

Missouri University of Science and Technology Scholars' Mine

in Geotechnical Earthquake Engineering and Soil Dynamics

International Conferences on Recent Advances 1981 - First International Conference on Recent Advances in Geotechnical Earthquake **Engineering & Soil Dynamics**

28 Apr 1981, 9:00 am - 12:30 pm

Effect of Material Properties on Soil Liquefaction

I. Ishibashi University of Washington, Seattle, Washington

M. A. Sherif University of Washington, Seattle, Washington

W. L. Cheng University of Washington, Seattle, Washington

Follow this and additional works at: https://scholarsmine.mst.edu/icrageesd



Part of the Geotechnical Engineering Commons

Recommended Citation

Ishibashi, I.; Sherif, M. A.; and Cheng, W. L., "Effect of Material Properties on Soil Liquefaction" (1981). International Conferences on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics. 16.

https://scholarsmine.mst.edu/icrageesd/01icrageesd/session02/16



This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License.

This Article - Conference proceedings is brought to you for free and open access by Scholars' Mine. It has been accepted for inclusion in International Conferences on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics by an authorized administrator of Scholars' Mine. This work is protected by U. S. Copyright Law. Unauthorized use including reproduction for redistribution requires the permission of the copyright holder. For more information, please contact scholarsmine@mst.edu.

Effect of Material Properties on Soil Liquefaction

I. Ishibashi, Research Associate Professor of Civil Engineering

M. A. Sherif, Professor of Civil Engineering

W. L. Cheng, Graduate Student in Civil Engineering

University of Washington, Seattle, Washington

SYNOPSIS Four material constants included in the pore-pressure buildup equation for saturated sands under earthquake loadings are determined as functions of grain size, soil angularity, coefficient of uniformity, and void ratio. This would allow engineers to readily calculate pore-pressure buildup as a function of time, and hence assess the liquefaction potential, for a given soil without conducting cyclic tests.

INTRODUCTION

The authors have previously proposed equations (summarized below) which predict pore-pressure buildup in saturated sands under earthquake-type loading (Sherif et al., 1978):

$$U_{N}^{\star} = U_{N-1}^{\star} + \frac{1}{2} \left(\Delta U_{Np}^{\star} + \Delta U_{Nn}^{\star} \right) \tag{1a}$$

$$\Delta U_{\text{Np}}^{\star} = (1 - U_{\text{N-1}}^{\star}) \cdot \frac{C_{1}(N_{\text{eq}})_{\text{p}}}{(N_{\text{eq}})_{\text{p}}^{C_{2}} - C_{3}} \cdot \left[\frac{\tau_{\text{Np}}}{\overline{\sigma}_{\text{N-1}}}\right]^{\alpha}$$
 (1b)

$$\Delta U_{\mathrm{Nn}}^{\star} = (1 - U_{\mathrm{N-1}}^{\star}) \cdot \frac{C_{1}(N_{\mathrm{eq}})_{\mathrm{n}}}{(N_{\mathrm{eq}})_{\mathrm{n}}^{\mathrm{c}_{2}} - C_{3}} \cdot \left[\frac{\tau_{\mathrm{Nn}}}{\overline{\sigma}_{\mathrm{N-1}}}\right]^{\alpha} \quad (1c)$$

$$(N_{eq})_p = \sum_{i=1}^{N} \left(\frac{\tau_{ip}}{\tau_{Np}}\right)^{\alpha}, \quad (N_{eq})_n = \sum_{i=1}^{N} \left(\frac{\tau_{in}}{\tau_{Nn}}\right)^{\alpha}$$
 (1d)

where U_{N-1}^{\star} and U_{N}^{\star} are the normalized porepressure values at the end of the N-1th and Nth cycles, ΔU_{Np}^{\star} and ΔU_{Nn}^{\star} are the normalized porepressure increments due only to the maximum positive and negative shear stresses, τ_{Np} and τ_{Nn} respectively, during the Nth cycle. C1, C2, C3, and α are the material constants which are determined during this study. The reader can refer to their previous paper (Sherif and Ishibashi, 1979) for the practical use of this equation.

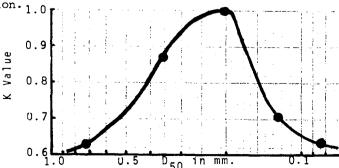


Fig. 1 Constant K versus Mean Grain Size D₅₀

PARAMETERS C1, C2, C3, AND α

These parameters were determined by running liquefaction tests in the Torsional Simple Shear Device for nine soil types with various mean grain size D_{50} , sphericity ψ , uniformity coefficient C_{u} , and volume decrease potential $e-e_{min}\cdot\ C_{2}$ and C_{3} appear to be constant for all soil types and densities and are nearly equal to 2.0 and 0.5, respectively. The α value can be expressed as a function of volume decrease potential for all soil types:

$$\alpha = 5.6 (e-e_{min}) + 1$$
 (2)

and C_1 can be expressed as a function of ψ , C_u , D_{50} , and $\text{e-e}_{\mbox{min}}$ as:

$$C_1 = K \cdot \psi^{5.4} (e - e_{min})^{2.25} \frac{10.66}{C_u^2 - 2.07C_u + 1.1} + 74$$
(3)

where K is the grain-size function as shown in Fig. 1 and is equal to unity at $D_{5\,0}=0.2$ mm. This implies that 0.2 mm is the most critical mean grain size for liquefaction. It is concluded that Eq. 1 can be readily used for liquefaction prediction after the basic soil properties, $D_{5\,0},~\psi,~C_{\rm u},~{\rm and}~e^{-e_{\rm min}}$ are known. It should be recognized that soil angularity (or sphericity) and volume decrease potential are more important than relative density in evaluating soil liquefaction potential.

REFERENCES

Sherif, M.A., I. Ishibashi and C. Tsuchiya (1978), "Pore-Pressure Prediction During Earthquake Loadings," Soils and Foundations, Japanese Soc. of Soil Mech. and Found. Eng., Vol. 18, No. 4.

Sherif, M.A. and I. Ishibashi (1979), "Prediction of soil Liquefaction Potential During Earthquakes," Proc. 2nd U.S. National Conf. on Earthquake Eng., Stanford University.