Geotechnical Engineering: Pile Design and Construction

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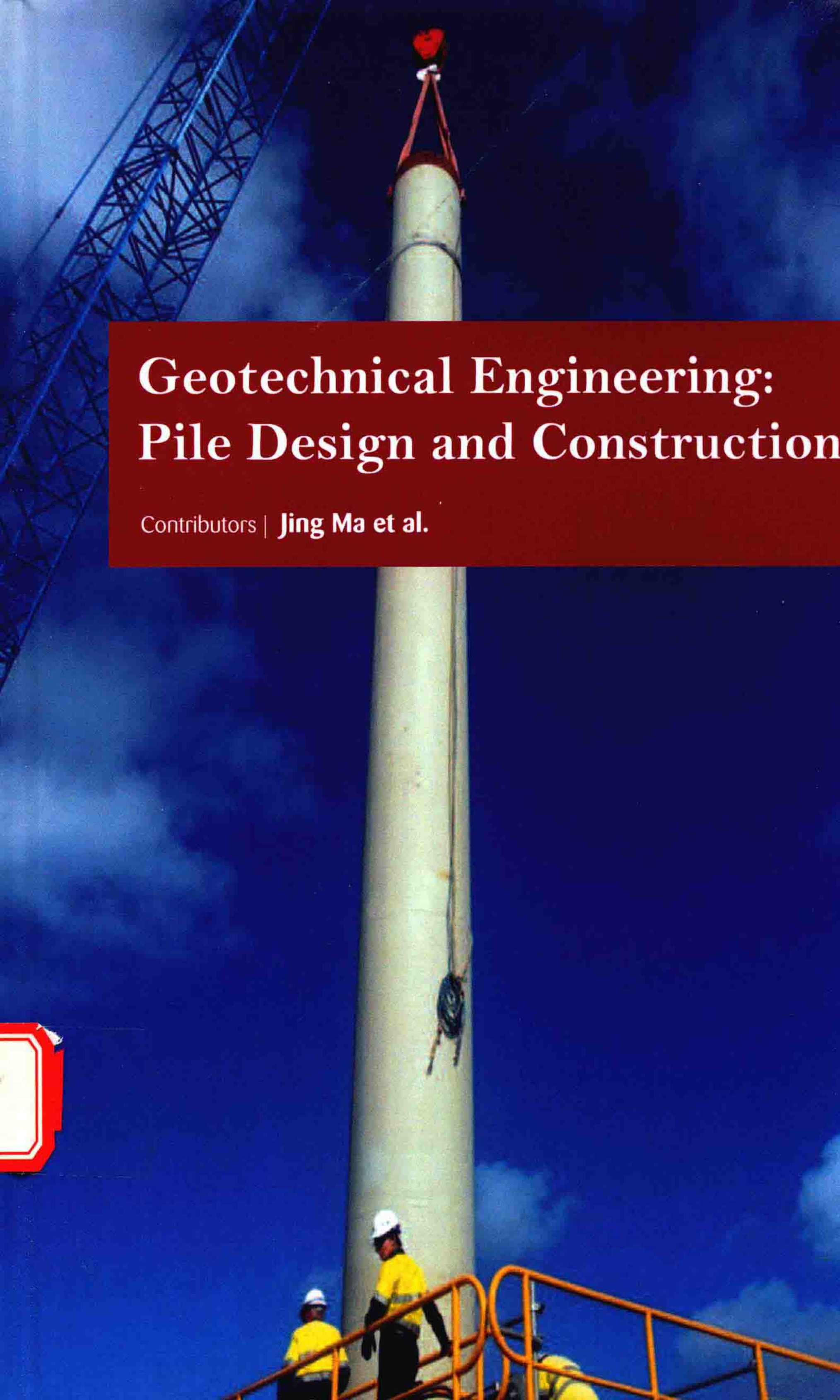

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List of Abbreviations

ANN	Artificial neural networks
ACIP	augured cast-in-place
BBN	Bayesian Belief Network
BOTDR	Brillouin Optical Time Domain Reflectometry
BHC	Butler–Hoy Criterion
CFG	Cement fly ash gravel
CKE	Chin–Kondner extrapolation
CPT	Cone Penetration Test
CFA	continuous flight auger
DOL	Davisson Offset Limit
DTL3	Down Town Line Stage 3
ERSS	Earth retaining and stabilizing structures
FBG	Fiber Bragg grating
FE	Finite element
Ge-doped	Germanium-doped
HMW	Hourly mean wind
OA	Old alluvium
PHC	Prestress high concrete
PDFs	Probability density functions
QA	quality assurance
ROC	Receiver operating characteristic
RMSE	Root mean squared error
SSI	Soil–structure interaction
TPW	Tampines West

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Preface

Geotechnical engineering is the branch of civil engineering concerned with the engineering behavior of earth materials. Geotechnical engineering is important in civil engineering, but also has applications in military, mining, petroleum and other engineering disciplines that are concerned with construction occurring on the surface or within the ground. The text *Geotechnical Engineering: Pile Design and Construction* covers construction and design aspects of piling. Influence analysis of a new building to the bridge pile foundation construction has been presented in first chapter. In second chapter, an evaluation method that can express the local leakage of leachate from the joint sections in the steel pipe sheet piles (SPSP) cutoff walls has been discussed. Experimental study of dynamic characteristics on composite foundation with CFG long pile and rammed cement-soil short pile has been focused in third chapter. A new method for prediction pile capacity executed by continuous flight auger (CFA) has been introduced in fourth chapter. In fifth chapter, the flexural behavior of laterally loaded tapered piles in cohesive soils is investigated. In sixth chapter, we present a numerical modeling of the interaction of using FLAC3D software. In seventh chapter, the application of multilayer neural network (MBPNN) as a structural analyzer for jetty structures has been explored. Wind load analysis of tall chimneys with piled raft foundation considering the flexibility of soil has been carried out in eighth chapter. Ninth chapter discusses the analysis and methodology to assess the effect on the pile foundation of a high-rise building due to the deep excavation of the down town line stage 3 (DTL3) tampines west (TPW) station. Tenth chapter focuses on the differences in the interpreted failure load for augered cast in place (ACIP) piles and seeks to determine which methods are suitable and which methods are inappropriate for the interpretation of ACIP piles. Eleventh chapter outlines a centrifugal model test, performed using a 60 g ton geocentrifuge, to investigate the performance of pipe piles used to reinforce the loess foundation below a widened embankment. The aim of twelfth chapter is to investigate the settlement behaviors of saturated tailings dam soft ground under cement fly ash gravel (CFG) pile composite foundation treatment. Last chapter introduces the receiver operating characteristic (ROC)-curve technique to estimate mainly the quality of a model and to be able to optimize parameters and variables in the model.

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Chapter 1

INFLUENCE ANALYSIS OF A NEW BUILDING TO THE BRIDGE PILE FOUNDATION CONSTRUCTION

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ABSTRACT

This paper is based on the analysis of an industrial factory building to the bridge pile foundation construction stability, and it researches the influence of a new building to the bridge pile foundation internal force by the finite element analysis software ANSYS. By calculating the changes of displacement and internal force of the bridge pile foundation, the deformation can be better controlled. Furthermore, comparing the data of numerical analysis with one of monitor measurements, we conclude that a new building has a small influence on the deformation under load action and the stress variation of a bridge pile foundation. That is to say, the bridge pile foundation is safe and stable under load action.

INTRODUCTION

Since the capital construction increasingly develops and improves in China, more and more new buildings are built on their neighboring existing buildings [1] [2] , which have a certain influence on existing buildings. All these situations, including a foreign-style house on the shallow tunnel, a tunnel under high-rise construction, or a deep foundation ditch around the bridge [3] , require a strict computational analysis to provide reliable data for the influence extent of new buildings to existing ones and estimate the force change of building structure.

ENGINEERING SITUATION

The new industrial factory is located on a high slope, part of the tectonic denudation hilly topography. According to the original relief map, the terrain is flat in the lows, with a gradient of 35. And the slope is a little steep, with a gradient of 15 or 20. Due to a consequent bedding rock landslide, a 25-meter-high and 30-meter-long fill slope is formed on the section of 10'-10' - 15'-15', whose interface obliquity is about 20 degree, consistent with the dip angle of rock stratum.

Currently, a support reinforcement has been applied to the slope by a pile sheet wall. The length of the slope retaining wall is 587.54 meters. Fifty piles are arranged in the middle of the slope, including the bridge pile foundation support and bolt structure beam protection. Specific plans are shown in Figure 1.

ANALYSIS OF THE FINITE ELEMENT MODEL

Computation Module

To reduce the boundary effect and guarantee the accuracy in computation, the model size is that: length along slope to the factory building (X-direction) is 120 m. Width along slope to Y-direction is 50 m. Height from the lower boundary to the surface (Y-direction) is 58 m.

The whole computation module is simulated with a total of 56,326 planar units and 10,659 nodes in the finite element grid. And the finite element grid is divided as Figure 2.

Design Conditions

The model is calculated and analyzed by using Drucker-Prager Yield Criterion in ANSYS [4] , and material parameters are determined based on data from geological survey report. The results are shown in Table 1.

The finite element simulation is computed under the load of self-weight stress and additional stress respectively. We divide the jump into two phases:

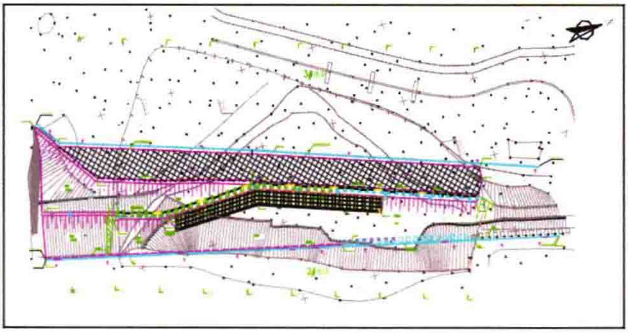

Figure 1: Master plan.

Figure 2: The finite element computation and analysis module.

Step 1: self-weight stress loading;

Step 2: factory loading.

Because the factory loading in process is subject to banded model, these loads are equivalently applied to the whole area of industrial buildings in the worst situation, and the force is 250 KN/M^3. Results are shown in Figure 3.

Results

Simulation of the Results of Self-Weight Stress to the Bridge Pile Foundation

Maximum displacement and stress values in all directions of the bridge pile foundation under self-weight stress are shown in Table 2.

The nephogram of maximum displacement and stress values in all directions of the bridge pile foundation under self-weight stress are shown in Figures 4-9.

Under self-weight stress, the displacement and stress values of the bridge pile foundation are both small. The maximum values of displacement and stress of the bridge pile foundation are both in Y-direction, while the ones are small in Z-direction.

Simulation of the Results of Load Action to the Bridge Pile Foundation

Maximum displacement and stress values in all directions of the bridge pile foundation under load action are shown in Table 3.

The nephogram of maximum displacement and stress values in all directions of the bridge pile foundation under load action are shown in Figures 10-15.

Under load action, the values of displacement and stress in each direction increase, especially in Y-direction, which is consistent with reality. The results verify the correctness of the simulation.

Then, the stresses of bridge pile foundation are less than concrete compression strength in each direction, and

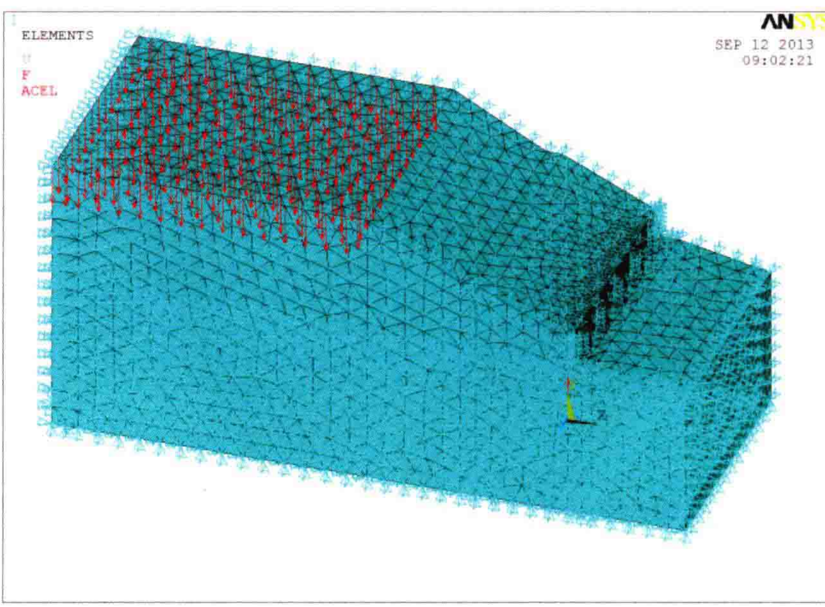

Figure 3: The loading model.

Table 1: Physical property parameter of material

Name	Multiplicity γ kg/m^3	Internal frictional angle Φ/°	Elasticity Modulus E/GPa	Poisson ratio μ
Backfill	2000	28	1.7e−3	0.35
Mudstone	2200	35	0.2	0.23
Concrete	2400	—	30	0.20

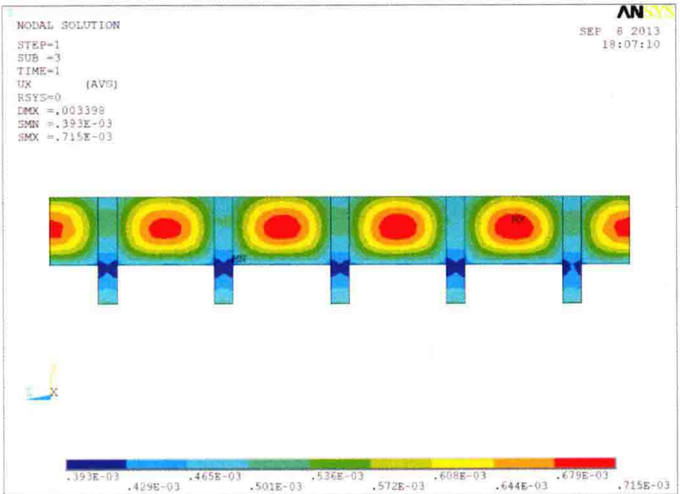

Figure 4: Displacement diagram under self-weight stress in X-direction.

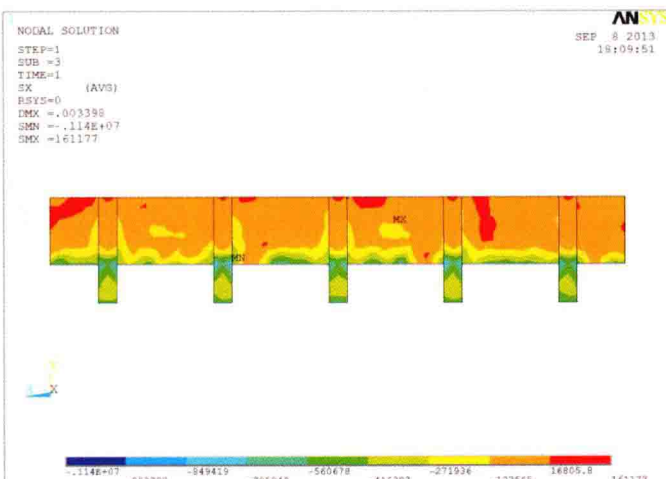

Figure 5: Stress diagram under self-weight stress in X-direction.

Table 2: Bridge pile foundation displacement and stress values under self-weight stress

		X-direction	Y-direction	Z-direction
Displacement (mm)		0.715	−3.347	−0.345
Stress (MPa)	Maximum	0.161	0.070	0.568
	Minimum	−1.140	−1.730	−0.730

the displacements under load action all meet the load bearing requirements, which makes it reasonable and feasible to an build an industrial factory near this bridge pile foundation.

RELATIVE ANALYSIS OF THE NUMERICAL COMPUTATION AND MONITOR MEASUREMENT

Since the only data we can measure is the bridge pile foundation deformation, we set up three stations along the

Table 3: Bridge pile foundation displacement and stress values under load action

		X-direction	Y-direction	Z-direction
Displacement (mm)		0.748	−3.354	−0.360
Stress (MPa)	Maximum	0.265	0.720	0.596
	Minimum	−1.160	−1.750	−1.190

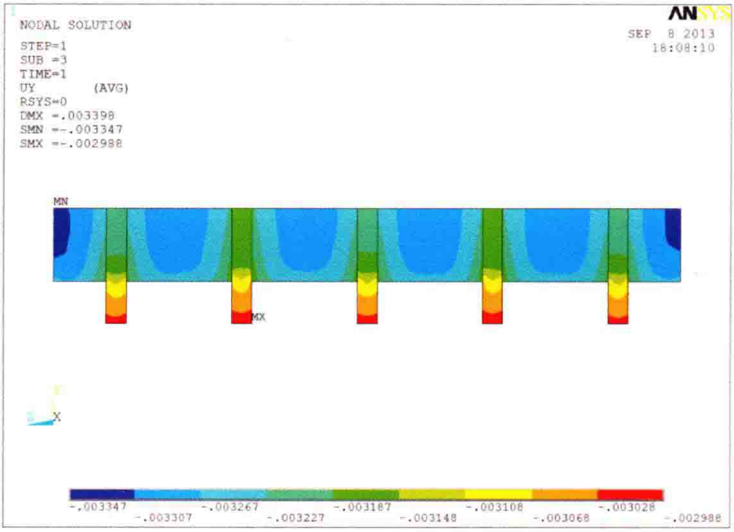

Figure 6: Displacement diagram under self-weight stress in Y-direction.

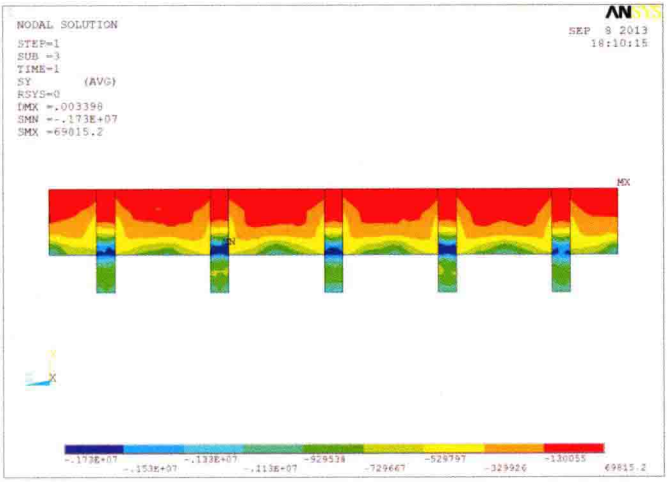

Figure 7: stress diagram under self-weight stress in Y-direction.

bridge pile foundation and conducted a long-term monitoring. We got primary data and current data of the bridge pile foundation, before and after setting up the industrial factory respectively. And the average value of three stations is chose as computed displacement value increment [5] . We compare the data of numerical simulation with that of monitor measurement to verify the reliability of the numerical simulation. Computed and measured values are shown in Table 4.

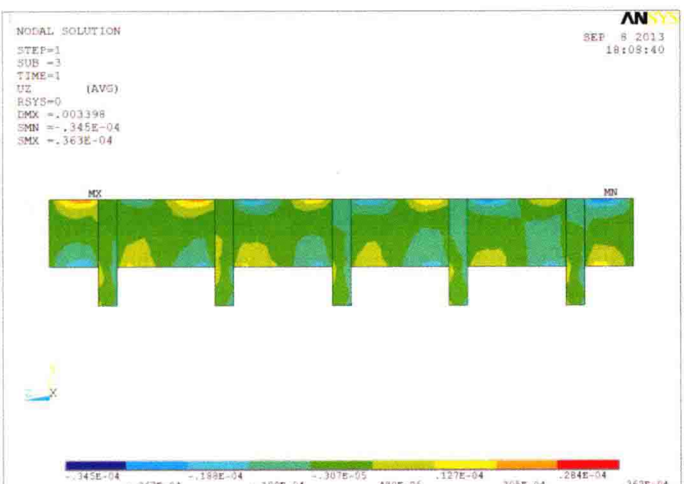

Figure 8: Displacement diagram under self-weight stress in Z-direction.