PanGEO INCORPORATED
Geotechnical & Earthquake Engineering Consultants

August 12, 2016
File No. 14-032.200

Barcelo Homes, LLC
32505 138th Place SE
Auburn, WA 98092
Attn: Bogdan Maksimchuk

Subject: **Geotechnical Report Addendum**
Evaluation of Surcharge Load on the Soldier Pile Wall
Proposed Single-Family Residence
4634 E Mercer Way, Mercer Island, WA

Dear Mr. Maksimchuk,

Based on the City's review comment, PanGEO performed additional analysis to evaluate the potential surcharge load on the lower soldier pile wall due to the upper soldier pile wall. The following sections present a summary of our additional analysis and conclusion for the soldier pile wall design.

Based on the current design plans, the upper and lower walls are spaced approximately 15 feet (see attached page 1). We selected a critical upper wall section with a height of 12.3 feet for our analysis (see page 2). Soil parameters are assigned based on the subsurface data for L-Pile analysis. We then performed L-Pile analyses to obtain the point of fixity of the soldier piles. The summary results of L-Pile analyses for the 12.3 feet and 8.9 feet high upper wall are included on pages 3 and 4 of the attachment. Based on the lateral pile analysis, the point of the fixity of the soldier pile is found to be at 23.8 feet for the 12.3 high wall section and 19.3 feet for the 8.9 high wall section. Based on the point of fixity, the approximate passive wedge of the upper wall is plotted on page 1, and it appears the passive wedge intercept the very top of the lower wall (approx. upper 1.6'). As a result, there will be some surcharge load on the lower wall due to the passive wedge of the upper wall.

3213 Eastlake Ave E, Ste B
Seattle, WA 98102
Tel:(206) 262-0370
Fax:(206) 262-0374

As an attempt to quantify this surcharge load, we reviewed AASHTO bridge design specification and other documents. According to AASHTO, the group effect for 2nd row for a pile spacing of 5 times the pile diameter is 0.85 (see page 5). The spacing between upper and lower walls are about 6 times the solder pile diameter. As such, the group effect factor will be between 0.85 and 1. Page 6 of the attachment also shows that the moved/disturbed soil in front of the pile is approximately ellipse in shape in plan review.

In summary, based on results of our analysis, there is likely small surcharge near the top of the lower wall due to mobilization of the passive wedge of the upper wall. To account for the impact of this surcharge due to upper wall passive pressure, we recommend to increase the active earth pressure of the lower wall 15% for the soldier pile design in areas it has a parallel upper soldier pile wall. It is our opinion that this simplified and conservative approach should be adequate to account for the potential impact of the upper wall on the lower wall.

CLOSURE

We trust that the information presented herein meets your need at this time. Please call if you have any questions.

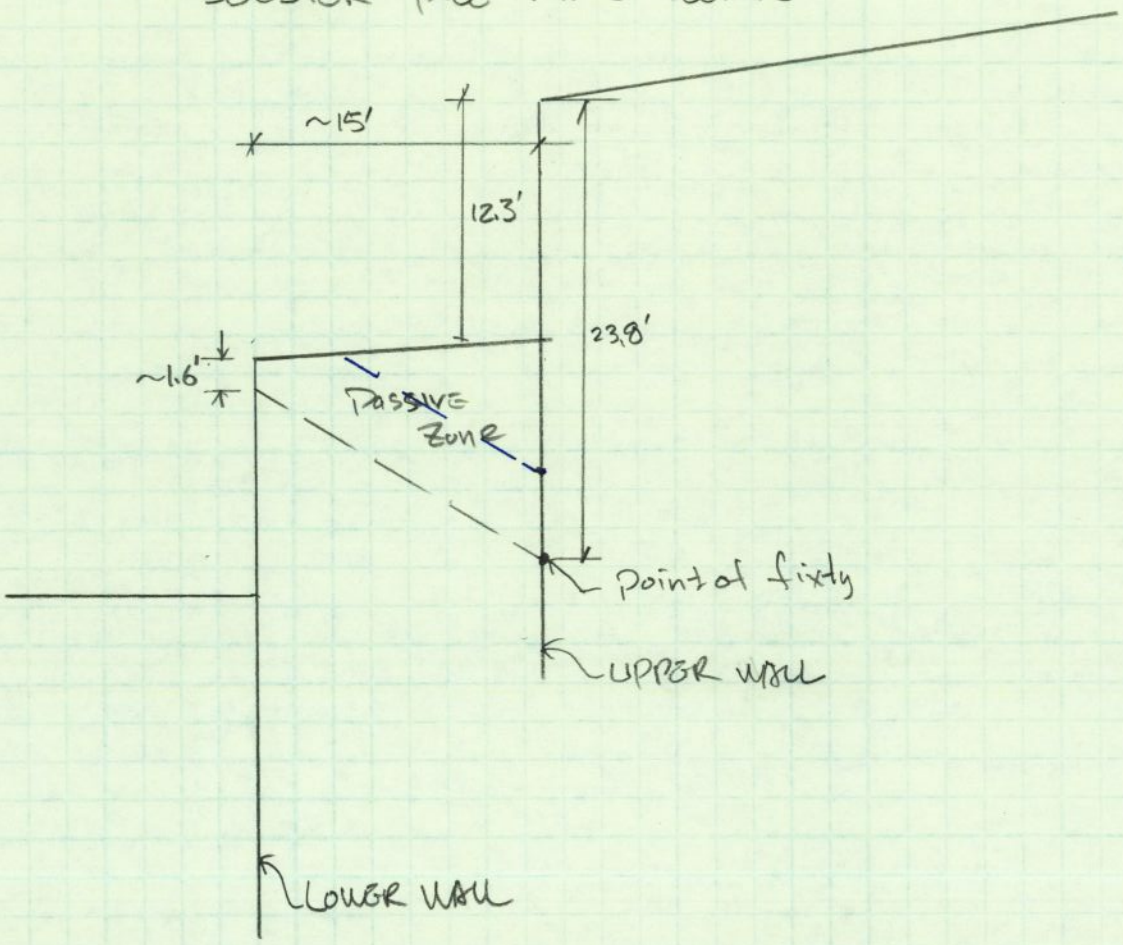
Sincerely,

Michael H. Xue, P.E.
Senior Geotechnical Engineer

Attachment: Summary Results of Engineering Analysis

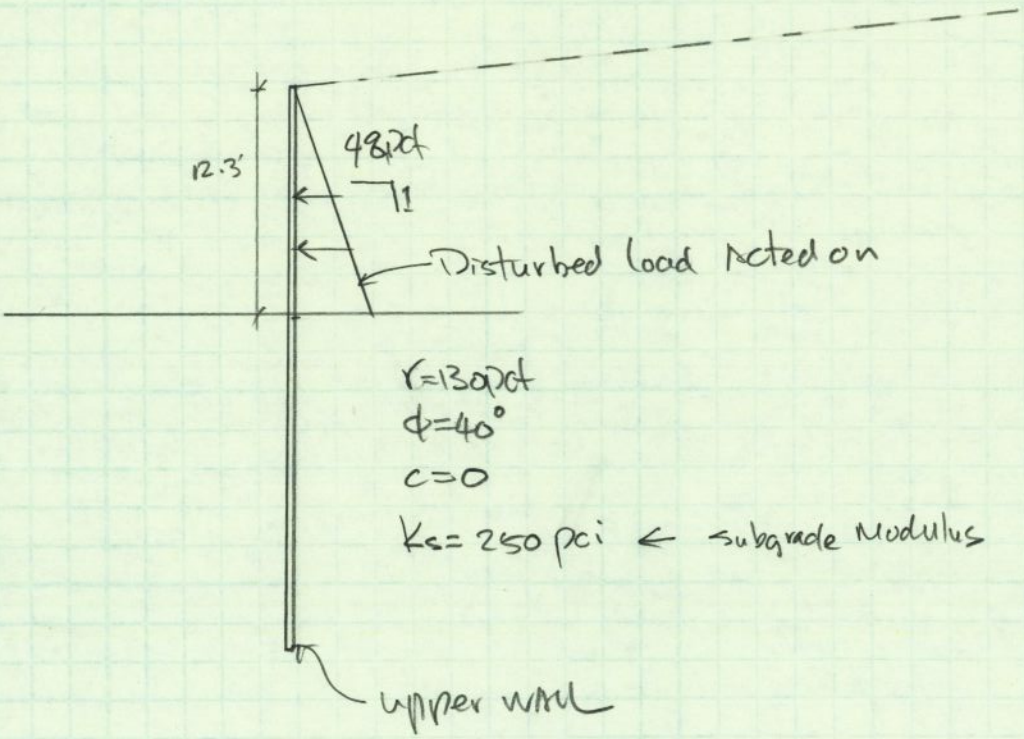
4634 E MERCER WAY

SOLDIER PILE WALL SECTION



SCALE: 1"=10'

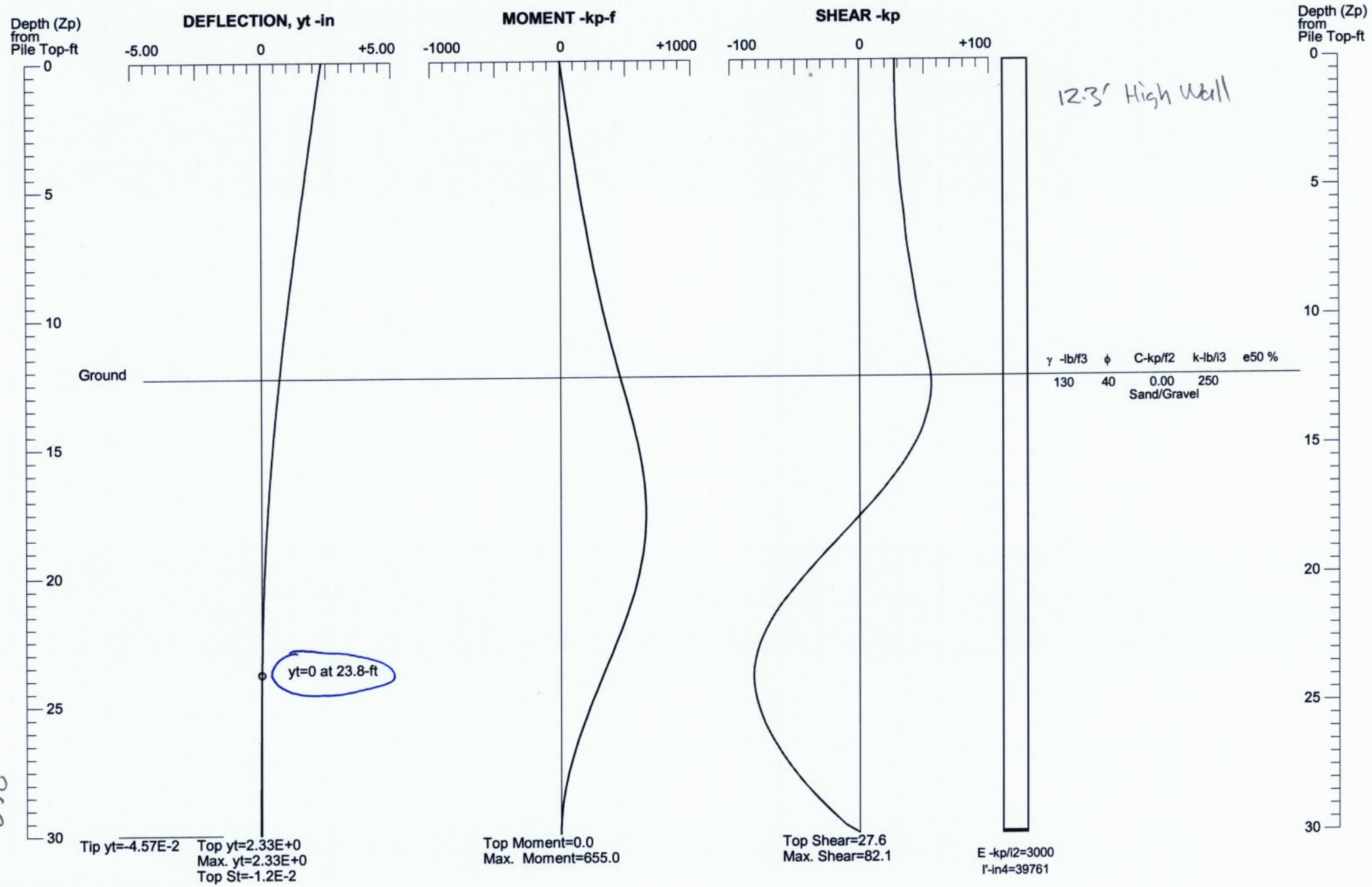
L-Pile (Allpile) Analysis Section



SOIL PROFILE TO FIND POINT OF FIXITY.

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1

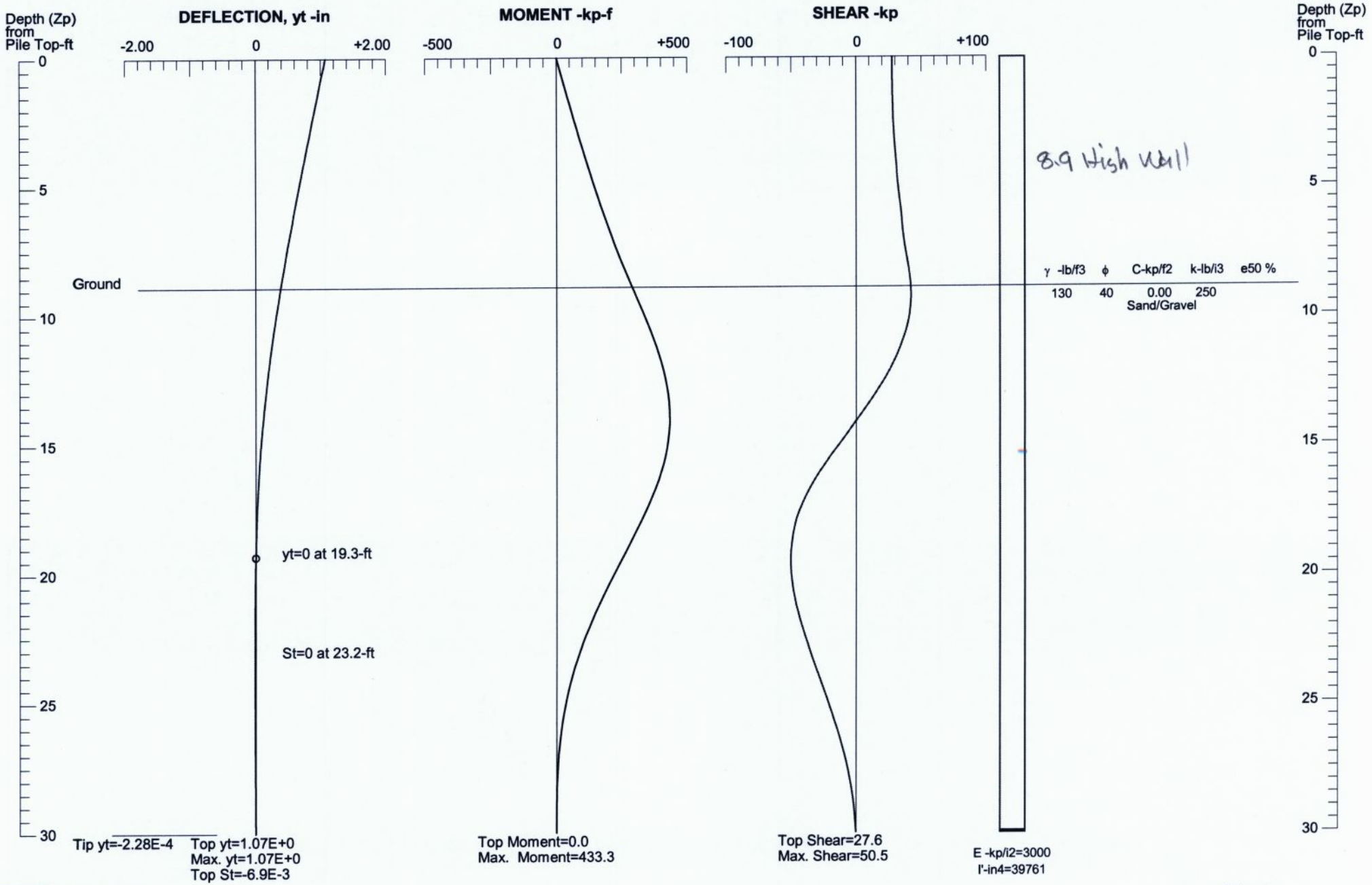


CivilTech Software

Figure 2

PILE DEFLECTION & FORCE vs DEPTH

Single Pile, Khead=2, Kbc=1



CivilTech Software

PG4

Figure 2

Table 10.7.2.4-1—Pile P-Multipliers, P_m, for Multiple Row Shading (averaged from Hannigan et al., 2006)

Pile *CTC* spacing (in the direction of loading)	*P*-Multipliers, P_m		
	Row 1	Row 2	Row 3 and higher
3*B*	0.8	0.4	0.3
5*B*	1.0	0.85	0.7

Loading direction and spacing shall be taken as defined in Figure 10.7.2.4-1. If the loading direction for a single row of piles is perpendicular to the row (bottom detail in the Figure), a group reduction factor of less than 1.0 should only be used if the pile spacing is 5*B* or less, i.e., a P_m of 0.8 for a spacing of 3*B*, as shown in Figure 10.7.2.4-1.

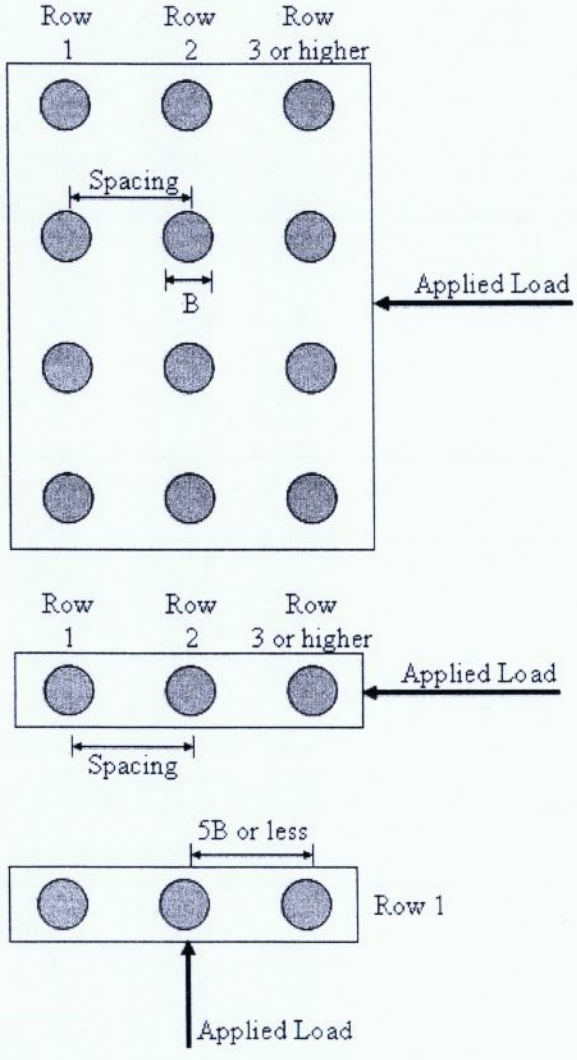


Figure 10.7.2.4-1—Definition of Loading Direction and Spacing for Group Effects

Since many piles are installed in groups, the horizontal resistance of the group has been studied and it has been found that multiple rows of piles will have less resistance than the sum of the single pile resistance. The front piles "shade" rows that are further back.

The P-multipliers, P_m, in Table 10.7.2.4-1 are a function of the center-to-center (*CTC*) spacing of piles in the group in the direction of loading expressed in multiples of the pile diameter, *B*. The values of P_m in Table 10.7.2.4-1 were developed for vertical piles only.

Lateral load tests have been performed on pile groups, and multipliers have been determined that can be used in the analysis for the various rows. Those multipliers have been found to depend on the pile spacing and the row number in the direction of loading. To establish values of P_m for other pile spacing values, interpolation between values should be conducted.

The multipliers are a topic of current research and may change in the future. Values from recent research have been tabulated by Hannigan et al. (2006).

Note that these *P-y* methods generally apply to foundation elements that have some ability to bend and deflect. For large diameter, relatively short foundation elements, e.g., drilled shafts or relatively short stiff piles, the foundation element rotates rather than bends, in which case strain wedge theory (Norris, 1986; Ashour et al., 1998) may be more applicable. When strain wedge theory is used to assess the lateral load response of groups of short, large diameter piles or shaft groups, group effects should be addressed through evaluation of the overlap between shear zones formed due to the passive wedge that develops in front of each shaft in the group as lateral deflection increases. Note that P_m in Table 10.7.2.4-1 is not applicable if strain wedge theory is used.

Batter piles provide a much stiffer lateral response than vertical piles when loaded in the direction of the batter.

The expression for W is

$$W = \gamma \frac{bH^2}{2} \tan\alpha \quad \text{.....(3-5)}$$

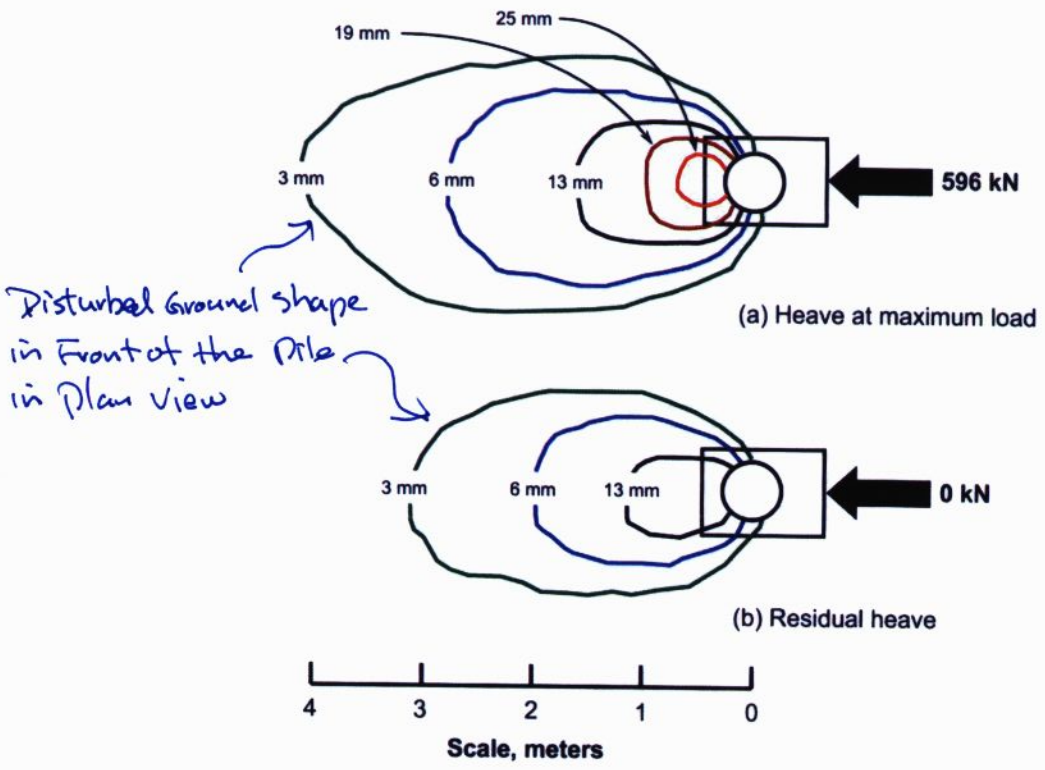


Figure 3-7 Measured Profiles of Ground Surface Heave Near Piles Due to Static Loading, (a) Ground Surface Heave at Maximum Load, (b) Residual Ground Surface Heave

where:

γ = unit weight of soil,

b = width (diameter) of pile, and

H = depth of wedge.

The resultant shear force on the inclined plane F_s is

$$F_s = c_a bH \sec\alpha \quad \text{.....(3-6)}$$

PG 6