

0-6956: Synthesis of Load-Deflection Characteristics of Laterally Loaded Large Diameter Drilled Shafts

Background

The project deals with evaluating how well current P-y curves predict the behavior of large diameter piles subjected to monotonic lateral loading. The motivation is that current P-y curves were developed starting about 60 years ago based on lateral load tests on piles that were about 2 ft in diameter while today's pile diameters can reach 12 ft. This significant difference in scale brings into question the application of these early P-y curves to today's large diameter piles. In this report, the boundary between small diameter and large diameter is set arbitrarily at 5 ft.

What the Researchers Did

A database of 89 load tests on piles subjected to monotonic lateral loading was collected (database spreadsheet available). Table 1 gives the pile and soil characteristics.

Table 1. Pile and Soil Characteristics.

Category		Pile Diameter B < 5 ft	Pile Diameter B ≥ 5 ft
Pile diameter range (ft)		1–5	5–9.8
Pile length range (ft)		5–120	7.5–220
Number of cases		52	37
Soil type	Sand	31	25
	Clay	21	12

Each load test case included the pile dimensions and material properties, the soil properties, and the lateral load versus lateral deflection curve. For each load test case, the work consisted of predicting the load-deflection curve using the program LPILF using the Matlock-Reese P-y curves and comparing it to the measured curve.

Evaluation of the predictions took place along two main comparisons: comparison between the predicted load L_{pred} and the measured load L_{meas} at

given deflections of 0.25, 0.5, 1, and 2 inches and comparison between the predicted deflection y_{pred} and measured deflection y_{meas} at lateral loads H corresponding to set percentages of the ultimate load H_u equal to 10 percent, 25 percent, 33 percent, and 50 percent. The ultimate lateral load was defined as the load corresponding to a horizontal deflection equal to 10 percent of the pile diameter. This deflection was not always reached in the load tests; in those cases, a hyperbolic extrapolation was used (33 percent of all cases).

What They Found

The ratio L_{pred}/L_{meas} was plotted against the pile diameter to evaluate the predictions in general and the influence of the diameter in particular. The following is a summary of the findings:

1. In sand, L_{pred}/L_{meas} averages about 0.9 for all piles and increases with diameter from about 0.7 for smaller diameter piles to about 1.1 for larger diameter piles. Overall, L_{pred}/L_{meas} can be expected to be between 0.4 and 1.4 most of the time.
2. In clay, L_{pred}/L_{meas} averages about 0.9 for all piles and decreases with diameter from about 1.3 for smaller diameter piles to about 0.7 for larger diameter piles. Overall, L_{pred}/L_{meas} can be expected to be between 0.4 and 1.6 most of the time.

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The ratio y_{pred}/y_{meas} was plotted against the pile diameter to evaluate the predictions in general and the influence of the diameter in particular. Overall more scatter was observed in the prediction of deflections at lateral loads H corresponding to set percentages of the ultimate load H_{ou} than in the prediction of loads at given deflection values. The following is a summary of the findings:

1. In sand, y_{pred}/y_{meas} averages about 1.9 for all piles and decreases with diameter from about 2.25 for smaller diameter piles to about 1 for larger diameter piles. Overall, the ratio y_{pred}/y_{meas} can be expected to be between 0.5 and 5 most of the time (Figure 1).
2. In clay, y_{pred}/y_{meas} averages about 1.4 for all piles and increases with diameter from about 0.9 for smaller diameter piles to about 3 for larger diameter piles. Overall, the ratio y_{pred}/y_{meas} can be expected to be between 0.2 and 5 most of the time with some values reaching 8 for larger diameter piles (Figure 2).

What This Means

When using the Matlock-Reese P-y curve approach in sand, the predicted lateral load at a given deflection (in the range of 0.25 to 2 inches) of large diameter piles is likely to be slightly over-predicted on the average.

When using the Matlock-Reese P-y curve approach in clay, the predicted lateral load at a given deflection (in the range of 0.25 to 2 inches) of large diameter piles is likely to be slightly under-predicted on the average.

When using the Matlock-Reese P-y curve approach in sand, the predicted lateral deflections at a fraction of the ultimate lateral load (in the range of 10 percent to 50 percent) of large diameter piles is likely to be slightly over-predicted on the average.

When using the Matlock-Reese P-y curve approach in clay, the predicted lateral deflections at a fraction of the ultimate lateral load (in the range of 10 percent to 50 percent) of large diameter piles is likely to be significantly over-predicted on the average (ratio of 3).

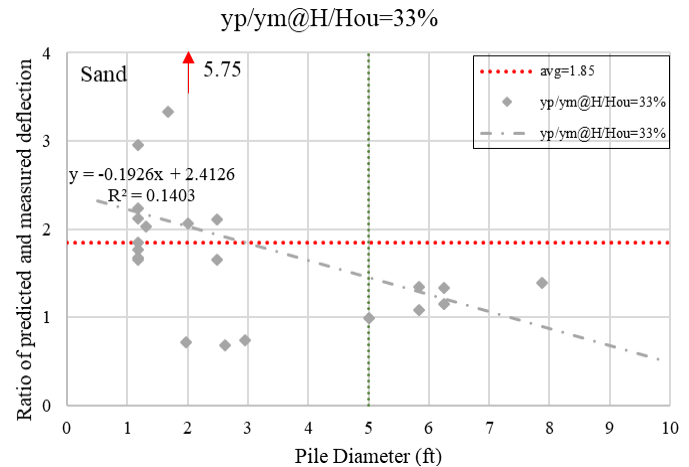


Figure 1. Ratio of Predicted over Measured Lateral Deflection versus Diameter in Sand.

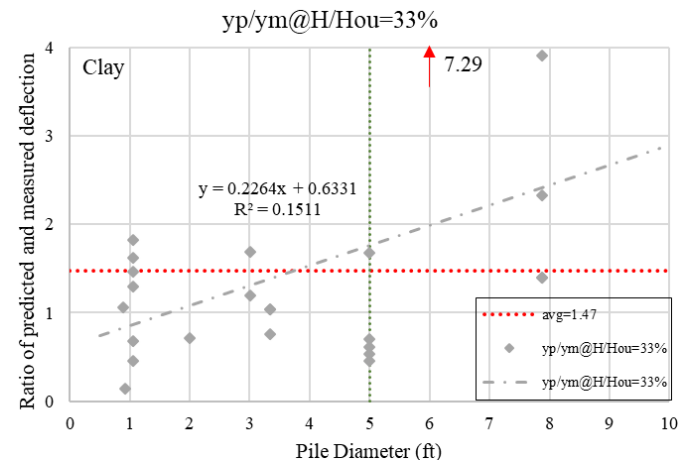


Figure 2. Ratio of Predicted over Measured Lateral Deflection versus Diameter in Clay.

For More Information

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