III-398 MODELING ISOTROPICALLY CONSOLIDATED NATURAL SILT-SAND IN TC

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INTRODUCTION. For any rational analysis, for example by FEM, the formulated pre-peak and post-peak stress-strain relationships of the soil including the peak strength properties are necessary. For this purpose Tatsuoka and Shibuya (1992) has proposed a Generalized Hyperbolic Equation to model the stress- strain relationships of sands. Herein presented is the modified method and the results of modeling the stress-strain relationship obtained from Consolidated drained triaxial compression (CDTC) tests performed under different testing conditions.

GENERAL HYPERBOLIC EQUATION (GHE). This method is able to model a given stress-strain relation from say 0.0001% to that at the peak stress state (1-10%). On the other hand the Conventional Hyperbolic Equation (CHE) can't fit the entire stress-strain relationship for a wide range of strain. Clear explanation and definition of GHE and its constants determination are given in Tatsuoka and Shibuya (1992).

MODELING THE STRESS-STRAIN RELATIONSHIPS OF NATURAL SILT-SAND. The stress-strain relations in TC at a constant σ_3 for any soil is represented by the following hyperbolic function,

$$q/q_{max} = \frac{\varepsilon_a}{\frac{q_{max}}{C_1 E_{max}} + \frac{\varepsilon_a}{C_2}}$$

Where q is the deviator stress, q_{max} is the maximum deviator stress, ε_a is axial strain, E_{max} is the maximum Young's modulus, C_1 and C_2 are a function of strain level (eq. (1) and (2)).

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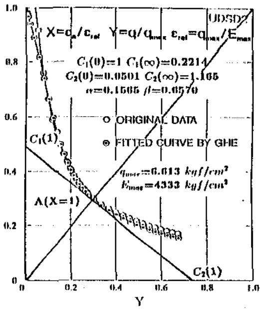

Fig. 1(b) Normalized plot using GHE.

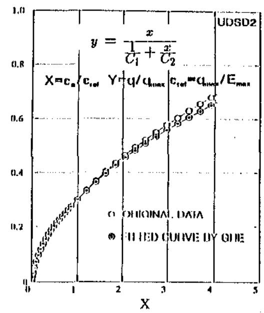

Fig. 1(a) Fitted curve.

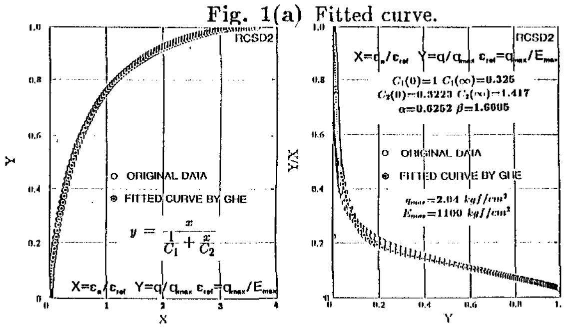

Fig. 2 Fitted curve.

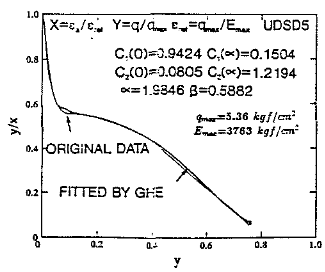

Fig. 3 Normalized plot using modified method.

$$C_1(x) = \frac{C_1(0)+C_1(\infty)}{2} + \frac{C_1(0)-C_1(\infty)}{2} cos\left(\frac{\pi}{\frac{\alpha}{x}+1}\right) \quad (1)$$

$$C_2(x) = \frac{C_2(0)+C_2(\infty)}{2} + \frac{C_2(0)-C_2(\infty)}{2} cos\left(\frac{\pi}{\frac{\beta}{x}+1}\right) \quad (2)$$

The parameter α and β can be obtained by the coordinates X=1 and Y at point A (Fig. 1(b)) and the values of $C_1(1)$ and $C_2(1)$ in to eq. (1) and (2). The values of $C_1(1)$ and $C_2(1)$ are the coordinates where the line tangent to the data curve at point A intersects the axes Y/X and Y. Arbitrarily chosen experimental data of test UDSD2 (Undisturbed sand), UDSD5 (Undisturbed silt-sand) and RCSD2 (Reconstitute sand) were fit by using GHE (Fig. 1 and 2).

Due to a large kink in the normalized plot (as shown in Fig. 3) the GHE could not model satisfactorily of the original data of UDSD5 (undisturbed silt-sand). To alleviate this problem the following approaches were taken for determining the constants in the normalized plot of GHE. The determination of constants C_1 (0), C_1 (∞), C_2 (0) and C_2 (∞) were the same as mentioned by Tatsuoka and Shibuya (1992). To determine the constants, C_1 (1) and C_2 (1) the following steps were introduced,

1. Intersection point 'A' (X_1,Y_1) between the lines 'uv' and 'rs' is obtained:

$$x_1 = \frac{C_2(\infty)C_2(0)[C_1(0)-C_1(\infty)]}{C_2(\infty)C_1(0)-C_2(0)C_1(\infty)}$$
$$y_1 = \frac{C_1(\infty)C_1(0)[C_2(\infty)-C_2(0)]}{C_1(\infty)C_2(0)-C_1(0)C_1(\infty)} \quad (3)$$

2. The line 'pq' which is passing through 'A' is obtained:

$$y = -m_p x + (y_1 + m_p x_1) \quad (4)$$
$$m_p = \tan(\frac{\theta_1+\theta_2}{2})$$

Slopes θ_1 and θ_2 can be defined by,

$$tan\theta_1 = \frac{C_1(0)}{C_2(0)}$$
$$tan\theta_2 = \frac{C_1(\infty)}{C_2(\infty)}$$

3. Point 'B' (X_2,Y_2) in the normalized data with minimum distance from 'A' is determine (Fig. 4). The distance or relative non-linearity index 'a' is given by:

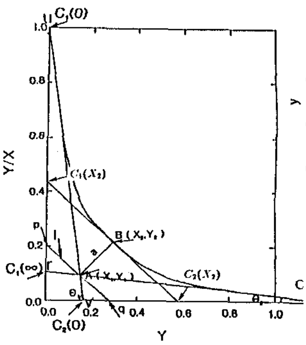

Fig. 4 Parameters determination for hyperbolic relation by modified method.

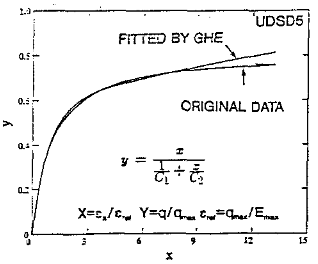

Fig. 5 Fitted curve.

$$x_2 = x_1 + a\cos(m_p)$$
$$y_2 = y_1 + a\sin(m_p) \quad (5)$$

4. Determine a line which is passing through 'B' and parallel with the line 'pq':

$$y = m_p x + (y_1 - m_p x_1) + a(\sin(m_p) - \cos(m_p))$$

5. The intersections of this line with the axes give the C_p and C_q. From Eq. (4), we obtained:

$$C_p = y_1 + m_p x_1$$
$$C_q = \frac{y_1 + m_p x_1}{m_p}$$

$$C_1(X_2) = C_1(p) + a\sec(m_p)$$
$$C_2(X_2) = C_2(q) + acosec(m_p)$$

α and β can be determine by substituting, X_2 and C_1 (X_2) and C_2 (X_2) into eq. (1) and (2). After this modification it is observable that 'a' becomes a significant parameter. Fig.5 shows the fitted curve using GHE with the modified constants.

CONCLUSION. After the modification a reasonable agreement between experimental data and prediction was obtained in the case where the non-linearity of stress-strain is peculiar characteristics.