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THREE CASE STUDIES FOR SHORT TERM STABILITY OF SOFT CLAY DEPOSITS*

Discussion by J. H. SCHMERTMANN**

The author has presented a fine paper adding three well documented case histories to the technical literature on the important question of how geotechnical engineers can best practically evaluate the essentially undraineds tability of loads on soft clays. It seems to the writer that the results presented by Hanzawa support a number of important concepts in geotechnical engineering :

Undrained strength not a basic soil property : The differences between the unconfined and vane-determined undrained strength, plus the numerous correction factors we now consider necessary to apply to measurements of undrained strength, all indicate that when we measure undrained strength we do not measure a basic property. Rather, we measure a behavioral response to the type of test employed. We can perhaps at least partially eliminate this problem by making our stability analyses in terms of effective stresses. However, many engineers still consider this impractical with the present state-of-practice with respect to pore pressure prediction capability.

Using plasticity as an empirical correlation tool : The writer of course agrees with the author's conclusion that geological conditions play an important part in the strength behavior of a soft clay. To expect a global correlation against another empirical concept such as plasticity index seems very unrealistic. The author has added to the information indicating that we should not do this. However, site-specific or geologic-specific correlations of this type could certainly prove useful, at least for preliminary analysis purposes.

The important effects of aging : The author's conclusions regarding the importance of aging seem particularly interesting. The writer believes that the whole subject of the effects of aging has not received the attention it deserves. Bjerrum deserves recognition as one of the first investigators to call attention to the importance of aging. He noted that some clays that should have had a normally consolidated geologic history, also had undrained shear strength to effective stress (s_u/p) ratios coosiderably higher than other normally consolidated clays. They behaved as if they were overconsolidated, at least at small values of strain. He noted that the stronger NC clays appeared older than the weaker and younger clays. He started separating clays into "young" and "aged" (Bjerrum, 1973).

At about the same time Leonards and his associates produced laboratory test results showing that secondary aging in the laboratory could produce a "quasi-consolidation" effect due to preconsolidation-like behavior at low strain. Bjerrum then attempted to help explain this behavior via the void ratio changes associated with secondary compression over long periods of time. Leonards challenged this concept (Leonards, 1973, 1980). Of course, we cannot simply classify real clays in situ as either "young" or "aged." They must range continuously over the full spectrum from the very young to the very old.

The writer believes that aging produces a dispersion-type change in soil structure which tends to primarily stiffen, but also can strengthen the clay because of a dramatic increase in its ability to mobilize soil friction at small additional strain. Although the same clay

* By Hideo Hanzawa, Vol. 23, No. 2, June 1983, pp. 140–154.
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aged may still have the same PI as when young, its pore pressure generation and sensitivity behavior, including progressive action, may bevery different after aging compared to its behavior when young. Again, to expect it to have the same correction factor with respect to the typical embankment failure problem, based on its PI which might be the same at all ages, again seems unlikely. The writer expects that one day someone will come out with Bjerrum-type correction factors based on PI, one applying to "young" clays and another applying to "aged" clays. These correction factors will gradually become more complex as the advocates of this approach have to adjust the method to explain new case histories such as those supplied by the author. It seems obvious that eventually the profession will change to less empirical methods.

Sensitivity to strength parameters used for embankment fills : The writer has at times found that the assumptions made with respect to the strength of the fill as used in the slope stability analysis can have an important influence on the back-calculated values of clay undrained strength. The author's case histories would have even more value if he would present the back-calculated undrained strength values as a range of values consistent with specified degrees of uncertainty in the strength assumptions used for the fill.

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A PROCEDURE FOR ESTIMATION OF UPLIFT CAPACITY OF ROUGH PILES*

Discussion by JOSEPH E. BOWLES**

The author has presented a paper which attempts to address the prediction of the pull-out capacity of all tension piles in sand using a series of tests on a roughened wooden dowel 25.4 mm in diameter and slightly over 610 mm in length. In the author's proposal there are three items which have significant influence on the computed tension capacity. These are the lateral earth pressure coefficient K_u, the friction coefficient (tan δ) and the critical embedment depth $(L/D)_{cr}$ ratio. The critical depth L_{cr} is used as the point where the lateral earth pressure on the pile is taken as a constant value. The form of the author's equation (Eq. (10)) is not new, however, the implicit claim of obtaining the location of the critical depth and the value of the friction coefficient are both new proposals.

There are a number of factors to consider before acceptance of the author's recommendations. The data of Fig. 3 and its subsequent plot in Fig. 4 suggest a continuing increase in critical depth ratio with increasing density and not a break at $L/D=14.5$ for all soils with $D_r>70$. While of no consequence to this discussion, the maximum value for D_r in Fig. 4 should have been 100 and not 120 as shown.

A factor of importance is whether it is possible to have a ratio $\delta/\phi>1$. The method of roughening the "pile" more likely caused an apparent increase in the pile diameter from interlocking with the glued on soil grains so the shear zone is on a pile perimeter somewhat larger than the diameter of the wooden dowel. It is difficult to see a δ angle larger than ϕ from minimum energy concepts. In this case the model pile is unrealistically rough compared to a wood pile driven into a

* By B. M. Das, Vol. 23, No. 3, September 1983, pp. 122-126.

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