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Prediction of Pile-group Settlement by the Finite Element Method

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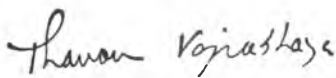
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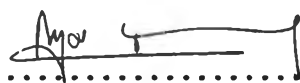
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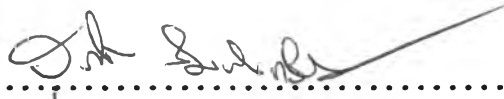
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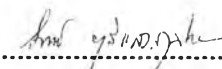

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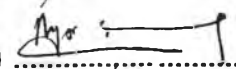


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In this research, a nonlinear three dimensional finite element program has been developed. The formulation for hexahedral element matrices were derived by using the isoparametric finite element discretization technique based on the work of Monkcar (10). The method for predicting pile-group settlements with three dimensional idealization associated with the developed finite element program has been presented. Focus was put on the case of axially loaded driven pile groups situated in a soft soil stratum with the pile tips embedded in an underlying stiffer soil stratum and different soil layers underlying the pile tips were also included in the analysis. Applications of the proposed method to practical problems have been investigated and discussed extensively. Finally, the pile-group settlements predicted by the proposed method were compared to those obtained by Poulos's method and field measurements and their results were in good agreement.

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ลายมือชื่ออาจารย์ที่ปรึกษาร่วม 



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(PREDICTION OF PILE-GROUP SETTLEMENT BY THE FINITE ELEMENT METHOD)

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งานวิจัยนี้ได้พัฒนาโปรแกรมไฟไนต์อีลิเมนต์สำหรับการวิเคราะห์ปัญหาสามมิติแบบไร้เชิงเส้น การสร้างเมตริกซ์แสดงคุณสมบัติของอีลิเมนต์ชนิดลูกบาศก์ใช้หลักการแยกเป็นส่วนย่อยของไฟไนต์อีลิเมนต์โดยอาศัยพื้นฐานจากงานของมอนคาร์(10) งานวิจัยนี้ได้เสนอวิธีการคาดคะเนการทรุดตัวของกลุ่มเสาเข็มโดยใช้แบบจำลองสามมิติประกอบกับโปรแกรมไฟไนต์อีลิเมนต์ที่ได้พัฒนาขึ้น การศึกษาได้เน้นเฉพาะกรณีของกลุ่มเสาเข็มตอรับน้ำหนักในแนวแกนดิ่งที่ฝังตัวอยู่ในชั้นดินอ่อน และปลายเสาเข็มฝังตัวอยู่ในชั้นดินที่แข็งกว่า โดยมีการคำนึงถึงชั้นดินชนิดต่างๆที่อยู่ใต้ปลายเสาเข็มด้วย งานวิจัยนี้ได้นำไปประยุกต์ใช้กับปัญหาจริงโดยทำการวิเคราะห์และตรวจสอบค่าการทรุดตัวของกลุ่มเสาเข็มสำหรับอาคารสูง และได้เปรียบเทียบผลที่ได้กับค่าที่หาโดยวิธีของพาวลอคส์และค่าที่วัดได้ในสนามซึ่งพบว่าให้ค่าใกล้เคียงกัน

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TABLE OF CONTENTS

	Page
Title Page in Thai	i
Title Page in English	ii
Thesis Approval	iii
Abstract in English	iv
Abstract in Thai	v
Acknowledgements	vi
Table of Contents	vii
List of Tables	x
List of Figures	xi
List of Symbols	xiii
 CHAPTER	
I. INTRODUCTION	1
Introduction	1
Objectives and Scope of Research	2
Assumptions	2
Literature Review	3
II. THEORETICAL BACKGROUND	6
Introduction	6
An Incremental Nonlinear Formulation of Equations of Motion for Finite Deformation	6
1. Introduction to the Concept of the Incremental Nonlinear Formulation of the Equations of Motion ..	6
2. Kinematic Relations	10
3. Equilibrium Equations	10

	Page
4. Constitutive Relations	14
5. Incremental Nonlinear Equations of Motion with Equilibrium Corrections	14
Finite Element Formulation of Equations of Motion for Finite Deformation	16
1. Introduction	16
2. Discretization of Equations of Motion by Finite Element Method	17
3. Three Dimensional Isoparametric Finite Element Matrices	20
3.1 Linear Isoparametric Hexahedral Element	20
3.1.1 Components of Stresses and Strains	20
3.1.2 Interpolation Functions	21
3.1.3 Strain-displacement Transformation	22
3.1.4 Jacobian Transformation	26
3.2 Evaluation of Element Matrices	29
3.2.1 Linear Element Stiffness Matrix	29
3.2.2 Geometric Stiffness Matrix	29
3.2.3 Equivalent Nodal Load Vector 1R for Equilibrium Correction	33
3.2.4 Consistent Nodal Load Vector 2P	34
III. NUMERICAL SCHEME	36
Introduction	36
Numerical Methods for the Solutions of Nonlinear Equations	36
Computational Procedure	38
Computer Program Development	40

	Page
IV. APPLICATION OF THE FINITE ELEMENT METHOD TO THE PROBLEM OF PILE-GROUP SETTLEMENT	41
Introduction	41
Determination of Parameters	41
1. Introduction	41
2. Pile Parameters	42
3. Soil Parameters	43
3.1 Laboratory Tests	43
3.2 Pile-loading Tests	45
3.3 Empirical Correlation	46
3.3.1 Piles in Clay	46
3.3.2 Piles in Sand	46
Behavior of Square-configuration Pile Group	47
1. Introduction	47
2. Method of Analysis	47
3. Pile and Soil Parameters	48
4. Comparisons with Poulos's Method	49
Illustrative Application	51
1. Introduction	51
2. Method of Analysis	51
3. Pile and Soil Parameters	53
4. Comparisons with Field Measurements and Poulos's Method	53
V. CONCLUSIONS AND RECOMMENDATIONS	54
LIST OF REFERENCES	56
VITA	85

LIST OF TABLES

Table	Title	Page
4.1	Suggested ranges of values of Poisson's ratio of soil	59
4.2	Suggested ranges of average values of soil modulus for driven pile in sand	59
4.3	Summary of parameters for the analysis of the settlements of pile groups	60
	(a) Pile	60
	(b) Soil	60
4.4	Summary of average settlements of pile groups	61
4.5	Immediate settlement and equivalent width B_e of smaller pile groups	62
4.6	Summary of parameters for the analysis of the settlements of Tower C Building	62
	(a) Pile	62
	(b) Soil	63
4.7	Comparisons of the settlements of Tower C Building	64

LIST OF FIGURES

Figure	Title	Page
2.1	Deformation path of a body	65
2.2	Three dimensional isoparametric hexahedral element	66
3.1	Flow chart for the computational procedure of the nonlinear elastic static finite element analysis	67
3.2	Elastic cantiliver beam under uniformly distributed load ..	68
3.3	The relation between load and tip displacement	69
3.4	Cross-section model of uniform soil mass under strip loading	70
3.5	The settlement profile of soil surface	71
4.1	Plan and elevation of 2x2 pile group	72
	(a) Plan	72
	(b) Elevation	72
4.2	Plan of 3x3 pile group	73
4.3	Plan of 4x4 pile group	73
4.4	Finite element model for 2x2 pile group	74
4.5	Finite element model for 3x3 pile group	75
4.6	Finite element model for 4x4 pile group	76
4.7	Finite element model for single pile	77
4.8	Relation between settlement ratio R_s and pile spacing s/d .	78
4.9	The floor plan of Tower C Building with observed points ...	79
4.10	The plan of pile arrangement	80
4.11	The plan of the smaller pile groups	81
4.12	The plan of the equivalent pile groups	82

Figure	Title	Page
4.13	The relation between the settlement and the equivalent width B_e of pile groups	83
4.14	The settlement values predicted by the proposed method	84

LIST OF SYMBOLS

${}^1A, {}^2A$	the part of the area in the current, a second deformed configurations
B	linear strain-displacement transformation matrix
B_e	equivalent width of the pile group
C_0, C_1, C_2	the undeformed, the current deformed, a second deformed configurations
C_{IJKMN}	component of constitutive matrix
c_u	undrained cohesion of the clay
D	width of the pile group
d	width or diameter of the pile
${}^2E_{IJ}, {}^1E_{IJ}$	component of strain at a second, the current deformed configurations
E_{IJ}	component of incremental strain between the current and a second deformed configurations
E_p, E_s	modulus of elasticity of pile, soil
E_u, E_s'	modulus of elasticity of soil in undrained, drained condition
E_b/E_s	ratio of soil modulus between base layer and founding layer
e_{IJ}	linear part of incremental strain
${}^2f_I, {}^1f_I$	component of body force at a second, the current deformed configurations
\bar{K}	nonlinear stiffness matrix
K_G	geometric stiffness matrix

K_L	linear stiffness matrix
L	length of pile
P	axial compression
\bar{P}	the generalized force vector
2P	generalized nodal load vector due to the body forces and the conservative surface tractions
q_{mk}	component of incremental displacement at node m
1R	consistent nodal load vector in equilibrium with the state of stress in the current deformed configuration
R_s	settlement ratio of pile group
(r,s,t)	natural coordinates
${}^2S_{i,j}, {}^1S_{i,j}$	component of stress at a second, the current deformed configurations
$S_{i,j}$	component of incremental stress between the current and a second deformed configurations
s	spacing of pile (center to center)
${}^2t_i, {}^1t_i$	component of surface traction at a second, the current deformed configurations
${}^2U_i, {}^1U_i$	component of displacement at a second, the current deformed configurations
U_i	component of incremental displacement between the current and a second deformed configurations
${}^0V, {}^1V, {}^2V$	volume of the body in the undeformed, the current deformed, a second deformed configurations
W_{ext}, W_{int}	virtual work of external forces, internal forces
X_{mk}	component of nodal coordinate
${}^0\Omega, {}^n\Omega, {}^f\Omega$	initial, current, final equilibrium stages
$\eta_{i,j}$	nonlinear part of incremental strain

$\phi^m(x)$	interpolation function at node m
γ_p, γ_s	unit weight of pile, total unit weight of soil
ν_p, ν_s	Poisson's ratio of pile, soil
ν_u, ν_s'	Poisson's ratio of soil in undrained, drained condition
ρ_i	immediate settlement of pile foundation
ρ_f	final settlement of pile foundation