Moment Resisting Force Distribution Along Submerged Piles

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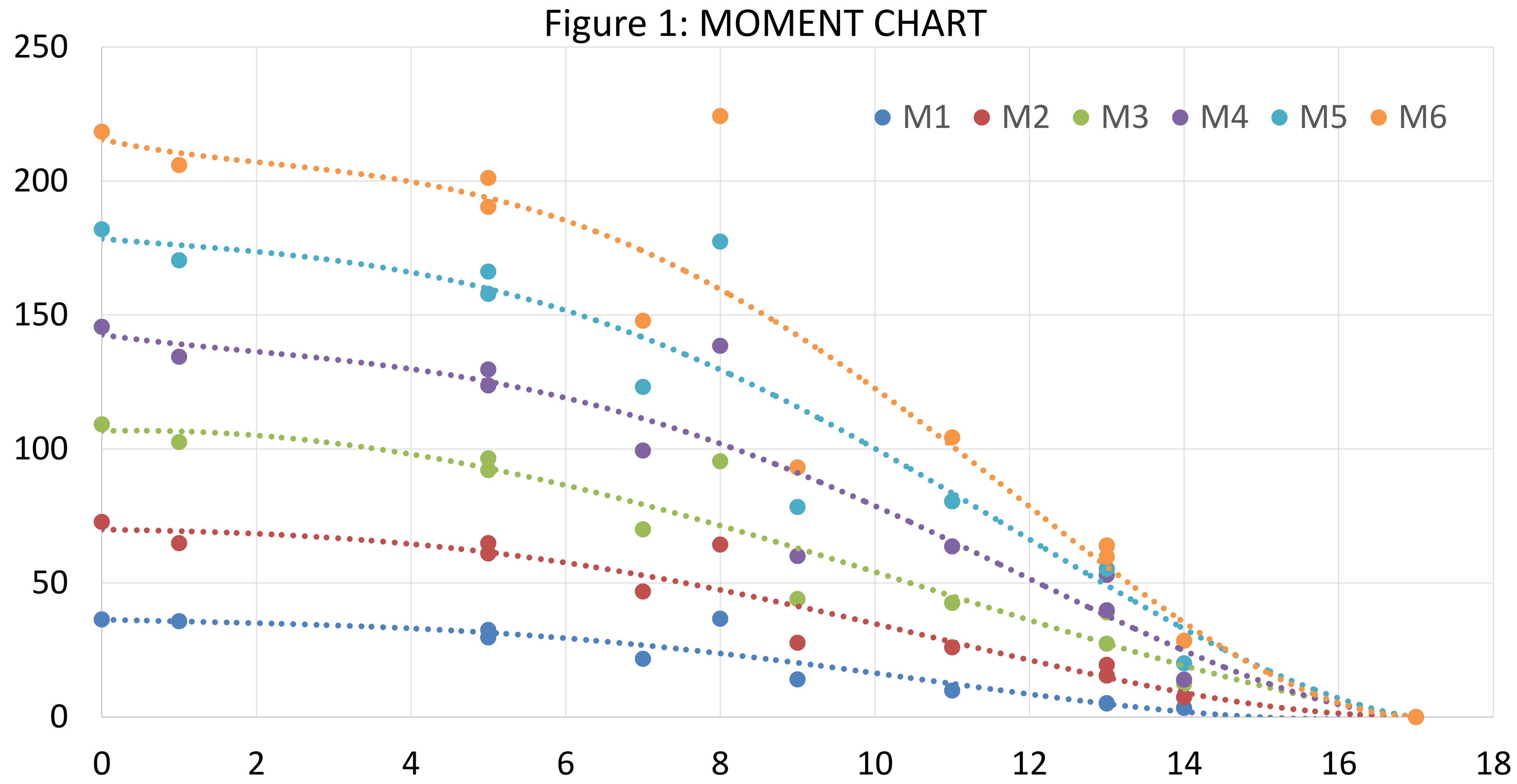
Goal

Determine the force distribution along embedded piles used for the GeoWall Competition's Mechanically Stabilized Earth(MSE) retaining wall.

Lab Testing and Data Analysis:

Lab testing was conducted to determine the amount of strain in the pile at various depths. This strain would then be converted to a moment. A uniform distributed load would be used to account for the difference in moment at any two locations along the pile.

Figure 1: MOMENT CHART



To calculate the distributed loads, the pile was cut into ½" long segments. Each segment was assumed to act as a simply supported beam, with the lower end pinned and the top end braced against horizontal movement (See figure 3). Using the moment distribution curve, the moment at either end of the segment could be determined. Then by using equation 2, a distributed load that accounted for the difference in moment was found.

Figure 3: Percent of Net Force

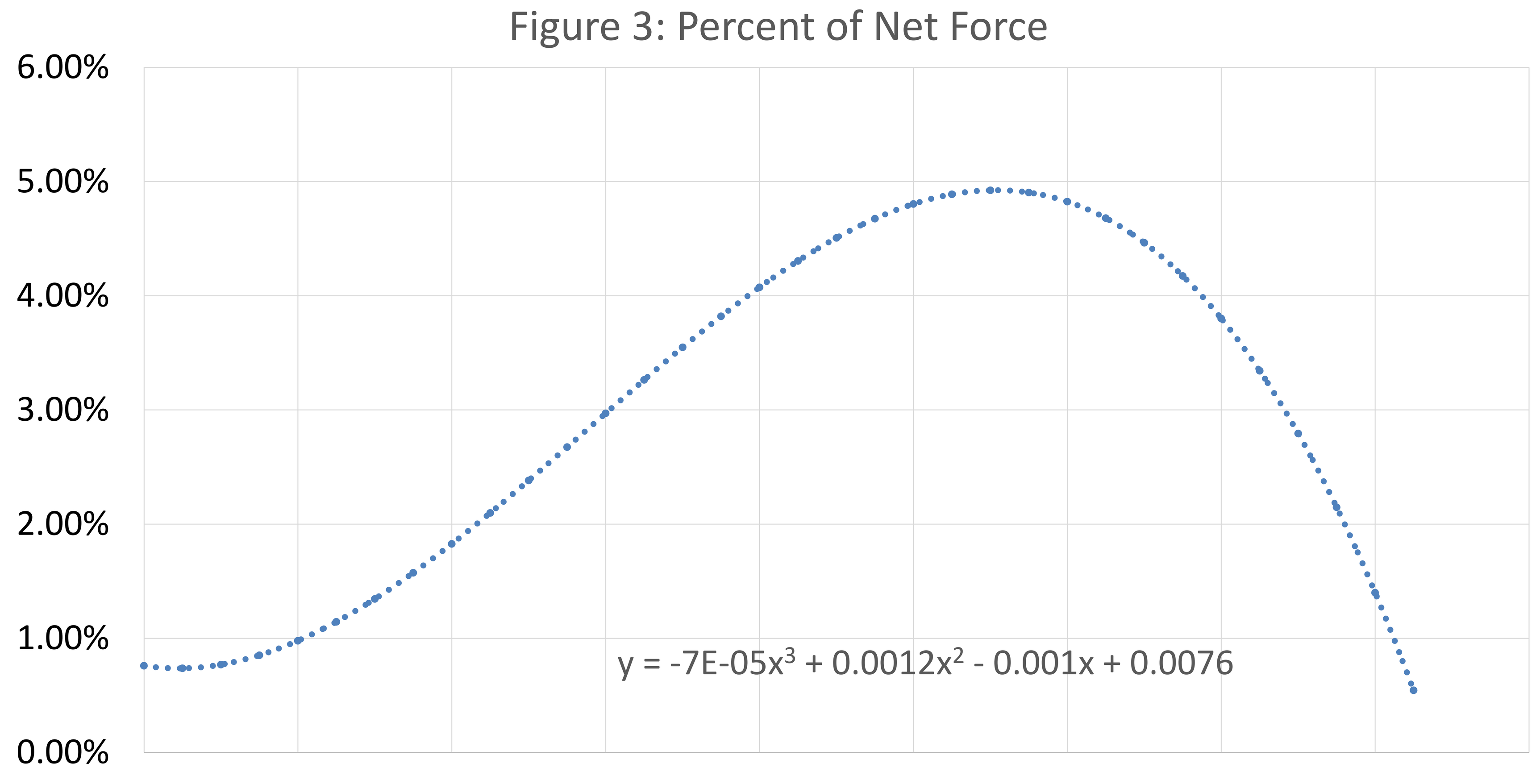


Photo 1: Lab Setup

Equation 1:

$$M = \frac{\epsilon I E}{C}$$

Where:

M= moment (in-lbs)

ε= strain

I= moment of inertia (in4)

E = modulus of elasticity (29,000,000 psi for steel)

C = distance to tension most fiber

Twelve different strain gauges recorded data. Of these twelve, 10 gave reliable data. Using the data from the strain gauges, moment distribution curves were generated for all six loading conditions. Then, best fit lines where generated between the data points. These best fit lines enable a more accurate calculation of the distributed loads (figure 1).

Equation 2:

$$w = \frac{2(M_1 - M_2)}{L^2}$$

Where:

w = distributed load (lbs/in)

M1 = Moment at top of segment (lbs-in)

M2 = moment at bottom of segment (lbs-in)

L = length of segment

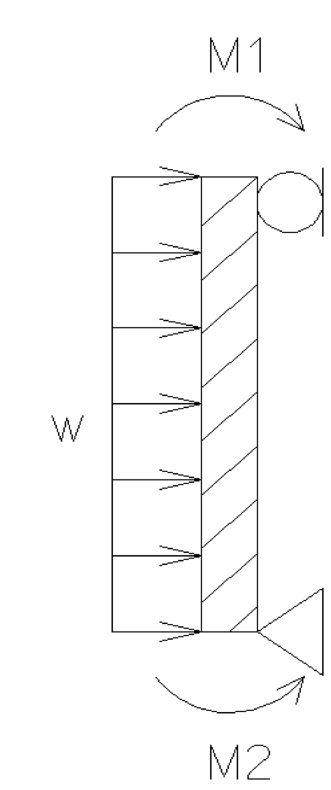


Figure 2: Pile Segment

Photo 2: Pile in Sand

Once the load was found, it was converted to a point load by multiplying it by the length of the segment. To better compare all 6 test, each point load was converted to a percent of the net force. The net force was found by adding all of the segment point loads. Once the percent of the net force for each segment of pile was determined, the average across all 6 test for each segment was plotted (figure 3).

Conclusion:

Based on figure 3, it can be seen that the pile resists most of the applied moment at deeper depth of embedment. The distribution is a third order differential, which contrasts the current best fit parabola used by the GeoWall team today. While the new proposed distribution results in a higher net force, it is distributed lower along the wall, and therefore is not as large of a design problem.