Behavior of Grouted Sheet Pile Connection under Horizontal Static and Dynamic Wind Loading

Aram M. Raheem, C. Vipulanandan and A. Ayoub
Texas Hurricane Center for Innovative Technology (THC-IT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
Email: engaram@yahoo.com, cvipulanandan@uh.edu Phone: (713) 743-4278

Abstract: In this study, behavior of grouted sheet pile was investigated under varying wind loading. Effect of various grouting materials on the behavior of the wind loaded sheet pile was investigated using the finite element method. Normal and shear stresses increased as the modulus of the grout increased while the displacement was decreased.

1. Introduction

Sheet piles are being used to protect coastal areas and inland from storm surge and flooding. In order to ensure the quality of the connections various types of grouts are being used (Pan, 2009).

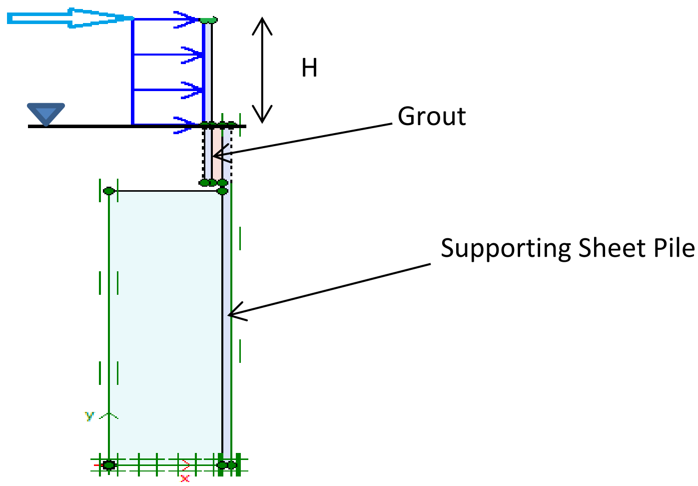

Figure 1 The Geometry of the Finite Element Analysis.

Table 1 The Details of the Finite Element Analysis.

Water depths:	8 m
Length of the grout connection, L_g:	7 m
Thickness of the grout, t_g:	90 mm
Height of fig. 1	13 m
Thickness of the pile and transition piece, t_p and t_s:	60 mm
Penetration into the soil:	34 m
Type of Analysis:	2D Plain Strain Condition
Type of Elements:	Triangular
Total No. of Elements:	271
Total No. of Nodes:	2377

2. Objectives

The objective of this study was to investigate the influence of grout properties on the maximum displacement and normal and shear stresses at the grouted pile interface under static and dynamic lateral loading on the connected pile.

3. Problem Explanation

The system consists of transition part, grout connection and supporting sheet pile. The supporting pile is embedded in the ground and the water is up to the grout connection while the transition zone is in the air. The typical grouting material is a composite material and its physical properties dependent on the w/c ratio as well as the size, amount of sand and reinforcing steel fibers in the grout. Wide range of grouting properties have been analyzed with two different loading condition, in which in the first case a horizontal concentrated load (P=2650kN) was applied while in the second case a combination of a concentrated load (P=2650kN) and a uniformly wind distributed load of (0.5 kN/m^2) which corresponds to a speed of (90 mph) were used for the analyses (Kok and Bujang, 2008). In Table 2 the materials used for the analyses are summarized.

Table 2 Material Properties Used in the FEM Program.

Material	Model	E (kPa)	ν	ɣ (kN/m^3)	k (m/s)
Steel	Linear Elastic	$200*10^6$	0.3	78.5	Non-Porous
Grout	Linear Elastic	$(5\text{-}15)*10^6$	0.19	(14-20)	Non-Porous
Soil	Linear Elastic	$2*10^3$	0.4	19	$1*10^{-9}$

4. Results

The relation between the effect of the modulus on the maximum displacement normalized with height of pile above W.L. (H) at the grout interface is shown in Fig.2.When the grout modulus was increased from 5 to 15 GPa, the deflection in the sheet pile was reduced by 200%. Increasing the modulus increased the shear stress at the joint.

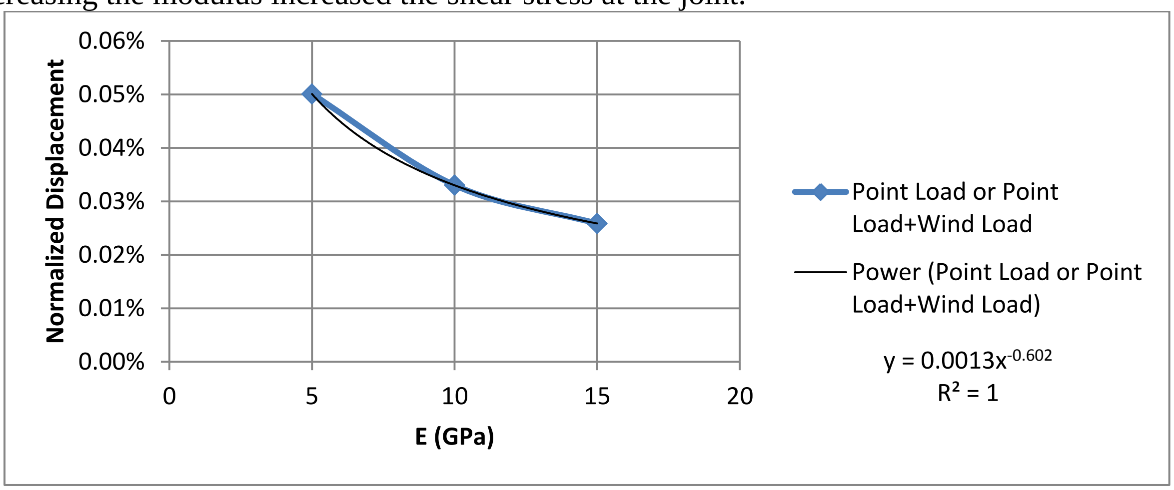

Figure 2 The Modulus-Normalized Deflection Relation at the Interface.

5. Conclusions

The horizontal displacement in the sheet pile decreased with the increased grout modulus for the sheet pile conjunction investigated in this study.

6. Acknowledgement

This study was supported by the Texas Hurricane Center for Innovative Technology (THC -IT).

7. References

1- Kok S.T. and Bujang B.K.,(2008),"Numerical Modeling of Laterally Loaded Piles", American Journal of Applied Science, Vol.5, No.10, pp1403-1408.

2- Pan N.F., (2009)," Selecting an Appropriate Excavation Construction Method Based on Qualitative Assessments", Expert Systems with Applications, Vol.36 (2009), pp5481–5490.