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Discussion by Claudio Cherubini[3] and Francesco Santoro[4]

Although the paper is really interesting, it seems useful to point out some statistical considerations:

1. Toward the comparison between measured and calculated deflection (Figs. 8 and 9), two determination coefficients have been obtained: $r^2 = 0.082$ and $r^2 = 0.35$. From a statistical point of view, only the second value is acceptable. This is because, for a number of measured data equal to 20, the necessary value of r^2 to reach a significance level of 10% must be equal to 0.3598, while to reach a higher level, that is, 1%, r^2 must be equal to 0.5368 (Gennaro 1975).
2. In order to overcome the known problems connected with the use of regression techniques (Troutman and Williams 1987)—which will not be summarized in this discussion—it is possible to analyze the set of the predicted value/measured value ratios (Cherubini et al. 1995). Once the above-mentioned ratios have been obtained, it is possible to calculate for them the mean value and the coefficient variation. These two entities allow estimation of the accuracy and the precision of the predicted values, where the words accuracy and precision have the following definitions:
   - A perfectly accurate method would be one that resulted in calculated values equal to the measured ones in every case (Tan and Duncan 1991). In a statistical sense, an accurate method would be one that yielded, for a set of n values of the predicted/measured ratio, a mean close to unity (Cherubini and Greco 1988).
   - A statistically precise method (Chapra and Canale 1988) would be one that, for the same set of n values of the predicted/measured ratio, resulted in very low scatter estimated; for example, by means of the coefficient of variation (Cherubini and Greco 1997; Cherubini, et al. 1995).

With regard to the paper discussed, we can therefore state:

- Regarding the ratio $H_{ou\ meas}/H_{ou\ pred}$, the mean value (equal to 1.06) leads to a good accuracy, while the coefficient of variation (equal to 28.4%) leads to a fairly good precision.
- Regarding the values y_{meas}/y_{pred} (0.02 B method), the mean value (equal to 0.916) leads, again, to a good accuracy, while the coefficient of variation (equal to 54.7%) leads to a bad precision.
- A different behavior has been detected for y_{meas}/y_{pred} (K method): the mean value (1.233) is higher than 1, with a high coefficient of variation equal to 54.05%. In this case, however, we can exclude from the whole set of the previously defined ratios the 20th value that is equal to 3.387. This value has to be considered, according to Chauvenet's criterion (Taylor 1986), an "outlier." Making this adjustment, the mean value becomes equal to 1.109 while the coefficient of variation shows a notable reduction, becoming equal to 39.04%.

To come to the point, via the elaboration of the predicted value/measured value ratios, it is possible to obtain useful information about the reliability of the prediction made by the theoretical model, in addition to the information possible using the regression techniques, which are affected by lots of conditions and limitations.

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APPENDIX. REFERENCES

Chapra, G. C., and Canale, R. P. (1988). *Metodi numerici per l'ingegneria.* McGraw-Hill Libri, Milano, Italy.
Cherubini, C., and Greco, V. R. (1997). "A comparison between measured and calculated values in geotechnics: An application to settlements." *Workshop Probamat 21st Century*, Perm, Russia.
Cherubini, C., Cucchiararo, L., and Orr, T. L. L. (1995). "Criteria to compare calculated and observed bearing capacity of piles." *Proc., ICASP 7—Paris*, 9–14.
Gennaro, P. (1975). *Introduzione alla statistica.* Etas Libri, Milano, Italy.
Tan, C. K., and Duncan, J. M. (1991). "Settlements of footings on sand: Accuracy and reliability." *Geotech. Engrg. Congr. 1191*, Geotech. Publ. 27, ASCE, Reston, Va., 446–455.
Taylor, J. R. (1986). *Introduzione all'analisi degli errori.* Zanichelli, Bologna, Italy.
Troutman, B. M., and Williams, G. P. (1987). "Fitting straight lines in the earth sciences." *Use and abuse of statistical methods in the earth sciences*, W. B. Size, ed., Oxford Univ. Press, New York.

Comparison of Four Methods to Assess Hydraulic Conductivity[a]

Discussion by Nadim F. Fuleihan,[6] Member, ASCE, and Anwar E. Z. Wissa,[7] Fellow, ASCE

The authors have presented an interesting case history: They evaluated differing clay liner construction techniques implemented by four different contractors that built test pads with the same borrow source. Whereas the discussers do concur that the quality of construction accounts for the documented differences in test pad performance, the discussers believe that better construction techniques could have been employed, and some construction problems avoided altogether, if the contractors had been adequately forewarned about the importance of hydration time and moisture equilibration.

The authors also compared four different test methods used to measure the hydraulic conductivity of the clay liner in each of the four test pads. They concluded that (1) all three large-scale (so-called "field-scale") test methods yield similar results, and that (2) tests on small specimens are of little value and should not be used. A review of the data presented by the authors does not lead the discussers to the same conclusions with respect to the relative ranking and reliability of the four test methods.

CLAY LINER CONSTRUCTION

The authors present a comprehensive evaluation demonstrating the importance of hydration time and moisture conditioning. The discussers agree, but feel that the contractors ought to have been adequately forewarned about this important

[a]October 1997, Vol. 123, No. 10, by Craig H. Benson, John A. Gunter, Gordon P. Boutwell, Stephen J. Trautwein, and Peter H. Berzanskis (Paper 12512).

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