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ELASTIC MODULUS DETERMINATION

Interpretation of static load test results often requires that the deep foundation's elastic modulus be known. For example, a common method of *failure load interpretation* is related to the foundation's elastic shortening, the calculation of which requires the elastic modulus. Driven piles, drilled shafts, and continuous flight auger (CFA) or augered cast-in-place (ACIP) piles are often instrumented with strain gages along their embedded length to determine how the applied load is transferred to the surrounding soil and/or rock materials during a static load test. In these tests, the elastic modulus is required to convert measured strain to calculated load.

The elastic modulus of steel is fairly well-defined. However, the elastic modulus of concrete and grout can vary over a wide range and must be determined. Use of empirical formulas or cylinder test results to estimate modulus values may not provide the desired accuracy. Curing conditions also affect concrete modulus. Test cylinders cured under different conditions than the deep-foundation's in-place concrete adds inaccuracy to modulus estimates from cylinder results. The elastic modulus of concrete is also strain-dependent, decreasing with increasing strain. For deep foundations containing concrete or grout, a preferred method to determine the elastic modulus involves using strain measurements from embedded instrumentation.

The applied loads and measured strains during a static load test provide a stress-strain relationship for the deepfoundation element from which a strain-dependent composite-section secant modulus can be determined. Fellenius (2001) recommended that the Tangent Modulus Method be used to determine a secant modulus relation for load-transfer evaluations of deep foundation elements that contain concrete. From strain gage measurements obtained during a static load test, the tangent modulus versus measured microstrain is plotted for all strain gage levels and all load increments as shown in Figure 1.

A best-fit line through the data (also shown in Figure 1) determines a slope and intercept. These values are used to define a strain-dependent secant modulus relation for the deep foundation element, from which measured strains can be converted to load in the pile. These calculated pile loads at the strain gage locations provide the basis for load transfer and unit shaft resistance determinations.

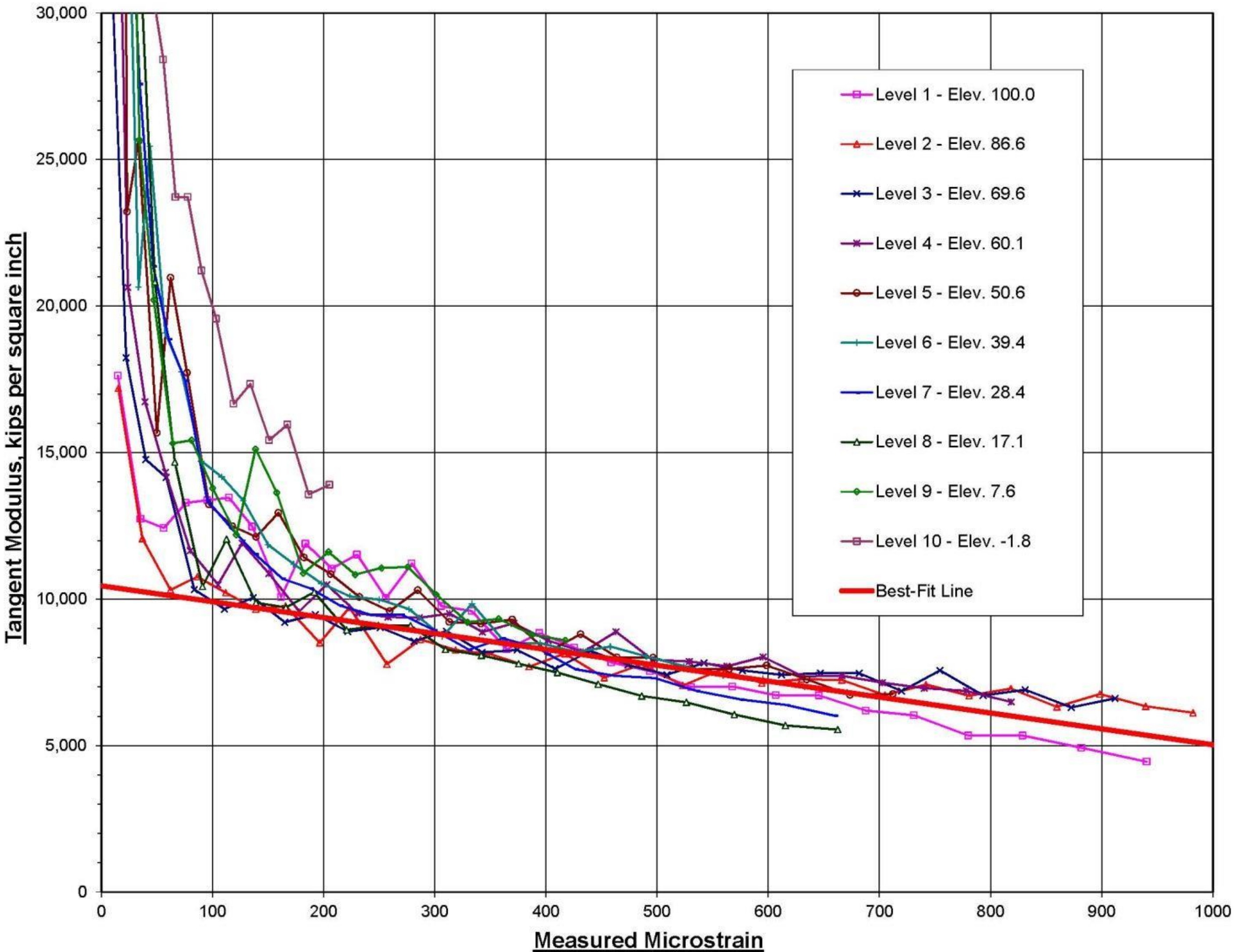

Figure 1. Tangent Modulus Versus Measured Microstrain from an Instrumented Static Load Test.

References

Fellenius, B.H. (2001). From Strain Measurements to Load in an Instrumented Pile. Geotechnical News Magazine, Vol. 19, No. 1, pp. 35 - 38.