1.10 Cyclic Triaxial Test Liquefaction Resistances of Soils

1. PURPOSE

Evaluating the liquefaction resistances of loose and saturated sandy soils
<cyclic stress ratio ($\Delta\sigma_d / 2\sigma_0'$) vs. number of cycles>

2. PROCEDURE

2.1 Preparation and Set-up of Specimen

Method	Sample
Trimming	Block-like or Frozen
Suction	Non-block and reconstituted

2.2 Back Pressure Saturation

- Check the degree of saturation by measuring B-value

2.3 Consolidation

2.4 Undrained Cyclic Loading

(1) Apply cyclic axial load under undrained condition.
- Typically sinusoidal wave form
- At a constant frequency in the range of 0.1 and 2.0Hz
- Measure the axial load, the axial displacement and the pore water pressure

(2) Terminate cyclic axial loading
- When liquefaction is observed. ($\Delta u = \sigma_c'$)
- Also when applied number of cycles exceeds about 200
  or when the value of $(\Delta L / H_c) \times 100$ becomes larger than 5%
- where ΔL : double amplitude of the axial displacement
  H_c : height of the specimen after consolidation

(3) Repeat (1) - (2) with another amplitude of cyclic axial load.
(we need 4~5 points of liquefaction)

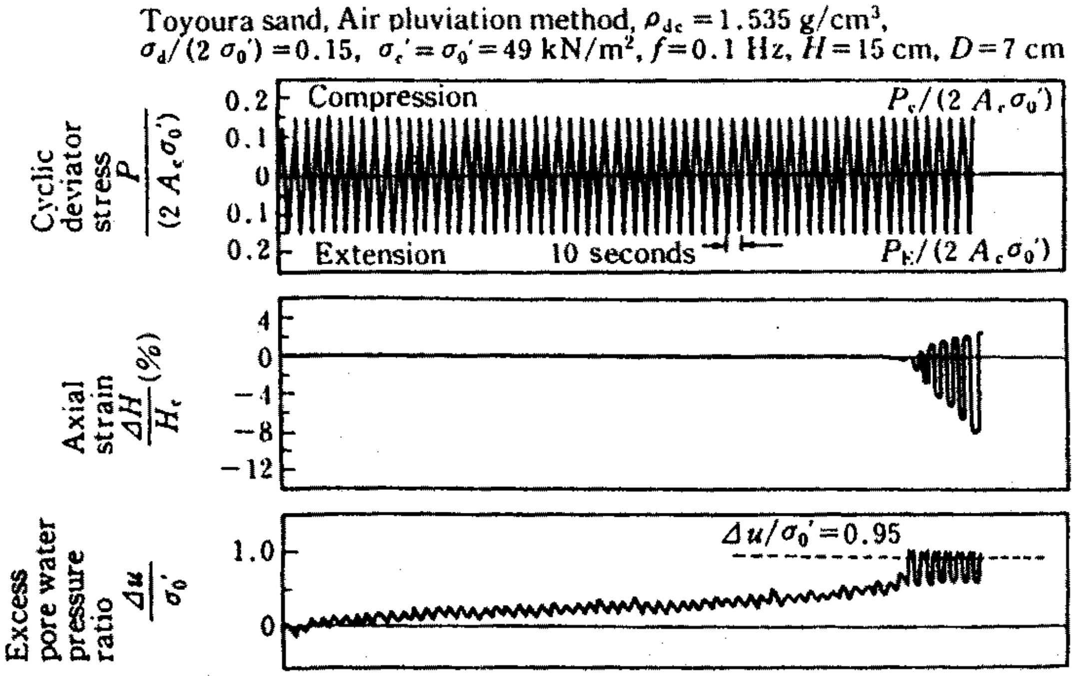


Fig. 1 Typical record of undrained cyclic triaxial test

3. CALCULATION OF TEST RESULTS

3.1 The number of cycles to cause liquefaction

(1) N_{u95}

- The number of cycles to cause excess pore water pressure (Δu) to reach the effective confining stress (σ_c')

$$\frac{\Delta u}{\sigma_c'} = 0.95$$

(2) N_c

- The number of cycles to cause the double amplitude of axial strain, *DA*, of 1, 2 and 5%

$$DA = \frac{\Delta L}{H_c} \times 100(\%)$$

3.2 Cyclic stress ratio (CSR)

- The stress ratio to cause liquefaction at the number of cycles N_{u95} or N_c

$$\text{CSR} = \frac{\sigma_d}{2\sigma_c'}$$

- Represent the ratio of shear stress ($\sigma_d / 2$) to normal stress(σ_c') on the plane X-X (Fig. 2)

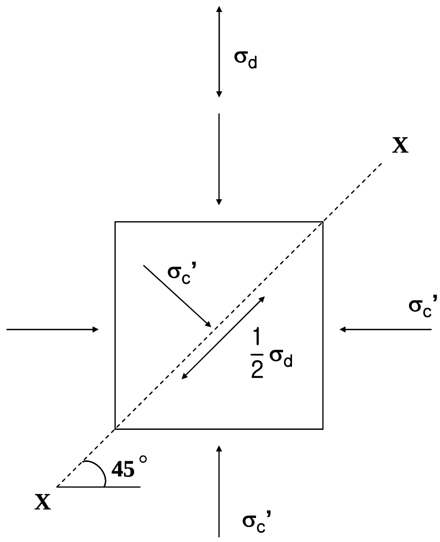


Fig. 2 Cyclic stress ratio

3.3 Liquefaction resistance

- Plot the relationship between cyclic stress ratio and the number of cycles

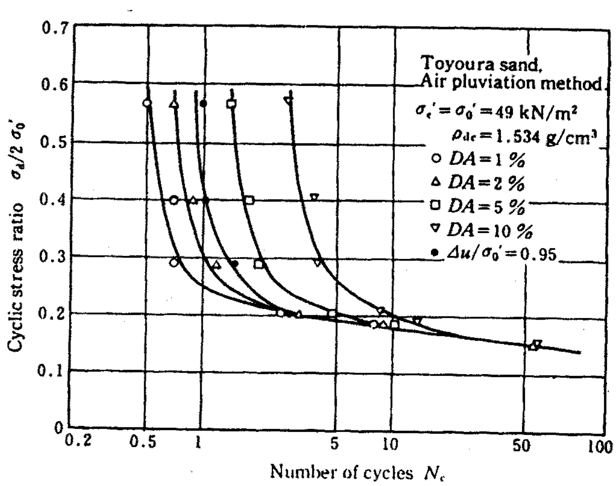


Fig. 3 Typical curve for liquefaction resistance

4. NOTES

(1) To consider the probable stress conditions during dynamic loading at field, excess pore water pressure should be corrected, as follows:

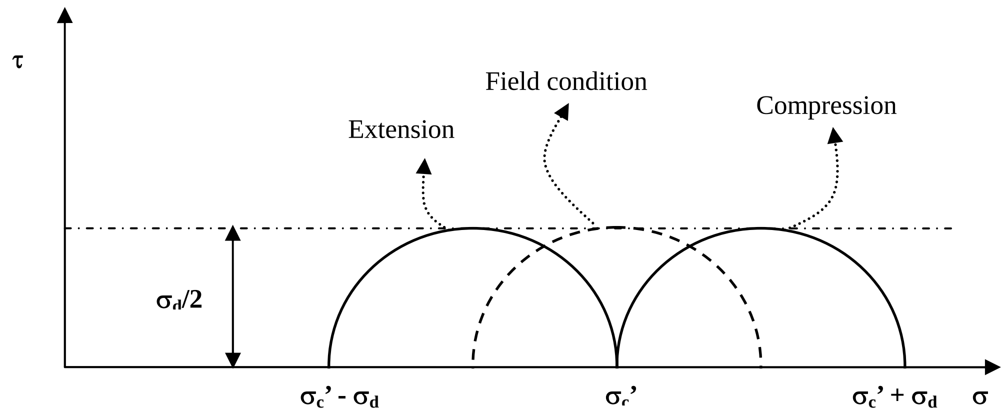
$$u_{corr} = u_m - \frac{1}{2}\sigma_d \quad \text{(in compression)}$$

$$u_{corr} = u_m + \frac{1}{2}\sigma_d \quad \text{(in extension)}$$

where

u_{corr} : corrected excess pore water pressure

u_m : measured excess pore water pressure



(2) The correlations for liquefaction potential between stress ratios in the field, cyclic simple shear tests, and cyclic triaxial tests.

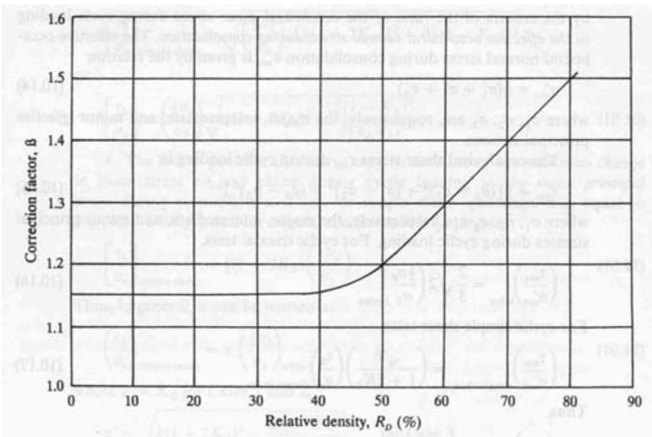
$$\left(\frac{\tau_h}{\sigma_v'}\right)_{field} = \beta\left(\frac{\tau_h}{\sigma_v'}\right)_{SS} = \alpha'\beta\left(\frac{\frac{1}{2}\sigma_d}{\sigma_c'}\right)_{TX} = C_r\left(\frac{\frac{1}{2}\sigma_d}{\sigma_c'}\right)_{TX}$$

where

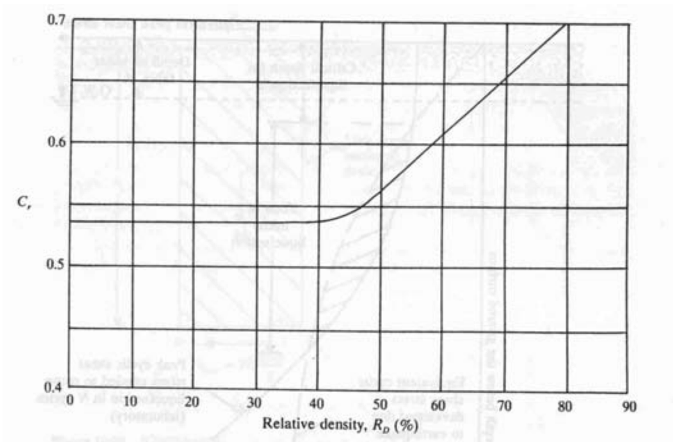
β : correction factor of the results from simple shear test to field condition

α' : correction factor of the results from triaxial test to simple shear test

C_r : correction factor of the results from triaxial test to field condition



(a) β



(b) C_r

Fig. 4 Variation of correction factors with relative density