Helical Foundations & Tiebacks Seminar

Results of Dynamic and Static Load Tests of Helical Piles

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Summary

Introduction

- Helical piles were invented by Alexander Mitchell in 1836 and have been used mainly to resist tension as anchor foundation elements.
- In the last decade they have increasingly been used to support and rehabilitate structures subjected to compressive axial loads.
- Simple empirical correlation between torque and compressive load bearing capacity is used as field control ($Q_{ult} = K_t \times T$), with K_t typically = 10.

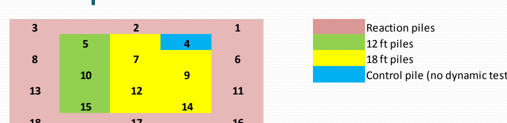
Objectives

- Perform Static and Dynamic tests on a group of Helical Piles, and compare the results with the estimates from the torque
- Compare the results of Static and Dynamic Load Tests, in order to verify the viability and recommend proper procedures for performing Dynamic Load Tests on Helical Piles.

Procedure

- 18 Helical piles were installed in the National Geotechnical Experimental Site of the University of Massachusetts – Amherst Campus (UMass-Amherst)
- 10 piles were used to verify different procedures of installation and to serve as reaction for the Static Tests.
- 7 piles were used first for Dynamic and then for Static tests.
- 1 pile was used as control; only Static Test performed.
- Results of Static and Dynamic Load Tests were compared; analysis parameters were established allowing good correlations between the two results.
- Those results were also compared with the estimates based on torque measurements during installation.

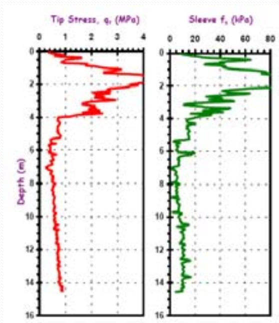
Description of the site



Description of the soil

•The soil at the Amherst site consists of 5 ft of stiff silty-clay fill overlaying a consolidated crust and the thick layer of the so called Connecticut Varved Clay (CVVC), composed of alternating layers of silt and clay formed in the Pleistocene by a glacial lake (Lake Hitchcok).

•The CPTU profile shows a clear drop in soil resistance at 4 to 5 meters (13 to 16 ft)



Description of the piles

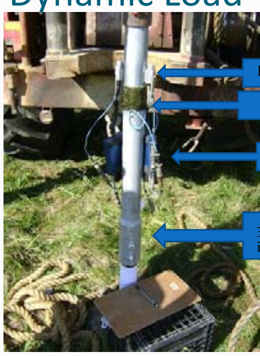
•2 $^7/_8$ inches in diameter, with one 7ft long lead with a 3-helices configuration, and 7ft long nominal extensions (6.5ft effective length with 0.5ft overlap connections).

•The axis of the first helix (8" diameter) is 6" from the tip, the second 10" helix is 24" from the first and third 12" helix is 30" from the second. The space between the helices is 3 times their diameter as is usual practice.

•3 piles were driven to 12ft below grade and consisted of one lead and one extension.

•5 piles were driven to 18ft below grade and consisted of one lead and two extensions.

Dynamic Load Tests



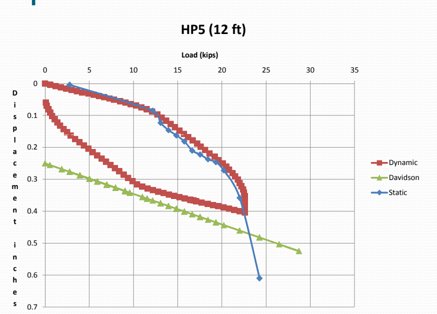
Dynamic Load Tests (continued)

About 2 ½ months after installation

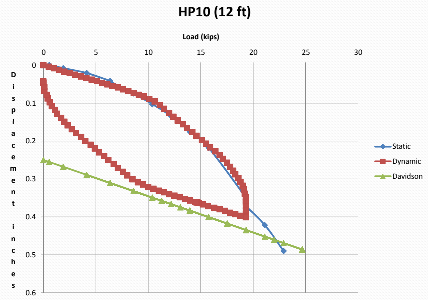
Static Load Tests

About one month after Dynamic Load Tests

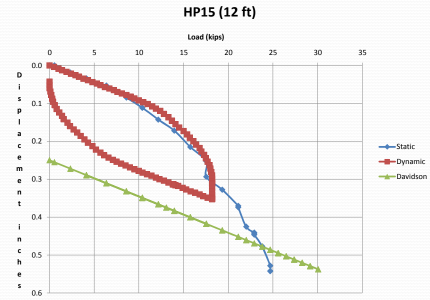
Comparison of results



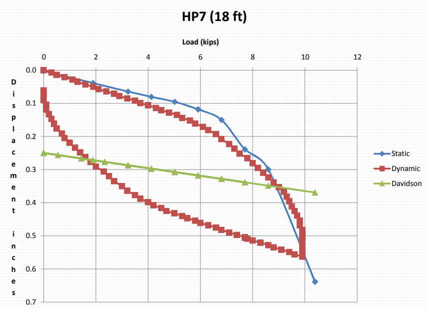
Comparison of results



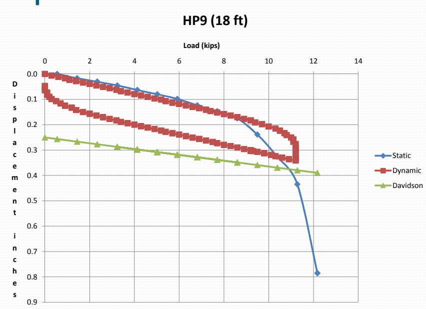
Comparison of results



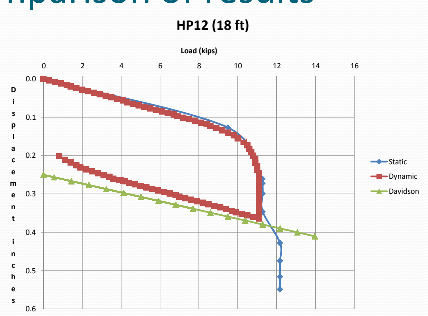
Comparison of results



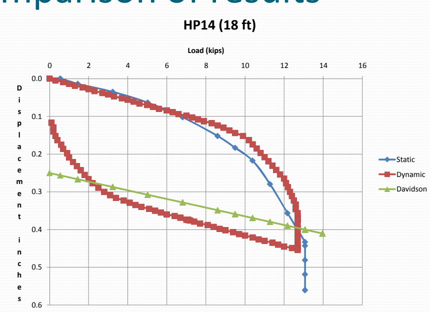
Comparison of results



Comparison of results



Comparison of results



Load Tests vs. Torque

•Compressive Bearing Capacity can be determined from torque measured during installation using:
- ($Q_{ult} = K_t \times T$).

•The usual value for K_t is 10. However, in this case:
- •12 ft piles (HP5, HP10, HP15) => $K_t \approx 15$
- •18 ft piles (HP7, HP9, HP12, HP14) => $K_t \approx 12$

•The usual K_t value proved to be conservative in this case.

Conclusions

The table below summarizes the main results:

Pile		HP5	HP10	HP15	HP7	HP9	HP12	HP14
Depth (ft)		12	12	12	18	18	18	18
Torque (ft-lbs)		1428	1544	1699	869	868	890	1101
Load according to Davidson Criterion (kips)	SLT	23.1	22.01	22.9	8.6	10.9	11.7	12.7
	DLT	22.6	19.3	18.2	8.6	11.2	11.1	12.7
	SLT/DLT	1.02	1.14	1.26	1.00	0.97	1.05	1.00
	kt static	16.2	14.3	13.5	9.9	12.6	13.1	11.5
	kt dynamic	15.8	12.5	10.7	9.9	12.9	12.5	11.5
Average kt static		14.6			11.8			

Conclusions

•For CVVC the results of the Static Load Tests were higher than the predictions made based on torque measurements, using the usual correlation factor K_t.

•The recommended procedure is to execute a load test in each site to determine the correct value of K_t.

•Good correlations were obtained between the results of the Static Load Tests using the Davidson criterion and the Dynamic Load Tests.

Conclusions (continued)

•The good correlations show that Dynamic Load Tests are a viable alternative to predict the compressive load capacity of Helical Piles in cohesive soils.

•Dynamic Load Testing procedure is simple and requires only a weight of 300 lbs with 3 ft drop height and a calibrated instrumented rod.

•Further research is recommended to verify if Dynamic Load Tests can be also used in Sand and Granular soils.

Acknowledgments

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