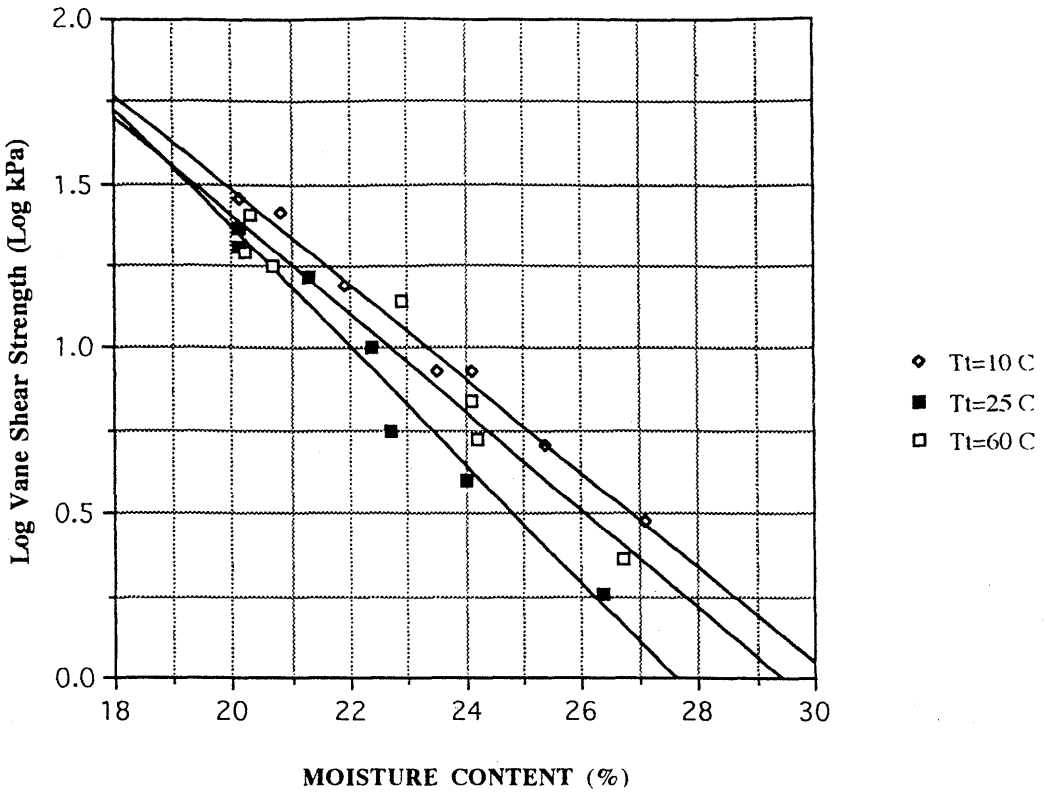

Fig. 17. Plots of log vane shear versus moisture content for weathered mercia mudstone for various thermal histories

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STUDIES ON THE CONTROL OF SWELL AND COLLAPSE POTENTIAL OF SELECTED JORDANIAN SOILS USING ASPHALT STABILIZATION[i]

Discussion by P. PAIGE-GREEN[ii]

The authors have carried out some interesting research with some useful results in an attempt to address two ubiquitous problems facing soils engineers around the world. The results published, however, can generally be considered to be somewhat pessimistic for the following reasons:

1 The "bitumen" contents illustrated in the figures and tables vary between 3 and 10%. As the bitumen was

[i] By A. S. Al-Homoud, T. Khesaywi and A. M. Al-Ajlouni, Vol. 35, No. 2, June 1995, pp. 15–23.
[ii] Manager, Transport Technology Division, Al Makarim Trading and Services, P.O. Box 2034, RUWI 112, Sultanate of Oman.

added to the soils as an MC-70 cut-back, which typically has about 65% residual bitumen depending on the quality (the standard specification requires more than 55% residual bitumen), the actual bitumen content varies between about 2 and 6.7%. When other forms of bitumen are used (e.g., MC-30, emulsions, etc.) the residual bitumen content should be used as a basis for comparison. Because the residual bitumen content is such an important parameter in this respect, it is unfortunate that this was not determined on the MC-70 material actually used for the investigation.

2 None of the samples was allowed to cure for any significant period of time after compaction resulting in the volatiles being mostly retained in the samples during testing. These would definitely affect the strength and permeability parameters of the samples and it is considered very likely that they would have affected the two properties measured, namely swell and collapse potential. Since both the collapse and swell potential are a function of, among other properties, the strength (mostly cohesion) of the material, sufficient curing to allow the bulk of the volatiles to escape and the viscosity of the bitumen to increase would result in larger effects on these two parameters.

The combination of these two factors would probably result in a significantly lower bitumen requirement for any specified reduction in swell or collapse potential than is indicated in the paper.

One other aspect which deserves mention is that potentially swelling and collapsing materials typically extend over large areas and to significant depths. In order to treat the material such that the two problems are within acceptable limits (avoidance is generally not practical), large volumes of material would require treatment. Therefore, although the process has been shown to be an effective remedy for certain Jordanian soils, it is unlikely that extensive bitumen stabilization would ever prove to be a practical or cost-effective solution to these two subgrade problems, for example on a road alignment. It may, however, permit the use of this type of soil in shallow fills and for selected structural layers in certain areas.

CORRELATIONS BETWEEN SHEAR WAVE VELOCITY AND CONE TIP RESISTANCE IN NATURAL CLAYS[i)]

Discussion by SATORU SHIBUYA[ii)]

The authors propose an empirical correlation for estimating the shear wave velocity V_s of clay deposit from CPT tip resistance, q_c. In a comparison with their preceding expression given in Mayne and Rix (1993), the new correlation has definitely been improved as a result of taking void ratio of in-situ subsoil, e_0, into account. It needs additional, but essential, information on e_0 profile with depth in a clay deposit that is cited. In the following, the writer describes his own view why e_0 is a fundamental property in governing the pseudo-elastic shear modulus, G_{max}, of natural soil deposit.

Neglecting shear modulus anisotropy, G_{max} can be expressed in the following form (e.g., Jamiolkowski et al., 1994);

$$G_{max}=A\cdot f(e)\cdot\sigma_r'^{(1-2n)}\cdot(\sigma_h'\cdot\sigma_v')^n\cdot(\mathrm{OCR})^k \qquad (3)$$

where σ_h' and σ_v' stand for effective horizontal and vertical stresses, respectively, and σ_r' is reference stress. The results of laboratory tests performed on various geomaterials show that the OCR effects on G_{max} are illusionary, showing the exponent k close to zero (Shibuya et al., 1992; Jamiolkowski et al., 1994). Jamiolkowski et al. (1991) showed also that the void ratio function in the form of e^{-x} fits well for a wide spectrum of geomaterials. Considering $K_0=\sigma_h'/\sigma_v'$, Eq. (3) becomes;

$$G_{max}=A\cdot K_0^n\cdot e^{-x}\cdot\sigma_r'^{(1-2n)}\cdot\sigma_v'^{2n}. \qquad (3')$$

The non-dimensional parameter, A, is subject to variation, for which it would increase in value as the effects of soil fabric, cementation, aging, etc. become dominant. In a given soil deposit, G_{max} can therefore be a function of e_0 as well as the current geostatic stress state.

Following the expression shown in Eq. (3′), an empirical equation of $G_{max}=5{,}000e^{-1.5}\sigma_v'$ (in kPa), has been obtained for estimating G_{max} of Holocene soil deposits only from routinely available borehole data; that is e_0 and the current geostatic effective overburden pressure, σ_v' (Shibuya and Tanaka, 1996). The empirical expression was derived from regression analysis applied to the results of several case records in Japan, together with two well-documented case records in Europe. Yet, the applicability has not been thoroughly examined, but the constant of 5,000 may be valid only for Holocene soil deposits exhibiting in-situ K_0 value not far from 0.5.

Figure 4 shows the result of predicting G_f ($=\rho_t V_s^2$) profile with depth at St. Alban site, based on the e_0 profile estimated from the well-documented soil properties (Lefebvre et al., 1994), together with the assumed soil density ρ_s of 2.70 g/cm^3. The result is encouraging in respect that the degree of prediction may be satisfactory like the authors' estimate using Eq. (2) (*see* Fig. 3).

Retrieval of undisturbed clay samples is a common practice in ordinary site investigation programme in Japan, implying that profiles of e_0 and σ_v' with depth are mostly known at first-hand. The writer wishes to know authors' opinion about the usefulness of developing empirical equation(s) as such which may also be plugged into US site investigation practice. He is also keen on

i) By P. W. Mayne and G. L. Rix, Vol. 35, No. 2, June 1995, pp. 107–110.

ii) Associate Professor, Asian Institute of Technology, Bangkok 10501, Thailand.