SIMPLIFIED P-Y CURVES BASED ON PRESSUREMETER TESTS

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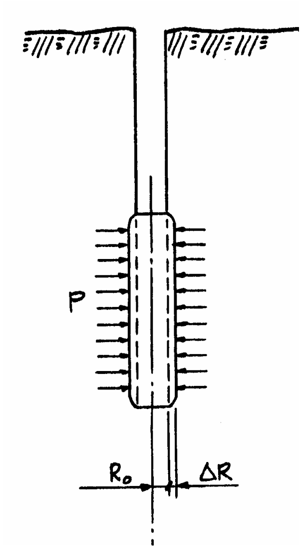
ABSTRACT

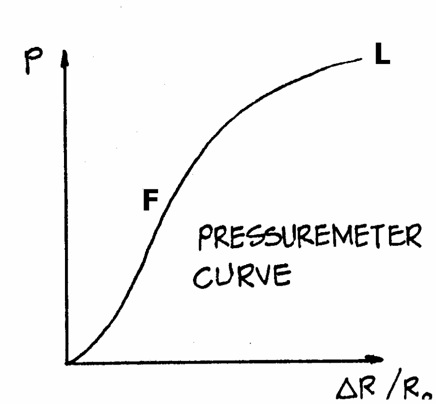
The pressure vs. radial strain described by a pressuremeter (PMT) curve is an excellent simulation of the soil reaction vs. horizontal displacement generated by a laterally loaded pile (Smith, 1983). This has led to published procedures for transforming PMT curves into pile p-y curves (Briaud, 1992). However, the existing procedure is a laborious point-by-point method, rarely used in practice.

This paper presents a new method for creating p-y curves from PMT curves that is convenient enough for use in routine analysis and design. The new method generates a pile p-y curve using only two basic PMT parameters: limit pressure and pressuremeter modulus.

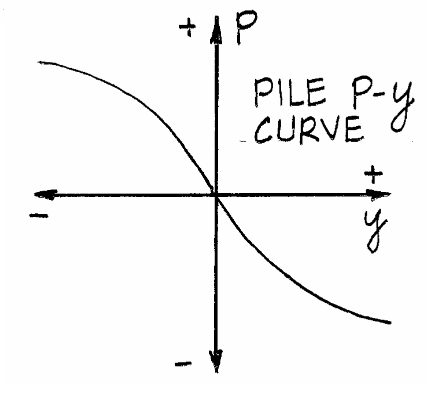


BACKGROUND

In the PMT, a cylindrical bladder (the "probe") is expanded in a pre-drilled borehole, resulting in a plot of probe pressure vs. radial strain. L is the point at which the cavity volume has been doubled. The pressure at L is P_L, the limit pressure, which represents the ultimate strength of the soil in the radial (horizontal) direction. F is the end of the pseudo-elastic phase of soil response. The pressure at F is P_F, the creep pressure. The pressuremeter modulus, E_M, is derived from the pseudo-elastic phase of the curve. There is a progressive decrease in modulus above the creep pressure.



The existing procedure for transforming a PMT curve into a pile p-y curve is a scaling procedure, wherein the PMT pressures are multiplied by the width or diameter of the pile, B, and adjusted by a shape factor, SF (1.0 for square piles and 0.75 for round piles). The corresponding pile displacement is also determined from a scaling technique, multiplying the radial strain from the PMT curve by B/2.



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THE NEW SIMPLIFIED PROCEDURE

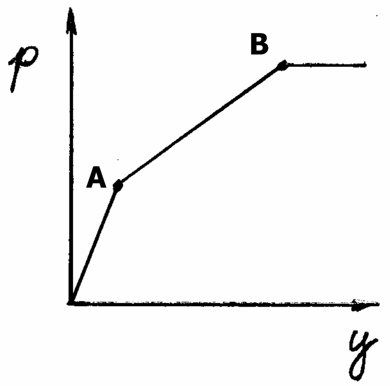
The pile p-y response is approximated with three linear segments: 1) from the origin to A, which corresponds to F, the creep pressure, 2) from A to B, which corresponds to L, the limit pressure, and 3) a plastic response above the limit pressure. Points A and B are determined as follows:

Point A: $p = P_L \cdot R \cdot B \cdot SF$ and $y = B/2 \cdot \varepsilon_{RF}$

Point B: $p = P_L \cdot B \cdot SF$ and $y = B/2 \cdot \varepsilon_{RL}$

where P_L = PMT net limit pressure
$R = P_F / P_L$ (use 0.5 for sand; 0.75 for clay) *
B = pile diameter or width
SF = shape factor (1.0 – square piles; 0.75 – round)
ε_{RF} = PMT radial strain at creep pressure, F
$= \text{SQRT}(1 + \varepsilon_{VF}) - 1$
where ε_{VF} = PMT volume strain at F
$= 1/ [(0.375/ R) \cdot (E_M / P_L) - 0.5]$
ε_{RL} = PMT radial strain at limit pressure, L
= 0.41

* typical range of P_F / P_L (from CGS, 1992); or, use values from actual PMT curve.



CONCLUSION

The pressuremeter test (PMT) can be viewed as a scale model test of the soil response to a laterally loaded pile, and if a PMT curve is “scaled up” it will provide an accurate p-y curve for laterally loaded pile analysis. The new simplified procedure presented herein requires only two PMT parameters, limit pressure and initial modulus, to establish p-y curves. If a third parameter, the creep pressure, is available, this can be used in the new procedure in lieu of the assumed values provided. With this new simplified procedure, the author has been able to obtain reasonable results to laterally loaded pile problems, using the currently available computerized finite difference solution procedure (Ensoft, Inc., 2004).

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