Appendix III Factor of Liquefaction Resistance, F_L and Index of Liquefaction Potential, P_L[7]

The ability of a soil element at an arbitrary depth to resist liquefaction can be expressed by the Factor of Liquefaction Resistance, F_L, as follows:

$$F_L = \frac{R}{L} \qquad (1)$$

Where R is in-situ resistance (or undrained cyclic strength) of soil element to dynamic loads and can be simply evaluated, based on undrained cyclic shear test results, as follows:

$$R = 0.0882 \sqrt{\frac{N}{\sigma_V' + 0.7}} + 0.19,$$

$$\text{for } 0.02 \text{ mm} \leqq D_{50} \leqq 0.05 \text{ mm} \qquad (2a)$$

$$R = 0.0882 \sqrt{\frac{N}{\sigma_V' + 0.7}} + 0.225 \log_{10} \frac{0.35}{D_{50}}$$

$$\text{for } 0.05 \text{ mm} \leqq D_{50} \leqq 0.6 \text{ mm} \qquad (2b)$$

$$R = 0.0882 \sqrt{\frac{N}{\sigma_V' + 0.7}} - 0.05,$$

$$\text{for } 0.6 \text{ mm} \leqq D_{50} \leqq 1.5 \text{ mm} \qquad (2c)$$

where N is the number of blows in the standard penetration test, σ_V' is the effective overburden pressure (in kg/cm²), and D_{50} is the mean particle diameter (in mm). L in eq. (1) is the dynamic load induced in the soil element by a seismic motion, and can be estimated by

$$L = \frac{\tau_{max}}{\sigma_V'} = \frac{\alpha_{smax}}{g} \frac{\sigma_V}{\sigma_V'} r_d = ks \frac{\sigma_V}{\sigma_V'} r_d \qquad (3)$$

Where τ_{max} is the maximum shear stress (in kg/cm²), α_{smax} is the maximum acceleration on the ground surface (in gal), g is the acceleration of gravity (= 980 gal), σ_V is the total overburden pressure (in kg/cm²), ks is the seismic coefficient, and r_d, the reduction factor for dynamic shear stress, is as follows:

$$r_d = 1 - 0.015\,Z \qquad (4)$$

Where Z is the depth in meters.

The Index of Liquefaction Potential P_L can be introduced to express the severity of liquefaction as,

$$P_L = \int_0^{20} F \cdot W(Z)\, dZ \qquad (5)$$

in which $F = 1 - F_L$ for $F_L \leqq 1.0$ and $F = 0$ for $F_L > 1.0$, and $W(Z) = 10 - 0.5Z$ (Z in meter), as illustrated in Figure III−1. For the case of $F_L = 0.0$ for the entire range from Z = 0 to Z = 20 m, P_L becomes 100, and for the case of $F_L \geqq 1.0$ for the entire range from Z = 0 to Z = 20 m, P_L becomes 0.0.

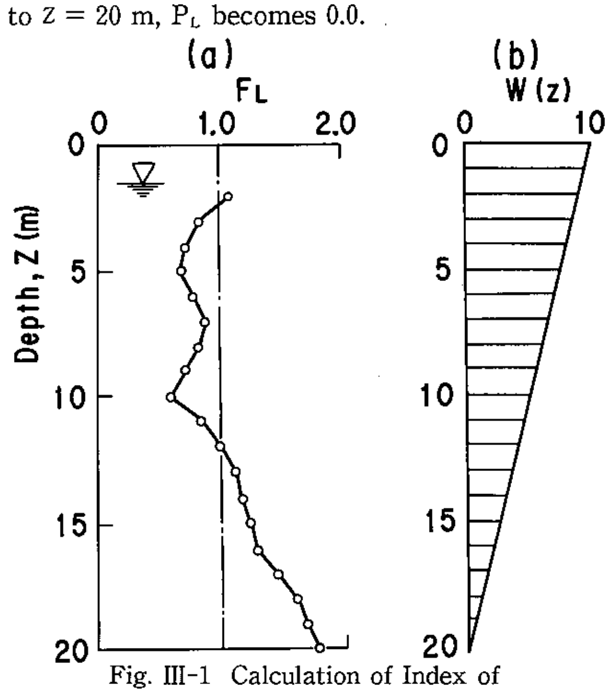

Fig. III-1 Calculation of Index of Liquefaction Potential, P_L