ผลกระทบของหน่วยแรงแบบแอนไอโซโทรปิกต่อค่าโมดูลัสของดินเหนียวโดยวิธีการตรวจวัดด้วยเบนเดอร์อิลิเมนต์

นาย ซูมาโยโน่

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมมหาบัณฑิต

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EFFECT OF STRESS ANISOTROPY ON STIFFNESS OF CLAYS USING BENDER ELEMENTS

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Sumaryono: ผลกระทบของหน่วยแรงแบบแอนไอโซโทรปิกต่อค่าโมดูลัสของดินเหนียวโดยวิธีการตรวจวัดด้วยเบนเดอร์อิลิเมนต์ (Effect of stress anisotropy on stiffness of clays using bender elements)
อาจารย์ที่ปรึกษา: รศ. ดร. สุพจน์ เตชวรสินสกุล, 109 หน้า ISBN 974-53-1685-7

โมดูลัสเฉือน (shear modulus) ของดินเหนียว มีความสำคัญเป็นอย่างมากในทางวิศวกรรมปฐพี โดยเป็นค่าพารามิเตอร์ที่สำคัญในงานทางปฐพีกลศาสตร์ โดยเฉพาะอย่างยิ่งใน small strain dynamics เทคนิคที่ใช้ในการศึกษานี้จะมีพื้นฐานมาจากการส่งผ่านคลื่นจากตัวส่งไปยังตัวอย่างดิน ในการศึกษาครั้งนี้ จะวัดค่าโมดูลัสเฉือน โดยค่าโมดูลัสเฉือนทำได้โดยการวัดค่าจากการนำ bender elements ติดตั้งไว้ที่ top cap และฐานวางตัวอย่างดินของเครื่องทดสอบแรงอัดสามแกน งานวิจัยนี้มีความมุ่งหมายเพื่อศึกษาการเปลี่ยนแปลงของโมดูลัสเฉือนและค่าความเร็วของเคลื่อนเฉือนของตัวอย่างดินที่มีการอัดตัวคายน้ำที่แตกต่างกัน (ที่ความเค้นเท่ากันทุกทิศทาง และที่ความเค้นไม่เท่ากันทุกทิศทาง) นอกจากนี้ยังทำการศึกษาผลกระทบของความเค้นเบี่ยงเบน (deviator stress) ที่มีต่อโมดูลัสเฉือน จากการศึกษาพบว่าความสัมพันธ์ระหว่างค่าโมดูลัสเฉือน และค่าหน่วยแรงประสิทธิผลในตัวอย่างที่มีการอัดตัวคายน้ำด้วยความเค้นที่เท่ากันทุกทิศทาง และไม่เท่ากันทุกทิศทาง จะมีความแตกต่างกันเพียงเล็กน้อย ค่าโมดูลัสเฉือนที่ได้ขณะเฉือนตัวอย่างดินแบบไม่ระบายน้ำ ได้ผลคล้ายกับที่ได้ระหว่างการทดสอบการอัดตัวคายน้ำ ซึ่งสามารถสรุปได้ว่าค่าโมดูลัสแรงเฉือนของดินเหนียวในการทดสอบแบบ triaxial นั้น จะไม่ขึ้นอยู่กับขนาดของหน่วยการเฉือน โดยได้นำเสนอสมการแสดงถึงความสัมพันธ์ระหว่างค่าโมดูลัสเฉือน กับค่าหน่วยแรงประสิทธิผลสำหรับดินเหนียวบริเวณกรุงเทพมหานคร

สาขา....วิศวกรรมโยธา.... ลายมือชื่อนิสิต....................
สถานศึกษา....วิศวกรรมโยธา.... ลายมือชื่ออาจารย์ที่ปรึกษา....................
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Sumaryono: EFFECT OF STRESS ANISOTROPY ON STIFFNESS OF CLAYS USING BENDER ELEMENTS. THESIS ADVISOR: ASSOC. PROF. SUPOT TEACHAVORASINSKUN, D.Eng. 109pp. ISBN 974-53-1685-7

Studying and determination of shear wave velocity and shear modulus of clay has a considerable importance in Geotechnical Engineering. By concerning the real field situation, the initial shear modulus of soil is an important parameter for a variety geotechnical design applications, especially in small strain dynamics. Several methods and techniques are exists. The technique which is based on propagation of shear wave through soil sample was adopted in this study to measure shear modulus. The shear modulus was measured using a pair of bender elements installed at the top cap and pedestal of the triaxial cell. This research aims are to study variation of shear modulus and shear wave velocity with different stress consolidation (isotropic and anisotropic). The isotropic and anisotropic consolidation was conducted step by step so the variation of shear modulus can be determined. To examine the influence of deviator stress on shear modulus, a number of tests of consolidated undrained triaxial compression tests were performed both in anisotropic and isotropic conditions. There is a unique relationship between shear modulus and mean effective stress for both isotropic and anisotropic consolidated samples. It was found that no discernible effect of anisotropy of stress on the values of shear modulus even at high mean effective stress. The undrained shearing was carried out at the strain rate of 0.02 mm/min, during this steps, the elastic shear modulus was continuously recorded. The shear modulus obtained during undrained triaxial shearing exhibit similar dependency on the mean effective stress. The path of shear modulus during undrained shearing, both from isotropically and anisotropically consolidated samples generally followed the path obtained during consolidations. It implied the negligible effect of the deviator stress on shear modulus. An empirical equation was then proposed to express the shear modulus against mean effective stress for Bangkok clay.

Department……....Civil Engineering…………Student's signature……………………
Field of Study……Civil Engineering…………Advisor's signature…………………...
Academic Year …..2004………………………

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This research was truly supported by the help of many other people, without them it would have been impossible to complete this research. I am grateful for the support of Head of Geological Engineering Department, Gadjah Mada University Dr. Dwikorita Karnawati, and my teachers Dr. Subagyo Pramumijoyo, Dr. Heru Hendrayana suggestion and their opinion that has made me a better person.

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CHAPTER I

INTRODUCTION

1.1 Background

Studying and determination of shear wave velocity and shear modulus of clay has a considerable importance in geotechnical engineering. To determination it, several methods and techniques are exist. One of the newest lab-techniques is the bender element test. This technique which is based on incorporation of shear wave theory was adopted in this study to measure shear modulus.

The design of earth structure like foundations and excavations requires the prediction of ground movements and hence a knowledge of the relevant stress-strain properties (Mair, 1993). It is now appreciated that under working conditions the strains in the ground surrounding foundations or excavations may be relatively small. Therefore it is important to measure stiffness at small strain levels < 0.1%, since stress-strain relationships are non-linear (Burland, 1989; Atkinson, 2000). Knowledge of the stiffness of soil at strain in the range 0.0001 – 0.001 % may be required in earthquake geotechnical engineering (Isihara, 1996). By concerning the real field situation, the initial shear modulus of soil is an important parameter for a variety geotechnical design applications, especially in small strain dynamic analysis which could predict soil behavior or soil structure interaction during earthquakes, explosions, and machine foundation or traffic vibrations.

Values of the shear modulus at very small strain (G_0) can be determine using dynamic techniques in field and laboratory tests, in which the deformation properties of the soil are related to elastic shear wave velocities. Laboratory testing on ounce have recently made remarkable progress. Advanced techniques are utilized not only for academic research but also in practice. Besides the safety factor at failure, accurate estimations of deformation, displacement and stresses in the ground and in structures have become an important topic of study in geotechnical engineering.

Baldy, Hight and Thomas (1988) quoted in Sahabdeen M. M (1995) concluded that measurement of stiffness in conventional test were generally unreliable at strain less than 1% in unconsolidated sample and at slightly smaller strains in isotropic consolidated sample. They also noted that in conventional triaxial test the first reading was often not obtained until axial strains of about 0.3%. There is no doubt that measurement of axial strain made in conventional triaxial test are normally inadequate for examining stress-strain behavior of soil and measuring realistic value of soil stiffness parameter for design of most geotechnical structures. It is only recently that the evaluation of stiffness at such small strain levels has been recognized. The most reliable method currently used to evaluate the initial stiffness modulus which is also called as maximum shear modulus or initial shear modulus is using bender elements, developed after resonant column test method in which the sample is excited torsionally and depend on resonant frequency of soil equipment system, calibration constants, specimen dimensions and mass. The selection of bender elements, mainly because of the adequate propagation of waves through the soil specimen the matching of approximately equal soil stiffness and simplicity of computation and installment compare with resonant column method.

The incorporation of shear velocity measurement in the controlled environment of laboratory tests connects techniques usually considered separate domains of geophysicists and soil mechanics. To the practicing geotechnical engineering, geophysics' data often appears incomprehensible, therefore, refereeing to literature (e.g., Viggiani (1995), where the interpretation of arrival times is highly subjective. In a controllable environment (such as a laboratory), it is an achievable goal to develop systems which generate, propagate and receive shear waves with a degree of clarity, that leaves no doubt as to how it takes for a wave to pass through a soil. Bender Element made from high impedance piezoceramic material, and therefore needs perfect insulation in the conductive watery environment of soils and triaxial cell. Signals from Bender element which pass into, through and out of soils are attenuated and distorted. The magnitudes of the sent and received signals are usually significantly different and the instrumentation used to send and detect signals, requires that the Bender element and the systems are within the range they are used and optimized.

1.2 Aims and Objectives of the Research

The objective of this research is to study effects of stress anisotropy on stiffness of clays using bender elements. The main parameter that can be estimated using bender elements is the initial shear modulus and shear wave velocity from different consolidation condition of clays. The tests can be carried out to study the followings;

1. To study the variation of shear modulus and shear wave velocity with different mean effective stress.
2. To monitor the variation of shear modulus and shear wave velocity with different consolidation conditions (isotropic and anisotropic) or to study stress induced anisotropy.
3. To examine the relationship between mean effective stress states and shear modulus at small strain of clay.
4. To compare factor controlling shear modulus in isotropic and anisotropic condition

1.3. Scope of the Research

Some constraints will be considered as to limit the scope of this research, so that investigation could be done deeply and clearly. These scopes are:

1. The sample of soil is Bangkok clay with depth 10 – 16 m.
2. Condition of isotropic consolidation and anisotropy consolidation in triaxial test to be performed in this research are K = 0.3, 0.6, 1 with mean effective stress 100, 300, 500 kPa.
3. Accuracy of bender elements test is based on the reliability of bender elements setup and reliability of the interpretation method that is used in analyzing bender elements test data.

1.4. Layout of Thesis

The work presented in this thesis is divided into the following chapters:
Chapter 1 presents introduction of the important of shear wave velocity or shear modulus measurement in geotechnical problem. This chapter explains about the aims, objectives and scope of the research.

Chapter 2 presents a literature review of factor controlling shear modulus in fine grain soil and previous researcher research related with this thesis. This chapter explains about the performance of bender elements and the potential error measurements of shear wave velocity using bender elements.

Chapter 3 presents the research methodology, instruments/equipments used, sample preparation, test program for both isotropic and anisotropic, and method of interpretation of bender elements and analysis data.

Chapter 4 presents the results and analysis from the laboratory investigation, where bender elements are used to measure the shear modulus of clay under different mean effective stress, consolidation process, and undrained shearing. Effect of stress induced anisotropy will be explained on this chapter.

Chapter 5 presents the conclusion of the effect of stress anisotropic of clay using bender elements in triaxial apparatus and recommendations. Recommendations are then drawn regarding each topic and suggestions are made for the direction of future research in terms of investigating the stress induced anisotropy on overconsolidated clay, investigate the effect of stiffness of clay on stress anisotropic in extension loading, direction of wave propagation using triaxial apparatus and determination of localization using bender elements.

CHAPTER II

LITERATURE RIVIEW

2.1 Introduction

The stress-strain characteristics of soils can be expressed in term of modulus (gradient of the stress-strain curve) at particular strain level. Strain levels can be categorized into very small, small and large. The boundaries between these ranges should be defined to avoid any confusion in this study though they are not definitive. There are a number of factors which controls the estimation of the modulus such as the rate of loading, time effects, the creep, the stress and strain level, the position of the state of the sample in boundary surface, the over consolidation ratio and stress-strain history of the soil sample.

Basically, the stiffness is obtained using secant of or tangential gradient of the stress-strain curve. Therefore it depends on both the stress and strain. However, the accuracy of measurement of the strain more practically governs the estimation of the stiffness of the soil. Figure 2.1 is an idealization of soil stiffness over a large range of strain, from very small to large, and approximately distinguishes strain ranges. At very small strains the shear modulus (G) reaches a nearly constant limiting value G_0. This figure summaries the current understanding of the variation of soil stiffness and shown the stiffness at very low strain level is almost constant and implies more relevancy to practical situation. The very small strain stiffness of soils is a useful parameter in both static and dynamic analyses of the behavior of geotechnical structures. Non-linear models for soil behavior may be developed using the theory of elasticity with empirical non-linear stress-strain curves obtained from laboratory stress path test.

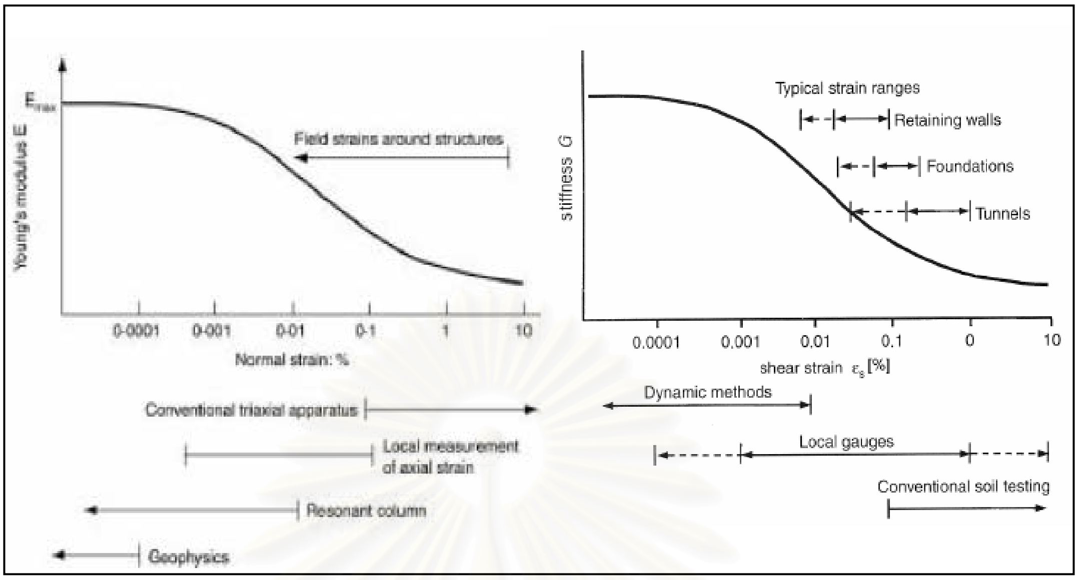

Figure 2.1: Characteristic stiffness-strain behavior of soils with typical strain ranges for laboratory tests and structures (after Atkinson and Sallfors, 1991; Mair, 1993)

2.2 Factor Controlling Shear Modulus

Review of literature shows that the shear modulus of unbound granular materials mainly depends on the void ratio e and on the effective principal stresses σ'_1 and σ'_3. Therefore, the shear modulus Gmax is expressed as a function of the void ratio and of the mean effective stress p' such as (Hardin& Richart, 1963; Iwasaki & Tatsuoka, 1977; Hicher, 1996; Lo Presti *et al.*, 1997) all the references quoted in Dano (2002) :

$$G_{max}(MN/m^2) = \frac{K}{F(e)} p'^n \, (kN/m^2)$$

Where K and n are material constants and F (e) a function of the void ratio (Table 2.1)

Table 2.1 Relations between Gmax, e and p' (Dano, 2002)

Reference	K	n	F(e)	Comments
Hardin & Richart (1963)	6.93	0.5	$(2.17-e)^2/(1+e)$	Rounded grains
Iwasaki & Tatsuoka (1977)	14.10	0.4	$(2.17-e)^2/(1+e)$	Cu < 1.8
Biarez & Hicher (1994)	5.69	0.5	1/e	All soils
Lo Presti *et al.* (1997)	9.25	0.45	$1/e^{1.3}$	Sands

Hardin and Black (1968) investigate the effect of void ratio and effective confining stress in a series of torsional vibration test. Effect of confining stress is allowed for implicitly through the void ratio which in turn is unique function of the confining stress during the normal consolidation (figure 2.2).

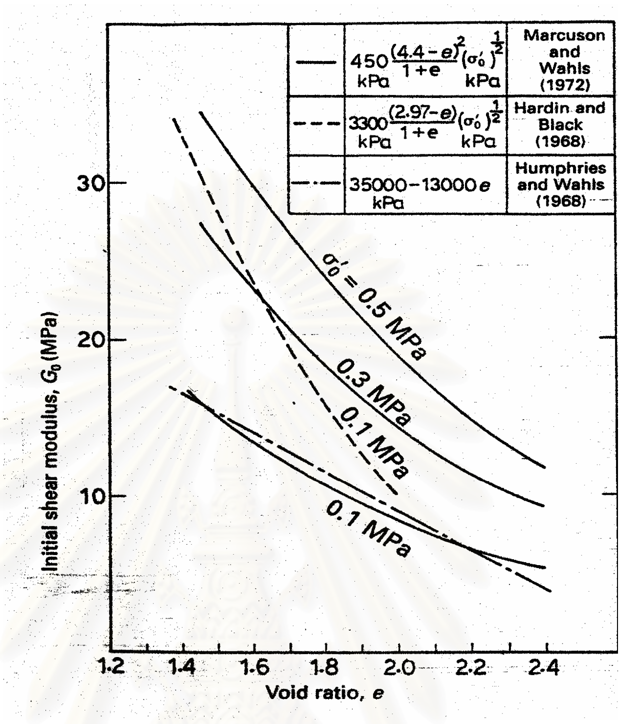

Figure 2.2: Low-amplitude shear modulus of cohesive soils as functions of void ratio and confining stress (Isihara K, 1996).

The elastic shear modulus for fine grained soil is generally expressed as function of the effective stresses. The most common stress component adopted is the effective mean stress, p' = (σ'$_1$+σ'$_2$+σ'$_3$)/3:

$$G^e = C(p')^n$$

Where G^e is the elastic shear modulus and C and n are constants.

They also included the overconsolidated ratio to obtain shear modulus in over consolidated clay:

$$G_{(OC)} = A_{OC}\, F(e)\, (p')^{no} \quad \text{or} \quad G_{(OC)} = A_{OC}\, F(e)\, (OCR)^{ks}\, (p')^{0.5}$$

$$A_{OC} = A\, (p')^{ks} \quad \text{and} \quad k_s = 0.5 - n_o$$

A_{OC} and n_o are material constant, k_s and n_o determined from figure 2.3.

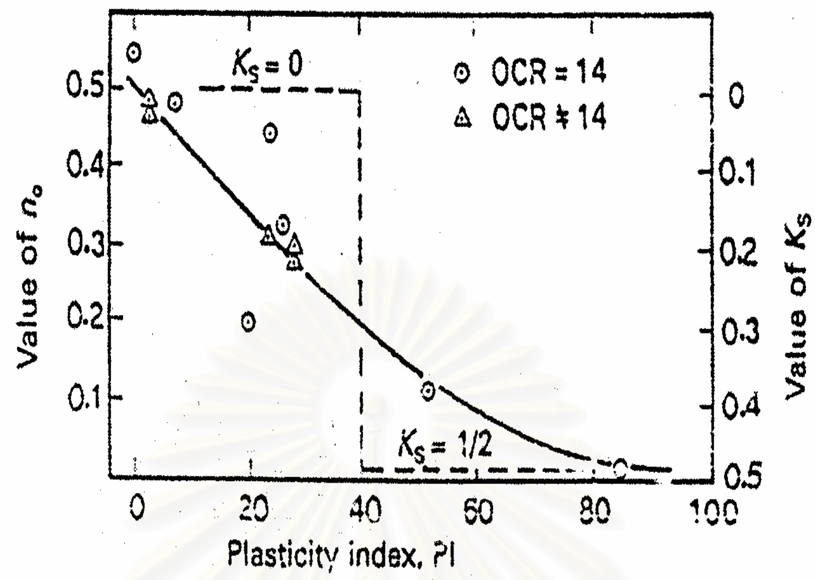

Figure 2.3: Relationship between plasticity index, k_s and n_o (Isihara K, 1996).

Viggiani and Atkinson (1995) have studied stiffness of fine grained soil at very small strain. They found that relation between shear modulus at very small strain in reconstituted samples of Kaolin, the relation given by;

$$\frac{G_0}{p_r} = A\left(\frac{p'}{p_r}\right)^n R_0^m$$

Where; *A, n, m* are coefficient that can be determined from figure 2.4. *p'* is mean effective stress, p_r : reference pressure (taken as 1 kPa), and *Ro* is overconsolidated ratio defined as ratio between effective stress at the intersection of a swelling line with the normal compression line and the mean effective stress (p_p'/p'). The equation above can extend for anisotropic stress state. The equation G_0 for anisotropic can be written as bellow:

$$\frac{G_0}{p_r} = A_a\left(\frac{\sigma'_a}{p_r}\right)^{na}\left(\frac{\sigma'_r}{p_r}\right)^{nr}$$

where σ'_a and σ'_r are the axial and radial stresses in triaxial sample, A_a equivalent to *A*, in general the value of n_a and n_r is not equal ($n = n_a + n_r$), n_a and n_r are the gradient of compression or extension line between G_0 with axial and radial stress.

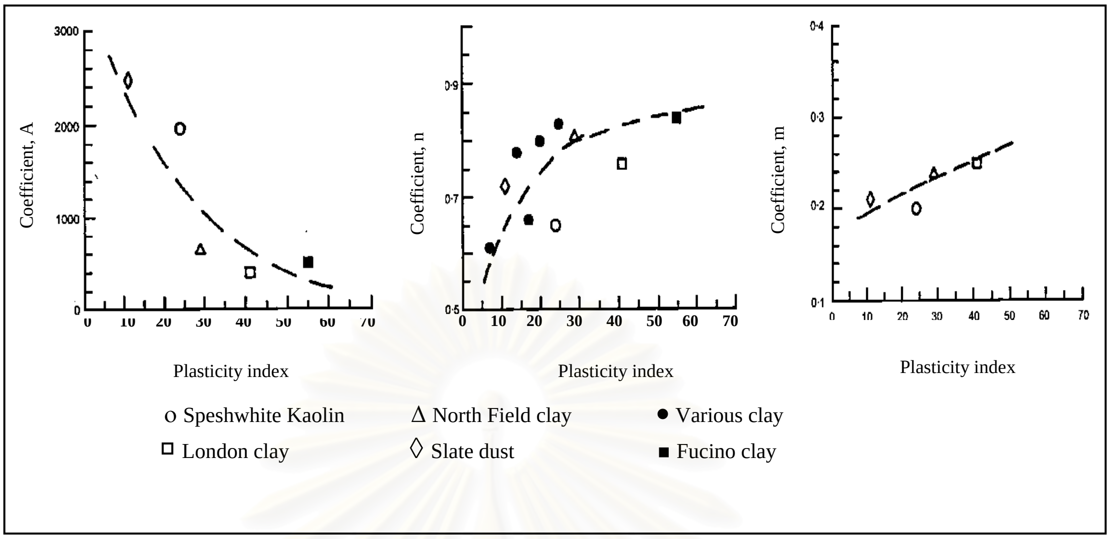

Figure 2.4: Variation of stiffness parameter for G_0 with plasticity index Viggiani and Atkinson (1995)

Isihara K (1996) found similar with Viggiani and Atkinson (1995), He found that trend increasing shear modulus with increasing plasticity index. Shear modulus is very high when the plasticity index increase and the confining pressure very low. His results is shown in figure 2.5.

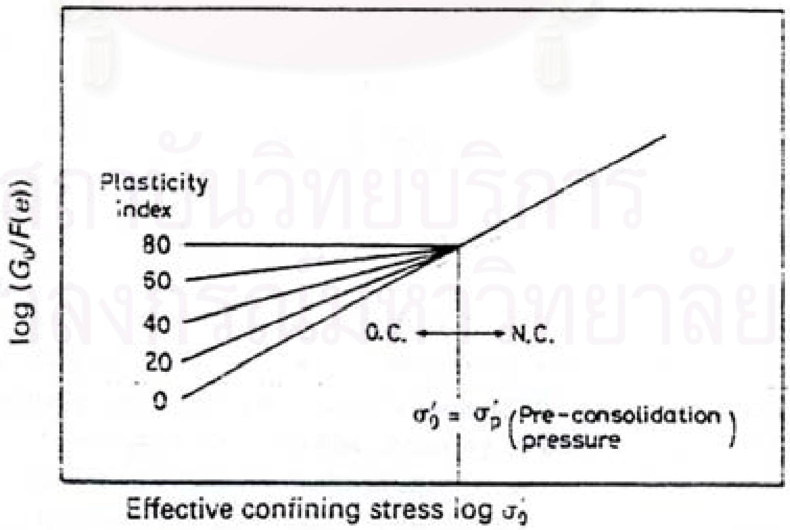

Figure 2.5: Trend increasing shear modulus with increasing plasticity index (Isihara , K. 1996)

Laboratory tests on samples of reconstituted Speswhite kaolin of different heights were conducted by Viggiani and Atkinson (1995) to investigate what should be taken as the travel distance. For different confining pressures the sample length was plotted against the travel time. Their results are shown in Figure 2.6.

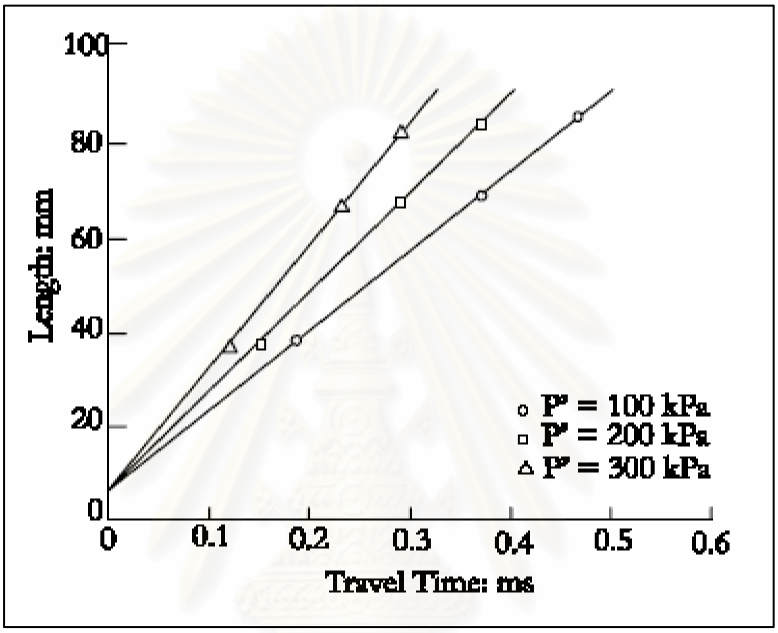

Figure 2.6: Relationship between travel time and sample length (after Viggiani and Atkinson (1995))

The bender elements used for these laboratory tests were 3 mm long. The intercept on the sample length axis is at 6 mm (i.e. twice the bender element length), implying that the travel distance should be taken as the tip to tip distance, not the total sample height. Based on figure 2.6, this is clearly that mean effective stress, p' is the main factor controlling travel time which, indirectly controlling shear modulus. In another laboratory test they have found the unique relationship between shear modulus and mean effective stress, p' for normal consolidated samples which is independent of the value of the effective stress ratio (η'= q/p') and is the same for compression and extension.

Sahabdeen M. M (1995) found that variation of initial shear modulus increases with increasing stress especially beyond the pre consolidation pressure (figure 2.7.a). The variation of shear normalized initial shear modulus and over consolidation ratio (OCR) is almost linear relationship (figure 2.7.b.)

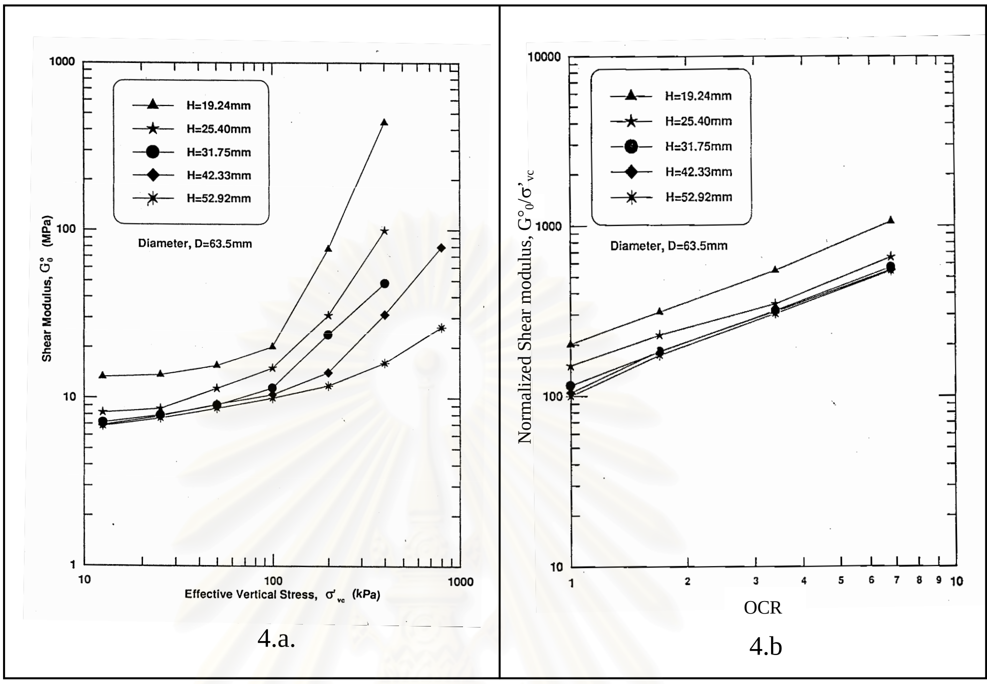

Figure 2.7(a): Variation shear modulus with effective stress; (b) normalized initial shear modulus with over consolidation ratio (OCR) Sahabdeen M. M (1995)

S. Teachavorasinskun and T. Amornwithayalax (2002) have studied shear wave velocity for Bangkok clay during triaxial test using bender element. They have found the relationship between plasticity index and shear modulus at these clays sample. The shear modulus increase when the plasticity index increase see figure 2.8. G^e – p' paths during undrained shearing almost follow those obtained during isotropic consolidation. The result of elastic shear modulus during loading and reloading show the reduction of elastic shear modulus is to be permanent, since shear modulus during reloading is similar to reduce value of shear modulus see figure 2.9. It implied the negligible effect of deviator stress repeated and the sharp deviator stress from the isotropic elastic modulus line occurred at high deviator stress level.

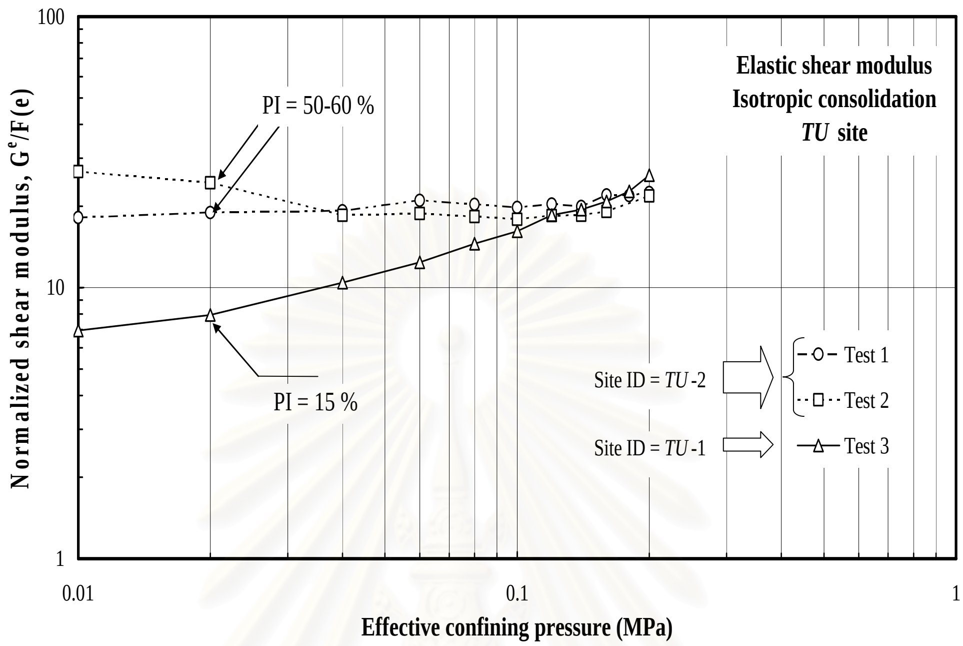

Figure 2.8: The elastic shear modulus during isotropic consolidation at different plasticity index (Teachavorasinskun, S and Amornwithayalax, T, 2002)

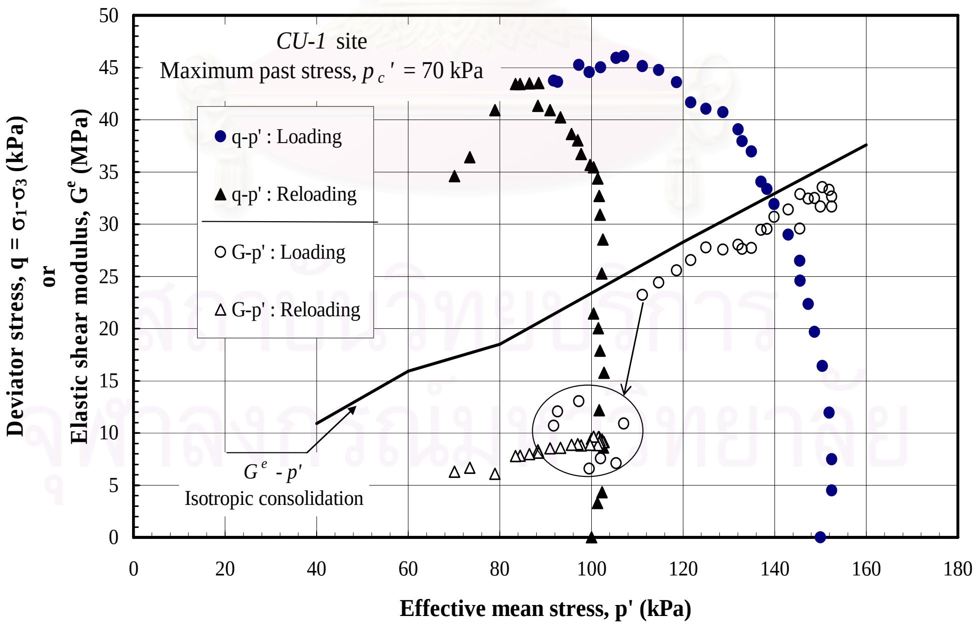

Figure 2.9: Variation of elastic shear modulus during loading and reloading cycle (Teachavorasinskun, S and Amornwithayalax, T, 2002).

In another research, S. Teachavorasinskun and T. Akkarun (2004) found that the deviator stress applied during undrained shearing significantly influences the elastic shear modulus of OC clay (Figure 2.10 and 2.11), but it is minor in NC clay. The reason is the stiffer structures during isotropic unloading of the OC clay may be destroyed during shearing.

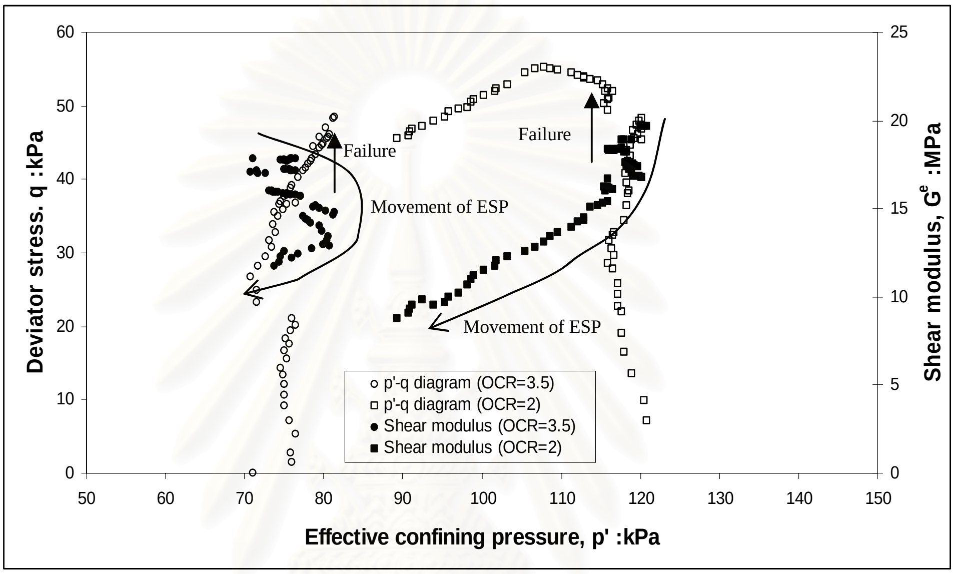

Figure 2.10: Effective stress path and ESP of OC samples at Chula site (Teachavorasinskun, S and Akkarun T, 2004).

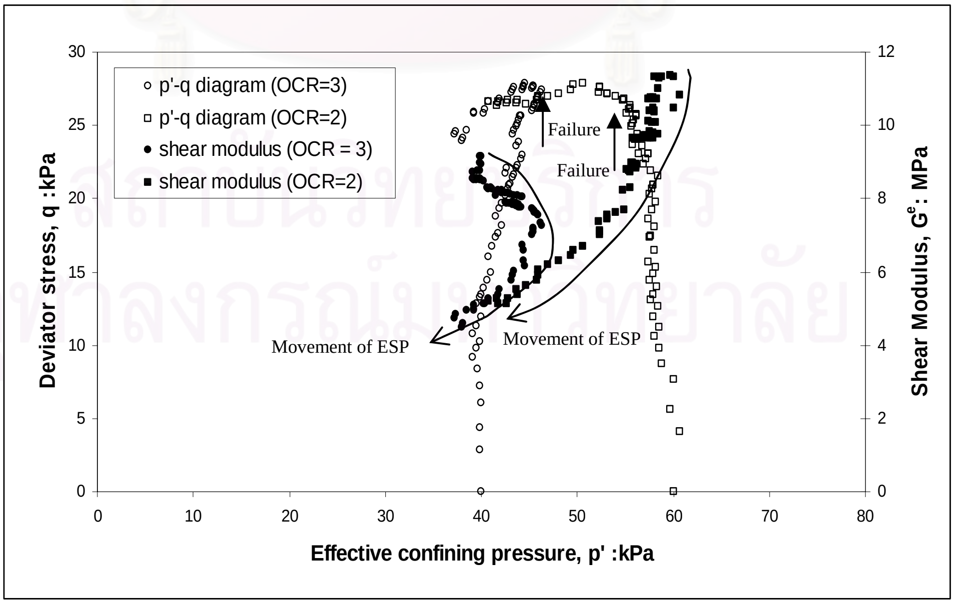

Figure 2.11: Effective stress path and ESP of OC samples from Suwannaphumi site (Teachavorasinskun, S and Akkarun T, 2004).

2.3 Factor Affecting Stress-Strain Relationship

Anderson and Stokoe (1978) found the similar effect of rest period on the very small strain shear modulus in resonant column test. He also observed that the increased stiffness occurred only for the initial part of the subsequent loading and continued loading the stiffness decreased to the value observed in the test carried out without a rest period.

Mukabi, Tatsuoka and Hirose (1992) have studied the effect of strain rate of small strain stiffness of Kaolin in consolidated undrained triaxial test. The initial shear modulus of the clay is independent of the strain rate, but the stiffness becomes strain rate dependent to larger degree as the strain increases.

Jardine, Potts, Fourie and Burland (1986) have shown that non linearity of the stress-strain response has very significant effects on soil-structure interaction, stress distribution in the soil mass, and displacement profiles around loaded areas and excavation. Unless small-strain non linearity is recognized, the interpretation of the field measurement and in-situ test may be confusing and misleading. To illustrate this Jardine, Potts, Fourie and Burland (1986) carried out numerical analysis of wide range of problem (a footing, a pile, a propped cantilever excavation, and an expanding cylindrical cavity) using non linear soil model having a fixed undrained stress-strain curve. The soil models represent low plasticity clay that is lightly overconsolidated.

JovicI & Cacute; V, Coop MR (1998) have studied the measurement of stiffness anisotropy in clays with bender element tests in the triaxial apparatus. The paper presented the results of a program of research investigating the effectiveness of bender elements when used in conjunction with the triaxial apparatus for measuring the anisotropy of small strain stiffness of fine-grained soils. Tests were carried out on both intact and reconstituted samples of London clay and on kaolin up to high stresses. They found that the transverse isotropy of small-strain stiffness that commonly occurs in many soils because of a one-dimensional loading history can be fully investigated in the conventional triaxial apparatus and that London clay is an example of such a soil. The stress-induced component of anisotropy was found to be very small for axi-symmetric loading conditions common to both the apparatus and the in situ state of these soils. In contrast, the inherent or structural anisotropy was much more significant and is shown to be a variable factor resulting from the plastic strain history and is not related to its natural structure. Consequently, inherent anisotropy is reversible, but the rate of change is very slow when a new regime of stresses is imposed. Inherent anisotropy of the very small strain stiffness also persists long after the plastic strains of the soil have become oriented toward the new stresses.

Sahabdeen M. M (1995) has studied stress-strain characteristics of Bangkok subsoil at low strain level using bender element. The result of his studied are:

a. The effect by insertion of the bender elements into the soil testing is insignificant, since the consolidation parameters from the consolidation test, both with and without bender elements are similar.
b. The variation of initial shear modulus between two adjacent incremental consolidation tests is not linear in the initial shear modulus versus consolidation stress plot.
c. The stiffness is independent of the strain rate at low strain levels because no significant change of the stiffness is observed with strain rate at low strain levels of the unconfined compression – bender elements tests.
d. The stiffness at low strain levels using conventional laboratory test are unreliable.
e. No significant change in the initial shear modulus is observed at the process of saturation, other than a small increment at the beginning stage.

Baranski M. (2003) has study laboratory measurements of the stiffness of normally consolidated till polluted by benzene with bender element tests. This study examines the effect of benzene in the pore space of normally consolidated till on the initial stiffness (G_0), the shear wave velocity being measured by the bender element method in a special designed triaxial cell. A significant reduction in G_0 was connected with increasing benzene in the till. The results obtained on the till specimens showed the strong influence of benzene on the undrained shear modulus.

There are a number of other factors which influence soil stiffness parameters in addition to those listed before. The most important of these are:

1. The influence of cementing, creep and ageing on the relationship between the current state and the state boundary surface.
2. Sample disturbance and reconsolidation, especially in structured and cemented soils.
3. The influence of recent history on the subsequent stiffness; recent history may consist of an extended rest period at constant stress or a sharp change in the direction of the stress path.
4. The influence of the loading rate on the accuracy of the test results and on the values of the measured parameter.

2.4 Measurement of Modulus at Large Strain Levels

Methods of measuring the modulus varies and depend on the strain level at which the modulus is required. If the strain level is large, the conventional routine laboratory test can be carried out as to get the stress-strain curve and thereby the modulus. Estimation the shear modulus at large strain levels the conventional laboratory test such as the unconfined compression test and the triaxial test can be used to plot the stress-strain curve at the mode of shearing and thereby modulus. Baldy, High and Thomas (1988) quoted in Sahabdeen M. M (1995) mentioned that the measurements of the stiffness in the conventional test are generally unreliable at the stains less than 1% in unconsolidated samples and slightly smaller strains in isotropically consolidated samples. Therefore the shear modulus from the conventional test is recommended only for large strain levels.

2.5 Measurement of Modulus at Small Strain Levels

Since conventionally laboratory test are usually at large strain levels, it is better to use wave propagation techniques for the estimation of the modulus at small strain levels. The strain induced by the propagation of wave usually small and it can be modified even to very small strain levels. However, the modulus estimated using the wave propagation techniques depends on the impedance, the resonant frequency, the amplitudes, the calibration constants, the specimen dimension and the mass. The most common methods using the wave propagation techniques are the Hardin resonant column test, the Drnevich resonant column test and ultra sonic shear wave velocity measurement test.

During the late 1980 and early 1990, dynamic soil stiffness was being measured in the laboratory using small strain resonant column apparatus. Investigators were studied the similarity of the *dynamic* modulus to *static* modulus back-analyzed from movements around real static structures like retaining walls and excavations. They realized the differences in modulus measured in the past between static tests (conventional triaxial) and dynamic tests (resonant column) were related to strain level. That is one test measured small strain modulus and the other large strain modulus - not that one test was “dynamic” and the other “static”

2.6 Measurement of Modulus at Very Small Strain Levels

Dyvic and Madshus (1985) estimated the maximum shear strain induced by bender elements to be less than 10^{-5}, and hence in the very small strain region. Accurately determining the strain-level induced by bender element test is difficult, as it will be directly proportional to the displacement at the tip of the bender element. An approximation of this displacement can be made knowing the piezoelectric properties of the bender element material and assuming it to be a cantilever with unrestrained boundary conditions. These assumptions may not be valid in reality due to the all-round epoxy coating used in construction of a bender element and the resistance from the surrounding soil. However, Jovicic (1997) demonstrated experimentally that the assumption of elasticity was valid. Jovicic found that when bender element tests were performed on drained samples, no extra volume change was observed or when they were tested on undrained samples no build up of excess pore pressures was found.

A bender element is an electromechanical transducer that either bends as an applied voltage is changed or generates a voltage as bends. Transmitter and receiver elements are installed in the top and bottom pedestal of triaxial. There are two piezoceramic plates rigidly bonded together as sandwich connected in series which more effective when it function as a receiver and in parallel which is more effective when it function as a transducer. Figure 2.12(a) and 2.12(b) shows the piezoceramic bender elements connected in series and parallel respectively. Bender element is highly impedance device therefore can't be exposed to moisture as it electrically short circuits the transducer. Therefore it is necessary to have proper protection by using epoxy. Figure 2.13 shows bender element prepared mounting into soil testing device.

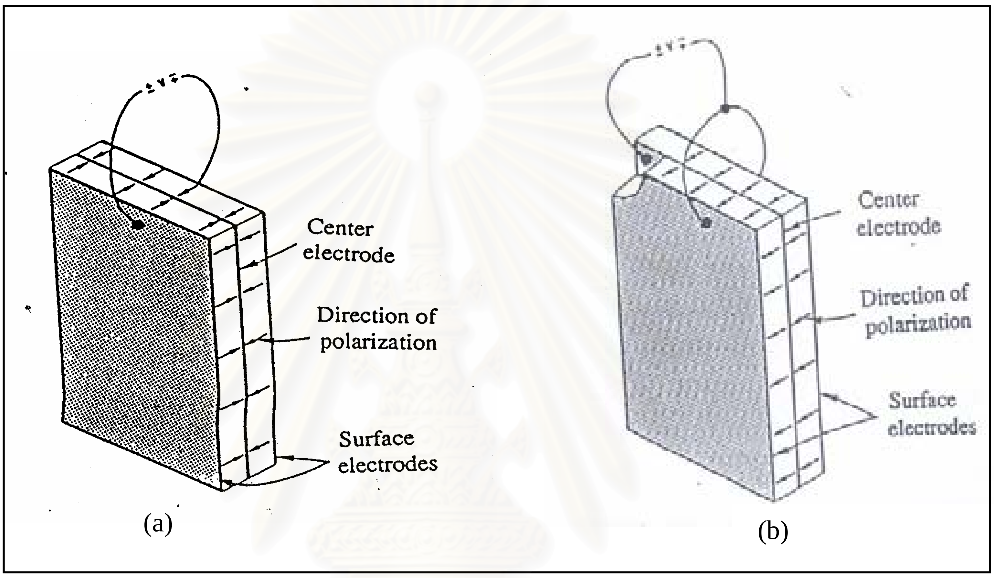

Figure 2.12 (a): Piezoceramic bender element connected in series;
(b): Piezoceramic bender element connected in parallel

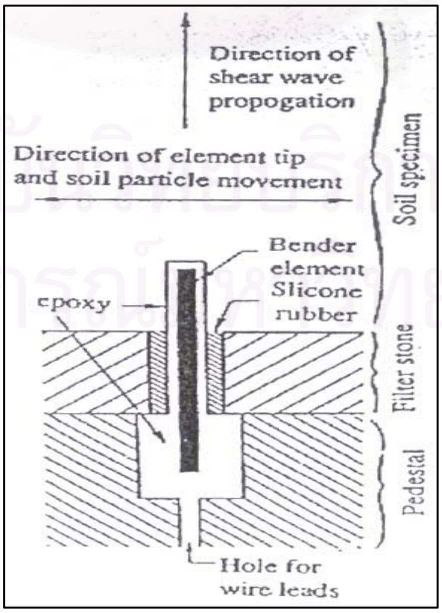

Figure 2.13: Bender element mounted in soil testing device

The value of G*max* (the value of the shear modulus at very small strains) is now treated as a fundamental soil property and is used extensively in finite element modeling. For this reason there is much current interest in the measurement of G*m*ax both in the laboratory and field. In the laboratory the small strain stiffness can be measured using local measurements of axial strains either with if for very small strain measurements the resonant column or bender element methods can be used. In the field seismic methods can be used for measuring the value of G*max*. This has given rise to the commercial development of a range of seismic tests in the field including the seismic refraction surveys, seismic cone penetration test (SCPT), cross-hole and down-hole shear wave velocity measurement and the surface wave (Rayleigh wave) methods.

2.7 Bender Element Tests

The use of bender elements to measure the elastic small strain stiffness of soils was first described by Shirley and Hampton (1977). Each bender element is made up of two oppositely polarized pieces of piezoelectric material bonded together back to back. The reason for the choice of this material is that when a voltage is applied to it, depending on the materials polarity, it will either contract or expand, and similarly when it expands or contracts it produces a voltage. Therefore if a voltage is applied to both sides of the bender element, one side will lengthen while the other will shorten. This in turn will cause the bender element to flex in one direction, and then in the opposite direction when the voltage is reversed as shown in Figure 2.14.

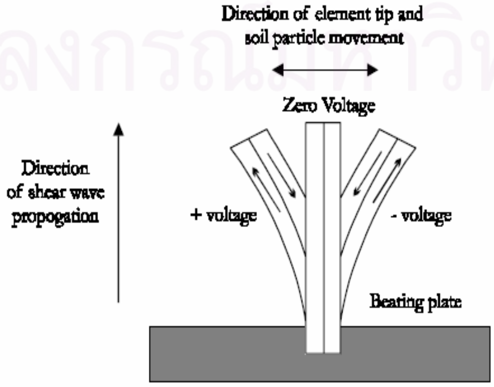

Figure 2.14 Piezoelectric bender elements (after Kramer (1996))

The motion of the bender element initiates a shear wave to propagate through the soil sample. When the shear wave reaches another bender element some distance away, it causes it to flex and thus producing a voltage. This output signal can be captured on an oscilloscope and the travel time determined by measuring the time difference between the input and the output signals. From this the shear wave velocity can be found by dividing the travel distance by the travel time and then *Gmax* can be calculated. The principal advantage that bender elements have over a resonant column test is that they can be incorporated into a variety of testing devices, and hence the shear modulus can be measured during different soil tests. They are most commonly incorporated into triaxial samples, with a bender element placed in the top and the bottom platens.

2.8 Performance of Bender Element Test

Measurement of soil stiffness at very small strains in the laboratory is difficult owing to insufficient resolution and accuracy of load and displacement measuring devices. The capability exists to regularly carry out measurements of small strain stiffness in the triaxial apparatus using local strain transducers, but this can be expensive and is generally confined to research projects.

Dyvick and Madshus (1985) of the Norwegian Institute have compared the results of stiffness measured by bender elements with the results of stiffness by resonant column test at different confining stress level for both loading and unloading, and concluded that they are in excellent agreement. They also tested with the bender elements to measure the initial shear modulus successfully in the odometer and the direct simple shear devices. The specimens in the test are of the order of 15 to 20 mm in height.

Dyvick and Oslen (1992) have tested the initial shear modulus using bender elements mounted in oedometer, direct simple shear apparatus and triaxial device at various consolidation stress levels. The results show that the initial shear modulus can be easily and accurately determined in the oedometer and direct simple shear device and the initial shear modulus value at comparable times are similar. The triaxial device, oedometer and direct shear devices all have specimens of different heights and therefore different primary consolidation times. It would seem logical to compare the G*max* at the end of primary consolidation for each of different type of test. They assumed the travel length of shear wave is the tip to tip distance of the bender elements. They used to estimate the variation of the initial shear modulus with log time and concluded that initial shear modulus increases with time at a particular stress level and the pattern of increment depended on the stress level.

Arulnathan R, et all 1998, a study of analysis of bender element test is presented of potential errors in, and methods of interpreting, the results of cantilever-type, and piezoceramic bender element tests for measuring the shear wave velocity of laboratory soil specimens. Interpretations based on the first direct arrival in the output signal are often masked by near-field effects and may be difficult to define reliably. Interpretations based on characteristic points or cross-correlation between the input and output signals are shown to be theoretically incorrect in most cases because of: (1) the effects of wave interference at the boundaries; (2) the phase lag between the physical wave forms and the measured electrical signals; and (3) non-one-dimensional wave travel and near-field effects. Interpretations based on the second arrival in the output signal are theoretically subject to errors from non-one-dimensional wave travel and near-field effects. Differences in shear wave velocity (V_s) values obtained by the different interpretation methods are illustrated analytically and experimentally. Similar with Arulnathan, Viggiani and Atkinson (1995) Potential error in the bender element test is not easy to determine length of sample and time arrival precisely.

CHAPTER III

RESEARCH METODHOLOGY

3.1 Methodology

This chapter discuss about the research methodology, sample preparation, laboratory testing, and analysis data. The general schematic of research methodology is outlined in the flowchart diagram shown in Figure 3.1.

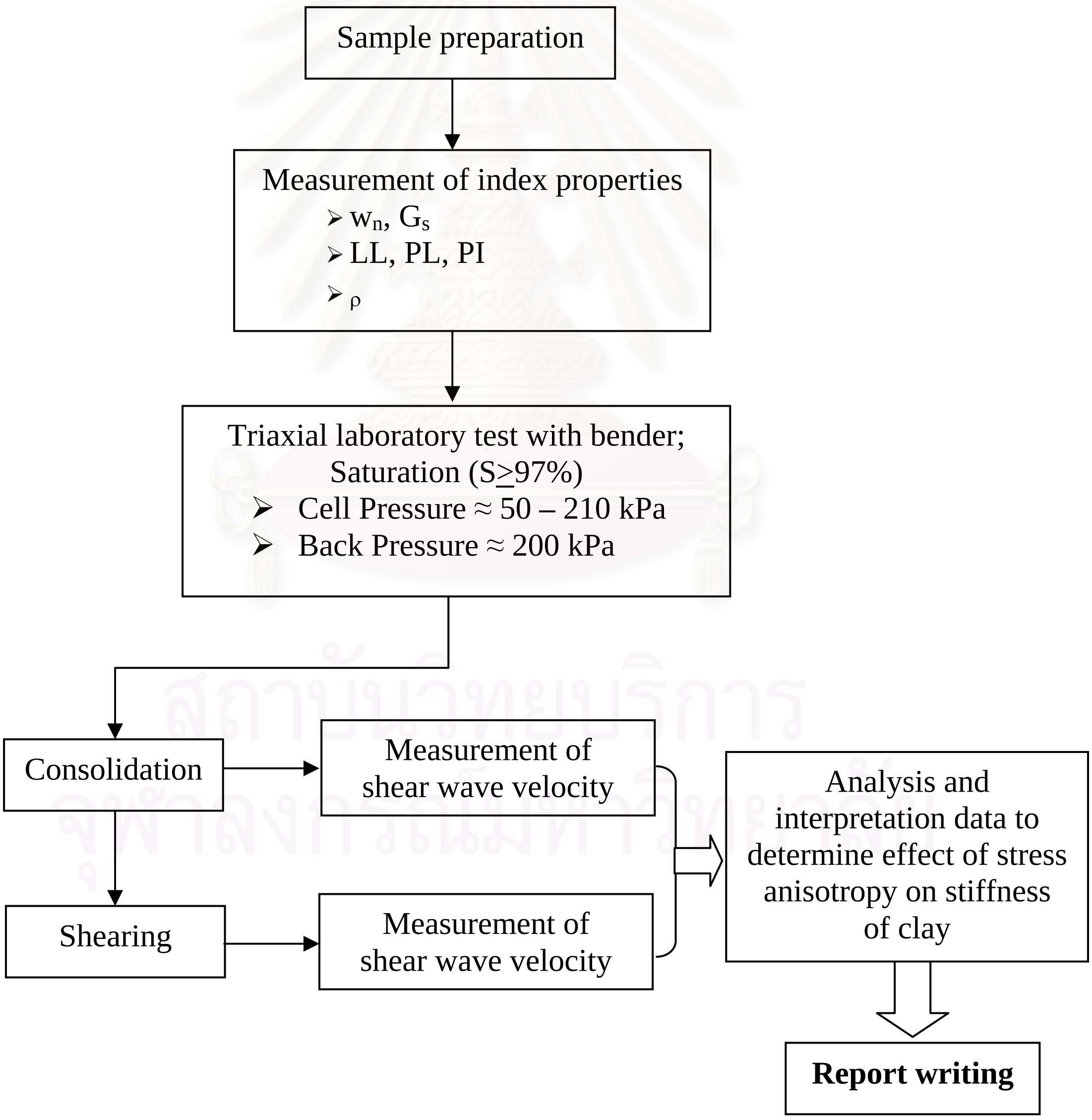

Figure 3.1: Schematic diagram of research methodology

3.2 Testing equipments

The equipments used for the experiment consists of five major components:

1. Triaxial Cell
2. Bender Elements
3. Oscilloscope
4. Computer
5. Function generator

The Bender Element transmitted is mounted on the bottom base pedestal, whereas the Bender Element receiver is mounted on pedestal. The wire outputs are taken away as to connect the accessories equipment such as function generator, and oscilloscope. To avoid any possible leakage through the holes of wire outputs, they should be covered with silicon or epoxy properly. Cylindrical soil is inserted in the cell and located on the bottom base, and then the top pedestal is lowered slowly until it contacts the soil sample. Figure 3.2 shows the section elevation of the properly when mounted into a soil testing device. A general schematic view for the triaxial cell and the bender element is shown in figure 3.3 and 3.4.

3.2.1 Component of Bender Element Set-up

Figure 3.4 show the layout or schematic diagram of the equipment and connections of the Bender Elements. The function generator produces signals run into the transmitter and to the oscilloscope through the exciter. The receiver receives the signal from the transmitter through the soil samples also connected to the oscilloscope. It is also possible to use the high or low switch of the exciter to excite the sample instead of function generator which gives the continuous excitement thereby continuous waves from the oscilloscope. The oscilloscope is used to measure travel time of the shear wave, function of the generator is to produce continuous wave. The travel length would be the tip to tip of the Bender Elements by assuming the shear wave are propagated from the tip of transmitter and are received at the tip of the receiver.

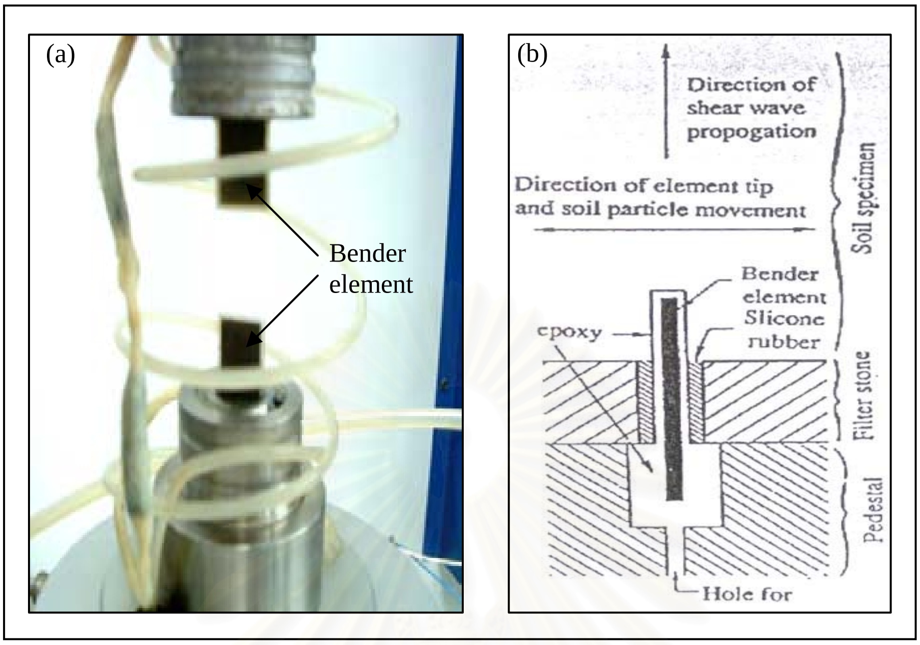

Figure. 3.2: (a) Bender element at the top cap and pedestal of the triaxial.
(b) Bender element mounted in the soil testing device

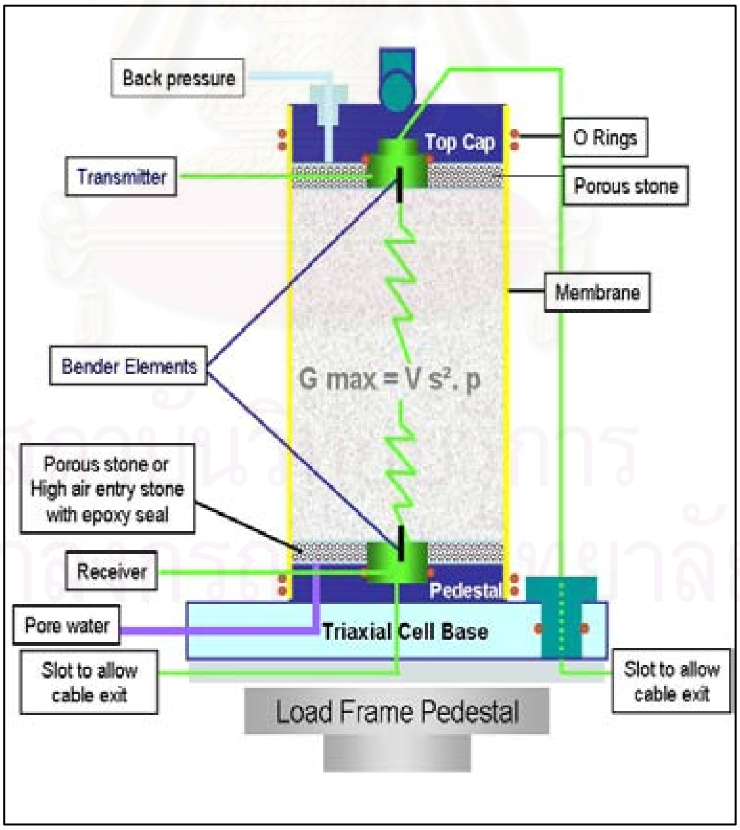

Figure 3.3: Schematic triaxial cell with the bender elements.

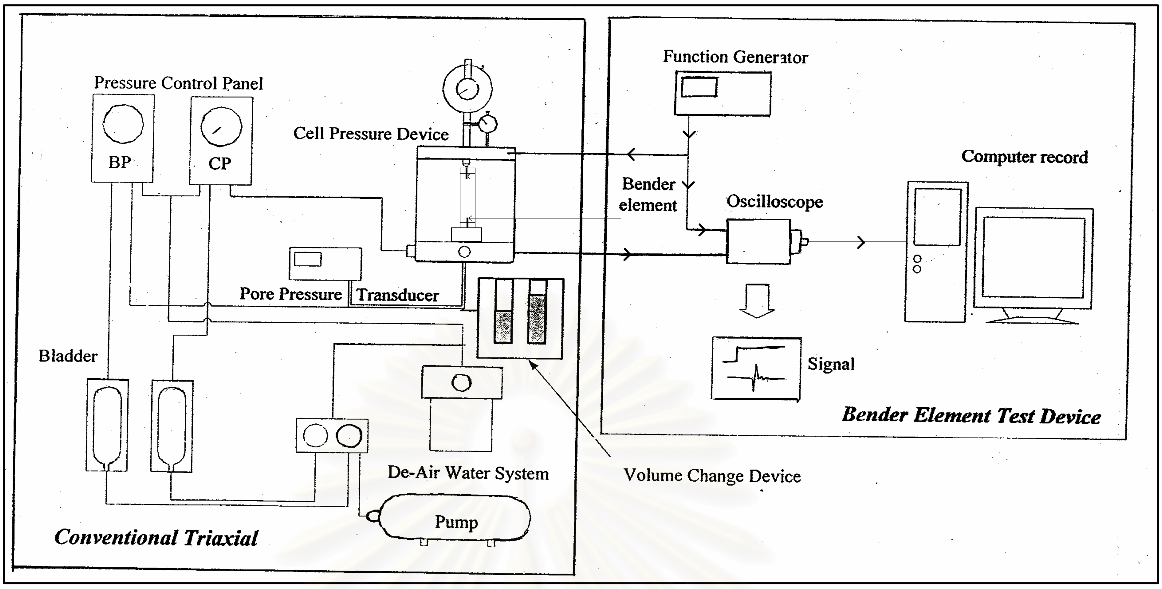

Figure 3.4: General schematic view the system of the bender elements

Figure 3.5: Setting of triaxial apparatus and bender elements

3.3 Sample Preparation

3.3.1 Preparation and Saturation

The samples used in this study are undisturbed Bangkok clay taken from Sirirot area. Three bore holes were drilled down to a maximum depth 20 m bellow the exiting surface. Undisturbed samples were collected through stationary piston samples as well as conventional push in Shelby tube. All the samples tubes were immediately sealed at both ends with paraffin wax to prevent the loss of moisture. These tubes were than transported to the laboratory. Samples are extruded and cut into pieces 15 cm long and immediately covered with paraffin wax.

Sample prepared according to ASTM standard, standard triaxial test sample were prepared by with cylindrical shape having minimum diameter of 3.3 cm (1.3 in). The high to diameter ratio shall be between 2 and 2.5. The cell consists three main components namely, the cell base, the perspex cylinder and the top head assembly. The cell base consists of the pedestal for setup of the specimen and four water passages, two drainage lines, one cell pressure line and one pore pressure measurement. The drainage lines connected the burette to measure the volume change during consolidation. The pore pressure line connected with the pore pressure transducer to measure the pore pressure during undrained loading.

The desired stress conditions imposed on the specimen by cell and back pressure combination. The water pressure line connected with mercury pot-spring system so that the constant pressure can maintained at any desired level. The pressure lines also connected to the transducer to measure the pore pressure. The load cell were calibrate before use. The ram frictional resistance measured by applying a desired cell pressure to uplift the piston. The uplift force measured by the load cell.

Before setting up the samples in the triaxial cell, the base of the triaxial cell should be connected to the pressure lines and the pore pressure transducer. The pressure lines flushed with de-aired and distilled water to ensure the system always saturated.

During the mounting of the specimen on the pedestal of the base, the saturated porous stone with the bender element and circular filter papers also placed at both ends of the specimen. Both ends of the filter paper strips extended to porous stones for easy drainage. To minimize the possible severe damage that might be caused during pushing bender elements into soil sample, pre-bored slot was manually prepared at each end of the sample.

Then, enclose of the sample in a rubber membrane, also coat the side of the base pedestal with silicon grease in order to prevent leakage through the sealing. The perspex cylinder with top assembly mounted and fixed to the cell base.

The sample saturated. The back pressure of 200 kPa applied to ensure the specimen fully saturated. The cell and back pressure were gradually increased. During the application of pressure, the cell pressure was always higher than back pressure. After back pressure reach to 200 kPa and cell pressure reached 210 kPa, the specimen was kept at least 24 hours after that check the saturation by the pore pressure response under undrained conditions (by closing both top and bottom drainage lines and increasing the cell pressure to estimate the pressure increment).

The preparation procedure was not changed by the pair of bender elements embedded in the lower and upper pedestals of the triaxial cell. These bender elements, which are piezoelectric transducers, provide a non destructive and punctual measure of the shear modulus. Application of a square impulse is converted into tangential vibrations of the transmitter, which cause a shear wave to be propagated through the sample. This phenomenon is reversible, and then a mechanical force on the receiver produces an electric field. The input and output electric signals were recorded on an oscilloscope on which the propagation time *Tw* of the shear wave could be determined, according to the instructions by Viggiani & Atkinson (1995) and Jovicic *et al.* (1998).

3.3.2 Consolidation

Anisotropic increments were applied for anisotropic test in the same manner with the drainage lines opened and pore pressure measuring system, vice versa isotropic test applied isotropic increments. In anisotropic consolidation test an axial load is applied to the sample during consolidation in order to maintain the ratio of the horizontal and vertical principal stresses (σ_h/σ_v) at constant value. Anisotropic test using axial load may be applied either by a dead-weight hanger or by a triaxial load frame with load measuring device by Head, KH (1982). The volume change in the burette and the axial displacement of the displacement transducer are recorded. The sample was allowed to consolidate and then it was checked by observing the pore pressure response when drainage lines closed. The consolidation pressure is applied step by step until the final effective stress reached. When the dissipation of the excess pore water pressure was ensured at the end of each step the shear wave was determined.

a. Dead Weight loading

The forces acting on the sample are shown diagrammatically in Figure 3.6. The net down force F applied to the sample top cap is given by the equation

$$F = \left[\frac{m_h + m + (m_p - m_{w})}{1000}\right] \times 9.81 - \frac{\sigma_h a}{1000} \qquad \text{N}$$

It is assumed bellow that piston is counteracted by the effective mass of the piston and top cap *(m_p –m_w).*

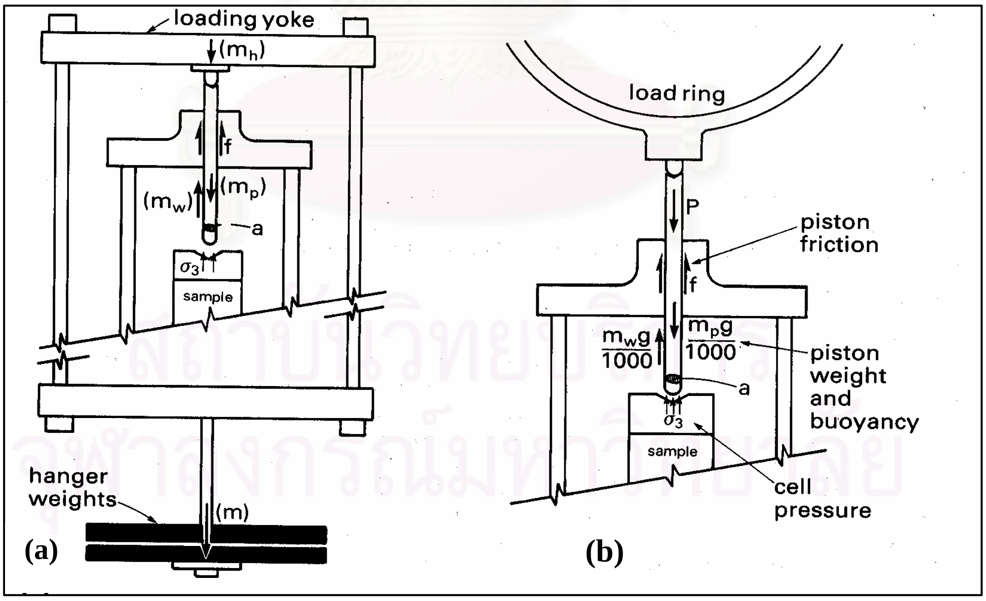

Figure 3.6: Anisotropic consolidation test in triaxial cell, illustrating forces acting on the sample; (a) under dead weight loading, (b) using a load ring (Head KH, 1982)

The axial stress σ_v is equal to

$$\sigma_v = \left(\frac{F}{A} \times 1000\right) + \sigma_h \quad \text{kPa}$$

$$\sigma_v = \frac{9.81}{A}(m_h + m) - \sigma_h \frac{a}{A} + \sigma_h \quad \text{kPa}$$

If σ_v/σ_h = constant = β, i.e. $\sigma_v = \beta\,\sigma_h$, then

$$\sigma_h\left(\beta - 1 + \frac{a}{A}\right) = \frac{9.81}{A}(m_h + m)$$

Hence

$$m = \frac{A}{9.81}\sigma_h(\beta - 1 + \frac{a}{A}) - m_h \text{ kPa}$$

Where,

σ_v, σ_h = vertical and horizontal stress (kPa)

A = corresponding area of cross section of sample (mm^2)

a = corresponding to area of cross section of the piston (mm^2)

m_h = mass of dead load hanger (grams)

m_p = mass of top cap and piston (grams)

m_w = volume (cm^3) or mass of water displaced by the top cap and submerged part of piston

m = mass of weight applied to hanger (g)

b. Load ring loading

When using a load frame fitted with an external load measuring device, the load or load dial reading, needed to give required principal stress ratio(σ_v/σ_h = β). The symbol are the same as those used above, with addition of force exerted by load ring, P (Newton) and friction force in cell bushing opposing downward movement of piston, f (Newton). The forces acting on the sample indicated in Figure 3.6(b).

The net downward force F on the sample top cap is given by the equation.

$$F = P + \frac{(m_p - m_w) \times 9.81}{1000} - \frac{\sigma_h a}{1000} - f \quad \text{N}$$

The force due to the effective mass of piston and top cap is represented by Q, where

$$Q = \frac{(m_p - m_w) \times 9.81}{1000} \quad \text{N}$$

The axial stress σ_v is equal to

$$\sigma_v = \left(\frac{F}{A} \times 1000\right) + \sigma_h \qquad \text{kPa}$$

i.e. $$\sigma_v = \frac{1000}{A}(P+Q) - \sigma_h \frac{a}{A} - \frac{1000\,f}{A} + \sigma_h \qquad \text{kPa}$$

Putting $\sigma_v = \beta\,\sigma_h$, then,

$$\sigma_h\left(\beta - 1 + \frac{a}{A}\right) = \frac{1000}{A}(P + Q - f) \qquad \text{kPa}$$

Hence, $$P = \frac{A}{1000}\sigma_h(\beta - 1 + \frac{a}{A}) - Q + f \qquad \text{N}$$

If the effective mass of the piston and top cap counteracts the piston friction (i.e. $Q = f$), then;

$$P = \frac{A}{1000}\sigma_h(\beta - 1 + \frac{a}{A}) \qquad \text{N}$$

The load reading in dial divisions is used, and the mean calibration is *Cr* N/div, the dial reading required is equal to *P/Cr* divisions.

3.3.3 Shearing

At the end of consolidation period and final mean effective stress the drainage values were closed and the specimen was sheared to failure at an appropriate strain rate 0.02 mm/min. At slow rate of strain was used so that the shear wave velocity could be accurately measured. The pore pressure readings, the dial gauge readings, the cell pressure readings and travel time readings recorded.

3.4 Test Program

The flow chart diagram of testing procedure of measurement shear modulus in triaxial apparatus for isotropic and anisotropic (figure 3.7) will be explained as bellow:

a) Trimming the sample of sample and then set up in triaxial apparatus.
b) The sample saturated until ≥ 97%.
c) In the drained condition, from hydrostatic pressure apply the horizontal stress (σ'_h) the vertical stress (σ'_v) until K_o = 0.6, 0.3 or K=1 for isotropic test.
d) Consolidate the sample until excess pore pressure zero ($\Delta U = 0$).

e) After final consolidation, the changes in the height and volume of the specimen measured.
f) Measure the shear wave velocities using the bender element.
g) Increase the horizontal and vertical stresses step by step until next isotropic or anisotropic stress state on each step.
h) Repeat the processes b) to e) until the final stress state for example; σ'_v = 300 kPa and σ'_h= 180 kPa is reached
i) Undrained shearing was conducted at strain rate 0.02 mm/min. During this step, shear modulus was continuously recorded.

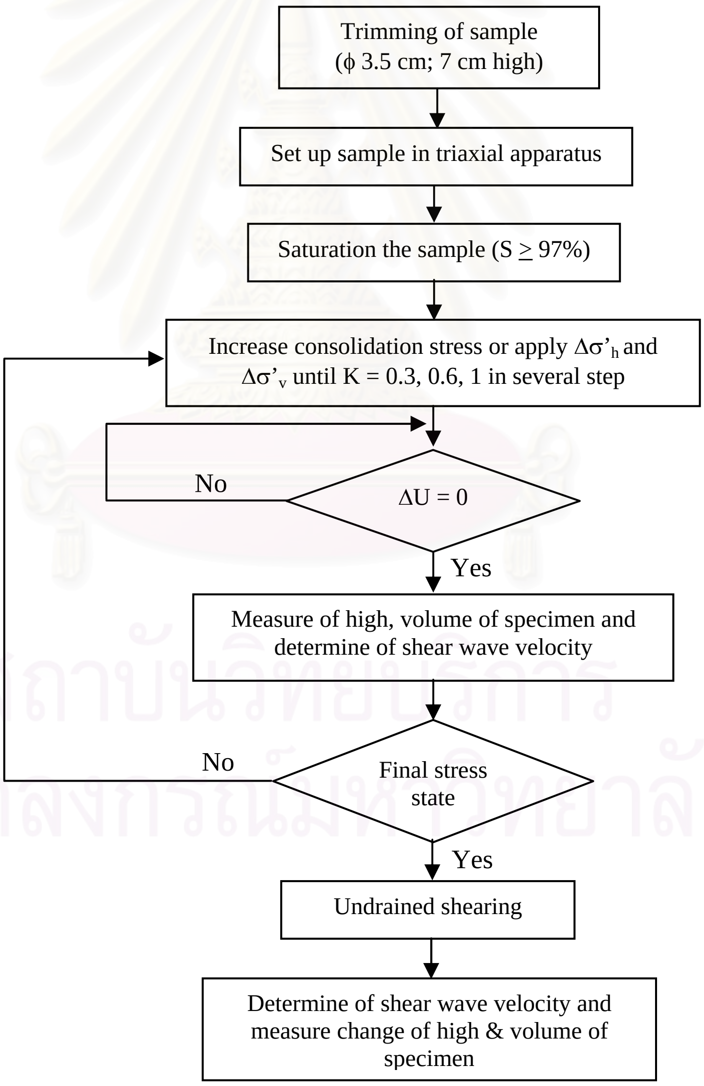

Figure 3.7: Schematic test procedure in the flow chart diagram

3.5 Analysis data of Bender Element Tests

3.5.1 Introduction

Although in principle the use of bender elements appears to be straight forward, in practice their use can lead to ambiguous and uncertain results. This has led to a great deal of research focused on the principles and assumptions underlying their use.

3.5.2 Wave Travel Time

The next parameter that needs to be ascertained is the travel time of the shear wave from the transmitting to the receiving bender element. In practice, the clarity of the arrival signal is greatly influenced by the shape of the transmitted signal. In early bender element tests the most popular input signals were either a step function or a square pulse. Tests performed by Viggiani and Atkinson (1995) demonstrated that using a square wave causes considerable distortion to the output signal. They concluded that this was caused by the square wave being composed of a wide spectrum of frequencies and each component therefore having different dispersive qualities. The effect of the dispersion of the input wave is that each frequency will travel with a different velocity and hence the output signal will become blurred. The solution suggested by Viggiani and Atkinson to overcome this problem was to use a sine wave input which is made up of predominantly one frequency. The results using this signal type were considered superior, as the output signal more closely resembled the input signal.

Although using a sine wave does clarify the first wave arrival, commonly the output signal still differs in form from the input signal. The result from a typical bender element test is shown in Figure 3.8.

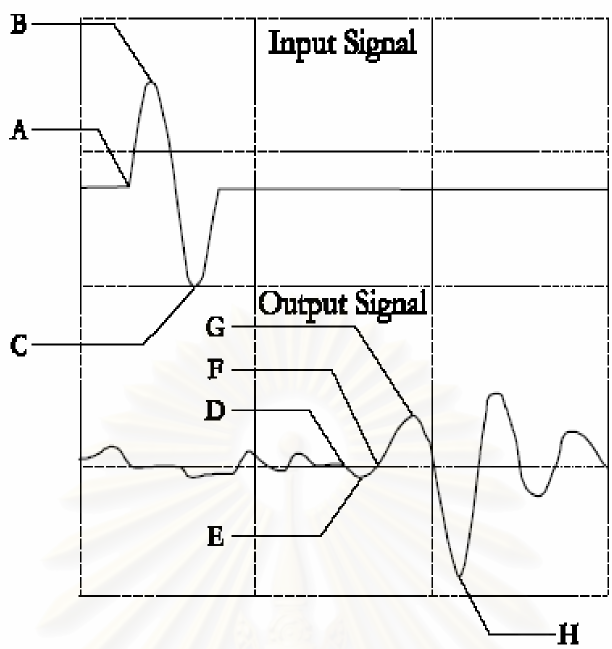

Figure 3.8: Typical input and output waves from bender element test Viggiani and Atkinson (1995)

Identifying at which point the shear wave arrives is open to user interpretation. Several options for the travel time have been suggested in the literature. They include A-D, A-E, A-F, B-G or C-H. The problem arises due to a phenomenon called the near field effect. This is characterized by an initial deflection of the output signal before the significant motion of the receiving bender element, seen in the output wave in Figure 3.7 between points D and F. This has the effect of masking the true arrival of the first shear wave. The presence of a near field effect in bender element tests was first identified by Brignoli and Gotti (1996), and further investigated by Jovičić *et al.* (1996).

Test Data obtained from Bender Elements tests, run for two amplitudes and for different frequencies, were analyzed using manual method. In this method simply the delay time (T) is computed as the difference time between two peaks of transmitted and received signals by Hardy, S (2003). The shear wave velocities were calculated using some of the techniques proposed in the literature. These are summarized as follows:

1. Measuring the time difference between the first peak of the input wave and the first peak of the output wave.

2. Measuring the time difference between the first trough of the input wave and the first trough of the output wave.
3. Measuring the time difference between the first shear wave arrival and its second arrival after reflecting from the top cap.
4. Measuring the time lag at which the cross correlation coefficient of the input and output waves is a maximum.
5. Measuring the time difference between the first and second maximums in the cross correlation plot.

To reduce the subjectivity, the pole of receiver must change during measurement time delay and also to make sure that determination of time delay is correct see Figure 3.9.

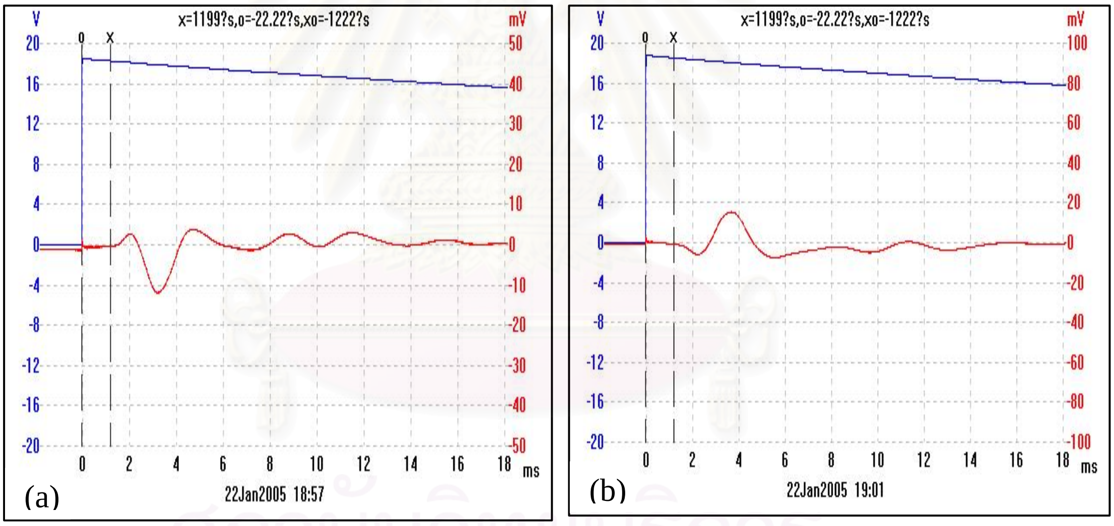

Figure 3.9: Method for determination time delay; (a) before change the pole in receiver; (b) after change the pole

3.6 Determination of shear modulus

According to the Viggiani & Atkinson (1995) and Jovicic *et al.* (1996), the distance of propagation L_w is the length between the tips of the bender elements, the propagation time T_w of the shear wave. The velocity of the shear wave is therefore:

$$V_s = L_w / T_w$$

The direction and the polarization of the shear wave, only the component *G* of the small strain stiffness matrix can be identified, assuming a linear cross-anisotropic elastic behavior (Kuwano *et al.*, 1999). The shear modulus is related to the unit mass ρ of the material and to the shear wave velocity *Vs*:

$$G = \rho . Vs^2 = \rho . (L_w/T_w)^2$$

CHAPTER IV

RESULT, ANALYSIS AND DISCUSSION

4.1 Introduction

Undisturbed samples of Bangkok clays were collected from Talingchan area. The typical subsoil profiles in Bangkok area is shown in figure 4.1. The subsoil consists of 13 – 16 m thick soft marine clay. This clay is sensitive, anisotropic, and creep (time dependent stress-strain-strength behavior) susceptible. This characteristic have made the design and construction of deep basement, filled embankments and tunneling in soft clay difficult. The first stiff to very stiff silty clay layer is encountered below soft clay and medium clay varying from 21 – 28 m depth. The groundwater condition is hydrostatic starting from 1 m below ground level. The general soil properties of material and varied of effective confining pressure performed in triaxial test at depth of sample 10 - 16 m are summarized in Table 4.1 and 4.2.

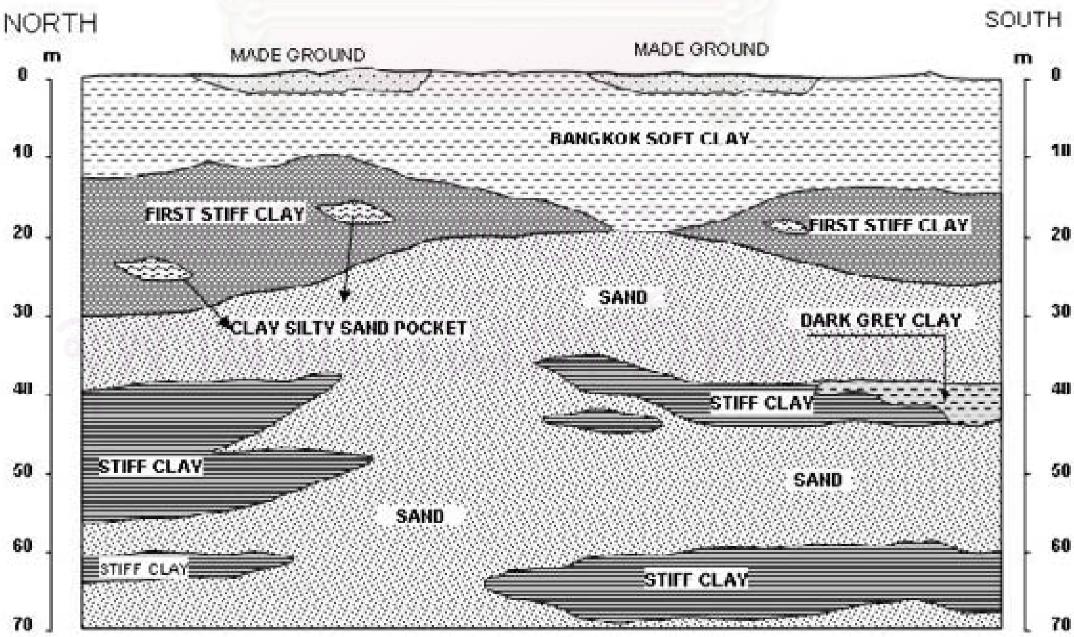

Figure 4.1 General soil profiles in Bangkok subsoil (Teparaksa, 2004)

Table 4.1 Physical properties of clay at depth of sample 10 - 16 m

Depth (m)	**10.5-11.2**	**11.5-12.2**	**13.5-14.2**	**15-15.7**
Water contents (%)	59 - 66	55 – 66	60 – 67	59 – 70
Total Density (t/m3)	1.59 – 1.6	1.59	1.58 – 1.61	1.58 – 1.6
Specific gravity	2.67 – 2.68	2.666 – 2.71	2.673 – 2.687	2.68 – 2.69
Liquid Limit (%)	77 – 79	81.8	79 – 84	80 – 84
Plastic Limit (%)	23 – 28	24.78	23 – 27	25 – 27
Plasticity Index (%)	51 – 54	57	55 – 57	55 – 58
Liquidity Index (%)	0.75 – 0.77	0.69	0.69 – 0.72	0.68 – 0.74
Pre consolidation pressure (p'_c), kPa	76	82	-	-

Table 4.2 Tested sample in triaxial test at depth of sample 10 - 16 m

Location	**Depth (m)**	**Mean effective stress (kPa)**	**Shearing**	**Remarks**
Talingchan	10.5 -11.2	25, 50, 75, 100	Yes	Isotropic (K=1)
	10.5 -11.2	25, 30.56, 50, 75, 100	Yes	Anisotropic (K_o=0.6)
	10.5 -11.2	25, 44.4, 50, 75, 100	Yes	Anisotropic (K_o=0.3)
	11.5– 12.2	50, 100, 150, 200, 250, 300	Yes	Isotropic (K=1)
	11.5– 12.2	25, 30.56, 50, 100, 150, 200, 250, 300	Yes	Anisotropic (K_o=0.6)
	13.5– 14.2	25, 44.4, 50, 100, 150, 200, 250, 300	Yes	Anisotropic (K_o=0.3)
	15 – 15.7	100, 200, 300, 400, 500	Yes	Isotropic (K=1)
	15 – 15.7	50, 61.11, 100, 200, 300, 400, 500	Yes	Anisotropic (K_o=0.3)
	15 – 15.7	50, 88.9, 100, 200, 300, 400, 500	Yes	Anisotropic (K_o=0.3)

4.2 Analysis and Discussion

Figure 4.2-4.3 shows the variation of normalized elastic shear modulus against the effective confining stress during isotropic and anisotropic consolidation. The elastic shear modulus has been normalized by a function, *F(e)*, to eliminate the effect of different in void ratio of the sample. The adopted function *F(e)* proposed by Hardin & Black (1968) as;

$$F(e) = \frac{(2.97 - e)^2}{(1 - e)}$$

Where, *e* is void ratio of the soil. Since there is no information on the effect of void ratio on the shear modulus of Bangkok clay, the function *F(e)* shown above was adopted because it provides the best normalization to the test results. The effect of plasticity seems to be conforming well to that reported in the literature.

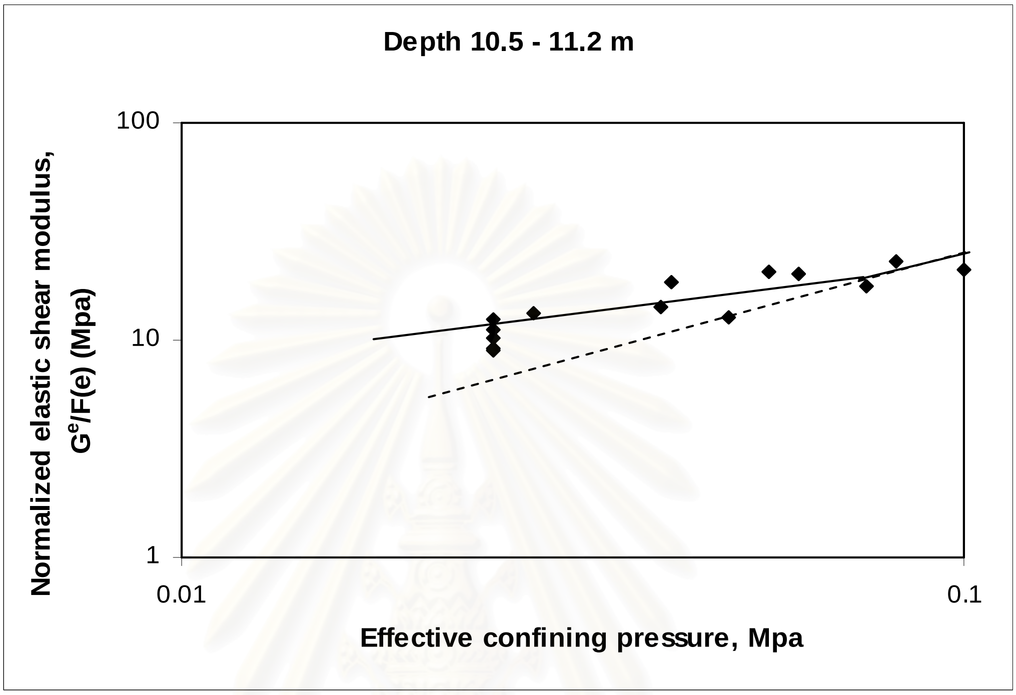

Figure 4.2: Normalized elastic shear modulus during isotropic and anisotropic consolidation at depth of sample 10.5 – 11.2 m

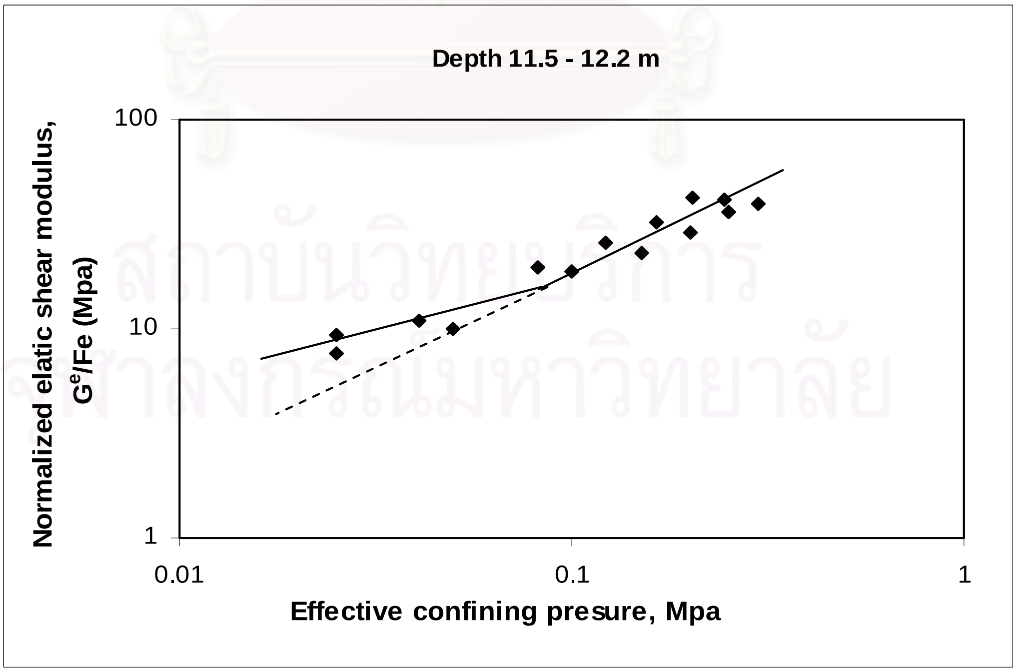

Figure 4.3: Normalized elastic shear modulus during isotropic and anisotropic consolidation at depth of sample 11.5 – 12.2 m

The results of isotropic tests show that the variation of elastic shear modulus during consolidation increase when the mean effective stress increase and also the variation of elastic shear modulus during the samples undergone undrained compression are addressed in Figure 4.4 – 4.6. A line refers to the elastic shear modulus during isotropic consolidation of each sample. It can be seen that graph of elastic shear modulus against the mean effective stress during undrained shearing is almost similar to those obtained during isotropic consolidation. This implies that the effect of the deviator shear stress is very small. In 100 and 500 kPa test, the elastic shear modulus decrease dramatically when deviator stress approaches in peak value but this behavior not clear in 300 kPa test. It should be noted that when deviator stress achieved its peak value, sudden reduction in the measured shear modulus is observed. It is believed that localization (or discontinuity) in the sample is the main reason for such drastic reduction of shear modulus. The undrained shearing was carried out at the strain rate of 0.02 mm/min during which the elastic shear modulus were continuously recorded. It was found that the shear modulus reduced as the pore water pressure increased (or the mean effective stress decreased). Figure 4.7 Shows the stress paths of all isotropic tested. In this figure, the undrained effective stress path of 500 kPa test is similar which each other, but its slope of failure line is somewhat high. This may be due the fact that the sample of 15 – 15.7 m more stiff than depth 10.5 – 11.2 m. Based on this figure, it is clearly that mean effective stress is the main factor controlling elastic shear modulus.

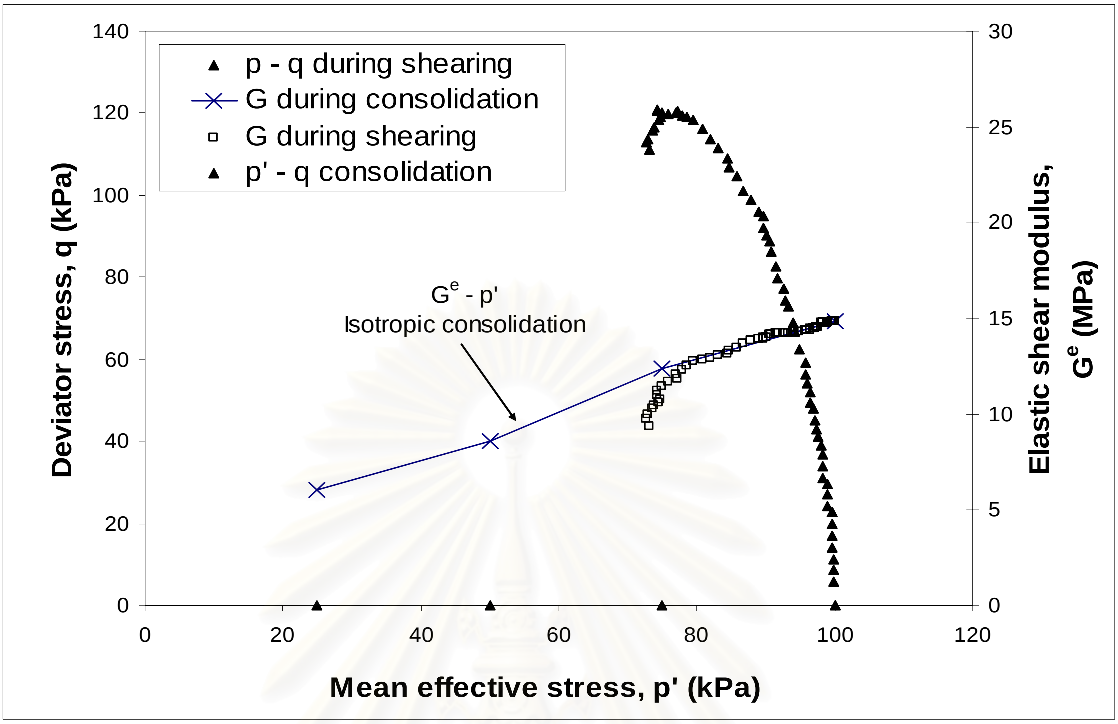

Figure 4.4: Variation elastic shear modulus during isotropic consolidation and undrained shearing at final mean effective stress, p’ = 100 kPa

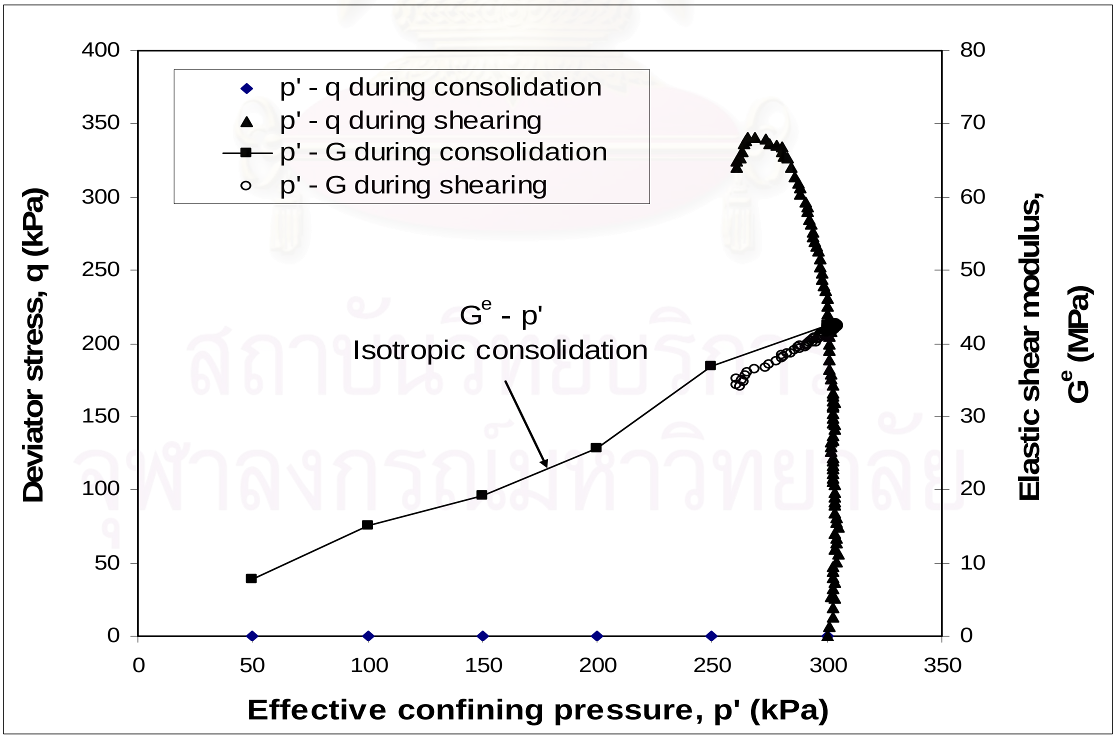

Figure 4.5: Variation elastic shear modulus during isotropic consolidation and undrained shearing at final mean effective stress, p’ = 300 kPa

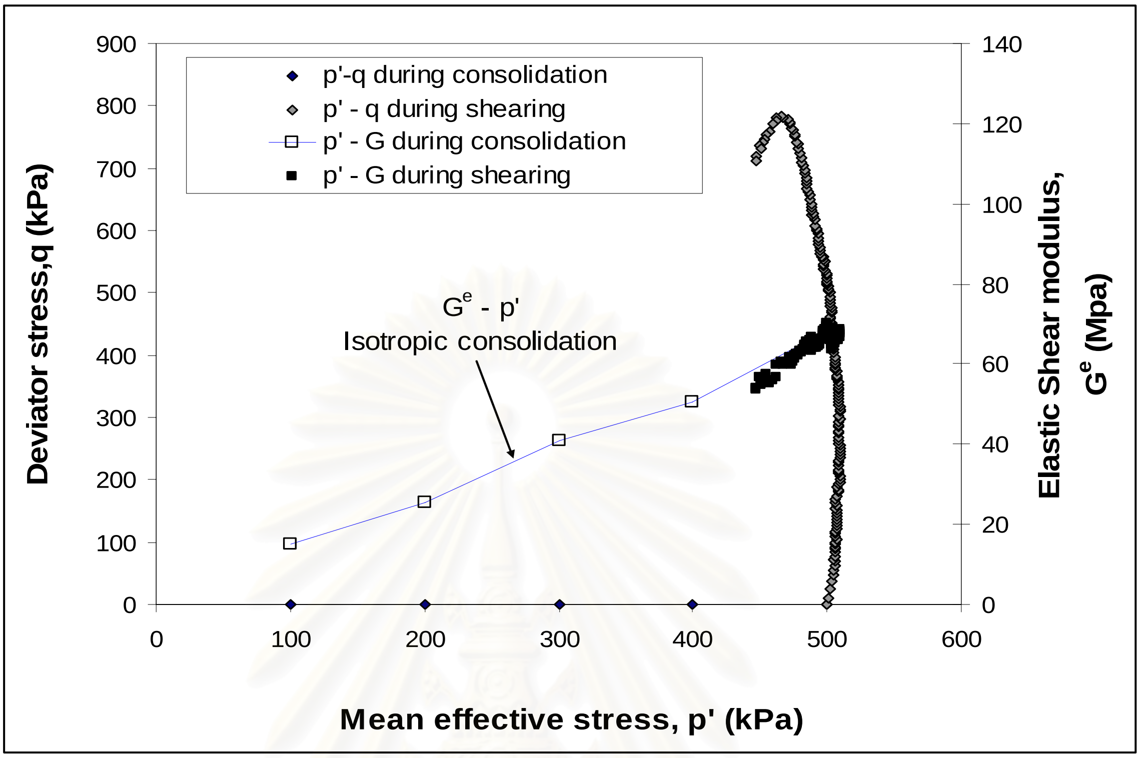

Figure 4.6: Variation elastic shear modulus during isotropic consolidation and undrained shearing at final mean effective stress, p’ = 500 kPa

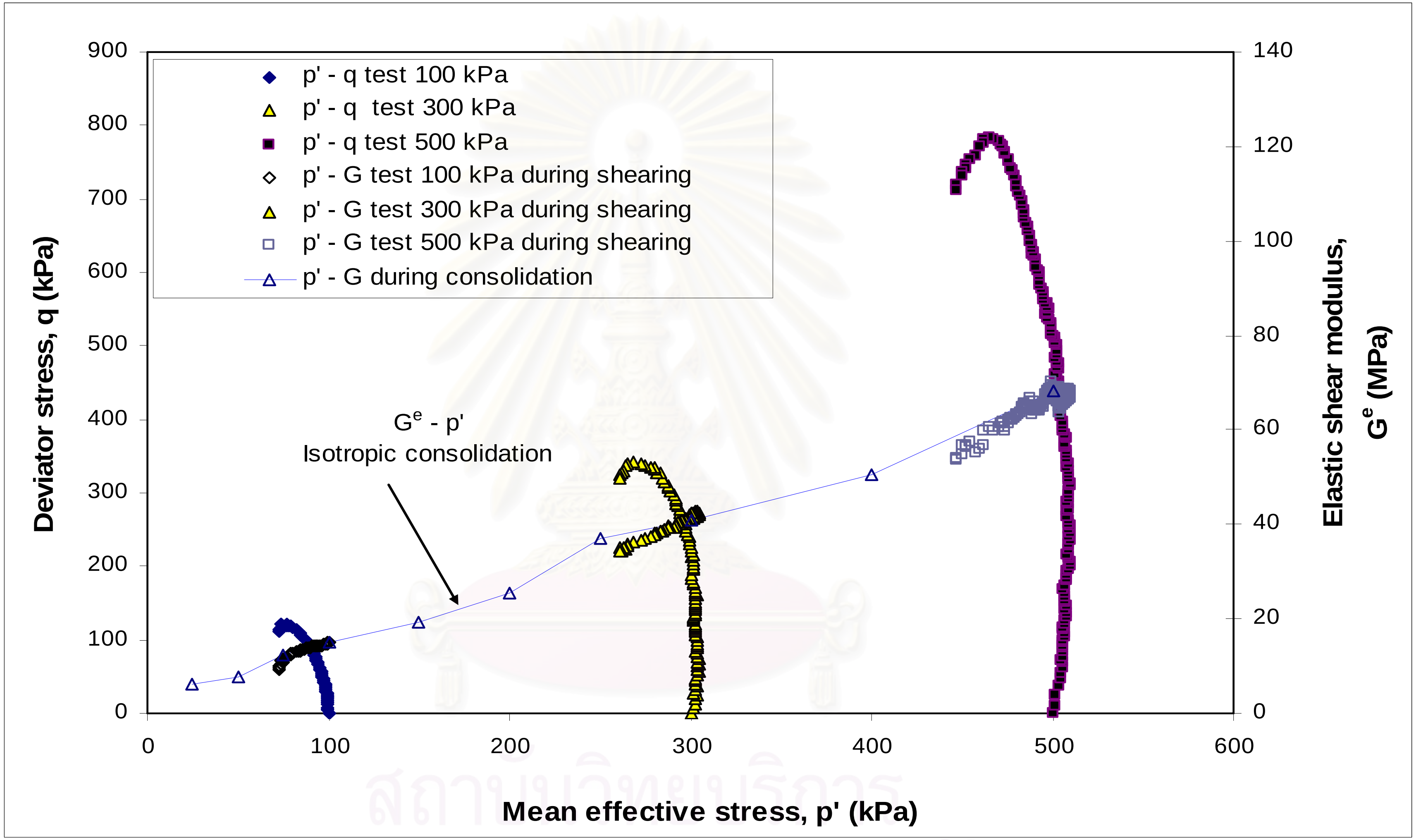

Figure 4.7: Variation of elastic shear modulus during consolidation and undrained shearing at different mean effective stress in isotropic test.

Based on the figure 4.8 - 4.14, this is unique result because the result of anisotropic (K_o= 0.3 and 0.6) test show that the variation of elastic shear modulus during anisotropic shearing is almost similar with isotropic shearing. It can be seen that the path of elastic shear modulus during undrained shearing followed the path obtained during consolidations. In both in anisotropic and isotropic test show that elastic shear modulus increase when the mean effective stress increase and also the elastic shear modulus is decrease dramatically when deviator stress, approaches in the peak value. The undrained shearing was carried out at the strain rate of 0.02 mm/min during which the elastic shear modulus were continuously recorded. It was found that the result is similar compare to the result from isotropic test, which the elastic shear modulus reduced as the mean effective stress decreased or the pore water pressure increased. The stress paths of final mean effective stress (p') 500 kPa in both anisotropic test (K_o = 0.3 and K_o = 0.6) are found nearly vertical compared than stress path of mean effective stress 100 kPa and 300 kPa. This may be due that the 500 KPa test or soil sample at depth 15 – 15.7 m is more stiffness. Based on figure 4.14, test of final mean effective stress (p') 500 kPa in anisotropic test (K_o = 0.3), it show that the elastic shear modulus during shearing state drop very fast and may be have effect of deviator stress to the shear modulus. Based on the shape of stress path, which is nearly vertical may be this sample is slightly overconsolidated. Unfortunately no information about ground water table in this location and OCR value in this sample could not be obtained in time, therefore it's impossible to confirm that the soil in-situ ground is overconsolidated.

Figure 4.15 show the stress path of all anisotropic specimens tested. In this figure, the undrained effective stress paths of the three samples are similar. The stress path of mean effective stress 300 or sample 6 is also similar with this, but its slope of failure line is small. This may be due to the fact that the samples at depth around 13 – 13.7 m contained silty or sandy layer and this was confirmed from visual inspection of the sample was prepared for the triaxial test.

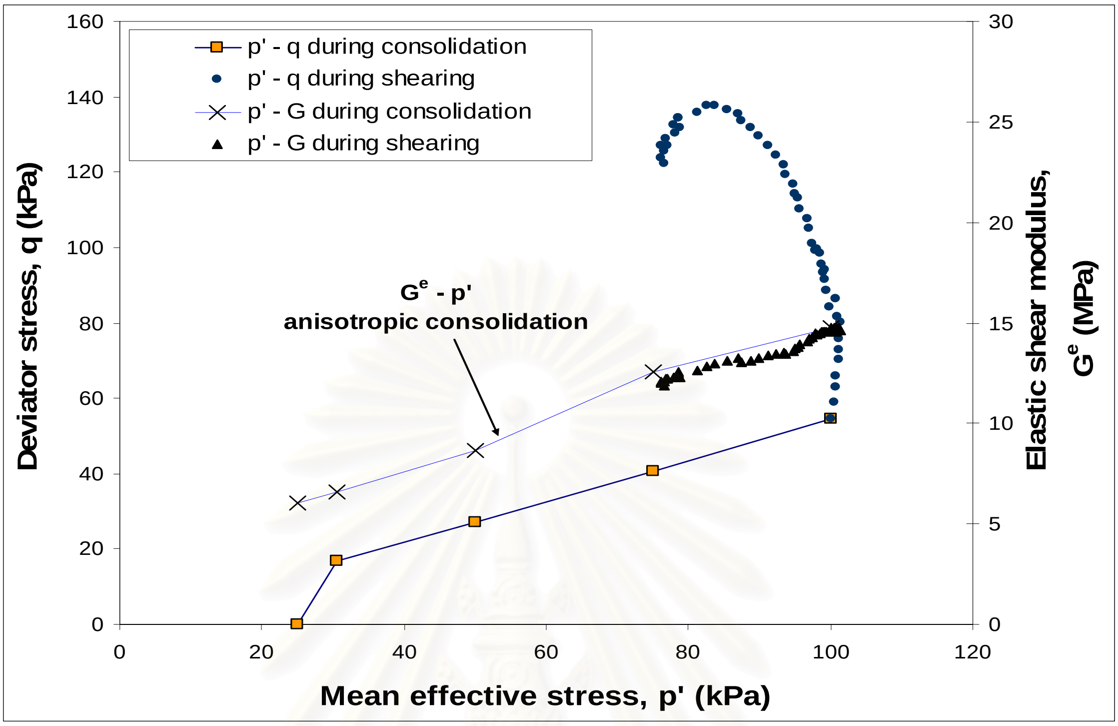

Figure 4.8: Variation of elastic shear modulus during consolidation and undrained shearing in anisotropic (K_o = 0.6) at final mean effective stress 100 kPa.

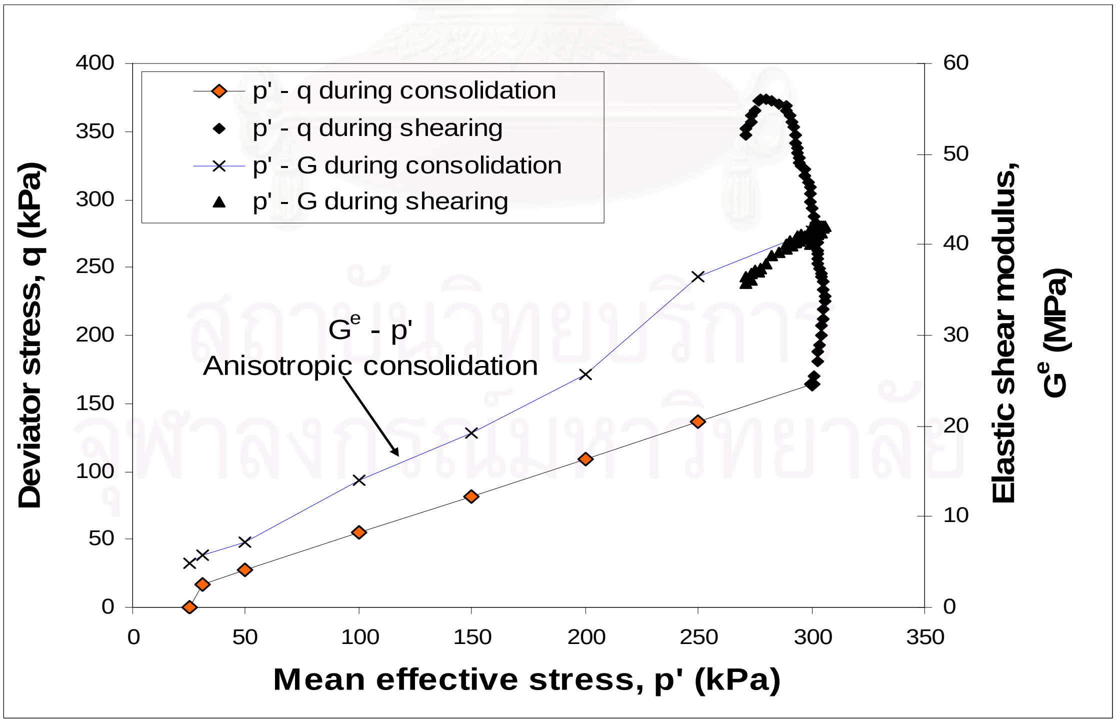

Figure 4.9: Variation of elastic shear modulus during consolidation and undrained shearing in anisotropic (K_o = 0.6) at final mean effective stress 300 kPa.

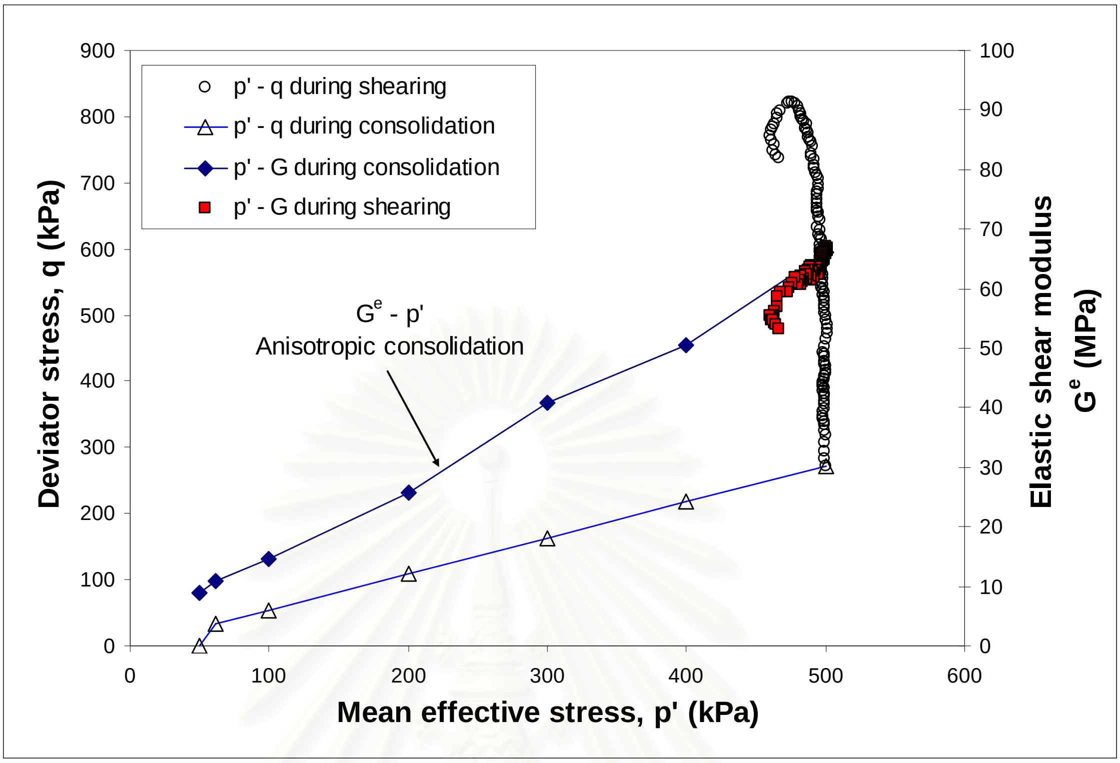

Figure 4.10: Variation of elastic shear modulus during consolidation and undrained shearing in anisotropic (K_o = 0.6) at final mean effective stress 500 kPa

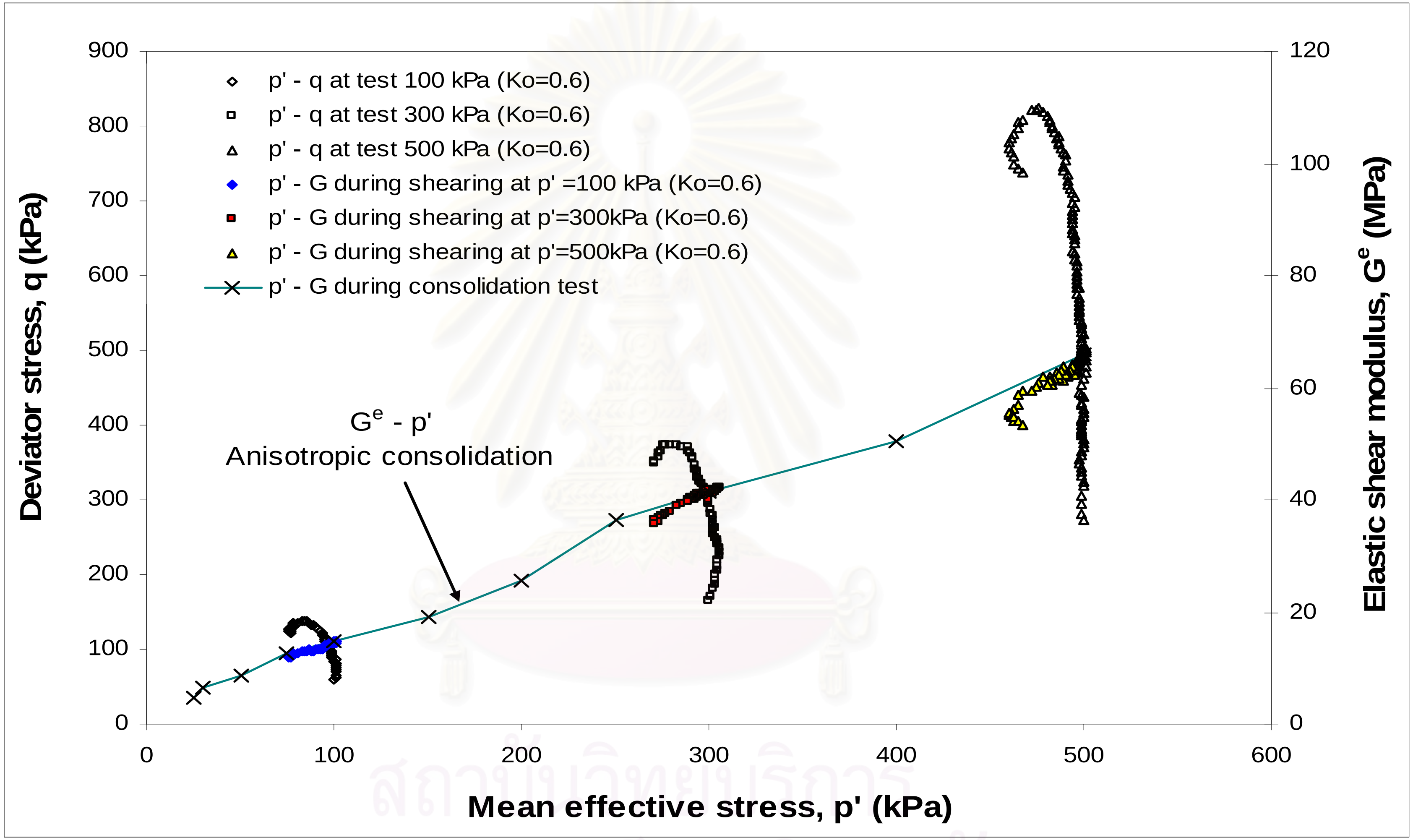

Figure 4.11: Variation of elastic shear modulus during consolidation and undrained shearing at different mean effective stress in anisotropic test (K_o = 0.6).

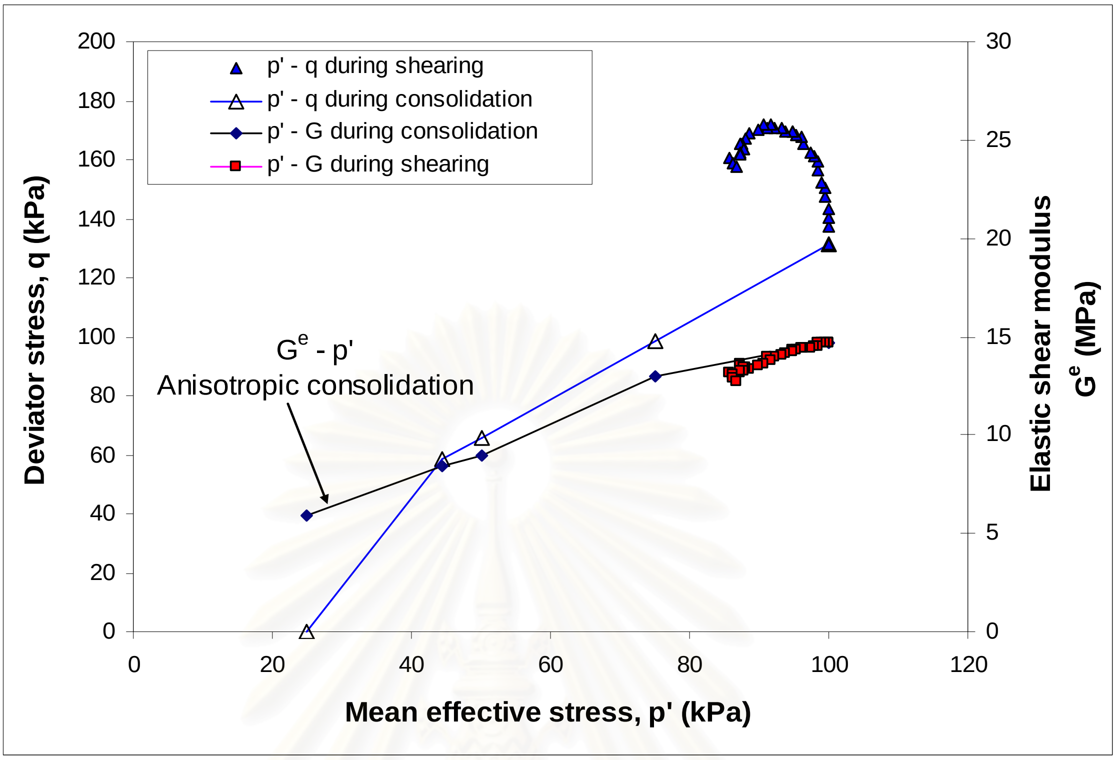

Figure 4.12: Variation of elastic shear modulus during consolidation and undrained shearing in anisotropic (K_o = 0.3) at final mean effective stress 100 kPa.

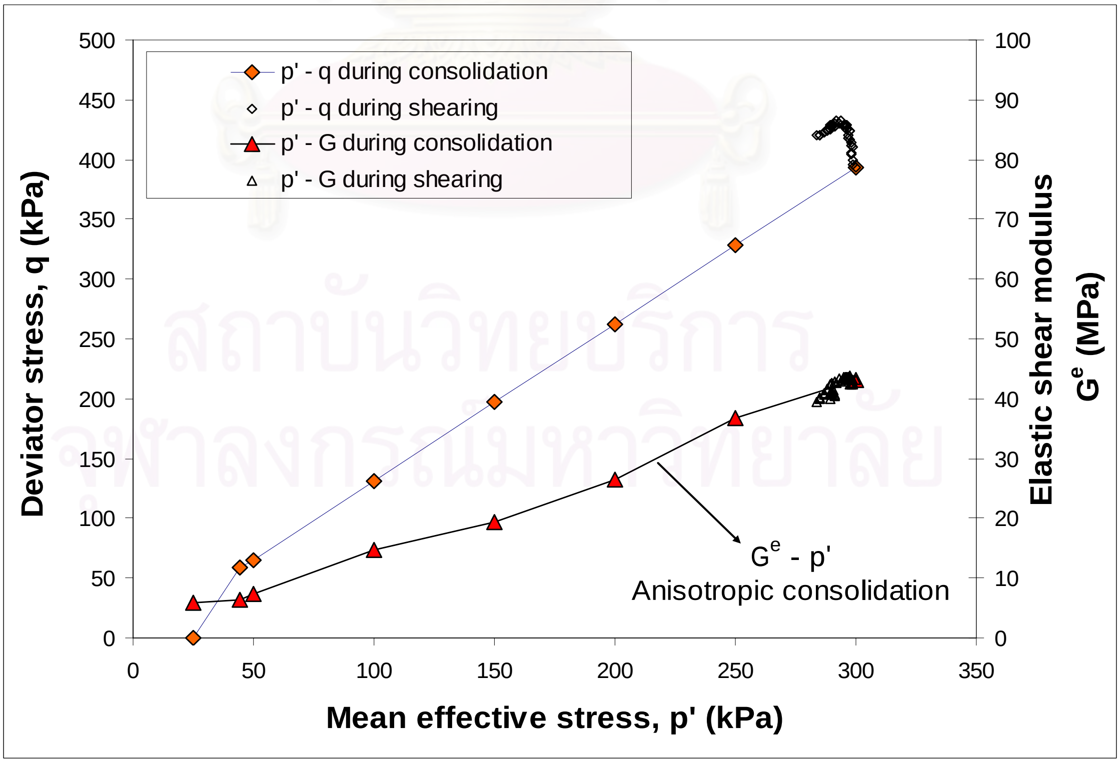

Figure 4.13: Variation of elastic shear modulus during consolidation and undrained shearing in anisotropic (K_o = 0.3) at final mean effective stress 300 kPa.

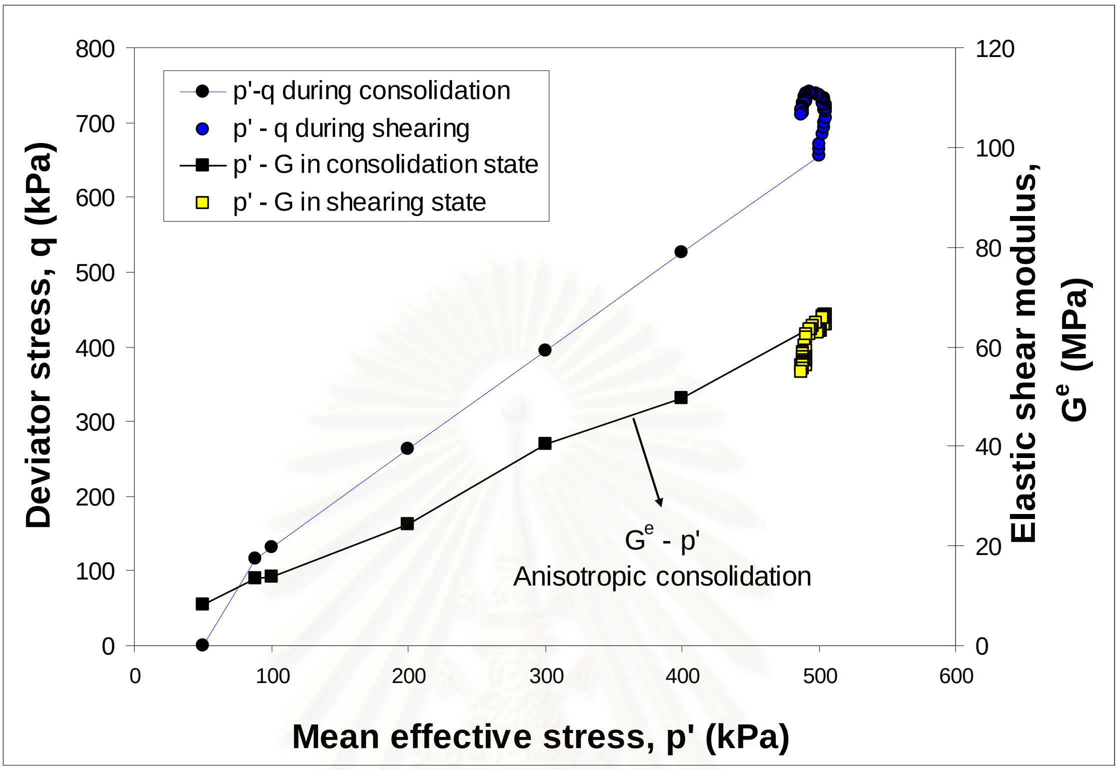

Figure 4.14: Variation of elastic shear modulus during consolidation and undrained shearing in anisotropic (K_o = 0.3) at final mean effective stress 500 kPa

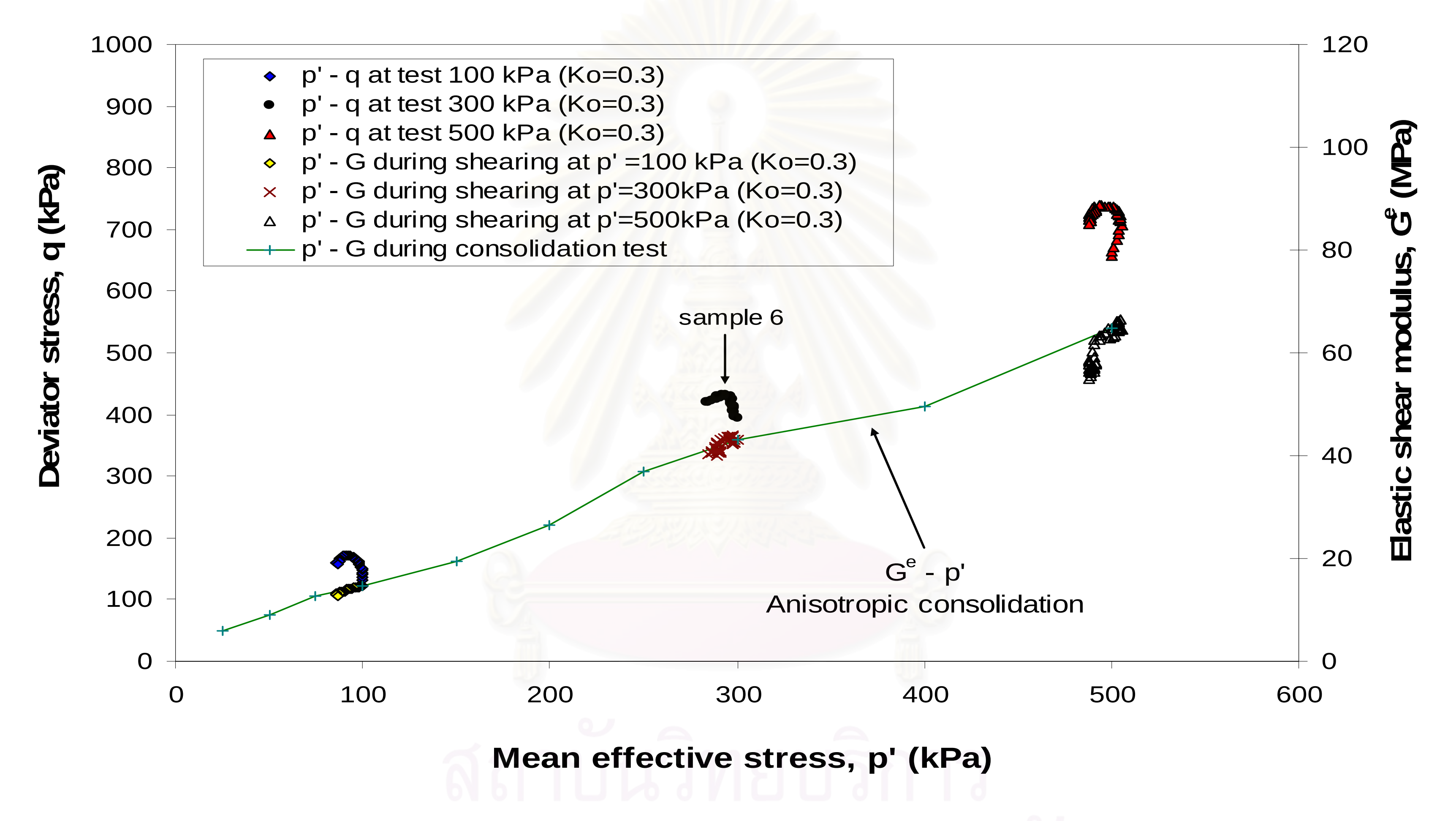

Figure 4.15: Variation of elastic shear modulus during consolidation and undrained shearing at different mean effective stress in anisotropic test ($K_o = 0.3$).

4.3. Effect of stress anisotropic on stiffness of Bangkok Clays

Elastic stiffness is known to be function of several factors, include effective stress level, plasticity index, overconsolidated ratio, and anisotropy stress condition (Isihara, 1996). Zytinski et all (1978) demonstrated that the shear modulus of elastic material could not simply be a function of the mean effective stress, p', since in this case a cycle of deviator stress, would result being done. This is implies that the shear modulus is more likely to depend on mean effective stress, p' and deviator stress, q. Viggiani and Atkinson (1995) found unique relationship between shear modulus and mean effective stress for normal consolidated clay which is independent of the value of effective stress ratio and it is same for compression and extension. It is mean that the effect of deviator stress is very small. This statement supported with researched of Teachavorasinskun and Amornwithayalax (2002), on the path of elastic shear modulus during shearing is follow the path of shear modulus during consolidation. It is implied that the effect of deviator stress, q on elastic shear modulus is very small or can be neglected.

To examine the influence of deviator stress on shear modulus, a series of measurements elastic shear modulus in isotropic and anisotropic were using Bangkok clays from Talingchan area. The number of tests of consolidated undrained triaxial compression tests were performed both in anisotropic and isotropic conditions (Table 4.2). Based on figure 4.16 – 4.18, It show that on no discernible effect of anisotropy of stress on the values of shear modulus even the high mean effective stress. All the data from the test show that similar result between isotropic and anisotropic during consolidation stage with the same mean effective stress. Figure 4.21 show the relationship between mean effective stress and shear modulus during triaxial consolidation and shearing before the sample failure. Based on this figure the result between isotropic and anisotropic test are also similar. This is clearly that no effect of stress anisotropy on stiffness of clay and the effect of deviator stress is very small and can be neglected, which is consistent with result during shearing and observation of Teachavorasinskun and Amornwithayalax (2002) on the variation of shear modulus during loading and unloading cycle and Viggiani and Atkinson (1995).

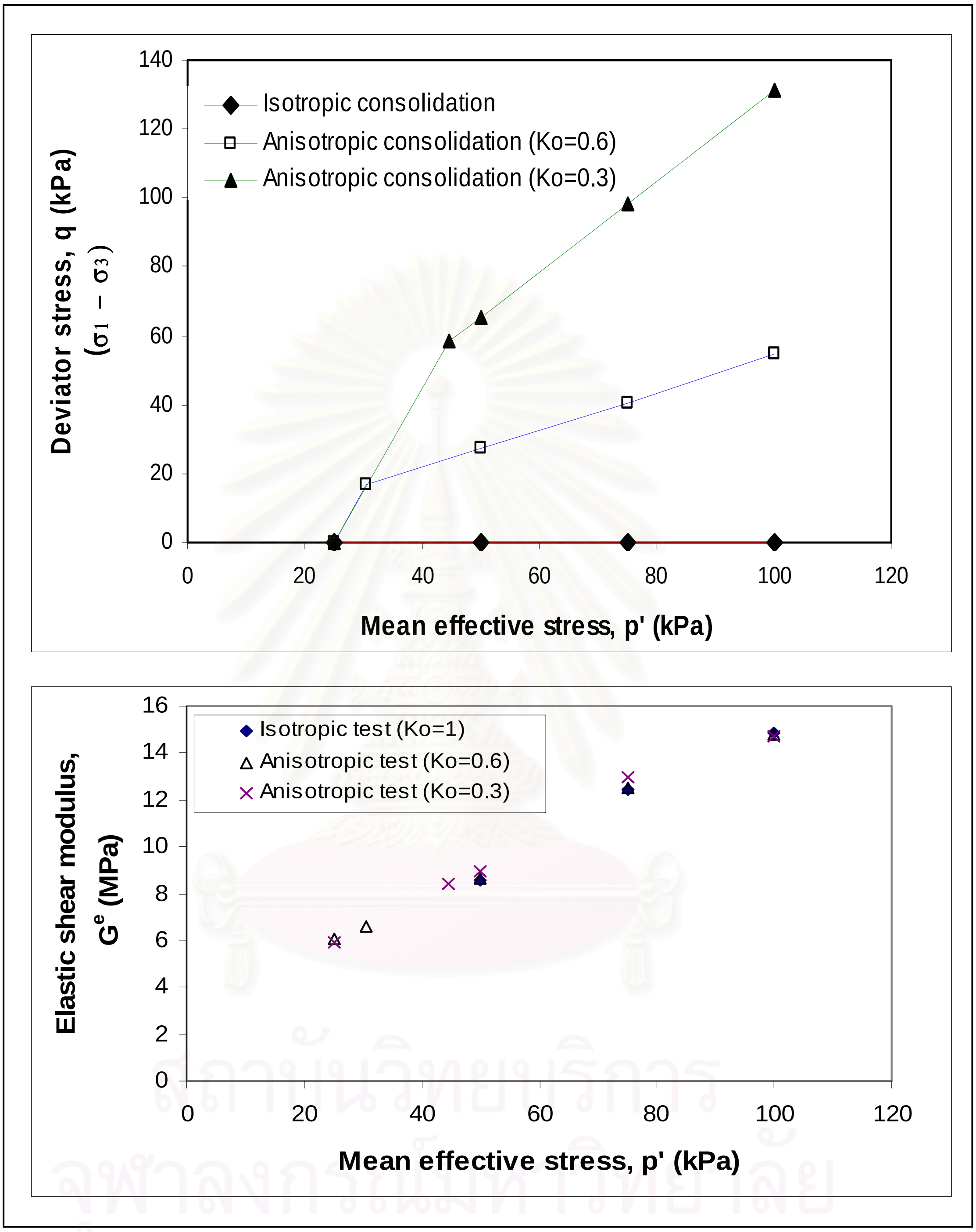

Figure 4.16: Variation of elastic shear modulus during consolidation with different mean effective stress and deviator stress

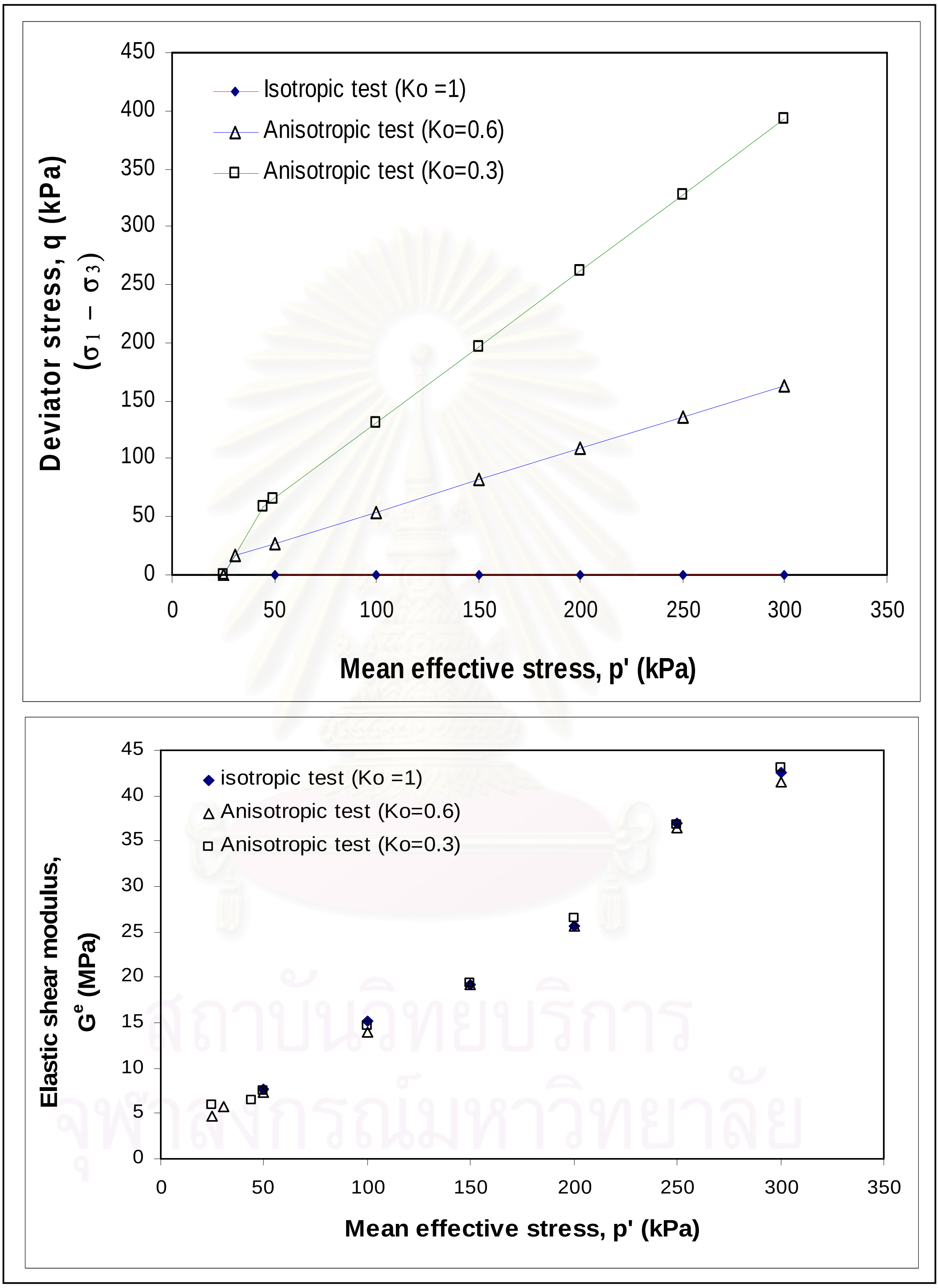

Figure 4.17: Variation of elastic shear modulus during consolidation with different mean effective stress and deviator stress

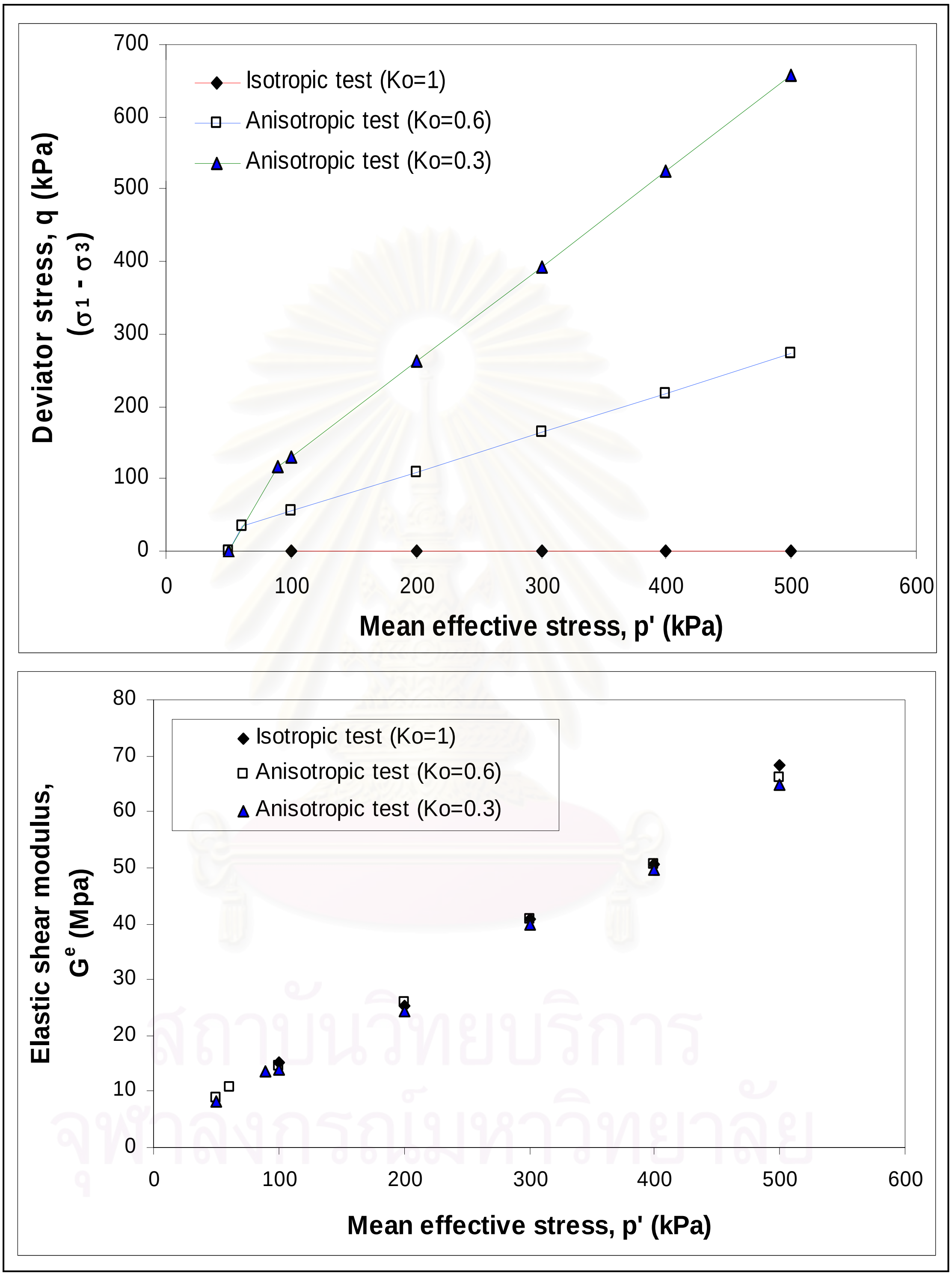

Figure 4.18: Variation of elastic shear modulus during consolidation with different mean effective stress and deviator stress

4.4 Empirical equation for Bangkok clays from Talingchan area

Figure 4.19-4.22 show the variation of elastic shear modulus during consolidation stage and shearing before the sample fail, It can be seen that the formula between consolidation stage and during shearing similar. Based on that figure 4.19 and 4.21, It is show that similarity result of elastic shear modulus and trend line of elastic shear modulus between isotropic test and anisotropic test on normal consolidated clay with the same mean effective stress. Because the result nearly similar between anisotropic and isotropic, we can develop a empirical equation in this area based on relationship between shear modulus and mean effective stress refer to figure 4.22. Based on the laboratory test result figure 4.20 and 4.21 the proposed empirical equation between the mean effective stress and shear modulus for Bangkok Clays from Talingchan area as bellow;

$$G^{e} = 238.3(p')^{0.9}\ (kPa) \qquad (1)$$

Where; G^e is the initial elastic shear modulus (kPa);

p’ is mean effective stress (kPa).

Base on the analyzed secondary data from Teachavorasinskun S and Akkarun T, 2004 with permission of Teachavorasinskun, the correlation between the mean effective stress and the low strain shear modulus of Bangkok Clays, of triaxial isotropic consolidation undrained test as bellow;

$$G^{e} = 389.04(p')^{0.771}\ (kPa) \qquad (2)$$

The sample of soft clay was collected from Chulalongkorn University site with depth 6 – 8 meter and with plasticity index 40 %.

Compare with equation 1 and previous empirical (equation 2), the measurement shear modulus in this research is little bit difference. It is similarly with the result of Viggiani and Atkinson, 1995, that the coefficient *A* and *m* controlled by plasticity index (figure 2.4), when the plasticity index increase the *A* parameter decrease and *m* parameter increase. Difference result may be cause by: (1) the different condition of soil properties such as plasticity index, specific gravity and stress history of the soil: (2) different depth of the soil.

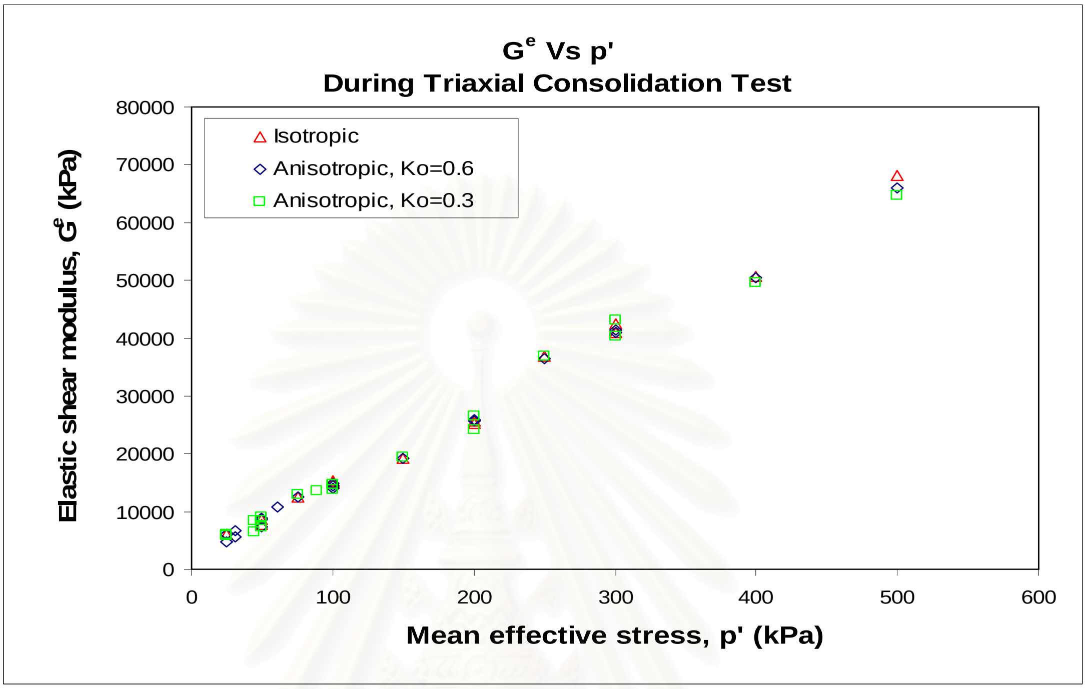

Figure 4.19: Variation of elastic shear modulus during consolidation with different mean effective stress

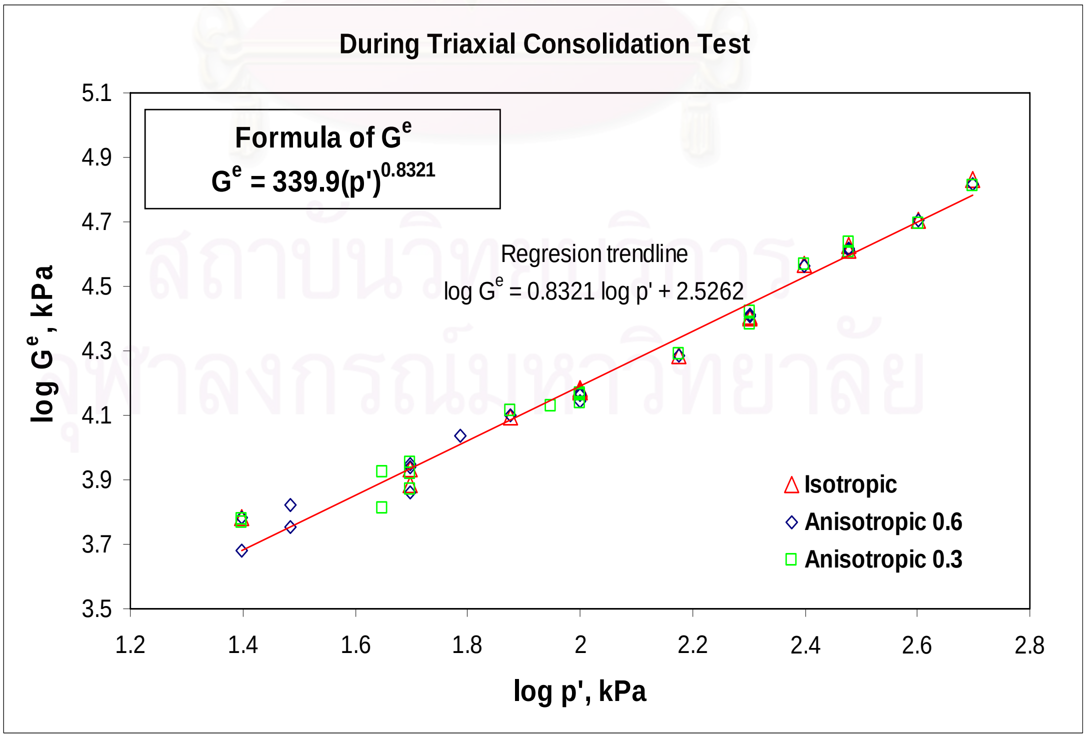

Figure 4.20: Developing formula of shear modulus during consolidation

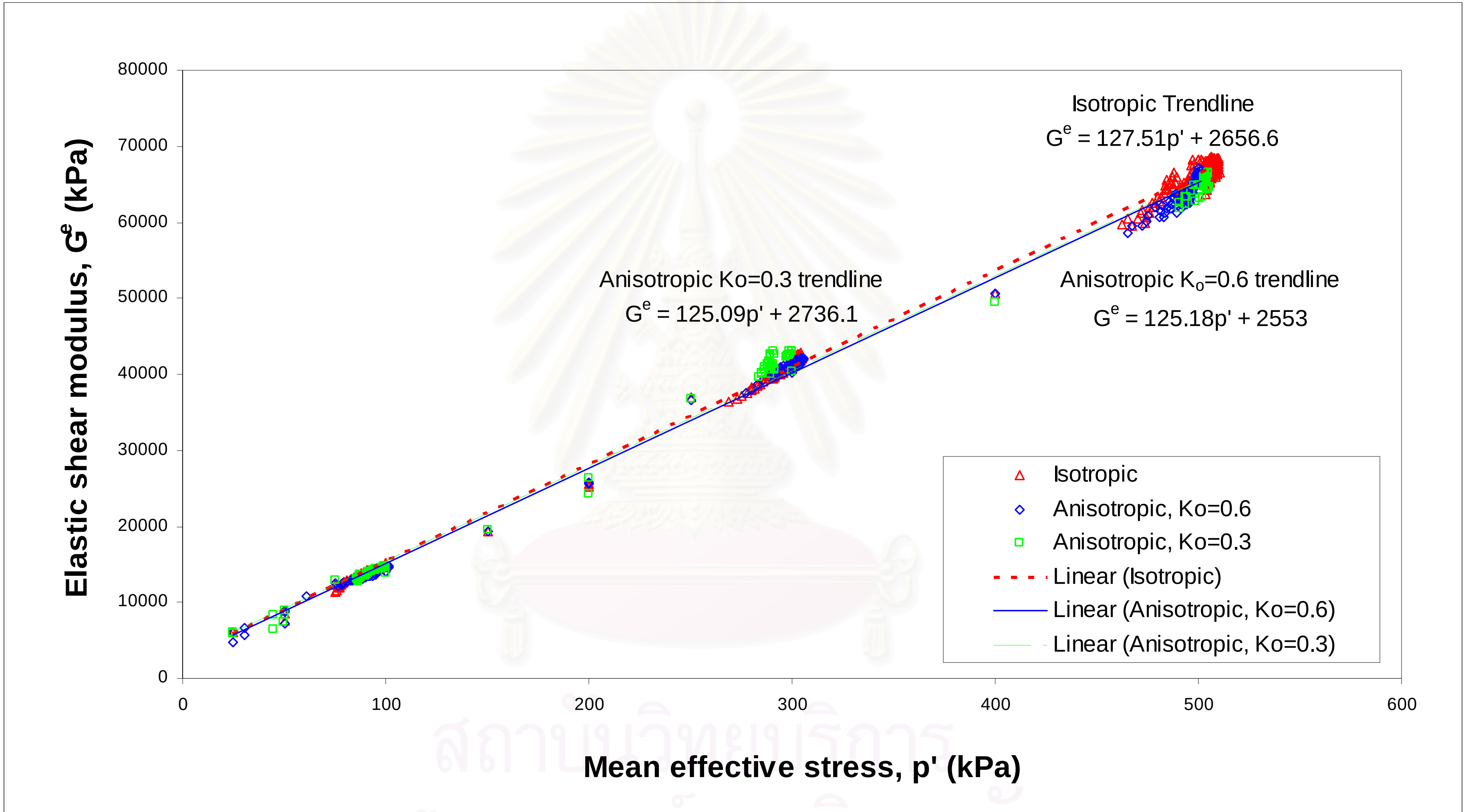

Figure 4.21: Variation of shear modulus during consolidation and shearing (before sample failure) with different mean effective stress

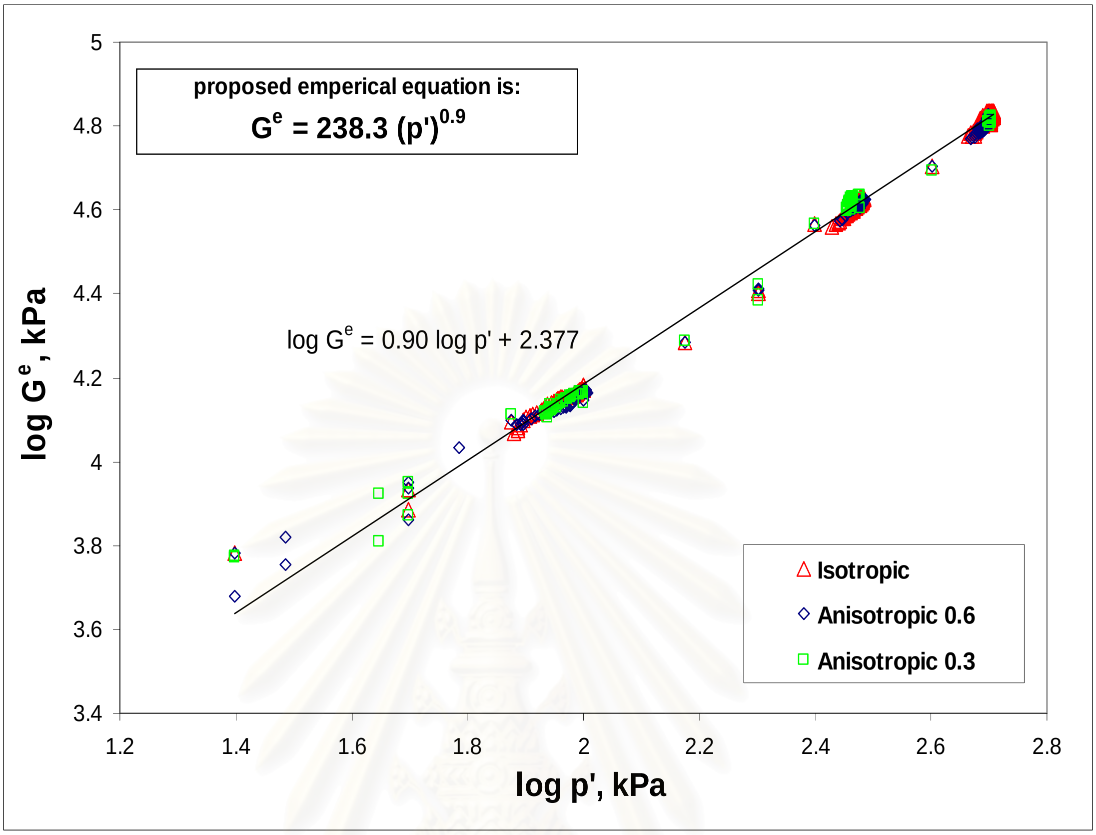

Figure 4.22: Developing formula of elastic shear modulus during consolidation and shearing.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.2 Summary and Conclusions

Study and determination of shear wave velocity and shear modulus of clay has a considerable importance in Geotechnical Engineering. To determinate it, several methods and techniques are exist, both in laboratory tests and insitu survey by wave propagation. To examine the influence of deviator stress on shear modulus, a number of triaxial tests were performed using Bangkok clay sample from Talingchan area. The samples were test from depth 10 – 16 m. The description of clay in this depth are dark gray color and contain some silt or fine sand layer at depth 13 – 14 m. The Plastic limit is stable around 23 – 27 %. Liquid limit ranged between 75 – 90 %, and the insitu natural water contents was closed to plasticity index.

This research focuses on the performance of bender elements to investigate the different stress consolidation (stress induced anisotropy). The test of consolidated undrained triaxial compression tests were conducted in both anisotropic and isotropic conditions. The results obtained from different test are compared and the following conclusions made;

a. There is unique relationship between isotropic and anisotropic for normal consolidated clay. All the data from the test show that similar result between isotropic and anisotropic tests during consolidation stage with the same mean effective stress. It is mean that no discernible effect of stress induced anisotropy on stiffness of clay even at high mean effective stress. This is clearly that the effect of deviator stress is very small and can be neglected. This is may be because stress induced anisotropy solely from anisotropy current stress condition. Therefore stress induced anisotropy dependent with stress-strain history. The main factor controlling shear modulus is mean effective stress, which is consistent with and observation done by Viggiani and Atkinson (1995) and Teachavorasinskun and Amornwithayalax (2002).

b. The shear modulus obtained during undrained shearing in both isotropic and anisotropic exhibit similar dependency on the mean effective stress. The path of elastic shear modulus during undrained shearing in both isotropically and anisotropically consolidated samples generally followed the path of elastic shear modulus obtained during consolidations. The result implied negligible effect of the deviator on shear modulus, which consistent with the result during consolidation stage. The undrained shearing was carried out at the strain rate of 0.02 mm/min during which the shear modulus were continuously recorded. It was found that the elastic shear modulus reduced as the mean effective stress decreased or the pore water pressure increased. Most of the test samples were drop of elastic shear modulus when the peak of deviator stress was achieved. However, it should be noted that the measurement of shear wave propagation velocity can be used to detect the formation of any discontinuity inside the sample.

c. Based on this laboratory test result a proposed correlation between the mean effective stress and shear modulus of Bangkok Clays from Talingchan area is shown as bellow;

$$G = 238.3(p')^{0.9}\ (kPa)$$

Where; G is the initial shear modulus (kPa);

p' is mean effective stress (kPa).

d. Shear modulus from this research compared with the empirical equation based on the cyclic triaxial test of soft Bangkok clay sample were collected from Chulalongkorn University site is little bit different. This may be cause by the difference plasticity index of soil sample.

5.2 Recommendations

In this study, show the consistency and similarly results of elastic shear modulus in both anisotropic and isotropic consolidated undrained test, which no effect of stress anisotropy on stiffness of clay and no effect of deviator stress both in normal consolidated clay. To make deeply investigation on stiffness of Bangkok clays, for future studies the following recommendation are suggested:

a. It is recommended to perform the triaxial extension test both in isotropic and anisotropic test using the bender elements with varying mean effective stress so that effect of deviator stress could be more clearly and evaluated.
b. It is recommended to perform Consolidated Anisotropic Undrained for overconsolidated clay to investigate the stress induced anisotropy on overconsolidated clay.
c. It is recommended to investigate the effect of inherent or structural anisotropy using the configuration bender element in the triaxial apparatus.
d. The main difficulty in estimating the initial shear modulus is to find the exact travel time of shear wave through the sample. This difficult can be minimized by using a modern digital oscilloscope. Therefore to obtain more accurate estimation of the initial shear modulus, to use high resolution digital oscilloscope is recommended.

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APPENDIXES

1. SPECIFIC GRAFITY TEST
2. ATTERBERLIMIT TEST
3. ANALYSIS DATA OF TRAXIAL TEST

SOIL MECHANICS LABORATORY

Specific grafity determination

Pycnometer No. : I

Tested by : Yono
Date : Feb 09, 2005

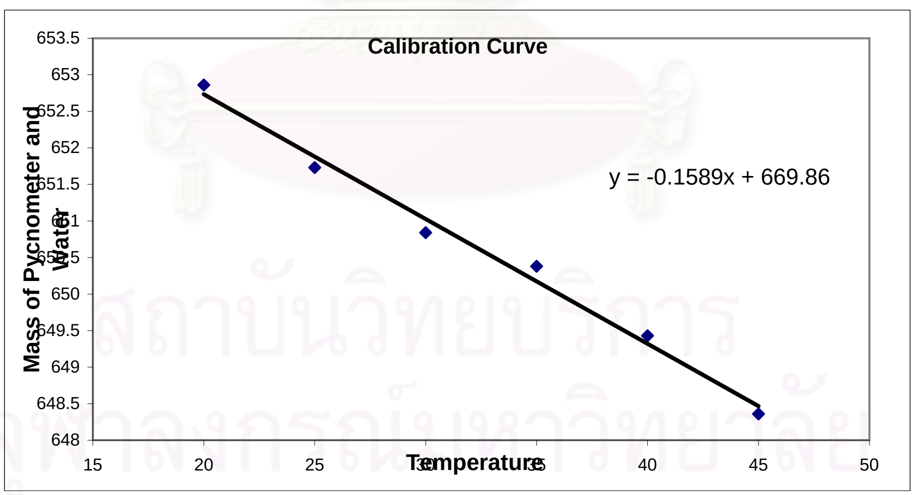
Calibration of Pycnometer

A. Experimental Procedure

Determination Number	1	2	3	4
Mass of Pycnometer and water, Ma (g)	651.2			
Temperatur ^{o}C	29			

B. Theorotical Procedure Method 1

Mass of Pycnometer, Mf : 280.15 9	Cubical Expansion for Pyrex Glass ε = 0.1 x 10-4/oC					
Temp. of Calibration, Tc 20^{o}C	ρ_a = 0.0012 g/cm^3					
Vol. Bottle at Tc, V_B = 500 cc	M_a (at T_x) = $M_f + V_B (1 + \Delta T.\varepsilon)(\rho_{Tx} - \rho_a)$					
Determination Number	1	2	3	4	5	6
Temperature, Tx ^{o}C	20	25	30	35	40	45
Density of water at Tx, ρ_{Tx} g/cm^3	0.9982	0.9971	0.9957	0.9941	0.9922	0.9902
Mass of pycnometer and water M_a(g)	652.86	651.73	650.84	650.38	649.43	648.36



SPECIFIC GRAVITY

Soil Sample : Gray clay with layer of fine sand

Location : Talingchan area
Boring no. : BH2
Sample No : 1/3

Depth : 10.5 - 11.2 m
Date : Feb 9, 2005
Made by : Yono

1	Sample Number	1	2
2	Mass Pycnometer + Water + Soil (gr)	692.02	691.36
3	Temperature t^{o}C	29.00	28.00
4	Mass Pycnometer + Water (gr) at T_x	665.25	665.41
5	Evaporating Dish No	YN1	YN2
6	Mass of Evaporating Dish + Oven dried Soil (gr)	330.29	331.73
7	Mass of Evaporating Dish (gr)	287.56	290.35
8	Mass of Dried Soil, Ws in gr (gr)	42.73	41.38
9	Specific Gravity of Water at Tc	0.99597	0.99626
10	Correction factor, K	0.9977	0.9980
11	Specific Gravity of Soil	2.67	2.68
12	Average of Specific Grafity	2.674	

SPECIFIC GRAVITY

Soil Sample : Clay, Grayish at natural with layer of fine sand

Location : Talingchan area
Boring no. : BH2
Sample No : 1/3

Depth : 13.5 - 14.2 m
Date : Feb 10, 2005
Made by : Yono

1	Sample Number	1	2
2	Mass Pycnometer + Water + Soil (gr)	667.30	668.35
3	Temperature t^{o}C	29.00	29.00
4	Mass Pycnometer + Water (gr) at T_x	651.420	651.420
5	Evaporating Dish No	A2	A1
6	Mass of Evaporating Dish + Oven dried Soil (gr)	313.73	314.47
7	Mass of Evaporating Dish (gr)	288.50	287.49
8	Mass of Dried Soil, Ws in gr (gr)	25.23	26.98
9	Specific Gravity of Water at Tc	0.9957	0.9957
10	Correction factor, K	0.9977	0.9977
11	Specific Gravity of Soil	2.687	2.673
12	Average specific gravity soil	2.680	

SPECIFIC GRAVITY

Soil Sample : Gray clay with layer of fine sand

Location : Talingchan area
Boring no. : BH2
Sample No : 3/3

Depth : 15 - 15.7 m
Date : Feb 9, 2005
Made by : Yono

1	Sample Number	1	2
2	Mass Pycnometer + Water + Soil (gr)	683.43	689.66
3	Temperature t°C	29.00	30.00
4	Mass Pycnometer + Water (gr) at T_x	665.11	664.97
5	Evaporating Dish No	YN1	YN2
6	Mass of Evaporating Dish + Oven dried Soil (gr)	316.58	329.45
7	Mass of Evaporating Dish (gr)	287.43	290.19
8	Mass of Dried Soil, Ws in gr (gr)	29.15	39.26
9	Specific Gravity of Water at Tc	0.9957	0.9957
10	Conversion factor, K	0.9977	0.9974
11	Specific Gravity of Soil	2.68	2.69
12	Average of Specific Grafity	2.686	

SOIL MECHANICS LABORATORY
Specific grafity determination

Pycnometer No. : 2

Tested by : Yono
Date : Feb 09, 2005

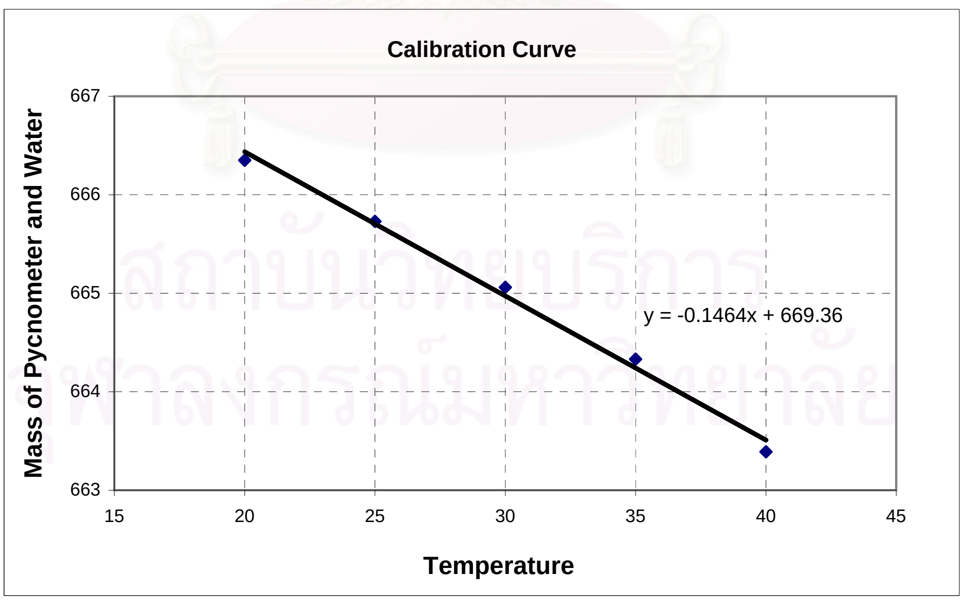
Calibration of Pycnometer

A. Experimental Procedure

Determination Number	1	2	3	4
Mass of Pycnometer and water, Ma (g)	651.2			
Temperatur ^{o}C	29			

B. Theorotical Procedure Method 1

Mass of Pycnometer, Mf : 280.15 9	Cubical Expansion for Pyrex Glass ε = 0.1 x 10-4/oC					
Temp. of Calibration, Tc 20^{o}C	ρ_a = 0.0012 g/cm^3					
Vol. Bottle at Tc, V_B = 500 cc	M_a (at T_x) = $M_f + V_B(1 + \Delta T.\varepsilon)(\rho_{Tx} - \rho_a)$					
Determination Number	1	2	3	4	5	
Temperature, Tx ^{o}C	20	25	30	35	40	
Density of water at Tx, ρ_{Tx} g/cm^3	0.9982	0.9971	0.9957	0.9941	0.9922	
Mass of pycnometer and water M_a(g)	666.35	665.73	665.06	664.33	663.39	



SPECIFIC GRAVITY

Soil Sample : Gray clay with layer of fine sand

Location : Sirirot area, Bangkok (near bus station)
Boring no. : BH2
Sample No : 3/3

Depth : 15 - 15.7 m
Date : Feb 9, 2005
Made by : Yono

1	Sample Number	1	2
2	Mass Pycnometer + Water + Soil (gr)	683.43	689.66
3	Temperature t°C	29.00	30.00
4	Mass Pycnometer + Water (gr) at T_x	665.11	664.97
5	Evaporating Dish No	YN1	YN2
6	Mass of Evaporating Dish + Oven dried Soil (gr)	316.58	329.45
7	Mass of Evaporating Dish (gr)	287.43	290.19
8	Mass of Dried Soil, Ws in gr (gr)	29.15	39.26
9	Specific Gravity of Water at Tc	0.9957	0.9957
10	Conversion factor, K	0.9977	0.9974
11	Specific Gravity of Soil	2.68	2.69
12	Average of Specific Grafity	2.686	

ATTERBERG LIMITS

Location : Talingchan area
No Sample : 2/2 Made by : yono
Depth : 10.5 -11.2 m Date : Feb 6, 2005

Soil sample (*disturbed/* ~~*undisturbed*~~)
Description of soil : Greyish clay, soft and homogenous
Specific Gravity, *Gs* : **2.674**

Water content determination

Can no.	1	2	3
Mass of can (gr)	21.14	17.08	18.49
Mass of wet soil + can (gr)	26.85	25.12	27.22
Mass of dry soil + can (gr)	24.58	21.93	23.75
Mass of dry soil (gr)	3.44	4.85	5.26
Mass of moisture (gr)	2.27	3.19	3.47
Water content, *w (%)*	65.99	65.77	65.97
Natural Water content (%)	65.91		

Plastic Limit Determination

Can no.	1	2	3
Mass of can (gr)	21.11	17.05	18.45
Mass of wet soil + can (gr)	21.57	17.56	19.37
Mass of dry soil + can (gr)	21.47	17.45	19.17
Mass of dry soil (gr)	0.36	0.40	0.72
Mass of moisture (gr)	0.10	0.11	0.20
Water content, w (%)	27.78	27.50	27.78
Plastis Limit (%)	27.69		

Liquid Limit Determination

Can no.	1		2		3		4		5	
No. of blows, *N*	**14**		**21**		**28**		**32**		**41**	
Mass of can (gr)	17.99	21.22	20.74	20.38	20.38	18.20	12.48	17.21	12.61	17.99
Mass of wet soil + can (gr)	20.91	25.84	22.20	23.54	23.53	22.25	15.44	20.66	16.07	20.91
Mass of dry soil + can (gr)	19.52	23.59	21.54	22.11	22.16	20.48	14.19	19.23	14.68	19.73
Mass of dry soil (gr)	1.53	2.37	0.80	1.73	1.78	2.28	1.71	2.02	2.07	1.74
Mass of moisture (gr)	1.39	2.25	0.66	1.43	1.37	1.77	1.25	1.43	1.39	1.18
Water content, *w* (%)	90.85	94.94	82.50	82.66	76.97	77.63	73.10	70.79	67.15	67.82
Water content, w	92.89		82.58		77.30		71.95		67.48	

Liquid Limit,	***LL***	**=**	**78.79**	**%**
Plastic Limit,	***PL***	**=**	**27.69**	**%**
Plasticity Index,	***PI***	**=**	**51.10**	**%**
Natural Water Content,	w_N	**=**	**65.91**	**%**
Liquidity Index,	***LI***	**=**	**0.75**	

ATTERBERG LIMITS

Location	: Talingchan area			
No Sample	: 2/2		Made by	: yono
Depth	: 11.5 -12.2 m		Date	: Feb 6, 2005

Soil sample (*disturbed*/ ~~*undisturbed*~~)
Description of soil : Greyish clay, soft and homogenous
Specific Gravity, *Gs* : **2.686**

Water content determination

Can no.	1	2	3
Mass of can (gr)	22.78	19.87	21.78
Mass of wet soil + can (gr)	30.72	26.34	28.65
Mass of dry soil + can (gr)	27.62	23.77	26.01
Mass of dry soil (gr)	4.84	3.90	4.23
Mass of moisture (gr)	3.10	2.57	2.64
Water content, *w (%)*	64.10	65.90	62.41
Natural Water content (%)	64.14		

Plastic Limit Determination

Can no.	1	2	3
Mass of can (gr)	20.45	17.08	18.49
Mass of wet soil + can (gr)	21.37	17.58	19.44
Mass of dry soil + can (gr)	21.2	17.48	19.24
Mass of dry soil (gr)	0.75	0.40	0.75
Mass of moisture (gr)	0.17	0.10	0.20
Water content, w (%)	22.67	25.00	26.67
Plastis Limit (%)	24.78		

Liquid Limit Determination

Can no.	1		2		3		4		5	
No. of blows, *N*	**14**		**21**		**28**		**32**		**41**	
Mass of can (gr)	18.01	21.25	20.75	20.41	20.40	18.25	15.32	17.26	15.76	20.15
Mass of wet soil + can (gr)	21.13	25.89	22.29	24.81	23.76	22.28	17.91	20.71	18.21	24.75
Mass of dry soil + can (gr)	19.53	23.52	21.59	22.77	22.24	20.50	16.84	19.26	17.24	22.94
Mass of dry soil (gr)	1.52	2.27	0.84	2.36	1.84	2.25	1.52	2.00	1.48	2.79
Mass of moisture (gr)	1.60	2.37	0.70	2.04	1.52	1.78	1.07	1.45	0.97	1.81
Water content, *w* (%)	105.26	104.41	83.33	86.44	82.61	79.11	70.39	72.50	65.54	64.87
Water content, w	104.83		84.89		80.86		71.45		65.21	

Liquid Limit,	***LL***	**=**	**81.80**	**%**
Plastic Limit,	***PL***	**=**	**24.78**	**%**
Plasticity Index,	***PI***	**=**	**57.03**	**%**
Natural Water Content,	w_N	**=**	**64.14**	**%**
Liquidity Index,	***LI***	**=**	**0.69**	

ATTERBERG LIMITS

Location	: Talingchan area	Made by	: yono
No Sample	: 1/2	Date	: Feb 6, 2005
Depth	: 13.5 -14.2 m		

Soil sample (*disturbed/* ~~*undisturbed*~~)
Description of soil : Greyish clay, soft and have layer of silty sand
Specific Gravity, *Gs* : **2.68**

Water content determination

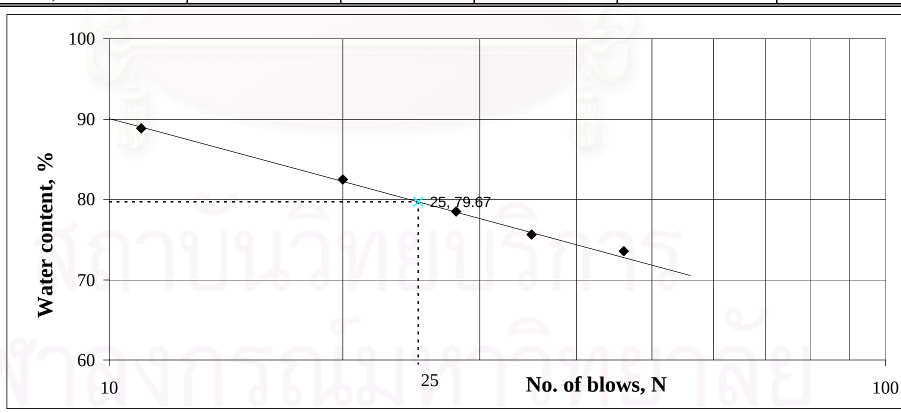
Can no.	1	2	3
Mass of can (gr)	36.12	42.09	85
Mass of wet soil + can (gr)	71.24	64.82	111.39
Mass of dry soil + can (gr)	57.53	55.93	101.11
Mass of dry soil (gr)	21.41	13.84	16.11
Mass of moisture (gr)	13.71	8.89	10.28
Water content, *w (%)*	64.04	64.23	63.81
Natural Water content (%)	64.03		

Plastic Limit Determination

Can no.	1	2	3
Mass of can (gr)	12.6	17.07	17.19
Mass of wet soil + can (gr)	13.46	17.52	18.19
Mass of dry soil + can (gr)	13.29	17.44	18.00
Mass of dry soil (gr)	0.69	0.37	0.81
Mass of moisture (gr)	0.17	0.08	0.19
Water content, w (%)	24.64	21.62	23.46
Plastis Limit (%)	23.24		

Liquid Limit Determination

Can no.	1		2		3		4		5	
No. of blows, *N*	**11**		**20**		**28**		**35**		**46**	
Mass of can (gr)	13.37	17.42	17.41	21.47	16.19	20.35	20.25	12.83	18.11	12.34
Mass of wet soil + can (gr)	22.63	22.97	20.92	27.33	19.64	25.49	25.07	17.44	24.13	15.49
Mass of dry soil + can (gr)	18.29	20.35	19.34	24.67	18.13	23.22	23.01	15.44	21.57	14.16
Mass of dry soil (gr)	4.92	2.93	1.93	3.20	1.94	2.87	2.76	2.61	3.46	1.82
Mass of moisture (gr)	4.34	2.62	1.58	2.66	1.51	2.27	2.06	2.00	2.56	1.33
Water content, *w* (%)	88.21	89.42	81.87	83.12	77.84	79.09	74.64	76.63	73.99	73.08
Water content, w	88.82		82.50		78.46		75.63		73.53	



Liquid Limit,	***LL*** **=**	**79.67**	**%**
Plastic Limit,	***PL*** **=**	**23.24**	**%**
Plasticity Index,	***PI*** **=**	**56.43**	**%**
Natural Water Content,	w_N **=**	**64.03**	**%**
Liquidity Index,	***LI*** **=**	**0.72**	

ATTERBERG LIMITS

Location	: Talingchan area	Made by	: yono
No Sample	: 2/2	Date	: Feb 6, 2005
Depth	: 15 -15.7 m		

Soil sample (*disturbed/* ~~*undisturbed*~~)
Description of soil : Greyish Clay, homogenous
Specific Gravity,*Gs* : **2.69**

Water content determination

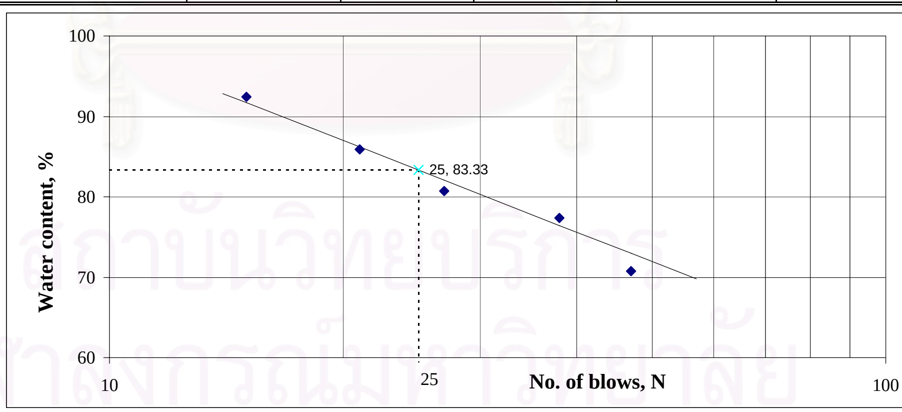
Can no.	1	2	3
Mass of can (gr)	17.99	16.86	18.38
Mass of wet soil + can (gr)	25.24	22.51	25.28
Mass of dry soil + can (gr)	22.3	20.23	22.45
Mass of dry soil (gr)	4.31	3.37	4.07
Mass of moisture (gr)	2.94	2.28	2.83
Water content, *w (%)*	68.21	67.66	69.53
Natural Water content (%)	68.47		

Plastic Limit Determination

Can no.	1	2	3
Mass of can (gr)	13.87	18.52	35.39
Mass of wet soil + can (gr)	14.42	18.81	35.72
Mass of dry soil + can (gr)	14.31	18.75	35.65
Mass of dry soil (gr)	0.44	0.23	0.26
Mass of moisture (gr)	0.11	0.06	0.07
Water content, w (%)	25.00	26.09	26.92
Plastis Limit (%)	26.00		

Liquid Limit Determination

Can no.	1		2		3		4		5	
No. of blows, *N*	**15**		**21**		**27**		**38**		**47**	
Mass of can (gr)	13.65	16.26	12.85	20.57	16.25	17.43	17.20	12.44	21.57	12.64
Mass of wet soil + can (gr)	18.74	22.27	14.80	24.96	19.65	21.72	20.66	16.20	24.45	15.72
Mass of dry soil + can (gr)	16.29	19.39	13.90	22.93	18.15	19.78	19.15	14.56	23.30	14.4
Mass of dry soil (gr)	2.64	3.13	1.05	2.36	1.90	2.35	1.95	2.12	1.73	1.76
Mass of moisture (gr)	2.45	2.88	0.90	2.03	1.50	1.94	1.51	1.64	1.15	1.32
Water content, *w* (%)	92.80	92.01	85.71	86.02	78.95	82.55	77.44	77.36	66.47	75.00
Water content, w	92.41		85.87		80.75		77.40		70.74	



Liquid Limit,	***LL*** =	**83.33**	**%**
Plastic Limit,	***PL*** =	**26.00**	**%**
Plasticity Index,	***PI*** =	**57.32**	**%**
Natural Water Content,	w_N =	**68.47**	**%**
Liquidity Index,	***LI*** =	**0.74**	

ATTERBERG LIMITS

Location	: Talingchan area	Made by	: yono
No Sample	: 2/2	Date	: Feb 7, 2005
Depth	: 13.5 -14.2 m		

Soil sample (*disturbed/ ~~undisturbed~~*)
Description of soil : Greyish clay, soft and have layer of silty sand
Specific Gravity, *Gs* : **2.68**

Water content determination

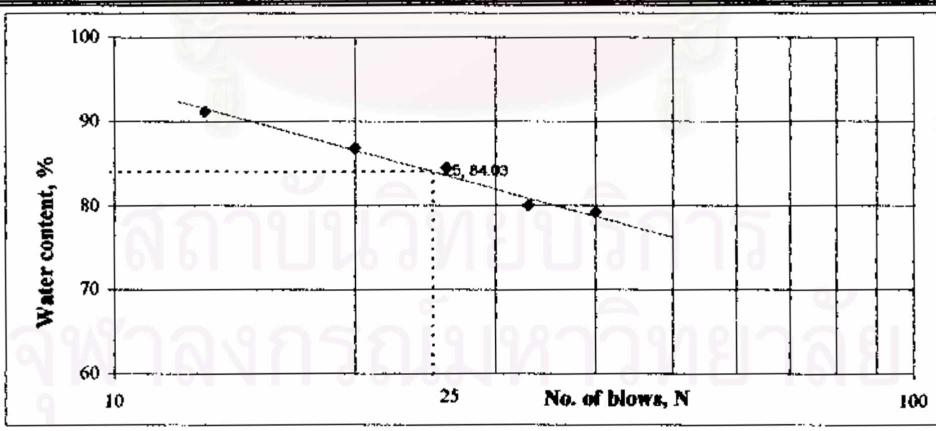
Can no.	1	2	3
Mass of can (gr)	38.12	42.09	85
Mass of wet soil + can (gr)	71.34	64.79	113.17
Mass of dry soil + can (gr)	57.2	55.78	101.87
Mass of dry soil (gr)	21.08	13.69	16.87
Mass of moisture (gr)	14.14	9.01	11.30
Water content, *w (%)*	67.08	65.81	66.98
Natural Water content (%)	66.63		

Plastic Limit Determination

Can no.	1	2	3
Mass of can (gr)	12.6	17.07	17.21
Mass of wet soil + can (gr)	13.37	17.43	18.27
Mass of dry soil + can (gr)	13.21	17.35	18.05
Mass of dry soil (gr)	0.61	0.28	0.84
Mass of moisture (gr)	0.16	0.08	0.22
Water content, w (%)	26.23	28.57	26.19
Plastis Limit (%)	27.00		

Liquid Limit Determination

Can no.	1		2		3		4		5	
No. of blows, *N*	**13**		**20**		**26**		**33**		**40**	
Mass of can (gr)	12.95	20.58	17.42	18.19	21.10	18.38	17.07	17.47	21.38	12.47
Mass of wet soil + can (gr)	16.76	27.06	23.43	27.52	24.32	21.99	20.87	22.28	25.12	17.82
Mass of dry soil + can (gr)	14.95	23.96	20.64	23.18	22.85	20.33	19.19	20.13	23.48	15.44
Mass of dry soil (gr)	2.00	3.38	3.22	4.99	1.75	1.95	2.12	2.66	2.10	2.97
Mass of moisture (gr)	1.81	3.10	2.79	4.34	1.47	1.66	1.68	2.15	1.64	2.38
Water content, *w* (%)	90.50	91.72	86.65	86.97	84.00	85.13	79.25	80.83	78.10	80.13
Water content, w	91.11		86.81		84.56		80.04		79.11	



Liquid Limit,	***LL*** =	**84.03**	**%**
Plastic Limit,	***PL*** =	**27.00**	**%**
Plasticity Index,	***PI*** =	**57.04**	**%**
Natural Water Content,	w_N =	**66.63**	**%**
Liquidity Index,	***LI*** =	**0.69**	

ATTERBERG LIMITS

Location	: Talingchan area	Made by	: yono
No Sample	:1/2	Date	: Feb 7, 2005
Depth	: 15 -15.7 m		

Soil sample (*disturbed/* ~~*undisturbed*~~)
Description of soil : Greyish Clay, homogenous
Specific Gravity, *Gs* : **2.69**

Water content determination

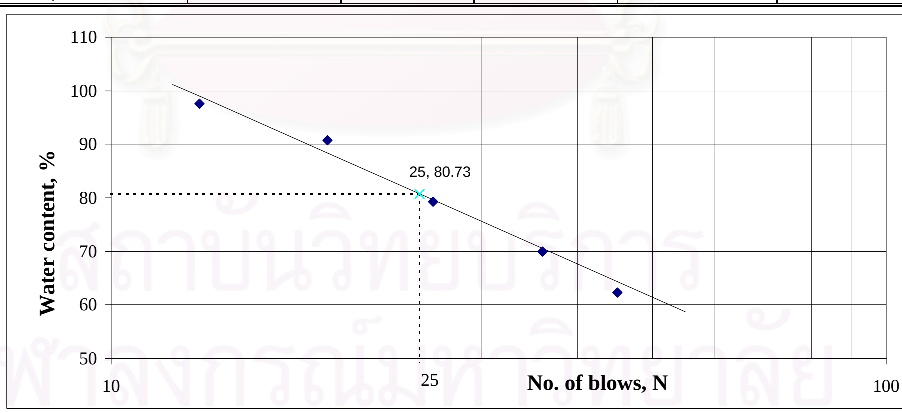
Can no.	1	2	3
Mass of can (gr)	18.02	16.79	18.02
Mass of wet soil + can (gr)	28.24	28.82	29.73
Mass of dry soil + can (gr)	24.32	24.13	25.19
Mass of dry soil (gr)	6.30	7.34	7.17
Mass of moisture (gr)	3.92	4.69	4.54
Water content, *w (%)*	62.22	63.90	63.32
Natural Water content (%)	63.15		

Plastic Limit Determination

Can no.	1	2	3
Mass of can (gr)	14.16	18.64	35.45
Mass of wet soil + can (gr)	15.63	18.86	35.81
Mass of dry soil + can (gr)	15.3	18.82	35.74
Mass of dry soil (gr)	1.14	0.18	0.29
Mass of moisture (gr)	0.33	0.04	0.07
Water content, w (%)	28.95	22.22	24.14
Plastis Limit (%)	25.10		

Liquid Limit Determination

Can no.	1		2		3		4		5	
No. of blows, *N*	**13**		**19**		**26**		**36**		**45**	
Mass of can (gr)	13.85	16.26	12.87	20.62	16.53	17.52	17.34	12.67	21.64	12.53
Mass of wet soil + can (gr)	18.93	22.27	14.97	25.08	19.75	21.82	20.87	16.74	24.51	15.29
Mass of dry soil + can (gr)	16.43	19.29	13.97	22.96	18.29	19.97	19.43	15.05	23.43	14.21
Mass of dry soil (gr)	2.58	3.03	1.10	2.34	1.76	2.45	2.09	2.38	1.79	1.68
Mass of moisture (gr)	2.50	2.98	1.00	2.12	1.46	1.85	1.44	1.69	1.08	1.08
Water content, *w* (%)	96.90	98.35	90.91	90.60	82.95	75.51	68.90	71.01	60.34	64.29
Water content, w	97.62		90.75		79.23		69.95		62.31	



Liquid Limit,	***LL***	**=**	**80.73**	**%**
Plastic Limit,	***PL***	**=**	**25.10**	**%**
Plasticity Index,	***PI***	**=**	**55.63**	**%**
Natural Water Content,	w_N	**=**	**63.15**	**%**
Liquidity Index,	***LI***	**=**	**0.68**	

ATTERBERG LIMITS

Location : Sirirot area, Bangkok (near bus station)
No Sample : 2/2 Made by : yono
Depth : 10.5 -11.2 m Date : Feb 9, 2005

Soil sample (*disturbed/ ~~undisturbed~~*)
Description of soil :
Specific Gravity, *Gs* : 2.674

Water Content Determination

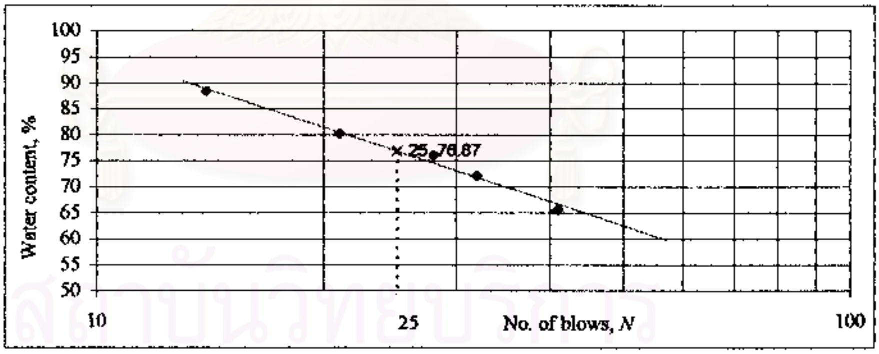
Determination No	1	2	3
Can no.	1	2	3
Mass of can (gr)	21.14	17.08	18.49
Mass of wet soil + can (gr)	26.85	25.12	27.22
Mass of dry soil + can (gr)	24.63	21.94	23.79
Mass of dry soil (gr)	3.49	4.86	5.30
Mass of moisture (gr)	2.22	3.18	3.43
Water content, *w (%)*	63.61	65.43	64.72
Natural Water content (%)		64.59	

Plastic Limit Determination

Determination No	1	2	3
Can no.	1	2	3
Mass of can (gr)	34.86	36.51	41.00
Mass of wet soil + can (gr)	36.18	37.28	41.90
Mass of dry soil + can (gr)	35.91	37.13	41.75
Mass of dry soil (gr)	1.05	0.62	0.75
Mass of moisture (gr)	0.27	0.15	0.15
Water content, w (%)	25.71	24.19	20.00
Plastis Limit (%)		23.303	

Liquid Limit Determination

Can no.		1	2	3	4	5
No. of blows, *N*		14	21	28	32	41
Mass of can	(gr)	17.99	20.74	20.38	12.48	12.61
Mass of wet soil + can	(gr)	20.91	22.20	23.53	15.44	16.07
Mass of dry soil + can	(gr)	19.54	21.55	22.17	14.20	14.70
Mass of dry soil	(gr)	1.55	0.81	1.79	1.72	2.09
Mass of moisture	(gr)	1.37	0.65	1.36	1.24	1.37
Water content, *w*	(%)	88.39	80.25	75.98	72.09	65.55
Liquid Limit (from the flow curve)				76.87		



Liquid Limit,	*LL*	=	76.87	%
Plastic Limit,	*PL*	=	23.30	%
Plasticity Index,	*PI*	=	53.56	%
Natural Water Content,	w_N	=	64.59	%
Liquidity Index,	*LI*	=	0.77	
Flow Index	*FI*	=	15.74	

Test apparatus : Triaxial
Sample/part No : 1/ 1 from 3
Location : Talingchan, Bangkok
Depth : 10.5 - 11.2 m
Discription of soil : Clay

Boring No : 2
Date of test : 15 Nov 04
Tested by : Yono

a. Specimen data

Type of test performed Consolidated Undrained
Diameter of specimen, Do 3.8667 cm

Top	Middle	Botom	**Average**
3.9	3.875	3.825	3.866667

Initial height of specimen : 7.81 cm
Initial area of specimen 11.7366 cm^2
Volume of specimen : 91.663 cm3
Mass of specimen : 145.73 gr
Wet unit of specimen : 1.58985 gr/cm3
Length tip to tip of bender element in sample : 6.7 cm

Water content of specimen

Can no	I	II	III
Mass of can	36.13	42.05	85
Mass of wet soil+can	64	72.6	116.19
Mass dry soil+can	53.67	61.23	104.66
Mass of water	10.33	11.37	11.53
Mass of dry soil	17.54	19.18	19.66
Water content	58.89	59.28	58.65
Average of water content	58.94		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
210	200	206	205	0.976190476

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm3)	Volume vhange (cm3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			32.8						1589.8	
25	25	25	31.6	1.2	20	62.36	1014	61.499	1597.7	6.0427
50	50	50	30.4	2.4	20	62.02	848.1	73.128	1605.7	8.5868
75	75	75	29.2	3.6	20	61.69	703.7	87.665	1614.0	12.404
100	100	100	28.1	4.7	20	61.37	641	95.741	1621.7	14.865

Table Analyses data of CU Isotropic Triaxial test with final mean effective stress 100 kPa

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma'1$ kPa	$\sigma'3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
conso25		62.36	1014	61.499	3782.13	1597.7	6.043	25	0				25	25						0
conso50		62.02	848.1	73.128	5347.73	1605.7	8.587	50	0				50	50						0
conso75		61.69	703.3	87.715	7693.93	1614.0	12.418	75	0				75	75						0
conso100		61.37	641	95.741	9166.34	1621.7	14.865	100	0				100	100						0
shearing																				
shear1-0	0	61.37	641	95.741	9166.34	1621.7	14.865	100	0	0	0	0	100	100	0	200	11.3299	0	0	0
shear1-1	0.01	61.36	641	95.725	9163.36	1621.7	14.860	99.891	2.837	1	4	0.65536	103.6737	98	2	202	11.33135	0.0578361	0.000128	5.673726044
shear1-2	0.02	61.35	641	95.710	9160.37	1621.7	14.855	99.836	4.255	2	6	0.98304	105.5095	97	3	203	11.3328	0.0867431	0.0002561	8.509499222
shear1-3	0.03	61.34	641	95.694	9157.39	1621.7	14.851	99.782	5.672	3	8	1.31072	107.3445	96	4	204	11.33425	0.1156427	0.0003841	11.34454584
shear1-4	0.04	61.33	641	95.679	9154.40	1621.7	14.846	99.726	7.089	4	10	1.6384	109.1789	95	5	205	11.33571	0.1445348	0.0005122	14.17886589
shear1-5	0.06	61.31	641	95.647	9148.43	1621.7	14.836	99.670	8.505	6	12	1.96609	111.0103	94	6	206	11.33861	0.1733973	0.0007682	17.0102797
shear1-6	0.075	61.295	641	95.624	9143.95	1621.7	14.829	99.614	9.921	7.5	14	2.29377	112.8415	93	7	207	11.34079	0.202258	0.0009603	19.84151186
shear1-7	0.09	61.28	641	95.601	9139.48	1621.7	14.821	99.557	11.336	9	16	2.62145	114.6717	92	8	208	11.34297	0.2311076	0.0011524	22.67165418
shear1-8	0.11	61.26	641	95.569	9133.51	1621.7	14.812	99.555	11.333	11	16	2.62145	114.6658	92	8	208	11.34588	0.2310483	0.0014085	22.66584168
shear1-9	0.13	61.24	641	95.538	9127.55	1621.7	14.802	99.025	12.038	13	17	2.78529	115.0763	91	9	209	11.34879	0.2454259	0.0016645	24.076281
shear1-10	0.15	61.22	641	95.507	9121.59	1621.7	14.792	98.967	13.451	15	19	3.11297	116.9019	90	10	210	11.3517	0.2742292	0.0019206	26.90188231
shear1-11	0.18	61.19	641	95.460	9112.65	1621.7	14.778	98.907	14.861	18	21	3.44065	118.7222	89	11	211	11.35607	0.3029788	0.0023047	29.72221603
shear1-12	0.21	61.16	641	95.413	9103.72	1621.7	14.764	98.375	15.563	21	22	3.60449	119.1256	88	12	212	11.36045	0.3172841	0.0026889	31.12557137
shear1-13	0.24	61.13	641	95.367	9094.79	1621.7	14.749	98.314	16.971	24	24	3.93217	120.9421	87	13	213	11.36482	0.3459948	0.003073	33.94209065
shear1-14	0.26	61.11	641	95.335	9088.84	1621.7	14.739	98.254	18.381	26	26	4.25985	122.7612	86	14	214	11.36774	0.3747314	0.0033291	36.76115289
shear1-15	0.28	61.09	641	95.304	9082.89	1621.7	14.730	97.957	19.436	28	27.5	4.50561	123.872	85	15	215	11.37067	0.3962487	0.0035851	38.8719984
shear1-16	0.3	61.07	645	94.682	8964.71	1621.7	14.538	97.661	20.491	30	29	4.75137	124.9818	84	16	216	11.37359	0.4177549	0.0038412	40.98175407
shear1-17	0.36	61.01	645	94.589	8947.11	1621.7	14.510	97.356	21.534	36	30.5	4.99713	126.0683	83	17	217	11.38237	0.4390241	0.0046095	43.06825974
shear1-18	0.4	60.97	645	94.527	8935.38	1621.7	14.491	97.054	22.582	40	32	5.24289	127.1631	82	18	218	11.38823	0.4603784	0.0051216	45.16312087
shear1-19	0.45	60.92	645	94.450	8920.73	1621.7	14.467	96.985	23.977	45	34	5.57057	128.9549	81	19	219	11.39556	0.4888373	0.0057618	47.95493702
shear1-20	0.5	60.87	645	94.372	8906.09	1621.7	14.443	96.445	24.667	50	35	5.73441	129.3336	80	20	220	11.4029	0.5028908	0.006402	49.33358924
shear1-21	0.55	60.82	645	94.295	8891.47	1621.7	14.419	96.373	26.060	55	37	6.0621	131.119	79	21	221	11.41025	0.5312849	0.0070423	52.11904797
shear1-22	0.6	60.77	645	94.217	8876.85	1621.7	14.396	96.066	27.099	60	38.5	6.30786	132.197	78	22	222	11.41762	0.552467	0.0076825	54.19701653
shear1-23	0.66	60.71	645	94.124	8859.33	1621.7	14.367	95.755	28.132	66	40	6.55362	133.265	77	23	223	11.42646	0.5735473	0.0084507	56.26499486
shear1-24	0.71	60.66	645	94.047	8844.75	1621.7	14.344	95.680	29.520	71	42	6.8813	135.0401	76	24	224	11.43384	0.6018359	0.0090909	59.04010007
shear1-25	0.75	60.62	645	93.984	8833.09	1621.7	14.325	94.841	31.261	75	44.5	7.2909	136.5221	74	26	226	11.43976	0.6373299	0.0096031	62.52205972
shear1-26	0.8	60.57	645	93.907	8818.52	1621.7	14.301	94.231	33.347	80	47.5	7.78242	138.6939	72	28	228	11.44716	0.6798562	0.0102433	66.69389039
shear1-27	0.85	60.52	645	93.829	8803.97	1621.7	14.277	93.919	34.378	85	49	8.02818	139.7555	71	29	229	11.45457	0.7008717	0.0108835	68.75551129
shear1-28	0.89	60.48	645	93.767	8792.33	1621.7	14.259	93.309	36.464	89	52	8.5197	141.9273	69	31	231	11.4605	0.7433971	0.0113956	72.92725115
shear1-29	0.92	60.45	645	93.721	8783.61	1621.7	14.244	92.767	37.150	92	53	8.68354	142.3008	68	32	232	11.46495	0.7573988	0.0117798	74.30081743
shear1-30	0.93	60.44	645	93.705	8780.71	1621.7	14.240	92.698	38.547	93	55	9.01122	144.0946	67	33	233	11.46644	0.785878	0.0119078	77.09463163
shear1-31	0.98	60.39	645	93.628	8766.18	1621.7	14.216	91.615	39.923	98	57	9.3389	144.8463	65	35	235	11.47387	0.8139277	0.012548	79.8463052
shear1-32	1.03	60.34	645	93.550	8751.68	1621.7	14.193	91.531	41.297	103	59	9.66658	146.5943	64	36	236	11.48132	0.8419403	0.0131882	82.59434597
shear1-33	1.06	60.31	645	93.504	8742.97	1621.7	14.178	90.687	43.030	106	61.5	10.0762	148.0606	62	38	238	11.48579	0.8772741	0.0135723	86.0605937
shear1-34	1.1	60.27	645	93.442	8731.38	1621.7	14.160	90.604	44.407	110	63.5	10.4039	149.8132	61	39	239	11.49176	0.9053331	0.0140845	88.81317548

continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma 1$ kPa	$\sigma 3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-35	1.15	60.22	647.7	92.975	8644.38	1621.7	14.019	90.051	45.077	115	64.5	10.5677	150.1532	60	40	240	11.49922	0.9189932	0.0147247	90.15322906
shear1-36	1.2	60.17	647.7	92.898	8630.03	1621.7	13.995	89.730	46.095	120	66	10.8135	151.1899	59	41	241	11.5067	0.9397541	0.0153649	92.18987439
shear1-37	1.3	60.07	647.7	92.744	8601.37	1621.7	13.949	89.620	47.430	130	68	11.1411	152.86	58	42	242	11.52168	0.9669724	0.0166453	94.85999133
shear1-38	1.4	59.97	647.7	92.589	8572.75	1621.7	13.902	89.043	48.065	140	69	11.305	153.1297	57	43	243	11.5367	0.979915	0.0179257	96.12965918
shear1-39	1.55	59.82	647.7	92.358	8529.92	1621.7	13.833	87.908	49.361	155	71	11.6327	153.7226	55	45	245	11.55931	1.0063464	0.0198464	98.72257887
shear1-40	1.9	59.47	647.7	91.817	8430.40	1621.7	13.672	86.680	50.520	190	73	11.9604	154.0394	53	47	247	11.6124	1.0299634	0.0243278	101.0394048
shear1-41	2.3	59.07	647.7	91.200	8317.37	1621.7	13.488	85.880	52.320	230	76	12.4519	155.6395	51	49	249	11.67368	1.0666618	0.0294494	104.6395217
shear1-42	2.7	58.67	647.7	90.582	8205.11	1621.7	13.306	84.609	53.413	270	78	12.7796	155.8265	49	51	251	11.73561	1.0889549	0.0345711	106.8264746
shear1-43	3	58.37	647.7	90.119	8121.41	1621.7	13.170	84.377	54.565	300	80	13.1072	157.1297	48	52	252	11.78249	1.112433	0.0384123	109.1296775
shear1-44	3.3	58.07	647.7	89.656	8038.15	1621.7	13.035	83.137	55.706	330	82	13.4349	157.4111	46	54	254	11.82975	1.1356889	0.0422535	111.4110836
shear1-45	3.5	57.87	647.7	89.347	7982.87	1621.7	12.946	81.941	56.912	350	84	13.7626	157.8233	44	56	256	11.86146	1.160278	0.0448143	113.8232708
shear1-46	3.74	57.63	647.7	88.976	7916.80	1621.7	12.839	80.719	58.079	374	86	14.0903	158.1584	42	58	258	11.89975	1.184082	0.0478873	116.1584425
shear1-47	4	57.37	647.7	88.575	7845.52	1621.7	12.723	79.481	59.222	400	88	14.418	158.4442	40	60	260	11.9415	1.2073823	0.0512164	118.4442079
shear1-48	4.5	56.87	647.7	87.803	7709.37	1621.7	12.502	78.661	59.491	450	89	14.5818	157.9819	39	61	261	12.02262	1.212863	0.0576184	118.9818641
shear1-49	5	56.37	647.7	87.031	7574.40	1621.7	12.283	77.834	59.751	500	90	14.7456	157.5014	38	62	262	12.10486	1.2181586	0.0640205	119.5013563
shear1-50	5.5	55.87	647.7	86.259	7440.63	1621.7	12.066	77.001	60.001	550	91	14.9095	157.0027	37	63	263	12.18823	1.223269	0.0704225	120.0026843
shear1-51	6	55.37	647.7	85.487	7308.05	1621.7	11.851	77.162	60.243	600	92	15.0733	157.4858	37	63	263	12.27275	1.2281942	0.0768246	120.4858484
shear1-52	6.5	54.87	647.7	84.715	7176.66	1621.7	11.638	75.883	59.825	650	92	15.0733	155.6503	36	64	264	12.35845	1.2196769	0.0832266	119.6503016
shear1-53	7	54.37	647.7	83.943	7046.46	1621.7	11.427	75.035	60.053	700	93	15.2372	155.1062	35	65	265	12.44536	1.2243244	0.0896287	120.1062195
shear1-54	7.5	53.87	647.7	83.171	6917.45	1621.7	11.218	74.181	60.272	750	94	15.401	154.544	34	66	266	12.5335	1.2287867	0.0960307	120.5439734
shear1-55	8	53.37	647.7	82.399	6789.64	1621.7	11.011	74.321	60.482	800	95	15.5648	154.9636	34	66	266	12.6229	1.2330638	0.1024328	120.9635632
shear1-56	8.3	53.07	651.2	81.496	6641.55	1621.7	10.771	74.726	59.589	830	94	15.401	154.178	35	65	265	12.67715	1.2148628	0.106274	119.178036
shear1-57	8.7	52.67	651.2	80.881	6541.81	1621.7	10.609	74.498	59.248	870	94	15.401	153.4951	35	65	265	12.75022	1.2079008	0.1113956	118.4950673
shear1-58	9.2	52.17	651.2	80.114	6418.19	1621.7	10.408	73.797	58.195	920	93	15.2372	151.3899	35	65	265	12.84275	1.1864409	0.1177977	116.3898526
shear1-59	9.5	51.87	651.2	79.653	6344.59	1621.7	10.289	73.628	57.942	950	93	15.2372	150.8831	35	65	265	12.89891	1.181275	0.1216389	115.8830753
shear1-60	10	51.37	656.2	78.284	6128.39	1621.7	9.938	72.934	56.901	1000	92	15.0733	148.8015	35	65	265	12.99362	1.1600558	0.128041	113.801474
shear1-61	10.6	50.77	656.2	77.370	5986.07	1621.7	9.708	72.600	56.399	1060	92	15.0733	147.7988	35	65	265	13.10911	1.149835	0.1357234	112.7988178
shear1-62	11.5	49.87	656.2	75.998	5775.72	1621.7	9.366	73.098	55.647	1150	92	15.0733	147.2948	36	64	264	13.28626	1.1345039	0.1472471	111.2948336

Test apparatus : Triaxial
Sample No/part no : 2/ 1 from3 Boring No : 2
Location : Talingchan, Bangkok Date of test : 26Nov 04
Depth : 11.5 - 12.2 m Tested by : Yono
Discription of soil : Clay

a. Specimen data

Type of test performed Consolidated Undrained
Diameter of specimen, Dc 3.85667 cm

Top	Middle	Botom	**Average**
3.86	3.855	3.855	3.8566667

Initial height of specimen 7.8 cm
Initial area of specimen 11.676 cm^2
Volume of specimen 91.0728 cm3
Mass of specimen 145.23 gr
Wet unit of specimen 1.59466 gr/cm3
Length tip to tip of bender element in sample : 62.6 cm

Water content of specimen

Can no	I	II	III
Mass of can	36.33	42.08	85.02
Mass of wet soil+can	71.39	69.12	121.38
Mass dry soil+can	58.93	59.35	108.23
Mass of water	12.46	9.77	13.15
Mass of dry soil	22.6	17.27	23.21
Water content	55.13	56.57	56.66
Average of water content	56.12		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	0		
210	200	206	206	0.980952381

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm^3)	Volume vhange (cm^3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			34.7						1594.7	
50	50	50	31.8	2.9	20	61.77	896.7	68.89	1614.2	7.66
100	100	100	29.4	5.3	20	61.09	634.3	96.31	1631.4	15.13
150	150	150	27.4	7.3	20	60.52	559.7	108.1	1646.5	19.25
200	200	200	24.6	10.1	20	59.72	482.4	123.8	1668.8	25.58
250	250	250	21	13.7	20	58.69	398.1	147.4	1700.0	36.95
300	300	300	16.4	18.3	20	57.38	367.6	156.1	1744.2	42.5

Table Analyses data of CU Isotropic Triaxial test with final mean effective stress 300 kPa

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
conso50		61.77	896.7	68.886	4745.27	1614.2	7.660	50	0				50	50						0
conso100		61.09	634.3	96.311	9275.79	1631.4	15.133	100	0				100	100						0
conso150		60.52	559.7	108.129	11691.96	1646.5	19.251	150	0				150	150						0
conso200		59.72	482.4	123.798	15325.87	1668.8	25.576	200	0				200	200						0
conso250		58.69	398.1	147.425	21734.21	1700.0	36.948	250	0				250	250						0
conso300		57.38	367.6	156.094	24365.21	1744.2	42.498	300	0				300	300						0
shearing																				
shear1-0	0	57.38	367.6	156.09358	24365.2057	1744.2	42.49779	300	0	0	0	0	300	300	0	200	10.0467	0	0	0
shear1-1	0.01	57.37	367.6	156.0663765	24356.7139	1744.2	42.48298	301.1328	3.19919666	1	4	0.65536	305.3984	299	1	201	10.048	0.065223	0.000128	6.398393318
shear1-2	0.02	57.36	367.6	156.039173	24348.2235	1744.2	42.46817	302.26505	6.39757291	2	8	1.31072	310.7951	298	2	202	10.0493	0.13043	0.000256	12.79514581
shear1-3	0.04	57.34	367.6	155.9847661	24331.2472	1744.2	42.43856	302.39593	9.59389812	4	12	1.96609	315.1878	296	4	204	10.0519	0.195594	0.000513	19.18779625
shear1-4	0.06	57.32	367.6	155.9303591	24314.2769	1744.2	42.40896	303.52572	12.7885825	6	16	2.62145	320.5772	295	5	206	10.0544	0.260725	0.000769	25.57716503
shear1-5	0.08	57.3	367.6	155.8759521	24297.3124	1744.2	42.37937	302.05625	13.5843822	8	17	2.78529	320.1688	293	7	207	10.057	0.27695	0.001026	27.16876435
shear1-6	0.1	57.28	367.6	155.8215452	24280.3539	1744.2	42.34979	302.65168	15.977524	10	20	3.27681	323.955	292	8	209	10.0596	0.32574	0.001282	31.95504805
shear1-7	0.13	57.25	367.6	155.7399347	24254.9273	1744.2	42.30544	303.24472	18.3670766	13	23	3.76833	327.7342	291	9	210	10.0635	0.374456	0.001667	36.73415315
shear1-8	0.14	57.24	367.6	155.7127312	24246.4547	1744.2	42.29067	302.30777	19.9616499	14	25	4.09601	328.9233	289	11	211	10.0648	0.406965	0.001795	39.92329976
shear1-9	0.16	57.22	367.6	155.6583243	24229.5139	1744.2	42.26112	302.90087	22.351305	16	28	4.58753	332.7026	288	12	212	10.0674	0.455684	0.002051	44.70260997
shear1-10	0.18	57.2	367.6	155.6039173	24212.5791	1744.2	42.23158	302.96112	23.9416737	18	30	4.91521	334.8833	287	13	213	10.0699	0.488108	0.002308	47.88334736
shear1-11	0.2	57.18	367.6	155.5495103	24195.6502	1744.2	42.20205	304.02081	25.531222	20	32	5.24289	338.0624	287	13	214	10.0725	0.520514	0.002564	51.06244392
shear1-12	0.22	57.16	367.6	155.4951034	24178.7272	1744.2	42.17254	304.61173	27.9175954	22	35	5.73441	341.8352	286	14	215	10.0751	0.569166	0.002821	55.83519083
shear1-13	0.24	57.14	367.6	155.4406964	24161.8101	1744.2	42.14303	303.6702	29.5052978	24	37	6.0621	343.0106	284	16	216	10.0777	0.601535	0.003077	59.01059554
shear1-14	0.26	57.12	367.6	155.3862894	24144.8989	1744.2	42.11353	304.25961	31.8894151	26	40	6.55362	346.7788	283	17	217	10.0803	0.650141	0.003333	63.77883018
shear1-15	0.29	57.09	365.8	156.0688901	24357.4985	1744.2	42.48435	304.31398	33.4709644	29	42	6.8813	348.9419	282	18	217	10.0842	0.682385	0.003718	66.94192871
shear1-16	0.3	57.08	365.8	156.0415528	24348.9662	1744.2	42.46947	303.37354	35.0603075	30	44	7.20898	350.1206	280	20	219	10.0855	0.714787	0.003846	70.12061507
shear1-17	0.35	57.03	365.8	155.904866	24306.3273	1744.2	42.3951	304.95112	37.4266834	35	47	7.7005	354.8534	280	20	220	10.092	0.763031	0.004487	74.85336689
shear1-18	0.4	56.98	365.8	155.7681793	24263.7257	1744.2	42.32079	303.99612	38.9941832	40	49	8.02818	355.9884	278	22	222	10.0985	0.794988	0.005128	77.98836631
shear1-19	0.45	56.93	363.5	156.6162311	24528.6438	1744.2	42.78286	304.03975	40.5596318	45	51	8.35586	358.1193	277	23	223	10.105	0.826904	0.005769	81.11926367
shear1-20	0.5	56.88	363.5	156.4786795	24485.5771	1744.2	42.70774	303.08202	42.1230295	50	53	8.68354	359.2461	275	25	225	10.1115	0.858777	0.00641	84.24605897
shear1-21	0.55	56.83	363.5	156.3411279	24442.5483	1744.2	42.63269	303.65242	44.4786375	55	56	9.17506	362.9573	274	26	223	10.118	0.906802	0.007051	88.95727497
shear1-22	0.6	56.78	363.5	156.2035763	24399.5573	1744.2	42.55771	303.69161	46.0374203	60	58	9.50274	365.0748	273	27	224	10.1246	0.938581	0.007692	92.07484064
shear1-23	0.65	56.73	363.5	156.0660248	24356.6041	1744.2	42.48279	303.72943	47.5941521	65	60	9.83043	367.1883	272	28	226	10.1311	0.970319	0.008333	95.18830424
shear1-24	0.7	56.68	363.5	155.9284732	24313.6887	1744.2	42.40794	303.76589	49.1488329	70	62	10.1581	369.2977	271	29	229	10.1377	1.002015	0.008974	98.29766578
shear1-25	0.75	56.63	363.5	155.7909216	24270.8113	1744.2	42.33315	303.32912	51.493673	75	65	10.6496	371.9873	269	31	231	10.1442	1.04982	0.009615	102.987346
shear1-26	0.8	56.58	363.5	155.65337	24227.9716	1744.2	42.25843	302.36249	53.0437389	80	67	10.9773	373.0875	267	33	233	10.1508	1.081422	0.010256	106.0874779
shear1-27	0.85	56.53	363.5	155.5158184	24185.1698	1744.2	42.18377	302.86705	53.800569	85	68	11.1411	374.6011	267	33	233	10.1574	1.096852	0.010897	107.6011381
shear1-28	0.9	56.48	363.5	155.3782669	24142.4058	1744.2	42.10918	302.89803	55.3470457	90	70	11.4688	376.6941	266	34	234	10.164	1.12838	0.011538	110.6940914
shear1-29	0.95	56.43	361.2	156.2292359	24407.5741	1744.2	42.57169	302.92765	56.8914713	95	72	11.7965	378.7829	265	35	235	10.1706	1.159867	0.012179	113.7829426
shear1-30	1	56.38	361.2	156.0908084	24364.3405	1744.2	42.49628	302.9559	58.4338459	100	74	12.1242	380.8677	264	36	236	10.1772	1.191312	0.012821	116.8676918
shear1-31	1.05	56.33	361.2	155.952381	24321.1451	1744.2	42.42094	302.98278	59.9741695	105	76	12.4519	382.9483	263	37	237	10.1838	1.222715	0.013462	119.9483389
shear1-32	1.11	56.27	361.2	155.786268	24269.3613	1744.2	42.33062	302.47728	60.7159245	111	77	12.6157	383.4318	262	38	238	10.1917	1.237837	0.014231	121.4318489
shear1-33	1.17	56.21	361.2	155.620155	24217.6327	1744.2	42.24039	302.0215	63.0322552	117	80	13.1072	386.0645	260	40	240	10.1997	1.285061	0.015	126.0645105
shear1-34	1.23	56.15	361.2	155.4540421	24165.9592	1744.2	42.15027	302.0384	64.5576063	123	82	13.4349	388.1152	259	41	241	10.2077	1.316159	0.015769	129.1152126

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-35	1.3	56.08	361.2	155.2602436	24105.7433	1744.2	42.04524	302.04792	66.0718818	130	84	13.7626	390.1438	258	42	242	10.217	1.347031	0.016667	132.1437635
shear1-36	1.35	56.03	361.2	155.1218162	24062.7779	1744.2	41.9703	302.54324	66.8148674	135	85	13.9264	391.6297	258	42	242	10.2236	1.362179	0.017308	133.6297348
shear1-37	1.4	55.98	361.2	154.9833887	24019.8508	1744.2	41.89542	302.56158	68.342372	140	87	14.2541	393.6847	257	43	243	10.2303	1.393321	0.017949	136.684744
shear1-38	1.45	55.93	361.2	154.8449612	23976.962	1744.2	41.82062	303.1019	70.6528574	145	90	14.7456	397.3057	256	44	244	10.237	1.440425	0.01859	141.3057147
shear1-39	1.48	55.9	361.2	154.7619048	23951.2472	1744.2	41.77577	303.12974	72.1946166	148	92	15.0733	399.3892	255	45	245	10.241	1.471858	0.018974	144.3892333
shear1-40	1.55	55.83	358.3	155.819146	24279.6062	1744.2	42.34849	302.60839	72.9125797	155	93	15.2372	399.8252	254	46	246	10.2504	1.486495	0.019872	145.8251594
shear1-41	1.65	55.73	358.3	155.5400502	24192.7072	1744.2	42.19692	302.58878	74.3831683	165	95	15.5648	401.7663	253	47	247	10.2638	1.516476	0.021154	148.7663365
shear1-42	1.8	55.58	358.3	155.1214066	24062.6508	1744.2	41.97008	302.53328	75.7999173	180	97	15.8925	403.5998	252	48	248	10.284	1.54536	0.023077	151.5998345
shear1-43	2	55.38	356.4	155.3872054	24145.1836	1744.2	42.11403	302.95943	77.9391416	200	100	16.384	406.8783	251	49	249	10.3111	1.588973	0.025641	155.8782832
shear1-44	2.1	55.28	356.4	155.1066218	24058.0641	1744.2	41.96208	302.40997	78.614956	210	101	16.5479	407.2299	250	50	250	10.3247	1.602751	0.026923	157.229912
shear1-45	2.25	55.13	356.4	154.6857464	23927.6801	1744.2	41.73466	303.34216	80.0132457	225	103	16.8756	410.0265	250	50	250	10.3451	1.631259	0.028846	160.0264914
shear1-46	2.5	54.88	354.1	154.9844677	24020.1852	1744.2	41.89601	302.68229	80.5234394	250	104	17.0394	410.0469	249	51	251	10.3794	1.64166	0.032051	161.0468789
shear1-47	2.75	54.63	354.1	154.2784524	23801.8409	1744.2	41.51517	302.53347	81.8002056	275	106	17.3671	411.6004	248	52	252	10.4139	1.66769	0.035256	163.6004113
shear1-48	3	54.38	350.8	155.0171038	24030.3025	1744.2	41.91365	302.37781	83.0667167	300	108	17.6948	413.1334	247	53	253	10.4486	1.693511	0.038462	166.1334334
shear1-49	3.2	54.18	350.8	154.4469783	23853.8691	1744.2	41.60592	302.2757	85.9135464	320	112	18.3501	416.8271	245	55	255	10.4765	1.75155	0.041026	171.8270928
shear1-50	3.5	53.88	348.5	154.6054519	23902.8458	1744.2	41.69134	301.574	87.8609994	350	115	18.8416	418.722	243	57	256	10.5187	1.791254	0.044872	175.7219988
shear1-51	3.6	53.78	345.2	155.7937428	24271.6903	1744.2	42.33468	301.51269	89.2690315	360	117	19.1693	420.5381	242	58	258	10.5328	1.81996	0.046154	178.5380631
shear1-52	3.75	53.63	345.2	155.3592121	24136.4848	1744.2	42.09886	300.91559	91.3733884	375	120	19.6609	422.7468	240	60	260	10.5541	1.862862	0.048077	182.7467767
shear1-53	4	53.38	345.2	154.6349942	23911.9814	1744.2	41.70728	300.73417	94.1012583	400	124	20.3162	426.2025	238	62	262	10.5898	1.918476	0.051282	188.2025166
shear1-54	4.2	53.18	345.2	154.0556199	23733.134	1744.2	41.39533	301.08739	97.631081	420	129	21.1354	431.2622	236	64	264	10.6185	1.99044	0.053846	195.262162
shear1-55	4.5	52.88	343	154.1690962	23768.1102	1744.2	41.45634	301.33031	99.4954673	450	132	21.6269	433.9909	235	65	265	10.6618	2.02845	0.057692	198.9909347
shear1-56	4.7	52.68	343	153.5860058	23588.6612	1744.2	41.14334	301.15436	102.231541	470	136	22.2823	437.4631	233	67	267	10.6909	2.084231	0.060256	204.4630828
shear1-57	4.9	52.48	337.2	155.6346382	24222.1406	1744.2	42.24826	301.4677	104.201556	490	139	22.7738	440.4031	232	68	268	10.7201	2.124395	0.062821	208.4031115
shear1-58	5.1	52.28	337.2	155.0415184	24037.8724	1744.2	41.92686	300.77284	106.159264	510	142	23.2653	442.3185	230	70	270	10.7496	2.164307	0.065385	212.3185279
shear1-59	5.25	52.13	337.2	154.5966785	23900.133	1744.2	41.68661	301.11934	108.179016	525	145	23.7569	445.358	229	71	271	10.7717	2.205485	0.067308	216.3580315
shear1-60	5.5	51.88	337.2	153.8552788	23671.4468	1744.2	41.28774	300.35851	110.037762	550	148	24.2484	447.0755	227	73	273	10.8089	2.243379	0.070513	220.0755235
shear1-61	5.7	51.68	331.7	155.8034368	24274.7109	1744.2	42.33995	300.13333	112.699999	570	152	24.9037	450.4	225	75	275	10.8388	2.297655	0.073077	225.3999975
shear1-62	5.9	51.48	331.7	155.2004824	24087.1897	1744.2	42.01288	299.89722	115.345827	590	156	25.5591	453.6917	223	77	277	10.8688	2.351597	0.075641	230.691655
shear1-63	6.1	51.28	331.7	154.5975279	23900.3956	1744.2	41.68707	299.65017	117.975248	610	160	26.2145	456.9505	221	79	279	10.8991	2.405204	0.078205	235.950496
shear1-64	6.25	51.13	331.7	154.145312	23760.7772	1744.2	41.44355	298.9577	119.936545	625	163	26.706	458.8731	219	81	281	10.9218	2.44519	0.080128	239.873091
shear1-65	6.5	50.88	331.7	153.3916189	23528.9888	1744.2	41.03926	298.14559	121.718378	650	166	27.1975	460.4368	217	83	283	10.96	2.481516	0.083333	243.4367557
shear1-66	6.75	50.63	328.5	154.1248097	23754.457	1744.2	41.43252	297.81034	124.215507	675	170	27.8529	463.431	215	85	285	10.9985	2.532426	0.086538	248.4310138
shear1-67	6.9	50.48	328.5	153.6681887	23613.9122	1744.2	41.18739	297.09428	126.141424	690	173	28.3444	465.2828	213	87	287	11.0217	2.571691	0.088462	252.2828482
shear1-68	7.1	50.28	328.5	153.0593607	23427.1679	1744.2	40.86167	296.79664	128.694957	710	177	28.9998	468.3899	211	89	289	11.0528	2.62375	0.091026	257.389913
shear1-69	7.25	50.13	328.5	152.6027397	23287.5962	1744.2	40.61823	296.54993	131.32489	725	181	29.6551	471.6498	209	91	291	11.0762	2.677368	0.092949	262.6497796
shear1-70	7.5	49.88	328.5	151.8417047	23055.9033	1744.2	40.21411	295.68654	133.029809	750	184	30.1466	473.0596	207	93	293	11.1155	2.712127	0.096154	266.059617
shear1-71	7.7	49.68	324.8	152.955665	23395.4355	1744.2	40.80632	294.87682	134.81523	770	187	30.6382	474.6305	205	95	295	11.1471	2.748527	0.098718	269.6304603
shear1-72	7.9	49.48	324.8	152.3399015	23207.4456	1744.2	40.47843	294.0589	136.588346	790	190	31.1297	476.1767	203	97	297	11.1789	2.784676	0.101282	273.1766913
shear1-73	8.15	49.23	324.8	151.570197	22973.5246	1744.2	40.07042	294.1668	138.250193	815	193	31.6212	478.5004	202	98	298	11.2189	2.818556	0.104487	276.5003854
shear1-74	8.35	49.03	322.3	152.1253491	23142.1218	1744.2	40.36449	292.80762	140.711429	835	197	32.2766	480.4229	199	101	301	11.2512	2.868735	0.107051	281.4228575
shear1-75	8.5	48.88	322.3	151.6599442	23000.7387	1744.2	40.11789	292.03106	142.546588	850	200	32.7681	482.0932	197	103	303	11.2754	2.906149	0.108974	285.0931758

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma 1$ kPa	$\sigma 3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-76	8.75	48.63	322.3	150.8842693	22766.0627	1744.2	39.70857	291.583	144.874507	875	204	33.4234	484.749	195	105	305	11.3161	2.953609	0.112179	289.749014
shear1-77	9	48.38	320.1	151.1402687	22843.3808	1744.2	39.84342	291.64954	146.47431	900	207	33.915	486.9486	194	106	306	11.3571	2.986224	0.115385	292.9486209
shear1-78	9.2	48.18	320.1	150.5154639	22654.9049	1744.2	39.51469	290.77761	148.16641	920	210	34.4065	488.3328	192	108	308	11.3902	3.020722	0.117949	296.3328204
shear1-79	9.3	48.08	320.1	150.2030615	22560.9597	1744.2	39.35083	288.51278	150.769167	930	214	35.0618	489.5383	188	112	312	11.4067	3.073785	0.119231	301.5383347
shear1-80	9.5	47.88	317.3	150.8982036	22770.2678	1744.2	39.7159	288.09344	153.140158	950	218	35.7172	492.2803	186	114	314	11.44	3.122124	0.121795	306.2803161
shear1-81	9.7	47.68	317.3	150.2678853	22580.4373	1744.2	39.3848	287.19621	154.794314	970	221	36.2087	493.5886	184	116	316	11.4735	3.155847	0.124359	309.5886276
shear1-82	9.9	47.48	317.3	149.637567	22391.4014	1744.2	39.05508	285.75636	157.134539	990	225	36.8641	495.2691	181	119	319	11.5072	3.203558	0.126923	314.2690782
shear1-83	10.15	47.23	317.3	148.8496691	22156.224	1744.2	38.64489	284.69116	160.036747	1015	230	37.6833	498.0735	178	122	322	11.5496	3.262727	0.130128	320.0734932
shear1-84	10.2	47.18	317.3	148.6920895	22109.3375	1744.2	38.56311	282.93021	163.395308	1020	235	38.5025	500.7906	174	126	326	11.5582	3.331199	0.130769	326.7906166
shear1-85	10.5	46.88	317.3	147.746612	21829.0614	1744.2	38.07425	281.37118	164.056765	1050	237	38.8302	500.1135	172	128	328	11.6095	3.344684	0.134615	328.1135309
shear1-86	10.75	46.63	314.4	148.3142494	21997.1166	1744.2	38.36737	280.34542	165.518124	1075	240	39.3217	501.0362	170	130	330	11.6527	3.374478	0.137821	331.0362487
shear1-87	11	46.38	314.4	147.519084	21761.8801	1744.2	37.95707	280.3094	166.964101	1100	243	39.8132	502.9282	169	131	331	11.6962	3.403957	0.141026	333.9282011
shear1-88	11.25	46.13	314.4	146.7239186	21527.9083	1744.2	37.54898	277.80678	167.710163	1125	245	40.1409	501.4203	166	134	334	11.74	3.419167	0.144231	335.4203255
shear1-89	11.5	45.88	314.4	145.9287532	21295.201	1744.2	37.14309	275.29731	168.44597	1150	247	40.4686	499.8919	163	137	337	11.7841	3.434169	0.147436	336.8919395
shear1-90	11.75	45.63	314.4	145.1335878	21063.7583	1744.2	36.73941	273.23395	169.850925	1175	250	40.9601	499.7019	160	140	340	11.8286	3.462812	0.150641	339.7018507
shear1-91	12	45.38	314.4	144.3384224	20833.5802	1744.2	36.33793	268.70911	170.563658	1200	252	41.2878	496.1273	155	145	345	11.8734	3.477343	0.153846	341.1273165
shear1-92	12.25	45.13	314.4	143.543257	20604.6666	1744.2	35.93866	265.50315	170.254722	1225	252.5	41.3697	492.5094	152	148	348	11.9185	3.471044	0.157051	340.5094437
shear1-93	12.5	44.88	314.4	142.7480916	20377.0177	1744.2	35.54159	264.84767	169.271509	1250	252	41.2878	490.543	152	148	348	11.964	3.450999	0.160256	338.5430187
shear1-94	13	44.38	314.4	141.1577608	19925.5134	1744.2	34.75408	263.98624	167.97936	1300	252	41.2878	487.9587	152	148	348	12.056	3.424656	0.166667	335.9587208
shear1-95	13.5	43.88	310.1	141.5027411	20023.0257	1744.2	34.92416	263.24286	165.364297	1350	250	40.9601	483.7286	153	147	347	12.1495	3.371341	0.173077	330.7285942
shear1-96	14	43.38	310.1	139.8903579	19569.3122	1744.2	34.13279	261.95072	163.426074	1400	249	40.7963	479.8521	153	147	347	12.2444	3.331826	0.179487	326.8521475
shear1-97	14.5	42.88	302	141.986755	20160.2386	1744.2	35.16349	261.09954	162.149308	1450	249	40.7963	477.2986	153	147	347	12.3408	3.305796	0.185897	324.2986151
shear1-98	15	42.38	302	140.3311258	19692.8249	1744.2	34.34823	260.81764	160.226467	1500	248	40.6324	474.4529	154	146	346	12.4388	3.266595	0.192308	320.4529337

Test apparatus : Triaxial
Sample/part No : 7 / 1 from 4
Location : Talingchan area, Bangkok
Depth : 15 - 15.7 m
Discription of soil : Clay

Boring No : 2
Date of test : 3-Feb-05
Tested by : Yono

a. Specimen data

Type of test performed : Consolidated Undrained
Diameter of specimen, Do 3.871667 cm

Top	Middle	Botom	**Average**
3.88	3.875	3.86	3.87166667

Initial height of specimen 7.8 cm
Initial area of specimen : 11.767 cm^2
Volume of specimen : 91.78256 cm3
Mass of specimen 145.95 gr
Wet unit of specimen 1.590171 gr/cm3
Length tip to tip of bender element in sample : 6.62 cm

Water content of specimen

Can no	I	II	III
Mass of can	36.13	42.05	85
Mass of wet soil+can	64	72.6	116.19
Mass dry soil+can	53.43	61.13	104.36
Mass of water	10.57	11.47	11.83
Mass of dry soil	17.3	19.08	19.36
Water content	61.10	60.12	61.11
Average of water content	60.77		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
210	200	206	205	0.9761905

c. Consolidation step

consol	$\sigma v'$ kPa	$\sigma h'$ kPa	Vol. change reading (cm^3)	Diff. volume change (cm^3)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			49.7					1590.7	
100	100	100	44.8	4.9	65.41	675.9	96.775	1624	15.2046
200	200	200	38.7	11	63.03	513	122.87	1670.5	25.2178
300	300	300	32.3	17.4	61.27	398.1	153.91	1728.2	40.936
400	400	400	24.1	25.6	59.66	357.5	166.88	1818.5	50.644
500	500	500	15.8	33.9	57.37	305.7	187.67	1935.8	68.1772

Table Analyses data of CU Isotropic Triaxial test with final mean effective stress 500 kPa

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	ρ kg/m³	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm²	stress ksc	strain mm/mm	Deviator stress kPa
conso100		65.41	675.9	96.77467081	9365.33691	1624	15.20462	100	0				100	100						0
conso200		63.11	513	123.0214425	15134.2753	1670.5	25.28181	200	0				200	200						0
conso300		61.27	398.1	153.9060538	23687.0734	1728.2	40.936	300	0				300	300						0
conso400		59.66	357.5	166.8811189	27849.3078	1818.5	50.64397	400	0				400	400						0
conso500		57.37	305.7	187.667648	35219.1461	1935.8	68.17722	500	0				500	500						0
shearing																				
shear1-0	0	57.37	305.7	187.667648	35219.1461	1935.8	68.17722	500	0	0	0	0	500	500	0	200	8.64	0	0	0
shear1-1	0.01	57.36	305.7	187.6349362	35206.8693	1935.8	68.15346	501.1001	4.6500823	1	5	0.819202	507.30016	498	2	202	8.641108	0.094803	0.00012821	9.300164663
shear1-2	0.02	57.35	305.7	187.6022244	35194.5946	1935.8	68.1297	502.0591	12.088664	2	13	2.129925	518.17733	494	6	206	8.642216	0.246456	0.00025641	24.17732767
shear1-3	0.04	57.33	305.7	187.5368008	35170.0516	1935.8	68.08219	503.3954	18.593174	4	20	3.276808	528.18635	491	9	209	8.644433	0.379066	0.00051282	37.18634887
shear1-4	0.06	57.31	305.7	187.4713772	35145.5173	1935.8	68.03469	504.4903	23.235506	6	25	4.09601	535.47101	489	11	211	8.646651	0.473711	0.00076923	46.47101127
shear1-5	0.08	57.29	305.7	187.4059535	35120.9914	1935.8	67.98722	504.9642	26.94627	8	29	4.751372	540.89254	487	13	213	8.648871	0.549363	0.00102564	53.89254029
shear1-6	0.1	57.27	305.7	187.3405299	35096.4742	1935.8	67.93975	505.4368	30.655127	10	33	5.406734	546.31025	485	15	215	8.651091	0.624977	0.00128205	61.31025336
shear1-7	0.12	57.25	305.7	187.2751063	35071.9654	1935.8	67.89231	505.9081	34.362075	12	37	6.062096	551.72415	483	17	217	8.653313	0.700552	0.00153846	68.7241505
shear1-8	0.14	57.23	305.7	187.2096827	35047.4653	1935.8	67.84488	505.1401	36.210183	14	39	6.389776	553.42037	481	19	219	8.655536	0.73823	0.00179487	72.42036673
shear1-9	0.16	57.21	305.7	187.1442591	35022.9737	1935.8	67.79747	505.9904	38.985565	16	42	6.881298	557.97113	480	20	220	8.65776	0.794813	0.00205128	77.97113048
shear1-10	0.18	57.19	304.1	188.0631371	35367.7435	1935.8	68.46488	505.8397	41.759516	18	45	7.372819	561.51903	478	22	222	8.659985	0.851366	0.00230769	83.51903227
shear1-11	0.205	57.165	304.1	187.9809273	35336.829	1935.8	68.40503	506.3769	44.065329	20.5	47.5	7.78242	565.13066	477	23	223	8.662768	0.898376	0.00262821	88.13065707
shear1-12	0.23	57.14	304.1	187.8987175	35305.928	1935.8	68.34522	505.9131	46.36965	23	50	8.192021	567.7393	475	25	225	8.665552	0.945355	0.00294872	92.73930066
shear1-13	0.245	57.125	304.1	187.8493916	35287.3939	1935.8	68.30934	506.1434	48.215135	24.5	52	8.519702	570.43027	474	26	226	8.667224	0.982979	0.00314103	96.43026997
shear1-14	0.26	57.11	304.1	187.8000658	35268.8647	1935.8	68.27347	506.3733	50.059904	26	54	8.847383	573.11981	473	27	227	8.668896	1.020589	0.00333333	100.1198083
shear1-15	0.285	57.085	304.1	187.717856	35237.9934	1935.8	68.21371	506.9071	52.360649	28.5	56.5	9.256984	576.7213	472	28	228	8.671685	1.067495	0.00365385	104.721297
shear1-16	0.3	57.07	304.1	187.6685301	35219.4772	1935.8	68.17786	506.4446	54.666938	30	59	9.666585	579.33388	470	30	230	8.673359	1.114515	0.00384615	109.3338758
shear1-17	0.35	57.02	304.1	187.5041105	35157.7915	1935.8	68.05845	505.6558	56.483684	35	61	9.994266	580.96737	468	32	232	8.678944	1.151553	0.00448718	112.9673675
shear1-18	0.4	56.97	304.1	187.3396909	35096.1598	1935.8	67.93915	505.8654	58.298045	40	63	10.32195	583.59609	467	33	233	8.684536	1.188543	0.00512821	116.5960893
shear1-19	0.45	56.92	302.3	188.2897784	35453.0406	1935.8	68.63	506.6899	61.03479	45	66	10.81347	588.06958	466	34	234	8.690135	1.244338	0.00576923	122.0695802
shear1-20	0.5	56.87	302.3	188.1243798	35390.7823	1935.8	68.50948	506.8959	62.843785	50	68	11.14115	590.68757	465	35	235	8.695742	1.281219	0.00641026	125.6875696
shear1-21	0.55	56.82	302.3	187.9589811	35328.5786	1935.8	68.38906	507.716	65.573972	55	71	11.63267	595.14794	464	36	236	8.701356	1.33688	0.00705128	131.1479433
shear1-22	0.6	56.77	302.3	187.7935825	35266.4296	1935.8	68.26875	507.5337	68.300581	60	74	12.12419	598.60116	462	38	238	8.706977	1.392469	0.00769231	136.601162
shear1-23	0.65	56.72	302.3	187.6281839	35204.3354	1935.8	68.14855	506.7342	70.101228	65	76	12.45187	600.20246	460	40	240	8.712605	1.429179	0.00833333	140.2024567
shear1-24	0.7	56.67	302.3	187.4627853	35142.2959	1935.8	68.02846	507.5475	72.821279	70	79	12.94339	604.64256	459	41	241	8.718241	1.484634	0.00897436	145.6425581
shear1-25	0.75	56.62	302.3	187.2973867	35080.3111	1935.8	67.90847	507.3585	75.537752	75	82	13.43491	608.0755	457	43	243	8.723883	1.540015	0.00961538	151.0755047
shear1-26	0.8	56.57	302.3	187.1319881	35018.381	1935.8	67.78858	506.5534	77.330052	80	84	13.7626	609.6601	455	45	245	8.729534	1.576556	0.01025641	154.6601046
shear1-27	0.85	56.52	302.3	186.9665895	34956.5056	1935.8	67.6688	506.7466	79.119967	85	86	14.09028	612.23993	454	46	246	8.735191	1.613047	0.01089744	158.2399347
shear1-28	0.9	56.47	302.3	186.8011909	34894.6849	1935.8	67.54913	506.5513	81.826901	90	89	14.5818	615.6538	452	48	248	8.740856	1.668234	0.01153846	163.6538015
shear1-29	0.95	56.42	300.7	187.628866	35204.5913	1935.8	68.14905	506.3535	84.530257	95	92	15.07332	619.06051	450	50	250	8.746528	1.723349	0.01217949	169.0605135
shear1-30	1	56.37	300.7	187.4625873	35142.2216	1935.8	68.02831	507.1534	87.230035	100	95	15.56484	623.46007	449	51	251	8.752208	1.77839	0.01282051	174.4600705
shear1-31	1.05	56.32	300.7	187.2963086	35079.9072	1935.8	67.90768	507.9508	89.926236	105	98	16.05636	627.85247	448	52	252	8.757895	1.833359	0.01346154	179.8524727
shear1-32	1.1	56.27	300.7	187.1300299	35017.6481	1935.8	67.78716	508.1346	91.701842	110	100	16.38404	630.40368	447	53	253	8.763589	1.869558	0.01410256	183.4036832
shear1-33	1.15	56.22	300.7	186.9637512	34955.4443	1935.8	67.66675	507.9277	94.391484	115	103	16.87556	633.78297	445	55	255	8.769291	1.924393	0.01474359	188.7829681
shear1-34	1.2	56.17	300.7	186.7974726	34893.2958	1935.8	67.54644	508.1078	96.161723	120	105	17.20324	636.32345	444	56	256	8.775	1.960484	0.01538462	192.3234462
shear1-35	1.25	56.12	298.4	188.0697051	35370.214	1935.8	68.46966	509.2864	97.929577	125	107	17.53092	639.85915	444	56	256	8.780717	1.996526	0.01602564	195.8591544

continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	ρ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-36	1.3	56.07	298.4	187.9021448	35307.216	1935.8	68.34771	510.0731	100.60968	130	110	18.02245	644.21936	443	57	257	8.786441	2.051166	0.01666667	201.2193596
shear1-37	1.35	56.02	298.4	187.7345845	35244.2742	1935.8	68.22587	509.8575	103.2862	135	113	18.51397	647.57241	441	59	259	8.792172	2.105733	0.01730769	206.5724099
shear1-38	1.45	55.92	298.4	187.3994638	35118.559	1935.8	67.98251	508.9848	104.97714	145	115	18.84165	648.95429	439	61	261	8.803658	2.140207	0.01858974	209.9542879
shear1-39	1.5	55.87	298.4	187.2319035	35055.7857	1935.8	67.86099	509.1554	106.73307	150	117	19.16933	651.46615	438	62	262	8.809412	2.176006	0.01923077	213.4661465
shear1-40	1.65	55.72	298.4	186.7292225	34867.8025	1935.8	67.49709	508.2298	108.34471	165	119	19.49701	652.68942	436	64	264	8.826719	2.208863	0.02115385	216.6894245
shear1-41	1.7	55.67	298.4	186.5616622	34805.2538	1935.8	67.37601	508.6088	111.91321	170	123	20.15237	657.82643	434	66	266	8.832503	2.281615	0.02179487	223.8264274
shear1-42	1.75	55.62	298.4	186.3941019	34742.7612	1935.8	67.25504	508.7723	113.65841	175	125	20.48005	660.31682	433	67	267	8.838295	2.317195	0.0224359	227.3168212
shear1-43	1.8	55.57	298.4	186.2265416	34680.3248	1935.8	67.13417	508.9341	115.40122	180	127	20.80773	662.80245	432	68	268	8.844094	2.352726	0.02307692	230.8024452
shear1-44	1.9	55.47	295.8	187.525355	35165.7588	1935.8	68.07388	509.6481	117.97221	190	130	21.29925	666.94443	431	69	269	8.855716	2.405142	0.02435897	235.9444262
shear1-45	1.97	55.4	295.8	187.2887086	35077.0604	1935.8	67.90217	509.3891	120.58363	197	133	21.79078	670.16726	429	71	271	8.86387	2.458382	0.02525641	241.1672575
shear1-46	2.05	55.32	295.8	187.0182556	34975.8279	1935.8	67.70621	510.1159	123.17382	205	136	22.2823	674.34764	428	72	272	8.873206	2.511189	0.02628205	246.3476365
shear1-47	2.1	55.27	295.8	186.8492224	34912.6319	1935.8	67.58387	509.2686	124.90292	210	138	22.60998	675.80583	426	74	274	8.879051	2.546441	0.02692308	249.8058333
shear1-48	2.18	55.19	295.8	186.5787694	34811.6372	1935.8	67.38837	509.9891	127.48369	218	141	23.1015	679.96737	425	75	275	8.88842	2.599056	0.02794872	254.9673711
shear1-49	2.25	55.12	295.8	186.3421231	34723.3868	1935.8	67.21753	509.1151	129.1726	225	143	23.42918	681.34519	423	77	277	8.896634	2.633488	0.02884615	258.3451947
shear1-50	2.32	55.05	295.8	186.1054767	34635.2484	1935.8	67.04691	508.8404	131.76064	232	146	23.9207	684.52128	421	79	279	8.904863	2.686252	0.02974359	263.5212807
shear1-51	2.4	54.97	293.4	187.3551466	35101.9509	1935.8	67.95036	508.5506	134.32591	240	149	24.41222	687.65181	419	81	281	8.914286	2.738551	0.03076923	268.6518139
shear1-52	2.5	54.87	293.4	187.0143149	34974.354	1935.8	67.70335	508.5329	137.29936	250	152.5	24.98566	691.59872	417	83	283	8.926093	2.799171	0.03205128	274.5987201
shear1-53	2.6	54.77	293.4	186.6734833	34846.9894	1935.8	67.4568	508.9102	139.36533	260	155	25.39527	694.73067	416	84	284	8.937931	2.841291	0.03333333	278.7306691
shear1-54	2.75	54.62	293.4	186.1622359	34656.3781	1935.8	67.08782	509.1183	142.67745	275	159	26.05063	699.3549	414	86	286	8.955748	2.908817	0.03525641	285.3549049
shear1-55	2.8	54.57	293.4	185.99182	34592.9571	1935.8	66.96505	508.2508	144.37614	280	161	26.37831	700.75229	412	88	288	8.961702	2.943448	0.03589744	288.7522852
shear1-56	2.9	54.47	293.4	185.6509884	34466.2895	1935.8	66.71984	508.9139	146.87081	290	164	26.86983	704.74163	411	89	289	8.973635	2.994308	0.03717949	293.7416286
shear1-57	3	54.37	291.1	186.7743044	34884.6408	1935.8	67.52969	509.5722	149.35833	300	167	27.36135	708.71666	410	90	290	8.9856	3.045022	0.03846154	298.7166622
shear1-58	3.15	54.22	291.1	186.2590175	34692.4216	1935.8	67.15759	509.1582	151.73733	315	170	27.85287	711.47466	408	92	292	9.003607	3.093524	0.04038462	303.4746641
shear1-59	3.25	54.12	291.1	185.915493	34564.5705	1935.8	66.9101	510.103	154.65444	325	173.5	28.42631	716.30888	407	93	293	9.015652	3.152996	0.04166667	309.3088807
shear1-60	3.4	53.97	291.1	185.4002061	34373.2364	1935.8	66.53971	510.3787	156.56808	340	176	28.83591	719.13615	406	94	294	9.03378	3.19201	0.04358974	313.1361507
shear1-61	3.5	53.87	288.4	186.7891817	34890.1984	1935.8	67.54045	509.4233	158.135	350	178	29.16359	720.26999	404	96	296	9.045906	3.223955	0.04487179	316.2699926
shear1-62	3.65	53.72	288.4	186.2690707	34696.1667	1935.8	67.16484	508.9843	160.47643	365	181	29.65512	722.95287	402	98	298	9.064156	3.271691	0.04679487	320.9528681
shear1-63	3.75	53.62	288.4	185.9223301	34567.1128	1935.8	66.91502	509.021	162.03143	375	183	29.9828	725.06286	401	99	299	9.076364	3.303393	0.04807692	324.0628604
shear1-64	4	53.37	288.4	185.0554785	34245.5301	1935.8	66.2925	509.0104	165.01562	400	187	30.63816	729.03123	399	101	301	9.107027	3.364233	0.05128205	330.0312312
shear1-65	4.16	53.21	286.3	185.8539993	34541.7091	1935.8	66.86584	508.5336	167.30041	416	190	31.12968	731.60082	397	103	303	9.126761	3.410814	0.05333333	334.600821
shear1-66	4.35	53.02	286.3	185.1903598	34295.4693	1935.8	66.38917	509.0031	169.50471	435	193	31.6212	735.00943	396	104	304	9.150305	3.455754	0.05576923	339.0094258
shear1-67	4.5	52.87	286.3	184.6664338	34101.6918	1935.8	66.01405	508.5259	171.78891	450	196	32.11272	737.57782	394	106	306	9.16898	3.502322	0.05769231	343.5778231
shear1-68	4.7	52.67	283.7	185.6538597	34467.3556	1935.8	66.72191	508.3798	173.06964	470	198	32.4404	739.13927	393	107	307	9.193997	3.528433	0.06025641	346.1392738
shear1-69	4.84	52.53	283.7	185.1603807	34284.3666	1935.8	66.36768	508.4858	176.22876	484	202	33.09576	743.45752	391	109	309	9.211591	3.592839	0.06205128	352.4575188
shear1-70	5	52.37	281.3	186.1713473	34659.7706	1935.8	67.09438	508.2601	178.89014	500	205.5	33.66921	746.78028	389	111	311	9.231781	3.647098	0.06410256	357.78028
shear1-71	5.2	52.17	281.3	185.4603626	34395.5461	1935.8	66.5829	507.3802	180.57035	520	208	34.07881	748.14069	387	113	313	9.257143	3.681353	0.06666667	361.1406934
shear1-72	5.4	51.97	281.3	184.7493779	34132.3326	1935.8	66.07337	507.2038	181.80576	540	210	34.40649	749.61152	386	114	314	9.282645	3.706539	0.06923077	363.6115155
shear1-73	5.55	51.82	278.8	185.8680057	34546.9156	1935.8	66.87592	506.6813	184.02198	555	213	34.89801	752.04397	384	116	316	9.301863	3.751722	0.07115385	368.0439699
shear1-74	5.75	51.62	278.8	185.1506456	34280.7616	1935.8	66.3607	507.6402	186.96026	575	217	35.55337	756.92052	383	117	317	9.327612	3.811626	0.07371795	373.9205196
shear1-75	5.85	51.52	278.8	184.7919656	34148.0705	1935.8	66.10383	506.6148	188.42224	585	219	35.88105	757.84448	381	119	319	9.340541	3.841432	0.075	376.8444847
shear1-76	6	51.37	278.8	184.2539455	33949.5164	1935.8	65.71947	506.4985	189.74769	600	221	36.20873	759.49537	380	120	320	9.36	3.868454	0.07692308	379.4953715
shear1-77	6.2	51.17	278.8	183.5365854	33685.6782	1935.8	65.20874	505.8595	191.78921	620	224	36.70025	761.57843	378	122	322	9.386072	3.910076	0.07948718	383.5784288

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	ρ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-78	6.35	51.02	275	185.5272727	34420.3689	1935.8	66.63095	505.7316	193.09737	635	226	37.02793	763.19473	377	123	323	9.405722	3.936746	0.08141026	386.1947336
shear1-79	6.6	50.77	275	184.6181818	34083.8731	1935.8	65.97956	505.5529	195.82934	660	230	37.6833	766.65868	375	125	325	9.438655	3.992443	0.08461538	391.6586847
shear1-80	6.8	50.57	275	183.8909091	33815.8664	1935.8	65.46075	505.4513	198.67699	680	234	38.33866	770.35398	373	127	327	9.465169	4.050499	0.08717949	397.3539772
shear1-81	7	50.37	272.6	184.7762289	34142.2548	1935.8	66.09258	504.337	201.50556	700	238	38.99402	773.01111	370	130	330	9.491831	4.108166	0.08974359	403.0111103
shear1-82	7.15	50.22	272.6	184.2259721	33939.2088	1935.8	65.69952	504.3062	204.45933	715	242	39.64938	776.91866	368	132	332	9.511927	4.168386	0.09166667	408.9186646
shear1-83	7.25	50.12	272.6	183.8591343	33804.1813	1935.8	65.43813	504.3636	207.54547	725	246	40.30474	781.09095	366	134	334	9.525371	4.231304	0.09294872	415.0909498
shear1-84	7.5	49.87	270.1	184.6353203	34090.2015	1935.8	65.99181	504.5561	209.3342	750	249	40.79626	783.66839	365	135	335	9.559149	4.267772	0.09615385	418.6683949
shear1-85	7.7	49.67	270.1	183.8948538	33817.3172	1935.8	65.46356	504.8369	211.25529	770	252	41.28779	786.51057	364	136	336	9.586344	4.306938	0.09871795	422.5105709
shear1-86	8	49.37	270.1	182.784154	33410.047	1935.8	64.67517	503.9053	212.85798	800	255	41.77931	787.71596	362	138	338	9.627429	4.339612	0.1025641	425.7159616
shear1-87	8.2	49.17	268.7	182.9921846	33486.1396	1935.8	64.82247	503.7195	215.57922	820	259	42.43467	791.15845	360	140	340	9.655014	4.395091	0.10512821	431.158448
shear1-88	8.4	48.97	268.7	182.2478601	33214.2825	1935.8	64.29621	504.5209	218.28139	840	263	43.09003	795.56278	359	141	341	9.682759	4.450181	0.10769231	436.562775
shear1-89	8.65	48.72	268.7	181.3174544	32876.0193	1935.8	63.6414	503.6522	219.97829	865	266	43.58155	796.95658	357	143	343	9.717664	4.484777	0.11089744	439.9565779
shear1-90	8.8	48.57	260.4	186.5207373	34789.9855	1935.8	67.34645	503.5355	222.80328	880	270	44.23691	800.60656	355	145	345	9.738728	4.542371	0.11282051	445.6065561
shear1-91	9	48.37	260.4	185.7526882	34504.0612	1935.8	66.79296	503.3004	225.45059	900	274	44.89227	803.90117	353	147	347	9.766957	4.596342	0.11538462	450.9011748
shear1-92	9.18	48.19	260.4	185.0614439	34247.738	1935.8	66.29677	502.5496	227.32445	918	277	45.3838	805.64891	351	149	349	9.792502	4.634545	0.11769231	454.6489063
shear1-93	9.35	48.02	260.4	184.4086022	34006.5325	1935.8	65.82985	502.8126	229.21883	935	280	45.87532	808.43766	350	150	350	9.816752	4.673167	0.11987179	458.4376591
shear1-94	9.5	47.87	254.3	188.2422336	35435.1385	1935.8	68.59534	502.1124	231.16854	950	283	46.36684	810.33707	348	152	352	9.838248	4.712916	0.12179487	462.3370742
shear1-95	9.7	47.67	254.3	187.4557609	35139.6623	1935.8	68.02336	503.8343	233.75145	970	287	47.0222	815.5029	348	152	352	9.867057	4.765575	0.12435897	467.5029048
shear1-96	9.9	47.47	254.3	186.6692882	34845.4232	1935.8	67.45377	503.0021	235.50321	990	290	47.51372	817.00642	346	154	354	9.896035	4.801289	0.12692308	471.006416
shear1-97	10.1	47.27	250.1	189.0043982	35722.6626	1935.8	69.15193	503.7002	238.05035	1010	294	48.16908	821.1007	345	155	355	9.925184	4.853218	0.12948718	476.1006978
shear1-98	10.3	47.07	250.1	188.2047181	35421.0159	1935.8	68.568	502.8474	239.7711	1030	297	48.6606	822.5422	343	157	357	9.954505	4.8883	0.13205128	479.5421999
shear1-99	10.5	46.87	250.1	187.405038	35120.6483	1935.8	67.98655	501.985	241.47754	1050	300	49.15213	823.95508	341	159	359	9.984	4.92309	0.13461538	482.9550825
shear1-100	10.75	46.62	250.1	186.4054378	34746.9873	1935.8	67.26322	502.5273	243.79096	1075	304	49.80749	827.58191	340	160	360	10.02112	4.970254	0.13782051	487.5819115
shear1-101	11	46.37	245.7	188.7260887	35617.5366	1935.8	68.94843	502.32	246.48	1100	308.5	50.54477	830.96	338	162	362	10.05851	5.025076	0.14102564	492.9600039
shear1-102	11.25	46.12	245.7	187.7085877	35234.5139	1935.8	68.20697	502.6255	249.9382	1125	314	51.44589	835.8764	336	164	364	10.09618	5.09558	0.14423077	499.8763976
shear1-103	11.5	45.87	245.7	186.6910867	34853.5618	1935.8	67.46953	501.5874	251.3811	1150	317	51.93741	836.7622	334	166	366	10.13414	5.124997	0.1474359	502.7622033
shear1-104	11.7	45.67	245.7	185.8770859	34550.2911	1935.8	66.88245	501.6646	252.99691	1170	320	52.42893	838.99383	333	167	367	10.16471	5.157939	0.15	505.9938287
shear1-105	11.9	45.47	240.5	189.0644491	35745.3659	1935.8	69.19588	501.2578	255.38665	1190	324	53.0843	841.7733	331	169	369	10.19546	5.206659	0.1525641	510.7732953
shear1-106	12	45.37	240.5	188.6486486	35588.3126	1935.8	68.89186	500.0496	256.57436	1200	326	53.41198	842.14872	329	171	371	10.21091	5.230874	0.15384615	513.1487188
shear1-107	12.15	45.22	240.5	188.024948	35353.3811	1935.8	68.43708	499.9696	257.95436	1215	328.5	53.82158	843.90872	328	172	372	10.23417	5.259008	0.15576923	515.9087176
shear1-108	12.3	45.07	240.5	187.4012474	35119.2275	1935.8	67.9838	499.8836	259.32541	1230	331	54.23118	845.65083	327	173	373	10.25753	5.286961	0.15769231	518.6508293
shear1-109	12.5	44.87	240.5	186.5696466	34808.233	1935.8	67.38178	499.4402	261.66029	1250	335	54.88654	848.32059	325	175	375	10.28885	5.334563	0.16025641	523.3205876
shear1-110	12.75	44.62	234.5	190.2771855	36205.4073	1935.8	70.08643	499.8493	263.77397	1275	339	55.5419	851.54794	324	176	376	10.32828	5.377655	0.16346154	527.5479351
shear1-111	13	44.37	234.5	189.2110874	35800.8356	1935.8	69.30326	499.2425	265.86379	1300	343	56.19726	853.72758	322	178	378	10.368	5.420261	0.16666667	531.7275834
shear1-112	13.2	44.17	234.5	188.358209	35478.8149	1935.8	68.67989	498.7578	268.13666	1320	347	56.85263	856.27332	320	180	380	10.4	5.466599	0.16923077	536.2733236
shear1-113	13.4	43.97	234.5	187.5053305	35158.249	1935.8	68.05934	497.7467	269.62011	1340	350	57.34415	857.24022	318	182	382	10.4322	5.496842	0.17179487	539.2402181
shear1-114	13.6	43.77	234.5	186.652452	34839.1378	1935.8	67.4416	496.7262	271.08925	1360	353	57.83567	858.17849	316	184	384	10.4646	5.526794	0.17435897	542.1784929
shear1-115	13.8	43.57	232.1	187.72081	35239.1025	1935.8	68.21585	497.2064	273.30965	1380	357	58.49103	861.61929	315	185	385	10.4972	5.572062	0.17692308	546.6192947
shear1-116	14	43.37	232.1	186.8591125	34916.3279	1935.8	67.59103	498.1652	274.74778	1400	360	58.98255	864.49556	315	185	385	10.53	5.601382	0.17948718	549.4955606
shear1-117	14.2	43.17	232.1	185.9974149	34595.0384	1935.8	66.96908	497.6216	276.93241	1420	364	59.63791	866.86481	313	187	387	10.56301	5.645921	0.18205128	553.8648134
shear1-118	14.4	42.97	232.1	185.1357174	34275.2338	1935.8	66.35	497.5597	278.33954	1440	367	60.12943	868.67907	312	188	388	10.59623	5.674608	0.18461538	556.6790702

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	ρ kg/m³	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm²	stress ksc	strain mm/mm	Deviator stress kPa
shear1-119	14.8	42.57	230.2	184.9261512	34197.6814	1935.8	66.19987	495.8999	278.84992	1480	370	60.62096	867.69983	310	190	390	10.66329	5.685014	0.18974359	557.6998345
shear1-120	15	42.37	230.2	184.0573414	33877.1049	1935.8	65.5793	495.315	280.97253	1500	374	61.27632	869.94507	308	192	392	10.69714	5.728288	0.19230769	561.9450693
shear1-121	15.2	42.17	230.2	183.1885317	33558.0382	1935.8	64.96165	495.2166	283.82495	1520	379	62.09552	873.6499	306	194	394	10.73121	5.786441	0.19487179	567.6499017
shear1-122	15.4	41.97	227.9	184.1597192	33914.8022	1935.8	65.65227	495.1023	286.65352	1540	384	62.91472	877.30703	304	196	396	10.7655	5.844108	0.1974359	573.3070348
shear1-123	15.6	41.77	227.9	183.2821413	33592.3433	1935.8	65.02806	493.9722	289.45823	1560	389	63.73392	879.91647	301	199	399	10.8	5.901289	0.2	578.9164687
shear1-124	15.8	41.57	227.9	182.4045634	33271.4248	1935.8	64.40682	493.3316	291.49738	1580	393	64.38928	881.99476	299	201	401	10.83473	5.942862	0.2025641	582.9947561
shear1-125	16	41.37	225.4	183.5403727	33687.0684	1935.8	65.21143	493.1712	294.25678	1600	398	65.20849	885.51356	297	203	403	10.86968	5.999119	0.20512821	588.5135613
shear1-126	16.2	41.17	225.4	182.6530612	33362.1408	1935.8	64.58243	492.9949	296.99233	1620	403	66.02769	888.98467	295	205	405	10.90485	6.05489	0.20769231	593.9846673
shear1-127	16.4	40.97	225.4	181.7657498	33038.7878	1935.8	63.95649	492.8027	299.70404	1640	408	66.84689	892.40807	293	207	407	10.94026	6.110174	0.21025641	599.408074
shear1-128	16.6	40.77	223.1	182.7431645	33395.0642	1935.8	64.64617	492.1065	301.65971	1660	412	67.50225	894.31941	291	209	409	10.9759	6.150045	0.21282051	603.3194139
shear1-129	16.8	40.57	223.1	181.8467055	33068.2243	1935.8	64.01347	490.8841	304.3261	1680	417	68.32145	896.65219	288	212	412	11.01176	6.204406	0.21538462	608.652192
shear1-130	17	40.37	221	182.6696833	33368.2132	1935.8	64.59419	491.1006	309.15088	1700	425	69.63218	903.30175	285	215	415	11.04787	6.30277	0.21794872	618.3017538
shear1-131	17.2	40.17	221	181.7647059	33038.4083	1935.8	63.95575	490.3583	311.03738	1720	429	70.28754	905.07477	283	217	417	11.08421	6.341231	0.22051282	622.0747658
shear1-132	17.4	39.97	221	180.8597285	32710.2414	1935.8	63.32049	489.1214	312.18217	1740	432	70.77906	905.36433	281	219	419	11.12079	6.36457	0.22307692	624.3643307
shear1-133	17.6	39.77	215.5	184.5475638	34057.8033	1935.8	65.9291	489.3553	314.0329	1760	436	71.43442	908.06579	280	220	420	11.15762	6.402302	0.22564103	628.0657938
shear1-134	17.8	39.57	215.5	183.6194896	33716.1169	1935.8	65.26766	488.5764	315.86455	1780	440	72.08978	909.7291	278	222	422	11.19468	6.439644	0.22820513	631.7290976
shear1-135	18	39.37	215.5	182.6914153	33376.1532	1935.8	64.60956	488.2617	318.39261	1800	445	72.90899	912.78522	276	224	424	11.232	6.491185	0.23076923	636.7852199
shear1-136	18.2	39.17	211.2	185.4640152	34396.9009	1935.8	66.58552	487.9312	320.89682	1820	450	73.72819	915.79364	274	226	426	11.26957	6.542239	0.23333333	641.793643
shear1-137	18.4	38.97	211.2	184.5170455	34046.5401	1935.8	65.90729	487.5324	324.79862	1840	457	74.87507	920.59724	271	229	429	11.30738	6.621786	0.23589744	649.5972431
shear1-138	18.6	38.77	211.2	183.5700758	33697.9727	1935.8	65.23254	486.6391	327.9587	1860	463	75.85811	923.9174	268	232	432	11.34545	6.686212	0.23846154	655.9173961
shear1-139	18.8	38.57	210.5	183.2304038	33573.3809	1935.8	64.99135	486.2561	330.38421	1880	468	76.67732	926.76841	266	234	434	11.38378	6.735662	0.24102564	660.7684116
shear1-140	19	38.37	210.5	182.280285	33226.1023	1935.8	64.31909	485.3263	333.48943	1900	474	77.66036	929.97886	263	237	437	11.42237	6.798969	0.24358974	666.9788562
shear1-141	19.15	38.22	207.6	184.1040462	33894.2998	1935.8	65.61259	484.5682	336.85223	1915	480	78.6434	933.70445	260	240	440	11.45149	6.867528	0.24551282	673.7044529
shear1-142	19.3	38.07	207.6	183.3815029	33628.7756	1935.8	65.09858	484.7957	340.19356	1930	486	79.62644	938.38712	258	242	442	11.48075	6.935649	0.2474359	680.3871203
shear1-143	19.5	37.87	207.6	182.4181118	33276.3675	1935.8	64.41639	484.3483	342.52248	1950	491	80.44565	941.04495	256	244	444	11.52	6.983129	0.25	685.0449537
shear1-144	19.7	37.67	205.8	183.0417881	33504.2962	1935.8	64.85762	483.3485	345.52276	1970	497	81.42869	944.04552	253	247	447	11.55952	7.044297	0.2525641	691.0455216
shear1-145	19.85	37.52	205.8	182.3129252	33238.0027	1935.8	64.34213	483.5296	348.79433	1985	503	82.41173	948.58867	251	249	449	11.58934	7.110996	0.25448718	697.5886686
shear1-146	20	37.37	205.8	181.5840622	32972.7716	1935.8	63.82869	482.6963	352.04444	2000	509	83.39477	952.08889	248	252	452	11.61931	7.177257	0.25641026	704.0888862
shear1-147	20.15	37.22	205.8	180.8551992	32708.6031	1935.8	63.31731	481.3888	354.58324	2015	514	84.21398	954.16647	245	255	455	11.64944	7.229016	0.25833333	709.1664732
shear1-148	20.3	37.07	205.8	180.1263362	32445.497	1935.8	62.80799	480.5281	357.7922	2030	520	85.19702	957.58441	242	258	458	11.67972	7.294438	0.26025641	715.5844097
shear1-149	20.5	36.87	203.9	180.8239333	32697.2949	1935.8	63.29542	480.1297	361.6946	2050	527.5	86.42582	962.3892	239	261	461	11.72035	7.373998	0.26282051	723.3892023
shear1-150	20.7	36.67	203.9	179.8430603	32343.5263	1935.8	62.6106	478.7075	365.56122	2070	535	87.65462	966.12245	235	265	465	11.76126	7.452828	0.26538462	731.122446
shear1-151	20.9	36.47	203.9	178.8621873	31991.6821	1935.8	61.9295	478.0344	369.05162	2090	542	88.80151	970.10323	232	268	468	11.80245	7.523988	0.26794872	738.1032338
shear1-152	21.15	36.22	201.6	179.6626984	32278.6852	1935.8	62.48508	477.217	370.82543	2115	547	89.62071	971.65087	230	270	470	11.85435	7.560152	0.27115385	741.6508668
shear1-153	21.3	36.07	201.6	178.9186508	32011.8836	1935.8	61.9686	476.1707	375.2561	2130	555	90.93143	976.5122	226	274	474	11.88571	7.650481	0.27307692	750.5121982
shear1-154	21.5	35.87	201.6	177.9265873	31657.8705	1935.8	61.28331	475.5341	377.30121	2150	560	91.75063	978.60241	224	276	476	11.92779	7.692175	0.27564103	754.6024104
shear1-155	21.7	35.67	201.6	176.9345238	31305.8257	1935.8	60.60182	474.3292	379.99383	2170	566	92.73368	980.98766	221	279	479	11.97016	7.747071	0.27820513	759.9876577
shear1-156	21.9	35.47	201.6	175.9424603	30955.7493	1935.8	59.92414	473.6592	381.98885	2190	571	93.55288	982.9777	219	281	481	12.01283	7.787744	0.28076923	763.9777014
shear1-157	22.15	35.22	197.3	178.5098834	31865.7785	1935.8	61.68577	472.6324	384.94859	2215	578	94.69976	985.89718	216	284	484	12.06661	7.848085	0.28397436	769.8971805
shear1-158	22.3	35.07	197.3	177.7496199	31594.9274	1935.8	61.16146	471.9358	386.90366	2230	582.5	95.43704	987.80733	214	286	486	12.0991	7.887944	0.28589744	773.807328
shear1-159	22.5	34.87	197.3	176.7359351	31235.5908	1935.8	60.46586	470.4363	389.15447	2250	588	96.33817	989.30895	211	289	489	12.1427	7.933832	0.28846154	778.3089463

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	ρ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-160	22.75	34.62	197.3	175.4688292	30789.31	1935.8	59.60195	467.4638	390.69576	2275	593	97.15737	988.39151	207	293	493	12.19765	7.965255	0.29166667	781.3915115
shear1-161	23	34.37	194.4	176.8004115	31258.3855	1935.8	60.50998	465.4715	392.20723	2300	598	97.97657	988.41445	204	296	496	12.25309	7.99607	0.29487179	784.4144525
shear1-162	23.25	34.12	194.4	175.5144033	30805.3058	1935.8	59.63291	462.283	390.42447	2325	598	97.97657	982.84893	202	298	498	12.30904	7.959724	0.29807692	780.8489323
shear1-163	23.5	33.87	198	171.0606061	29261.7309	1935.8	56.64486	461.6612	387.9918	2350	597	97.81273	978.98361	203	297	497	12.3655	7.910129	0.30128205	775.983607
shear1-164	23.75	33.62	198	169.7979798	28831.3539	1935.8	55.81173	459.6121	384.91818	2375	595	97.48505	972.83636	203	297	497	12.42249	7.847465	0.30448718	769.8363639
shear1-165	24	33.37	198	168.5353535	28404.1654	1935.8	54.98478	457.2831	379.92466	2400	590	96.66585	963.84933	204	296	496	12.48	7.745661	0.30769231	759.8493298
shear1-166	24.2	33.17	192.4	172.4012474	29722.1901	1935.8	57.53622	455.0619	376.59287	2420	587	96.17433	957.18574	204	296	496	12.52639	7.677734	0.31025641	753.1857422
shear1-167	24.4	32.97	192.4	171.3617464	29364.8481	1935.8	56.84447	452.8503	373.27539	2440	584	95.6828	950.55077	204	296	496	12.57313	7.6101	0.31282051	746.5507741
shear1-168	24.6	32.77	192.4	170.3222453	29009.6673	1935.8	56.15691	452.4972	371.24578	2460	583	95.51896	947.49157	205	295	495	12.62022	7.568721	0.31538462	742.4915664
shear1-169	24.8	32.57	190.5	170.9711286	29231.1268	1935.8	56.58562	450.3014	367.95215	2480	580	95.02744	940.9043	205	295	495	12.66767	7.501573	0.31794872	735.9042976
shear1-170	25	32.37	192.3	168.3307332	28335.2357	1935.8	54.85135	450.5366	365.30484	2500	578	94.69976	937.60968	207	293	493	12.71547	7.447601	0.32051282	730.6096789
shear1-171	25.25	32.12	192.3	167.0306812	27899.2485	1935.8	54.00737	446.8717	359.8075	2525	572	93.71672	926.615	207	293	493	12.77573	7.335525	0.32371795	719.6149978
shear1-172	25.4	31.97	192.3	166.25065	27639.2786	1935.8	53.50412	447.5169	356.27537	2540	568	93.06136	922.55074	210	290	490	12.81217	7.263514	0.32564103	712.5507363

Test apparatus	: Triaxial			
Sample/part No	: 3/ 2 from 3		Boring No	: 2
Location	: Talingchan area, Bangkok		Date of test	: 9 Dec 04
Depth	: 10.5 - 11.2 m		Tested by	: Yono
Discription of soil	: Clay			

a. Specimen data

Type of test performed : Consolidated Undrained

Diameter of specimen, Do : 3.84567 cm

Top	Middle	Botom	**Average**
3.844	3.852	3.841	3.845667

Initial height of specimen : 7.78 cm

Initial area of specimen : 11.6095 cm^2

Volume of specimen : 90.3218 cm3

Mass of specimen 143.16 gr

Wet unit of specimen 1.585 gr/cm3

Length tip to tip of bender element in sample : 6.24 cm

Water content of specimen

Can no	I	II	III
Mass of can	35.67	39.52	76.45
Mass of wet soil+can	65.9	73.23	113.75
Mass dry soil+can	54.33	60.33	99.4
Mass of water	11.57	12.9	14.35
Mass of dry soil	18.66	20.81	22.95
Water content	62.00	61.99	62.53
Average of water content	62.17		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
212	200	207	206	0.980952381

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm3)	Volume vhange (cm3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			33.9						1585.0	
25	25	25	32.2	1.7	20	61.91	1007	61.48	1596.2	6.0332
30.56	41.66	25	31.9	2	20	61.83	961.5	64.306	1598.2	6.6089
50	68.182	40.91	31	2.9	20	61.57	838.8	73.402	1604.4	8.6444
75	102.27	61.56	29.9	4	20	61.25	694.4	88.206	1612.1	12.543
100	136.36	81.82	28.4	5.5	20	60.82	637.3	95.434	1622.9	14.781

Table Analyses data of CU Triaxial test with final mean effective stress 100 kPa (Ko = 0.6)

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma 1$ kPa	$\sigma 3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
consolidation																				
conso25		61.91	1007	61.480	3779.75	1596.2	6.033	25	0				25	25						0
conso30.56		61.83	961.5	64.306	4135.23	1598.2	6.609	31	8				41.66	25						16.66
conso50		61.57	838.8	73.402	5387.92	1604.4	8.644	50	14				68.182	40.91						27.272
conso75		61.25	694.4	88.206	7780.24	1612.1	12.543	75	20				102.273	61.56						40.713
conso100		60.82	637.3	95.434	9107.62	1622.9	14.781	100	27				136.36	81.82						54.54
shearing																				
shear1-0	0	60.82	637.3	95.434	9107.62	1622.9	14.781	100	27	0	0	0.00	136.36	81.82	0	200	11.309	0.00	0.0000	54.54
shear1-1	0.01	60.81	637.3	95.418	9104.63	1622.9	14.776	100.421	29.402	1	3	0.49	139.62	80.82	1	201	11.310	0.04	0.0001	58.80
shear1-2	0.03	60.79	637.3	95.387	9098.64	1622.9	14.766	100.841	31.532	3	6	0.98	142.88	79.82	2	202	11.313	0.09	0.0004	63.06
shear1-3	0.04	60.78	637.3	95.371	9095.65	1622.9	14.761	100.788	32.952	4	8	1.31	144.72	78.82	3	203	11.315	0.12	0.0005	65.90
shear1-4	0.06	60.76	637.3	95.340	9089.66	1622.9	14.752	101.207	35.081	6	11	1.80	147.98	77.82	4	204	11.318	0.16	0.0008	70.16
shear1-5	0.08	60.74	637.3	95.308	9083.68	1622.9	14.742	101.152	36.499	8	13	2.13	149.82	76.82	5	205	11.321	0.19	0.0010	73.00
shear1-6	0.1	60.72	639.5	94.949	9015.35	1622.9	14.631	101.097	37.916	10	15	2.46	151.65	75.82	6	206	11.324	0.22	0.0013	75.83
shear1-7	0.12	60.7	639.5	94.918	9009.41	1622.9	14.621	101.041	39.332	12	17	2.79	153.48	74.82	7	207	11.326	0.25	0.0015	78.66
shear1-8	0.14	60.68	639.5	94.887	9003.47	1622.9	14.612	101.512	40.038	14	18	2.95	154.90	74.82	7	207	11.329	0.26	0.0018	80.08
shear1-9	0.16	60.66	639.5	94.855	8997.54	1622.9	14.602	100.983	40.744	16	19	3.11	155.31	73.82	8	208	11.332	0.27	0.0021	81.49
shear1-10	0.18	60.64	639.5	94.824	8991.61	1622.9	14.592	99.926	42.158	18	21	3.44	156.14	71.82	10	210	11.335	0.30	0.0023	84.32
shear1-11	0.2	60.62	639.5	94.793	8985.68	1622.9	14.583	100.632	43.218	20	22.5	3.69	158.26	71.82	10	210	11.338	0.33	0.0026	86.44
shear1-12	0.22	60.6	639.5	94.762	8979.75	1622.9	14.573	99.338	44.277	22	24	3.93	158.37	69.82	12	212	11.341	0.35	0.0028	88.55
shear1-13	0.24	60.58	639.5	94.730	8973.82	1622.9	14.564	99.279	45.689	24	26	4.26	160.20	68.82	13	213	11.344	0.38	0.0031	91.38
shear1-14	0.26	60.56	639.5	94.699	8967.90	1622.9	14.554	98.984	46.747	26	27.5	4.51	161.31	67.82	14	214	11.347	0.40	0.0033	93.49
shear1-15	0.28	60.54	639.5	94.668	8961.98	1622.9	14.544	99.217	47.096	28	28	4.59	162.01	67.82	14	214	11.350	0.40	0.0036	94.19
shear1-16	0.3	60.52	639.5	94.636	8956.05	1622.9	14.535	98.686	47.798	30	29	4.75	162.42	66.82	15	215	11.353	0.42	0.0039	95.60
shear1-17	0.35	60.47	639.5	94.558	8941.26	1622.9	14.511	98.620	49.200	35	31	5.08	164.22	65.82	16	216	11.360	0.45	0.0045	98.40
shear1-18	0.4	60.42	639.5	94.480	8926.48	1622.9	14.487	97.846	49.539	40	31.5	5.16	163.90	64.82	17	217	11.367	0.45	0.0051	99.08
shear1-19	0.5	60.32	639.5	94.324	8896.96	1622.9	14.439	98.062	49.864	50	32	5.24	164.55	64.82	17	217	11.382	0.46	0.0064	99.73
shear1-20	0.65	60.17	641.4	93.810	8800.39	1622.9	14.282	97.503	50.524	65	33	5.41	164.87	63.82	18	218	11.404	0.47	0.0084	101.05
shear1-21	0.85	59.97	641.4	93.499	8741.99	1622.9	14.187	96.868	52.573	85	36	5.90	166.97	61.82	20	220	11.434	0.52	0.0109	105.15
shear1-22	1.15	59.67	641.4	93.031	8654.74	1622.9	14.046	96.736	53.874	115	38	6.23	168.57	60.82	21	221	11.479	0.54	0.0148	107.75
shear1-23	1.4	59.42	641.4	92.641	8582.37	1622.9	13.928	95.609	55.183	140	40	6.55	169.19	58.82	23	223	11.516	0.57	0.0180	110.37
shear1-24	1.65	59.17	641.4	92.251	8510.31	1622.9	13.811	95.475	56.483	165	42	6.88	170.79	57.82	24	224	11.554	0.60	0.0212	112.97
shear1-25	1.8	59.02	641.4	92.017	8467.21	1622.9	13.741	94.900	57.120	180	43	7.05	171.06	56.82	25	225	11.577	0.61	0.0231	114.24
shear1-26	2.1	58.72	641.4	91.550	8381.35	1622.9	13.602	94.743	58.385	210	45	7.37	172.59	55.82	26	226	11.623	0.63	0.0270	116.77
shear1-27	2.4	58.42	641.4	91.082	8295.93	1622.9	13.463	93.579	59.639	240	47	7.70	173.10	53.82	28	228	11.669	0.66	0.0308	119.28
shear1-28	2.6	58.22	637.1	91.383	8350.82	1622.9	13.553	93.438	60.927	260	49	8.03	174.67	52.82	29	229	11.700	0.69	0.0334	121.85
shear1-29	2.8	58.02	637.1	91.069	8293.55	1622.9	13.460	92.291	62.207	280	51	8.36	175.23	50.82	31	231	11.731	0.71	0.0360	124.41
shear1-30	3	57.82	637.1	90.755	8236.47	1622.9	13.367	91.140	63.480	300	53	8.68	175.78	48.82	33	233	11.763	0.74	0.0386	126.96
shear1-31	3.25	57.57	637.1	90.363	8165.40	1622.9	13.252	89.968	64.721	325	55	9.01	176.26	46.82	35	235	11.802	0.76	0.0418	129.44
shear1-32	3.5	57.32	637.1	89.970	8094.63	1622.9	13.137	88.789	65.953	350	57	9.34	176.73	44.82	37	237	11.842	0.79	0.0450	131.91
shear1-33	3.7	57.12	637.1	89.656	8038.24	1622.9	13.045	87.396	66.864	370	58.5	9.58	176.55	42.82	39	239	11.874	0.81	0.0476	133.73
shear1-34	3.9	56.92	630.5	90.278	8150.04	1622.9	13.227	87.000	67.770	390	60	9.83	177.36	41.82	40	240	11.906	0.83	0.0501	135.54

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma 1$ kPa	$\sigma 3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-35	4.1	56.72	630.5	89.960	8092.86	1622.9	13.134	85.376	68.333	410	61	9.99	176.49	39.82	42	242	11.938	0.84	0.0527	136.67
shear1-36	4.3	56.52	632.7	89.331	7980.11	1622.9	12.951	83.749	68.893	430	62	10.16	175.61	37.82	44	244	11.971	0.85	0.0553	137.79
shear1-37	4.5	56.32	632.7	89.015	7923.73	1622.9	12.859	82.673	68.780	450	62	10.16	174.38	36.82	45	245	12.003	0.85	0.0578	137.56
shear1-38	4.7	56.12	635.9	88.253	7788.57	1622.9	12.640	81.153	67.999	470	61	9.99	171.82	35.82	46	246	12.036	0.83	0.0604	136.00
shear1-39	4.9	55.92	635.9	87.938	7733.15	1622.9	12.550	78.634	67.222	490	60	9.83	168.26	33.82	48	248	12.069	0.81	0.0630	134.44
shear1-40	5.1	55.72	635.9	87.624	7677.94	1622.9	12.461	78.561	67.112	510	60	9.83	168.04	33.82	48	248	12.102	0.81	0.0656	134.22
shear1-41	5.5	55.32	635.9	86.995	7568.10	1622.9	12.282	77.975	66.232	550	59	9.67	166.28	33.82	48	248	12.169	0.79	0.0707	132.46
shear1-42	6	54.82	630.5	86.947	7559.76	1622.9	12.269	78.795	65.963	600	59	9.67	166.75	34.82	47	247	12.254	0.79	0.0771	131.93
shear1-43	6.3	54.52	625.9	87.107	7587.55	1622.9	12.314	78.252	65.148	630	58	9.50	165.12	34.82	47	247	12.305	0.77	0.0810	130.30
shear1-44	6.5	54.32	625.9	86.787	7531.99	1622.9	12.224	76.747	64.391	650	57	9.34	162.60	33.82	48	248	12.340	0.76	0.0835	128.78
shear1-45	6.75	54.07	625.9	86.388	7462.82	1622.9	12.111	76.228	63.612	675	56	9.18	161.04	33.82	48	248	12.383	0.74	0.0868	127.22
shear1-46	7	53.82	620.1	86.792	7532.93	1622.9	12.225	77.143	63.484	700	56	9.18	161.79	34.82	47	247	12.427	0.74	0.0900	126.97
shear1-47	7.25	53.57	620.1	86.389	7463.11	1622.9	12.112	76.628	62.712	725	55	9.01	160.24	34.82	47	247	12.471	0.72	0.0932	125.42
shear1-48	7.5	53.32	620.1	85.986	7393.61	1622.9	11.999	76.116	61.944	750	54	8.85	158.71	34.82	47	247	12.516	0.71	0.0964	123.89
shear1-49	7.8	53.02	620.1	85.502	7310.65	1622.9	11.864	76.591	61.157	780	53	8.68	158.13	35.82	46	246	12.569	0.69	0.1003	122.31

Test apparatus : Triaxial
Sample No/part no : 8/ 2 from 3
Location : Talingchan area, Bangkok
Depth : 11.5 - 12.2 m
Discription of soil : Clay

Boring No : 2
Date of test : 12 jan 05
Tested by : Yono

a. Specimen data

Type of test performed : Consolidated Undrained
Diameter of specimen, Do : 3.44667 cm

Top	Middle	Botom	**Average**
3.45	3.44	3.45	3.4466667

Initial height of specimen : 7.635 cm
Initial area of specimen : 9.32542 cm^2
Volume of specimen : 71.1996 cm3
Mass of specimen 114.03 gr
Wet unit of specimen 1.602 gr/cm3
Length tip to tip of bender element in sample : 6.095 cm

Water content of specimen

Can no	I	II	III
Mass of can	30.64	36.28	35.48
Mass of wet soil+can	51.3	50.89	46.41
Mass dry soil+can	43.39	45.29	42.23
Mass of water	7.91	5.6	4.18
Mass of dry soil	12.75	9.01	6.75
Water content	62.04	62.15	61.93
Average of water content	62.04		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
215	200	206	205	0.976190476

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm3)	Volume vhange (cm3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			33.7						1601.5	
25	25	25	32.5	1.2	20	60.47	1112	54.38	1611.9	4.7666
30.6	41.667	25	31.3	2.4	20	60.04	1014	59.21	1622.5	5.6884
50.0	68.18	40.91	30.5	3.2	20	59.76	896.7	66.64	1629.9	7.2392
100.0	136.36	81.82	28.3	5.4	20	58.97	641	92	1650.9	13.972
150.0	204.55	122.73	26.8	6.9	20	58.44	543.4	107.5	1666.1	19.27
200.0	272.73	163.64	24.6	9.4	20	57.54	467.7	123	1693.1	25.626
250.0	340.91	204.55	21.6	12.1	20	56.58	388.9	145.5	1724.7	36.506
300.0	409.09	245.5	16.9	16.8	20	54.86	360	152.4	1787.3	41.505

Table Analyses data of CU Triaxial test with final mean effective stress 300 kPa (Ko = 0.6)

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma 1$ kPa	$\sigma 3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
consol 25		60.47	1112	54.38	2957.13	1611.9	4.767	25.0	0.0				25	25						0
consol30.6		60.04	1014	59.21	3505.95	1622.5	5.688	30.6	8.3				41.667	25						16.667
conso50		59.76	896.7	66.64	4441.47	1629.9	7.239	50.0	13.6				68.18	40.91						27.27
conso100		58.97	641	92.00	8463.43	1650.9	13.972	100.0	27.3				136.36	81.82						54.54
conso150		58.44	543.4	107.55	11565.95	1666.1	19.270	150.0	40.9				204.55	122.73						81.82
conso200		57.54	467.7	123.03	15135.79	1693.1	25.626	200.0	54.5				272.73	163.64						109.09
conso250		56.58	388.9	145.49	21166.55	1724.7	36.506	250.0	68.2				340.91	204.55						136.36
conso300		54.86	360	152.39	23222.37	1787.3	41.505	300.0	81.8				409.09	245.5						163.59
shearing																				
shear1-0	0	54.86	360	152.39	23222.37	1787.3	41.5053481	300.0	81.8	0	0	0	409.09	245.5	0	200	9.325	0	0	163.59
shear1-1	0.01	54.85	360	152.36	23213.91	1787.3	41.4902181	301.3279	85.241786	1	4	0.655362	414.984	244.5	1	201	9.326222	0.0702709	0.000131	170.4835721
shear1-2	0.02	54.84	360	152.33	23205.44	1787.3	41.4750909	302.7739	90.410836	2	10	1.638404	423.322	242.5	3	203	9.327443	0.1756542	0.000262	180.8216728
shear1-3	0.04	54.82	360	152.28	23188.52	1787.3	41.4448447	303.0693	93.85401	4	14	2.293766	428.208	240.5	5	205	9.329888	0.2458514	0.0005239	187.7080208
shear1-4	0.06	54.8	360	152.22	23171.60	1787.3	41.4146095	303.7895	96.434246	6	17	2.785287	432.368	239.5	6	206	9.332334	0.2984556	0.0007859	192.8684926
shear1-5	0.08	54.78	360	152.17	23154.69	1787.3	41.3843854	304.0827	99.874034	8	21	3.440649	437.248	237.5	8	208	9.334781	0.3685838	0.0010478	199.748068
shear1-6	0.1	54.76	357.5	153.17	23462.53	1787.3	41.9345746	304.3747	103.31202	10	25	4.09601	442.124	235.5	10	210	9.33723	0.4386751	0.0013098	206.6240315
shear1-7	0.12	54.74	357.5	153.12	23445.39	1787.3	41.9039487	305.0918	105.88774	12	28	4.587532	446.275	234.5	11	211	9.339679	0.4911873	0.0015717	211.7754731
shear1-8	0.14	54.72	357.5	153.06	23428.26	1787.3	41.8733339	305.3816	109.32233	14	32	5.242893	451.145	232.5	13	213	9.34213	0.5612096	0.0018337	218.644664
shear1-9	0.16	54.7	356.3	153.52	23569.10	1787.3	42.1250533	305.6701	112.75512	16	36	5.898255	456.01	230.5	15	215	9.344583	0.6311951	0.0020956	225.5102428
shear1-10	0.18	54.68	356.3	153.47	23551.87	1787.3	42.0942545	305.811	114.46655	18	38	6.225936	458.433	229.5	16	216	9.347036	0.6660866	0.0023576	228.9330992
shear1-11	0.2	54.66	356.3	153.41	23534.64	1787.3	42.063467	305.5244	117.03663	20	41	6.717457	461.573	227.5	18	218	9.349491	0.7184837	0.0026195	234.0732532
shear1-12	0.22	54.64	356.3	153.35	23517.42	1787.3	42.0326907	305.2369	119.60535	22	44	7.208978	464.711	225.5	20	220	9.351947	0.7708532	0.0028815	239.2106982
shear1-13	0.24	54.62	356.3	153.30	23500.21	1787.3	42.0019257	304.3757	121.31362	24	46	7.536659	466.127	223.5	22	222	9.354405	0.8056803	0.0031434	242.6272335
shear1-14	0.26	54.6	356.3	153.24	23483.00	1787.3	41.971172	304.514	123.02098	26	48	7.86434	468.542	222.5	23	223	9.356864	0.8404889	0.0034054	246.0419627
shear1-15	0.29	54.57	356.3	153.16	23457.20	1787.3	41.9250625	303.6479	124.7218	29	50	8.192021	469.944	220.5	25	225	9.360554	0.8751641	0.0037983	249.4435983
shear1-16	0.31	54.55	356.3	153.10	23440.01	1787.3	41.8943369	302.7848	126.42713	31	52	8.519702	471.354	218.5	27	227	9.363016	0.9099313	0.0040602	252.854264
shear1-17	0.35	54.51	358	152.26	23183.89	1787.3	41.4365669	302.9129	128.11937	35	54	8.847383	473.739	217.5	28	228	9.367944	0.9444316	0.0045842	256.2387424
shear1-18	0.5	54.36	358	151.84	23056.47	1787.3	41.2088313	302.9935	129.74027	50	56	9.175063	475.981	216.5	29	229	9.38647	0.9774775	0.0065488	259.4805454
shear1-19	0.65	54.21	355.4	152.53	23266.12	1787.3	41.5835366	303.0696	131.3544	65	58	9.502744	478.209	215.5	30	230	9.405069	1.0103854	0.0085134	262.7088032
shear1-20	0.75	54.11	355.4	152.25	23180.36	1787.3	41.4302617	302.7326	133.84896	75	61	9.994266	481.198	213.5	32	232	9.41751	1.0612429	0.0098232	267.697929
shear1-21	0.9	53.96	355.4	151.83	23052.02	1787.3	41.2008798	302.3671	136.30063	90	64	10.48579	484.101	211.5	34	234	9.436233	1.111226	0.0117878	272.6012688
shear1-22	1.15	53.71	350.7	153.15	23455.18	1787.3	41.9214435	301.9443	138.66652	115	67	10.97731	486.833	209.5	36	236	9.467603	1.1594601	0.0150622	277.333037
shear1-23	1.25	53.61	350.7	152.87	23367.92	1787.3	41.7654859	301.5893	141.13399	125	70	11.46883	489.768	207.5	38	238	9.48021	1.2097654	0.016372	282.2679822
shear1-24	1.45	53.41	350.7	152.30	23193.89	1787.3	41.4544426	301.1749	143.51229	145	73	11.96035	492.525	205.5	40	240	9.505524	1.2582526	0.0189915	287.0245831
shear1-25	1.7	53.16	350.7	151.58	22977.27	1787.3	41.0672733	300.2845	146.67677	170	77	12.61571	495.854	202.5	43	243	9.537358	1.3227681	0.0222659	293.3535487
shear1-26	2	52.86	350.7	150.73	22718.66	1787.3	40.6050679	299.7892	148.93373	200	80	13.10723	498.367	200.5	45	245	9.575841	1.3687815	0.0261952	297.8674659
shear1-27	2.3	52.56	350.7	149.87	22461.52	1787.3	40.1454783	299.8375	152.00622	230	84	13.7626	502.512	198.5	47	247	9.614635	1.4314214	0.0301244	304.0124434
shear1-28	2.6	52.26	342.2	152.72	23322.70	1787.3	41.6846593	299.3128	154.21916	260	87	14.25412	504.938	196.5	49	249	9.653746	1.4765374	0.0340537	308.4383171
shear1-29	2.9	51.96	342.2	151.84	23055.70	1787.3	41.207449	298.7745	156.41178	290	90	14.74564	507.324	194.5	51	251	9.693176	1.5212391	0.037983	312.8235555
shear1-30	3.1	51.76	342.2	151.26	22878.55	1787.3	40.8908351	297.2927	158.68905	310	93	15.23716	508.878	191.5	54	254	9.719642	1.5676667	0.0406025	317.3781081
shear1-31	3.25	51.61	342.2	150.82	22746.14	1787.3	40.654176	296.838	161.00697	325	96	15.72868	511.514	189.5	56	256	9.739586	1.6149228	0.0425671	322.0139315
shear1-32	3.5	51.36	338.5	151.73	23021.45	1787.3	41.1462385	295.7538	162.38067	350	98	16.05636	512.261	187.5	58	258	9.77301	1.642929	0.0458415	324.7613369
shear1-33	3.75	51.11	338.5	150.99	22797.88	1787.3	40.7466465	294.6621	163.74308	375	100	16.38404	512.986	185.5	60	260	9.806663	1.6707051	0.0491159	327.4861671

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain mm/mm	Deviator stress kPa
shear1-34	4	50.86	338.5	150.25	22575.40	1787.3	40.3490042	294.5628	165.09421	400	102	16.71172	514.688	184.5	61	261	9.840549	1.698251	0.0523903	330.1884221
shear1-35	4.25	50.61	334.3	151.39	22919.22	1787.3	40.9635302	293.9986	167.24789	425	105	17.20324	516.996	182.5	63	263	9.874671	1.7421588	0.0556647	334.4957759
shear1-36	4.5	50.36	334.3	150.64	22693.35	1787.3	40.5598318	293.8824	168.57362	450	107	17.53092	518.647	181.5	64	264	9.909029	1.7691869	0.0589391	337.1472367
shear1-37	4.75	50.11	334.3	149.90	22468.60	1787.3	40.1581324	293.2975	170.69625	475	110	18.02245	520.893	179.5	66	266	9.943628	1.8124619	0.0622135	341.3925086
shear1-38	5	49.86	330.6	150.82	22745.68	1787.3	40.653347	293.2382	173.6073	500	114	18.6778	524.715	177.5	68	268	9.978469	1.871811	0.065488	347.2146603
shear1-39	5.25	49.61	330.6	150.06	22518.15	1787.3	40.246694	292.1639	176.4958	525	118	19.3332	527.492	174.5	71	271	10.01355	1.9307	0.068762	352.9916616
shear1-40	5.5	49.36	330.6	149.30	22291.77	1787.3	39.842085	291.5414	178.562	550	121	19.8247	529.624	172.5	73	273	10.04889	1.972824	0.072037	357.1240574
shear1-41	5.75	49.11	326.7	150.32	22596.52	1787.3	40.386764	290.9075	180.6113	575	124	20.3162	531.723	170.5	75	275	10.08447	2.014603	0.075311	361.2225903
shear1-42	6	48.86	326.7	149.56	22367.05	1787.3	39.976624	289.2624	182.6436	600	127	20.8077	532.787	167.5	78	278	10.12031	2.056037	0.078585	365.2872604
shear1-43	6.25	48.61	326.7	148.79	22138.74	1787.3	39.568577	288.606	184.659	625	130	21.2993	534.818	165.5	80	280	10.1564	2.097126	0.08186	369.3180676
shear1-44	6.5	48.36	326.7	148.03	21911.61	1787.3	39.162623	285.8871	185.0806	650	131	21.4631	532.661	162.5	83	283	10.19275	2.105721	0.085134	370.1612525
shear1-45	6.75	48.11	326.7	147.26	21685.65	1787.3	38.758762	282.6881	186.2822	675	133	21.7908	531.064	158.5	87	287	10.22936	2.130218	0.088409	372.5643857
shear1-46	7	47.86	328.9	145.52	21174.72	1787.3	37.845574	279.9598	186.6897	700	134	21.9546	528.879	155.5	90	290	10.26624	2.138525	0.091683	373.3793515
shear1-47	7.25	47.61	328.9	144.76	20954.08	1787.3	37.451229	277.2277	187.0915	725	135	22.1185	526.683	152.5	93	293	10.30338	2.146718	0.094957	374.1830296
shear1-48	7.5	47.36	328.9	144.00	20734.60	1787.3	37.058949	276.4556	185.9334	750	134	21.9546	524.367	152.5	93	293	10.3408	2.123107	0.098232	371.8668111
shear1-49	7.75	47.11	326.4	144.33	20831.76	1787.3	37.2326	275.1386	182.4579	775	130	21.2993	518.416	153.5	92	292	10.37848	2.052252	0.101506	364.9158979
shear1-50	8	46.86	326.4	143.57	20611.25	1787.3	36.838482	273.8654	180.5481	800	128	20.9716	514.596	153.5	92	292	10.41644	2.013315	0.104781	361.096169
shear1-51	8.5	46.36	326.4	142.03	20173.75	1787.3	36.056537	273.3626	178.2939	850	126	20.6439	511.088	154.5	91	291	10.4932	1.967359	0.111329	356.5878957
shear1-52	9	45.86	320.8	142.96	20436.16	1787.3	36.525556	270.8749	176.0624	900	124	20.3162	505.625	153.5	92	292	10.5711	1.921863	0.117878	352.1247728
shear1-53	9.5	45.36	320.8	141.40	19992.97	1787.3	35.73344	271.4023	173.8534	950	122	19.9885	503.207	155.5	90	290	10.65017	1.876828	0.124427	347.7068003

Test apparatus : Triaxial
Sample No/part no : 7/ 2 from4
Location : Talingchan area, Bangkok
Depth : 15 - 15.7 m
Discription of soil : Clay

Boring No : 2
Date of test : 14 Feb 05
Tested by : Yono

a. Specimen data

Type of test performed : Consolidated Undrained
Diameter of specimen, Do : 3.83667 cm

Top	Middle	Botom	**Average**
3.85	3.84	3.82	3.8366667

Initial height of specimen : 7.8 cm
Initial area of specimen : 11.5552 cm^2
Volume of specimen : 90.1306 cm3
Mass of specimen 143.2 gr
Wet unit of specimen 1.58881 gr/cm3
Length tip to tip of bender element in sample : 6.62 cm

Water content of specimen

Can no	I	II	III
Mass of can	18	12.55	35.22
Mass of wet soil+can	39.44	46.2	54.9
Mass dry soil+can	31.29	33.73	47.49
Mass of water	8.15	12.47	7.41
Mass of dry soil	13.29	21.18	12.27
Water content	61.32	58.88	60.39
Average of water content	60.20		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
210	200	206	205	0.976190476

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm3)	Volume vhange (cm3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			57.9						1588.8	
50	50	50	55.1	2.8	20	65.39	878.1	74.47	1607.7	8.915
61.11	83.33	50	54.8	3.1	20	65.31	796.2	82.03	1609.8	10.83
100	136.364	81.818	53.6	4.3	20	64.96	685.1	94.82	1618.3	14.55
200	272.727	163.636	46.9	11	20	63.03	507	124.3	1670.7	25.82
300	409.091	245.455	40.9	17	20	61.3	398.2	153.9	1725.7	40.9
400	545.455	327.273	32.7	25.2	20	58.9	353.2	166.8	1817.3	50.54
500	681.818	409.091	24.8	33.1	20	56.48	306.3	184.4	1940.4	65.98

Table Analyses data of CU Triaxial test with final mean effective stress 500 kPa (Ko = 0.6)

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	$\sigma 1$ kPa	$\sigma 3$ kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain cm/cm	Deviator stress kPa
Consolidation																				
50		65.39	878.1	74.4676005	5545.42	1607.7	8.91538	50	0				50	50						0
61.11		65.31	796.2	82.02712886	6728.45	1609.8	10.8315	61.11	16.665				83.33	50						33.33
100		64.96	685.1	94.8182747	8990.51	1618.3	14.5493	100	27.273				136.364	81.818						54.546
200		63.03	507	124.3195266	15455.34	1670.7	25.8212	199.9997	54.5455				272.727	163.636						109.091
300		61.3	398.2	153.9427423	23698.37	1725.7	40.8963	300.0003	81.818				409.091	245.455						163.636
400		58.9	353.2	166.7610419	27809.25	1817.3	50.5377	400.0003	109.091				545.455	327.273						218.182
500		56.48	306.3	184.3943846	34001.29	1940.4	65.9761	500	136.3635				681.818	409.091						272.727
Shearing																				
shear1-0	0	56.48	306.3	184.3943846	34001.29	1940.4	65.9761	500	136.3635	0	0	0	681.818	409.091	0	200	8.5	0	0	272.727
shear1-1	0.02	56.46	306.3	184.3290891	33977.21	1940.4	65.9294	499.1507	141.08957	2	5	0.8192	687.2701	405.091	4	204	8.50218	0.096352	0.00025641	282.1791317
shear1-2	0.03	56.45	306.3	184.2964414	33965.18	1940.4	65.906	498.9307	146.75951	3	11	1.80224	694.61	401.091	8	208	8.50327	0.2119472	0.00038462	293.5190231
shear1-3	0.05	56.43	306.3	184.2311459	33941.12	1940.4	65.8593	499.3382	153.37079	5	18	2.94913	703.8326	397.091	12	212	8.505452	0.3467338	0.00064103	306.7415833
shear1-4	0.06	56.42	306.3	184.1984982	33929.09	1940.4	65.836	500.1157	159.03698	6	24	3.93217	712.165	394.091	15	215	8.506543	0.4622524	0.00076923	318.0739595
shear1-5	0.08	56.4	306.3	184.1332027	33905.04	1940.4	65.7893	499.6304	162.80911	8	28	4.58753	716.7092	391.091	18	218	8.508727	0.5391561	0.00102564	325.6182103
shear1-6	0.1	56.38	306.3	184.0679073	33880.99	1940.4	65.7427	499.1439	166.57929	10	32	5.24289	721.2496	388.091	21	221	8.510911	0.6160202	0.00128205	333.1585824
shear1-7	0.12	56.36	306.3	184.0026118	33856.96	1940.4	65.696	499.0267	169.40354	12	35	5.73441	724.8981	386.091	23	223	8.513097	0.6735991	0.00153846	338.8070735
shear1-8	0.13	56.35	306.3	183.9699641	33844.95	1940.4	65.6727	498.2824	171.28705	13	37	6.0621	726.6651	384.091	25	225	8.51419	0.7119991	0.00166667	342.574108
shear1-9	0.15	56.33	306.3	183.9046686	33820.93	1940.4	65.6261	498.1637	174.109	15	40	6.55362	730.309	382.091	27	227	8.516378	0.769531	0.00192308	348.217993
shear1-10	0.17	56.31	306.3	183.8393732	33796.92	1940.4	65.5795	498.044	176.92948	17	43	7.04514	733.95	380.091	29	229	8.518566	0.8270333	0.00217949	353.858969
shear1-11	0.19	56.29	306.3	183.7740777	33772.91	1940.4	65.533	498.9233	179.74852	19	46	7.53666	738.588	379.091	30	230	8.520756	0.884506	0.0024359	359.4970359
shear1-12	0.22	56.26	306.3	183.6761345	33736.92	1940.4	65.4631	498.7978	182.56016	22	49	8.02818	742.2113	377.091	32	232	8.524042	0.9418279	0.00282051	365.1203149
shear1-13	0.25	56.23	304.1	184.9062808	34190.33	1940.4	66.3429	499.6707	185.36962	25	52	8.5197	746.8302	376.091	33	233	8.527331	0.9991053	0.00320513	370.7392302
shear1-14	0.28	56.2	304.1	184.8076291	34153.86	1940.4	66.2721	499.5423	188.17689	28	55	9.01122	750.4448	374.091	35	235	8.530623	1.0563382	0.00358974	376.3537819
shear1-15	0.3	56.18	304.1	184.7418612	34129.56	1940.4	66.225	499.7891	190.0472	30	57	9.3389	753.1854	373.091	36	236	8.532819	1.0944688	0.00384615	380.0943921
shear1-16	0.32	56.16	304.1	184.6760934	34105.26	1940.4	66.1778	499.4076	190.97495	32	58	9.50274	754.0409	372.091	37	237	8.535015	1.1133834	0.00410256	381.9499093
shear1-17	0.35	56.13	304.1	184.5774416	34068.83	1940.4	66.1072	498.6485	192.83629	35	60	9.83043	755.7636	370.091	39	239	8.538313	1.1513311	0.00448718	385.6725801
shear1-18	0.4	56.08	304.1	184.413022	34008.16	1940.4	65.9894	498.8784	194.68114	40	62	10.1581	758.4533	369.091	40	240	8.543814	1.1889427	0.00512821	389.3622812
shear1-19	0.45	56.03	304.1	184.2486024	33947.55	1940.4	65.8718	498.48	195.58357	45	63	10.3219	759.2581	368.091	41	241	8.549323	1.2073408	0.00576923	391.1671317
shear1-20	0.5	55.98	304.1	184.0841828	33886.99	1940.4	65.7543	498.7071	197.42417	50	65	10.6496	761.9393	367.091	42	242	8.554839	1.2448659	0.00641026	394.8483479
shear1-21	0.55	55.93	304.1	183.9197632	33826.48	1940.4	65.6369	498.2455	199.73175	55	67.5	11.0592	764.5545	365.091	44	244	8.560362	1.2919114	0.00705128	399.4635046
shear1-22	0.6	55.88	304.1	183.7553436	33766.03	1940.4	65.5196	498.7819	202.0363	60	70	11.4688	768.1636	364.091	45	245	8.565891	1.338895	0.00769231	404.0726006
shear1-23	0.65	55.83	304.1	183.590924	33705.63	1940.4	65.4024	499.0037	203.86903	65	72	11.7965	770.8291	363.091	46	246	8.571429	1.3762595	0.00833333	407.7380592
shear1-24	0.7	55.78	302.3	184.51869	34047.15	1940.4	66.0651	500.2239	205.69933	70	74	12.1242	774.4897	363.091	46	246	8.576973	1.4135746	0.00897436	411.3986694
shear1-25	0.75	55.73	302.3	184.3532914	33986.14	1940.4	65.9467	500.0667	208.46358	75	77	12.6157	778.0182	361.091	48	248	8.582524	1.4699303	0.00961538	416.9271604
shear1-26	0.8	55.68	302.3	184.1878928	33925.18	1940.4	65.8284	499.9071	211.22419	80	80	13.1072	781.5394	359.091	50	250	8.588083	1.5262118	0.01025641	422.4483786
shear1-27	0.85	55.63	302.3	184.0224942	33864.28	1940.4	65.7102	499.1217	213.04601	85	82	13.4349	783.183	357.091	52	252	8.593649	1.5633539	0.01089744	426.092019
shear1-28	0.9	55.58	302.3	183.8570956	33803.43	1940.4	65.5922	499.3346	214.86541	90	84	13.7626	785.8218	356.091	53	253	8.599222	1.6004466	0.01153846	429.730811
shear1-29	1	55.48	302.3	183.5262984	33681.90	1940.4	65.3564	499.7556	218.49692	100	88	14.418	791.0848	354.091	55	255	8.61039	1.6744837	0.01282051	436.9938493
shear1-30	1.05	55.43	302.3	183.3608998	33621.22	1940.4	65.2386	498.9637	220.30905	105	90	14.7456	792.7091	352.091	57	257	8.615984	1.7114281	0.01346154	440.6180958
shear1-31	1.1	55.38	302.3	183.1955012	33560.59	1940.4	65.121	498.1702	222.11875	110	92	15.0733	794.3285	350.091	59	259	8.621586	1.7483231	0.01410256	444.2374938
shear1-32	1.2	55.28	302.3	182.8647039	33439.50	1940.4	64.886	499.1989	226.66178	120	97	15.8925	801.4146	348.091	61	261	8.632813	1.8409436	0.01538462	453.3235645
shear1-33	1.3	55.18	296.6	186.0418071	34611.55	1940.4	67.1603	500.2195	231.1927	130	102	16.7117	808.4764	346.091	63	263	8.644068	1.9333169	0.01666667	462.3853927
shear1-34	1.4	55.08	296.6	185.7046527	34486.22	1940.4	66.9171	501.232	235.71149	140	107	17.5309	815.514	344.091	65	265	8.655352	2.0254432	0.01794872	471.4229785
shear1-35	1.5	54.98	296.6	185.3674983	34361.11	1940.4	66.6743	501.6183	239.29089	150	111	18.1863	820.6728	342.091	67	267	8.666667	2.0984177	0.01923077	478.5817744

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain cm/cm	Deviator stress kPa
shear1-79	7	49.48	274.4	180.3206997	32515.55	1940.4	63.0932	492.4507	357.5395	700	257	42.107	969.17	254.091	155	355	9.338028	4.5091948	0.08974359	715.0790071
shear1-80	7.15	49.33	274.4	179.7740525	32318.71	1940.4	62.7112	491.4293	360.50739	715	261	42.7623	972.1058	251.091	158	358	9.357798	4.5697021	0.09166667	721.0147712
shear1-81	7.3	49.18	274.4	179.2274052	32122.46	1940.4	62.3304	491.3981	363.46072	730	265	43.4177	976.0124	249.091	160	360	9.377652	4.6299128	0.09358974	726.9214445
shear1-82	7.5	48.98	274.4	178.4985423	31861.73	1940.4	61.8245	491.8184	367.09103	750	270	44.2369	981.2731	247.091	162	362	9.404255	4.7039252	0.09615385	734.1820586
shear1-83	7.7	48.78	274.4	177.7696793	31602.06	1940.4	61.3206	489.6543	369.84497	770	274	44.8923	982.7809	243.091	166	366	9.43101	4.7600708	0.09871795	739.6899435
shear1-84	7.9	48.58	268	181.2686567	32858.33	1940.4	63.7583	489.4773	372.57952	790	278	45.5476	986.25	241.091	168	368	9.457917	4.815821	0.10128205	745.1590405
shear1-85	8.2	48.28	268	180.1492537	32453.75	1940.4	62.9733	490.7517	377.49104	820	285	46.6945	994.0731	239.091	170	370	9.498567	4.9159539	0.10512821	754.9820817
shear1-86	8.5	47.98	268	179.0298507	32051.69	1940.4	62.1931	489.8689	380.6668	850	290	47.5137	997.4246	236.091	173	373	9.539568	4.9806993	0.10897436	761.333604
shear1-87	8.75	47.73	263.4	181.2072893	32836.08	1940.4	63.7151	488.9618	382.3062	875	293	48.0052	998.7034	234.091	175	375	9.574007	5.0141223	0.11217949	764.6123955
shear1-88	9	47.48	263.4	180.2581625	32493.01	1940.4	63.0494	487.6002	384.76378	900	297	48.6606	1000.619	231.091	178	378	9.608696	5.0642258	0.11538462	769.5275525
shear1-89	9.25	47.23	263.4	179.3090357	32151.73	1940.4	62.3872	487.2224	387.19711	925	301	49.316	1003.485	229.091	180	380	9.643636	5.1138351	0.11858974	774.3942245
shear1-90	9.5	46.98	263.4	178.3599089	31812.26	1940.4	61.7285	486.8285	389.60621	950	305	49.9713	1006.303	227.091	182	382	9.678832	5.1629502	0.12179487	779.2124117
shear1-91	9.7	46.78	260	179.9230769	32372.31	1940.4	62.8152	485.9913	391.35045	970	308	50.4628	1007.792	225.091	184	384	9.707174	5.1985107	0.12435897	782.7009004
shear1-92	9.9	46.58	260	179.1538462	32096.10	1940.4	62.2793	486.6947	393.9056	990	312	51.1182	1011.902	224.091	185	385	9.735683	5.2506036	0.12692308	787.8112092
shear1-93	10.1	46.38	260	178.3846154	31821.07	1940.4	61.7456	484.3852	396.44136	1010	316	51.7736	1012.974	220.091	189	389	9.764359	5.302301	0.12948718	792.8827299
shear1-94	10.3	46.18	260	177.6153846	31547.22	1940.4	61.2142	483.5157	398.13712	1030	319	52.2651	1014.365	218.091	191	391	9.793205	5.3368731	0.13205128	796.2742489
shear1-95	10.5	45.98	260	176.8461538	31274.56	1940.4	60.6852	482.6366	399.81834	1050	322	52.7566	1015.728	216.091	193	393	9.822222	5.3711486	0.13461538	799.6366769
shear1-96	10.75	45.73	255.6	178.9123631	32009.63	1940.4	62.1115	482.1598	402.10319	1075	326	53.412	1018.297	214.091	195	395	9.858736	5.4177307	0.13782051	804.2063789
shear1-97	11	45.48	255.6	177.9342723	31660.61	1940.4	61.4342	481.6669	404.3638	1100	330	54.0673	1020.819	212.091	197	397	9.895522	5.4638185	0.14102564	808.7275961
shear1-98	11.3	45.18	255.6	176.7605634	31244.30	1940.4	60.6264	480.5618	407.20623	1130	335	54.8865	1023.503	209.091	200	400	9.94003	5.5217681	0.14487179	814.4124509
shear1-99	11.6	44.88	251.2	178.6624204	31920.26	1940.4	61.9381	478.4325	410.01229	1160	340	55.7057	1025.116	205.091	204	404	9.98494	5.5789763	0.14871795	820.0245783
shear1-100	12	44.48	251.2	177.0700637	31353.81	1940.4	60.8389	475.4669	411.56381	1200	344	56.3611	1024.219	201.091	208	408	10.04545	5.6106077	0.15384615	823.1276121
shear1-101	12.25	44.23	251.2	176.0748408	31002.35	1940.4	60.157	474.3032	411.31835	1225	345	56.5249	1022.728	200.091	209	409	10.08365	5.6056035	0.15705128	822.6367024
shear1-102	12.5	43.98	251.2	175.0796178	30652.87	1940.4	59.4788	472.6063	410.2729	1250	345	56.5249	1019.637	199.091	210	410	10.12214	5.5842894	0.16025641	820.545791
shear1-103	13	43.48	248.4	175.0402576	30639.09	1940.4	59.4521	467.5861	404.24259	1300	340	55.7057	1006.576	198.091	211	411	10.2	5.4613473	0.16666667	808.4851715
shear1-104	13.3	43.18	248.4	173.8325282	30217.75	1940.4	58.6345	465.239	402.22198	1330	339	55.5419	1001.535	197.091	212	412	10.2473	5.4201524	0.17051282	804.4439549
shear1-105	13.6	42.88	250.3	171.3144227	29348.63	1940.4	56.9481	464.856	398.64743	1360	336	55.0504	996.3859	199.091	210	410	10.29503	5.3472768	0.17435897	797.2948561
shear1-106	13.9	42.58	250.3	170.115861	28939.41	1940.4	56.154	462.9695	394.31773	1390	332	54.395	988.7265	200.091	209	409	10.34321	5.2590056	0.17820513	788.6354525
shear1-107	14.15	42.33	250.3	169.1170595	28600.58	1940.4	55.4966	461.7828	392.53772	1415	331	54.2312	985.1664	200.091	209	409	10.38371	5.2227161	0.18141026	785.0754485
shear1-108	14.3	42.18	250.3	168.5177787	28398.24	1940.4	55.1039	460.8374	389.61954	1430	328	53.7397	980.3301	201.091	208	408	10.40816	5.163222	0.18333333	779.2390784
shear1-109	14.5	41.98	248.3	169.0696738	28584.55	1940.4	55.4655	460.2547	385.7456	1450	324	53.0843	974.5822	203.091	206	406	10.44094	5.0842425	0.18589744	771.491191
shear1-110	14.75	41.73	248.3	168.0628272	28245.11	1940.4	54.8068	461.0668	382.46377	1475	321	52.5928	971.0185	206.091	203	403	10.48221	5.0173348	0.18910256	764.9275473
shear1-111	15	41.48	248.3	167.0559807	27907.70	1940.4	54.1521	462.8911	379.20013	1500	318	52.1013	968.4913	210.091	199	399	10.52381	4.9507978	0.19230769	758.4002674
shear1-112	15.25	41.23	245.8	167.7379984	28136.04	1940.4	54.5952	462.7133	374.43346	1525	313	51.2821	961.9579	213.091	196	396	10.56574	4.853618	0.19551282	748.8669234
shear1-113	15.5	40.98	245.8	166.7209113	27795.86	1940.4	53.9351	464.5658	371.21225	1550	310	50.7905	959.5155	217.091	192	392	10.608	4.7879459	0.19871795	742.424492
shear1-114	15.75	40.73	245.8	165.7038242	27457.76	1940.4	53.279	466.9335	368.76376	1575	308	50.4628	958.6185	221.091	188	388	10.6506	4.7380277	0.20192308	737.5275169

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 $(m/s)^2$	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress ksc	strain cm/cm	Deviator stress kPa
shear1-36	1.6	54.88	296.6	185.0303439	34236.23	1940.4	66.432	500.9981	242.86059	160	115	18.8416	824.8122	339.091	70	270	8.67801	2.1711945	0.02051282	485.7211763
shear1-37	1.7	54.78	296.6	184.6931895	34111.57	1940.4	66.1901	500.0631	245.95817	170	118.5	19.4151	828.0073	336.091	73	273	8.689384	2.2343459	0.02179487	491.9163347
shear1-38	1.8	54.68	296.6	184.3560351	33987.15	1940.4	65.9487	500.1225	249.04726	180	122	19.9885	832.1855	334.091	75	275	8.700787	2.2973244	0.02307692	498.0945233
shear1-39	1.9	54.58	296.6	184.0188806	33862.95	1940.4	65.7077	498.8688	251.66666	190	125	20.4801	834.4243	331.091	78	278	8.712221	2.350727	0.02435897	503.333317
shear1-40	2	54.48	296.6	183.6817262	33738.98	1940.4	65.4671	499.2243	255.2	200	129	21.1354	839.491	329.091	80	280	8.723684	2.4227624	0.02564103	510.3999916
shear1-41	2.1	54.38	293.5	185.2810903	34329.08	1940.4	66.6122	498.9601	257.80364	210	132	21.6269	842.6983	327.091	82	282	8.735178	2.4758437	0.02692308	515.6072701
shear1-42	2.2	54.28	293.5	184.9403748	34202.94	1940.4	66.3674	499.691	260.4	220	135	22.1185	846.891	326.091	83	283	8.746702	2.5287768	0.02820513	520.8000031
shear1-43	2.28	54.2	293.5	184.6678024	34102.20	1940.4	66.1719	499.1334	262.56364	228	137.5	22.5281	849.2183	324.091	85	285	8.755943	2.5728877	0.02923077	525.1272807
shear1-44	2.35	54.13	293.5	184.4293015	34014.17	1940.4	66.0011	498.5839	264.7394	235	140	22.9377	851.5698	322.091	87	287	8.764045	2.6172457	0.03012821	529.4788007
shear1-45	2.4	54.08	293.5	184.2589438	33951.36	1940.4	65.8792	499.3601	267.40365	240	143	23.4292	855.8983	321.091	88	288	8.769841	2.6715626	0.03076923	534.8072914
shear1-46	2.45	54.03	293.5	184.088586	33888.61	1940.4	65.7575	498.5233	269.1485	245	145	23.7569	857.388	319.091	90	290	8.775645	2.7071355	0.03141026	538.2969923
shear1-47	2.5	53.98	293.5	183.9182283	33825.91	1940.4	65.6358	497.6849	270.89092	250	147	24.0845	858.8728	317.091	92	292	8.781457	2.742659	0.03205128	541.7818447
shear1-48	2.6	53.88	293.5	183.5775128	33700.70	1940.4	65.3928	497.7847	272.54062	260	149	24.4122	861.1722	316.091	93	293	8.793103	2.776292	0.03333333	545.0812423
shear1-49	2.7	53.78	293.5	183.2367973	33575.72	1940.4	65.1503	497.4898	275.0982	270	152	24.9037	864.2874	314.091	95	295	8.804781	2.8284342	0.03461538	550.1963995
shear1-50	2.8	53.68	293.5	182.8960818	33450.98	1940.4	64.9083	498.19	277.64851	280	155	25.3953	868.388	313.091	96	296	8.816489	2.8804282	0.03589744	555.2970112
shear1-51	2.9	53.58	293.5	182.5553663	33326.46	1940.4	64.6667	497.8854	280.19154	290	158	25.8868	871.4741	311.091	98	298	8.828229	2.932274	0.03717949	560.3830775
shear1-52	3	53.48	293.5	182.2146508	33202.18	1940.4	64.4255	497.5759	282.7273	300	161	26.3783	874.5456	309.091	100	300	8.84	2.9839714	0.03846154	565.4545983
shear1-53	3.1	53.38	293.5	181.8739353	33078.13	1940.4	64.1848	497.2615	285.25579	310	164	26.8698	877.6026	307.091	102	302	8.851802	3.0355206	0.03974359	570.5115736
shear1-54	3.2	53.28	293.5	181.5332198	32954.31	1940.4	63.9445	496.9423	287.777	320	167	27.3614	880.645	305.091	104	304	8.863636	3.0869215	0.04102564	575.5540034
shear1-55	3.25	53.23	293.5	181.362862	32892.49	1940.4	63.8246	497.291	291.30004	325	171	28.0167	885.6911	303.091	106	306	8.869565	3.1587469	0.04166667	582.6000719
shear1-56	3.3	53.18	293.5	181.1925043	32830.72	1940.4	63.7047	495.8256	292.10186	330	172	28.1806	885.2947	301.091	108	308	8.875502	3.1750939	0.04230769	584.20371
shear1-57	3.4	53.08	293.5	180.8517888	32707.37	1940.4	63.4654	496.4951	294.6061	340	175	28.6721	889.3032	300.091	109	309	8.887399	3.2261488	0.04358974	589.2122004
shear1-58	3.5	52.98	293.5	180.5110733	32584.25	1940.4	63.2265	496.1597	297.10307	350	178	29.1636	892.2971	298.091	111	311	8.899329	3.2770555	0.04487179	594.2061454
shear1-59	3.6	52.88	293.5	180.1703578	32461.36	1940.4	62.988	495.8195	299.59277	360	181	29.6551	895.2765	296.091	113	313	8.91129	3.3278139	0.04615385	599.1855449
shear1-60	3.75	52.73	293.5	179.6592845	32277.46	1940.4	62.6312	496.0001	302.86369	375	185	30.3105	899.8184	294.091	115	315	8.929293	3.3944992	0.04807692	605.7273703
shear1-61	3.9	52.58	289.8	181.4354727	32918.83	1940.4	63.8757	496.7698	307.01824	390	190	31.1297	906.1275	292.091	117	317	8.947368	3.4791995	0.05	614.0364705
shear1-62	4	52.48	289.8	181.0904072	32793.74	1940.4	63.633	496.1112	309.03036	400	192.5	31.5393	908.1517	290.091	119	319	8.959459	3.5202214	0.05128205	618.0607174
shear1-63	4.1	52.38	289.8	180.7453416	32668.88	1940.4	63.3907	495.4486	311.03642	410	195	31.9489	910.1638	288.091	121	321	8.971583	3.5611197	0.0525641	622.072843
shear1-64	4.25	52.23	288	181.3541667	32889.33	1940.4	63.8185	495.5961	314.25764	425	199	32.6042	914.6063	286.091	123	323	8.989831	3.6267918	0.05448718	628.5152744
shear1-65	4.4	52.08	288	180.8333333	32700.69	1940.4	63.4524	494.1391	316.57219	440	202	33.0958	916.2354	283.091	126	326	9.008152	3.6739793	0.05641026	633.1443705
shear1-66	4.75	51.73	288	179.6180556	32262.65	1940.4	62.6024	495.7112	321.93037	475	209	34.2426	924.9517	281.091	128	328	9.051195	3.7832186	0.06089744	643.860746
shear1-67	4.9	51.58	284.9	181.045981	32777.65	1940.4	63.6017	495.23	324.20856	490	212	34.7342	927.5081	279.091	130	330	9.069767	3.8296648	0.06282051	648.4171148
shear1-68	5.1	51.38	284.9	180.3439803	32523.95	1940.4	63.1095	495.2438	327.22917	510	216	35.3895	931.5493	277.091	132	332	9.09465	3.891247	0.06538462	654.4583336
shear1-69	5.2	51.28	284.9	179.99298	32397.47	1940.4	62.8641	494.2458	328.7322	520	218	35.7172	932.5554	275.091	134	334	9.107143	3.9218899	0.06666667	657.4643975
shear1-70	5.4	51.08	284.9	179.2909793	32145.26	1940.4	62.3747	493.6535	330.84372	540	221	36.2087	934.7784	273.091	136	336	9.132231	3.9649382	0.06923077	661.6874325
shear1-71	5.6	50.88	280.2	181.5845824	32972.96	1940.4	63.9807	494.2216	334.69584	560	226	37.0279	940.4827	271.091	138	338	9.157459	4.0434728	0.07179487	669.3916835
shear1-72	5.75	50.73	280.2	181.0492505	32778.83	1940.4	63.604	494.283	337.78797	575	230	37.6833	944.6669	269.091	140	340	9.176471	4.1065131	0.07371795	675.5759328
shear1-73	5.9	50.58	280.2	180.5139186	32585.27	1940.4	63.2285	494.3347	340.86555	590	234	38.3387	948.8221	267.091	142	342	9.195562	4.1692568	0.07564103	681.7310912
shear1-74	6.1	50.38	280.2	179.8001428	32328.09	1940.4	62.7294	493.9901	343.34858	610	237.5	38.9121	951.7882	265.091	144	344	9.22114	4.2198793	0.07820513	686.6971573
shear1-75	6.3	50.18	277.7	180.6985956	32651.98	1940.4	63.3579	494.6341	345.81464	630	241	39.4855	955.7203	264.091	145	345	9.246862	4.2701558	0.08076923	691.629284
shear1-76	6.5	49.98	277.7	179.978394	32392.22	1940.4	62.8539	494.5557	348.69707	650	245	40.1409	959.4851	262.091	147	347	9.272727	4.3289209	0.08333333	697.3941389
shear1-77	6.7	49.78	277.7	179.2581923	32133.50	1940.4	62.3518	494.6167	353.28859	670	251	41.1239	965.6682	259.091	150	350	9.298738	4.4225299	0.08589744	706.5771794
shear1-78	6.8	49.68	274.4	181.0495627	32778.94	1940.4	63.6043	494.14	355.57344	680	254	41.6155	968.2379	257.091	152	352	9.311798	4.4691119	0.08717949	711.1468815

Test apparatus : Triaxial
Sample/part No : 4 /3 from 3
Location : Talingchan area, Bangkok
Depth : 10.5 - 11.2 m
Discription of soil : Clay

Boring No : 2
Date of test : 21 Dec 04
Tested by : Yono

a. Specimen data

Type of test performed : Consolidated Undrained
Diameter of specimen, Do : 3.79 cm

Top	Middle	Botom	Average
3.782	3.8	3.79	3.79

Initial height of specimen : 7.75 cm
Initial area of specimen : 11.2798 cm^2
Volume of specimen : 87.4183 cm3
Mass of specimen 138.73 gr
Wet unit of specimen 1.58697 gr/cm3
Length tip to tip of bender element in sample : 6.21 cm

Water content of specimen

Can no	I	II	III
Mass of can	37.21	40.12	76.47
Mass of wet soil+can	71.92	68.31	112.33
Mass dry soil+can	59.17	57.64	98.97
Mass of water	12.75	10.67	13.36
Mass of dry soil	21.96	17.52	22.5
Water content	58.06	60.90	59.38
Average of water content		59.45	

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
210	200	205	204	0.971428571

c. Consolidation step

Consolidation	σv' kPa	σh' kPa	Vol. change reading (cm3)	Volume vhange (cm3)	Voltage (volt)	Length of sample (mm)	time int. Δt *10⁻⁶sec	Vs m/s	ρt kg/m3	G Mpa
			44.1						1587.0	
25	25	25	42.3	1.8	20	61.57	1014	60.72	1599.3	5.8965
44.4	83.333	25	41.4	2.7	20	61.3	848.1	72.279	1605.7	8.3886
50	93.75	28.125	41.1	3	20	61.21	820.3	74.619	1607.8	8.9522
75	140.625	42.188	39.6	4.5	20	60.77	679.3	89.46	1618.8	12.955
100	187.5	56.25	38.3	5.8	20	60.39	635.1	95.087	1628.7	14.726

Table Analyses data of CU Triaxial test with final mean effective stress 100 kPa (Ko = 0.3)

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 (m/s)^2	ρ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress [illegible]	strain [illegible]	Deviator stress kPa
conso25		61.57	1014	60.720	3686.91	1599.3	5.896	25	0				25.00	25.00						0.000
conso44.4		61.3	848.1	72.279	5224.28	1605.7	8.389	44	29				83.33	25.00						58.330
cnso50		61.21	820.3	74.619	5568.00	1607.8	8.952	50	33				93.75	28.13						65.620
conso75		60.77	679.3	89.460	8003.04	1618.8	12.955	75	49				140.63	42.19						98.440
conso100		60.39	635.1	95.087	9041.61	1628.7	14.726	100	66				187.50	56.25						131.260
Shearing																				
shear1-0	0	60.39	635.1	95.087	9041.61	1628.7	14.726	100	66	0	0	0.000	187.50	56.25	0	200	10.773	0.0000	0.00000	131.250
shear1-1	0.01	60.38	635.1	95.072	9038.62	1628.7	14.721	99.989	68.609	1	4	0.655	191.47	54.25	2	202	10.774	0.0608	0.00013	137.217
shear1-2	0.03	60.36	635.1	95.040	9032.63	1628.7	14.711	99.983	70.099	3	6	0.983	193.45	53.25	3	203	10.777	0.0912	0.00039	140.198
shear1-3	0.04	60.35	635.1	95.024	9029.64	1628.7	14.707	99.976	71.590	4	8	1.311	195.43	52.25	4	204	10.779	0.1216	0.00052	143.179
shear1-4	0.06	60.33	635.1	94.993	9023.65	1628.7	14.697	99.466	73.824	6	11	1.802	197.90	50.25	6	206	10.781	0.1672	0.00077	147.649
shear1-5	0.08	60.31	635.1	94.961	9017.67	1628.7	14.687	99.458	75.313	8	13	2.130	199.88	49.25	7	207	10.784	0.1975	0.00103	150.626
shear1-6	0.11	60.28	635.1	94.914	9008.70	1628.7	14.672	98.953	76.054	11	14	2.294	200.36	48.25	8	208	10.788	0.2126	0.00142	152.108
shear1-7	0.14	60.25	635.1	94.867	8999.74	1628.7	14.656	98.439	78.284	14	17	2.765	202.82	46.25	10	210	10.792	0.2581	0.00181	156.567
shear1-8	0.16	60.23	638.8	94.288	8869.88	1628.7	14.479	98.429	79.769	16	19	3.113	204.79	45.25	11	211	10.795	0.2864	0.00206	159.538
shear1-9	0.19	60.2	638.8	94.239	8881.03	1628.7	14.465	97.922	80.506	19	20	3.277	205.27	44.25	12	212	10.799	0.3034	0.00245	161.016
shear1-10	0.22	60.17	638.8	94.192	8872.18	1628.7	14.450	97.414	81.246	22	21	3.441	206.74	43.25	13	213	10.804	0.3185	0.00284	162.492
shear1-11	0.25	60.14	638.8	94.145	8863.33	1628.7	14.436	96.401	82.727	25	23	3.768	206.70	41.25	15	215	10.808	0.3487	0.00323	165.454
shear1-12	0.3	60.09	638.8	94.067	8848.60	1628.7	14.412	96.137	83.631	30	24.5	4.014	207.91	40.25	16	216	10.815	0.3712	0.00387	167.661
shear1-13	0.4	59.99	638.8	93.910	8819.17	1628.7	14.364	95.369	84.178	40	25	4.096	207.61	39.25	17	217	10.829	0.3782	0.00516	168.356
shear1-14	0.5	59.89	638.8	93.754	8789.80	1628.7	14.316	94.847	84.895	50	26	4.260	208.04	38.25	18	218	10.843	0.3929	0.00645	169.790
shear1-15	0.65	59.74	638.8	93.519	8746.82	1628.7	14.244	94.822	84.858	65	26	4.260	207.97	38.25	18	218	10.864	0.3921	0.00839	169.715
shear1-16	0.8	59.59	638.8	93.284	8701.96	1628.7	14.173	93.797	84.820	80	26	4.260	206.89	37.25	19	219	10.886	0.3913	0.01032	169.640
shear1-17	1	59.39	638.8	92.971	8643.64	1628.7	14.078	93.254	85.506	100	27	4.424	207.26	36.25	20	220	10.914	0.4053	0.01290	171.013
shear1-18	1.25	59.14	638.8	92.560	8571.03	1628.7	13.960	92.211	85.441	125	27	4.424	206.13	35.25	21	221	10.950	0.4040	0.01613	170.883
shear1-19	1.5	58.89	635.9	92.609	8576.41	1628.7	13.968	91.168	85.376	150	27	4.424	205.00	34.25	22	222	10.988	0.4027	0.01935	170.753
shear1-20	1.8	58.59	635.9	92.137	8489.25	1628.7	13.826	91.601	86.027	180	28	4.588	206.30	34.25	22	222	11.029	0.4159	0.02323	172.054
shear1-21	2.2	58.19	635.9	91.508	8373.73	1628.7	13.638	90.530	85.919	220	28	4.588	205.09	33.25	23	223	11.088	0.4137	0.02839	171.839
shear1-22	2.5	57.89	635.9	91.036	8287.81	1628.7	13.498	89.994	85.117	250	27	4.424	203.48	33.25	23	223	11.132	0.3974	0.03226	170.233
shear1-23	2.75	57.64	635.9	90.643	8216.19	1628.7	13.382	88.471	84.332	275	26	4.260	200.91	32.25	24	224	11.169	0.3614	0.03548	168.664
shear1-24	3	57.39	632.1	90.793	8243.30	1628.7	13.426	87.952	83.552	300	25	4.096	199.35	32.25	24	224	11.207	0.3655	0.03871	167.105
shear1-25	3.25	57.14	632.1	90.397	8171.63	1628.7	13.309	87.435	82.778	325	24	3.932	197.81	32.25	24	224	11.246	0.3497	0.04194	165.556
shear1-26	3.5	56.89	621.7	91.507	8373.56	1628.7	13.638	87.397	82.720	350	24	3.932	197.69	32.25	24	224	11.283	0.3485	0.04516	165.440
shear1-27	3.75	56.64	621.7	91.105	8300.13	1628.7	13.518	87.358	82.662	375	24	3.932	197.57	32.25	24	224	11.321	0.3473	0.04839	165.324
shear1-28	4	56.39	621.7	90.703	8227.02	1628.7	13.399	87.848	81.897	400	23	3.768	197.04	33.25	23	223	11.359	0.3317	0.05161	163.794
shear1-29	4.25	56.14	621.7	90.301	8154.23	1628.7	13.281	87.811	81.842	425	23	3.768	196.93	33.25	23	223	11.398	0.3306	0.05484	163.683
shear1-30	4.5	55.89	621.7	89.899	8081.77	1628.7	13.163	87.306	81.083	450	22	3.604	195.42	33.25	23	223	11.437	0.3152	0.05806	162.167
shear1-31	4.75	55.64	615.9	90.339	8161.20	1628.7	13.292	87.270	81.031	475	22	3.604	195.31	33.25	23	223	11.476	0.3141	0.06129	162.061
shear1-32	5	55.39	615.9	89.933	8088.02	1628.7	13.173	85.770	80.280	500	21	3.441	192.81	32.25	24	224	11.516	0.2988	0.06452	160.560
shear1-33	5.25	55.14	615.9	89.526	8015.18	1628.7	13.054	86.273	79.534	525	20	3.277	192.32	33.25	23	223	11.556	0.2836	0.06774	159.068
shear1-34	5.5	54.89	615.9	89.122	7942.86	1628.7	12.936	86.240	79.486	550	20	3.277	192.22	33.25	23	223	11.596	0.2826	0.07097	158.971
shear1-35	6	54.39	615.9	88.310	7798.62	1628.7	12.702	86.717	78.701	600	19	3.113	191.65	34.25	22	222	11.677	0.2666	0.07742	157.402

Test apparatus	: Triaxial		
Sample/part No	: 6/ 2 from3	Boring No	: 2
Location	: Talingchan area, Bangkok	Date of test	: 20 Jan 05
Depth	: 13.5 - 14.2 m	Tested by	: Yono
Discription of soil	: Clay		

a. Specimen data

Type of test performed : Consolidated Undrained

Diameter of specimen, Do : 3.49333 cm

Top	Middle	Botom	Average
3.48	3.5	3.5	3.4933333

Initial height of specimen : 7.72 cm

Initial area of specimen : 9.57965 cm^2

Volume of specimen : 73.9549 cm3

Mass of specimen 118.45 gr

Wet unit of specimen 1.602 gr/cm3

Length tip to tip of bender element in sample : 61.8 cm

Water content of specimen

Can no	I	II	III
Mass of can	35.01	35.83	36.85
Mass of wet soil+can	65.07	68.71	70.62
Mass dry soil+can	53.7	56.59	57.77
Mass of water	11.37	12.12	12.85
Mass of dry soil	18.69	20.76	21.12
Water content	60.83	58.38	60.84
Average of water content	60.02		

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
210	200	207	206	0.980952381

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm3)	Volume vhange (cm3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			34.6						1601.7	
25	25	25	33	1.6	20	61.24	1007	60.814	1615.0	5.9729
44.4	83.33	25	31	3.6	20	60.55	961.5	62.975	1632.4	6.4738
50	93.175	28.125	30.3	4.3	20	60.3	895.5	67.337	1638.8	7.4307
100	187.5	56.25	28.4	6.2	20	59.64	634.3	94.025	1656.7	14.646
150	281.25	84.375	25.3	9.3	20	58.56	545.7	107.31	1688.2	19.441
200	375	112.5	21.2	13.4	20	57.14	462.9	123.44	1734.8	26.434
250	468.75	140.625	18.2	16.5	20	56.06	388.9	144.15	1774.4	36.871
300	562.5	168.75	15.4	19.2	20	55.12	357.5	154.18	1812.6	43.089

Table Analyses data of CU Triaxial test with final mean effective stress 300 kPa (Ko = 0,3)

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 (m/s)^2	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm2	stress	strain	Deviator stress kPa
consol 25		61.24	1007	60.814	3698.38	1615.0	5.973	25	0.0				25	25						0.000
consol44.4		60.55	961.5	62.975	3965.79	1632.4	6.474	44	29.2				83.33	25						58.330
conso50		60.3	895.5	67.337	4534.23	1638.8	7.431	50	32.5				93.175	28.125						65.050
conso100		59.64	634.3	94.026	8840.68	1656.7	14.646	100	65.6				187.5	56.25						131.250
conso150		58.56	545.7	107.312	11515.60	1688.2	19.441	150	98.4				281.25	84.375						196.875
conso200		57.14	462.9	123.439	15237.23	1734.8	26.434	200	131.3				375	112.5						262.500
conso250		56.06	388.9	144.150	20779.27	1774.4	36.871	250	164.1				468.75	140.625						328.125
conso300		55.12	357.5	154.182	23772.03	1812.6	43.089	300	196.9				562.5	168.75						393.750
Shearing																				
shear1-0	0	55.12	357.5	154.1818182	23772.03	1812.6	43.089	300	196.9	0	0	0	562.5	168.75	0	200	7.8332	0	0	393.750
shear1-1	0.02	55.1	357.5	154.1258741	23754.79	1812.6	43.058	298.684	197.901	2	1	0.16384	562.5513	166.75	2	202	7.8352	0.02091	0.00026	395.801
shear1-2	0.04	55.08	359.4	163.2654257	23487.23	1812.6	42.573	299.051	199.951	4	3	0.49152	565.6524	166.75	3	203	7.8373	0.06272	0.00052	399.902
shear1-3	0.06	55.06	359.4	163.1997774	23470.17	1812.6	42.542	298.417	202.001	6	5	0.8192	567.7614	163.75	5	205	7.8393	0.1045	0.00078	404.001
shear1-4	0.09	55.03	359.4	153.118306	23444.60	1812.6	42.496	298.099	203.023	9	6	0.98304	568.7969	162.75	6	206	7.8423	0.12535	0.00117	406.047
shear1-5	0.11	55.01	359.4	153.0606566	23427.56	1812.6	42.465	298.464	205.071	11	8	1.31072	571.8916	161.75	7	207	7.8444	0.16709	0.00142	410.142
shear1-6	0.13	54.99	359.4	153.0050083	23410.53	1812.6	42.434	298.145	206.093	13	9	1.47456	572.9358	160.75	8	208	7.8464	0.18793	0.00168	412.186
shear1-7	0.16	54.96	359.4	152.9215359	23385.00	1812.6	42.388	297.825	207.113	16	10	1.6384	573.9762	159.75	9	209	7.8495	0.20873	0.00207	414.226
shear1-8	0.19	54.93	359.4	152.8380634	23359.47	1812.6	42.341	297.506	208.133	19	11	1.80224	575.0151	158.75	10	210	7.8525	0.22951	0.00246	416.265
shear1-9	0.22	54.9	353.7	155.216285	24092.10	1812.6	43.669	297.184	209.151	22	12	1.96609	576.0523	157.75	11	211	7.8556	0.25028	0.00285	418.302
shear1-10	0.25	54.87	353.7	155.1314673	24065.77	1812.6	43.622	296.863	210.169	25	13	2.12993	577.088	156.75	12	212	7.8586	0.27103	0.00324	420.336
shear1-11	0.27	54.85	353.7	155.0749223	24048.23	1812.6	43.590	297.223	212.210	27	15	2.45761	580.1705	155.75	13	213	7.8607	0.31265	0.0035	424.420
shear1-12	0.3	54.82	352.6	155.4736246	24172.05	1812.6	43.814	297.220	212.204	30	15	2.45761	580.1585	155.75	13	213	7.8638	0.31252	0.00389	424.409
shear1-13	0.35	54.77	352.6	155.3318208	24127.97	1812.6	43.734	296.553	212.705	35	15.5	2.53953	580.1599	154.75	14	214	7.8689	0.32273	0.00453	425.410
shear1-14	0.4	54.72	352.6	155.190017	24083.94	1812.6	43.655	296.546	212.695	40	15.5	2.53953	580.1393	154.75	14	214	7.874	0.32252	0.00518	425.389
shear1-15	0.45	54.67	352.6	155.0482133	24038.95	1812.6	43.575	295.880	213.194	45	16	2.62145	580.1386	153.75	15	215	7.8791	0.33271	0.00583	426.389
shear1-16	0.5	54.62	352.6	154.9064095	23996.00	1812.6	43.495	296.552	214.203	50	17	2.78529	582.156	153.75	15	215	7.8843	0.35327	0.00646	428.406
shear1-17	0.7	54.42	352.6	154.3391946	23820.59	1812.6	43.177	295.522	214.158	70	17	2.78529	581.0656	152.75	16	216	7.9049	0.35235	0.00907	428.316
shear1-18	0.8	54.32	350.1	155.1556698	24073.26	1812.6	43.635	294.845	214.643	80	17.5	2.86721	581.0357	151.75	17	217	7.9152	0.36224	0.01036	429.286
shear1-19	1	54.12	350.1	154.5844045	23896.34	1812.6	43.315	293.152	215.103	100	18	2.94913	579.9653	149.75	19	219	7.936	0.37161	0.01295	430.206
shear1-20	1.2	53.92	350.1	154.0131391	23720.05	1812.6	42.995	293.793	216.065	120	19	3.11297	581.8796	149.75	19	219	7.9569	0.39123	0.01554	432.130
shear1-21	1.4	53.72	350.1	153.4418738	23544.41	1812.6	42.677	291.760	216.014	140	19	3.11297	579.7786	147.75	21	221	7.9779	0.3902	0.01813	432.029
shear1-22	1.6	53.52	347.6	153.9700806	23706.79	1812.6	42.971	291.056	214.959	160	18	2.94913	577.6683	147.75	21	221	7.999	0.36869	0.02073	429.918
shear1-23	1.8	53.32	347.6	153.3947066	23529.94	1812.6	42.650	289.890	214.410	180	17.5	2.86721	575.5706	146.75	22	222	8.0202	0.3575	0.02332	428.821
shear1-24	2	53.12	347.6	152.8193326	23353.75	1812.6	42.331	289.659	214.364	200	17.5	2.86721	575.4776	146.75	22	222	8.0415	0.35655	0.02591	428.728
shear1-25	2.2	52.92	350.1	151.1568123	22848.38	1812.6	41.415	290.628	214.317	220	17.5	2.86721	576.3845	147.75	21	221	8.063	0.3556	0.0285	428.635
shear1-26	2.4	52.72	350.1	150.585547	22676.01	1812.6	41.103	290.266	213.774	240	17	2.78529	575.2975	147.75	21	221	8.0845	0.34462	0.03109	427.547
shear1-27	2.5	52.62	350.1	150.2999143	22590.06	1812.6	40.947	289.251	213.751	250	17	2.78529	574.2523	146.75	22	222	8.0954	0.34406	0.03238	427.502
shear1-28	2.7	52.42	350.1	149.728649	22418.67	1812.6	40.636	290.221	213.706	270	17	2.78529	575.1619	147.75	21	221	8.1171	0.34314	0.03497	427.412
shear1-29	2.9	52.22	347.6	150.2301496	22569.10	1812.6	40.909	290.191	213.661	290	17	2.78529	575.0715	147.75	21	221	8.1389	0.34222	0.03756	427.322
shear1-30	3	52.12	347.6	149.9424626	22482.74	1812.6	40.752	291.175	213.638	300	17	2.78529	576.0264	148.75	20	220	8.1499	0.34176	0.03886	427.276
shear1-31	3.15	51.97	347.6	149.5109321	22353.52	1812.6	40.518	291.153	213.604	315	17	2.78529	575.9586	148.75	20	220	8.1664	0.34107	0.0408	427.209
shear1-32	3.5	51.62	347.6	148.5040276	22053.46	1812.6	39.974	289.447	212.546	350	16	2.62145	572.8416	147.75	21	221	8.2052	0.31949	0.04534	425.092
shear1-33	4	51.12	334.2	152.962296	23397.46	1812.6	42.410	289.376	212.439	400	16	2.62145	572.629	147.75	21	221	8.2612	0.31732	0.05181	424.879

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 (m/s)^2	γ kg/m^3	G_0 MPa	p',kPa	q,kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm^2	stress [illegible]	strain [illegible]	Deviator [illegible]
shear1-34	4.4	50.72	334.2	151.7654099	23032.74	1812.6	41.749	288.320	212.354	440	16	2.62145	571.4689	146.75	22	222	8.3066	0.31558	0.05699	424.709
shear1-35	4.6	50.52	334.2	151.1669659	22851.45	1812.6	41.421	288.291	212.312	460	16	2.62145	571.3738	146.75	22	222	8.3296	0.31472	0.05959	424.624
shear1-36	4.9	50.22	334.2	150.2692996	22580.86	1812.6	40.930	286.608	211.287	490	15	2.45761	568.3246	145.75	23	223	8.3641	0.29363	0.06347	422.575
shear1-37	5.1	50.02	334.2	149.8708558	22401.37	1812.6	40.605	286.582	211.247	510	15	2.45761	568.2449	145.75	23	223	8.3873	0.29302	0.06606	422.495
shear1-38	5.3	49.82	334.2	149.0724117	22222.58	1812.6	40.281	284.916	210.252	530	14	2.29377	565.2541	144.75	24	224	8.4106	0.27272	0.06865	420.504
shear1-39	5.5	49.62	334.2	148.4739677	22044.52	1812.6	39.958	284.893	210.215	560	14	2.29377	565.1797	144.75	24	224	8.4341	0.27196	0.07124	420.430
shear1-40	5.75	49.37	334.2	147.7259126	21822.95	1812.6	39.556	283.862	210.168	575	14	2.29377	564.0867	143.75	26	226	8.4636	0.27102	0.07448	420.337

Test apparatus	: Triaxial			
Sample/part No	: 9 / 3 from 4		Boring No	: 2
Location	: Talingchan area, Bangkok		Date of test	: 23 Feb 05
Depth	: 15 - 15.7 m		Tested by	: Yono
Discription of soil	: Clay			

a. Specimen data

Type of test performed : Consolidated Undrained

Diameter of specimen, Do : 3.91667 cm

Top	Middle	Botom	Average
3.9	3.925	3.925	3.9166667

Initial height of specimen : 7.7 cm

Initial area of specimen : 12.0421 cm^2

Volume of specimen : 92.7243 cm3

Mass of specimen : 148.17 gr

Wet unit of specimen : 1.59796 gr/cm3

Length tip to tip of bender element in sample : 6.52 cm

Water content of specimen

Can no	I	II	III
Mass of can	12.53	12.43	17.97
Mass of wet soil+can	29.14	31.27	28.17
Mass dry soil+can	22.99	24.14	24.42
Mass of water	6.15	7.13	3.75
Mass of dry soil	10.46	11.71	6.45
Water content	58.80	60.89	58.14
Average of water content		59.27	

b. Saturation

Cell pressure (kPa)	Back pressure (kPa)	Pore Pressure (kPa)	PWP Difference (kPa)	B value
0	0	1		
210	200	206	205	0.976190476

c. Consolidation step

consol	σv' kPa	σh' kPa	Vol. change reading (cm^3)	Volume vhange (cm^3)	Voltage (volt)	Length of sample (mm)	time int. Δt $*10^{-6}$sec	Vs m/s	ρt kg/m3	G Mpa
			59.7						1598.0	
50	50	50	57.1	2.6	20	64.48	896.7	71.908	1615.2	8.352
88.89	166.67	50	56.3	3.4	20	64.26	703.7	91.317	1620.7	13.51
100	187.5	56.25	55.6	4.1	20	64.07	694.4	92.267	1625.6	13.84
200	375	112.5	49	10.7	20	62.24	517.7	120.22	1676.0	24.22
300	562.5	168.75	42.9	16.8	20	60.55	396.8	152.6	1730.3	40.29
400	750	225	34.8	24.9	20	58.31	353.2	165.09	1817.5	49.54
500	937.5	281.25	26.7	33	20	56.07	305.9	183.3	1928.4	64.79

Table Analyses data of CU Triaxial test with final mean effective stress 500 kPa (Ko = 0.3)

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 (m/s)	γ kg/m³	G_0 MPa	p' kPa	q kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area cm²	stress	strain	Deviator stress kPa
50		64.48	898.7	71.91	5170.78	1615.2	8.35	50	0				50	50						0
61.11		64.26	703.7	91.32	8338.85	1620.7	13.51	88.89	58.335				166.67	50						116.67
100		64.07	694.4	92.27	8513.14	1625.8	13.84	100	65.625				187.5	56.25						131.25
200		62.24	517.7	120.22	14453.83	1676.0	24.22	200	131.25				375	112.5						262.5
300		60.55	398.8	151.83	23052.50	1730.3	39.89	300	198.875				562.5	168.75						393.75
400		58.31	353.2	165.09	27254.91	1817.5	49.54	400	262.5				750	225						525
500		56.07	305.9	183.30	33597.13	1928.4	64.79	500	328.125				937.5	281.25						656.25
Shearing																				
shear1-0	0	56.07	305.9	183.30	33597.13	1928.4	64.79	500	328.125	0	0	0	937.5	281.25	0	200	8.968	0	0	656.25
shear1-1	0.01	56.06	305.9	183.26	33585.15	1928.4	64.77	500.389	331.709	1	4	0.66	942.67	279.25	2	202	8.9681499	0.073	0.000	663.418
shear1-2	0.02	56.05	305.9	183.23	33573.16	1928.4	64.74	500.778	335.292	2	8	1.31	947.83	277.25	4	204	8.9703001	0.146	0.000	670.584
shear1-3	0.04	56.03	305.9	183.16	33549.21	1928.4	64.70	502.957	341.560	4	15	2.46	958.37	275.25	6	206	8.9726013	0.274	0.001	683.120
shear1-4	0.06	56.01	305.9	183.10	33525.26	1928.4	64.65	503.939	346.034	6	20	3.28	965.32	273.25	8	208	8.9749038	0.365	0.001	692.067
shear1-5	0.08	55.99	305.9	183.03	33501.32	1928.4	64.60	504.323	349.610	8	24	3.93	970.47	271.25	10	210	8.9772074	0.438	0.001	699.219
shear1-6	0.1	55.97	305.9	182.97	33477.40	1928.4	64.56	505.706	353.184	10	28	4.59	976.62	270.25	11	211	8.9795122	0.511	0.001	706.368
shear1-7	0.15	55.92	305.9	182.80	33417.61	1928.4	64.44	505.080	356.748	15	32	5.24	980.74	267.25	14	214	8.9852794	0.583	0.002	713.491
shear1-8	0.2	55.87	305.9	182.64	33357.88	1928.4	64.33	504.260	358.515	20	34	5.57	982.28	265.25	16	216	8.991054	0.620	0.003	717.030
shear1-9	0.25	55.82	300.5	185.76	34505.69	1928.4	66.54	504.842	359.389	25	35	5.73	984.03	265.25	16	216	8.996836	0.637	0.003	718.777
shear1-10	0.3	55.77	300.5	185.59	34443.90	1928.4	66.42	505.019	361.154	30	37	6.06	986.56	264.25	17	217	9.0026255	0.673	0.004	722.308
shear1-11	0.37	55.7	300.5	185.36	34357.49	1928.4	66.25	503.594	362.016	37	38	6.23	986.26	262.25	19	219	9.0107433	0.691	0.005	724.032
shear1-12	0.45	55.62	300.5	185.09	34258.87	1928.4	66.06	503.165	362.872	45	39	6.39	986.99	261.25	20	220	9.0200387	0.708	0.006	725.744
shear1-13	0.5	55.57	300.5	184.93	34197.30	1928.4	65.95	504.337	364.630	50	41	6.72	990.51	261.25	20	220	9.0258581	0.744	0.006	729.261
shear1-14	0.55	55.52	300.5	184.76	34135.79	1928.4	65.83	503.914	365.497	55	42	6.88	991.24	260.25	21	221	9.031665	0.762	0.007	730.993
shear1-15	0.6	55.47	300.5	184.59	34074.33	1928.4	65.71	502.491	366.362	60	43	7.05	990.97	258.25	23	223	9.0375194	0.780	0.008	732.723
shear1-16	0.67	55.4	305.9	181.10	32799.00	1928.4	63.25	502.060	367.215	67	44	7.21	991.68	257.25	24	224	9.0457002	0.797	0.009	734.431
shear1-17	0.75	55.32	305.9	180.64	32704.34	1928.4	63.07	500.625	368.062	75	45	7.37	991.37	255.25	26	226	9.055068	0.814	0.010	736.125
shear1-18	0.85	55.22	305.9	180.52	32586.21	1928.4	62.84	498.886	368.454	85	45.5	7.45	990.16	253.25	28	228	9.0668049	0.822	0.011	736.908
shear1-19	1	55.07	300.5	183.26	33584.68	1928.4	64.76	498.129	368.818	100	46	7.54	989.89	252.25	29	229	9.0844675	0.830	0.013	737.636
shear1-20	1.3	54.77	300.5	182.26	33219.76	1928.4	64.06	496.317	369.100	130	46.5	7.62	988.45	250.25	31	231	9.12	0.835	0.017	738.200
shear1-21	1.6	54.47	300.5	181.26	32856.84	1928.4	63.36	494.502	369.379	160	47	7.70	987.01	248.25	33	233	9.1558115	0.841	0.021	738.757
shear1-22	2	54.07	300.5	179.93	32376.04	1928.4	62.43	493.940	370.036	200	48	7.86	987.32	247.25	34	234	9.204	0.854	0.026	740.071
shear1-23	2.35	53.72	296.4	181.24	32848.51	1928.4	63.35	493.812	369.843	235	48	7.86	986.94	247.25	34	234	9.2465829	0.851	0.030	739.685
shear1-24	2.7	53.37	296.4	180.06	32421.87	1928.4	62.52	491.106	368.785	270	47	7.70	982.82	245.25	36	236	9.2895618	0.829	0.035	737.569
shear1-25	3	53.07	296.4	179.05	32058.40	1928.4	61.82	490.711	368.192	300	46.5	7.62	981.63	245.25	36	236	9.32672	0.817	0.038	736.383
shear1-26	3.5	52.57	297.3	176.82	31266.99	1928.4	60.30	490.248	367.497	350	46	7.54	980.24	245.25	36	236	9.3893154	0.803	0.045	734.993
shear1-27	4	52.07	297.3	175.14	30675.05	1928.4	59.15	490.505	366.362	400	45	7.37	979.01	246.25	35	235	9.4527568	0.780	0.051	732.765
shear1-28	4.5	51.57	297.3	173.46	30088.77	1928.4	58.02	491.333	366.124	450	45	7.37	979.50	247.25	34	234	9.5170612	0.775	0.058	732.248
shear1-29	5	51.07	297.3	171.78	29508.14	1928.4	56.90	490.861	365.446	500	44.5	7.29	978.14	247.25	34	234	9.5822466	0.761	0.064	730.892
shear1-30	5.25	50.82	297.3	170.94	29219.95	1928.4	56.35	490.517	364.900	525	44	7.21	977.05	247.25	34	234	9.6151753	0.750	0.067	729.800
shear1-31	5.5	50.57	292.3	173.01	29931.49	1928.4	57.72	491.433	364.774	550	44	7.21	977.80	248.25	33	233	9.648331	0.747	0.071	729.548
shear1-32	5.7	50.37	292.3	172.32	29695.20	1928.4	57.26	490.811	363.842	570	43	7.05	975.93	248.25	33	233	9.6750207	0.726	0.073	727.684
shear1-33	5.85	50.22	287.8	174.50	30448.92	1928.4	58.72	488.209	362.939	585	42	6.88	972.13	246.25	35	235	9.6951351	0.710	0.075	725.878
shear1-34	6	50.07	287.8	173.97	30267.29	1928.4	58.37	488.161	362.867	600	42	6.88	971.98	246.25	35	235	9.7153333	0.708	0.077	725.733
shear1-35	6.25	49.82	287.8	173.11	29965.80	1928.4	57.79	488.081	362.746	625	42	6.88	971.74	246.25	35	235	9.7491847	0.708	0.080	725.492
shear1-36	6.4	49.67	287.8	172.59	29785.63	1928.4	57.44	489.758	362.262	640	41.5	6.80	972.77	248.25	33	233	9.7696089	0.696	0.082	724.525

Continued

Step	Vert. displacement mm	Distance l (mm)	Time arrival *10-6 sec	Shear wave velocity m/s	V_s^2 (m/s)^2	γ kg/m^3	G_0 MPa	p kPa	q kPa	def dial	prov dial	ΔP kg	σ1 kPa	σ3 kPa	excess pore pressure kPa	pore pressure kPa	Area [illegible]	stress [illegible]	strain [illegible]	Deviator stress kPa
shear1-37	6.6	49.47	287.8	171.89	29546.24	1928.4	56.98	488.874	360.937	660	40	6.55	970.12	248.25	33	233	9.7969748	0.669	0.085	721.873
shear1-38	6.8	49.27	284.7	173.08	29949.54	1928.4	57.75	488.268	360.027	680	39	6.39	968.30	248.25	33	233	9.8244944	0.650	0.087	720.053
shear1-39	7	49.07	284.7	172.36	29706.89	1928.4	57.29	488.664	359.121	700	38	6.23	967.49	249.25	32	232	9.852169	0.632	0.090	718.243
shear1-40	7.2	48.87	284.7	171.65	29465.22	1928.4	56.82	488.064	358.221	720	37	6.06	965.69	249.25	32	232	9.88	0.614	0.092	716.441
shear1-41	7.4	48.67	284.7	170.95	29224.54	1928.4	56.36	488.007	358.136	740	37	6.06	965.52	249.25	32	232	9.9079887	0.612	0.095	716.271
shear1-42	7.6	48.47	283.1	171.21	29313.41	1928.4	56.53	488.872	356.433	760	35	5.73	964.12	251.25	30	230	9.9361364	0.577	0.097	712.866
shear1-43	7.8	48.27	283.1	170.51	29072.00	1928.4	56.06	488.818	356.353	780	35	5.73	963.96	251.25	30	230	9.9644444	0.575	0.100	712.705
shear1-44	8	48.07	283.1	169.80	28831.58	1928.4	55.60	488.765	356.272	800	35	5.73	963.79	251.25	30	230	9.9929143	0.574	0.103	712.544
shear1-45	8.25	47.82	283.1	168.92	28532.47	1928.4	55.02	487.629	354.569	825	33	5.41	960.39	251.25	30	230	10.026731	0.539	0.106	709.136

BIBLIOGRAPHY

Sumaryono was born in Kulon Progo, Yogyakarta Special Province, Indonesia in July 23, 1973. After finished undergraduate from Geological Engineering Department Gadjah Mada University Indonesia, he worked at Virama Karya Consultant as Engineering Geology. In 1998, he joined as Research assistant and member of Landslide mitigation team at Environmental Geology Laboratory, Geological Engineering Department, Gadjah Mada University and Researcher at Center of Environmental Studies Gadjah Mada University. In May 2003 he continued Master Degree at Geotechnical Engineering, Civil Engineering, Chulalongkorn University, Thailand under AUN SEED Net-JICA Scholarship.