PARAMETRIC STUDY OF DEEP EXCAVATION USING SAGE CRISP SOFTWARE

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Universiti Malaysia Sarawak
2001

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A Project Submitted in Partial Fulfillment for the Bachelor of Degree of Civil Engineering (CIVIL) with Honours in the Faculty of Engineering Universiti Malaysia Sarawak
2001

Borang Penyerahan Tesis
Universiti Malaysia Sarawak

BORANG PENYERAHAN TESIS

Judul: **PARAMETRIC STUDY OF DEEP EXCAVATION USING SAGE CRISP SOFTWARE**

SESI PENGAJIAN: 2000/2001

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APPROVAL SHEET

This project report attached here to, entitled "Parametric study of deep excavation using sage crisp software", prepared and submitted by Isaruddin b. Morshidi in partial fulfillment of the requirements for the degree of Bachelor of Engineering (CIVIL) is hereby accepted.

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Dedicated to my
parents, brothers and sisters,
loves one & friends.

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to Allah s.w.t, the God almighty, of His gracefulness for allowing me to finish my final year project.

My most sincerely thanks to people who have contributed towards the preparation of this project. Firstly, I wish to thank my supervisor, Mr. Ahmad Kamal for his guidance, advice, comments and encouragement's through this project. Thanks also to all lectures and staffs of the engineering Faculty, UNIMAS, for their supports.

I would also like to thanks my family, especially to my parents, loves one and also my brothers and sisters for all the help and motivation along the way to completing this project. Acknowledgement will not be complete without mentioning all my friends especially Ratman, Abang Mohd Faizal, Hariman, Ahmad Salihin, Irwanddy, Wenddy, Ateh, Aida, Meering, and Mahyuddin, who have given their constant support and encouragement.

To all those named above and other people has not been mentioned, I'm extremely thankful.

ABSTRACT

The settlement and lateral deformation are main concerns for a deep excavation in soft soil. This parametric study of deep excavation by using Finite Element Method (FEM) that is Sage CRISP computer program. The excavation was supported by sheet piles and supported with steel struts. Numerical results are presented in term of bending moment in the wall, wall deflection, surface settlement, major effective principal stress and direction of major principal strain. Comparing the numerical result with field data can give acceptable deformation prediction, and the results can be references for the design of support excavation in the soft soil.

ABSTRAK

Pemendapatan dan perubahan tegak merupakan perkara yang penting di dalam proses pengorekan dalam. Projek ini merupakan kajian mengenai parameter tanah dengan menggunakan kaedah unsur tak terhingga, iaitu dengan bantuan perisian komputer Sage CRISP. Kajian ini melibatkan pengorekkan dalam yang disokong oleh "sheet pile', manakala dindingnya disokong pula dengan 'strut'. Keputusan daripada kajian ini berbentuk moment lentur, bengkokan dinding 'sheet pile', permendapan permukaan tanah, kecekapan utama prinsipal rincihan dan arah utama prinsipal terikan. Dengan membuat perbandingan dengan data dari tapak kita boleh membuat analisa dan keputusannya boleh digunakan untuk mereka bentuk struktur dinding penahan.

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NOTATIONS

E	=	Modulus of elasticity
G	=	Shear elasticity
V	=	Void ratio
OCR	=	Over consolidation ratio
W	=	Moisture content
LL	=	Liquid limit
PL	=	Plasticity limit
PI	=	Plasticity index
LI	=	Liquid index
c	=	Unit weight of soil per unit volume
e	=	In situ void ratio

CHAPTER ONE

INTRODUCTION

1.1 General

Excavation in soft clay deposits are frequently made for a number of purposes, namely: basements for tall buildings, canals for water supply and drainage, dry docks and for pipe-laying in transmission of natural gas, and industrial use of water. The lateral deformation and the settlement characteristics are the critical aspects in an excavation in soft clay.

This project is to analyze parameter by finite element software called Sage CRISP. It will be used to analyze the performance of deep excavation in Bangkok subsoils with different height of sheet pile wall. By comparing the numerical results with field data in terms of wall lateral deflection indicates that finite element analysis can give acceptable deformation prediction.

1.2 Objective

The objectives of this project are:

1) *To use of Sage CRISP computer program to simulate and also study the effect of various depth of sheet pile wall on the braced excavation on soil.*

2) *To use of Sage CRISP computer program to simulate the bending moment, sheet pile wall deflection and settlements on Bangkok Cam clay. The results can served as references for excavation design and solve geotechnical problem.*

CHAPTER TWO

LITERATURE REVIEW

2.1 General

Excavation involved a removal of material and consequently causes a change in the state of stress in soil or rock beneath and beside the excavated (Wolmer Fellenius,1876). In as much as no material can experience a change in stress without corresponding deformations, excavation is always associated with movements of the adjacent ground surface

Some soil will stand to considerable depths when cut vertically although most will not. When vertical slopes slough out to a stable angle, large blocks of material may slide down into the excavation work. So, some temporary of slopes are needed during the excavation which depends the soil type and seepage

2.2 Slope stability

Three main considerations must take into account when determination of stable slopes for open excavation. First, types of soil. The second is the length of time over which the excavation is required to remain open, and lastly is the permissible degree of risk of slipping.

Gravity and seepage force tend to instability in natural slopes especially in excavation and embankment slope. When a slope is formed by excavation, the degrease in total stress result in changes in pore water pressure in vicinity of the slopes and particular, along a potential failure surface (W.H Ting, 1987).

Many excavation are started with a vertical cut. Some soil will stand to considerable depths when cut vertically although most will not. When vertical slopes slough off to a stable angle, long blocks of material may slide down into the excavation.

2.2.1 Slope Failure

Slopes may fail because of the number of mechanisms, depending on the nature of the soil involved and the arrangement of natural earth material at site. The soil failure can be divided into three, there are rotational slump, translational and slip.

Slope failures occur because of forces tending to cause instability exceed those tending to resist it. Generally, the driving forces are represented by a component of soil weight down-slope and resisting forces are represented by the soil strength acting in opposite direction.

The factor of safety for slope is expressed as the ratio of resisting moments to the driving forces or moments. When the factor of safety is 1 or less, the slope must fail. When the factor of safety exceeds 1, the slope theoretically stable. In designing cut slopes, the usual factor of safety required is in between 1.3 and 1.5.

2.3 Soil pressure

Actually, for every excavation work, soil pressure is one of the most important criteria to be considered. Soil behave linearly elastic porous material which deforms with the change in the effective stress applied (Biot,1941,1955&1956).

2.3.1 Rowe (1952)

Rowe (1952) was using the flexibility method for design approach of sheet pile in sand. By assuming the that the anchor and subsoil yield approximately have same amount, such the wall will translate away from approximately have same amount, such the wall will translate away from the retained soil into the soil below dredge level. This is the free earth support condition and the equations governing the pressure distribution on gravity walls apply.

Factor soil properties are used on the passive side and taking moments of the active and passive forced about the anchorage point gives an equation for penetration depth D from which D determined.

2.3.2 Terzaghi and Peck (1967)

Terzaghi presented the method of earth pressure calculation in general use for excavation supports based on observations of actual loads in struts in full-scale excavation in sand Berlin (Spilker,1937). Later, Terzaghi and Peck shown apparent pressure for wall and strut design using measured soil pressures. The pressure envelope was given maximum ordinate base on a portion of the active earth pressure using the Coulumb or Rankine pressure coefficient.

2.4 Stability of supported excavation

Excavation support are associated with cuts. As cut is made, the soil at the face tend to expand or move into cut area. This expansion mobilize some of soil strength. If a support is placed against the excavation surface in such a manner as to prevent all movement, then the stress existing before excavation maintained. If some movement is permitted, the distribution of pressure changes. The actual distribution of pressure will depend on the mode of movement permitted.

Without adequate lateral support the new excavation will cause loss of bearing capacity, settlements, or lateral movements to existing property.

Anchored sheet pile walls also known as anchored bulkheads which are the most common types of retaining wall used in waterfront construction, being generally more economical than gravity walls. Another types of sheet pile wall are cantilever sheetpiling, heetpiling with relieving platform and lastly, cellular cofferdams (Krey,1933).

Sheet piles are prefabricated or precast members to be driven vertically into the ground to form a continous vertical wall. The characteristic of sheet piles are described roughly below (Wayne C. Teng,1962).

- Steel sheet piles

  Steel sheet piles are rolled structural members with interlocking to engage with one another. There a variety of steel sheet piles for example. Finger-and-thumb type and Ball-and socket type. The interlocks have somewhat different forms in sheet piles produced by different manufacturers, and only a few sections manufactured by the same manufacturer will interlock each other.

2.4.3 Bjerrum and Kirkerdam (1958)

In 1958, Bjerrum and Kirkerdam measured strut forces in an excavation indicated the lateral earth pressure increased from 20 to 63 Kpa owing to an apparent loss of cohesion. The observation was based or back-computing using consolidated-undrained strength values of both and C and later assuming only a drained Ø angle.

Bjerrum and Kirkerdam also presented the mechanics of bottom heave. Bottom heave usually accompanied by settlement of the ground surface near the excavation. The magnitude of the yielding and it's accompanying settlement depends on the type of ground and the care with which the ground is supported. In soft silts and clays, there is additional risk of upward heaving of the bottom of excavation accompanied by major settlement of the ground surface. Therefore the critical depth of an excavation as shown below,

$$\textbf{Critical depth, } \mathbf{D = N_c/\gamma}$$

And also, the factor of safety against bottom heave is given by,

$$\mathbf{F = (Ncs) / (\gamma D + P)}$$

where,

N_c = Coefficient depending on the dimensions of the excavation

S = Undrained shear strength of the soil in a zone immediately around the bottom of excavation.

γ = Density of the soil

D = Depth of excavation

P = Surface surcharge

The undrained of shear strengths of soft or firm normally consolidated clay obtained by using Vane test. And need to correct by using the factor. This is because the author, Bjerrum concluded the difference is caused by the anisotropy of the soil and the difference in the rate of loading between a rapidly executed field vane and the slow application of loading from foundations and earthworks.

2.5 Displacement around excavation

2.5.1 Clough and Danby (1976)

Both of Clough and Danby (1976) stated that the amount of yielding for any given depth of excavation is a function of the characteristics of the supported soil and not of the stiffness of the support. Steel structural members. even of heavy section, are not stiff enough to reduce yielding by any significant amount. Yielding also take place with cast in-place concrete diaphgram-walls which can be of the same order as that experienced with sheet pile.

2.6 Settlement due to increasing load on surrounding soil

Karl Terzaghi and Ralph B.Peck presented that an application of a load to one portion of the ground surface above any type of soil causes the surface of the adjacent tilt. The distance within which the tilt is of any practical importance depends, however, upon the soil profile as the dimensions of the loaded area. If the subsoil contain soft clay, the magnitude and distribution of the settlement can be estimated on the basis of the results of soil tests. If the subsoil is sand, the settlement cannot be computed and estimates can be base only on the records of precedents.

2.6.1 Open cuts in soft clay

Open cut in soft clay, the clay that located at the sides of the cut will act as surcharge. Under this surcharge the clay near the bottom of the cut will yields laterally toward the excavation, and the bottom of the cut will rises. As a consequence of these movements, the ground surface that located above the yielding clay will settles. An additional lateral yield occurs above the bottom of the cut during the intermission between excavation installation of the struts. The magnitude of the lateral movement and the corresponding settlement depends primarily on:

(a) The width-depth ratio of the cut.

(b) The construction procedure

(c) Depth and stress-strain characteristics of the soft clay beneath bottom of the cut.