Correlations with CPT $q_c$ Value

The cone penetration test (CPT) tip resistance, $q_c$, has been used effectively to profile the preconsolidation stress in clays. Figure 3-10 presents the available data from 49 clays. This correlation is somewhat better than with the N value, and the standard derivation is smaller. This correlation also shows more clearly that the fissured clays behave differently from the intact clays. However, it is important to note that the data in Figure 3-10 are not corrected for pore water stress effects.

Correlations with CPTU Results

The piezocene (CPTU) provides additional data during penetration and generally is considered to be a more sensitive type of cone penetration test. Tavenas and Leroueil (20) demonstrated that the preconsolidation stress ($\bar{\sigma}_p$) was well-correlated with the net corrected cone tip resistance ($q_{tt} - \sigma_{vo}$) for eleven Canadian clays. A larger sample of piezocene data is shown in Figure 3-11. The regression in this case gave an even higher $r^2$ with lower standard deviation.

In addition to measurements of cone tip resistance, piezocones provide the
Figure 3-10. \( \bar{\sigma}_p \) Correlated with CPT \( q_c \)

Source: Based on Mayne (13), p. 786, and others (14 - 19).

Figure 3-11. \( \bar{\sigma}_p \) Correlated with CPTU \( q_T \)

Source: Based on Mayne and Holtz (21), p. 25, and others (14, 15, 17 - 19).

3-11
magnitude of pore water stress ($\Delta u$) caused by penetration. A relationship between $\bar{\sigma}_p$ and $\Delta u_c$ from CPTU tests with tip or face pore water stress measurements is shown in Figure 3-12. For pore water stress measurements behind the tip, the relationship is given in Figure 3-13. The results are similar for the intact clays. However, for piezocones in heavily overconsolidated fissured clays, pore water stresses measured behind the tip are near zero and sometimes are even negative. On the cone tip, positive pore water stresses are observed for all clays at all OCR values, regardless of whether fissuring is present.

From cavity expansion theory, the general relationship between $\bar{\sigma}_p$ and the excess pore water stress measured at the tip during piezocone penetration can be given by the following (23):

$$\frac{\bar{\sigma}_p}{\Delta u} = \frac{3}{(M \ln I_T)} \quad (3-16)$$

in which $M$ = critical state parameter (Appendix G) and $I_T$ = rigidity index ($G/\gamma_H$). For measurements behind the tip, the coefficient 3 becomes equal to 4. This equation gives values consistent with those in Figures 3-12 and 3-13 for the intact clays.

![Figure 3-12. $\bar{\sigma}_p$ Correlated with CPTU $\Delta u_c$](image)

Source: Based on Mayne and Holtz (21), p. 23, and others (14, 18, 22).

3-12
Correlations with PMT Results

Several correlations have been attempted with the pressuremeter test (PMT) to estimate the value of $\bar{\sigma}_p$. Early work with the Menard pressuremeter indicated that the PMT creep pressure was approximately equal to $\bar{\sigma}_p$ for Chicago area lake clays (25). Later work showed that the limit stress from the self-boring pressuremeter test (SBPMT) could be correlated with $\bar{\sigma}_p$, as shown in Figure 3-14. Other studies have shown the correlations given in Figure 3-15, including the undrained shear strength ($s_u$) and the rigidity index ($I_p$).

Correlations with DMT Results

The initial contact stress ($p_0$) from the dilatometer test (DMT) is a measure of the induced total pore water stress caused by insertion of the DMT blade. Analogous to the previous relationship between $\bar{\sigma}_p$ and $\Delta u$ for piezocene tests, a similar relationship applies for the DMT between $\bar{\sigma}_p$ and $(p_0 - u_0)$, as shown in Figure 3-16.

Figure 3-13. $\bar{\sigma}_p$ Correlated with CPTU $\Delta u_{bt}$

Source: Based on Mayne and Holtz (21), p. 24, and others (14, 15, 17, 19, 22).