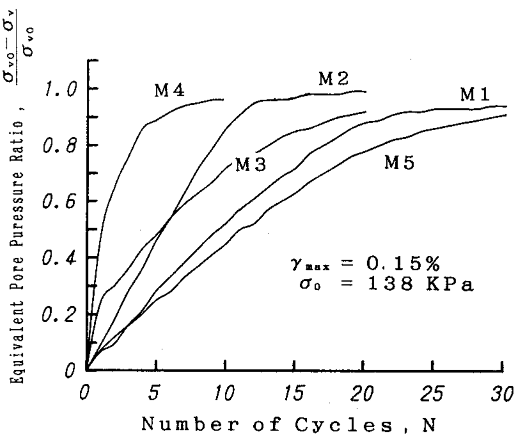

FIG.3 EQUIVALENT PORE PRESSURE RATIO VERSUS NUMBER OF CYCLES

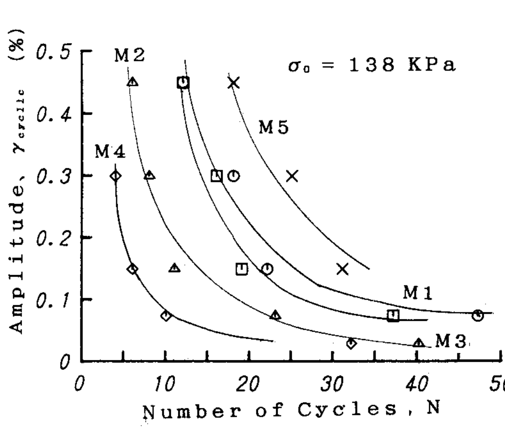

FIG.4 LIQUEFACTION POTENTIAL UNDER UNIFORM CYCLIC SHEAR STRAIN

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REFERENCE

Ishibashi, I. and Kiku, H.,"Change of Directional Rigidity of Anisotropic Granular Materials by Discrete Element Model", Proceedings of the 27th Annual Meeting of Japanese Society of Soil Mechanics and Foundation Engineering, Kohchi, June 1992.