



DID YOU KNOW?

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DYNAMIC TESTING OF MICROPILES

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Micropiles are more and more frequently chosen as a solution for difficult foundation problems. Although they may differ in size, length and construction method, they are generally built by drilling a hole less than 300 mm diameter and then grouting around a center steel reinforcement or pipe. They usually have a high capacity relative to their diameter. This bearing capacity is frequently verified by static load testing of a few initial test piles. The following case shows dynamic testing as an economical and effective alternative to static testing, and a supplemental quality control tool.

On a recent fast track project, geotechnical consultant Schnabel Engineering recommended that a new structure be supported by a micropile foundation. The piles were drilled using a down-hole hammer with a bit diameter of about 200 mm (8 inch). The pile was then constructed with a 180 mm (7 inch) casing above the bond zone and a 3 m (10 ft) socket to bond the pile into a Karst bedrock. Two 57 mm (#18) reinforcing steel bars connected the socket to the upper cased pile section. The contractor installed two initial test piles and then immediately began production piling. Unfortunately, one of the two static test piles failed before the required ultimate pile capacity was reached. A third static test pile was therefore quickly installed, but it also failed prematurely. This caused all other already installed production piles to immediately become suspect. An efficient and rapid method to assess the capacity of these installed production piles was needed.

Based upon the need to evaluate multiple piles and the desire to start and complete the testing quickly, the consultant recommended performing dynamic tests with the Pile Driving Analyzer.

The geotechnical consultant considered both Dynamic and Rapid load testing methods to evaluate the micropile foundations. Based upon the need to evaluate multiple piles and the desire to start and complete the testing quickly, the consultant recommended performing dynamic tests with the Pile Driving Analyzer®. A local pile driving contractor was selected who could quickly mobilize a single acting air hammer with 2.2 Mg (5 kip) ram weight and 0.9 m (3 ft) drop height. The hammer was evaluated by wave equation analysis and, while not perfect, was considered suitable to accomplish the necessary dynamic loading.

The first piles to be dynamically tested by GRL Engineers (see photo) were the ones on which static tests had been performed. This was done to establish a Class A correlation between static and dynamic testing, therefore GRL was not made aware of the load testing history of the piles before submitting the dynamic test results. These results, obtained after



Scott Webster attaching a transducer on a micropile

CAPWAP® analysis of the Pile Driving Analyzer data, are shown in Table 1, and were only slightly higher than static test capacities.

Table 1. Class A Correlation Results

Pile	Static Load Test		CAPWAP	
	(kN)	(kips)	(kN)	(kips)
TP-1	1000	225	1110	250
TP-2	>1330	>300*	2200	495
TP-3	1160	260	1170	263

* TP-2 static load test did not fail

Satisfied with this good correlation, the geotechnical engineer called for dynamic testing of an additional 22 production piles. However, before testing of these piles could be accomplished, the pile driving hammer had to be fitted with a follower that would accommodate the hook bars protruding from the top of the micropiles. Ignoring one statistical outlier defective pile with a 360 kN (81 kips) capacity, the results shown in Table 2 were obtained for the other 21 production piles.

Table 2. Capacity results for 21 production piles

Unit	Min.	Max.	Mean	St. Dev.
kN	880	1420	1240	180
kips	198	320	278	40

Dynamic testing of the 22 production piles was successfully completed within two test days. Results demonstrated which piles had adequate bearing capacity and identified questionable production piles. Dynamic testing also assisted in revising pile installation techniques for the remaining production piles.

Dynamic testing was clearly a valuable tool for very efficient and economical load testing of the micropiles, and was most effective in resolving the foundation problems encountered at the start of this project.