CPT BASED COMPRESSIBILITY ASSESSMENT OF SOILS

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FATMA ÖZKAHRİMAN

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Prof. Dr. Canan ÖZGEN

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

____

Prof. Dr. Erdal ÇOKÇA

Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Prof. Dr. Orhan EROL	**Assoc. Prof. Dr. Kemal Önder ÇETİN**
Co-supervisor	**Supervisor**

Examining Committee Members

Prof. Dr. Ufuk ERGUN	**(METU - CE)**	__________________
Assoc. Prof. Dr. Kemal Önder ÇETİN	**(METU - CE)**	__________________
Prof. Dr. Orhan EROL	**(METU - CE)**	__________________
Prof. Dr. Erdal ÇOKÇA	**(METU - CE)**	__________________
Dr. Mutlu AKDOĞAN	**(Geoteknik Çözüm&Proje Ltd)**	__________________

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Name, Last Name: FATMA ÖZKAHRİMAN

Signature:

ABSTRACT

CPT BASED COMPRESSIBILITY ASSESSMENT OF SOILS

Özkahriman, Fatma

M.S., Department of Civil Engineering

Supervisor: Assoc. Prof. Dr. Kemal Önder Çetin

Co-Supervisor: Prof. Dr. Orhan Erol

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One of the most critical problems geotechnical engineers face with is the determination of the amount of consolidation settlement that will occur at a site as a result of the construction of a structure. The compressibility behavior of the soil is an important parameter in determining the amount of consolidation settlement. The goal of this study is to develop probabilistically based correlation between the compressibility behavior of soil and in-situ test data. Within the scope of this research effort, performed CPT tests and the recorded settlement case histories where consolidation settlements at the field under various surcharge loads were compiled from the Bursa East and West Waste Water Treatment Plant soil investigation projects.

A database was composed of the results of 45 CPT and 57 settlement plate recordings. For the compilation of this database, a series of finite difference software FLAC-3D analyses were carried out to calculate the change in stress distribution under the settlement plates. A maximum likelihood framework was used for the development of compressibility behavior of soils.

As a result of careful processing of available data, the cone tip resistance (q_c), soil behavior type index (I_c) were selected as two important parameters effecting the value of the one-dimensional constraint modulus, M. The regression analysis which uses the settlement values recorded at the site and those computed using the change in the stress distribution, the thickness of the sublayers and the proposed one-dimensional constraint modulus were carried out to calculate the values of these model parameters. Two correlations based on the cone tip resistance and soil behavior type index were developed for the computation of the one-dimensional constraint modulus, M.

Keywords: Compressibility of soils, one-dimensional constrained modulus, cone penetration test, maximum likelihood methodology, limit state models.

ÖZ

KONİK PENETRASYON DENEYİ (CPT) VERİLERİNİ KULLANARAK ZEMİNİN SIKIŞABİLİRLİĞİNİN BELİRLENMESİ

Özkahriman, Fatma

Yüksek Lisans, İnşaat Mühendisliği Bölümü

Tez Yöneticisi: Doç. Dr. Kemal Önder Çetin

Yardımcı Tez Yöneticisi: Prof. Dr. Orhan Erol

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İnşaat ve sonrasında zeminlerde oluşabilecek konsolidasyon oturmalarının belirlenmesi geoteknik mühendislerinin karşılaştığı en önemli problemlerden birisidir. Konsolidasyon oturmalarını etkileyen en önemli parametrelerinden birisi zeminlerin sıkışabilirlik karakteridir. Bu çalışmanın amacı zeminlerin sıkışabilirlik özelliği ile saha deneyleri arasında istatistiksel bağıntılar elde etmektir. Bu araştırma kapsamında Bursa Doğu ve Batı Atıksu Arıtma Tesisleri zemin etüdleri dahilinde gerçekleştirilen Konik Penetrasyon deneyleri ve farklı yüklemeler altında sahada oluşan konsolidasyon oturmaları kullanılmıştır.

Bursa Doğu ve Batı Atıksu Arıtma Tesisleri zemin etüdleri kapsamında yapılan 45 Konik Penetrasyon deneyi ve 57 oturma plakası kaydı toplanarak bir veritabanı oluşturulmuştur. Sonlu Farklar Metodu temelli FLAC 3D programı kullanılarak hesaplanan oturma plakaları altındaki basınç dağılımı bu veritabanına eklenmiştir. Bu veriler kullanılarak zeminlerin sıkışabilirliği maksimum olabilirlik yöntemi kullanılarak belirlenmiştir.

Eldeki verilerin değerlendirilmesi sonucu, ödometrik deformasyon modülünü (M) etkileyen en önemli faktörlerin uç direnci (q_c), ve zemin tipi indeksi (I_c) olduğuna karar verilmiştir. Ödometrik deformasyon modül, tabaka kalınlığı ve plaka altındaki basınç dağılımı kullanılarak hesaplanan oturma değerleri, gerçek ölçümlerle karşılaştırılarak model değişkenleri bulunmuştur. CPT uç direnci ve zemin tipi indeksine bağlı olasılıksal ödometrik deformasyon modülü bağıntıları geliştirilmiştir.

Anahtar Kelimeler: Zeminlerin sıkışabilirliği, Ödometrik deformasyon modül, konik penetrasyon deneyi, limit durum foksiyonu, maksimum olabilirlik.

To My Family

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LIST OF SYMBOLS

a	:	Cone area ratio
A_n	:	Cross-sectional area of the load cell
A_c	:	Projected area of the cone
B	:	Width of rectangular loading area
BCPT	:	Cone penetration test at Bursa west waste water treatment plant
BSP	:	Settlement plate at Bursa west waste water treatment plant
C_c	:	Compression index
C_Q	:	Normalization factor for cone tip resistance
CPT	:	Cone penetration test
E_u	:	Undrained Young's modulus
e	:	Void ratio of soils
F	:	Normalized friction ratio
f_s	:	Friction sleeve resistance
H	:	Thickness of sublayers in soil profile
I_c	:	Soil behavior type index
I_σ	:	Influence factor
L	:	Length of rectangular loading area
m_v	:	Coefficient of volume compressibility
M	:	One-dimensional constrained modulus
P_a, P_{a2}	:	Reference pressures
S	:	Total settlement
S_f	:	The ultimate settlement
S_o	:	Observed settlement at the site
S_p	:	Predicted settlement

SP	:	Settlement plate
t	:	time
u_2	:	Pore pressure acting on the cone
v	:	Settlement speed
Q	:	Normalized CPT penetration resistance
q_t	:	Corrected total cone resistance
q_c	:	Cone tip resistance
q_{c1N}	:	Cone tip resistance corrected for overburden stress
σ_{v0}	:	Total overburden stress
σ'_{v0}	:	Effective overburden stress
σ'_{v}	:	Effective vertical stress
$\Delta\sigma$	:	Change in vertical stress
α_m, α_n, α_i	:	Coefficient of constrained modulus
ε_v	:	Vertical strain
ε	:	Model correction term
φ	:	Standard normal probability density function
θ	:	Model parameters
σ_ε	:	Standard deviation

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Cone penetration testing is a versatile tool for the purpose of soil investigation. CPT is widely used due to its simplicity, good repeatability and continuous sounding capability. The results of cone penetration test can, in principle, be used to evaluate the nature and sequence of soil, groundwater conditions, physical and mechanical properties of the soil. Moreover, it provides data for geotechnical design.

In the past decades, many correlations were proposed by several researchers to predict the compressibility behavior of soils based on the CPT results. The essential parameter representing one-dimensional consolidation conditions is one-dimensional constrained modulus, M. Sanglerat (1972), Jones and Rust (1995), Senneset et al. (1982, 1989) proposed methods of estimating M based on CPT data. Similarly, Kulhawy and Mayne (1990) suggested a model for constrained modulus for clays. Lunne and Christophersen (1983) proposed a method to estimate M for overconsolidated and normally consolidated sands. These correlations will be discussed in detail in Section 2.2.

1.2 RESEARCH STATEMENT

The main purpose of this study is to develop probabilistically based correlations to predict the compressibility behavior of soils by CPT data. The parameters that define the compressibility of soils are crucial for evaluating the settlement of soils. In practice, the most frequently utilized parameter for soils is the one dimensional constrained modulus, M. In this study a new correlation will be proposed to assess the compressibility of soils calibrated by settlement case histories where consolidation settlements at the field under various surcharge loads were recorded along with CPT-based soil profile data.

For this purpose, a database of 45 CPT sounding data consisting of cone tip resistance (q_c), friction sleeve resistance (f_s) along with 57 settlement plate records was compiled.

1.3 PROBLEM SIGNIFICANCE AND LIMITATIONS OF PREVIOUS STUDIES

Deformation characteristics or compressibility behavior of soils can be defined in terms of soil modulus. In practice, the one dimensional constrained modulus, M, undrained Young's modulus in compression loading, E_u and compression index, C_c are the most commonly used parameters. Most of the estimations of these deformability parameters are based on the correlation between in-situ test data and/or laboratory test results. Several numbers of available methods in the literature do not cover the real situations observed in the field since they were mainly derived based on the laboratory tests such as oedometer and triaxial tests results. However, the laboratory tests may not yield reliable results due to some reasons including the possible disturbances introduced during sampling.

To eliminate limitations of available methods for the assessment of soil compressibility based on the CPT data; settlement case histories where consolidation settlements at the field under different surcharge load were used in this study. Recorded settlement values of soils reveal the real compressibility behavior of soils under various loading cases. These proposed correlations calibrated by field performance data and based on easy to perform and repeatable CPT, are believed to be a convenient and reliable way to estimate compressibility characteristics of soils.

1.4 SCOPE OF THE THESIS

Following this introduction chapter, Chapter 2 presents the general description of CPT, test procedure, interpretation of cone penetration data and also limitations and advantages of this in-situ test. An overview of available CPT based compressibility estimations and the concepts of compressibility of cohesive and cohesionless soils are also discussed in Chapter 2.

Chapter 3 presents the works on this study that had been carried out for the development of the new correlations based on the CPT data. Discussed process starts with CPT data processing to develop soil profiles for the purpose of calculating soil settlements under various surcharges.

Chapter 4 discusses the development of probabilistic models for CPT based compressibility assessment of soils. Limit state models as well as maximum likelihood method are discussed. As a conclusion, recommended new correlations are also presented in Chapter 4.

Finally, Chapter 5 presents a summary of research, main conclusions, and recommendations for future studies.

CHAPTER 2

AN OVERVIEW OF AVAILABLE METHODS OF SOIL COMPRESSIBILITY BASED ON CPT DATA

2.1 INTRODUCTION

Attempts to develop a correlation for estimating compressibility behavior of soils based on the CPT data require clear understanding of compressibility characteristics of soils as well as cone penetration testing. The general information about cone penetration test is given in Section 2.2 of this chapter. Especially, test procedure, CPT corrections, advantages and limitations of this in-situ test and CPT based soil classification method are discussed in detail. The second part of this chapter gives the general idea of the consolidation theory and the available methods for soil compressibility predictions based on the CPT data.

2.2 CONE PENETRATION TEST (CPT)

Cone penetration test is a widely used in-situ test for the purpose of soil investigation. In the cone penetration test (CPT), a cone penetrometer attached to the ends of rods is pushed vertically into the ground at a constant rate of penetration (2 cm/sec) and the resistance of the soil at the tip and sleeve of the penetrometer is recorded. The cone penetrometer consists of the cone, friction sleeve and the sensors and the data acquisition test system, as well as the connections to the push rods. CPT is carried out by advancing a 60° apex angle cone with a diameter of 35.7 mm (10 cm^2 cross-sectional area) into the soil. Figure 2.1 presents the sections of cone and detailed terminology.

During the penetration, resistance to the penetration of the cone and the surface of the sleeve are recorded. The values are represented as cone tip resistance (q_c) and friction sleeve resistance (f_s). Additionally, pore water pressure, verticality and shear wave velocity can be measured by attaching additional sensors to the CPT system. The number of the readings taken must be adequate to obtain data to give a detailed picture of the variation of the measured parameters with the penetration depth.

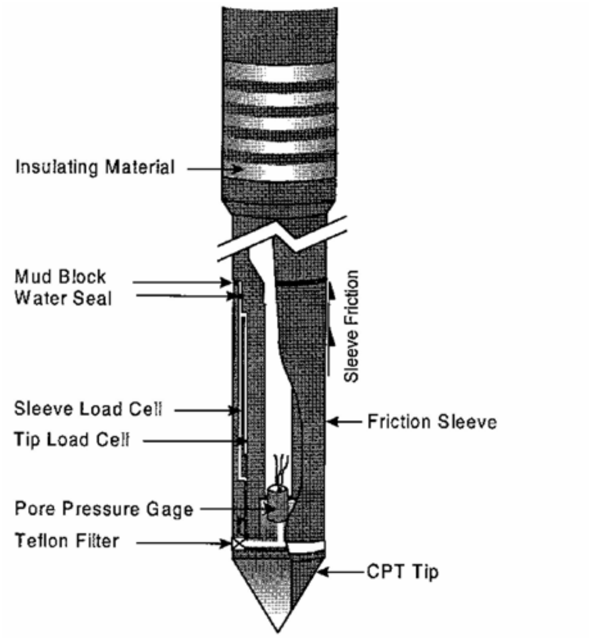


Figure 2-1 - Schematic view of a cone penetrometer probe

The results obtained from cone penetration test are used to evaluate the nature and sequence of soil, groundwater conditions, physical and mechanical properties of the soil. These results are used to estimate valuable parameters for geotechnical design.

2.2.1 Test procedure

In order to obtain reliable and robust data from field tests with the electric penetrometers, well-trained operators, good technical back-up facilities for calibration and maintenance of the equipment used are required. During the cone penetration tests, there are certain details that must be taken care of. Criteria that must be checked during the test are given in detail following sections.

2.2.1.1 Pre-drilling, on Land Testing

In order to avoid overloading or disturbing the cone penetrometer, pre-drilling gain importance for performing test in fills or hard soils. Fills with coarser particles such as stones are always predrilled.

In tests in soft soils, this procedure should be done through the dry crust. The hole is filled with water to at least water table level to guarantee the maintenance of piezo element's saturation.

In certain cases, the pre-drilling can be replaced with pre-forming hole with a solid dummy cone whose diameter is slightly larger than cone penetrometer (about 45-50 mm) through the stiffer layers (Lunne et al., 1997).

2.2.1.2 Verticality

Verticality of thrust and straightness of pushing rods are the two aspects that should be checked during penetration. The thrust machine shall be set up as to obtain vertical thrust direction. Minimum 2˚ exceedence can be acceptable as the deviation of the initial thrust direction from the vertical. The other point checked is the coincidence of the axis of push rods with the direction of thrust.

Once the penetrometer deflects, it continues along a path with consistent radius of curvature. 1˚ of deflection per meter length of standard push rods does not cause noticeable damage. On the other hand, a sudden deflection in excess of 5˚ over one meter cause damage to the penetrometer end rods as a consequence of bending. Slope sensor is attached to the electric cone system, hence deflection can be monitored. When a sudden deflection occurs, penetration should be stopped to avoid the probable damage (Lunne et al., 1997).

2.2.1.3 Rate of penetration

The other point considered during cone penetration tests is the rate of penetration due to its significant effect on the measurements of pore pressure. In cone penetration tests without pore pressure measurements, the rate of penetration may be within 20 mm/s ± 25%. In the tests with pore pressure measurement, the rate of penetration is narrowed to 20 mm/s ± 10%. Excess pore pressure will start to dissipate, if any pause occurs during the penetration. To avoid the effect of dissipation on the CPT measurements, soundings are performed as continuous as possible (Lunne et al., 1997).

2.2.1.4 Frequency of readings

Continuous analogue data is obtained by electric cone penetrometer that converts the data to digital format in the selected interval. The chosen interval depends on the project demand. Collecting data at close intervals is preferable if information of thin layers is required. In general the depth interval readings will be in the range of 10-50 mm (Lunne et al., 1997).

2.2.2 Advantages and Limitations of CPT

The CPT has several advantages over other exploration methods, thus, the popularity of it continues to increase. The cone penetration test (CPT) is a widely used sounding procedure that has valuable outcomes to classify the materials in a soil profile and to estimate their engineering properties. Besides these main advantages, CPT test is one of the most rapid and economical exploration forms of in-situ testing. The test can be performed in a wide range of soils, although very hard soils or gravel can not be penetrated with current technology. Significant advantage of electric cone penetration is that, it provides continuous or near continuous data.

The CPT has also a number of disadvantages. The significant limitation is that no sample is obtained during the testing process. The penetrometer can not penetrate very dense soils or soils contain boulder or cobbles because of the excessive force required to penetrate in these materials.

2.2.3 CPT corrections

Various factors may influence the results of cone penetration test results; hence the outcomes should be corrected to obtain more accurate ones. The pore pressure around the penetrating cone is an important factor that must be taken into consideration. Cone resistance and sleeve friction measurements are influenced by the pore pressure around the penetrating cone.

Other factors that influence the measurements are the temperature changes, inclination, calibration errors and wear of the cone. In this study only pore pressure effect is considered.

Because of the inner geometry of cone penetrometer, the ambient pore water pressure will act on the shoulder area behind the cone and on the ends of the friction sleeve. This phenomenon occurred during the cone penetration tests are defined as unequal area effect (Campanella et al. (1982)). This concept has influence on the measured total stresses determined from cone and friction sleeve.

The corrected total cone resistance, q_t, is given in equation 2.1.

$$q_t = q_c + u_2(1 - a) \tag{2.1}$$

where u_2 is the pore pressure acting behind the cone, q_c is the measured tip resistance and a is the cone area ratio. Cone area ratio, a, can be found by equation 2.2.

$$a = {}^{A_n}\!/\!_{A_c} \tag{2.2}$$

where A_n is the cross-sectional area of the load cell or shaft and A_c is the projected area of cone, as shown in Figure 2.2.

The pore water pressure gains more importance in soft-fine grained saturated soils because of the fact that the ratio of the pore pressure to the cone resistance can be higher in these soils.

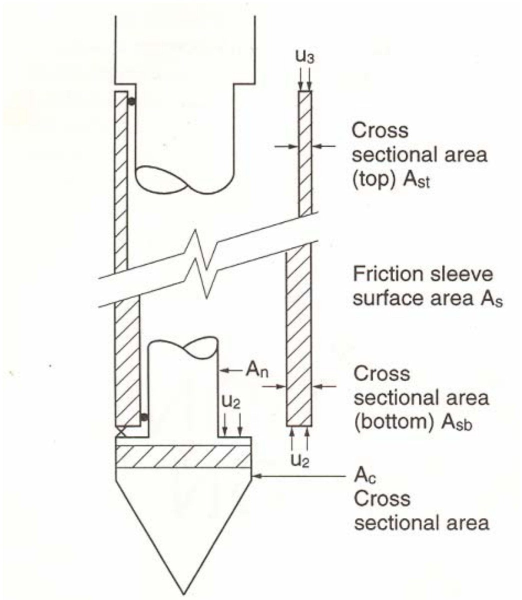


Figure 2-2 - Pore water pressure effects on measured parameters

2.2.4 Soil classification based on CPT

Classifying soils based on CPT data require the use of correlations due to the lack of direct soil sampling. In this section, the procedure that is used to describe and classify soils is presented.

In recent years, numerous correlations were developed to estimate the soil type from CPT soundings. Olsen and Malone (1988), Olsen and Koester (1995), Robertson and Campanella (1988) proposed methods that are amongst widely used correlations for the soil type classifications.

In this study, soil behavior type chart developed by Robertson and Wride (1997) was used to estimate the grain size characteristics of soils directly from CPT results. Robertson (1990) suggested that the chart shown in Figure 2.3 is global in nature and should be used as a guide to define the soil behavior type based on CPT.

The soil behavior type classification chart includes 9 different zones. The boundaries between soil behavior type zones 2 to 7 can be approximated as concentric circles (Jefferies and Davies, 1993). The radius of each circle can be defined as a soil behavior type index, I_c. Soil behavior type index, I_c (Robertson and Wride, 1997) based on the CPT chart can be found out from below given equation.

$$I_c = \left[(3.47 - \log Q)^2 + (\log F + 1.22)^2\right]^{0.5} \quad (2.3)$$

where

$$Q = \left[\frac{(q_c - \sigma_{Vo})}{P_{a2}}\right] \times \left[\frac{P_a}{\sigma'_{Vo}}\right]^n \quad (2.4)$$

and

$$F = \left[\frac{f_S}{(q_c - \sigma_{V0})}\right] \times 100\% \quad (2.5)$$

Q and F are the normalized CPT penetration resistance and normalized friction ratio, respectively. Q is a dimensionless parameter and F is in percent. q_c and f_s are the cone tip resistance and friction sleeve resistance, respectively and are recorded during penetration. σ_{v0} and σ'_{v0} are the total and effective overburden stresses and P_{a2} and P_a are the reference pressures that have the same units as q_c , σ_{v0} and σ'_{v0} respectively.

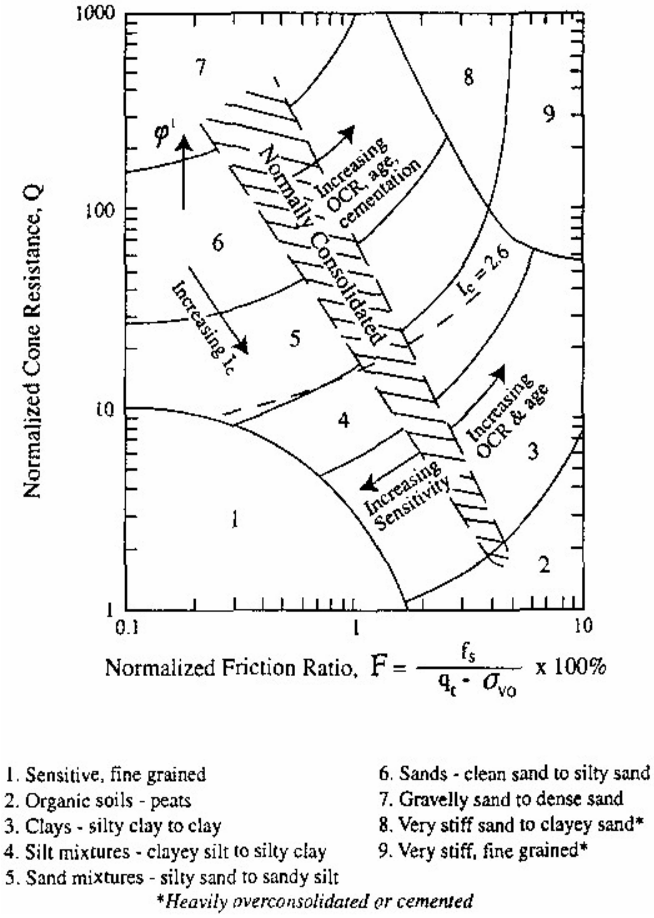


Figure 2-3 - CPT-based soil classification chart (Robertson, 1990)

The soil behavior type chart developed by Robertson (1990) is given in Figure 2.3. This figure uses a normalized cone penetration resistance (Q) calculated by a simple linear stress exponent of n = 1.0. A value in the range of 0.5 to 1.0 for the linear stress exponent was suggested depending on the grain characteristics of soils for normalization purposes (Olsen, 1994; Olsen and Mitchell, 1995). Suggested exponent value of 0.5 is suitable for clean sands and the value of 1 is appropriate for clayey soil types. For silts and sandy silts, selected stress exponent value can be adopted as 0.75.

The procedure recommended by Robertson and Wride (1997) is rather complex and iterative and requires the calculation of the soil behavior type index,

I_c. The proposed procedure is initiated by calculating the dimensionless normalized tip resistance and soil behavior type index by assuming the stress exponent equal to 1. If the calculated soil behavior type index is larger than 2.6, the soil can be classified as clay soil type. On the other hand, if the evaluated value of I_c is smaller than 2.6, then value of stress exponent value should be adopted as 0.5 because of the fact that soil is most likely granular in nature. Hence, the normalized cone tip resistance Q, essentially q_{C1N}, is calculated by using Equation (2.6). Soil type index, I_c is recalculated by using an exponent n of 0.5. If the second calculated I_c value still remains smaller than 2.6, the soil can be classified as nonplastic and granular soils. On the other hand, if calculated soil type index value changes depending on the selected stress exponent value n, all calculations are repeated by new n value of 0.75. At this instant, truly normalized (i,e. dimensionless) cone penetration resistance corrected for overburden stress, q_{c1N} are calculated. I_c value is calculated using Equation (2.3) according to the intermediate exponent n value and q_{c1N}. This I_c value is used to determine the soil classification. All these procedures are summarized in Figure 2.4.

$$q_{C1N} = \frac{q_c}{P_a} \times C_Q \tag{2.6}$$

$$C_Q = \left(\frac{P_a}{\sigma'_{V0}}\right)^n \tag{2.7}$$

In equation 2.6 and 2.7 q_{c1N} is the dimensionless cone penetration resistance corrected for overburden stress and C_Q is the normalization factor for cone tip resistance.

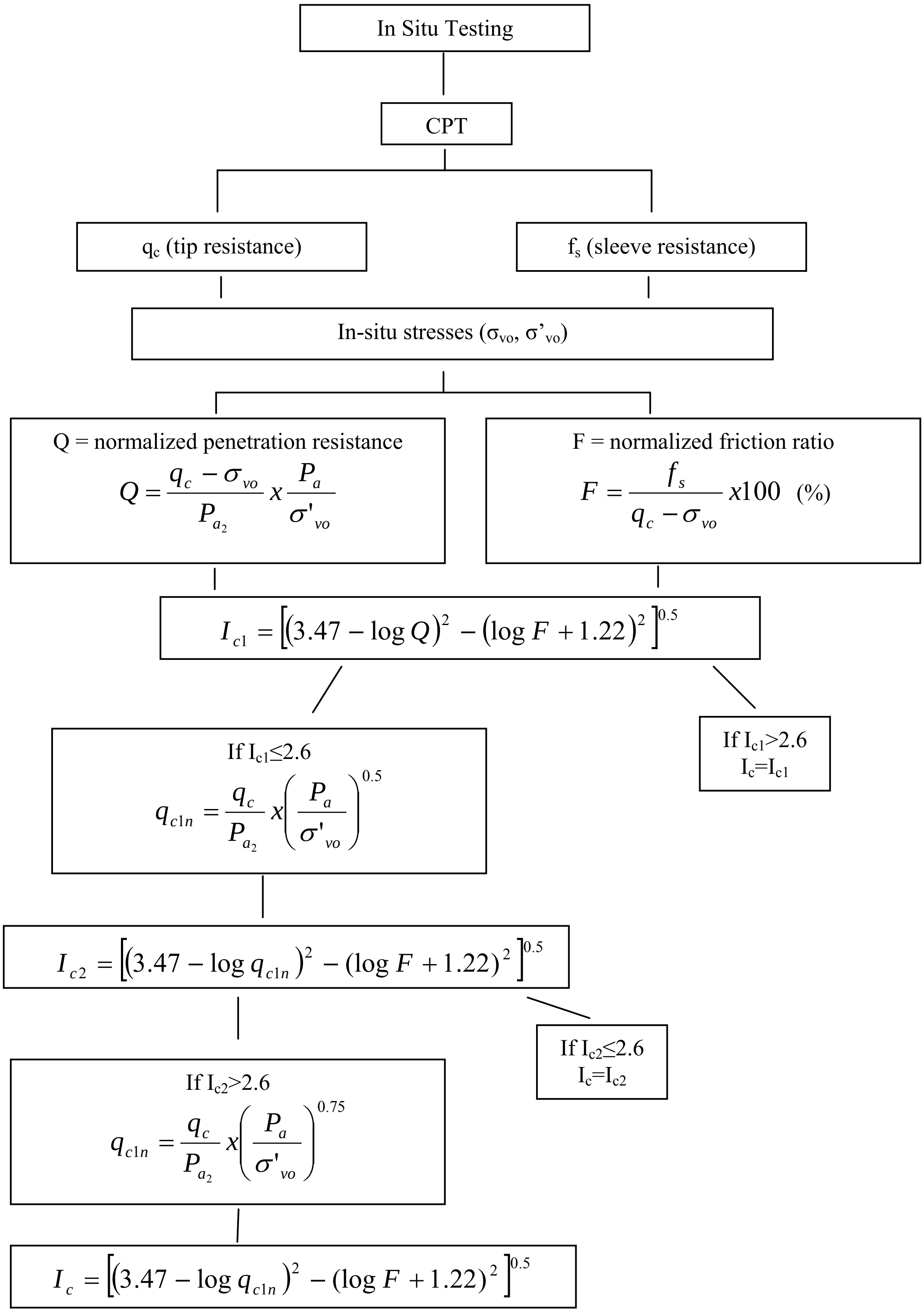


Figure 2-4 - Flowchart illustrating the application of the process of CPT-based soil classification method (Robertson, 1990)

As mentioned before, the boundaries between soil behavior type zones 2 to 7 can be approximated as concentric circles (Jefferies and Davies, 1993). The radius of each circle can be defined as a soil behavior type index, I_c. Hence, the soil behavior type index does not apply to zones 1, 8 and 9. The variation of soil behavior type index, I_c with soil behavior type zones are given in Table 2.1.

Table 2-1 - Boundaries of soil behavior type (Robertson, 1990)

Soil Behavior Type Index, I_C	Zone	Soil Behavior Type
I_C <1.31	7	Gravelly sand to dense sand
1.31< I_C <2.05	6	Sands: clean sand to silty sand
2.05< I_C <2.60	5	Sand Mixtures: silty sand to sandy silt
2.60< I_C <2.95	4	Silt Mixtures: clayey silt to silty clay
2.95< I_C <3.60	3	Clays: silty clay to clay
3.60< I_C	2	Organic soils: peats

2.2.5 Illustrative Example

According to the details of the procedure given above, the programing language Visual Basic was selected as the tool to develop software. One of the outputs of this developed software based on the CPT data is presented in Figure 2.5. Column 1 and 2 in Figure 2.5 shows tip resistance and local friction. Column 3, column 4 and 5 in Figure 2.5 shows total and effective stresses, SPT blow counts and soil profile respectively. The location of the CPT tests can be seen in Appendix A.

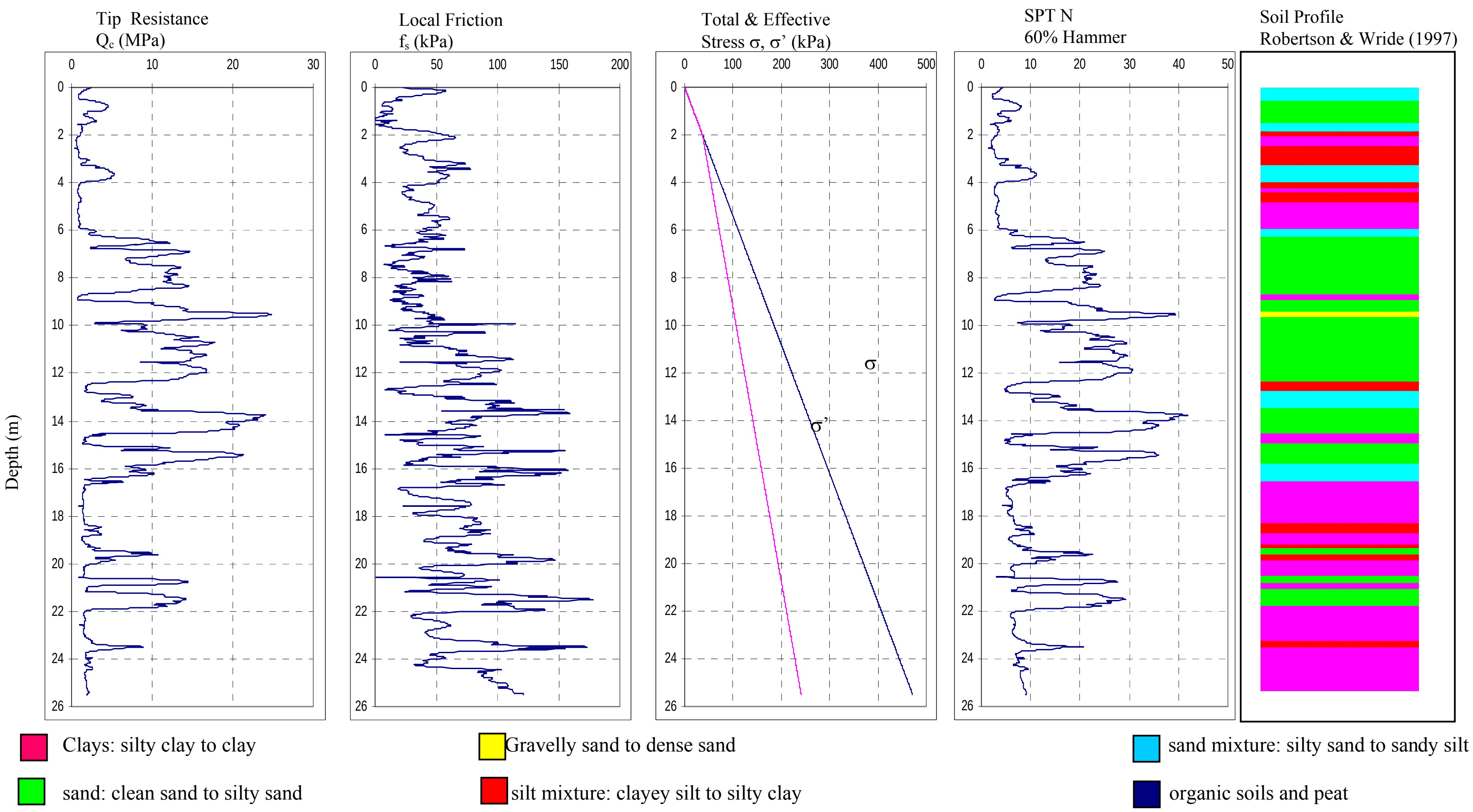


Figure 2-5 - Output of developed software for CPT-based soil classification chart (Robertson, 1990)

2.3 CPT BASED COMPRESSIBILITY ESTIMATIONS

2.3.1 Fundamentals of one-dimensional consolidation

Compressibility of soils has always been a controversial issue among geotechnical engineerings. During the construction stage of a structure or any other external loading conditions, soil layers are subjected to a compressive or sometimes tensile stresses. A change in the effective stresses in a compressible soil, such as clay and sand-silt mixture, produces a certain change in the volume of voids. If the soil is permeable and not very compressible, the change in the volume of voids due to the change in the state of stress in the soils can be assumed as negligible. Process involving the reduction in the water content of saturated soils without the replacement of the water by air is called a consolidation process (Terzaghi, 1947).

As soon as a saturated soil mass is subjected to an external load, the water in the pores usually carries the load since the compressibility of water is relatively smaller than the compressibility of the soil structure. With time, water starts to dissipate from the soil pores under the effect of loading; hence the load is transferred to the soil skeleton. As a consequence of the load application, a significant reduction in the soil volume and a change in the height of the soil are observed. The vertical displacement in the soil structure due to the drainage of pore water under the sustained loading is defined as *consolidation settlement*. The pore water dissipation and also consolidation settlement are time dependent processes. A certain amount of settlement is generated rapidly after the load application, but after that, the amount of settlement increases with a decreasing rate. Due to the accumulation of vertical displacement with time, the application of the time of surcharge loading application gains importance. In practice, the soil can not be subjected to external loads for a long time in order to observe the ultimate value of the settlement. Due to the time limitation and emergency of the construction, applied loads must be removed before the visualization of the real compressibility characteristics of soil. In recent decades, some graphical and semi-empirical methods were proposed to estimate the ultimate consolidation settlement for a site which was subjected to an external loading for a certain time. In this study, Asaoka's method (1978) and Horn's method (1983) were used for the calculation of ultimate consolidation settlement. Details of these two methods are summarized in Section 3.4.

2.3.2 General Compressibility Characteristics of Soil

In order to calculate the consolidation settlement, the value of the compression index or coefficient of volume compressibility of soils must be known. As mentioned before, every change in the effective state of stresses of soils produces a reduction in the volume of voids. The distribution of the void ratio (e) with respect to the effective stress (σ') for saturated soils presented in Figure 2.6 shows the compressibility characteristics. Figure 2.6 illustrates the initial compression that is followed by the expansion and recompression (Craig, 1987). The stress history of soils can be seen from the shapes of the curves in Figure 2.6.

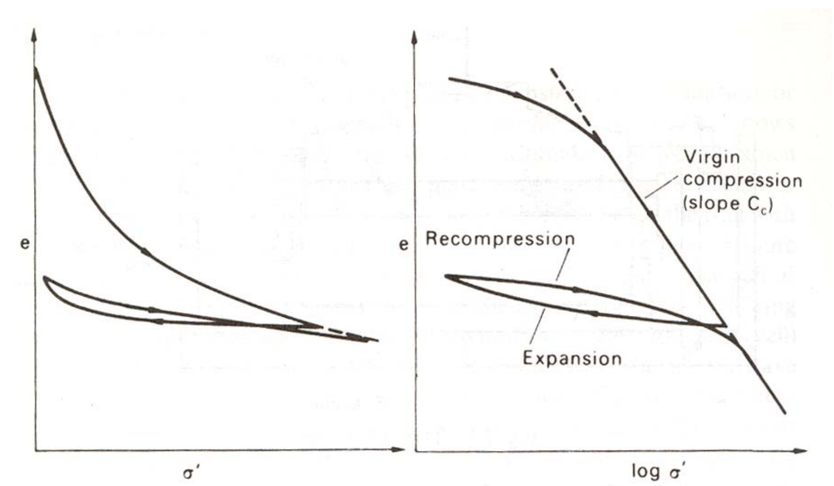


Figure 2-6 - Void ratio-effective stress relationships (Craig, 1987)

Virgin compression line the linear or nearly linear part of the e-log σ' shows the behavior of the normally consolidated clay. On the other hand, the state of the overconsolidated is represented by the point on the expansion or recompression parts of these curves. After the recompression stage the further compression happens along the virgin line. The plots also illustrates that the compressibility of overconsolidated clays is expected to be much less than the same clay in the normally consolidated state (Craig, 1987).

The compressibility of soils is represented by two different parameters:

- Coefficient of volume compressibility (m_v)
- Compression index (C_c)

Coefficient of volume compressibility (m_v) is defined as the volume change per unit increase in effective stress. This parameter can be calculated by as follows:

$$m_V = \frac{1}{(1+e_0)} \times \frac{(e_0 - e_1)}{(\sigma_0' - \sigma_1')} \tag{2.8}$$

$$m_V = \frac{1}{(H_0)} \times \frac{(H_0 - H_1)}{(\sigma_0' - \sigma_1')} \tag{2.9}$$

where e_0 is initial void ratio, e_1 is final void ratio, H_0 is initial layer thickness, and H_1 is layer thickness after external loadings. σ'_0, σ'_1 are initial effective vertical stress and effective vertical stress after applied loads respectively.

The value of the coefficient of volume compressibility is not constant for a certain type of soil because of the fact that coefficient of volume compressibility depends on the range of effective stresses. When effective stresses get larger, the value of void ratio becomes smaller.

The variation of initial effective stresses (σ'_0), the increase in the stress due to the applied external loading and the value of the coefficient of volume compressibility (m_v) with depth is presented in Figure 2.7. When this figure is examined, reduction in the value of the m_V parameter can be understood. The possible reason of this observation is that in-situ effective stresses and the confining stresses applied to soil masses gets larger with depth, thus the stiffness of soil gets higher and the value of the coefficient of volume compressibility reduces.

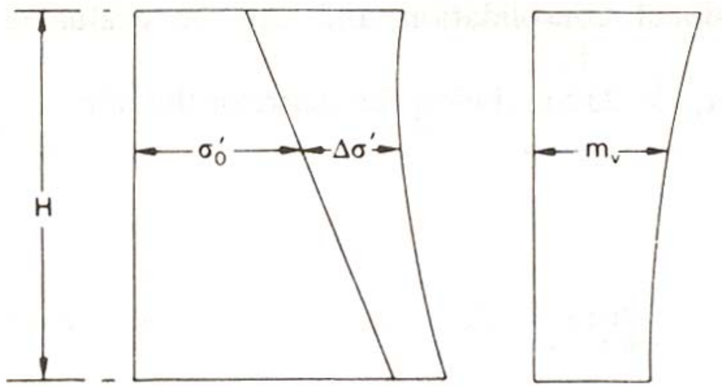


Figure 2-7 - The variation of initial effective stress and the coefficient of volume compressibility with depth (Craig, 1987)

The compression index (C_c) that is the other essential parameter to estimate the vertical deformation characteristics of soils can be evaluated by finding the slope of the linear part of curves of the variation of void ratio with effective stress i.e. the e-log σ' plots. Two different points are selected that are on the linear portion of that curve. C_c is calculated as a dimensionless parameter. The value of compression index (C_c) can be evaluated by the equation 2.10.

$$C_c = \frac{(e_0 - e_1)}{\log(\sigma_0' / \sigma_1')} \qquad (2.10)$$

2.3.3 Calculation of Consolidation Settlement

Predictions of consolidation settlement using the one-dimensional consolidation theory are based on the knowledge of the value of either coefficient of volume compressibility (m_v) and compression index (C_c). Thickness of soils (H) under the external loading, the change in the effective stress ($\Delta\sigma$) due to the subjected surcharge must also be known. The one-dimensional consolidation method commonly uses the results of oedometer tests that are performed on representative soil samples. It is assumed that the net lateral strain developed within the soil is equal to zero. The reason behind this assumption is the rigid confining ring used during oedometer test.

After the completion of the consolidation an equal increase $\Delta\sigma'$ in the effective stress will have occurred corresponding to a stress change from the σ'_0 to σ'_1 and a decreasing in void ratio from e_0 from e_1 on the curves of void ratio-effective stress relationship. The change in the void ratio results in the volume change. As mentioned before, the lateral strain is assumed to be zero and the observed change in volume per unit volume is equal to the displacement in the vertical direction. The settlement of the soil is calculated by the given equation:

By using the coefficient of volume compressibility (m_v)

$$\Delta V / V_0 = \frac{(e_0 - e_1)}{(1 + e_0)} \tag{2.11}$$

$$dS_C = \frac{(e_0 - e_1)}{(1 + e_0)} dz \tag{2.12}$$

$$dS_C = \left[\frac{(e_0 - e_1)}{(\sigma'_0 - \sigma'_1)}\right] \times \left[\frac{(\sigma'_0 - \sigma'_1)}{(1 + e_0)}\right] dz \tag{2.13}$$

$$dS_c = m_V \Delta\sigma' dz \tag{2.14}$$

$$S_c = m_V \Delta\sigma' H \tag{2.15}$$

By using the compression index (C_c)

$$S_c = C_c H \frac{\log(\sigma'_1 / \sigma'_0)}{(1 + e_0)} \tag{2.16}$$

The amount of consolidation settlement can be calculated by using equation 2.15 and 2.16. In order to predict the total settlement, initially soil is divided into sublayers and then the consolidation settlement is calculated for all individual layers. The sum of the sublayer settlements gives the amount of settlement of the whole layer.

2.3.4 Correlations between CPT Data and Compressibility of Soils

Deformation characteristics of soils are generally expressed by one-dimensional constrained modulus, M, undrained Young's modulus, in compression loading, E_u and small-strain shear modulus, G_o. One-dimensional consolidation settlement is based on the assumption that the lateral strain is equal to zero. Hence, the appropriate parameter to define the deformation characteristics of soils in the consolidation process is the one-dimensional constrained modulus, M. One-dimensional constrained modulus, M is defined as follows;

$$M = d\sigma_V' / d\varepsilon_V \quad (2.17)$$

$$M = 1/m_V \quad (2.18)$$

In which σ_v' is the vertical effective stress, ε_v is the vertical strain, and m_v is the coefficient of volume compressibility.

The amount of consolidation settlement can be calculated by substituting equation 2.18 in equation 2.15. Hence, the equation below is obtained:

$$S_c = 1/M \, \Delta\sigma' H \quad (2.19)$$

2.3.4.1 Methods to estimate the constrained modulus, M, for Clay

After an extensive literature survey, available methods based on the CPT data for determining the compressibility characteristics of soils have been complied. Sanglerat (1972), Jones and Rust (1995), Senneset et al. (1982, 1989) and Kulhawy and Mayne (1990) suggested a model for estimating constrained modulus of clays. Moreover, Manas et al. (1995), Formanavicius (1995), Mahesh et al. (1995) and Kaplan et al. (2004) also proposed a correlation for clays. Lunne and Christophersen (1983) suggested a method for overconsolidated and normally consolidated sands. All these methods will be discussed next.

The 1-D constrained modulus is expressed in terms of the cone tip resistance and coefficient, α_m as given in equation 2.20. Sanglerat (1972) proposed a comprehensive relationship for the coefficient, α_m for a wide range of the cone tip resistance (q_c) and type of the soils. This correlation is presented in Table 2.2.

$$M = \alpha_m q_c \tag{2.20}$$

Table 2-2 - Estimations of coefficient, α_m to find the constrained modulus, M, for clays (Sanglerat, 1972)

Cone tip resistance, q_C (MPa)	The range of coefficient α_m	Soil Type
q_C <0.7	3< α_m <8	Clay of low plasticity (CL)
0.7< q_C <2.0	2< α_m <5	
q_C >2.0	1< α_m <2.5	
q_C >2.0	3< α_m <6	Silts of low plasticity (ML)
q_C <2.0	1< α_m <3	
q_C <2.0	2< α_m <6	High plastic silts and clays (MH, CH)
q_C >1.2	2< α_m <8	Organic silts (OL)

After the data in Table 2.2 were studied, it was concluded that the value of coefficient, α_m gets smaller with the increase in the tip resistance. This observation is compatible with the observation that compressibility decreases with increased effective stress and increased strength.

Another correlation developed by Kulhawy and Mayne (1990) has a more general form as shown in equation 2.21 and does not depend on the soil type or the amount of the tip resistance. General relationship is expressed as follows

$$M = 8.25(q_t - \sigma_0) \tag{2.21}$$

The above correlation is also presented in the graphical form in Figure 2.8.

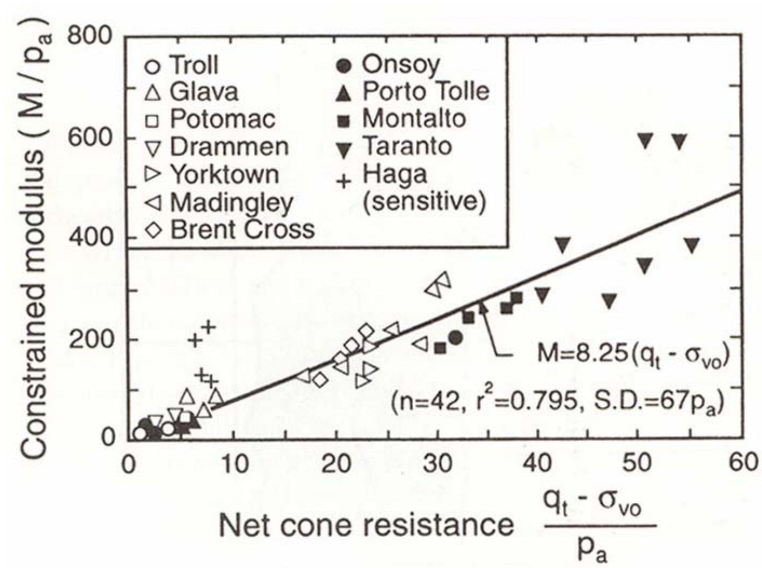


Figure 2-8 - General relationships between constrained modulus and net cone resistance (Kulhawy and Mayne, 1990)

An alternative correlation for the determination of constrained modulus is given by Senneset et al. (1982, 1989). Two different relations were developed for normally consolidated and overconsolidated clays. Senneset et al. (1982, 1989) proposed a linear interpretation model for overconsolidated clays, in the form of:

$$M_i = \alpha_i (q_t - \sigma_0) \tag{2.22}$$

The coefficient, α_i ranges from 5 to 15 for overconsolidated clays. Constrained modulus, M_i, for Glava clay was calculated by the Senneset et al.

(1989) methods as shown in Figure 2.9. Figure 2.9 also compares the values of constrained modulus, M_i, obtained from oedometer tests. When the plots shown in the Figure 2.9 are observed, a good match between the results of laboratory tests and the interpreted values of M_i for Glava clay can be seen.

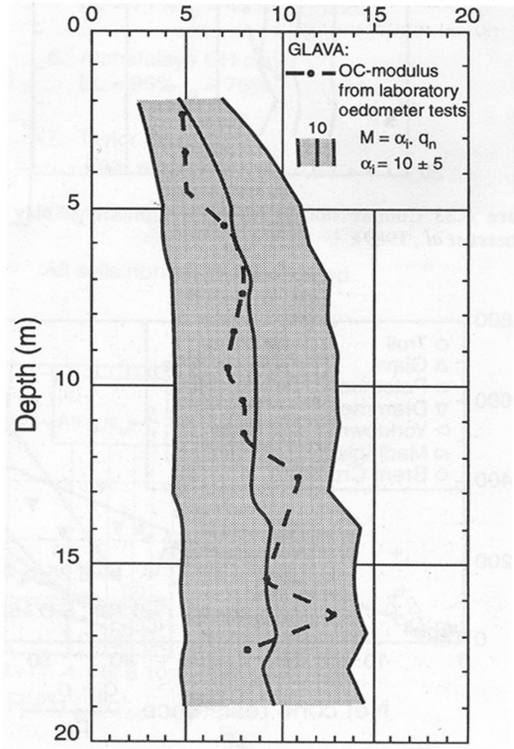


Figure 2-9 - Constrained modulus M_i for Glava clay (Senneset et al., 1989)

For normally consolidated clays the following relationship is recommended;

$$M_n = \alpha_n (q_t - \sigma_0) \tag{2.23}$$

According to the methods of Senneset et al. (1989) the coefficient, α_n is in the range of 4 to 8 for normally consolidated clays.

Some of the most recent correlations were developed by Manas et al. (1995), Formanavicius (1995), Mahesh et al. (1995) and Kaplan et al. (2004). Manas et al. (1995) suggested that the value of coefficient of one dimensional constrained modulus, α_n is equal to 0.8 for soft clays. On the other hand, Formanavicius (1995) has indicated that, a representative value of 10 can be used for the coefficient, α_n for clays. Mahesh et al. (1995) proposed another relationship for the coefficient, α_n for a wide range of the cone tip resistance (q_c) and type of clays. This correlation is presented in Table 2.3.

Table 2-3 - Estimations of coefficient, α_n to find the constrained modulus, M, for clays Mahesh et al. (1995)

Cone tip resistance, q_C (MPa)	The range of coefficient α_n	Soil Type
4.5< q_C <6.0	α_n = 1.37	Clays of low plasticity
4.0< q_C <4.5	α_n = 1.67	
2.5< q_C <4.0	1.7< α_n <2.8	
0.5< q_C <2.5	2.8< α_n <6.1	Clays of high plasticity

Kaplan et al. (2004) recommended another method for one dimensional constrained calculation. In this method, the database consisted of laboratory tests results and in-situ tests results obtained from Romania and Iskenderun sites was used. Distribution of cone tip resistance values with respect to the coefficient α values was developed and presented as in Figure 2.10.

Kaplan et al. (2004) recommended that the coefficient α is in the range of 4 to 12 for clay with a cone tip resistance value smaller than 0.75 MPa. Whereas, when the cone tip resistance value exceeds 0.75 MPa for clay, the coefficient α may be taken between 2.7 and 4.7.

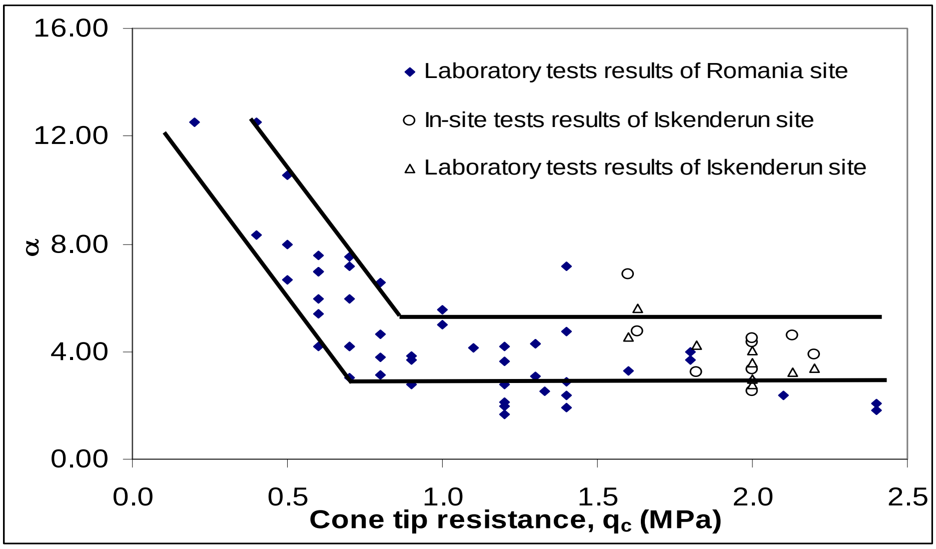


Figure 2-10 – Variation of α with cone tip resistance (Kaplan et al., 2004)

2.3.4.2 Methods to estimate the constrained modulus, M, for Sands

Lunne and Christophersen (1983) proposed a new method that evaluates M_0 for normally consolidated unaged and uncemented silica sands. This correlation is presented in equation 2.24 - 2.26.

$$M_0 = 4q_c \quad \text{for } q_c < 10 \text{ MPa} \tag{2.24}$$

$$M_0 = 2q_c + 20 \quad \text{for } 10\text{MPa} < q_c < 50 \text{ MPa} \tag{2.25}$$

$$M_0 = 120MPa \quad \text{for } q_c > 50\text{MPa} \tag{2.26}$$

Lunne and Christophersen (1983) recommended another correlation for overconsolidated sands as shown below:

$$M_0 = 5q_c \quad \text{for } q_c < 50 \text{ MPa} \tag{2.27}$$

$$M_0 = 250MPa \quad \text{for } q_c > 50 \text{ MPa} \tag{2.28}$$

CHAPTER 3

CASE HISTORY PROCESSING

3.1 INTRODUCTION

To develop robust and defensible correlations for the assessment of the soil compressibility based on CPT data, a database consisting of CPT logs and settlement plate readings was compiled. The database is composed of 57 settlement plate records and 45 CPT boring data consisting of cone tip resistance (q_c), friction sleeve resistance (f_s). CPT data and settlement plate readings were obtained from two different sites, which are (1) Bursa East Waste Water Treatment Plant Project and, (2) Bursa West Waste Water Treatment Plant Project.

Within the scope of West and East Waste Water Treatment Plant Projects, site investigation studies composed of 45 CPT were performed in Bursa city. An electronic cone penetrometer probe was used to perform CPT. 30 of CPT soundings were carried out in the East Waste Water Treatment Plant site and 15 of them were performed in the West Waste Water Treatment Plant site. Three of CPT were extended to a depth of 25 meter. Bursa West and East Waste Water Treatment Plant soil investigation layouts that show the location of available cone penetration tests are presented in Appendix A. Distribution of cone tip resistance (q_c), friction sleeve resistance (f_s), soil behavior type index (I_c) and soil profile of each one of the CPT logs are also given in Appendix B. After the CPT profiles were studied, it was concluded that the soil was too compressible and excessive settlements can occur.

In order to improve the soil site and prevent excessive settlements, it was decided to preload the site by 4 m high embankments. Several settlement plates were placed on embankments to record the variation of settlements with time. The compressibility of soils can be predicted by assessing the records of these settlement plates. The lay out of settlement plates of Bursa West and East Waste Water Treatment Plant sites are also presented in Appendix A.

The ultimate goal of this study is to develop a correlation to estimate one dimensional constraint modulus, which will later be used to estimate the settlement of soils. In order to predict the settlement of soil, soil profile, compressibility of soil and the change in effective stresses due to the applied preloading have to be known. To be able to obtain the first of these variables, the results of the CPT were evaluated and soil profiles were determined using Robertson and Wride (1997) CPT based soil classification correlation. The details of this part had been summarized in Chapter 2. Following that step, increase in the effective stresses in the soil masses due to the applied loading was calculated. For this, Boussinesq's method and the results of the Flac 3D models were used. Having the soil profile and change in the vertical stresses at hand, the compressibility of the soil must be estimated to compute the final settlement. For this, records of the settlement plates were used to evaluate the ultimate settlements occurring at the site which were then used in the regression analyses together with the settlement values predicted using the proposed one-dimensional constraint modulus, change in the stress distribution due to the applied surcharge and thickness of each sublayer. All these procedures are summarized in detail in the following sections of this chapter. The details of the development of the correlations will be discussed in Chapter 4.

Presenting results of all numerical analyses, theoretical calculations and outcomes of CPT soundings for whole site would not be feasible. Due to this fact, a smaller representative area was selected and is shown in Figure 3.1. The steps of this study, which had been carried out for entire site, will be summarized on this representative area.

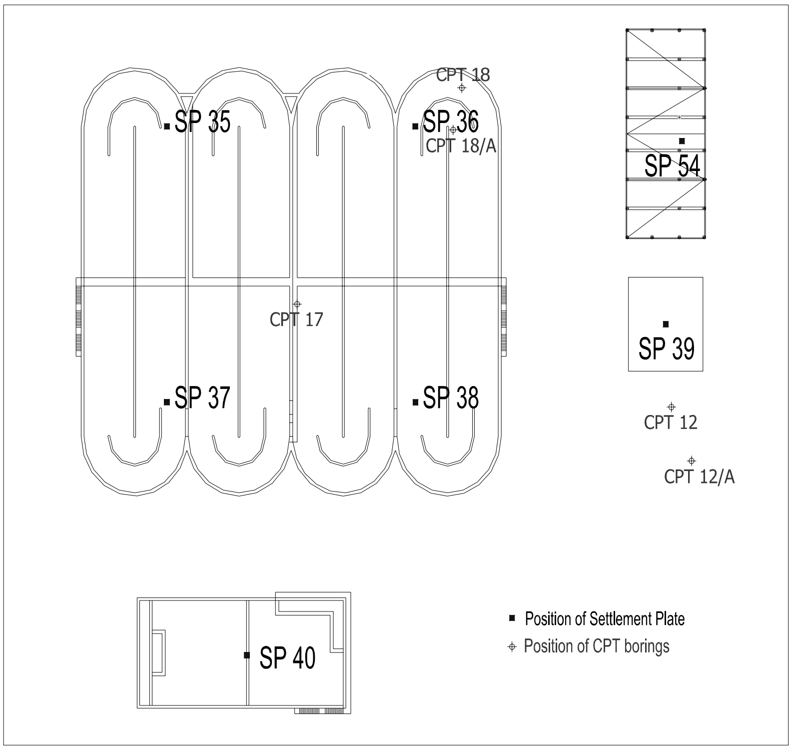


Figure 3-1 - The layout of selected representative area in the Bursa Eastern Waste Water Treatment Plant site

3.2 ESTIMATION OF ELASTIC STRESS DISTRIBUTIONS

The widely used method for calculation of settlements is based on the knowledge of the original stresses in the subsoil and their variation due to the external loadings. The state of stress produced in the subsoil by external loads was calculated by two different methods, which are: (1) Boussinesq's mathematical models and (2) results of Flac 3D, which is a three-dimensional finite-difference program. This section is divided into two parts in order to be able to focus on these two methods separately. Section 3.2.1 deals with Boussinesq's mathematical model and Section 3.2.2 deals with Flac 3D elastic analyses.

3.2.1 Boussinesq's Method

The initial step in the determination of the state of stress in soils is the determination of the character of external loads. The character of external loads can be defined by the intensity and geometry. The load may be either concentrated or continuous. Other parameters used to define the applied load are the type of the load distribution, (uniform, triangular, trapezoidal etc.) its direction and inclination. The dynamics of the external load, which is defined as the way in which the intensity and the geometry of that load vary with time, is another important parameter (J.Feda, 1978). In this study, applied loads that produce the change in effective stresses, $\Delta\sigma$, have variable geometries but a constant height of 4 m. Surcharge loadings are uniformly distributed short-term loadings.

In the calculations of the state of stress in the subsoil, the real soil is changed by a mathematical model of a half space to which various mechanical properties can be assigned. Boussinesq proposed a method based on the elastic theory that aims the calculation of changes in vertical stresses due to surface loads. Three dimensional problems involving stresses induced by various loading types can be solved by Boussinesq's equation. In order to use elastic relationships following assumptions are made:

- The soil is perfectly elastic material
- The relationship between strain and stress is linear
- The soil is isotropic and homogeneous
- The stresses are computed in a semi-infinite mass

The most frequent case in the geotechnical applications is a rectangular area subjected to a uniformly distributed load. This case can be solved in a comprehensive way by Boussinesq's method. The vertical stress at any point at a depth z below the corner of a uniformly loaded rectangular area can be calculated by the integration of the Boussinesq's equation given for the solution of the point load application. This mathematical expression is given in equation 3.2 and 3.3 for the point under the corner of the loading area.

$$\sigma_Z = qI_\sigma \qquad (3.2)$$

$$I_{\sigma} = \frac{1}{4\pi}\left[\frac{2mn(m^2+n^2+1)^{0.5}}{m^2+n^2+m^2n^2+1} * \frac{m^2+n^2+2}{m^2+n^2+1} + \tan^{-1}\frac{2mn(m^2+n^2+1)^{0.5}}{m^2+n^2-m^2n^2+1}\right] \quad (3.3)$$

where

$m = B/z$

$n = L/z$

In these equations I_{σ} is defined as influence factor, B and L are the width and length of rectangular loading, respectively.

Equation 3.3 was modified to compute the stress change at any point under the rectangular loaded area. This modification was based on dividing the loaded area to appropriate rectangles in order to make the point at which you want to compute $\Delta\sigma_z$, the corner of the all rectangular areas. This procedure could best be carried out by a software that computes the effects of various load patterns in the soil. To develop such a software, the programing language Visual Basic was selected. It was used effectively in order to give results in tabular form and plot the distribution of vertical stress with depth clearly.

That developed code can be used for only regular rectangular loading area. However, approximately half of the geometries of preloadings that were applied in the Bursa East and West Waste Water Treatment Plant project were irregular rectangular areas. Hence, another method had to be used in the calculation of that state of stress in the soil. The most appropriate way for this seemed to be the utilization of 3 dimensional finite difference program, Flac 3D. The details of that method is given in the next section.

3.2.2 Flac 3D Analyses

3.2.2.1 General Information

Flac 3D is a three-dimensional finite-difference program that is used in engineering computations. This program, which is based on the well established numerical formulations, has extended its analysis capacity into three dimensions, and simulates the behavior of three dimensional soil structures in a good manner. In that program, materials are represented by polyhedral elements within a three-dimensional grid to obtain the shape of the object to be modeled. Flac 3D analyses require the use of data input files.

In order to create a model in Flac 3D, three fundamental steps must be followed:

1. formation of a finite difference grid
2. assignment of constitutive behavior and material properties
3. definition of boundary and initial conditions

The grid generates the geometry of the problem. The constitutive behavior and material properties represent the response of the model under the external disturbance. Boundary and initial conditions define the state of in-situ conditions before the loading.

As mentioned before, first basic component of the Flac 3D analysis is creating the model by a finite difference grid. During the model generation, there are a number of criteria that must be considered. The first one is that, the boundary has to be placed far away enough from the surcharge to reduce the effect of boundary conditions. Secondly, in order to obtain more accurate results at critical points, the mesh size used at these points must be finer. The last one is that, the gradual change in the mesh sizes is preferable if different zones are needed to create a model. Abrupt changes in element sizes may cause some errors in the results, hence, that kind of modeling should be avoided. Within the scope of this study, the soil under the surcharge loading was modeled by finer meshes and it gets coarser as we move far away from the point of application of the surcharge. A model with a unique mesh size causes an increase in the number of elements and time of computation. Under the concern of these three crucial criteria, mesh geometry was constructed by optimizing the element size that will reduce the computation time and also give more reliable results. When the geometry of loading area is complex and has an irregular shape, the primitive geometry must be connected to form the irregular shape of application area with unbroken continuum. The most difficult step for obtaining an irregular model is that, all grid points along adjoining faces must correspond to each other. If grid points do not connect with each other, a discontinuity is observed in the stress distribution across the attached faces.

Once the grid generation is completed, material models and related properties have to be assigned to all of the elements in the model. The elastic, isotropic model is acceptable for homogeneous, isotropic, continuous material that shows a linear stress-strain behavior. For the elastic model, the required parameters are bulk and shear moduli of soil. In that model, each element behaves according to a predefined linear stress vs. strain relationship under the effect of applied loads. The method given in section 3.2.1 is based on the same material model; therefore the comparison of these two methods can be meaningful.

The last step in generating a Flac 3D model is the definition of the boundary and initial conditions. In Flac 3D, the boundaries are free of stress and unconstrained by default. In this study, displacement boundary conditions are used, in other words roller or pin boundaries are defined. A pinned boundary condition representing constraints in the x-, y- and z-directions is specified at the level of bedrock. The boundary condition at the other faces can be defined as fixed in the x-, y-directions only and free to move in the z-direction. Initial stress conditions, including gravitational loading can be imposed by adding the gravitational acceleration vector of 9.81 m/sec^2.

The final stage of a Flac 3D analysis is the solution of the generated problem. The Flac 3D finalizes the calculation steps once the ratio of the maximum unbalanced force for all the grid points in the model to the average applied load fall below the value of 1.0×10^{-5}. The outcomes of the solution can be presented as stress contours. Moreover, numeric values of the variation of stresses in the soil with depth can be obtained as an output. The second way of presenting the results of analysis gives more detailed information. The outputs of the Flac 3D analysis for all placed settlement plates are presented in Appendix C in tabular forms.

3.2.2.2 Comparison of two methods

In Bursa West and East Waste Water Treatment Plant project sites, small portion of preloaded area has regular shape. As mentioned before, the increase in the vertical stress under regular rectangular loaded area can be determined by both developed software based on the Boussinesq's method and Flac 3D analyses. To compare these two different methods, the loading case at settlement plate 50 (SP50) that is shown in the Bursa East Waste Water Treatment Plant soil investigation layout in Appendix A was used. The geometry of the applied loading is also given in Appendix A. The results of the Flac 3D analyses and Boussinesq's solution are presented in Figure 3.2. Once the graphs are evaluated, it was observed that the distributions of effective stresses in both cases are almost equal to each other. The small difference, less than 10%, that was seen in the variation of the effective stress changes with depth for two methods are negligible. The possible reason of that difference is the defined boundaries condition and mesh sizes in Flac 3D. Due to its simplicity, in this study the computations for the change in stresses due to applied loadings were performed by Flac 3D analysis.

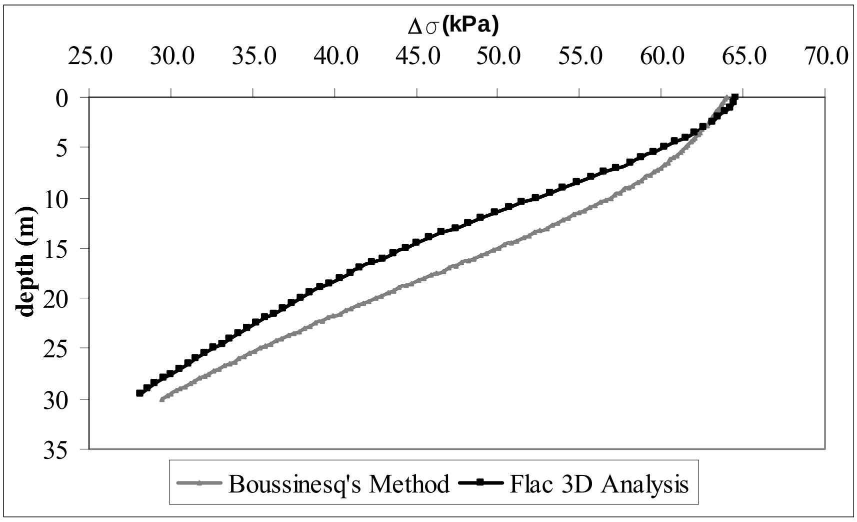


Figure 3-2 - Distribution of the change in vertical stress with depth at SP50 obtained by Boussinesq's method and Flac 3D analysis

3.2.2.3 Performed Flac 3D analysis results for the selected representative area

In this section, Flac 3D analyses results for the selected representative area shown in Figure 3.1 are presented in order to discuss the change in stress due to the given loading condition. The geometry of the applied external load is shown in Figure 3.3. As shown in that figure, the geometry of this loading case is not appropriate for the determination of the stress change by using Boussinesq's method. Thus, Flac 3D program was used.

The geometry of loading area with a constant height of 4 m is shown in Figure 3.3. Although the edges of the loading area have an inclination, the generated model did not have these inclined edges. As mentioned before, the most crucial criterion to obtain reliable and robust results from Flac 3D analysis is the attachment process. The geometry of this loading case is not primitive hence the primitive small areas were joined to each other to obtain this complex shape. During that step, grid points had to be attached to each other along the adjoining faces of the complex shape of loading area. To obey this rule and get consistent outputs, inclined portions could not be generated. Instead of the inclined parts, a new area which has an equivalent effect with the discarded inclined parts was generated. Then, the material properties of the soil were assigned to the generated elements. The unit weight of the material used as the external load was assumed to be 16 kN/m^3.

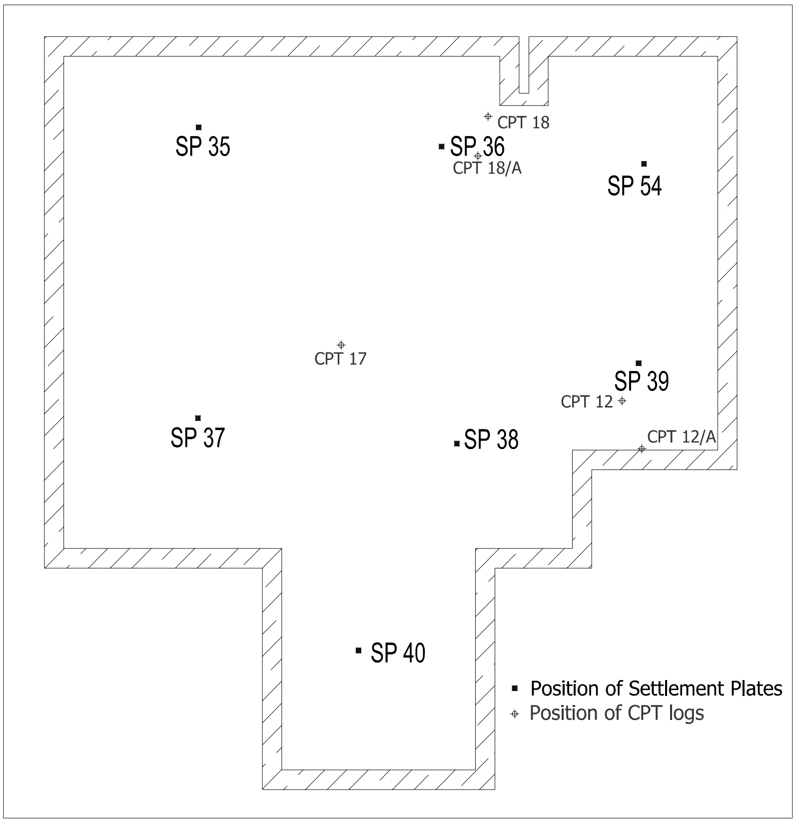


Figure 3-3 - Plan View of the Loading for Representative Site

By generating the model representing this preloaded area and solving that problem, the change in vertical stress at the points of SP35, SP36, SP37, SP38, SP39, SP40 and SP54 can be obtained. The variations of the increase in the stress at those points were summarized in Table 3.1.

Table 3-1 - The Distribution of Change in Vertical Stress with depth at the Position of Settlement Plate

	SP35	SP36	SP37	SP38	SP39	SP40	SP54
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.95	63.96	63.94	63.98	63.92	63.81	63.88
2.50	63.35	63.40	63.05	63.87	62.60	62.12	61.77
5.00	63.01	63.16	62.41	63.84	61.99	60.94	60.26
7.50	62.81	63.04	61.79	63.81	61.14	59.45	58.54
10.00	62.39	62.73	60.91	63.71	59.99	57.85	56.66
12.50	61.78	62.25	59.86	63.57	58.66	56.26	54.79
15.00	61.04	61.65	58.75	63.14	57.25	54.75	53.06
17.50	60.19	60.95	57.63	62.52	55.85	53.31	51.54
20.00	59.21	60.14	56.49	61.73	54.45	51.92	50.19
22.50	58.05	59.22	55.31	60.80	53.00	50.54	48.89
25.00	56.70	58.18	54.07	59.80	51.44	49.13	47.55
27.50	55.26	57.12	52.84	58.85	49.88	47.78	46.22
30.00	54.09	56.29	51.90	58.17	48.70	46.71	45.24

Once the results of the analyses were evaluated, it was observed that the change in stress at the surface was approximately 64 kPa, which seems to be a reasonable value. According to the available studies and knowledge about the increase in the vertical stress due to the applied external loads, the value is expected to be equal to the value of the applied pressure at the surface of the soil. Another point that was observed from the data given in Table 3.1 is that, the variation in the stress gradually decreases with the increase in depth.

Figure 3.4 presents the variation of stress with depth in the form of stress contours.

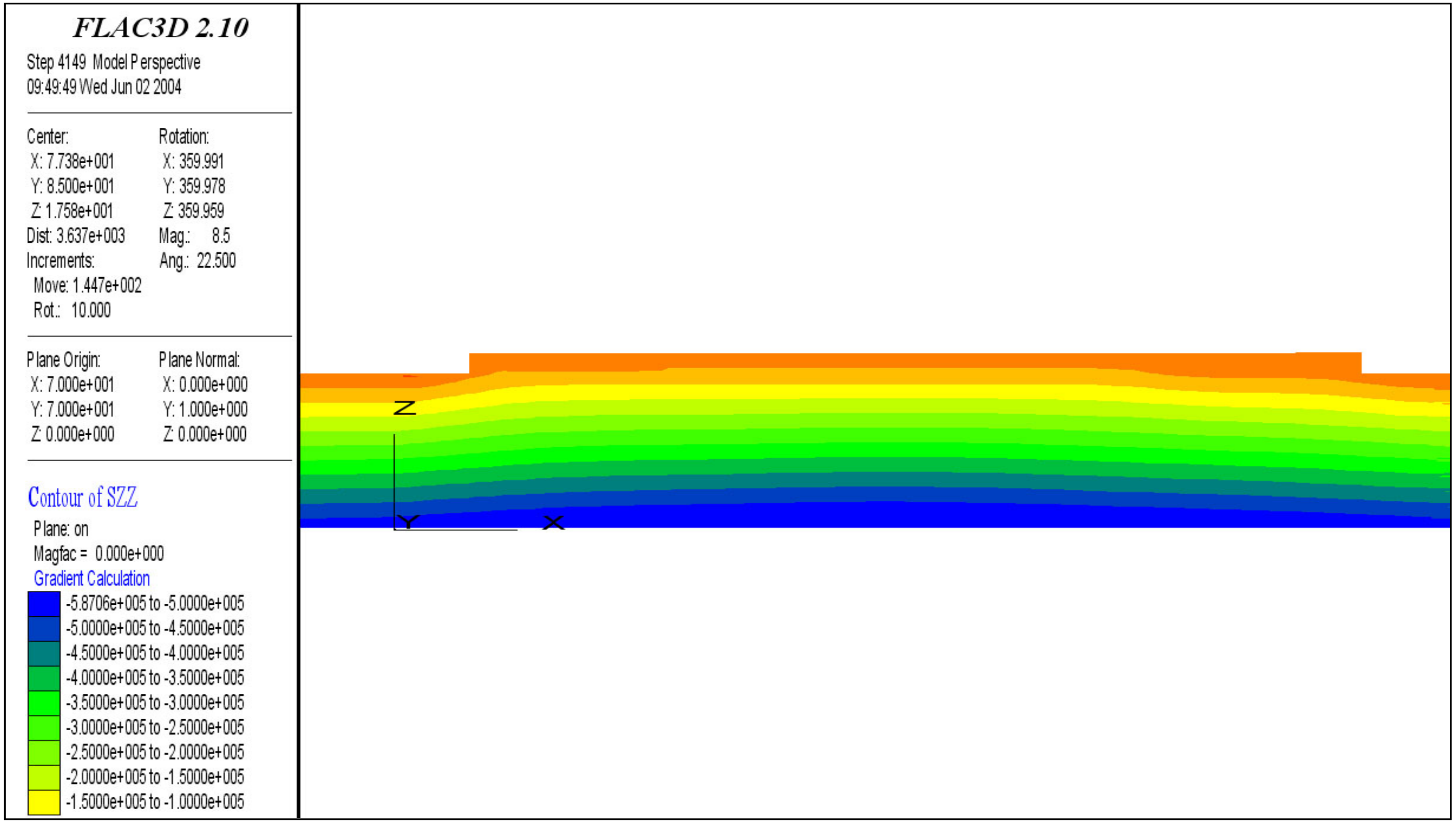


Figure 3-4 - Stress contours obtained from FLAC 3D for representative site

More continues information about the stress variation with depth at SP36 can be seen in Figure 3.5. Figure 3.5 shows the distribution of change in vertical stress due to the applied load. The results of the Flac 3D analyses for all settlement plates are given in Appendix C.

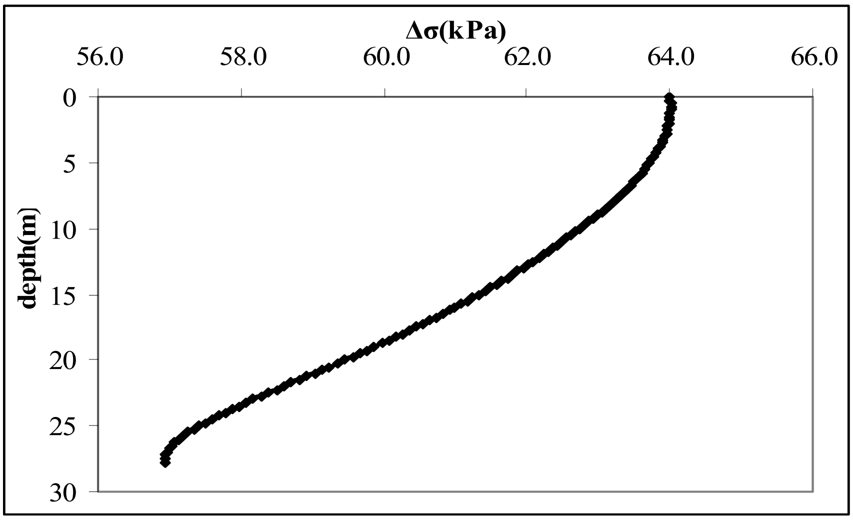


Figure 3-5 - Distribution of change in vertical stress due to the applied load

3.3 DETERMINATION OF CHARACTERISTICS OF SOIL SUBLAYERS

To predict the final settlement of a site, certain parameters such as the constrained modulus of the soil (M) and the variation of vertical stress in the soil must be known. The parameter that governs the compressibility behavior of soil varies with depth. Soil is an anisotropic and inhomogeneous material. Hence, using a single value for all of these parameters for a site may not yield reliable results. To obtain reliable results, soil must be divided into sublayers with representative parameters.

Performed CPT tests describe the soil profile and the sublayers of the soil at the location of the settlement plates. Because of the nonexistence of the CPT tests at exactly the same positions with the settlement plates, CPT tests that are in the close proximity to the considered settlement plate were selected to estimate the soil profile under that plate. Locations of the CPT soundings and settlement plates for the selected representative site can be seen in Figure 3.1. The summary of matching between CPT tests and settlement plates (SP) for the representative area is presented in Table 3.2.

Table 3-2 - Match between related CPT and Settlement Plate for chosen representative site

Site Name	Performed CPT Name	Placed Settlement Plate Name
Anaerobic Reactors	CPT18,CPT18/A	SP35
	CPT18,CPT18/A	SP36
	CPT17	SP37
	CPT17,CPT12,CPT12/A	SP38
Air Blower Building	CPT12,CPT12/A	SP39
Selector Tank	CPT17,CPT12,CPT12/A	SP40
Substation Building	CPT12,CPT12/A, CPT18,CPT18/A	SP54

CPT based soil classification charts provide the valuable data for the soil profiles. For some cases, for which the soil profile can not be known exactly, two or more CPT results were utilized for soil sublayering. The average values of cone tip resistance (q_c), friction sleeve resistance (f_s), soil type index (I_c) and also the variation in vertical stress due to the external loads ($\Delta\sigma$) were evaluated and used as representative parameters for each soil layer. The values of the representative parameters for each sublayer of soil at the location of SP54 were calculated and one of them was presented in Figure 3.6. These results will be used to propose a new method for calculation of settlement. The predicted settlement will be evaluated based on two or more different soil profiles and finally the average of those results will be used to estimate the settlement of soil under the applied load.

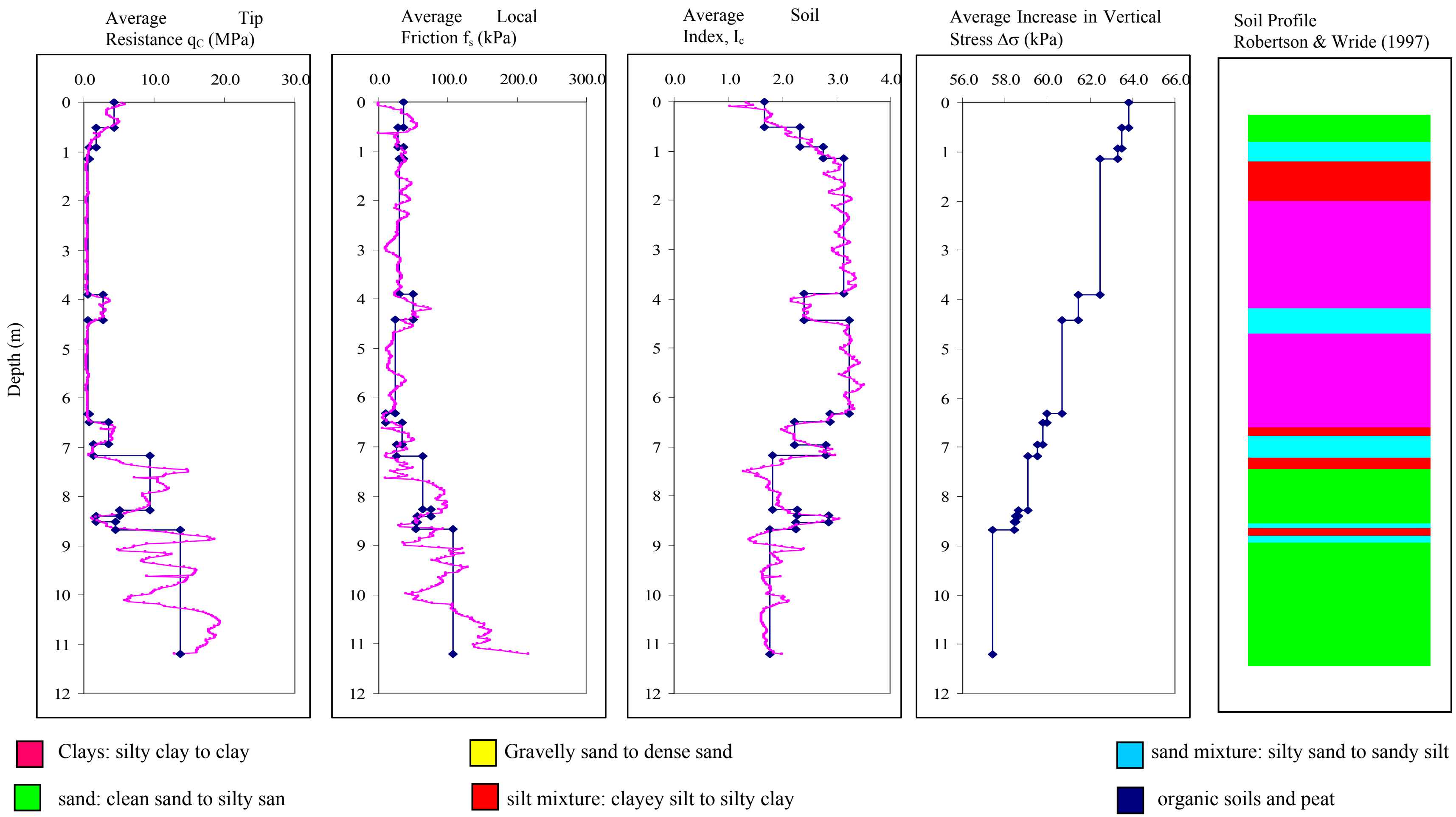


Figure 3-6 - Representative Parameters for CPT 12 and SP 54

3.4 Prediction of Soil Settlements by Graphical and Semi-empirical Methods

In this study various external loads were applied to different sites and the amount of settlement at each settlement plate was recorded with respect to time. The variation of the amount of accumulated settlement with settlement time is presented in Figure 3.7 for SP54. Once Figure 3.7 was evaluated, it was observed that the rate of consolidation settlement decreases with time. The observed settlement in the field due to the external load increases rapidly in the first 30-35 days. After the initial stage, the secondary compression phase starts and the consolidation settlement increases gradually. The rate of accumulation of settlement gradually decreases. Finally, the measured value of settlement reaches its ultimate value and becomes invariant under the given loading condition.

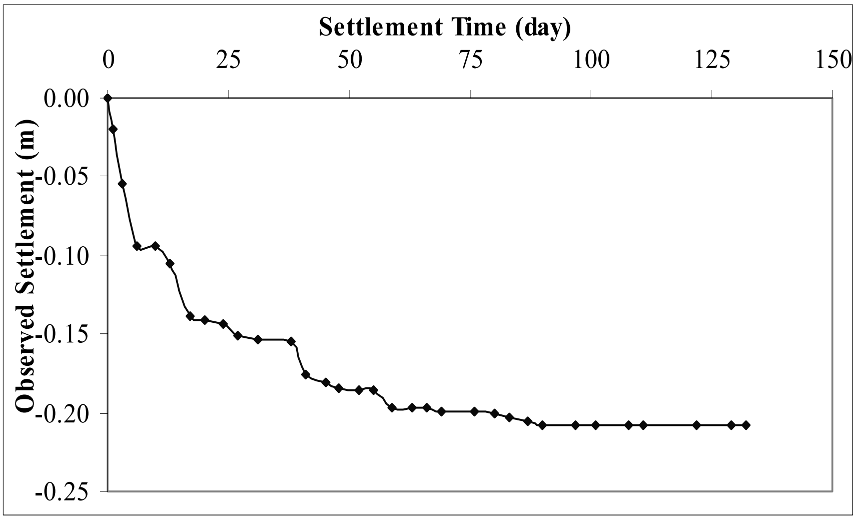


Figure 3-7 - The variation of consolidation settlement with time

Predicting the final consolidation settlement is a very crucial process for design purposes in geotechnical engineering. As mentioned before, required time to observe the final settlement is too long (theoretically infinite), and it is not practical to wait for this ultimate settlement to occur. Hence, the available methods in the literature are generally used to estimate the ultimate settlement. In this study, two different methods were used for the calculation of consolidation settlement:

- Asaoka's method
- Horn's method

Both of these methods are based on Terzaghi's one-dimensional consolidation theory. Details of these two methods are summarized in following sections

3.4.1 Asaoka's Method (Asaoka, 1978)

The method developed by Asaoka is based on the assessment of the past observations in order to predict the ultimate settlement. In order to be able to use this method, the settlement values measured at a certain time interval (Δt) must be known. The settlement values obtained at a time t_j ($t_j = \Delta t \, x \, j$; j=0, 1, 2,…) (S_j) are plotted against the amount of settlement measured at the time t_{j-1} (S_{j-1}). According to the definition of consolidation settlement, once the pore water dissipation is completed, the amount of settlement observed at the site remains constant meaning that the consolidation settlement process is over. In order to determine the ultimate value of the settlement that can take place due to the prescribed loading condition, the line that is fitted to the observed data points on the S_j vs. S_{j-1} plot is intersected with the x = y line. This intersection point designates the value where the two consecutive settlement values are equal to each other, and, in turn, this means that the settlement process was completed and the obtained value is the final value of the consolidation settlement due to the applied load.

This theory can be expressed by the graphical presentation that is shown in Figure 3.8. β_0 represents the intercept and β_1 represents the slope of the fitted line to the S_j and S_{j-1} values. The intersecting point of the fitted line with the $y = x$ line shows the expected final settlement (S_f). This philosophy is expressed by the following expression:

$$S_j = S_{j-1} \tag{3.5}$$

$$S_j = \beta_0 + \beta_1 \times S_{j-1} \tag{3.6}$$

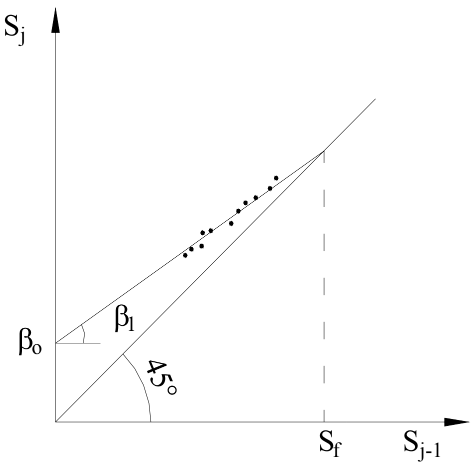


Figure 3-8 - Graphical presentation of Asaoka's method (Asaoka, 1978)

In this study, Asaoka's method was used to determine the ultimate settlement under different kinds of load cases for all settlement plates that were placed at various locations. A sample application of the Asaoka's method for settlement plate 54 (SP54) is shown in Figure 3.9.

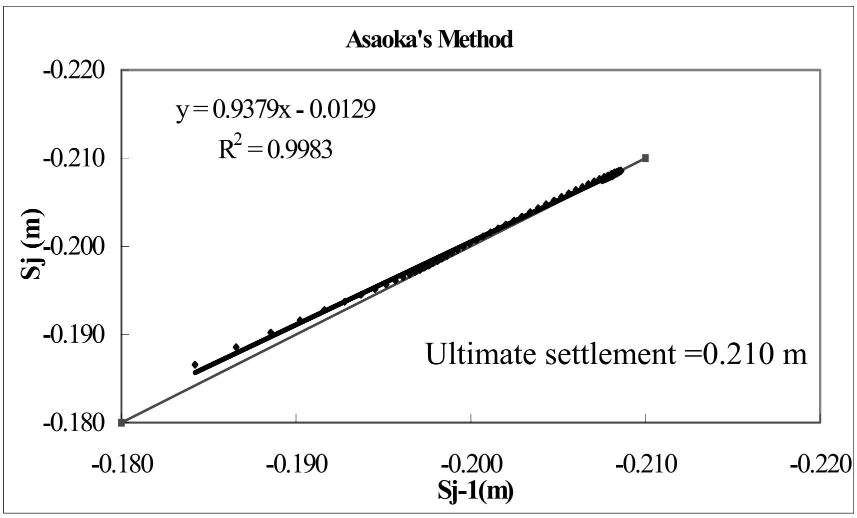


Figure 3-9 - Estimation of final settlement at SP54 due to the surcharge by using Asaoka's method

Prediction of the final settlement is effected by the variation in the observation period, meaning that time of the application of external loading is an effective parameter for the anticipation of settlement-time correlation and making reliable estimation of the ultimate settlement. Time between the start of the surcharge loading and the removal of the external load was approximately 130 days for the settlement plate 54 (SP54). At the end of the load application period, the measured settlement under the SP54 was 0.208 m. The settlement value estimated by using Asaoka's method is approximately 0.210 m. Once Figure 3.7 was evaluated, it was observed that the rate of consolidation settlement decreases with time and after a certain time, the value of settlement becomes invariant. Hence, the observation time is assumed to be enough to understand the consolidation behavior of soil, and, in turn, the calculated settlement by Asaoka's method is expected to be not too different from the last recorded settlement in the site.

Performed settlement predictions using Asaoka's method based on the past observations for all settlement plates that were placed at various places on West and East Waste Water Treatment Plant Project sites are given in Appendix D.

3.4.2 Horn's Method (Horn, 1983)

The other method used for the prediction of ultimate settlement in this study is Horn's method, which is based on the evaluation of the observed time vs. settlement curves. As mentioned before, the rate of the settlement decreases and then becomes zero after a certain time. The settlement speed, v^*, can be determined from the observed settlement vs. time curves. The slope of the tangent of those curves gives the rate of settlement. Figure 3.10 shows the representative settlement vs. time diagram and the inclination of these curves can be evaluated by using equation 3.6.

$$v^* = \frac{\partial s}{\partial t} \tag{3.6}$$

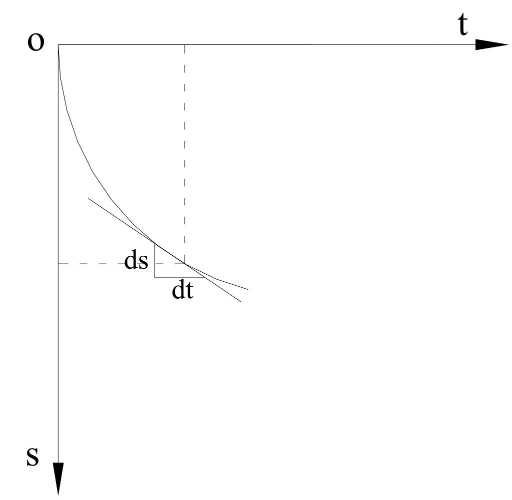


Figure 3-10 - Settlement vs. Time Diagram (Horn, 1983)

In order to estimate the ultimate settlement, total settlement time, t_f, must be known. Figure 3.11 shows the time vs. velocity diagram. The Horn's method (Horn, 1983) evaluates the rate of settlement curve, t - v^{*}, that runs against zero with a straight line. The value of the time at the zero speed, which means that intersection point of that straight line with the v = 0 line gives the total settlement time, t_f. In practice, drawing the real time-velocity curve as shown in Figure 3.11 is nearly impossible. Hence; a more practical and easier way was proposed by Horn to evaluate the ultimate settlement.

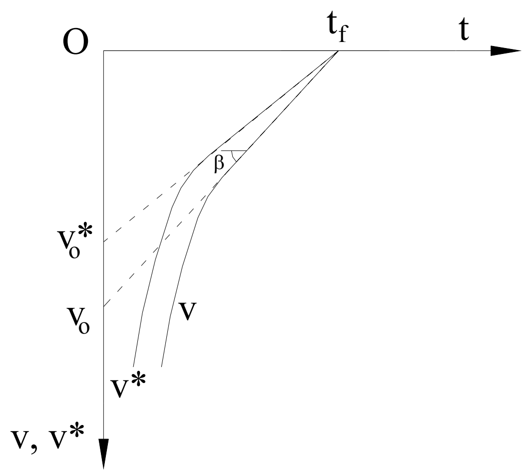


Figure 3-11 - Time vs. Velocity Relationship (Horn, 1983)

The easier way is based on the equation 3.7 leading practically to the same result without great deviation. The ultimate settlement value, S_f, can be evaluated by drawing the reciprocal of the velocity 1/v = t/s against time. Figure 3.12 presents the t vs. t/s diagram. By using that diagram, and the formulation given below, the ultimate settlement can be calculated.

$$S_f = \frac{t}{(t/s)} = \tan\alpha \tag{3.7}$$

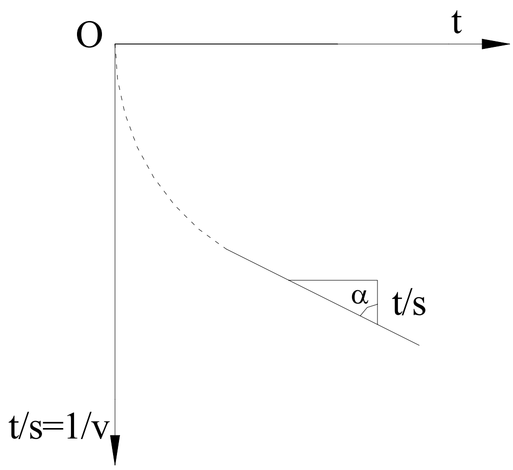


Figure 3-12 - Time vs. t/s Relationship (Horn, 1983)

Application of the Horn's method on the settlement plate 54 (SP54) is presented in Figure 3.13.

The ultimate settlement predicted by Horn's method is approximately 0.210 m. Once the results of the Asaoka's and Horn's methods were investigated, it was observed that these two settlement prediction methods give close results. The average of the results of these two methods is very close to the ultimate settlement value observed at the site. The predicted settlement values for the settlement plates in the selected representative site are summarized in Table 3.3. Conducted settlement prediction analyses based on Horn's method for all of the settlement plates at the project sites are presented in Appendix D.

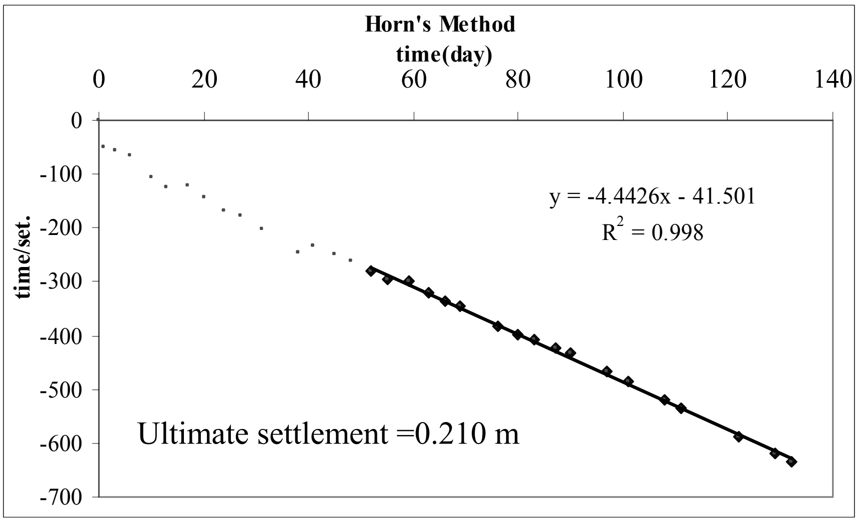


Figure 3-13 - Estimation of final settlement at SP54 due to the surcharge by using Horn's method

Table 3-3 - Review of final settlement prediction by using two different methods for the representative site

Settlement Plate	Final Settlement by Asaoka's Method (m)	Final Settlement by Horn's Method (m)	Average Final Settlement (m)
SP 39	0.211	0.212	0.2115
SP 54	0.210	0.210	0.210
SP 35	0.159	0.157	0.158
SP 36	0.200	0.198	0.199
SP 37	0.192	0.190	0.191
SP38	0.208	0.207	0.208
SP 40	0.181	0.184	0.183

3.5 DATABASE SUMMARY

The compiled database was used in this study for the development of CPT based compressibility assessment methods for soils. The most significant point in the database compilation for the regression analysis is that the predicted settlements and the observed ones must cover the same thickness of soils.

Once the performed CPT data were examined, it was observed that cone tip resistance (q_c) values are bit low. Hence; compressible soils may extend to deeper sublayer than the level of performed CPT reached. To investigate the correctness of that idea, the settlement was calculated between 25 meter and 50 meter depth of soils by using the correlation proposed by Sanglerat (1972) for one dimensional constrained modulus. Soil profile between these depths was found by an assumption that the last soil layer in CPT profile extends to 50 meter. The settlement occurred in the range of 25 meter to 50 meter depth was calculated approximately as 4-5 cm. In the light of this discussion, observed settlement values were corrected by subtracting that value from the settlements recorded at the site. The predicted settlement values were obtained along the CPT profile. Majority of performed CPT extended to a depth of 18-20 meters. Only three of them extended to 25 meter. To make logical comparison between the corrected observed settlement values and predicted ones CPT profiles were extended to a depth of 25 meter. These three CPT data were used properly to generate profiles for last 5-7 meter. The values of the corrected observed settlement and the predicted ones for soil profiles with 25 meter depth were used in the regression analysis.

The database used in this study for the development of CPT based compressibility assessment methods for soils consists of soil type index (I_c) that represents the type of soil layers and characteristic parameters such as; average cone tip resistance (q_c), and average friction sleeve resistance (f_S) of each sublayer of soil. The other two important parameters in the calculation of the settlement are the average value of increase in the vertical stress due to the sustained loading for each sublayer and the calculated ultimate settlement for each settlement plate for different loading conditions. These two parameters and others were compiled and database of this study was generated.

One of the examples of the prepared database for settlement plate 54 (SP54) in the selected site is presented in Table 3.4. Complete database is given in Appendix E.

Table 3-4 - Database Summary of SP54 with the related CPT 12 results in the selected representative area

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-54
SP54- Obserced Settlemen =0.180m	0.00	0.53	4.30	1.67	Sands:Clean Sand to Silty Sand	63.80
	0.53	0.93	1.73	2.32	Sand Mixture:Silty Sand to Sandy Silt	63.50
	0.93	1.15	0.69	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.32
	1.15	3.90	0.53	3.13	Clays: Silty Clay to Clay	62.46
	3.90	4.43	2.76	2.41	Sand Mixture:Silty Sand to Sandy Silt	61.48
	4.43	6.33	0.58	3.24	Clays: Silty Clay to Clay	60.70
	6.33	6.50	0.80	2.87	Silt Mixture: Clayey Silt to Silty Clay	60.00
	6.50	6.95	3.60	2.22	Sand Mixture:Silty Sand to Sandy Silt	59.79
	6.95	7.18	1.28	2.81	Silt Mixture: Clayey Silt to Silty Clay	59.54
	7.18	8.28	9.36	1.82	Sands:Clean Sand to Silty Sand	59.06
	8.28	8.40	5.12	2.28	Sand Mixture:Silty Sand to Sandy Silt	58.61
	8.40	8.53	1.78	2.85	Silt Mixture: Clayey Silt to Silty Clay	58.52
	8.53	8.68	4.53	2.24	Sand Mixture:Silty Sand to Sandy Silt	58.41
	8.68	11.20	13.77	1.77	Sands:Clean Sand to Silty Sand	57.40
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	57.36
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	57.00
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	56.55
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	55.85
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	55.23
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	54.98
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	54.80
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	54.69
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	54.54

Table 3-4 - Database Summary of SP54 with the related CPT 12 results in the selected representative area (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-54
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	54.28
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	54.01
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	53.85
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	53.57
	20.60	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	52.91
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	52.38
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	51.71
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	51.39
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	51.14

CHAPTER 4

DEVELOPMENT OF PROBABILISTIC CPT BASED COMPRESSIBILITY ASSESSMENT OF SOILS

4.1 INTRODUCTION

The main objective of this study is to develop a correlation for the prediction of compressibility of soil based on CPT data. In the development of this formulation, the database consisting of CPT data, field measurements of settlements and results of numerical analyses was used. The compiled database is presented in tabular form in Appendix E. In order to develop the correlations, maximum likelihood (ML) method was applied on select representative limit state models. This chapter summarizes the development of limit state models, implementation of ML method and the comparison of the proposed correlations with the other correlations available in literature.

4.2 LIMIT STATE MODELS FOR CPT BASED SOIL COMPRESSIBILITY

Development of limit state model for the CPT-based soil compressibility assessment starts with the selection of a mathematical model, which will capture the essentials of the problem. The model for the limit-state function is going to have a general functional form of $\hat{g} = g(x, \Theta)$, where x is a set of descriptive variables and Θ is the set of unknown model parameters.

Based on extensive sensitivity study and literature survey given in the section 2.2.4, one dimensional constraint modulus, M was assumed to be calculated by using the below given equation;

$$M = \alpha_m q_c \tag{4.1}$$

When the studies by Sanglerat (1972) and Lunne and Christophersen (1983) for the prediction of the one-dimensional constrained modulus coefficient, α_m, were examined, the general trend for α_m was observed to be possibly modeled by an exponential or logarithmic functions. The assumed general form of the α_m can be written as

$$\alpha_m = \theta_1 \ln(q_c^{\theta_2}) + \theta_3 \ln(I_c^{\theta_4}) + \theta_5 \tag{4.2}$$

$$\alpha_m = \theta_1 e^{\theta_2 (q_c^{\theta_3} I_c^{\theta_4})} \tag{4.3}$$

To evaluate the compressibility behavior of soils, specifically the one-dimensional constrained modulus coefficient, α_m, the values of ultimate observed settlements at the field were used in the regression analysis together with the predicted settlement calculated by developed formulation for α_m.

$$S_p = \sum_{i=0}^{i=n} S_i (q_{ci}, \Delta H_i, \Delta\sigma_i, \alpha_{mi}) \tag{4.4}$$

$$S_i(q_{ci}, \Delta H_i, \Delta\sigma_i, \alpha_{mi}) = \left[1 \big/ (\alpha_{mi} \times q_{ci}) \right] \times \Delta H_i \times \Delta\sigma_i \tag{4.5}$$

where

S_p is the total predicted settlement

S_i is the predicted settlement at the i^{th} sublayer

$i = 0, \ldots, n$ is the number of the sublayer for each soil profile

ΔH_i is the thickness of i^{th} sublayer

$\Delta\sigma_i$ is the increase in vertical stress for i^{th} sublayer

q_{ci} is the average cone tip resistance for the i^{th} sublayer

α_{mi} is the proposed constrained modulus coefficient for i^{th} sublayer

By using the proposed correlation for α_m in equations 4.2 and 4.3, the formulations given in equations 4.6 and 4.7 were developed to predict the final settlement of the soil. The representative functional forms that were used for the development of the functional form of one dimensional constraint modulus α_m:

$$\hat{g}_{\mathrm{I}}(S_o, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \Theta_{\mathrm{I}}) = S_o - \sum_{i=0}^{i=n}\left[(\Delta H_i \times \Delta\sigma_i) \Big/ ((\theta_1 \ln(q_{ci}^{\theta_2}) + \theta_3 \ln(I_{ci}^{\theta_4}) + \theta_5) \times q_{ci}) \right] \quad (4.6)$$

$$\hat{g}_{\mathrm{II}}(S_o, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \Theta_{\mathrm{II}}) = S_o - \sum_{i=0}^{i=n}\left[\Delta H_i \times \Delta\sigma_i \Big/ ((\theta_1 e^{\theta_2 q_c^{\theta_3} I_c^{\theta_4}}) \times q_{ci}) \right] \quad (4.7)$$

where

S_o is the observed settlement in the field

I_{ci} is the soil type index for ith sublayer

$\Theta_{\mathrm{I}} = (\theta_1, \ldots, \theta_5)$ is the set of model parameters for exponential function

$\Theta_{\mathrm{II}} = (\theta_1, \ldots, \theta_4)$ is the set of model parameters for logarithmic function

The limit state function given in equations 4.6 and 4.7 assume that the compressibility behavior of soils can be completely explained by the two descriptive variables of q_c and I_c. Obviously, there may exist additional parameters that influence the compressibility behavior of soils. However, both the observed field measurements and previous works such as Sanglerat (1972) and Lunne and Christophersen (1983) on this subject indicate that q_c is the most significant parameters that affect the value of α_m. Based on this fact, and in order to keep the proposed expression as simple as possible only these two parameters were used. However, to account for the influences of the missing variables and the possible deficiencies in the functional form, a random model correction term, ε was introduced and limit state function was modified.

$$\hat{g}_{\mathrm{I}}(S_o, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \Theta_{\mathrm{I}}) = S_o - \sum_{i=0}^{i=n}\left[(\Delta H_i \times \Delta\sigma_i) \Big/ ((\theta_1 \ln(q_{ci}^{\theta_2}) + \theta_3 \ln(I_{ci}^{\theta_4}) + \theta_5) \times q_{ci}) \right] + \varepsilon \tag{4.8}$$

$$\hat{g}_{\mathrm{II}}(S_o, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \Theta_{\mathrm{II}}) = S_o - \sum_{i=0}^{i=n}\left[\Delta H_i \times \Delta\sigma_i \Big/ ((\theta_1 e^{\theta_2 q_c^{\theta_3} I_c^{\theta_4}}) \times q_{ci}) \right] + \varepsilon \tag{4.9}$$

$\boldsymbol{\theta}_{\mathrm{I}} = (\theta_1, \ldots, \theta_5)$ is the set of model parameters for the logarithmic model, and $\boldsymbol{\theta}_{\mathrm{II}} = (\theta_1, \ldots, \theta_4)$ is the set of model parameters for exponential model. For the error terms in all models, it is reasonable and also convenient to assume that ε has a normal distribution. With the aim of producing an unbiased model (i.e., one that, in the average, makes the correct prediction), the mean of ε is set to zero. The standard deviation of ε, denoted σ_ε, however is unknown and must be determined. The set of unknown parameters of the exponential and logarithmic models, therefore, are $\boldsymbol{\Theta}_{\mathrm{I}} = (\boldsymbol{\theta}_{\mathrm{I}}, \sigma_\varepsilon)$ and $\boldsymbol{\Theta}_{\mathrm{II}} = (\boldsymbol{\theta}_{\mathrm{II}}, \sigma_\varepsilon)$ respectively.

4.3 Formulation of Likelihood Function for CPT-Based Compressibility Assessment of Soil

Let S_{oj} and S_{pj} is the observed and predicted settlement values at the j^{th} location in the site, respectively. Let ε_j be the corresponding realization of the model correction term. Assuming the observations compiled from different locations at the field to be statistically independent, the likelihood function can be written as the product of the probabilities of the observations:

$$L(\boldsymbol{\theta}, \sigma_\varepsilon) = \prod_{\text{SP no}=j=1}^{55} P\left[g(S_{oj}, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \varepsilon_j, \boldsymbol{\theta}) = 0 \right] \tag{4.10}$$

Here it is assumed that the measured values S_{oj}, $\Delta\sigma_i$, q_{ci}, I_{ci}, ΔH_i at each observation are exact, i.e., no measurement or estimation error is present. Then, noting that

$$g(S_{oj}, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \varepsilon_j, \boldsymbol{\theta}) = \hat{g}(S_{oj}, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \boldsymbol{\theta}) + \varepsilon_j \tag{4.11}$$

has a normal distribution with a mean of $\hat{g}(S_{oj}, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \boldsymbol{\theta})$ and standard deviation of σ_ε, the likelihood function can be written as

$$L(\boldsymbol{\theta}, \sigma_\varepsilon) = \prod_{j=1}^{55} \varphi\left[\frac{g(S_{oj}, q_{ci}, I_{Ci}, \Delta H_i, \Delta\sigma_i, \varepsilon_j, \boldsymbol{\theta})}{\sigma_\varepsilon}\right] \tag{4.12}$$

where $\varphi[\cdot]$ is the standard normal probability density function. Note that the above expression is a function of the unknown parameters $\boldsymbol{\theta}$ and σ_ε.

Having formulated the likelihood function, the values of the unknown model parameters $\boldsymbol{\theta}_{\mathrm{I}} = (\theta_1, \ldots, \theta_5)$ for exponential function, $\boldsymbol{\theta}_{\mathrm{II}} = (\theta_1, \ldots, \theta_4)$ for logarithmic function and standard deviation σ_ε of the model error term ε, which maximize the likelihood function, are computed. Table 4.1 and 4.2 summarize the exponential and logarithmic models parameters of the CPT-based compressibility assessment of soil limit state models.

Table 4-1 - Maximum likelihood estimates of logarithmic model parameters for CPT-based compressibility assessment of soil

θ_1	-0.30
θ_2	5.00
θ_3	-0.30
θ_4	2.00
θ_5	6.00
σ_ε	0.04
Ln (Max. likelihood value)	45.08

Table 4-2 - Maximum likelihood estimates of exponential model parameters for CPT-based compressibility assessment of soil

θ_1	6.61
θ_2	-0.10
θ_3	1.00
θ_4	0.40
σ_ε	0.04
Ln(Max. likelihood value)	45.32

4.4 PROPOSED NEW CORRELATIONS

If the model parameters given in Tables 4.1 and 4.2 are put into the Equations 4.2 and 4.3, the final closed form of the correlations for α_m becomes:

$$\alpha_m = -0.3\ln(q_c)^{5.0} - 0.3\ln(I_c)^{2.0} + 6.0 \tag{4.13}$$

$$\alpha_m = 6.6e^{-0.1(q_c \times I_c^{0.4})} \tag{4.14}$$

for the logarithmic and exponential cases, respectively.

4.4.1 Comparison of Settlement Values Obtained Using Logarithmic Correlation with Field Measurements

The observed and the predicted values or several cases are plotted in Figure 4.1 together with $y = x$, $y = x/2$ and $y = 2x$ lines. The predicted settlements shown in Figure 4.1 are calculated based on the logarithmic relation given above. When the data points in Figure 4.1 are examined, it is observed that the predicted values are close to the observed values and all the data points remain in the zone defined by $y = x/2$ and $y = 2x$ lines. This shows that, the proposed logarithmic correlation estimates the probable settlement of soil that will take place under a certain loading in a good manner.

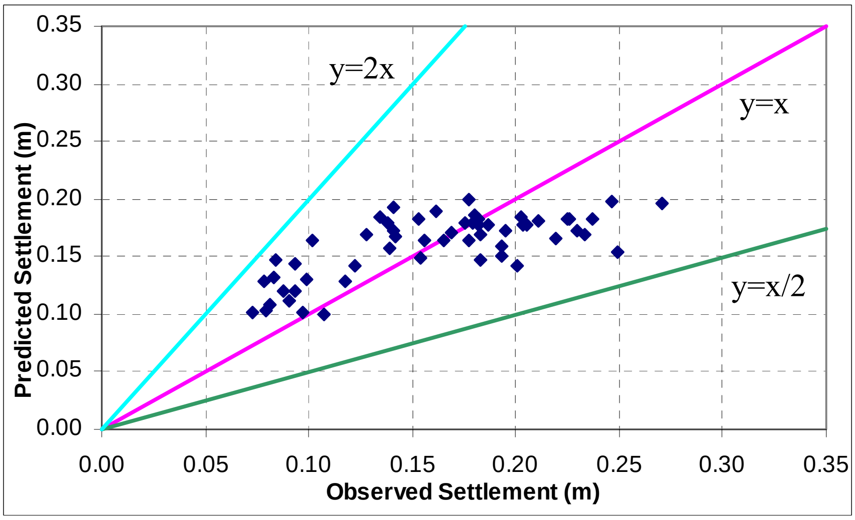


Figure 4-1 - Distribution of observed settlement and predicted settlement based on the logarithmic correlation

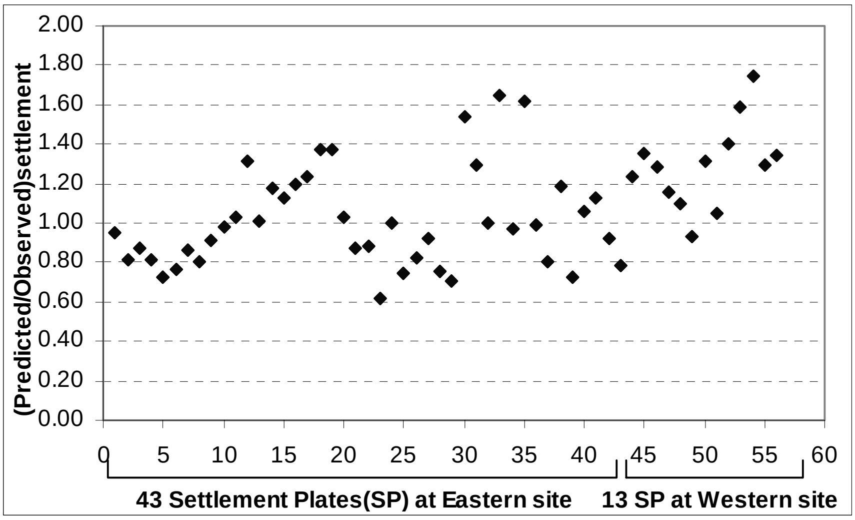


Figure 4-2 - Variation of the ratio of predicted settlement to the observed settlement

The other way of the assessment of the predictions of logarithmic correlation is the evaluating the ratio of the predicted settlement to the observed settlement. Those ratios are plotted in Figure 4.2. The ratios of settlement values generally fall in the range of 0.6 to 1.6. This figure shows that the proposed logarithmic correlation underestimates the settlement at some observations and also for the other observations overestimation can be seen.

4.4.2 Comparison of Settlement Values Obtained Using Exponential Correlation with Field Measurements

The values of settlement based on the above correlation are calculated and plotted with the measured settlement values at the field. This graph is presented in Figure 4.3. For the assessment of the correctness of method, the most crucial point is that, almost all of the predicted settlement values vs. observed settlement values must fall in the zone defined by $y = x/2$ and $y = 2x$ lines. This observation is still valid for the developed exponential correlation. The relationship between observed and predicted settlement values for the exponential form is very similar to the one for the logarithmic formulation.

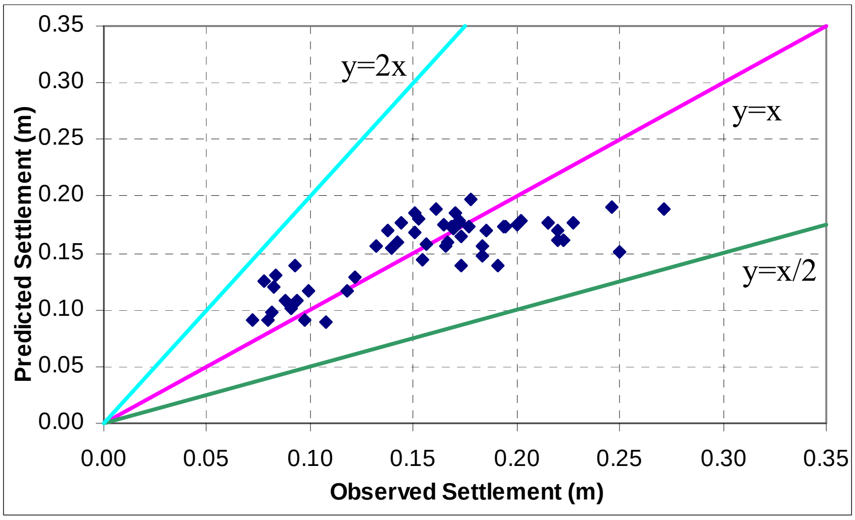


Figure 4-3 - Distribution of observed settlement and predicted settlement based on the exponential correlation

The ratio of predicted settlement to the observed settlement for the exponential form is shown in Figure 4.4.

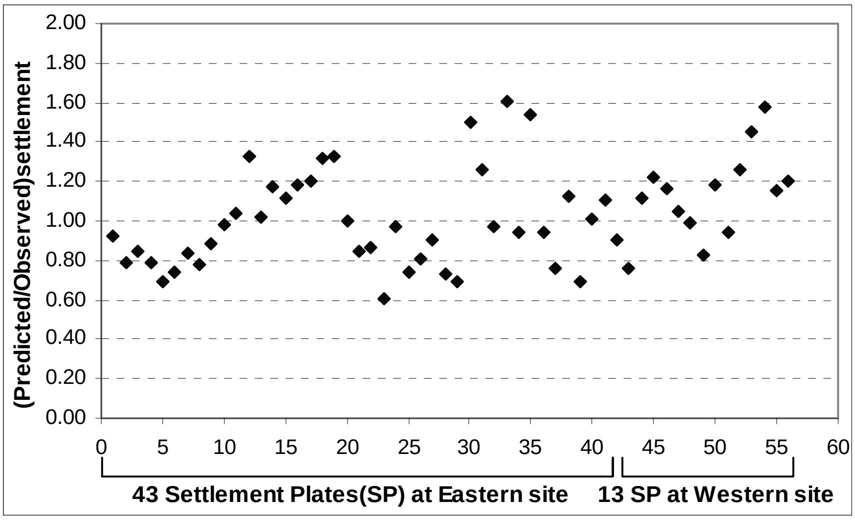


Figure 4-4 - Variation of the ratio of predicted settlement to the observed settlement

Table 4-3 - Partial descriptive of developed two methods for observed and predicted values of settlement

Proposed methods		S_p/S_o
Exponential method	**mean**	1.02
	St. dev	0.24
	cov	0.24
	Ln(Max.likelihood value)	45.32
Logarithmic method	**mean**	1.07
	St.dev	0.27
	cov	0.25
	Ln(Max.likelihood value)	45.08

The proposed correlations can be compared by focusing on the values of mean, standard deviation and coefficient of variation (COV) of the ratio of predicted to observed settlement values. When the results presented in Table 4.3 for exponential and logarithmic relations are evaluated; it is observed that the values of COV and standard deviation of exponential function is smaller than the logarithmic function. Once the maximum likelihood values given in Table 4.3 are evaluated, the value for exponential model is slightly higher than the logarithmic one. Hence, it can be stated proposed exponential correlation works better than the other for the purpose of the settlement calculation. On the other hand, the difference is too small and proposed two different relations give logical and consistent results with the observed settlement plate readings.

4.5 VALIDATION OF PROPOSED CORRELATIONS

In order to check the efficiency of the proposed models, settlement values were calculated for three different points, which were not used in the regression analyses. These points are located at the Bursa West Waste Water Treatment Plant site. Values of settlements observed from the developed models were compared with the observed settlements at the site.

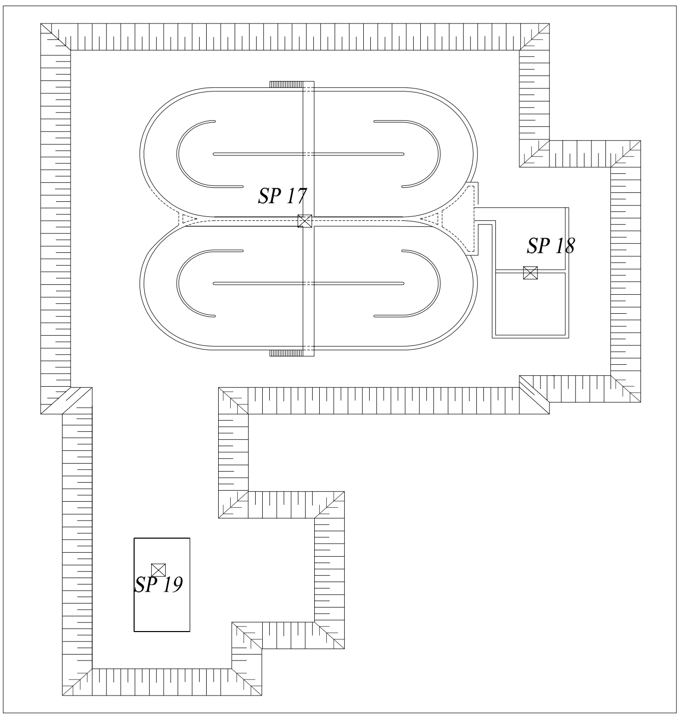


Figure 4-5 - Geometry of surcharge area of the selected validation cases

Soil profile for the selected site and the change in the effective stresses due to the applied preloading were obtained form CPT data and Flac 3D analysis respectively. The geometry of the surcharge area is presented in Figure 4.5 and the related Flac 3D model was generated for this applied loading. Having the soil profile and change in the vertical stresses at hand, the compressibility of the soil was evaluated by the proposed models. Thus, the final settlement can be computed. In Table 4.4, the settlement values obtained from the proposed models and the observed settlements are given together with the ratio of predicted to observed values. As it was observed from this table, the calculated settlement values are close to the observed ones, supporting the reliability of the proposed methods.

Table 4-4 - Comparison of the observed and predicted settlement values

	SP17	**SP18**	**SP19**
Observed Settlement (m)	0.09	0.16	0.09
Predicted Settlement by exponential (m)	0.11	0.14	0.11
Predicted/Observed	1.22	0.90	1.22
Predicted Settlement by Logarithmic (m)	0.13	0.16	0.12
Predicted/Observed	1.40	1.00	1.33

The ratio of predicted to observed settlement values for these three cases are presented in Figure 4.6 together with the ratios of others. After this figure was evaluated, it was observed that the ratios of these three points fall in the range of 0.6 to 1.6. That observation is compatible with the general trend of that model. In the same way, the observed and predicted values are plotted together with the values of other cases in Figure 4.7. This figure shows that observed settlement values for three validation points fall in the zone defined by $y = x/2$ and $y = 2x$ lines. This observation is also valid for the developed logarithmic correlation. All of those observations support the reliability of the proposed correlations.

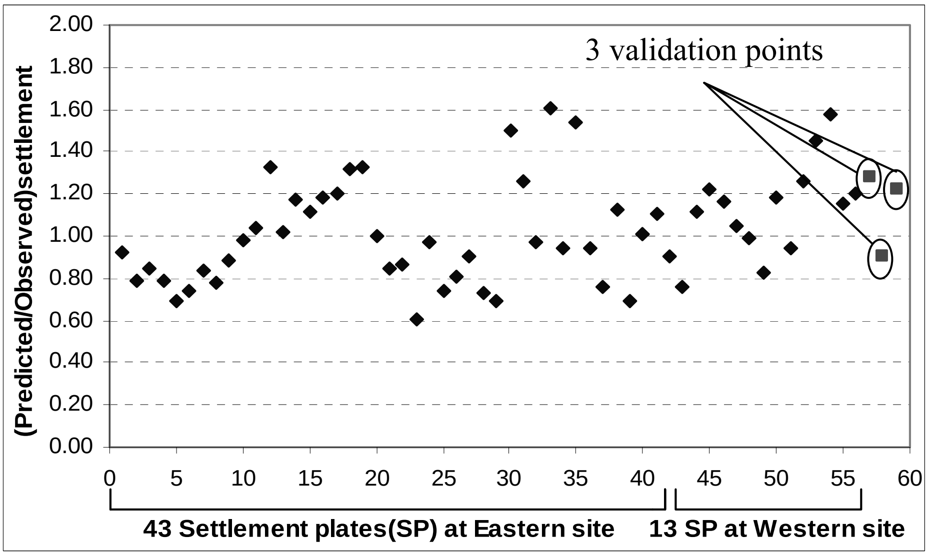


Figure 4-6 - Variation of the ratio of predicted settlement by exponential model to the observed settlement

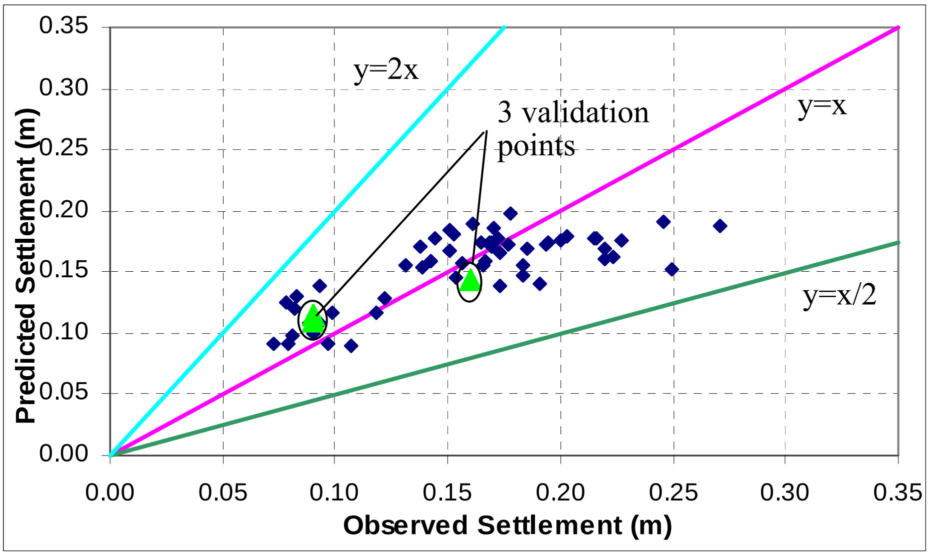


Figure 4-7 - Distribution of observed and predicted settlement based on the exponential correlation

4.6 SUMMARY OF DEVELOPED CORRELATIONS

In this study two correlations were proposed to predict the coefficient of one dimensional constrained modulus α_m. Proposed exponential and logarithmic correlations' results are presented in Table 4.5 and 4.6. These tables show that estimations of coefficient α_m for typical normally consolidated soils.

Table 4-5 - Estimations of coefficient α_m for different soil types according to the proposed exponential correlation

Soil Behavior Type Index, I_C	Soil Behavior Type	The Range of coefficient α_m	Typical value
I_C<1.31	Gravelly sand to dense sand	α_m<3.0	1.5
1.31<I_C<2.05	Sands: clean sand to silty sand	5.0<α_m<2.5	4.0
2.05<I_C<2.60	Sand Mixtures: silty sand	6.0<α_m<4.0	5.0
2.60<I_C<2.95	Silt Mixtures: clayey silt to silty clay	6.5<α_m<5.5	6.0
2.95<I_C<3.60	Clays: silty clay to clay	7.5<α_m<6.0	6.5
2.95<I_C<3.60	Over consolidated Clays: silty clay to clay	5.5<α_m<3.5	4.5
3.60<I_C	Organic soils: peats	α_m>6.0	6.5

Table 4-6 - Estimations of coefficient α_m for different soil types according to the proposed logarithmic correlation

Soil Behavior Type Index, I_C	Soil Behavior Type	The Range of coefficient α_m	Typical value
I_C<1.31	Gravelly sand to dense sand	α_m<3.0	1.5
1.31<I_C<2.05	Sands: clean sand to silty sand	5.0<α_m<2.5	4.0
2.05<I_C<2.60	Sand Mixtures: silty sand	6.0<α_m<3.5	4.8
2.60<I_C<2.95	Silt Mixtures: clayey silt to silty clay	7.0<α_m<5.0	6.0
2.95<I_C<3.60	Clays: silty clay to clay	9.0<α_m<6.5	7.5
2.95<I_C<3.60	Over consolidated Clays: silty clay to clay	5.5<α_m<3.0	4.5
3.60<I_C	Organic soils: peats	α_m>7.0	7.5

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 SUMMARY

One of the most critical problems a geotechnical engineer confronts with is the determination of the amount of consolidation settlement that will occur at a site as a result of the construction of a structure. If excessive settlements are expected due to the weight of the structure, precautions must be taken to prevent these excessive settlements. The compressibility behavior of the soil is an important parameter in determining the amount of consolidation settlement. The compressibility of the soil may be estimated using correlations based on laboratory results. However, the laboratory tests may not yield reliable results due to some reasons such as the possible disturbances introduced during sampling. Thus, using field data for the estimation of the compressibility of soils may be a more convenient way. The main objective of this study was to develop a correlation between the compressibility behavior of soil and in-situ test data, especially CPT.

Of the in-situ tests available, Cone Penetration Test (CPT) was used in this study. The main reason under this selection is the ability of CPT to supply continuous data about the soil.

First of all, a database composed of the results of 45 CPT and 57 settlement plate recordings was obtained from the Bursa East and West Waste Water Treatment Plants soil investigation projects. The data obtained from the CPT results include cone tip resistance (q_c) and friction sleeve resistance (f_s). These data were then used to determine the soil behavior type index (I_c) and finally the soil profiles at the test locations.

After the compilation of this database, a series of finite difference analyses were carried out using the commercial software FLAC 3D. The change in stress distribution under the settlement plates were computed using these analyses.

Then, two correlations were developed for the computation of the one-dimensional constraint modulus, M. One of them is of logarithmic form and the other one is exponential. These correlations are based on the cone tip resistance (q_c), soil behavior type index (I_c) and a number of model parameters (five in case of logarithmic expression and four in case of exponential). The values of these model parameters were computed by carrying out a regression analysis which uses the settlement values recorded at the site and those computed using the change in the stress distribution, the thickness of the sublayers and the proposed one-dimensional constraint modulus. The maximum likelihood method was utilized in the regression analyses carried out within the scope of this study.

5.2 CONCLUSION AND OBSERVATIONS

- Compressibility of soils can be estimated thought the use of one dimensional constraint modulus, M, which can be estimated as a function of cone tip resistance, q_c, and coefficient of constraint modulus, α_m.

$$M = q_c \times \alpha_m \tag{5.1}$$

As a part of these studies, α_m can be estimated by equation 5.2 or as given in Table 5.1.

$$\alpha_m = 6.6e^{-0.1(q_c \times I_c^{0.4})} \tag{5.2}$$

Table 5-1 - Estimations of coefficient α_m for different soil types according to the proposed exponential correlation

Soil Behavior Type Index, I_C	Soil Behavior Type	The Range of coefficient α_m	Typical value
I_C <1.31	Gravelly sand to dense sand	α_m <3.0	1.5
1.31< I_C <2.05	Sands: clean sand to silty sand	5.0< α_m <2.5	4.0
2.05< I_C <2.60	Sand Mixtures: silty sand	6.0< α_m <4.0	5.0
2.60< I_C <2.95	Silt Mixtures: clayey silt to silty clay	6.5< α_m <5.5	6.0
2.95< I_C <3.60	Clays: silty clay to clay	7.5< α_m <6.0	6.5
2.95< I_C <3.60	Over consolidated Clays: silty clay to clay	5.5< α_m <3.5	4.5
3.60< I_C	Organic soils: peats	α_m >6.0	6.5

- Both of the proposed correlations can estimate the settlement values by a factor of maximum 1.25. These proposed correlations are believed to be calibrated in the settlement range 0-30 cm.
- The cone tip resistance and soil behavior type index are very significant parameters that affect the compressibility behavior of soils.
- Three settlement plate records, which were not used in regression analyses, were used as validation cases. The settlement predictions at these validation cases were proved to be accurate within a factor of 1.25.
- One of the most important benefits of this study is that, the proposed correlations in this study take the effect of the variations in the soil type throughout the depth in contrast to the available methods which assume that all the soil profile is composed of a single soil type.

5.3 RECOMMENDATIONS

- The proposed correlations may be improved using a larger database which includes data from various sites.

- The settlement plate records used in this study give the settlement of the site as a whole. If the settlement value of each sublayer is recorded and used, an improvement in the proposed correlations can be achieved.

REFERENCES

Asaoka, A. (1978), "Observational Procedure of Settlement Prediction", Soils and Foundations, Vol.18, pp. 87-100.

Campanella, R.G., Gillespie, D. and Robertson, P.K. (1982), "Pore Pressures During Cone Penetration Testing", Proceedings, 2nd European Symposium on Penetration Testing, ESOPT II, pp.507-512.

Craig, R.F. (1987), Soil Mechanics, ELBS Edition (UK), England.

Das, B.V. (1983), Advanced Soil Mechanics, McGraw-Hill Book Company, New York

Feda, J. (1978), Stress in Subsoil and Methods of Final Settlement Calculation, Elsevier Scientific Publishing Company, New York

Furmonavicius L., Dagys A. (1995), "Cone Penetration Testing In Lithuania", International Symposium on Cone Penetration Testing, Vol.1, pp.125-131, Linköping, Sweden.

Horn, A. (1983), "Determination of Properties of Weak Soils by Test Embankments", International Symposium on Soil and Rock Investigations by In-situ Testing, Paris, Vol.2, pp.61-66.

Jefferies, M.G. and Davies M.P. (1993)", Use of CPTu to Estimate Equivalent SPT N_{60}", Geotechnical Testing Journal, Vol.16, pp.458-467.

Jones, G.A. and Rust, E. (1995), “Piezocone Settlement Prediction Parameters for Embankments on Alluvium”, Proceedings of the International Symposium on Cone Penetration Testing, CPT’95, Linköping, Sweden, Vol.2, pp.501-508, Swedish Geotechnical Society.

Kaplan, N., Cakan, G. and Erol, A.O. (2004), “Plastik Killerde Ödometrik Deformasyon Modülünün CPT Uç Direncinden Tahmini”, Zemin Mekaniği ve Temel Mühendisliği Onuncu Ulusal Kongresi, Istanbul Teknik Üniversitesi, Istanbul.

Kulhawy, F.H. and Mayne, P.H. (1990), “Manual on Estimating Soil Properties for Foundation Design”, Electric Power Research Institute, EPRI, August, 1990.

Lunne, T. and Christophersen, H.P. (1983), “Interpretation of Cone Penetrometer Data for Offshore Sands”, Proceedings of the Offshore Technology Conference, Richardson, Texas, Paper No. 4464.

Lunne, T., Robertson, P.K. and Powell, J.J.M. (1997), “Cone Penetration Testing in Geotechnical Practice”, Blackie Academic& Professionals

Mahesh, D. and Vikash, J. (1995), “State of Art of CPT in India”, International Symposium on Cone Penetration Testing, Vol.1, pp.87-95 Linköping, Sweden.

Manas, S. and Linaresh, H. (1995), “The use of Cone Penetration Testing in Spain (NR4)”, International Symposium on Cone Penetration Testing, Vol.1, pp.213-220, Linköping, Sweden.

NCEER (1997), "Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils", Edited by Youd, T. L., Idriss, I. M., Technical Report No. NCEER-97-0022, December 31, 1997.

Olsen, R.S. (1994), "Normalization and Prediction of Geotechnical Properties using Cone Penetration Test (CPT)", Ph.D. Dissertation, University of California, Berkeley, CA.

Olsen, R.S. and Mitchell, J.K. (1995), "CPT Stress Normalization and Prediction of Soil Classification", Proceedings of the International Symposium on Cone Penetration Testing, CPT'95, Linköping, Sweden, Vol.2, pp.257-262, Swedish Geotechnical Society.

Robertson, P.K. (1990), "Soil Classification using the Cone Penetration Test", Canadian Geotechnical Journal, Vol.27 (1), pp.151-158.

Robertson, P.K. and Wride, C.E. (1997), "Cyclic Liquefaction and its Evaluation Based on the SPT and CPT", Proceedings of NCEER Workshop on Evaluation of Liquefaction Resistance of Soils, National Center For Earthquake Engineering Research State University of New York at Buffalo.

Sanglerat, G. (1972), "The Penetrometer and Soil Exploration", Elsevier, Amsterdam, pp. 464

Senneset, K., Janbu, N. and Svano, G. (1982), "Strength and Deformation Parameters from Cone Penetration Tests", Proceedings of the 2nd Europen Symposium on Penetration Testing, ESOPT-II, Amsterdam, 2, 863-70, Balkema Pub., Rotterdam.

Senneset, K., Sandven, R. and Janbu, N. (1989), “The Evaluation of Soil Parameters from Piezocone Tests”, Transportation Research record, No. 1235, pp.24-37.

Terzaghi, K. (1947), Theoretical Soil Mechanics, Chapman and Hall, Limited John Wiley and Sons, Inc New York.

APPENDIX A

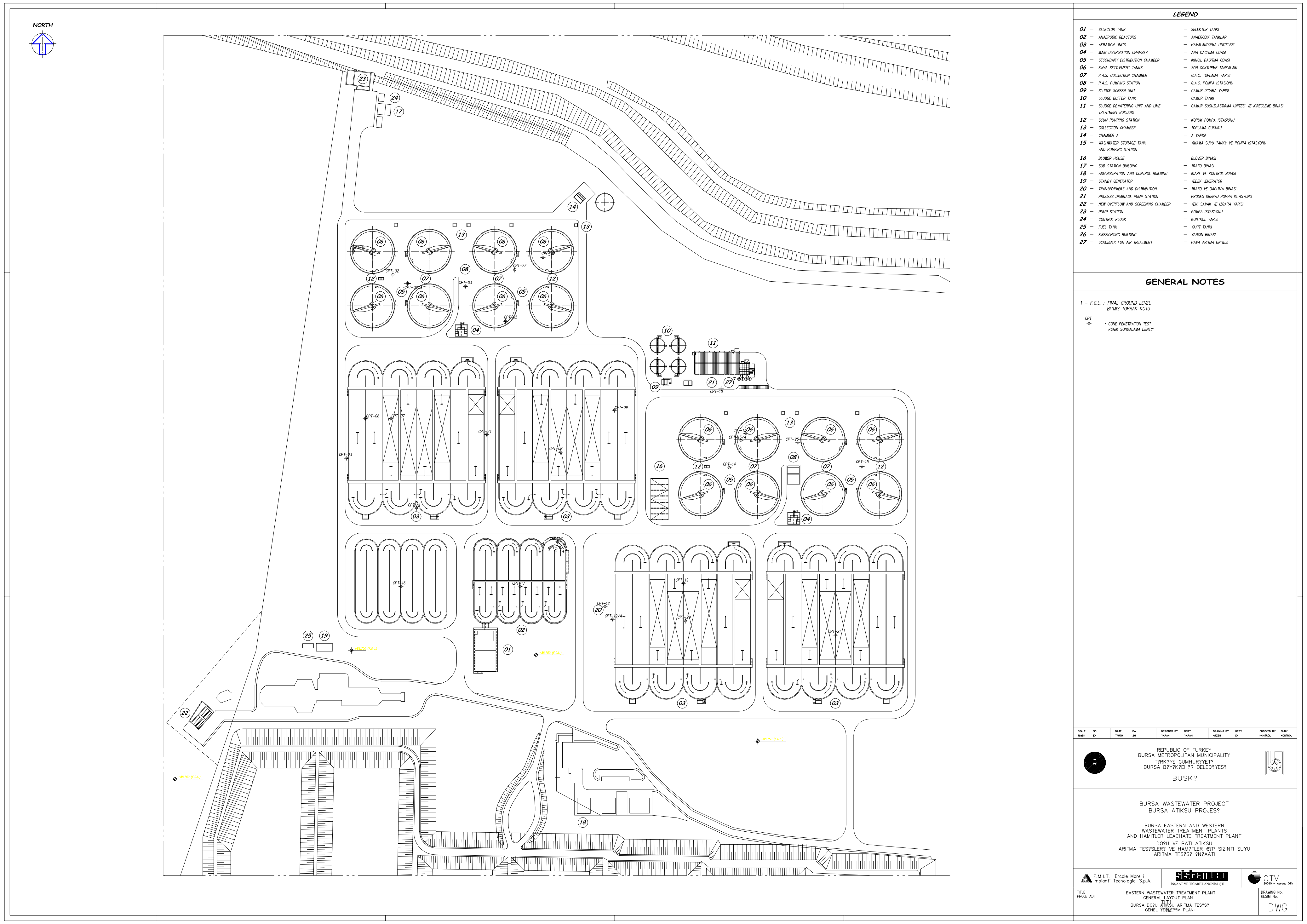


Figure A1 - CPT Layout of Bursa East Waste Water Treatment Plant

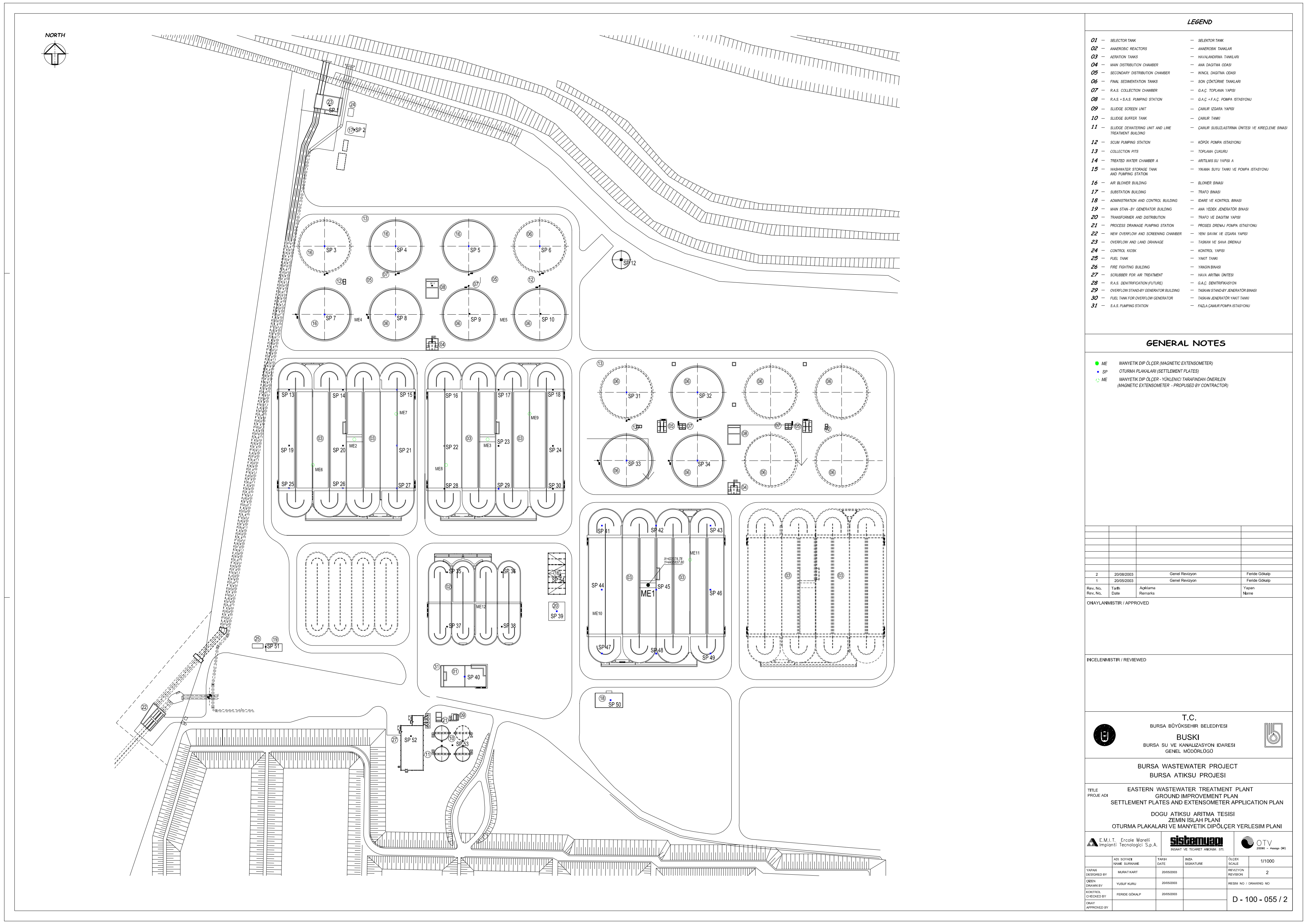


Figure A2 - SP Layout of Bursa East Waste Water Treatment Plant Project

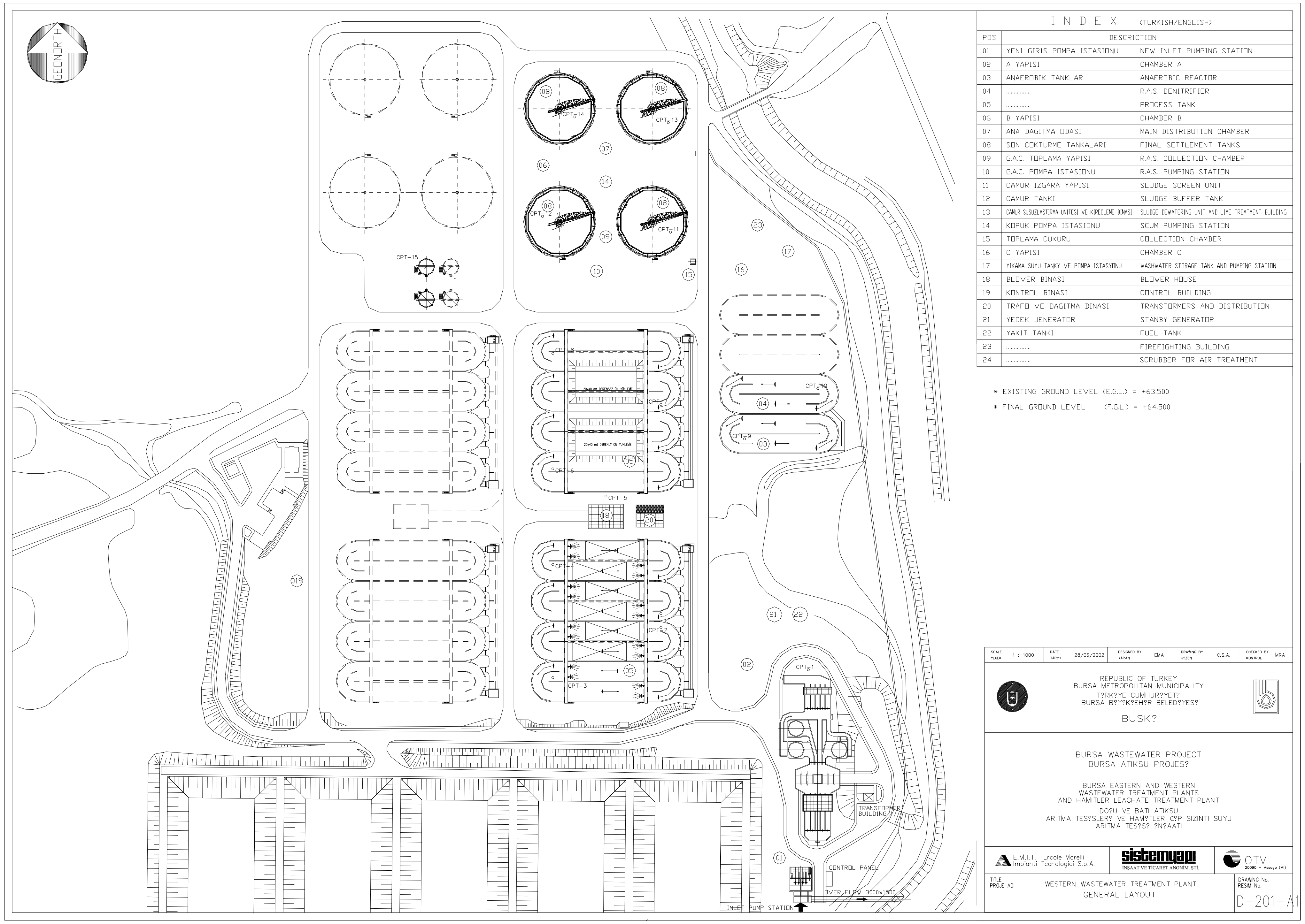


Figure A3 - CPT Layout of Bursa West Waste Water Treatment Plant Project

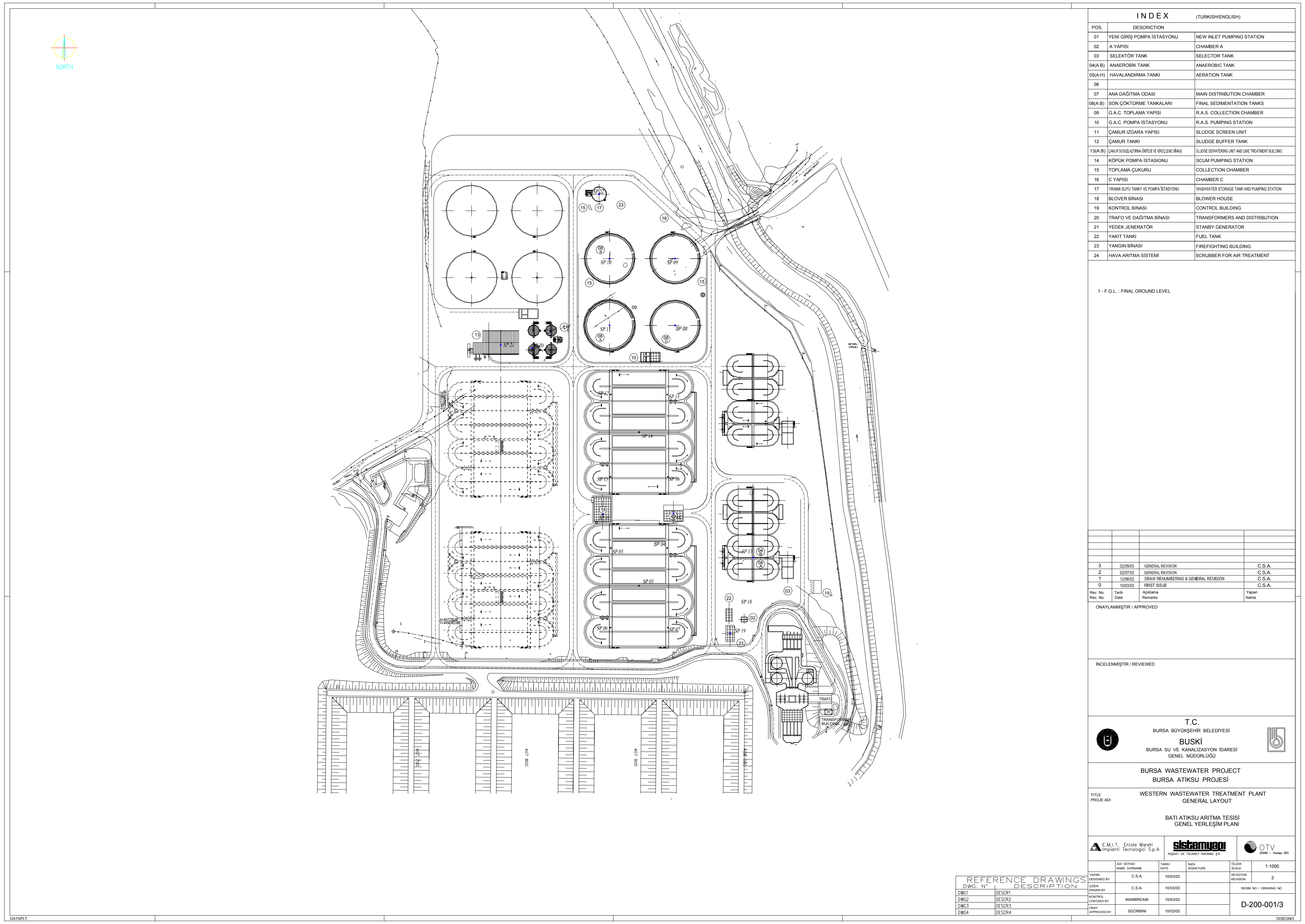


Figure A4 – SP Layout of Bursa West Waste Water Treatment Plant Project

APPENDIX B

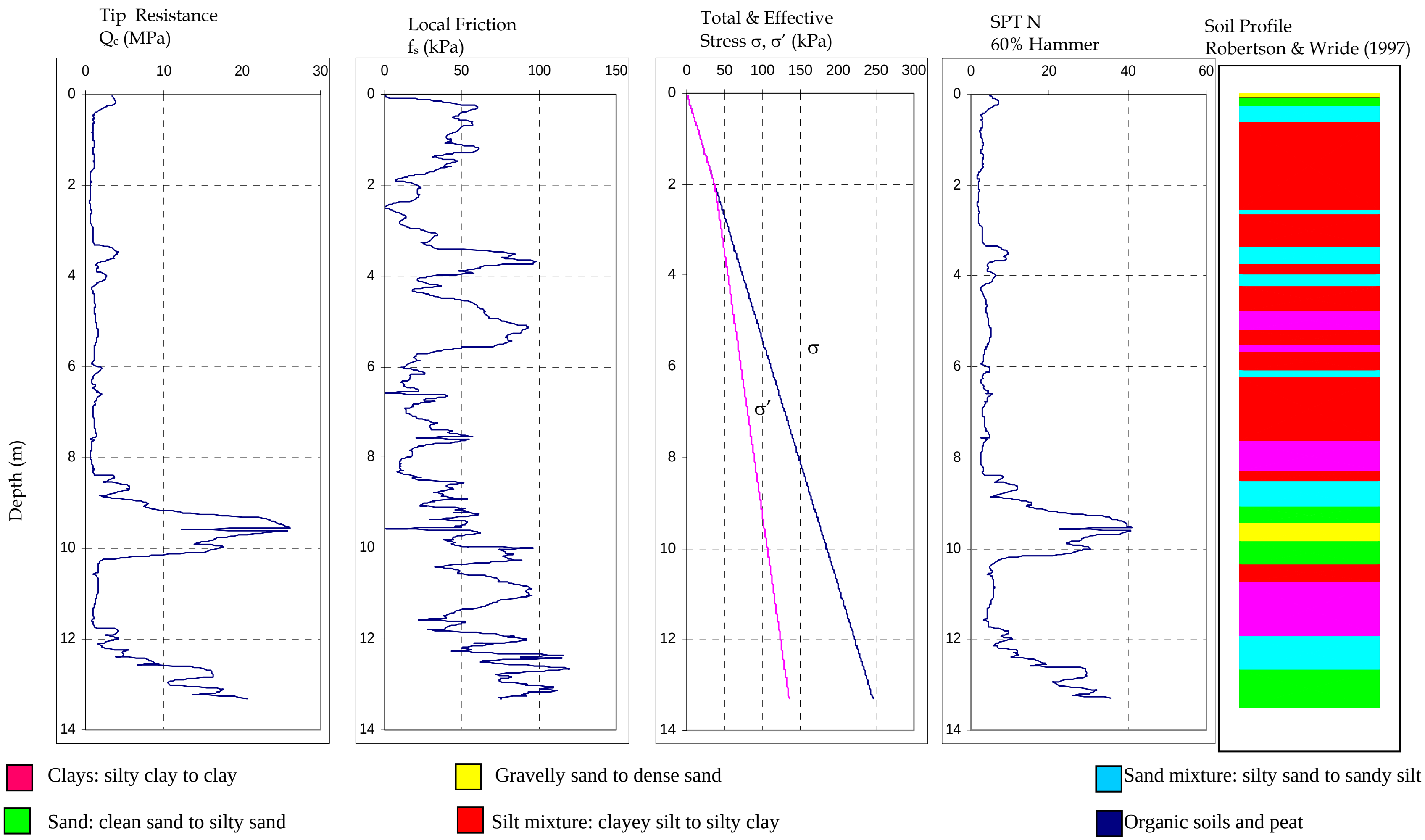


Figure B.1 – CPT 2

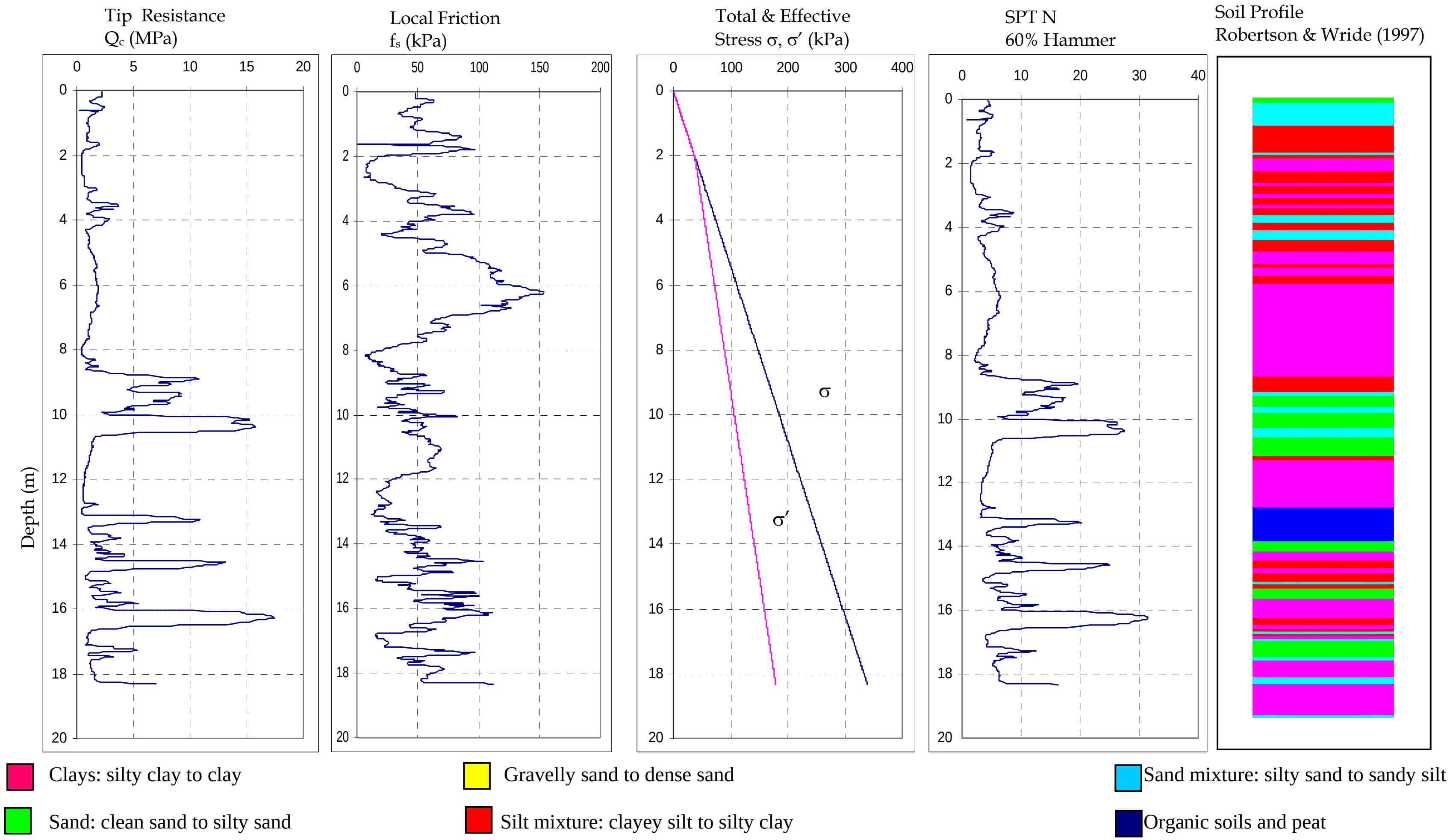


Figure B.2 – CPT 2a

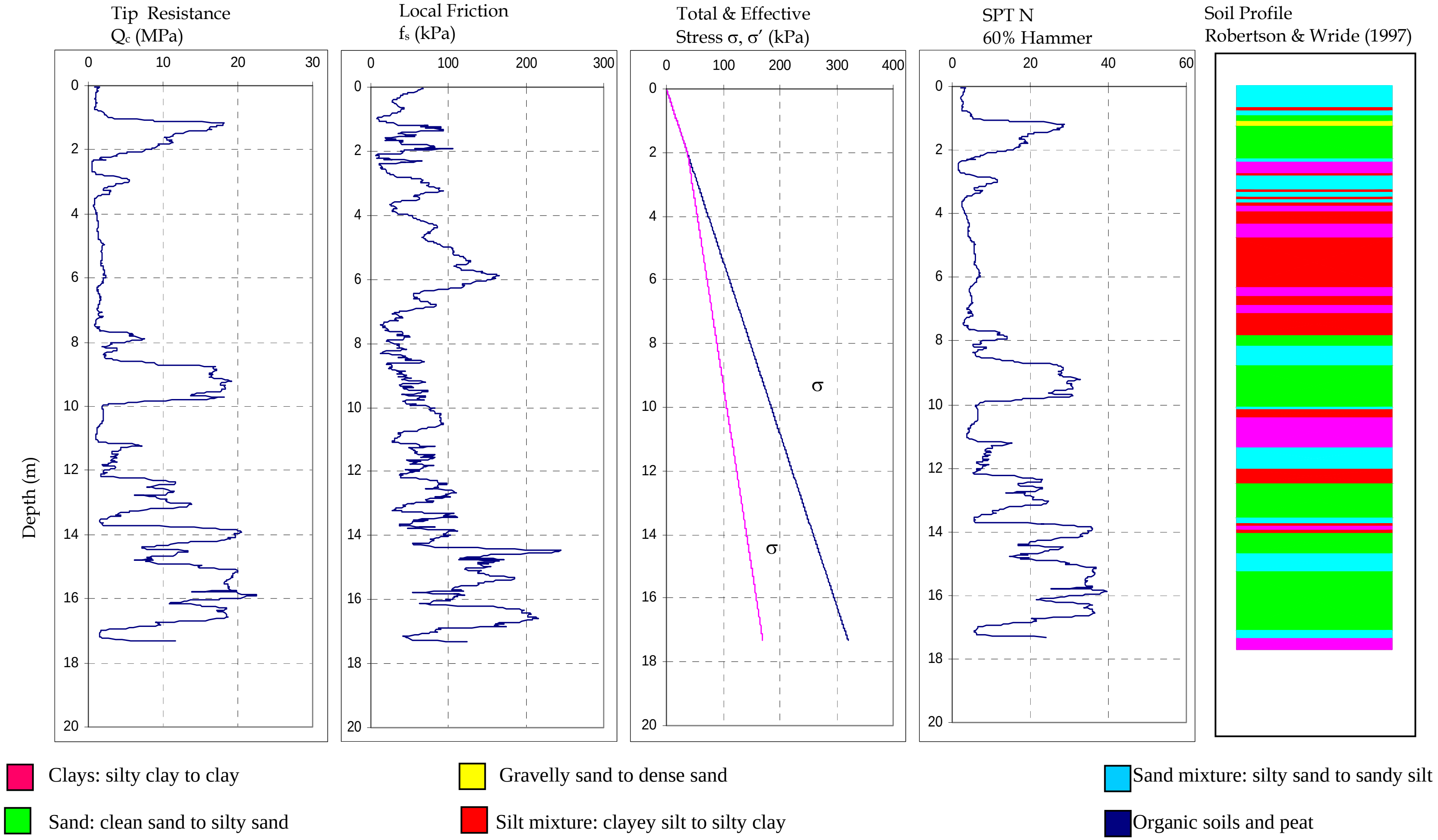
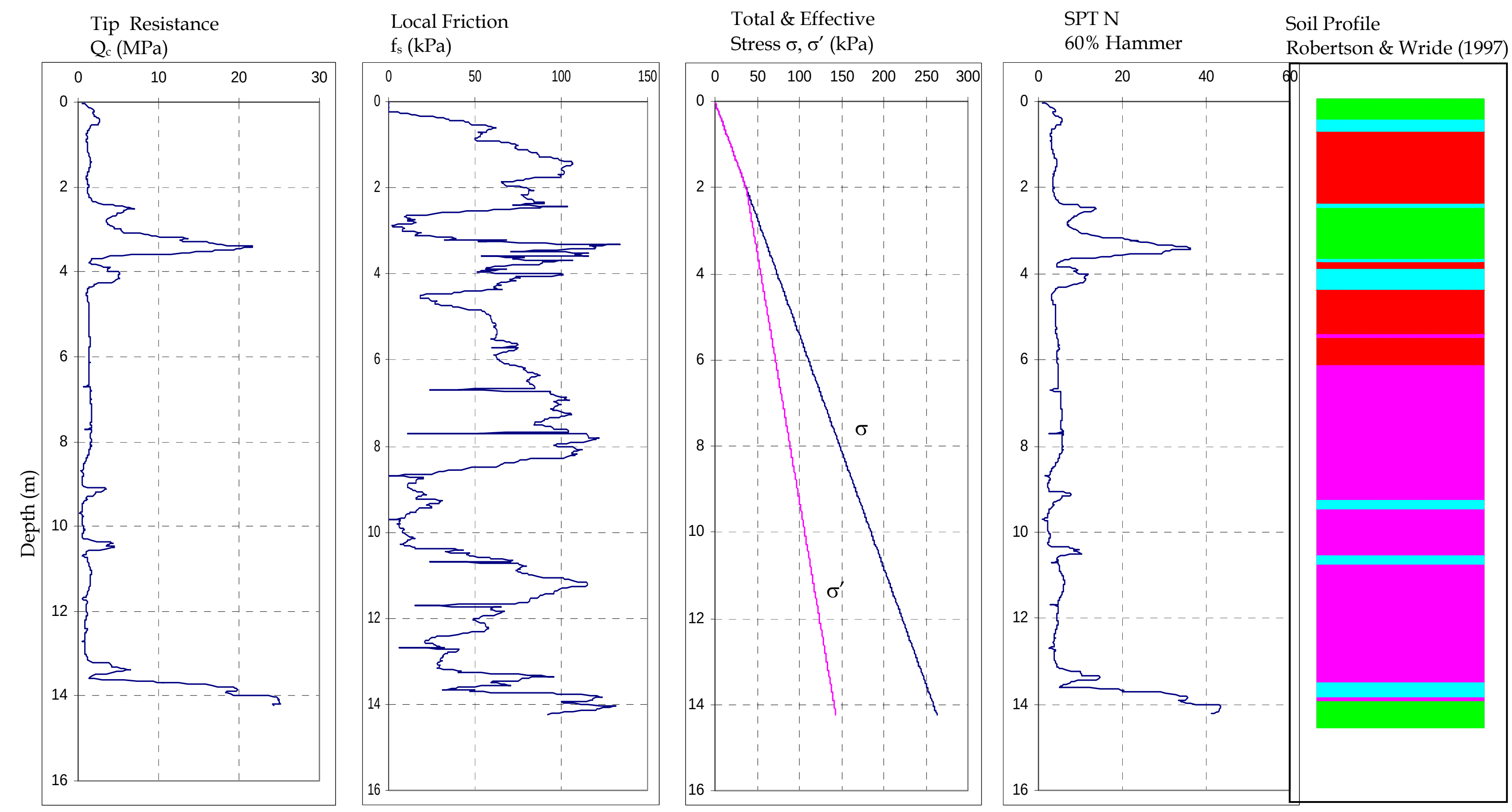


Figure B.3 – CPT 3



Clays: silty clay to clay

Sand: clean sand to silty sand

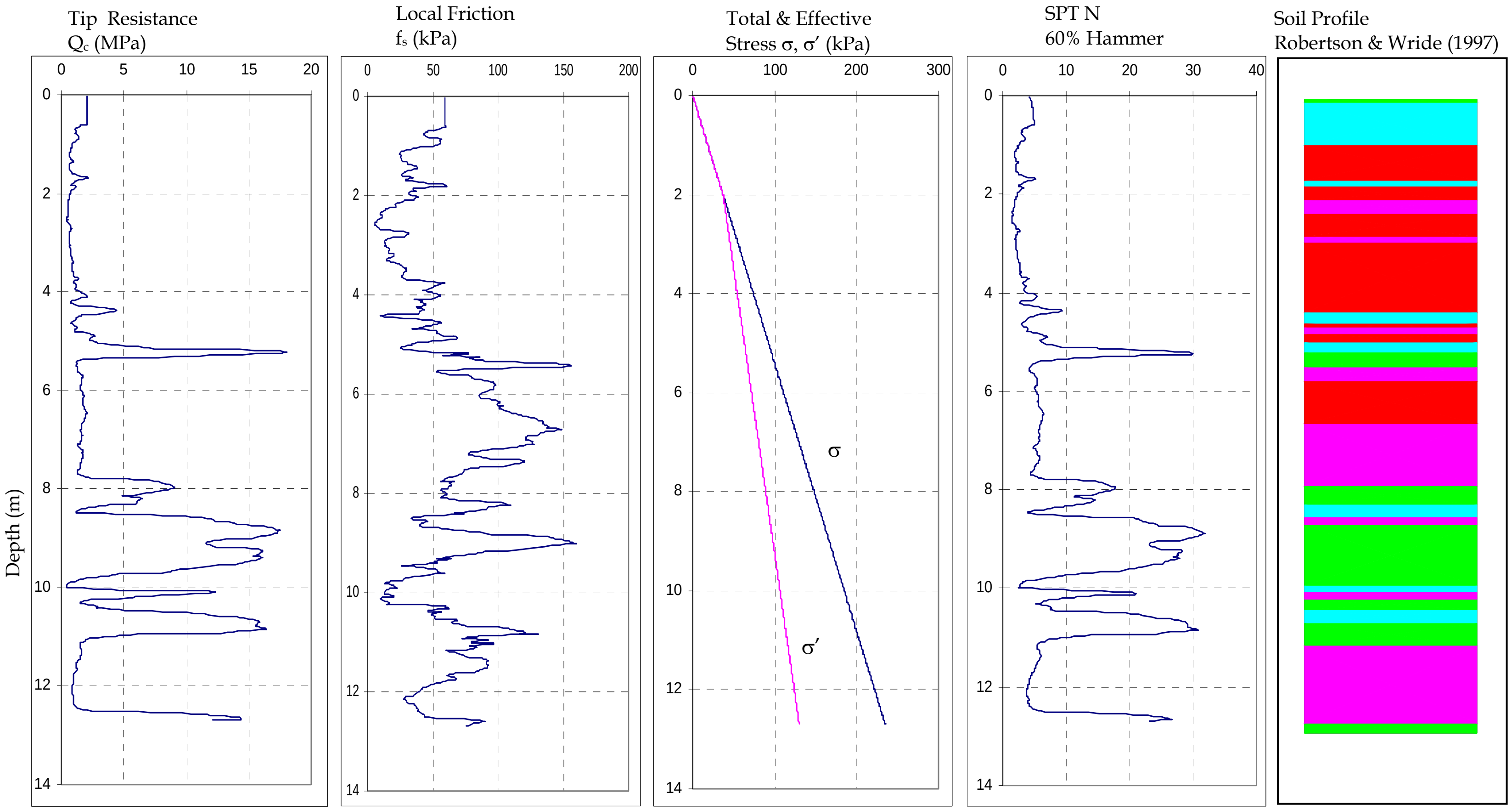
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.4 – CPT 4



Clays: silty clay to clay

Sand: clean sand to silty sand

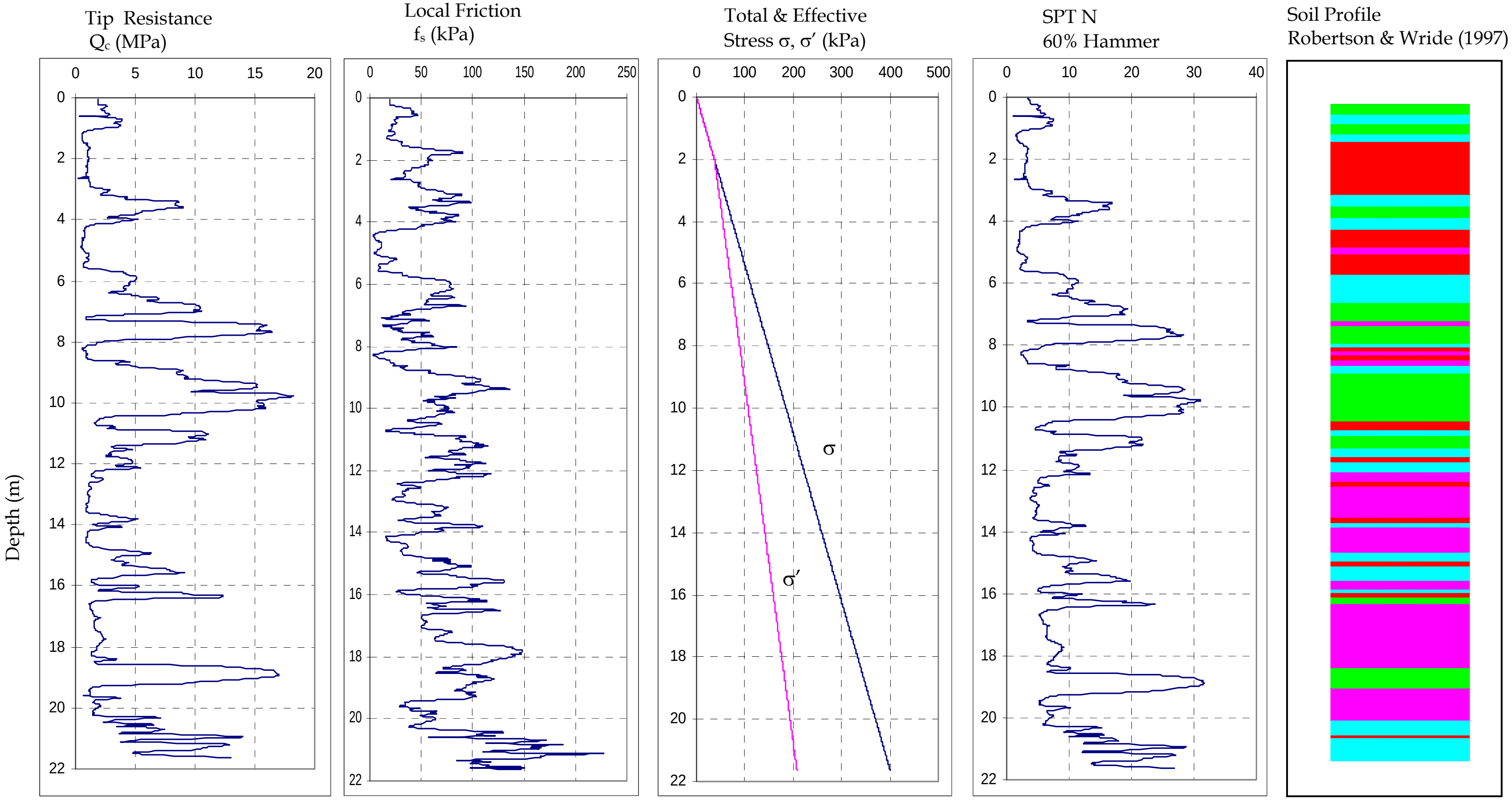
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.5 – CPT 5



Clays: silty clay to clay

Sand: clean sand to silty sand

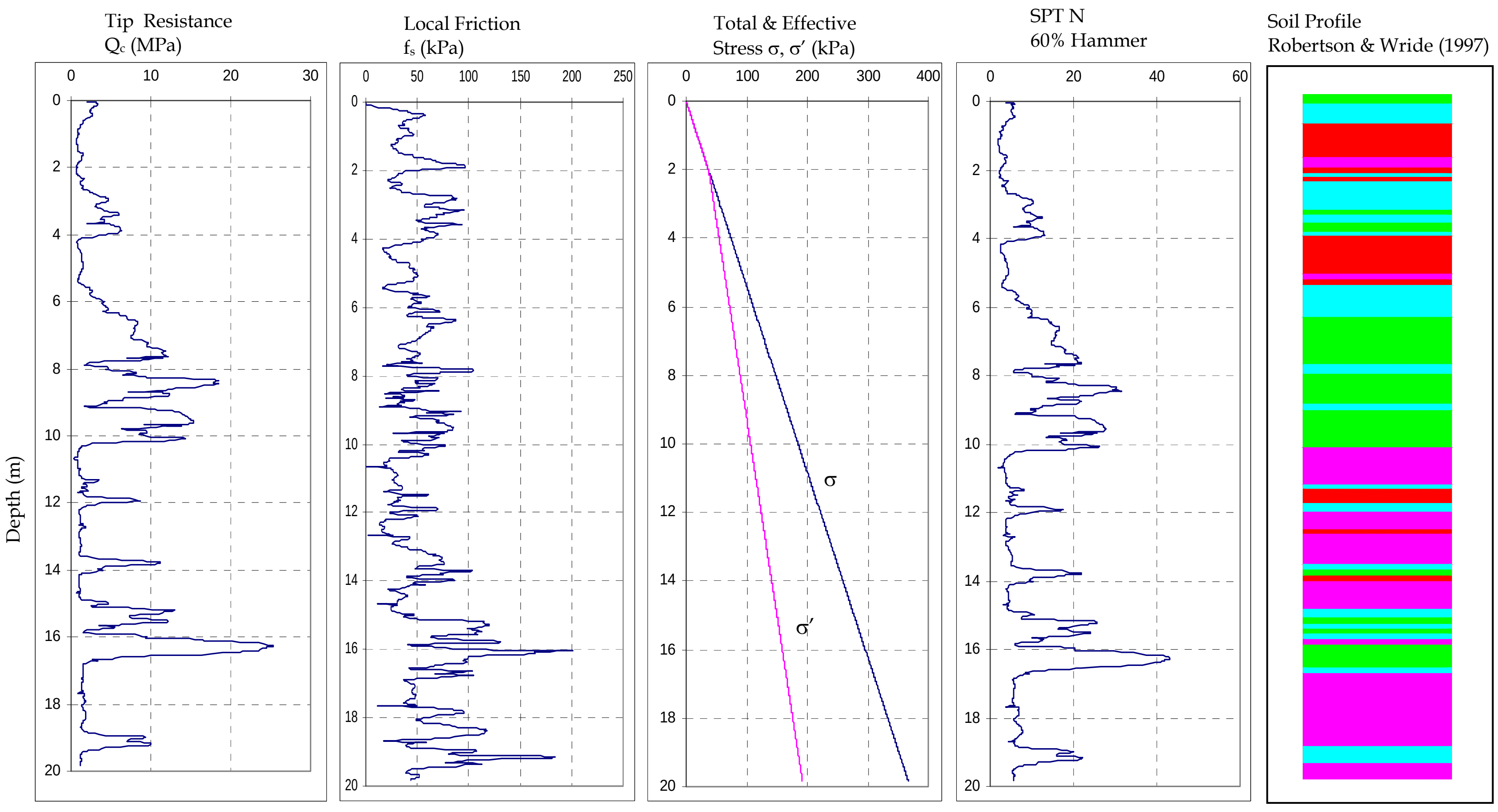
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.6 – CPT 6



Clays: silty clay to clay

Sand: clean sand to silty sand

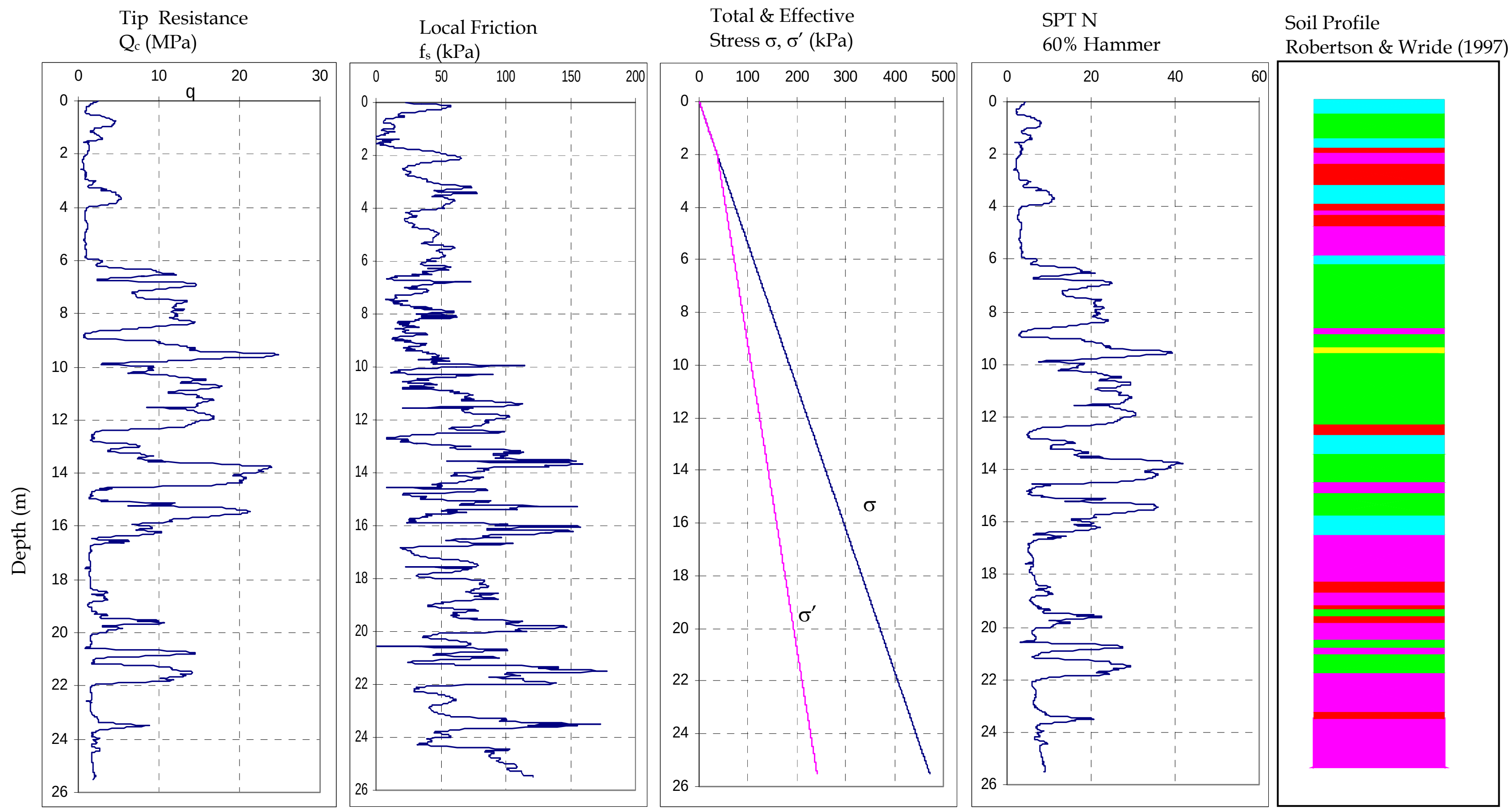
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.7 – CPT 7



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.8 – CPT 8

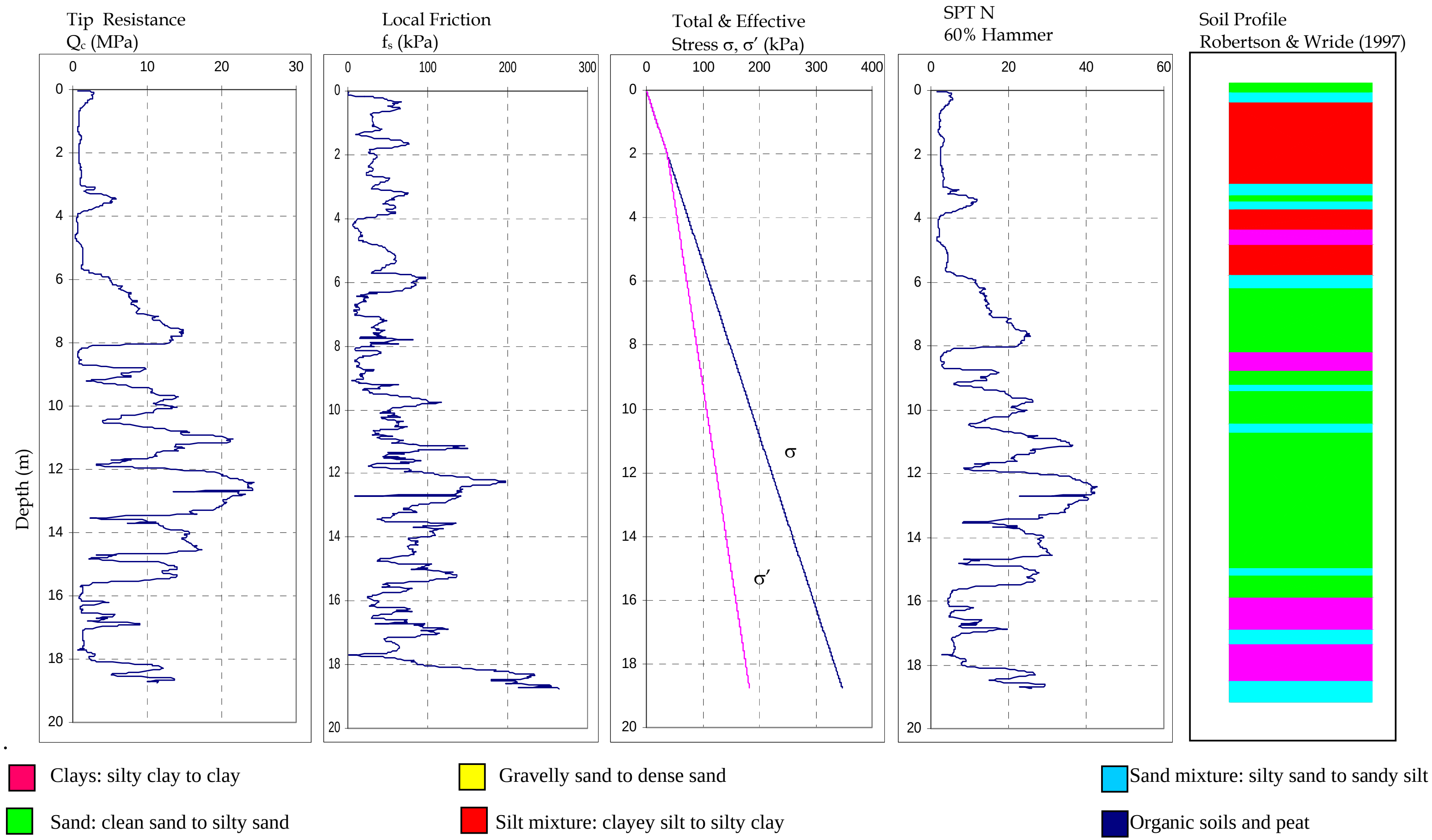
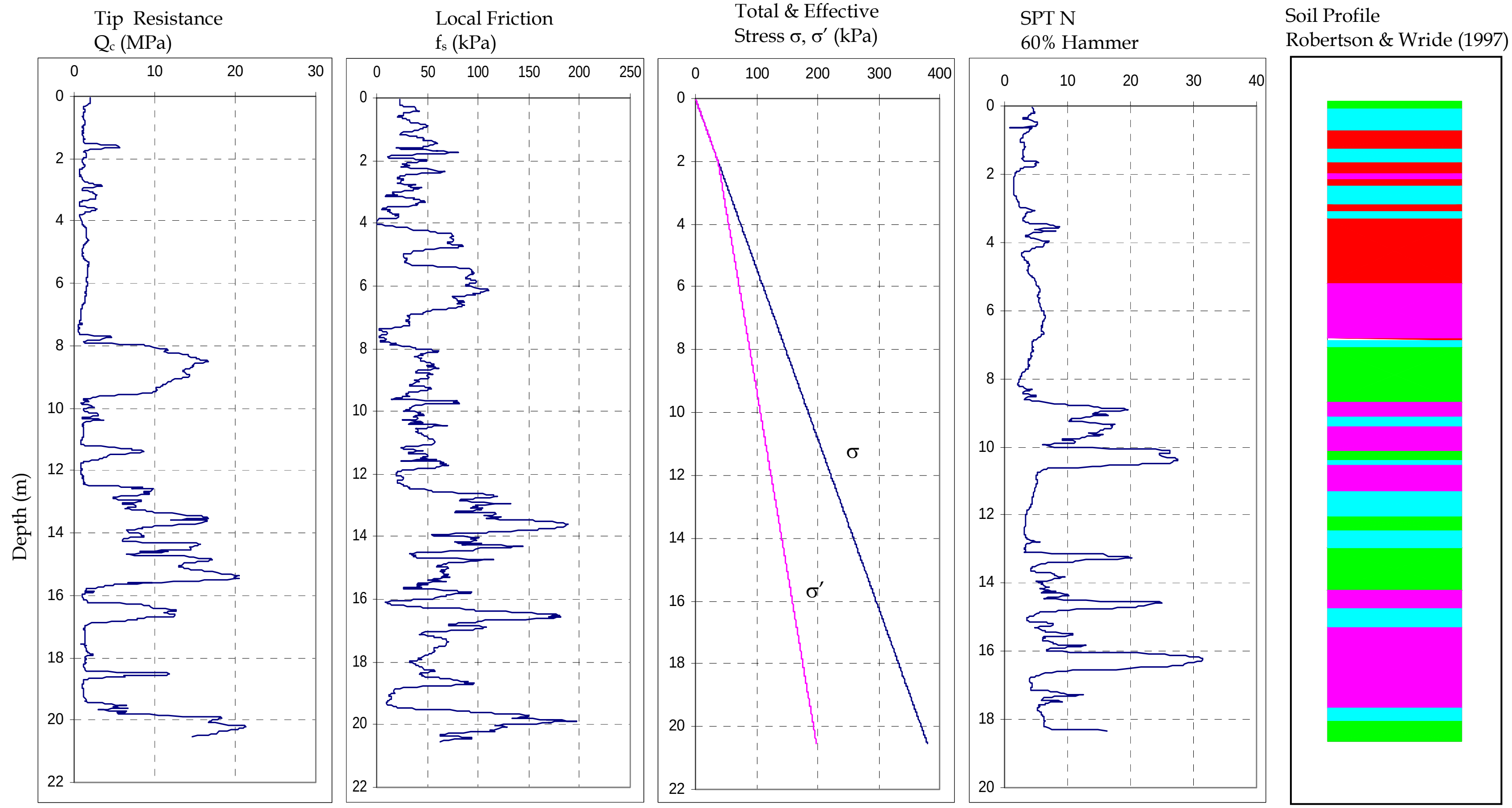


Figure B.9 – CPT 9



Clays: silty clay to clay

Sand: clean sand to silty sand

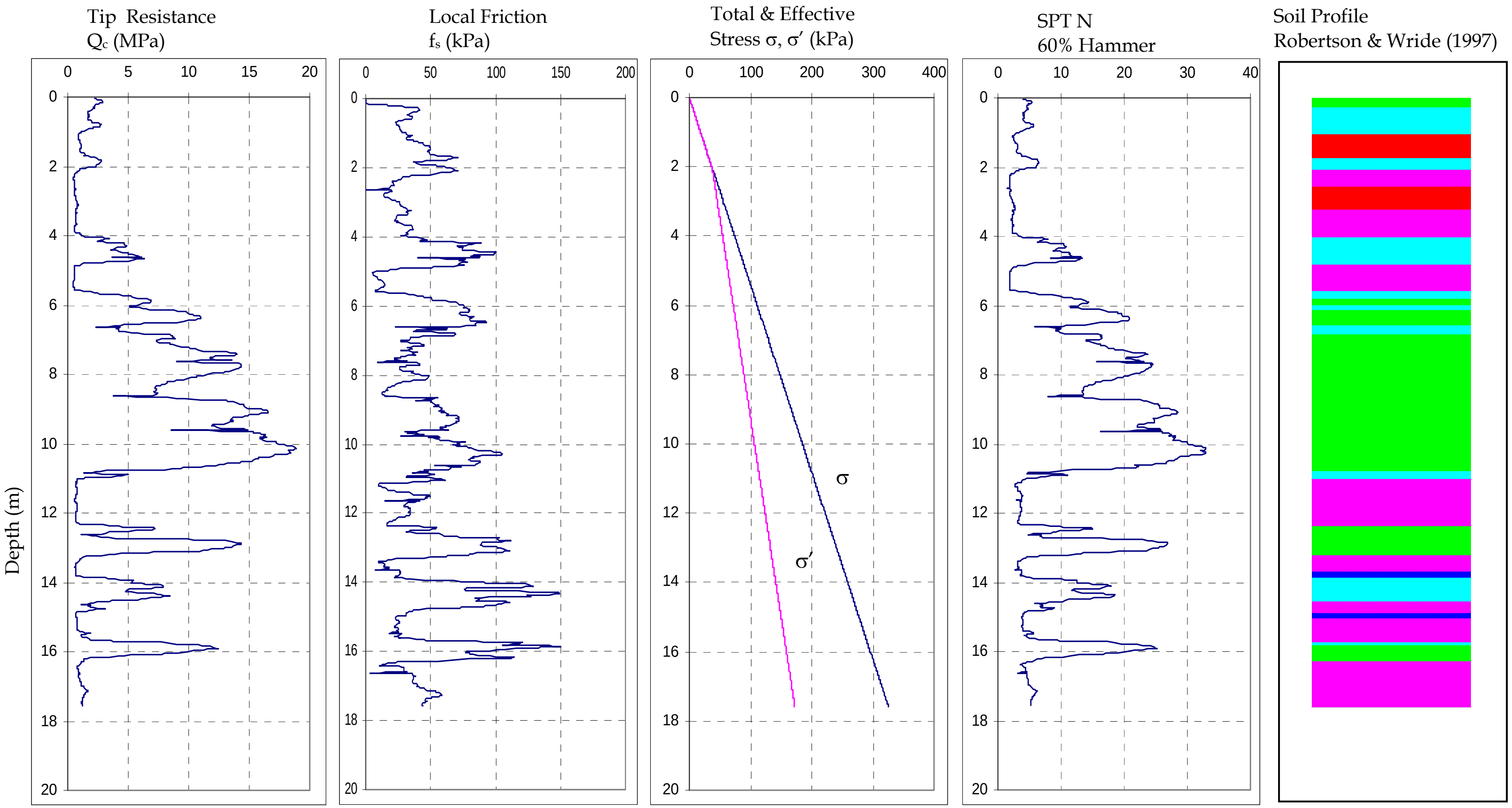
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.10 – CPT 10



Clays: silty clay to clay

Sand: clean sand to silty sand

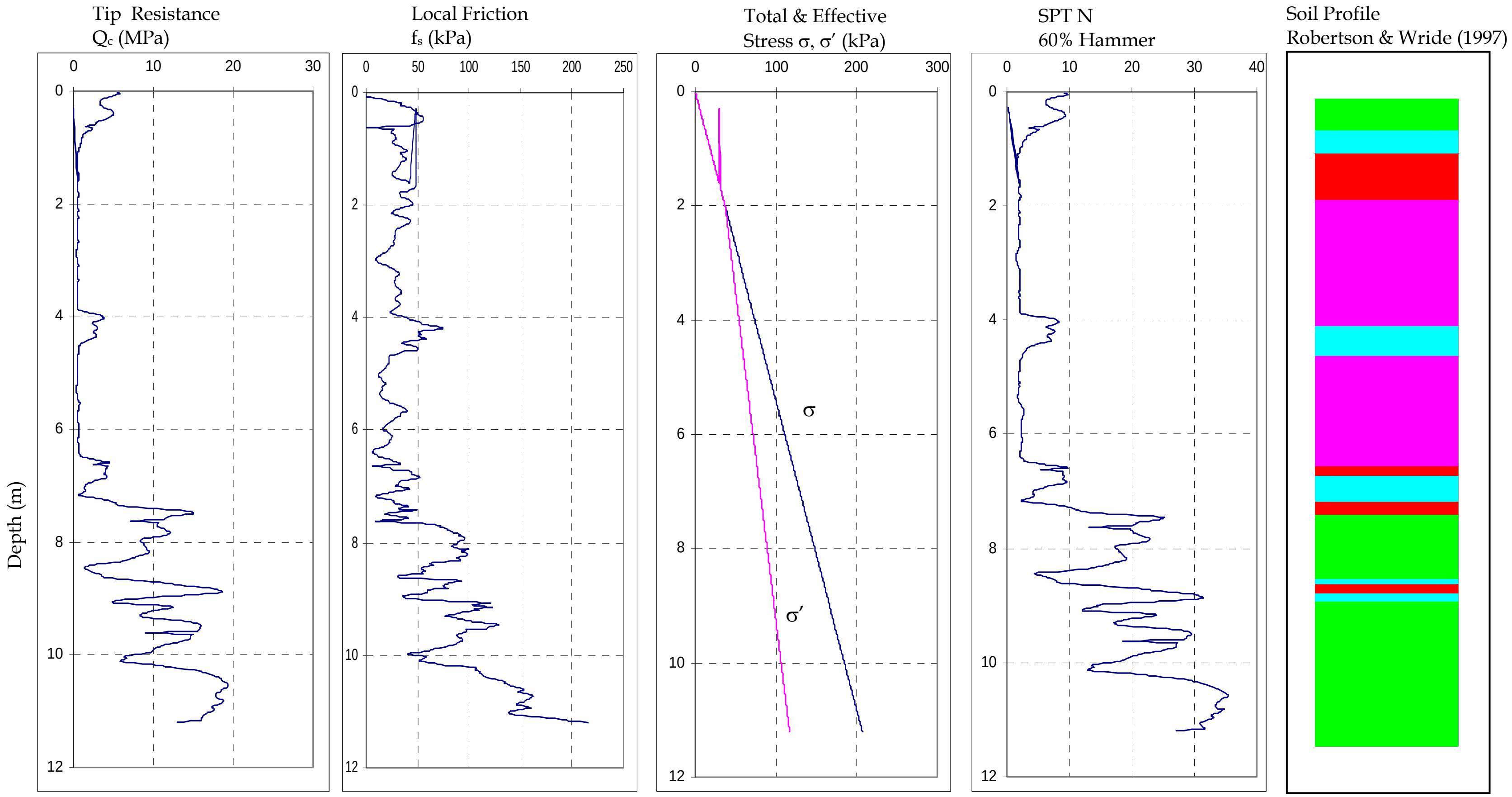
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.11 – CPT 11



Clays: silty clay to clay

Sand: clean sand to silty sand

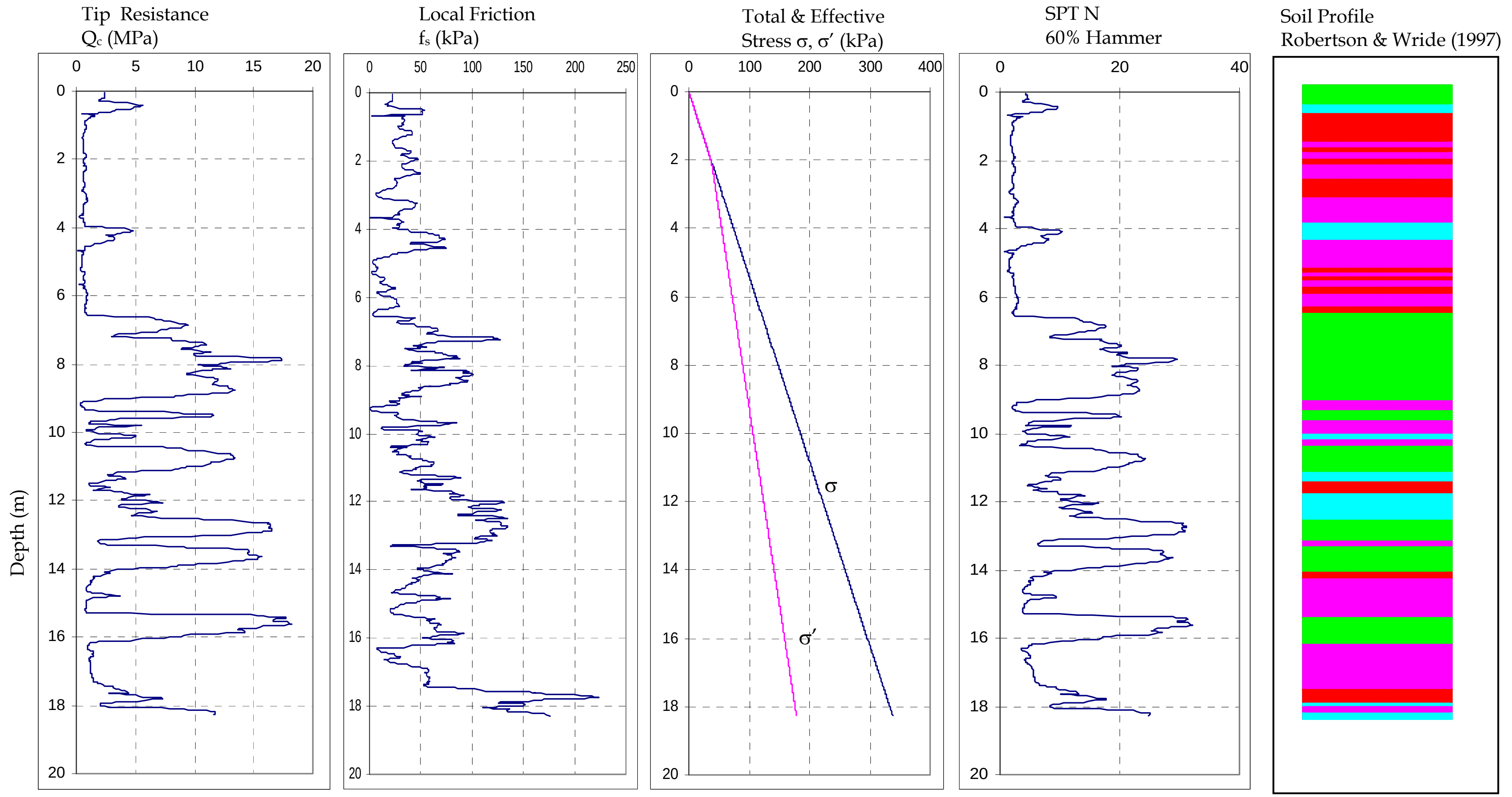
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.12 – CPT 12



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.13 – CPT 12a

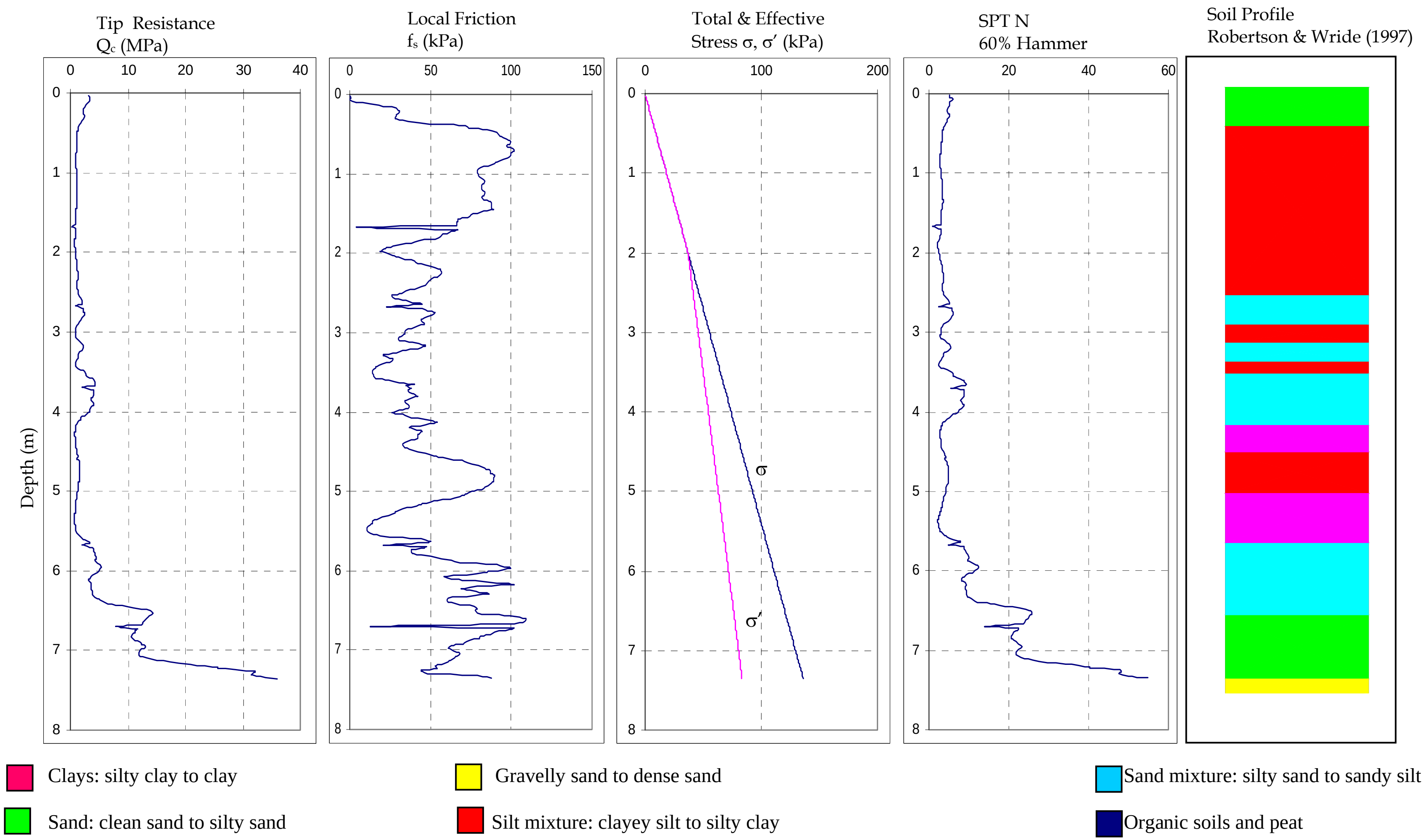
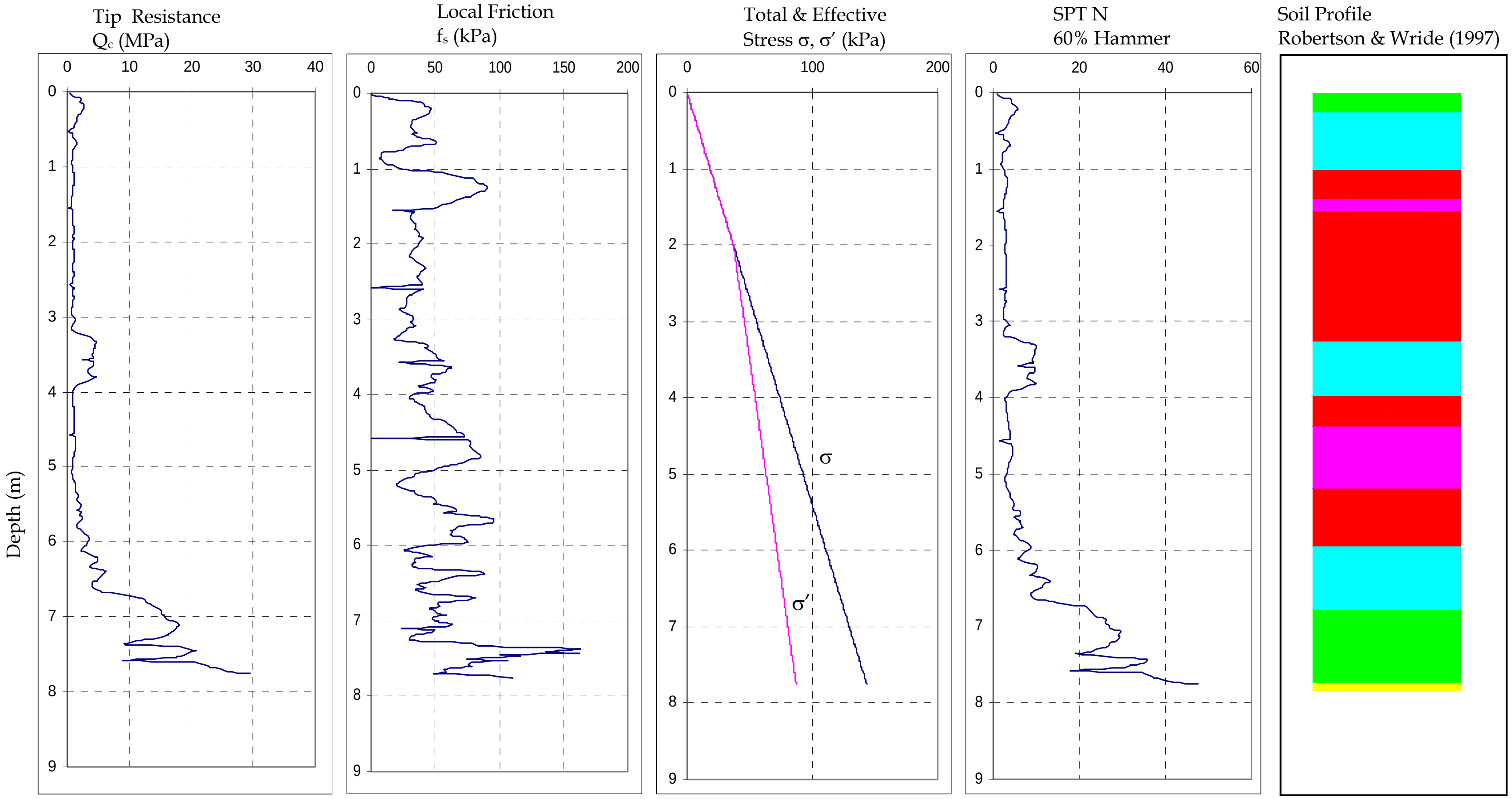


Figure B.14 – CPT 13



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.15 – CPT 13a

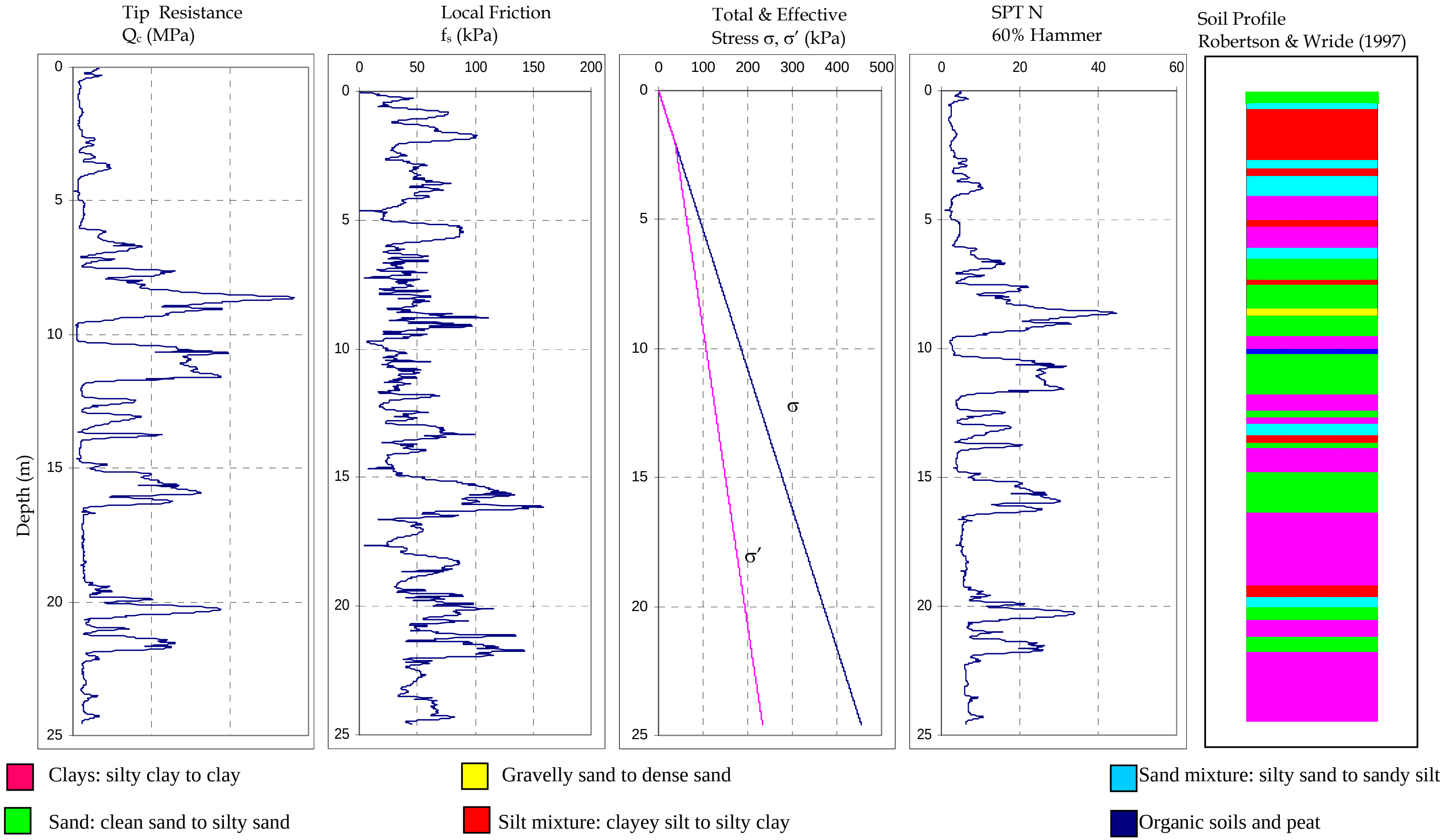


Figure B.16 – CPT 14

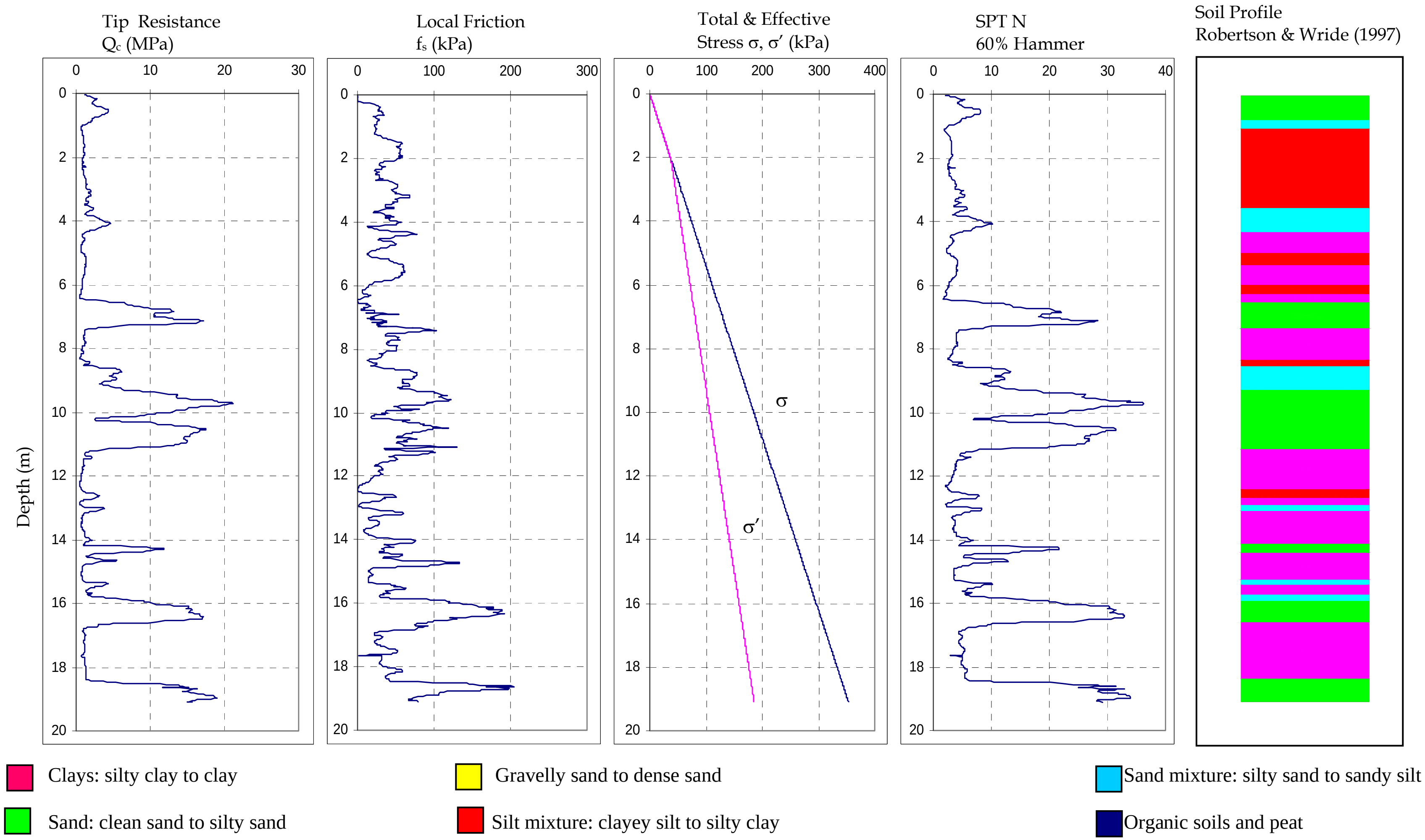
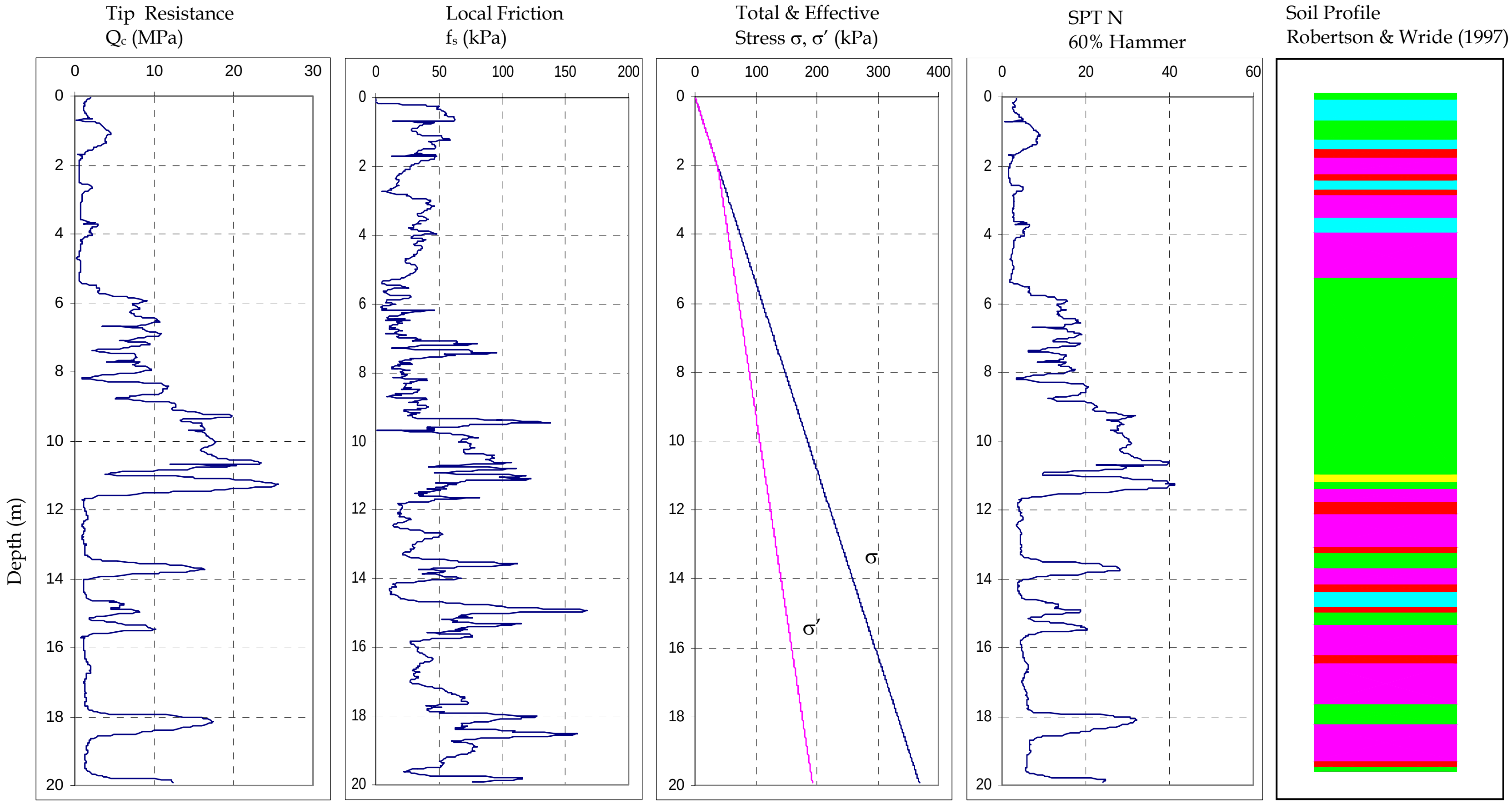


Figure B.17 – CPT 15



Clays: silty clay to clay

Gravelly sand to dense sand

Sand mixture: silty sand to sandy silt

Sand: clean sand to silty sand

Silt mixture: clayey silt to silty clay

Organic soils and peat

Figure B.18 – CPT 16

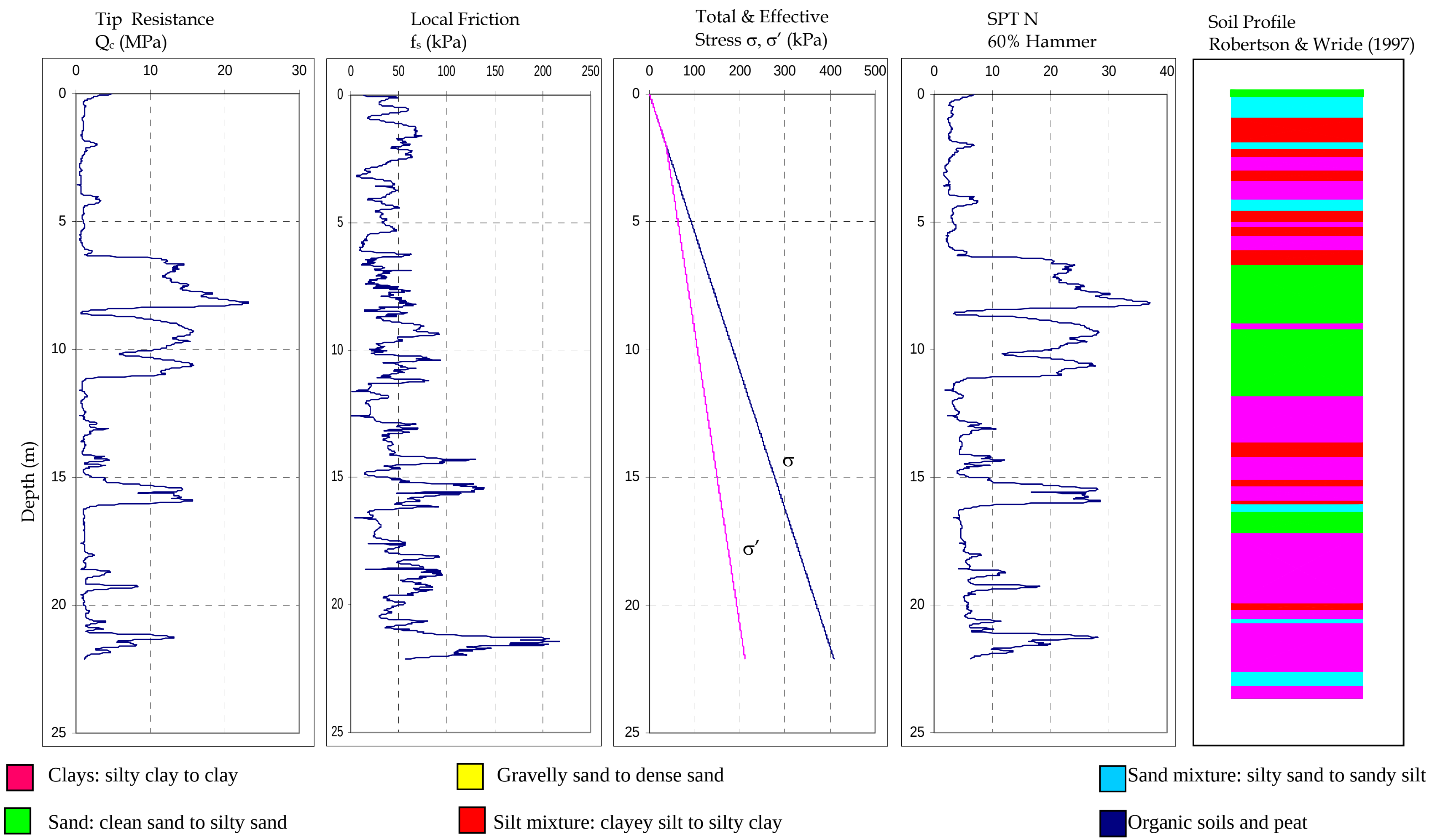


Figure B.19 – CPT 17

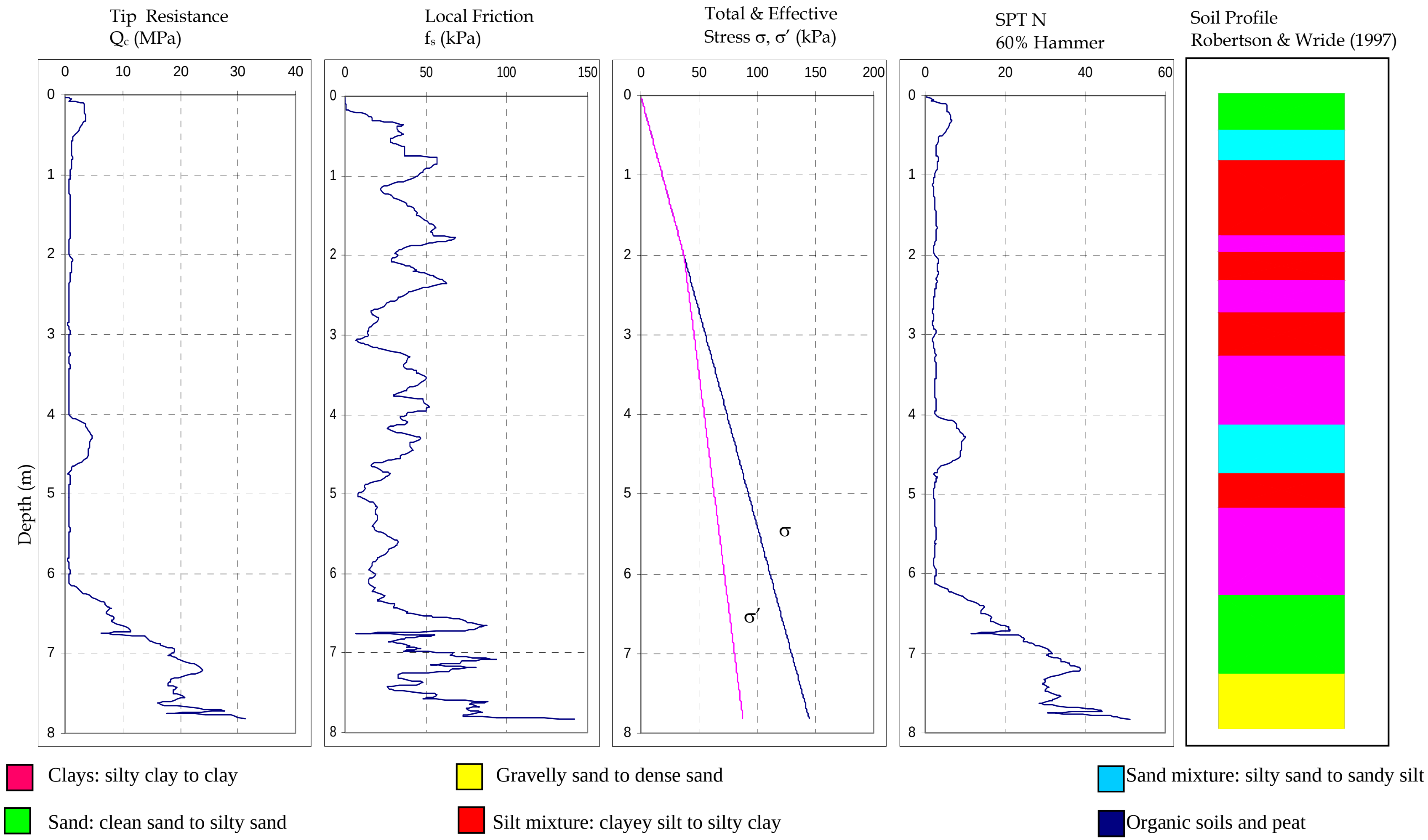
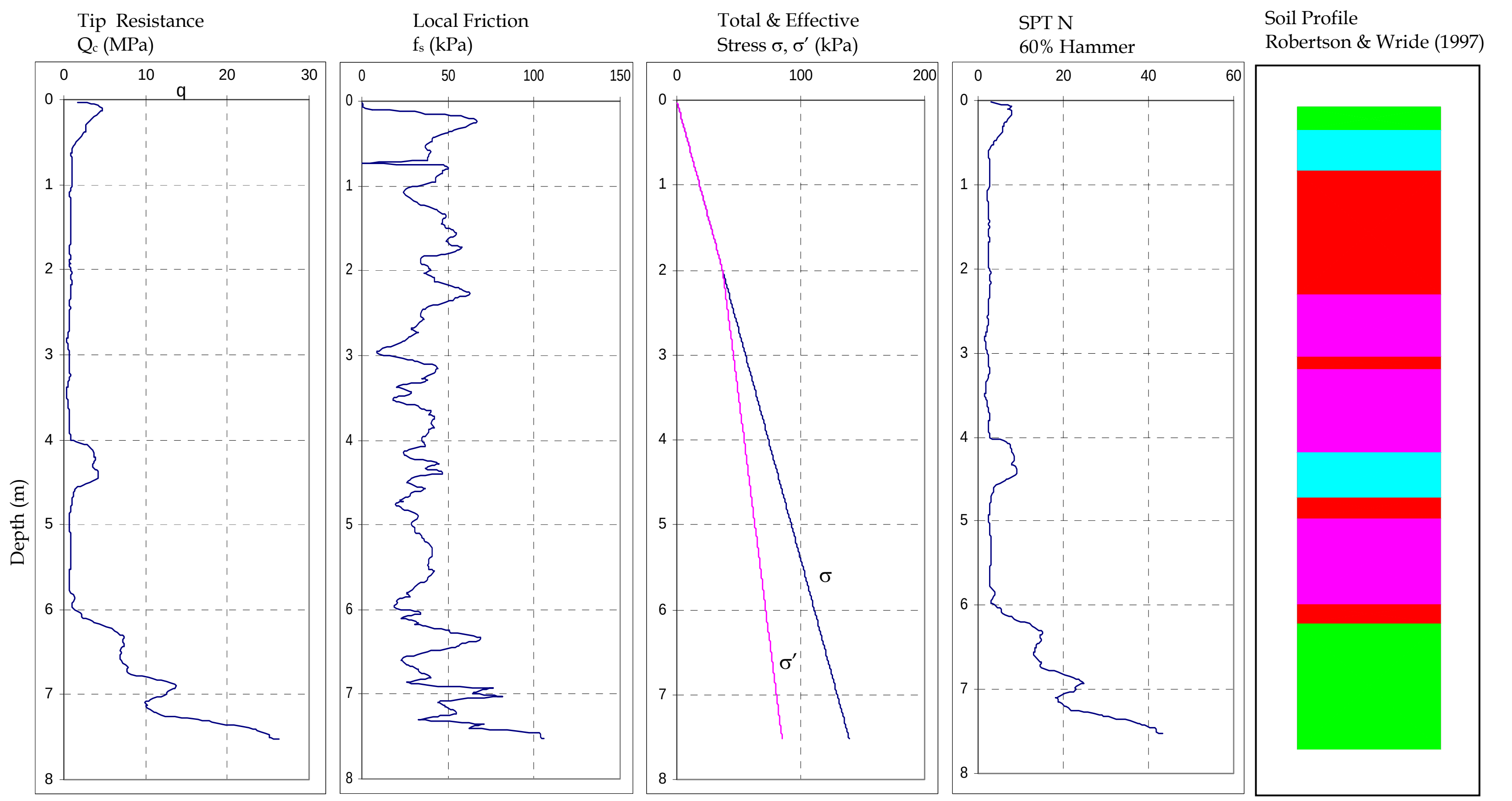


Figure B.20 – CPT 18



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.21 – CPT 18a

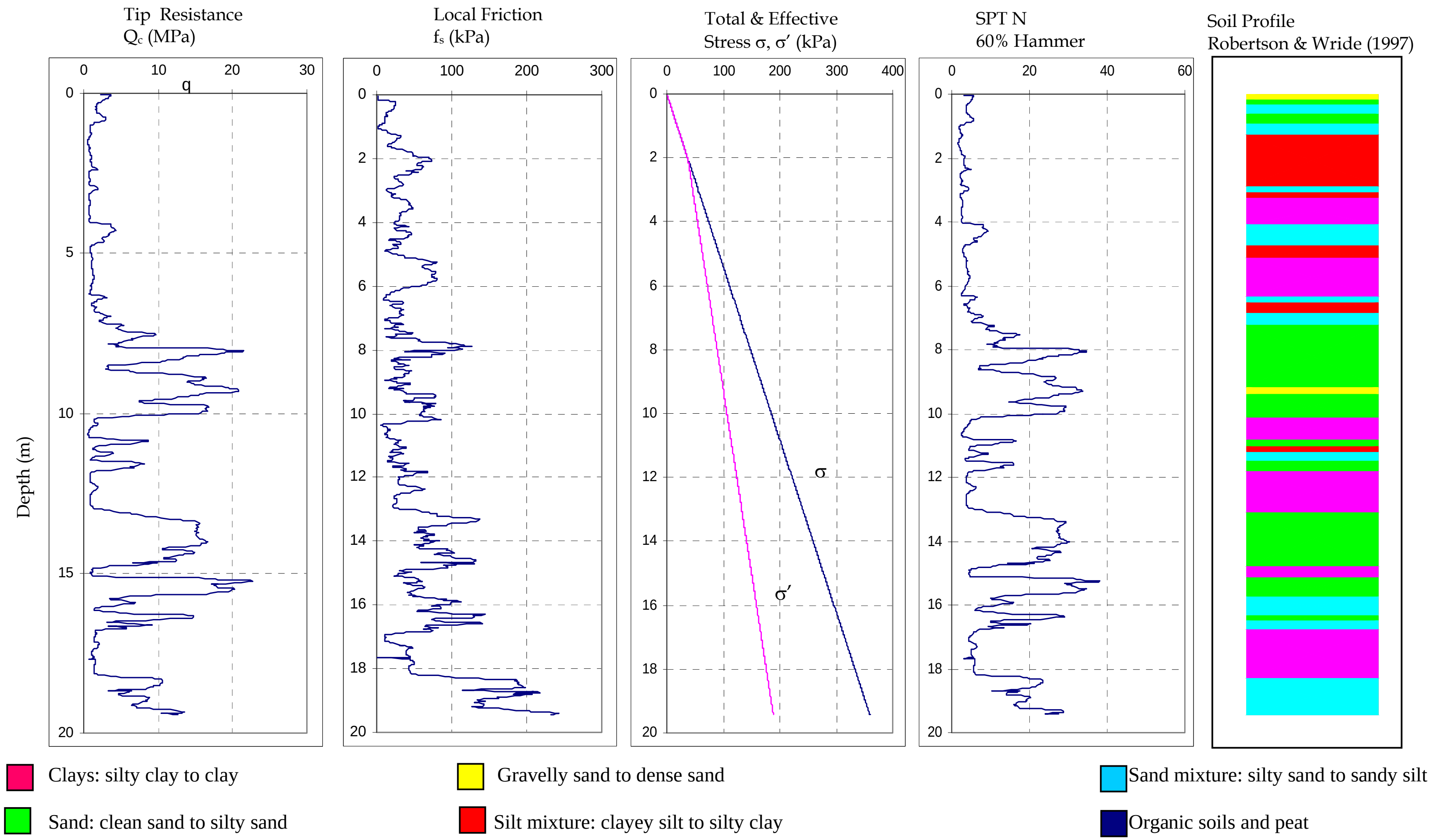
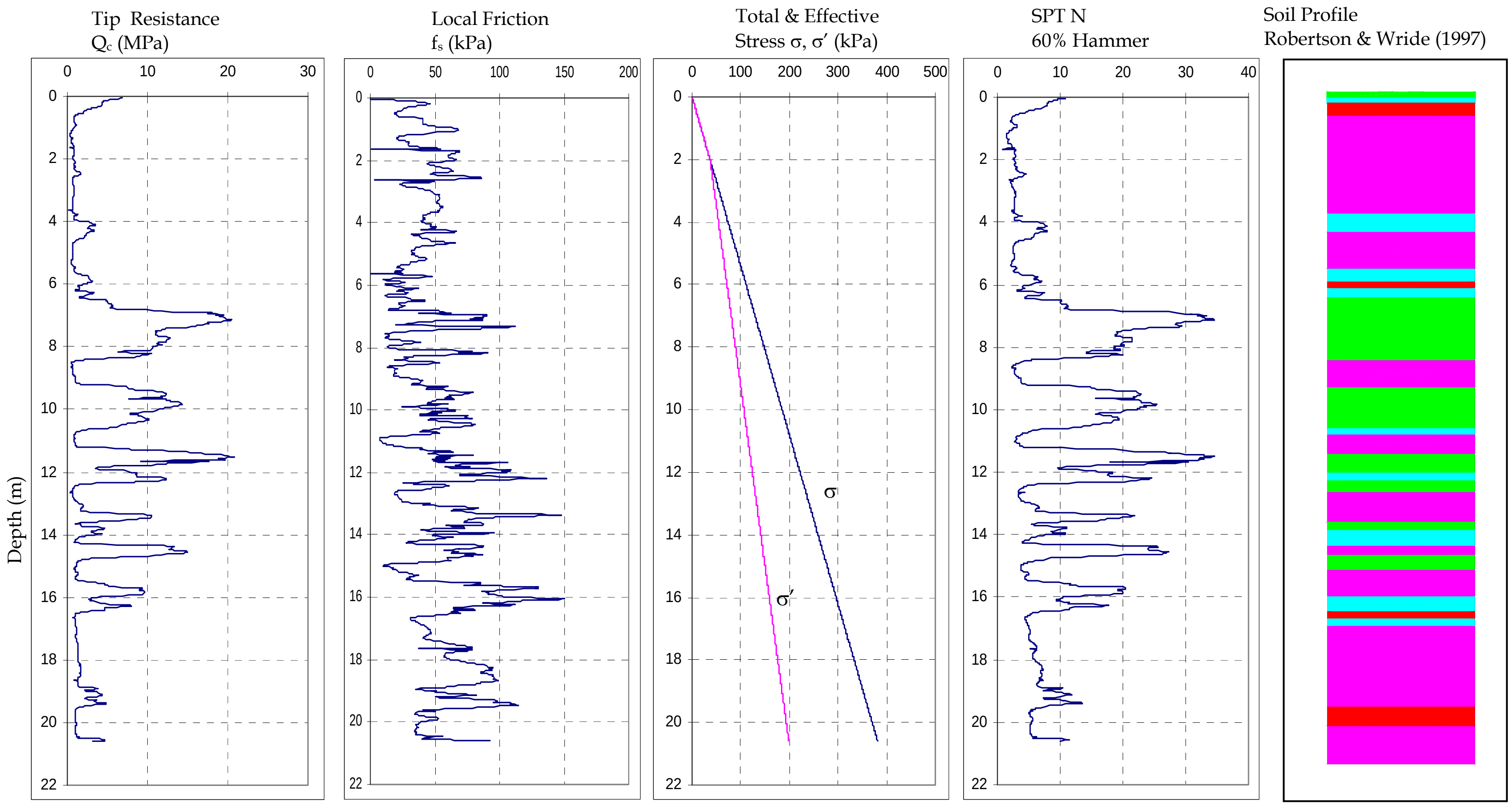


Figure B.22 – CPT 19



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.23 – CPT 20

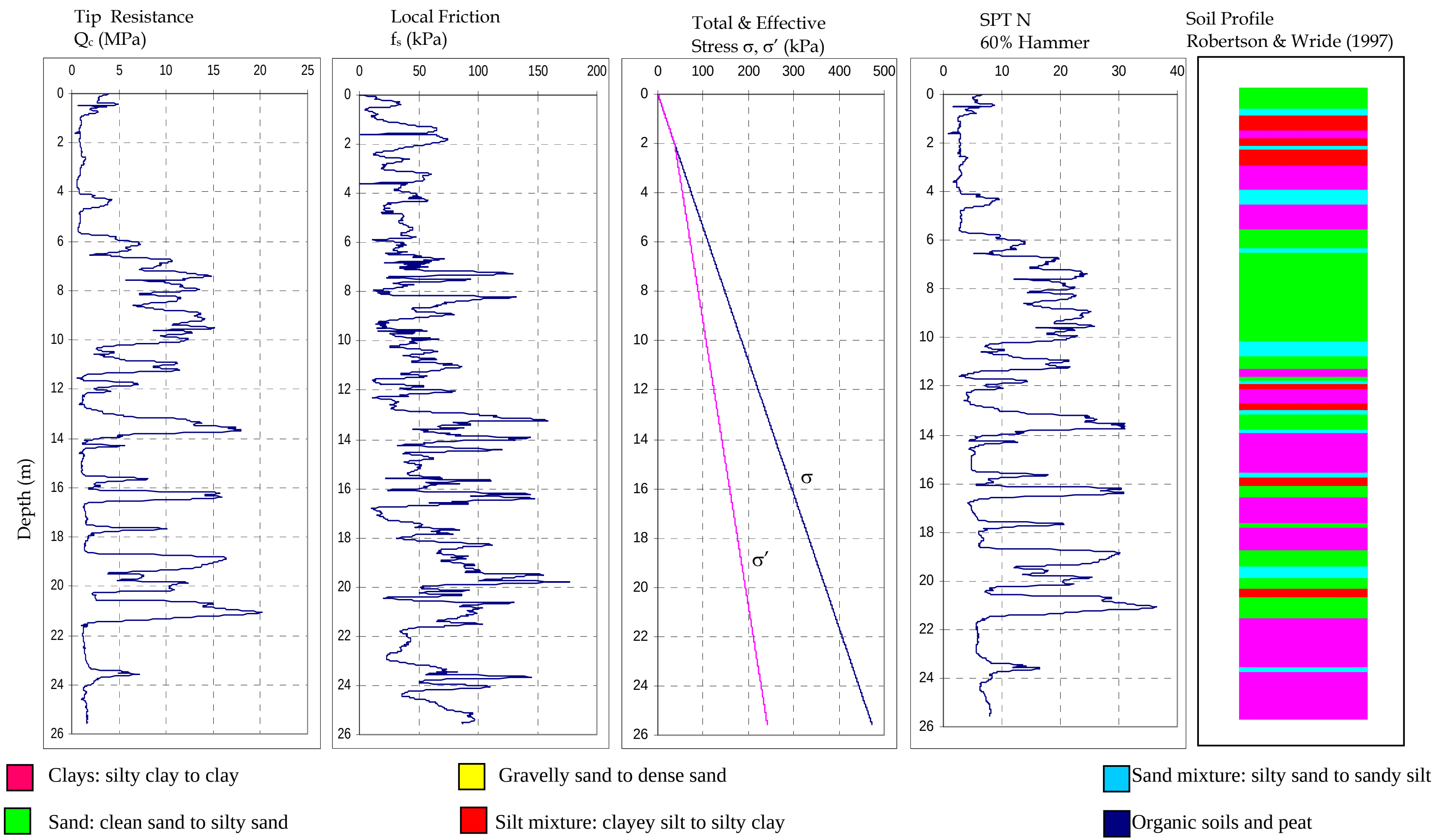


Figure B.24 – CPT 21

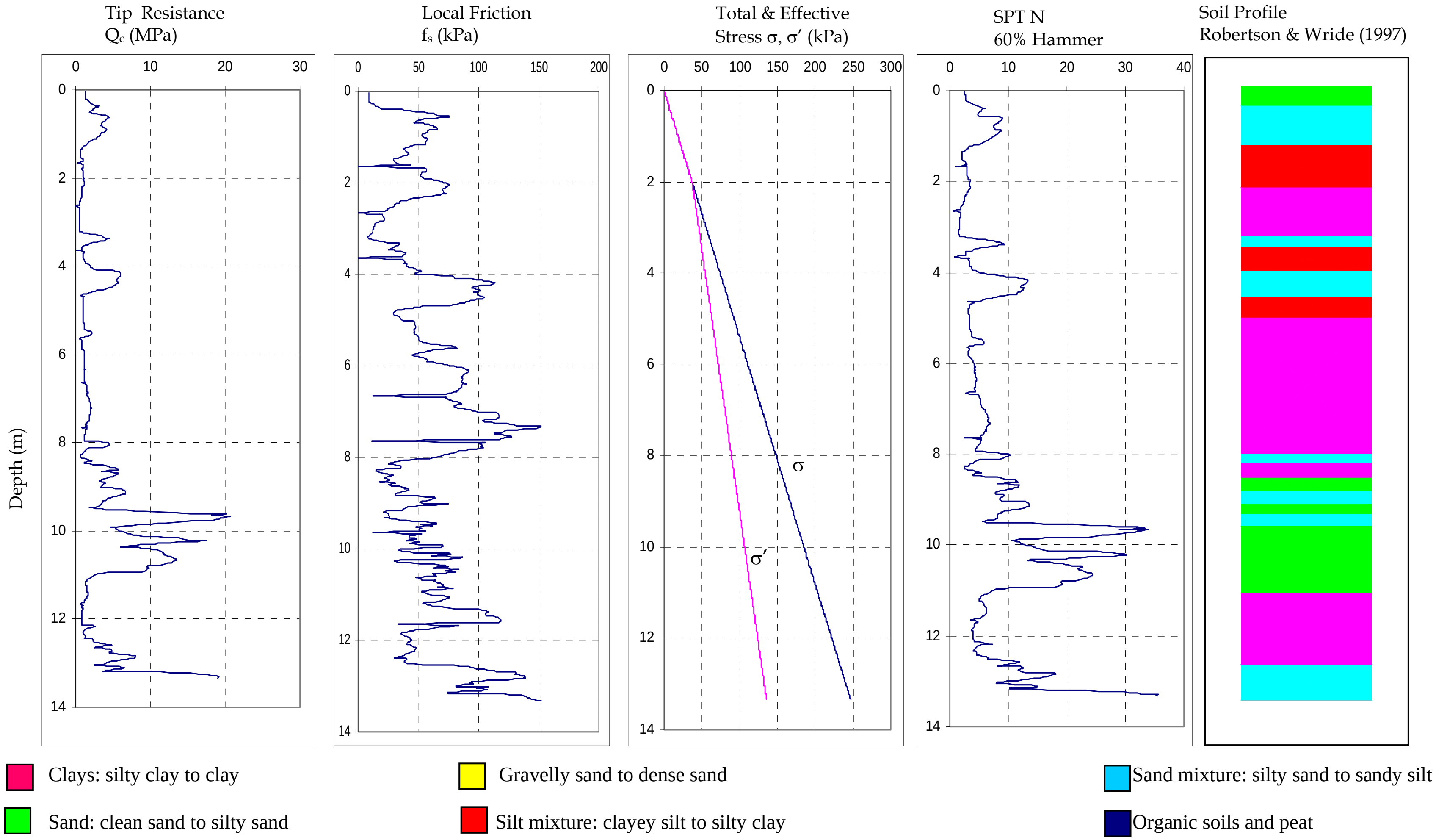
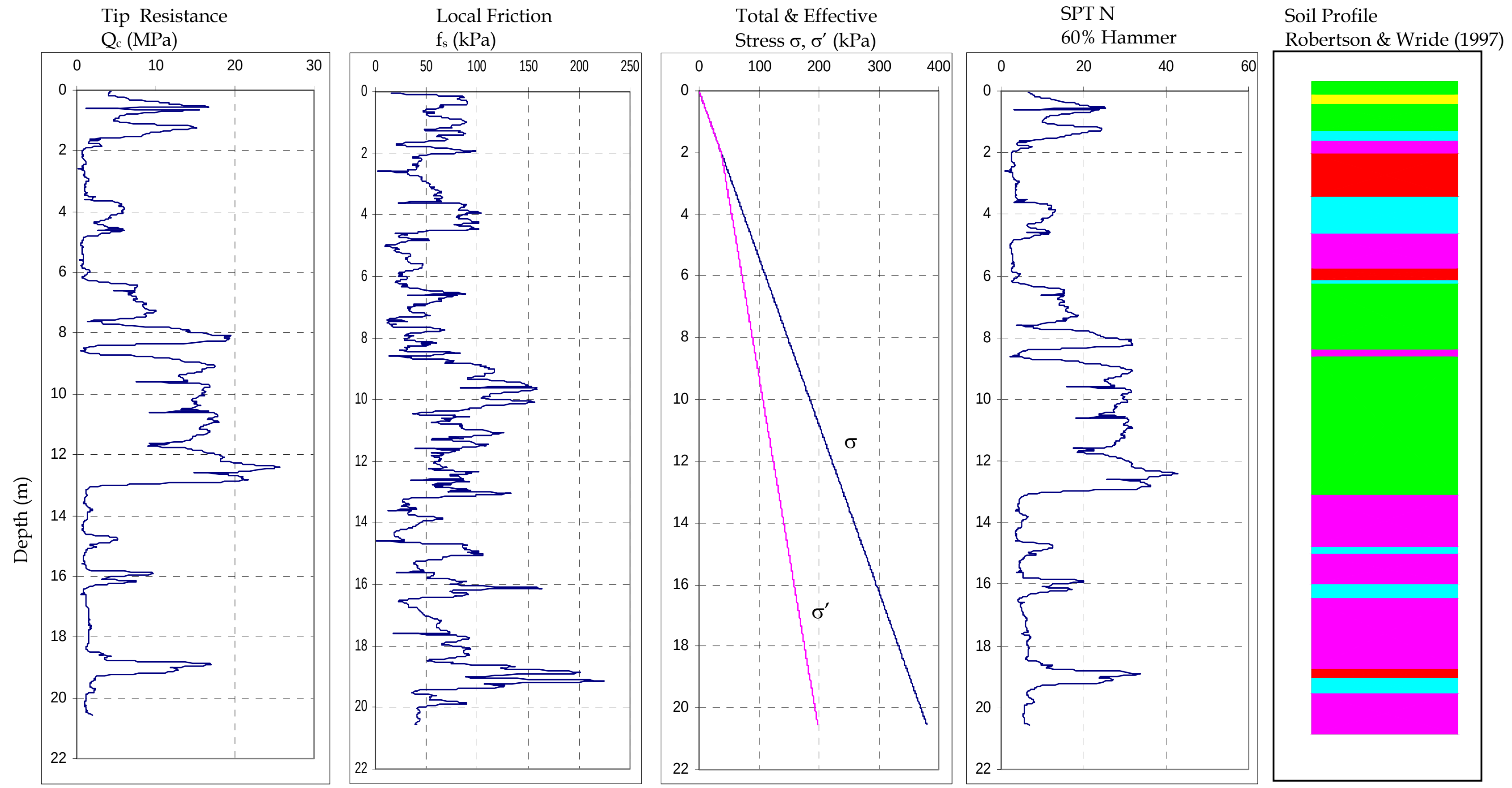


Figure B.25 – CPT 22



Clays: silty clay to clay

Sand: clean sand to silty sand

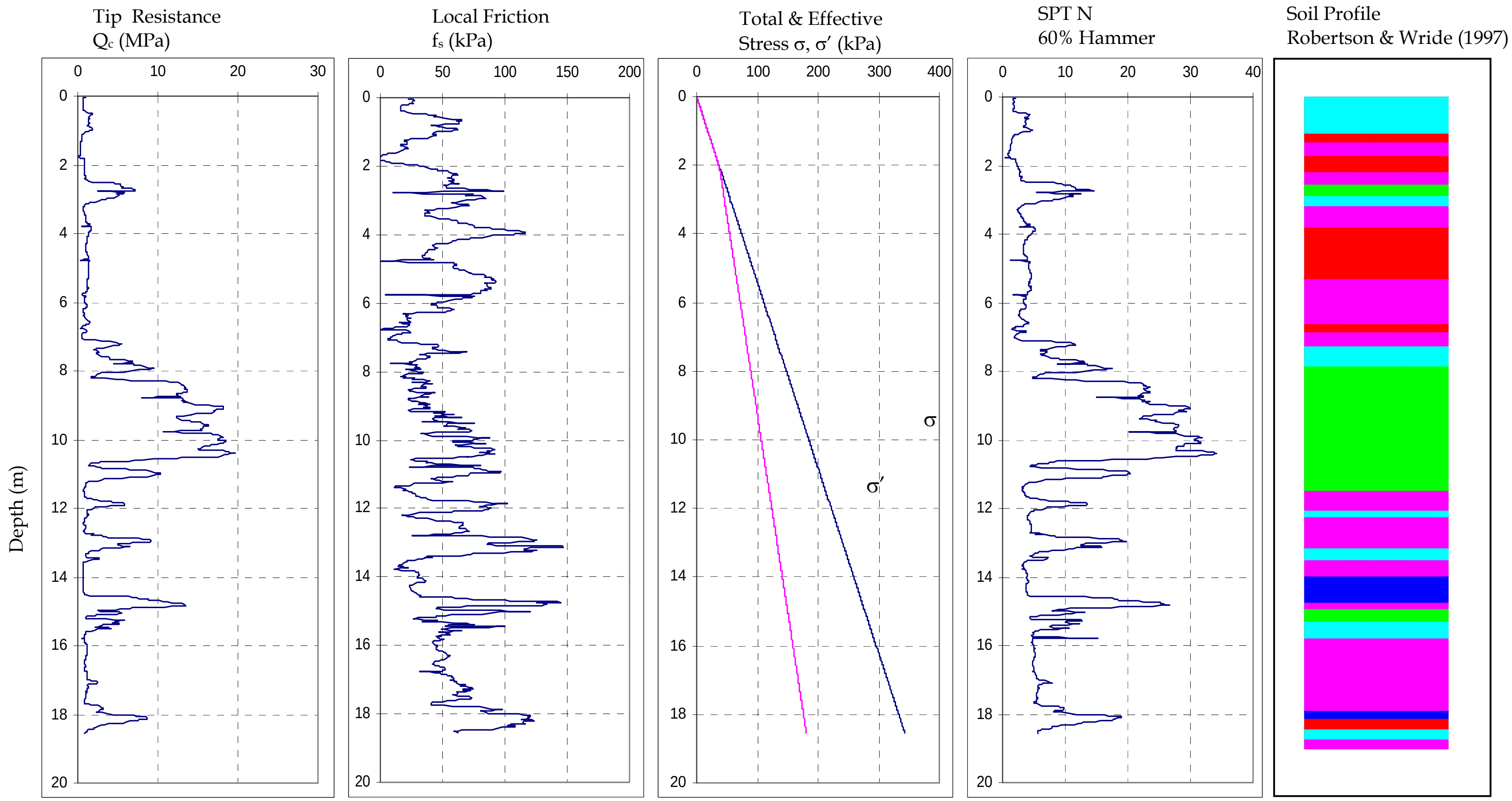
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.26 – CPT 23



Clays: silty clay to clay

Gravelly sand to dense sand

Sand mixture: silty sand to sandy silt

Sand: clean sand to silty sand

Silt mixture: clayey silt to silty clay

Organic soils and peat

Figure B.27 – CPT 24

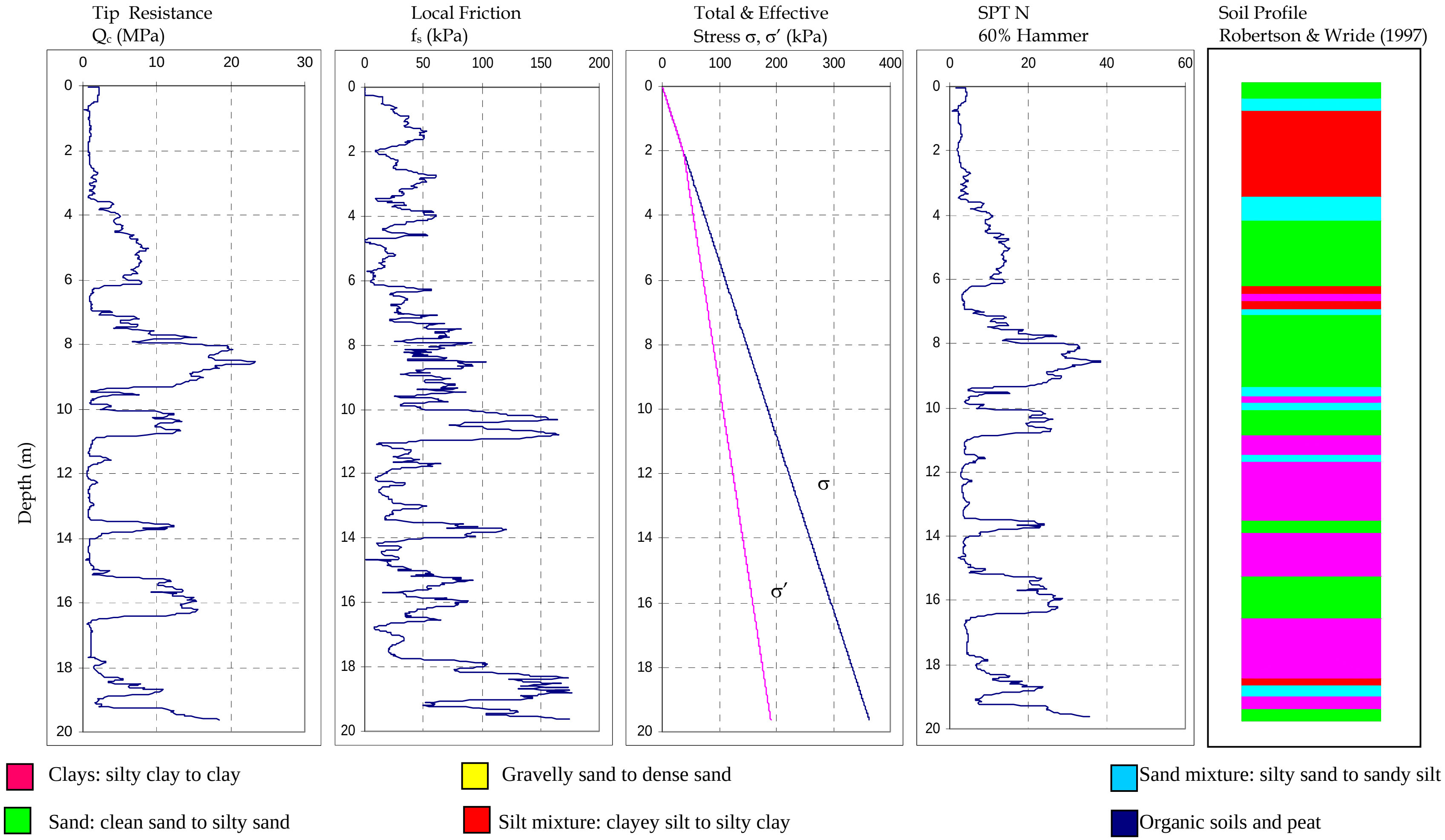
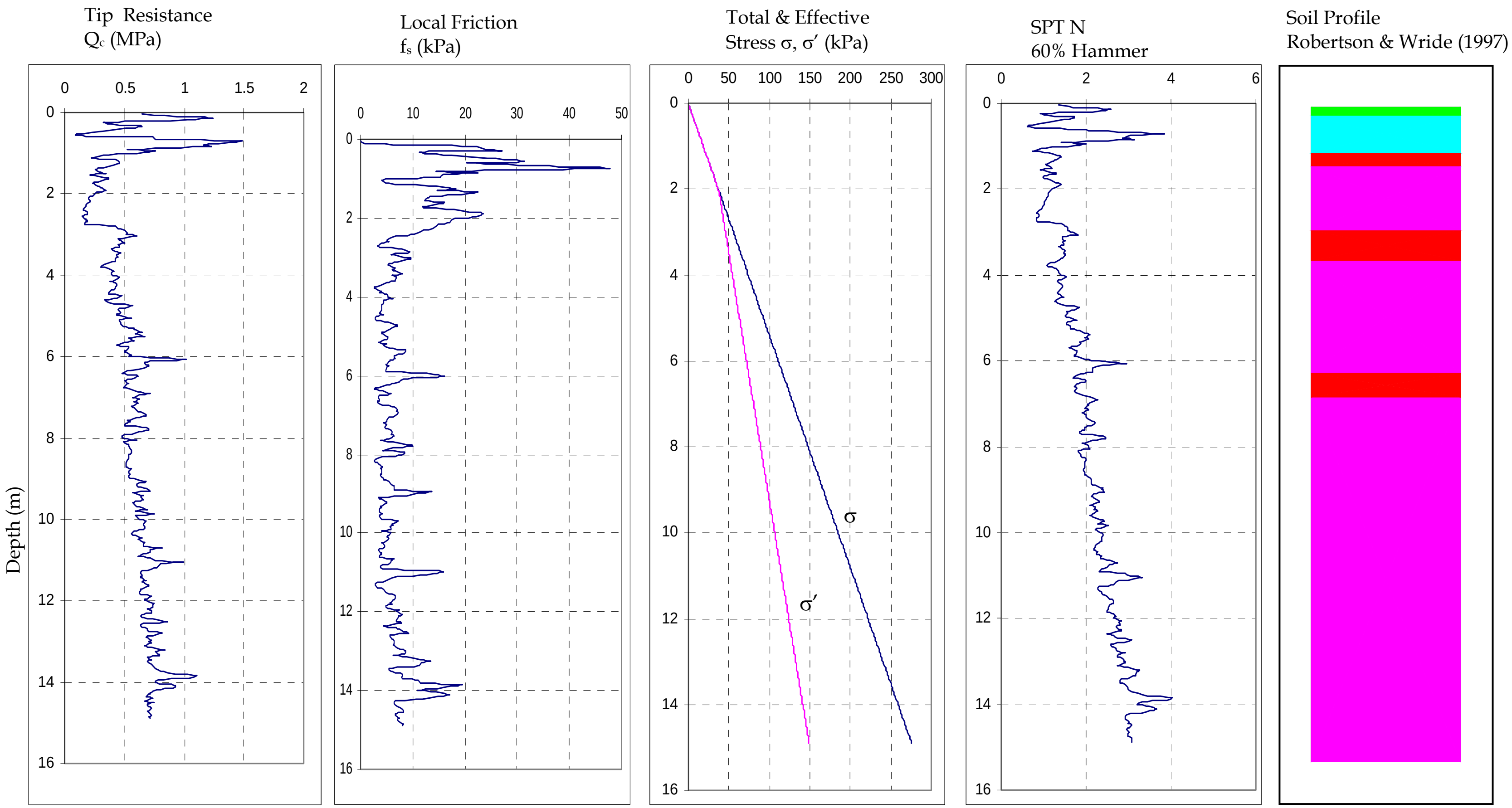


Figure B.28 – CPT 25



Clays: silty clay to clay

Sand: clean sand to silty sand

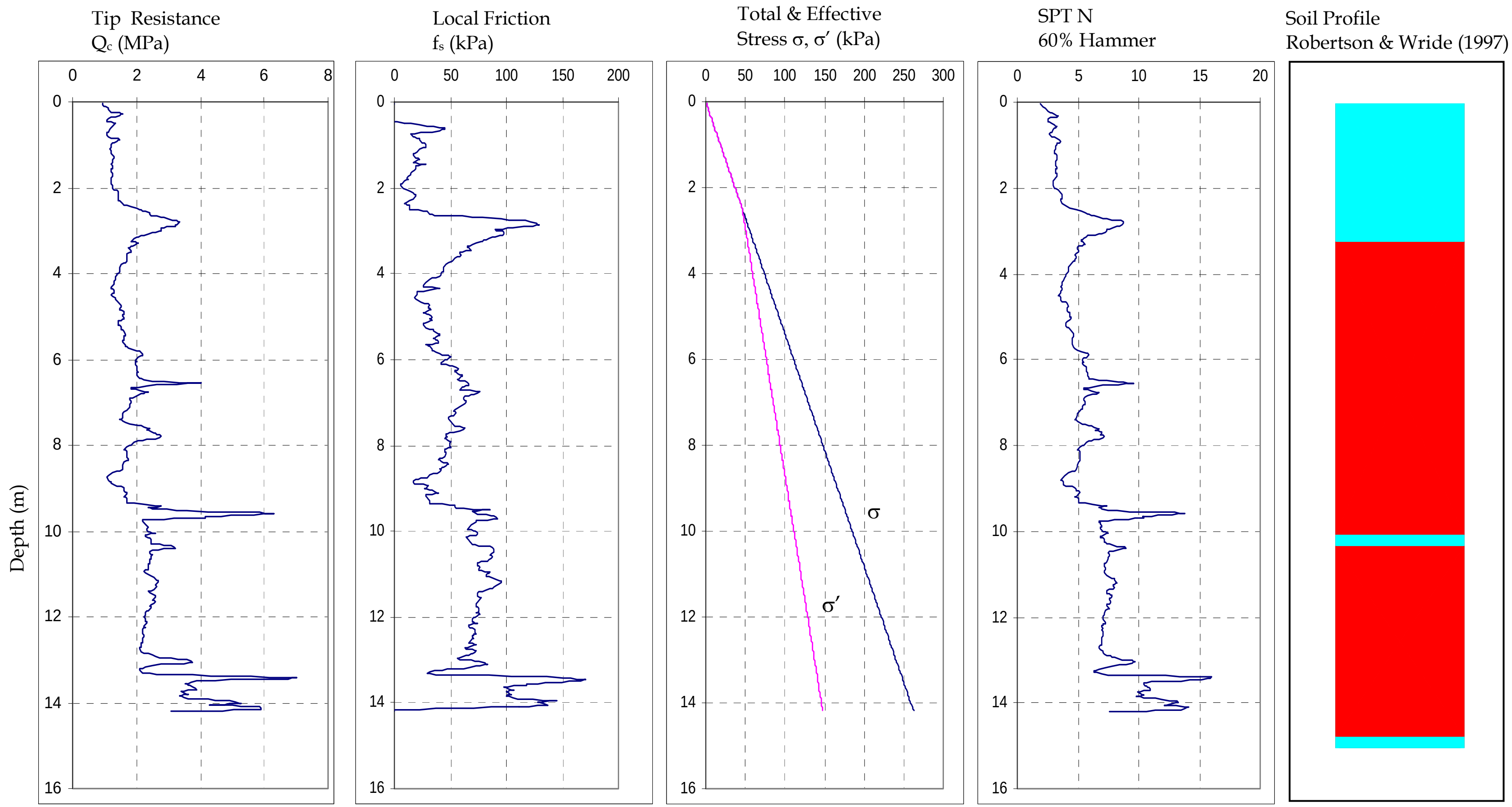
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.29 – CPT 203



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.30 – BCPT 15

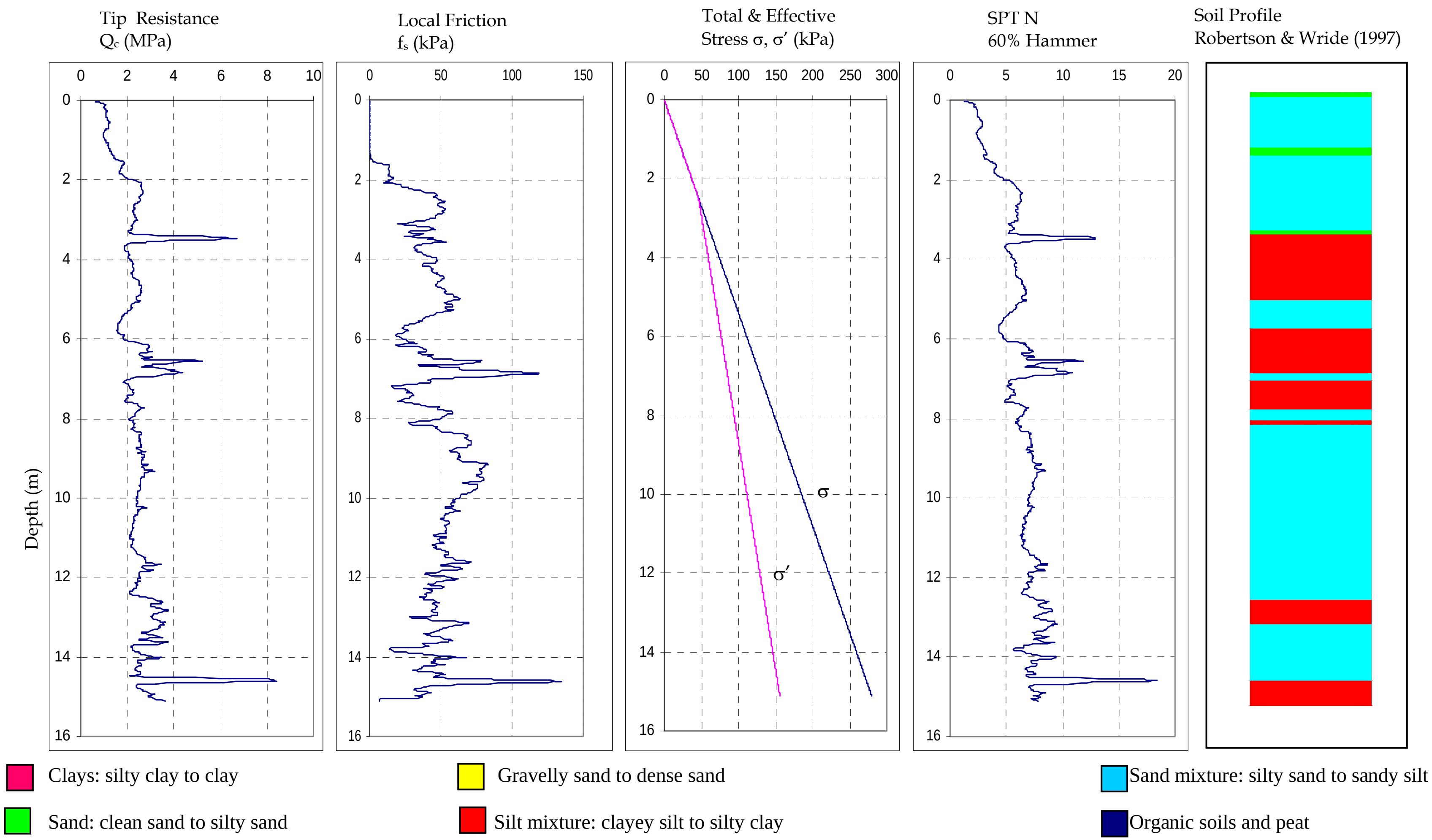
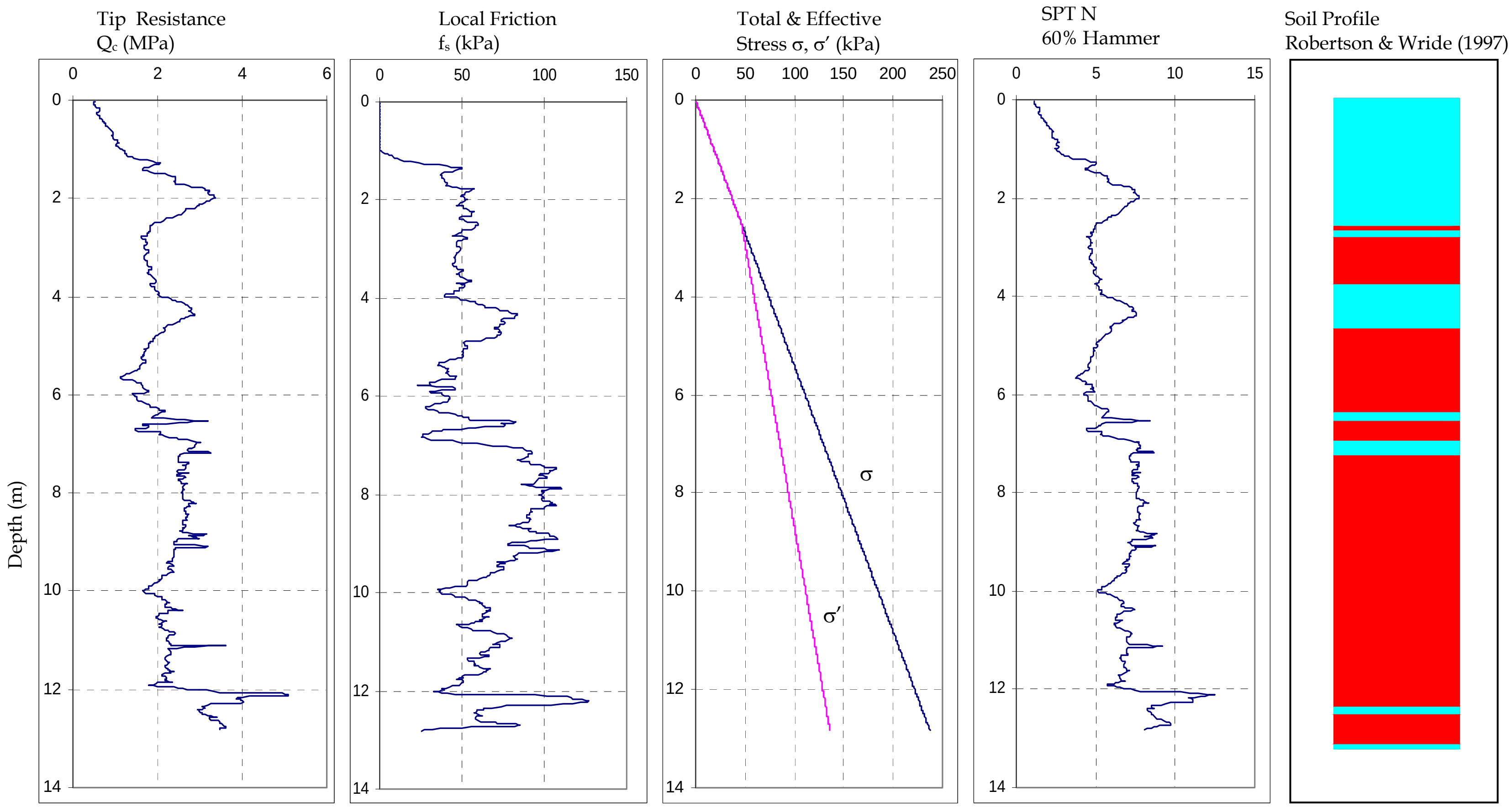


Figure B.31 – BCP14



Clays: silty clay to clay

Sand: clean sand to silty sand

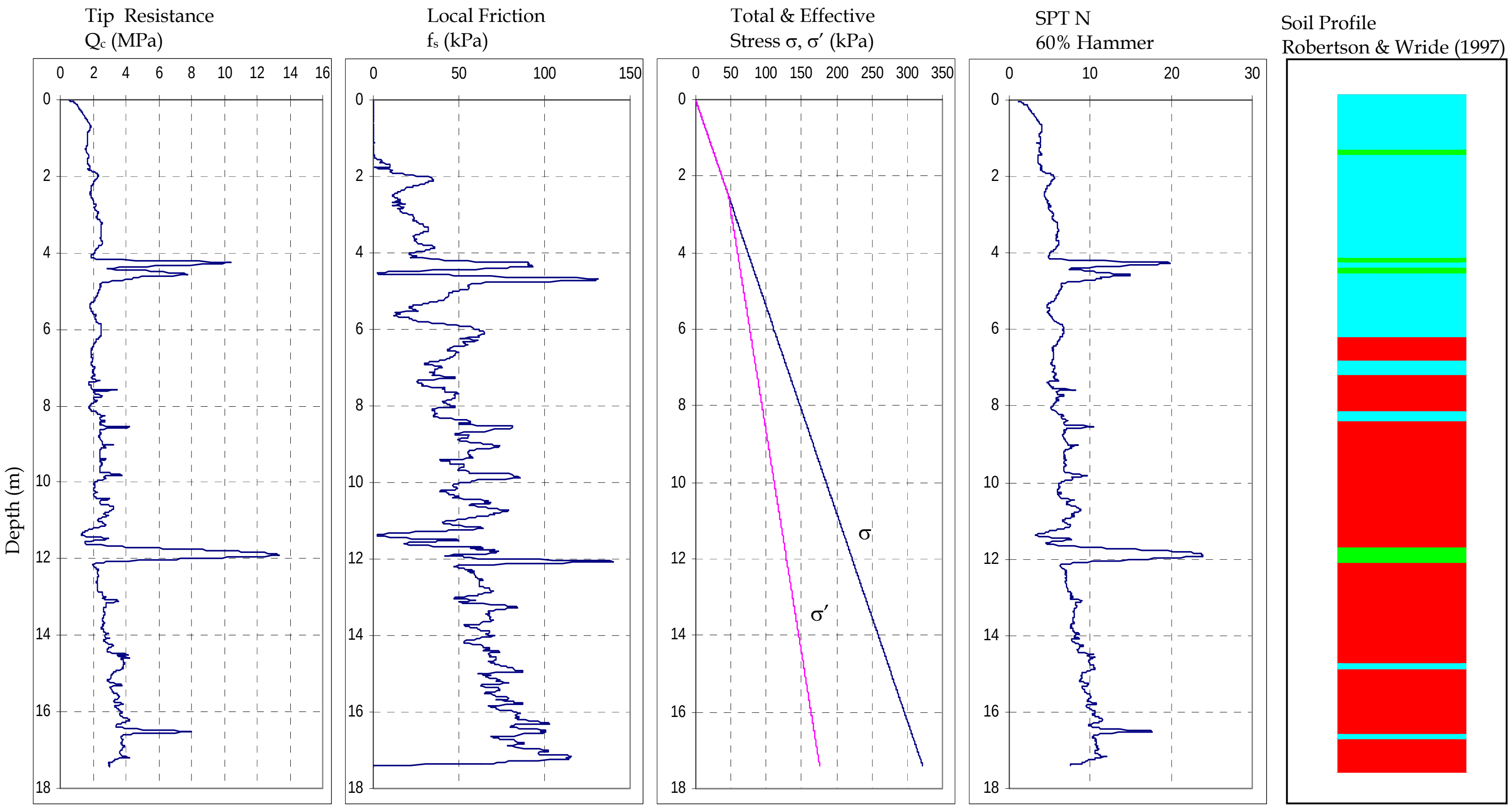
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.32 – BCPT 13



Clays: silty clay to clay

Sand: clean sand to silty sand

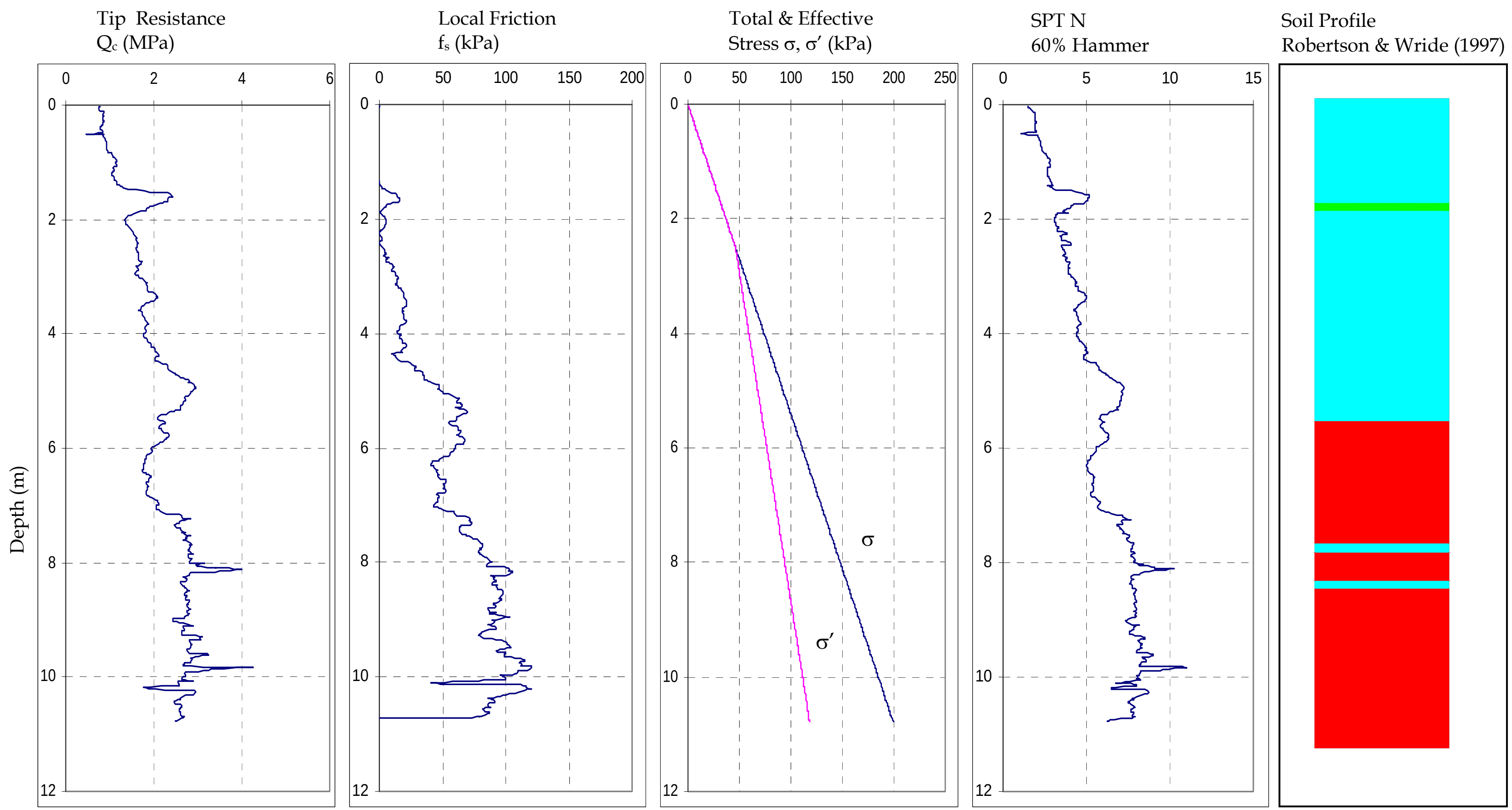
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.33 – BCPT 12



Clays: silty clay to clay

Sand: clean sand to silty sand

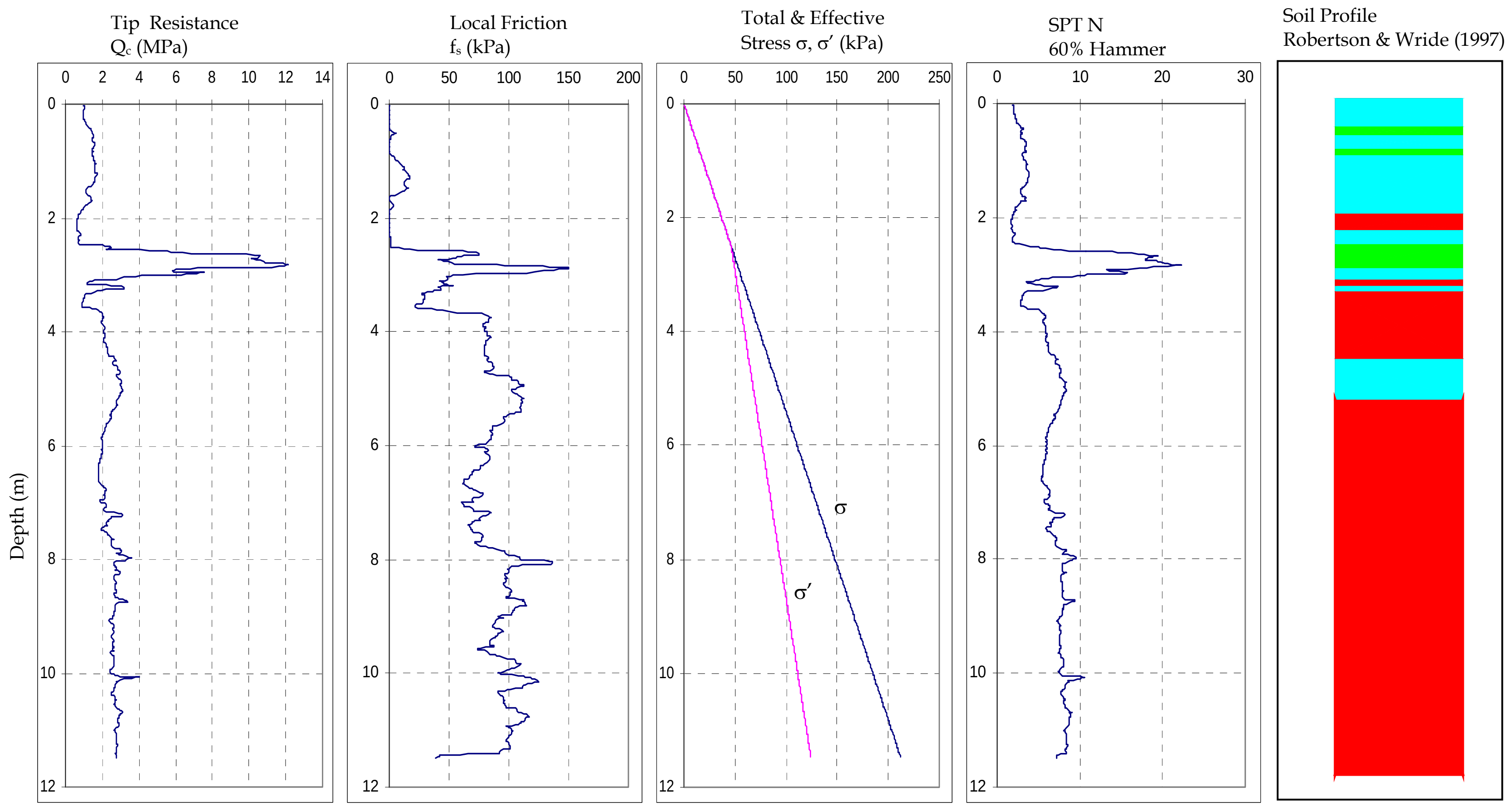
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.34 – BCPT 11



Clays: silty clay to clay

Sand: clean sand to silty sand

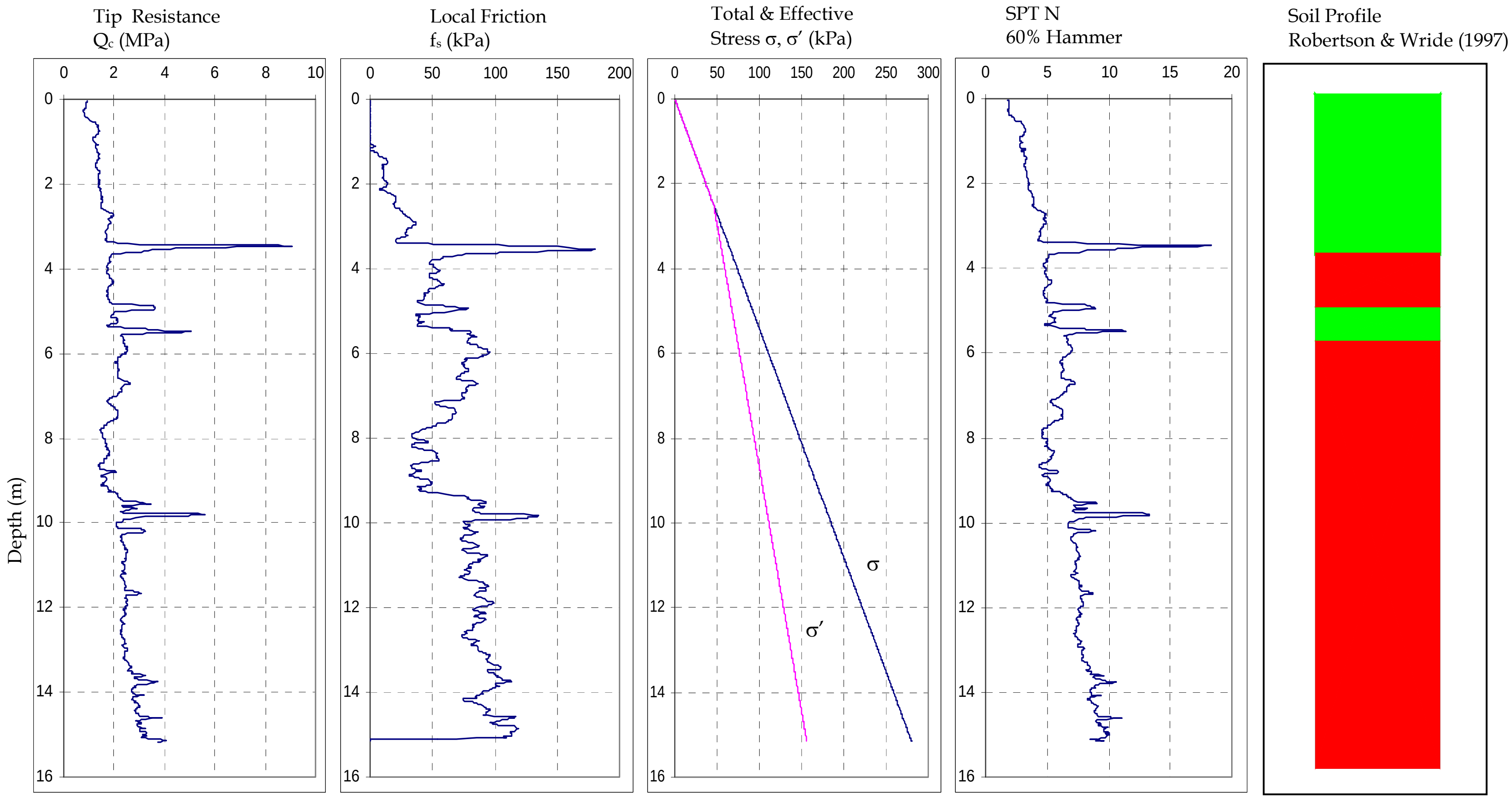
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.35 – BCPT 10



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.36 – BCPT 9

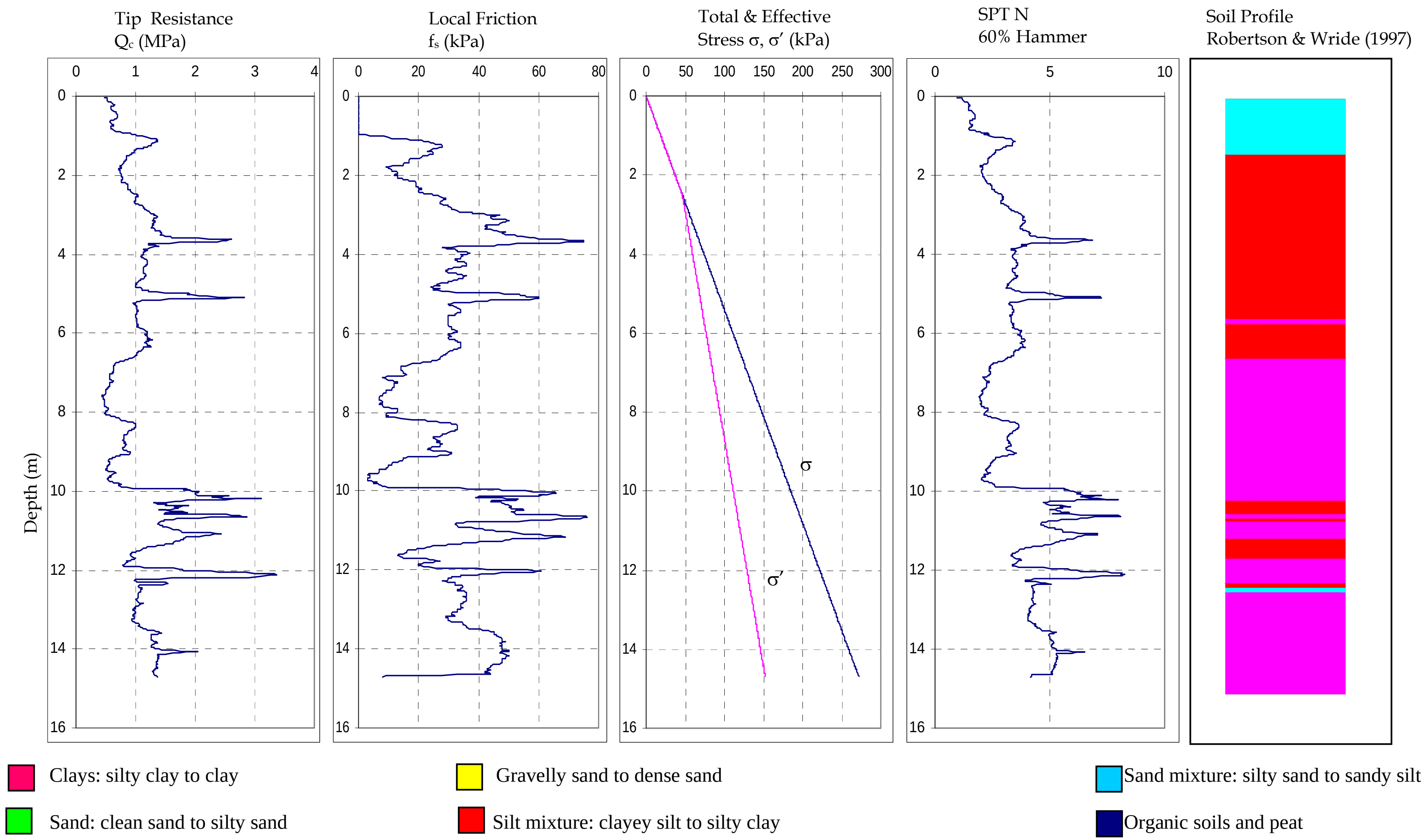


Figure B.37 – BCPT 8

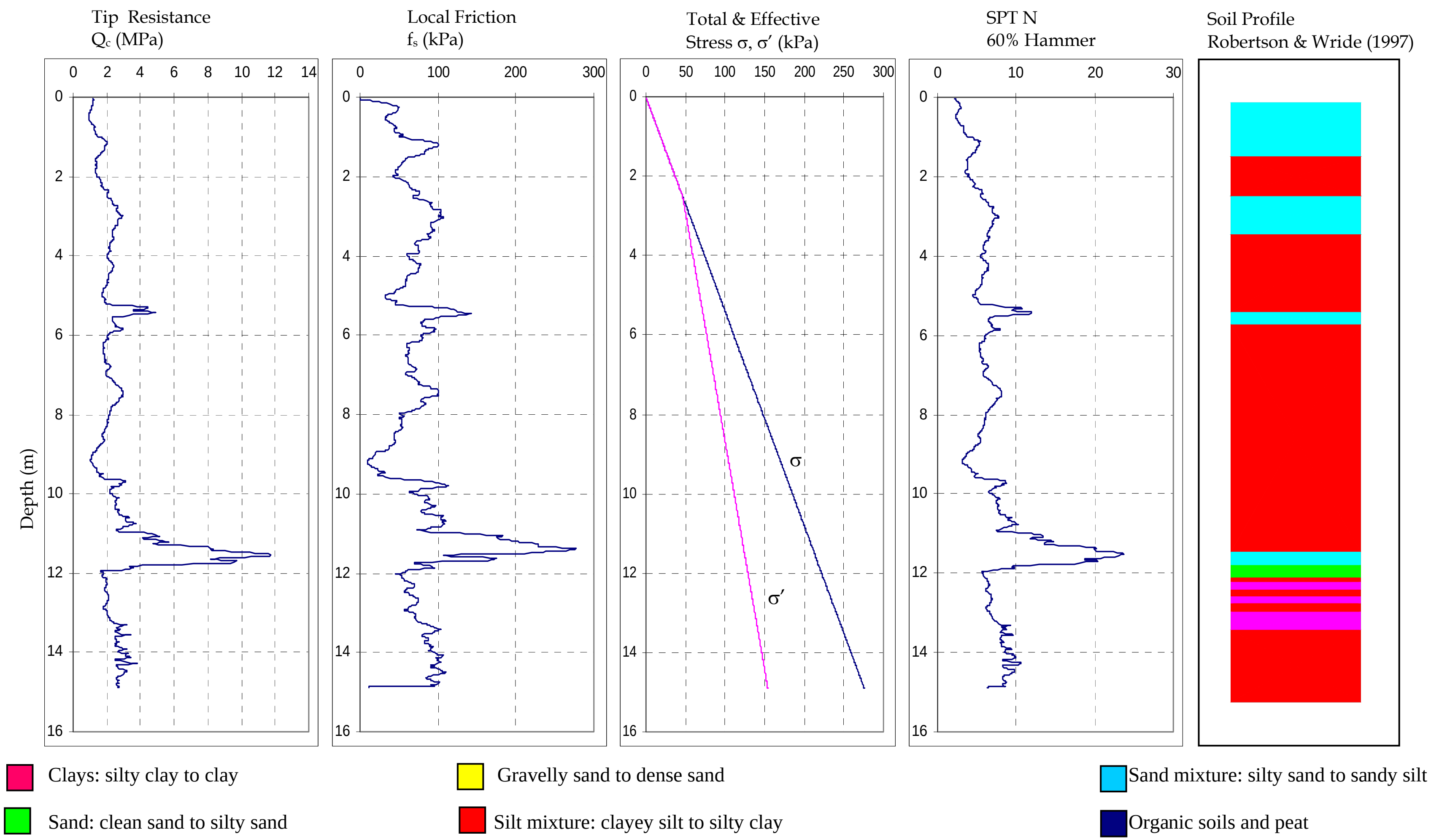
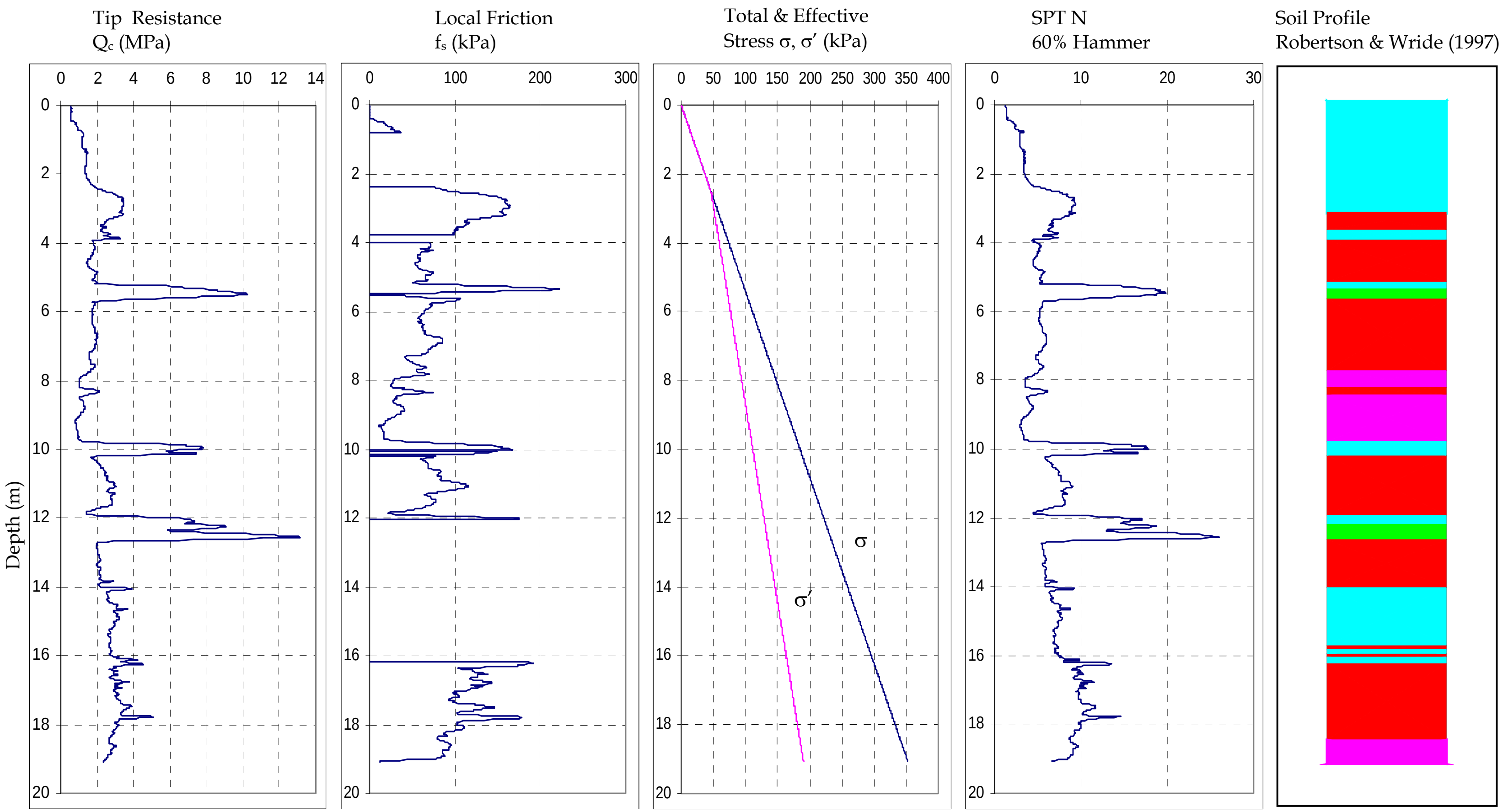


Figure B.38 – CPT 7



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.39 – BCPT 6

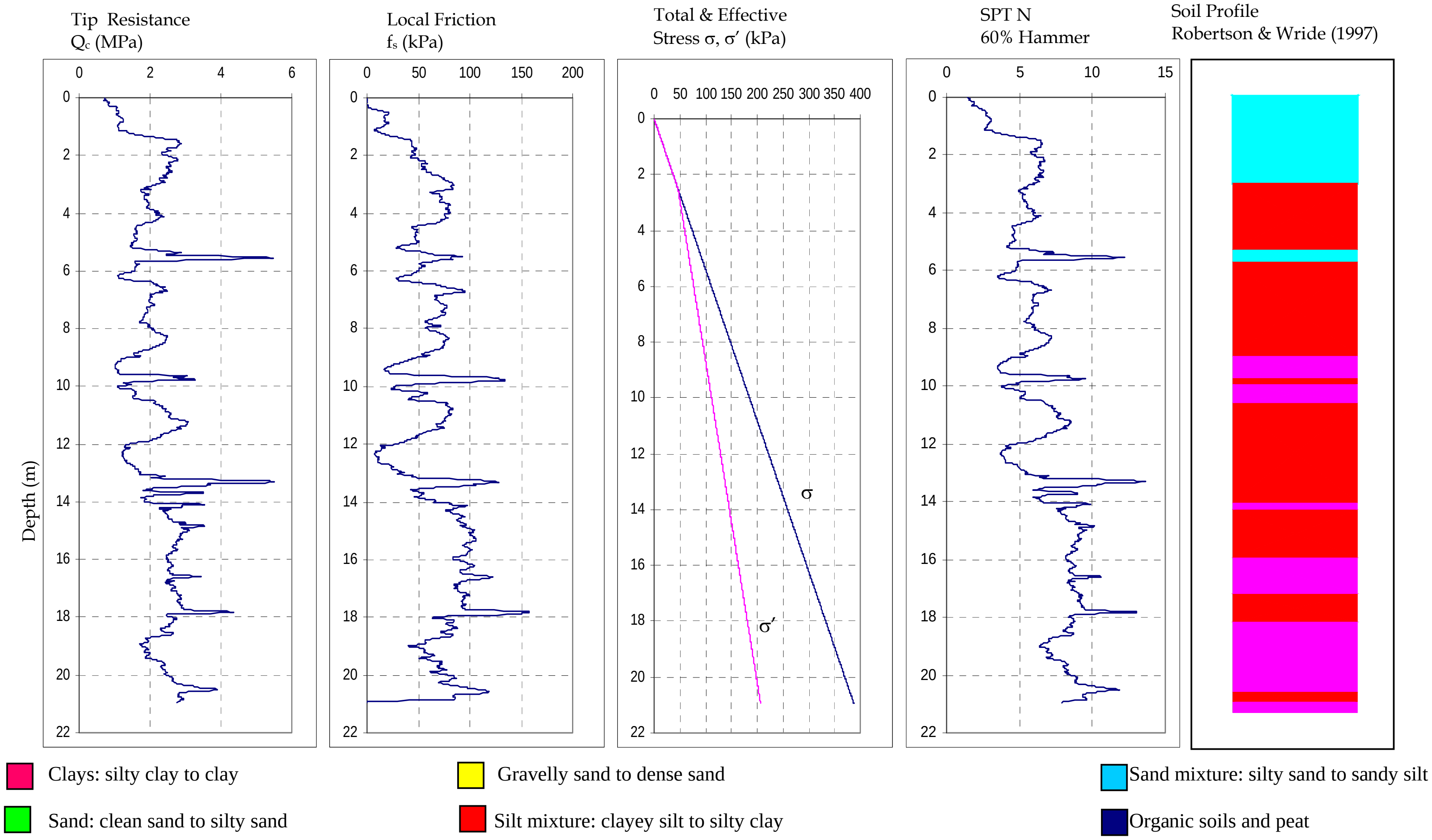
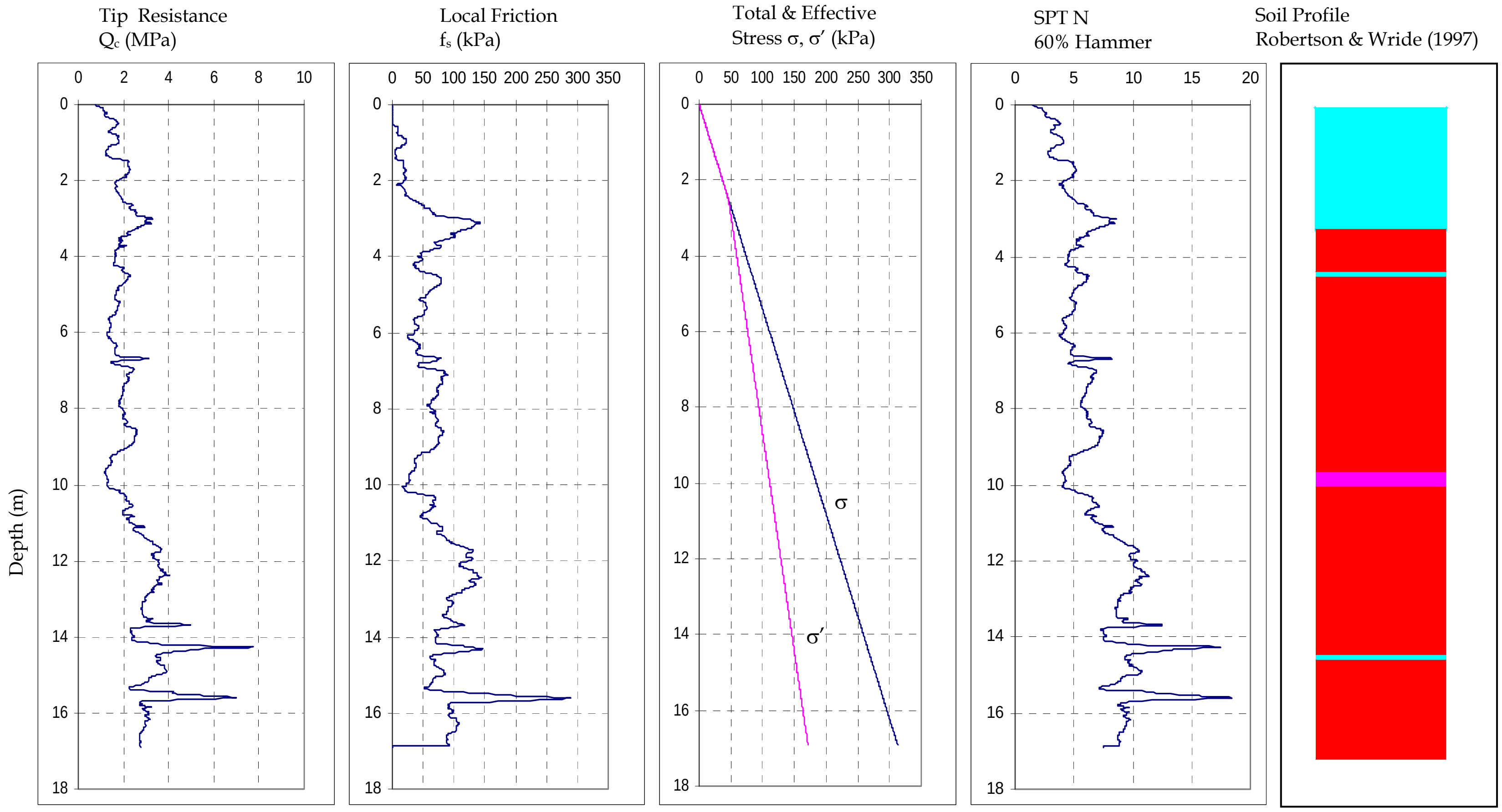


Figure B.40 – BCPT 5



Clays: silty clay to clay

Sand: clean sand to silty sand

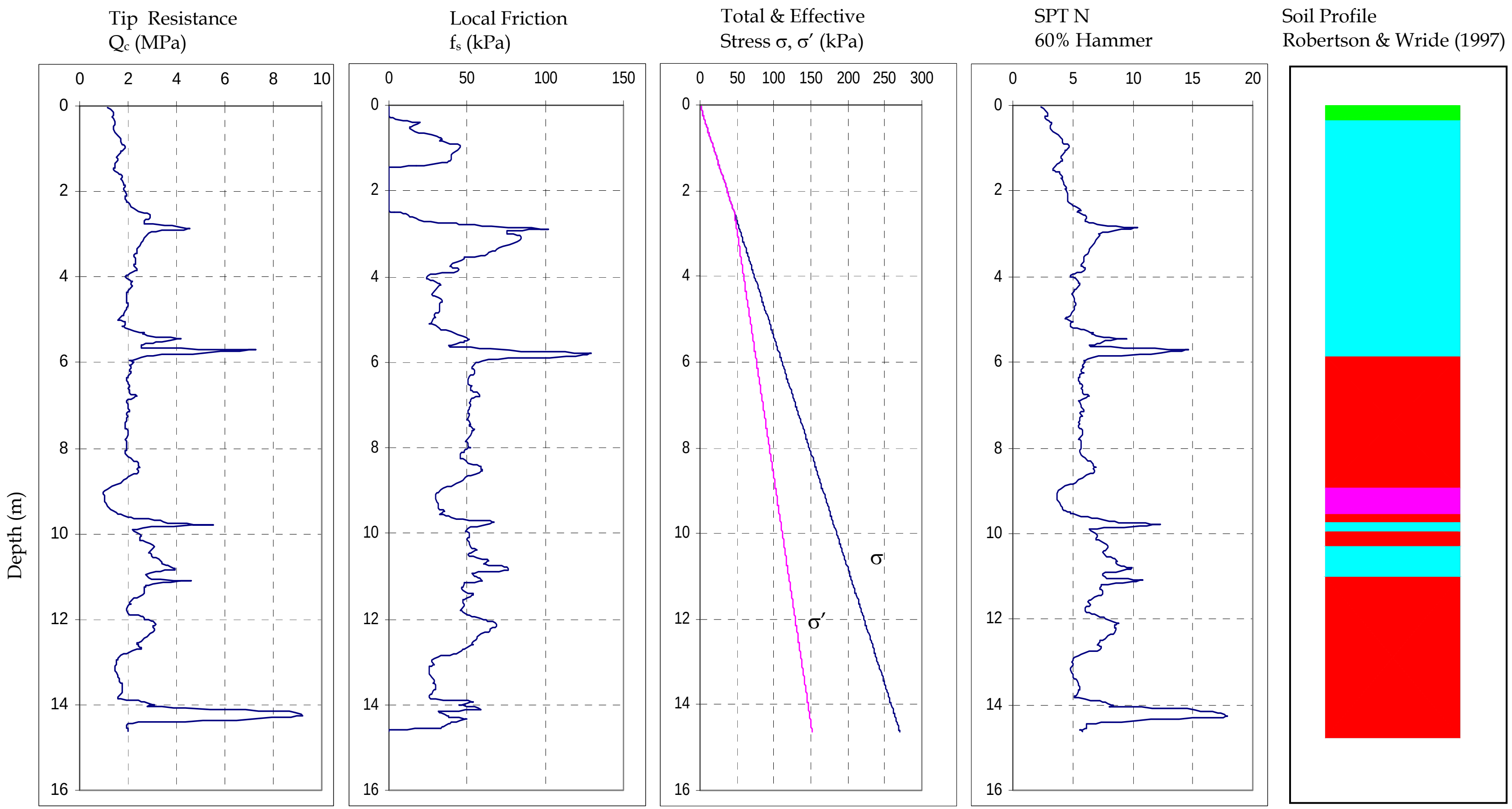
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.41 – BCPT 4



Clays: silty clay to clay

Sand: clean sand to silty sand

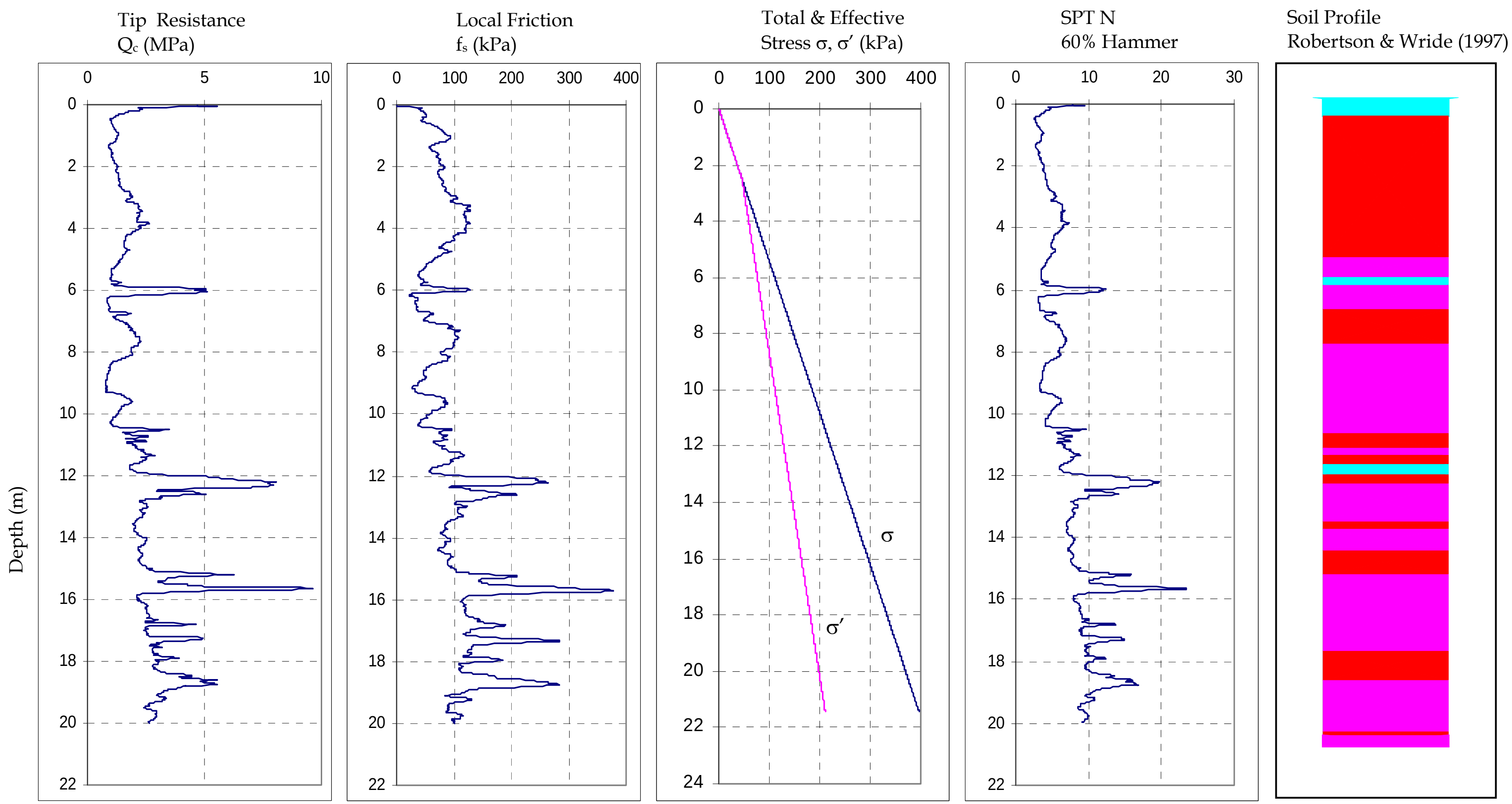
Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.42 – BCPT 3



Clays: silty clay to clay

Sand: clean sand to silty sand

Gravelly sand to dense sand

Silt mixture: clayey silt to silty clay

Sand mixture: silty sand to sandy silt

Organic soils and peat

Figure B.43 – BCPT 2

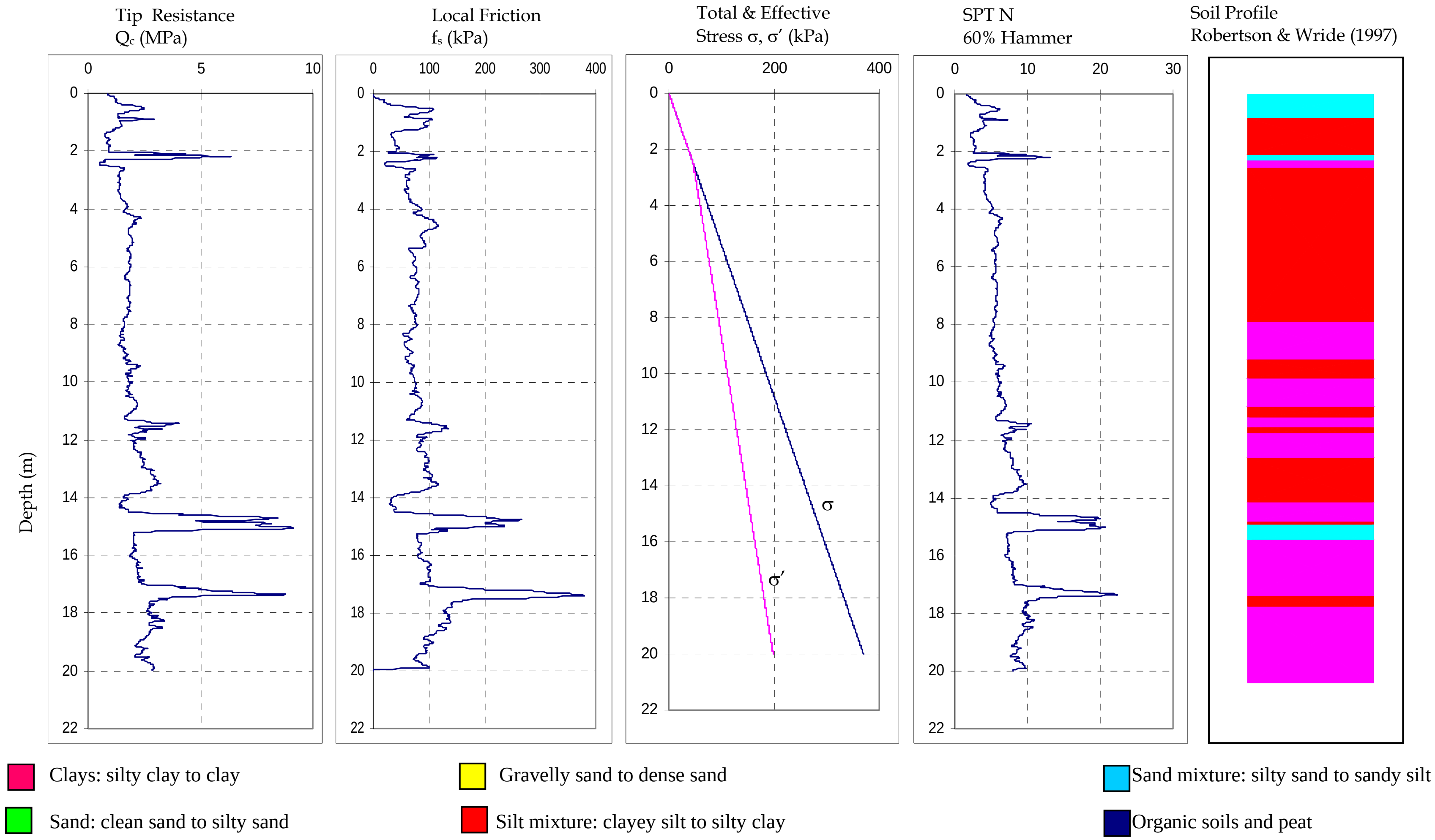


Figure B.44 – BCPT 1

APPENDIX C

Table.1 - Distribution of Change in Vertical Stresses at the Settlement Plates

	SP35	**SP36**	**SP37**	**SP38**	**SP39**	**SP40**	**SP54**
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.95	63.96	63.94	63.98	63.92	63.81	63.88
2.50	63.35	63.40	63.05	63.87	62.60	62.12	61.77
5.00	63.01	63.16	62.41	63.84	61.99	60.94	60.26
7.50	62.81	63.04	61.79	63.81	61.14	59.45	58.54
10.00	62.39	62.73	60.91	63.71	59.99	57.85	56.66
12.50	61.78	62.25	59.86	63.57	58.66	56.26	54.79
15.00	61.04	61.65	58.75	63.14	57.25	54.75	53.06
17.50	60.19	60.95	57.63	62.52	55.85	53.31	51.54
20.00	59.21	60.14	56.49	61.73	54.45	51.92	50.19
22.50	58.05	59.22	55.31	60.80	53.00	50.54	48.89
25.00	56.70	58.18	54.07	59.80	51.44	49.13	47.55
27.50	55.26	57.12	52.84	58.85	49.88	47.78	46.22
30.00	54.09	56.29	51.90	58.17	48.70	46.71	45.24
	SP33	**SP34**	**SP1**	**SP2**	**SP7**	**SP8**	**SP9**
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	64.00	64.00	64.00	63.90	63.85	63.95	63.92
2.50	63.76	63.86	60.92	60.57	63.57	63.99	63.65
5.00	63.74	63.70	58.82	57.91	63.40	63.90	63.45
7.50	63.68	63.50	56.45	54.10	63.30	63.75	63.19
10.00	63.45	63.45	53.85	49.70	63.10	63.53	62.99
12.50	63.01	63.35	51.35	46.50	62.90	63.32	62.65
15.00	62.37	63.15	49.05	43.60	62.50	63.18	62.11
17.50	61.51	62.55	46.75	41.10	61.70	62.68	61.35
20.00	60.40	61.85	45.15	39.30	61.20	62.00	60.38
22.50	59.03	60.75	42.15	36.70	59.20	61.14	59.24
25.00	57.42	59.65	40.35	35.00	57.90	60.15	58.00
27.50	55.69	58.35	38.35	33.50	56.30	59.17	56.74
30.00	54.15	57.05	36.75	32.30	55.10	58.41	55.54

Table.1 -Distribution of Change in Vertical Stresses at Settlement Plates (Continued)

	SP16	SP17	SP18	SP22	SP23	SP24	SP28
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.85	63.95	63.95	63.95	63.99	63.97	63.88
2.50	63.60	63.55	63.22	63.75	63.72	63.72	63.62
5.00	63.15	63.05	62.72	63.55	63.32	62.62	62.42
7.50	62.80	62.50	60.45	63.35	63.05	60.85	60.75
10.00	61.90	61.80	58.25	63.25	62.85	59.25	59.05
12.50	61.00	61.40	55.85	63.10	62.65	57.65	57.05
15.00	59.70	60.40	54.35	62.80	62.25	56.25	54.75
17.50	58.80	59.60	52.15	62.10	61.95	54.45	53.45
20.00	57.90	59.10	51.25	61.80	62.05	54.15	52.65
22.50	55.80	57.40	48.75	60.10	60.85	51.95	50.15
25.00	54.30	56.40	47.95	59.40	60.75	51.25	48.45
27.50	53.00	55.50	46.45	58.70	60.55	50.40	47.65
30.00	51.90	54.80	45.35	58.20	60.35	49.55	46.75
	SP29	**SP30**	**SP41**	**SP42**	**SP43**	**SP44**	**SP45**
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.96	63.81	63.91	63.95	63.91	63.94	63.95
2.50	63.72	63.37	63.75	63.80	63.77	63.47	63.82
5.00	62.62	60.87	63.35	63.65	63.17	63.67	63.52
7.50	60.95	57.20	62.95	63.45	62.20	63.40	63.15
10.00	59.55	54.50	62.45	63.25	61.90	62.60	62.95
12.50	57.65	51.50	61.55	62.65	60.70	62.10	62.65
15.00	56.35	49.40	60.35	61.75	59.30	61.80	62.55
17.50	54.75	46.80	58.75	61.15	58.30	60.50	62.05
20.00	54.15	46.00	57.95	60.65	57.10	60.30	62.15
22.50	51.85	43.10	55.65	58.75	54.60	58.60	60.85
25.00	51.25	42.30	54.15	57.95	53.70	57.40	60.75
27.50	50.15	40.80	52.75	56.85	51.90	56.60	60.55
30.00	49.55	39.90	51.45	56.35	50.90	55.80	60.65

Table.1 -Distribution of Change in Vertical Stresses at Settlement Plates (Continued)

	SP46	SP47	SP48	SP49	SP50	SP3	SP26
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.91	63.91	63.94	63.95	64.00	63.95	63.96
2.50	63.77	63.87	63.87	63.82	63.57	63.83	63.72
5.00	63.61	63.70	63.58	63.72	62.88	63.65	62.62
7.50	63.30	63.50	63.45	63.55	62.23	63.62	60.95
10.00	63.10	62.90	63.40	63.45	61.47	63.35	59.55
12.50	62.30	62.20	63.20	62.75	60.57	63.22	57.65
15.00	61.50	61.30	62.70	61.95	59.51	62.45	56.35
17.50	60.80	59.90	62.20	61.35	58.28	61.85	54.75
20.00	60.30	59.10	61.70	60.45	56.88	59.65	54.15
22.50	58.50	57.10	59.90	57.95	55.34	58.65	51.85
25.00	57.80	55.60	59.40	57.05	53.67	56.15	51.25
27.50	56.50	54.30	58.40	55.35	51.90	54.65	50.15
30.00	56.20	53.00	57.90	54.35	50.06	52.75	49.55
	SP13	**SP14**	**SP15**	**SP19**	**SP20**	**SP21**	**SP25**
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.85	63.95	63.95	63.95	63.99	63.97	63.88
2.50	63.60	63.55	63.22	63.75	63.72	63.72	63.62
5.00	63.15	63.05	62.72	63.55	63.32	62.62	62.42
7.50	62.80	62.50	60.45	63.35	63.05	60.85	60.75
10.00	61.90	61.80	58.25	63.25	62.85	59.25	59.05
12.50	61.00	61.40	55.85	63.10	62.65	57.65	57.05
15.00	59.70	60.40	54.35	62.80	62.25	56.25	54.75
17.50	58.80	59.60	52.15	62.10	61.95	54.45	53.45
20.00	57.90	59.10	51.25	61.80	62.05	54.15	52.65
22.50	55.80	57.40	48.75	60.10	60.85	51.95	50.15
25.00	54.30	56.40	47.95	59.40	60.75	51.25	48.45
27.50	53.00	55.50	46.45	58.70	60.55	50.40	47.65
30.00	51.90	54.80	45.35	58.20	60.35	49.55	46.75

Table.1 -Distribution of Change in Vertical Stresses at Settlement Plates (Continued)

	BSP1	BSP2	BSP3	BSP4	BSP5	BSP6	BSP7
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.95	64.00	63.95	63.90	63.99	63.97	63.96
2.50	60.67	61.47	63.70	63.75	63.82	63.93	63.89
5.00	57.47	59.37	63.50	63.60	63.72	63.89	63.79
7.50	54.60	57.50	63.40	63.57	63.65	63.60	63.62
10.00	51.30	55.30	63.27	63.50	63.35	63.30	63.42
12.50	49.10	53.30	63.20	63.38	63.15	62.70	63.12
15.00	47.00	51.10	62.90	63.27	62.95	61.80	62.52
17.50	45.10	49.50	62.50	62.90	62.65	61.30	61.92
20.00	43.90	48.10	62.30	62.70	62.75	59.50	61.42
22.50	41.90	45.80	60.40	61.10	61.25	58.40	59.52
25.00	40.80	44.30	59.40	60.20	60.95	57.10	58.42
27.50	39.80	43.10	58.40	59.10	60.55	56.20	57.12
30.00	38.90	42.00	57.50	58.30	60.05	55.30	56.12
	BSP12	**BSP13**	**BSP14**	**BSP15**	**BSP16**	**BSP20**	**BSP21**
Depth (m)	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**	**Δσ (kPa)**
0.00	63.92	63.93	63.92	63.96	63.97	63.96	63.91
2.50	63.87	63.89	63.77	63.75	63.77	63.57	63.47
5.00	63.80	63.82	63.62	63.65	63.65	62.07	63.07
7.50	63.65	63.78	63.51	63.58	63.50	59.50	62.20
10.00	63.30	63.62	63.40	62.88	63.00	57.10	61.20
12.50	62.80	62.92	63.20	62.38	62.50	54.50	59.80
15.00	62.00	62.32	63.00	61.88	61.70	49.80	58.30
17.50	61.10	61.42	62.50	60.78	60.70	48.40	56.60
20.00	60.40	60.82	62.40	59.58	60.10	45.30	55.40
22.50	58.50	58.72	61.90	57.98	58.20	43.70	52.70
25.00	57.30	57.52	60.70	56.78	57.00	41.60	50.80
27.50	56.00	56.22	60.30	55.48	55.70	40.10	48.80
30.00	55.00	55.22	60.10	54.38	54.70	63.96	47.10

APPENDIX D

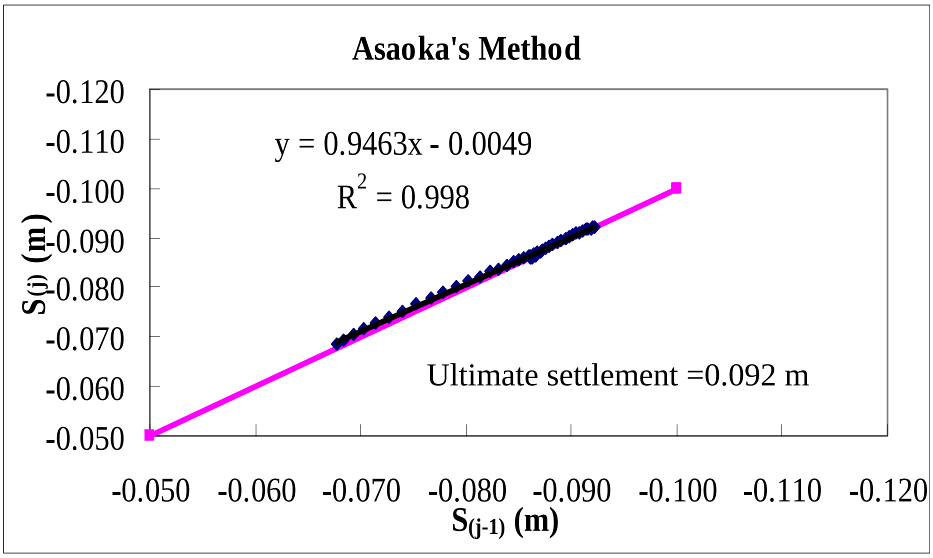


Figure D.1- Estimation of final settlement at SP1 due to the surcharge by using Asaoka's method

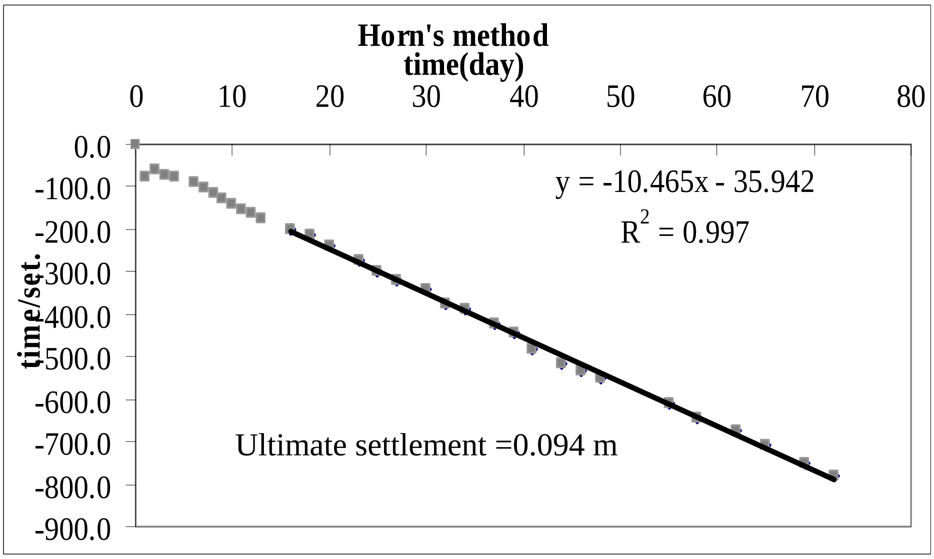


Figure D.2- Estimation of final settlement at SP1 due to the surcharge by using Horn's method

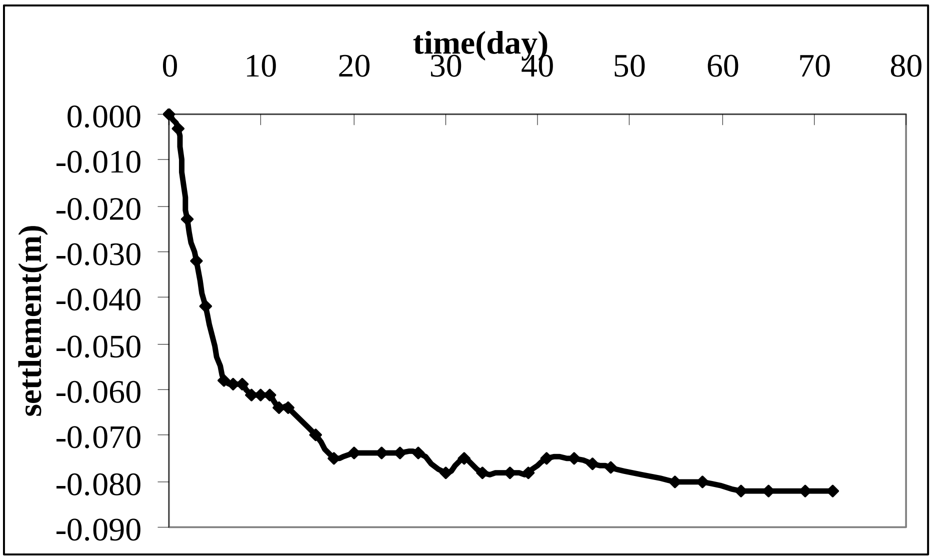


Figure D.3- The distribution of consolidation settlement due to the applied load with time at SP1

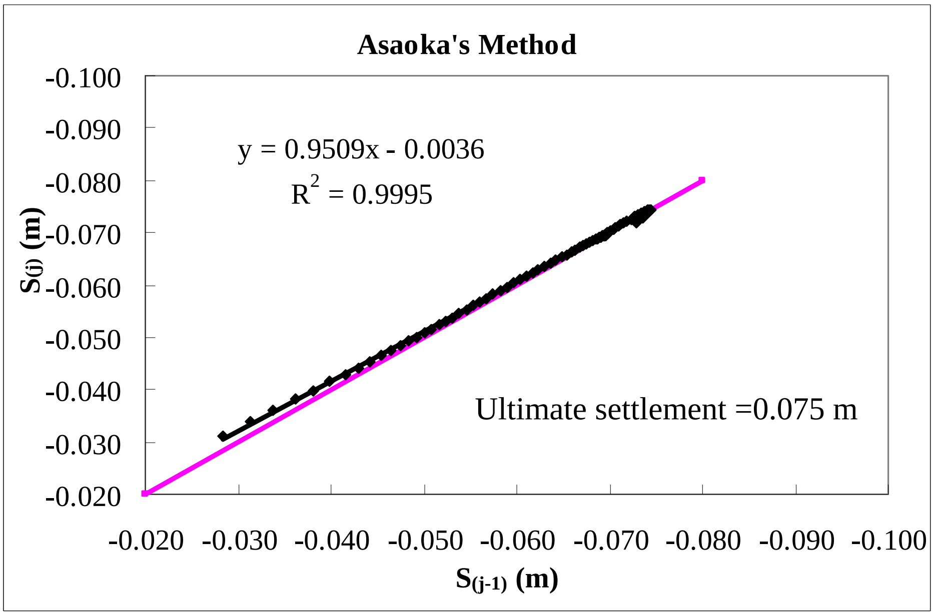


Figure D.4- Estimation of final settlement at SP2 due to the surcharge by using Asaoka's method

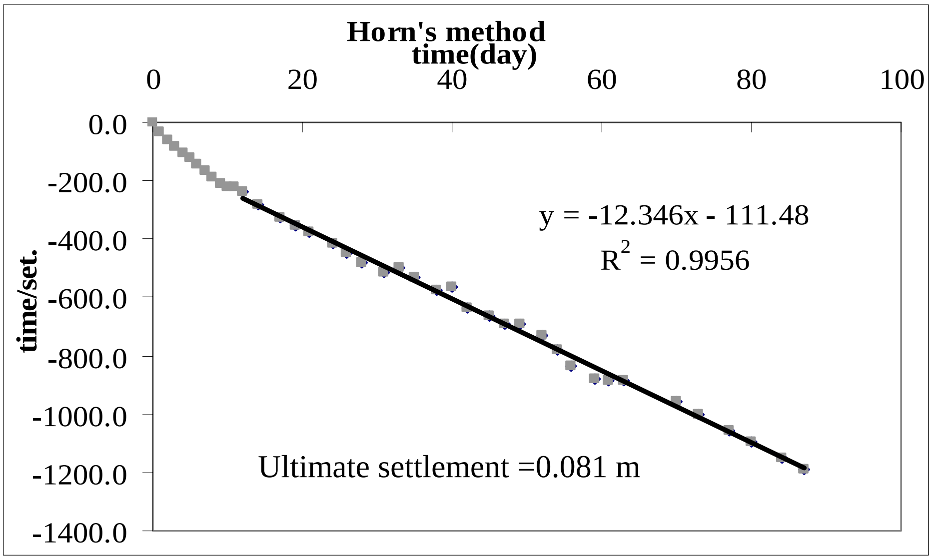


Figure D.5- Estimation of final settlement at SP2 due to the surcharge by using Horn's method

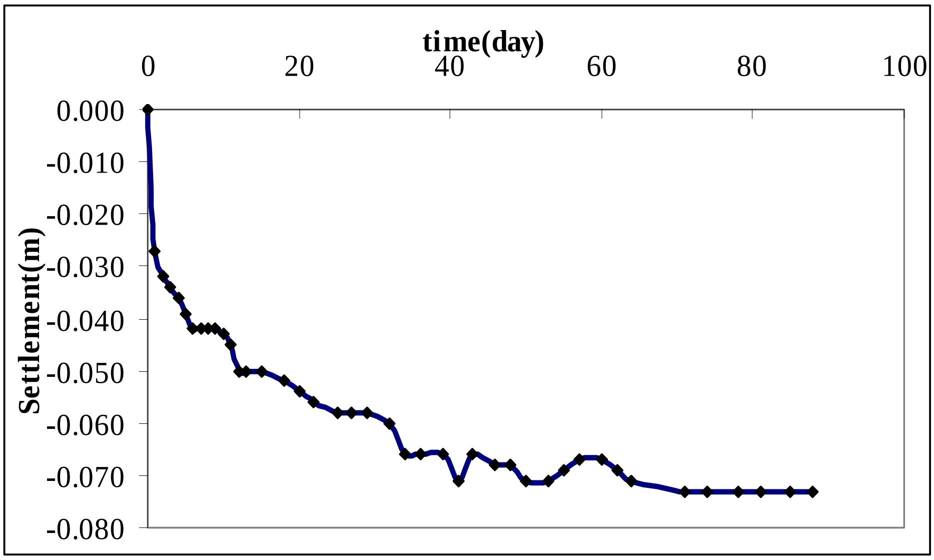


Figure D.6- The distribution of consolidation settlement due to the applied load with time at SP2

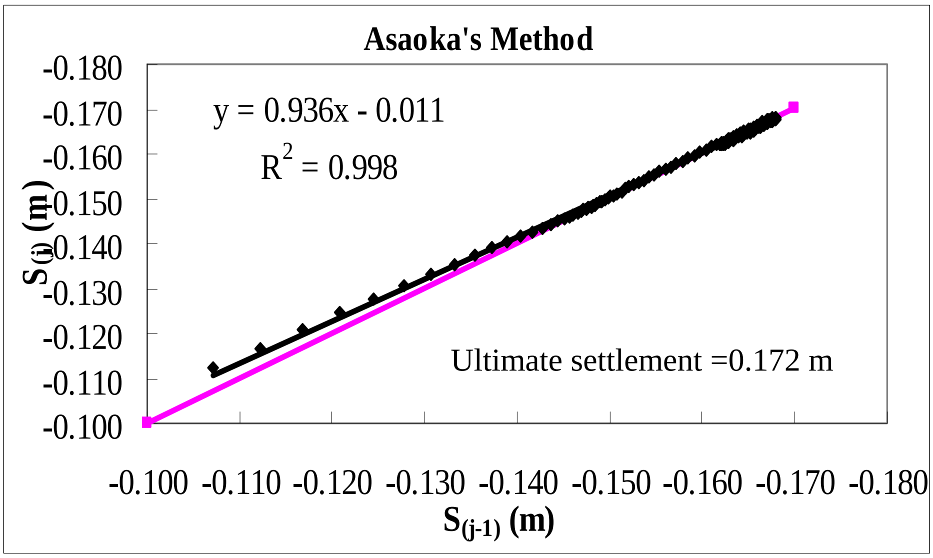


Figure D.7- Estimation of final settlement at SP3 due to the surcharge by using Asaoka's method

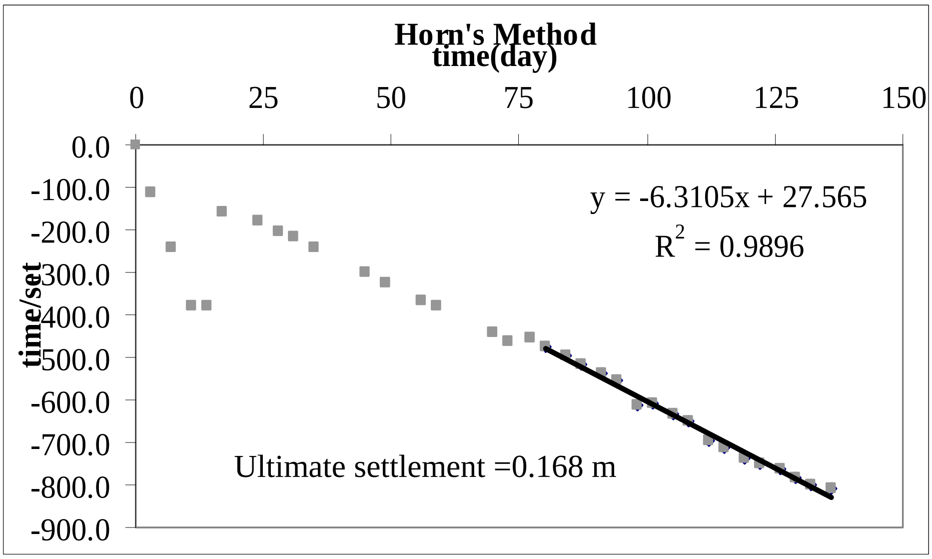


Figure D.8- Estimation of final settlement at SP3 due to the surcharge by using Horn's method

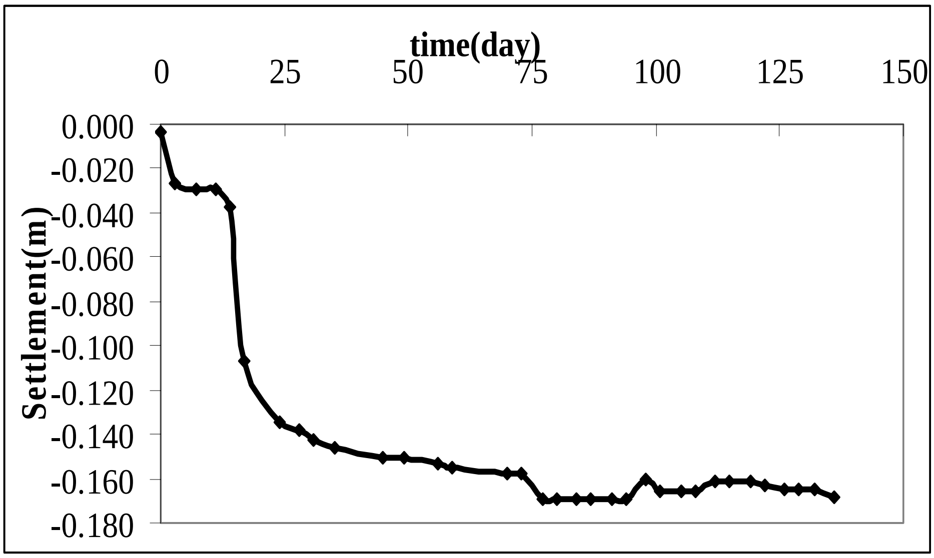


Figure D.9- The distribution of consolidation settlement due to the applied load with time at SP3

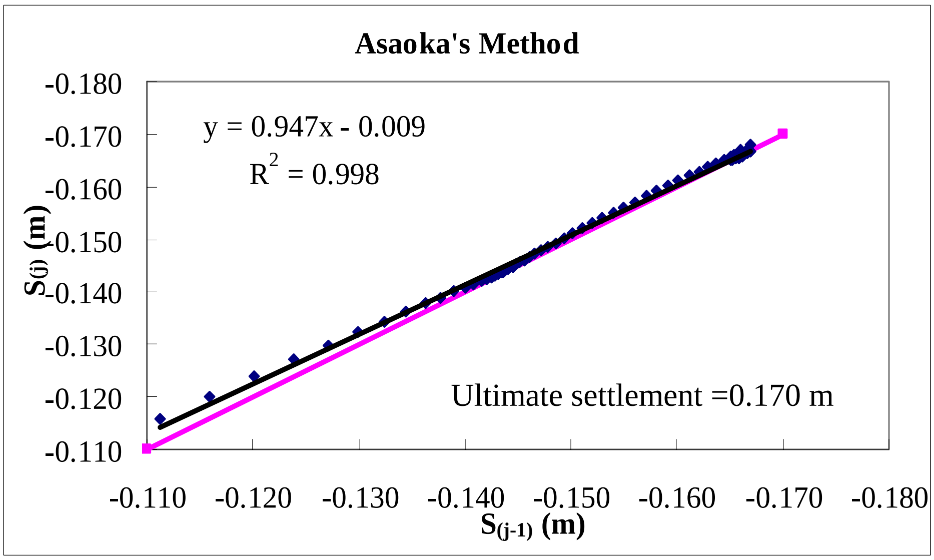


Figure D.10- Estimation of final settlement at SP7 due to the surcharge by using Asaoka's method

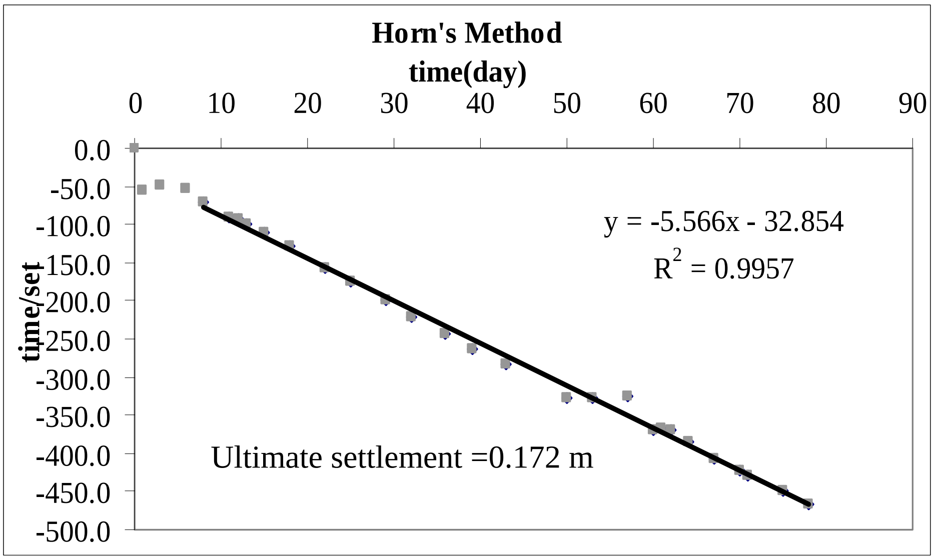


Figure D.11- Estimation of final settlement at SP7 due to the surcharge by using Horn's method

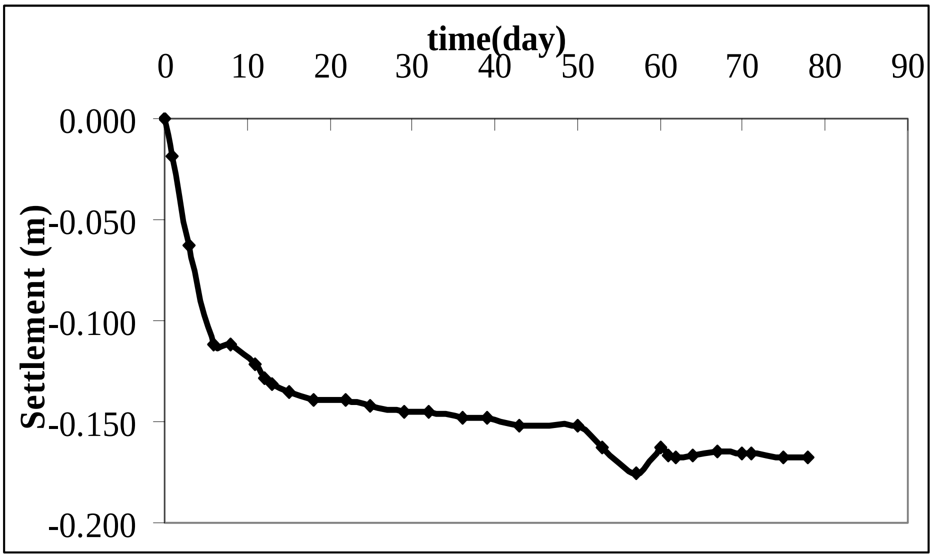


Figure D.12- The distribution of consolidation settlement due to the applied load with time at SP7

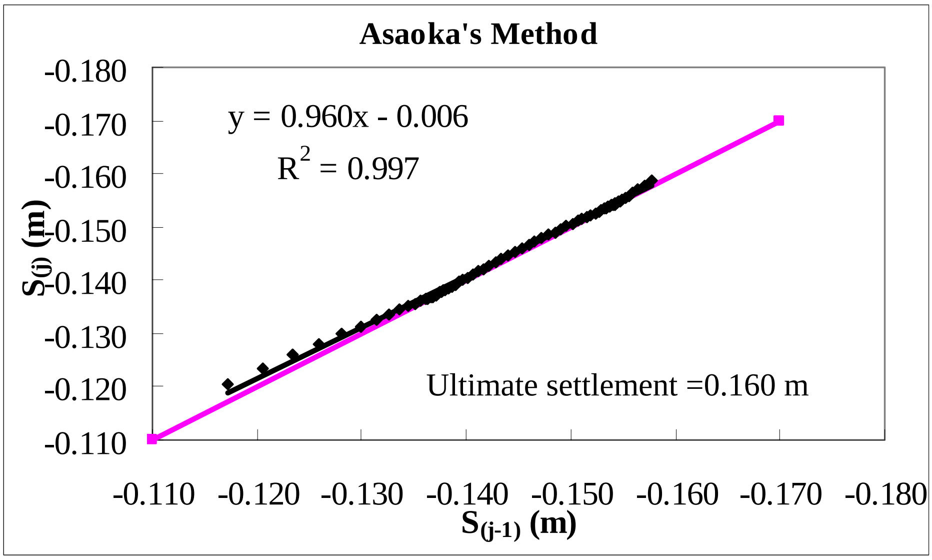


Figure D.13- Estimation of final settlement at SP8 due to the surcharge by using Asaoka's method

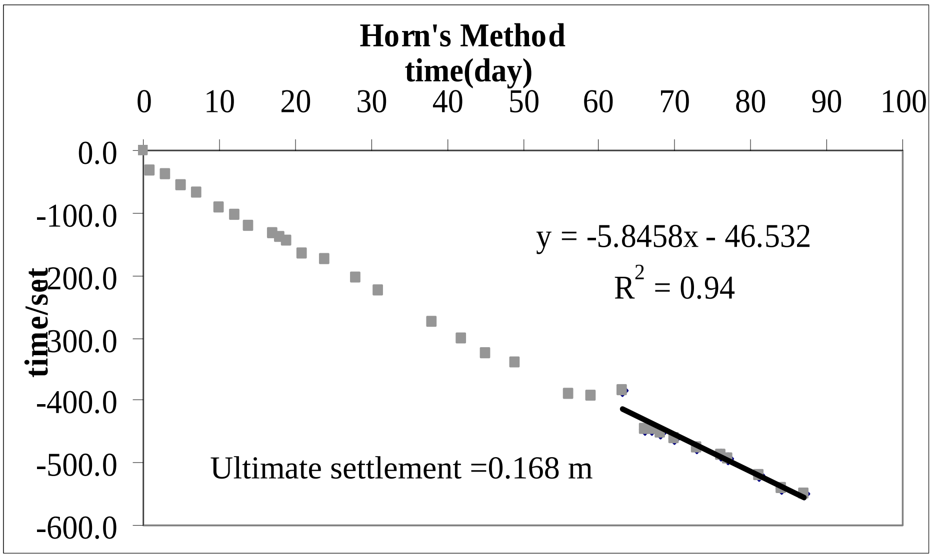


Figure D.14- Estimation of final settlement at SP8 due to the surcharge by using Horn's method

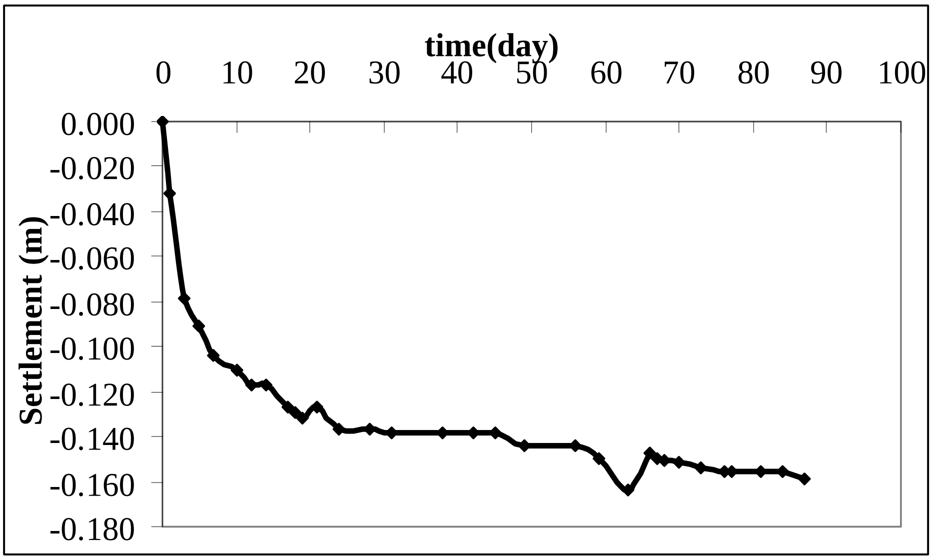


Figure D.15- The distribution of consolidation settlement due to the applied load with time at SP8

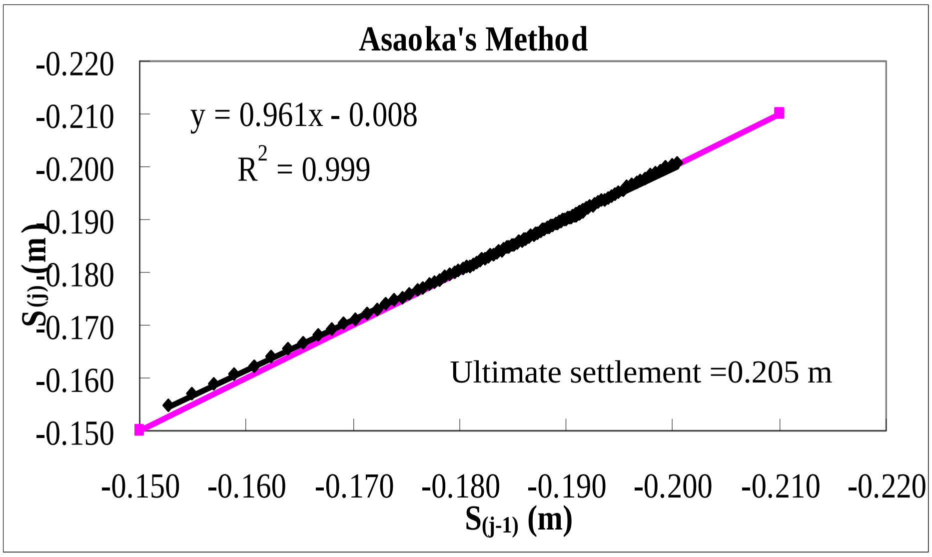


Figure D.16- Estimation of final settlement at SP9 due to the surcharge by using Asaoka's method

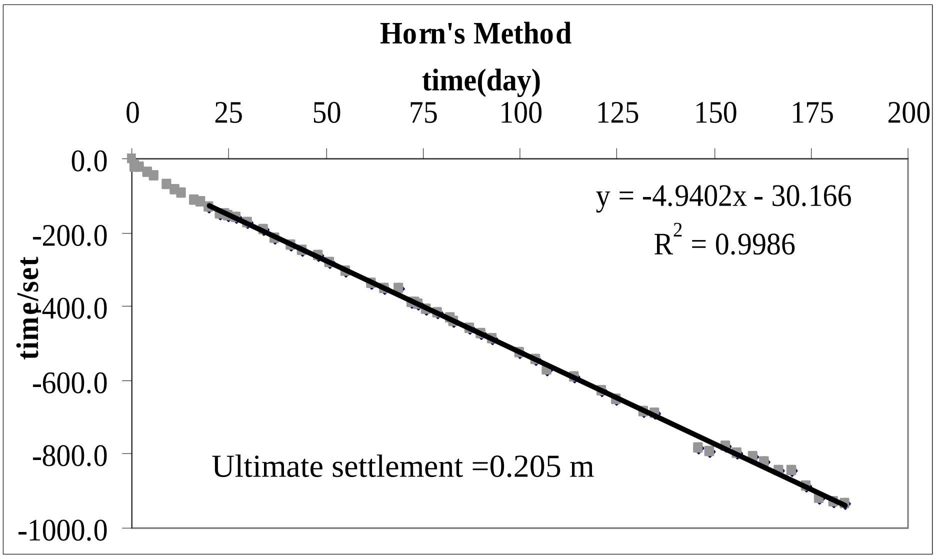


Figure D.17- Estimation of final settlement at SP9 due to the surcharge by using Horn's method

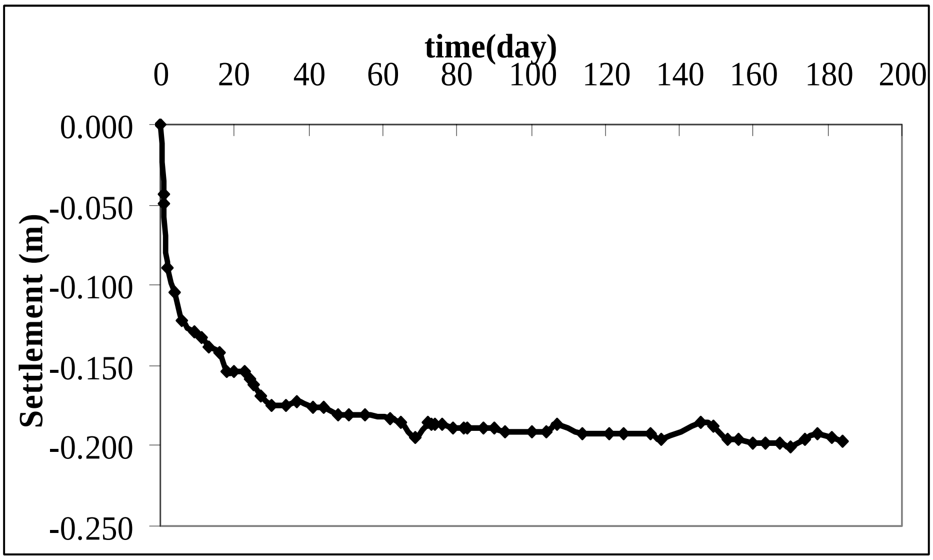


Figure D.18- The distribution of consolidation settlement due to the applied load with time at SP9

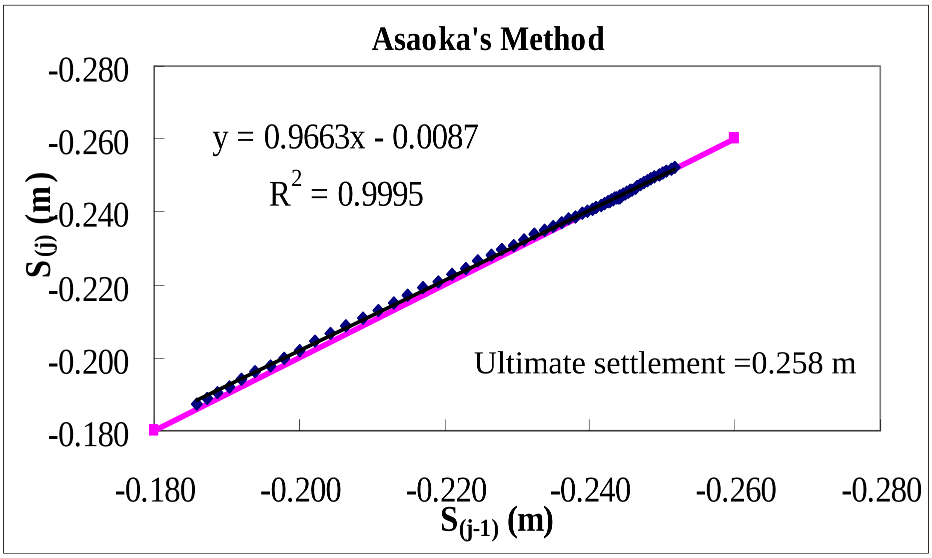


Figure D.19- Estimation of final settlement at SP16 due to the surcharge by using Asaoka's method

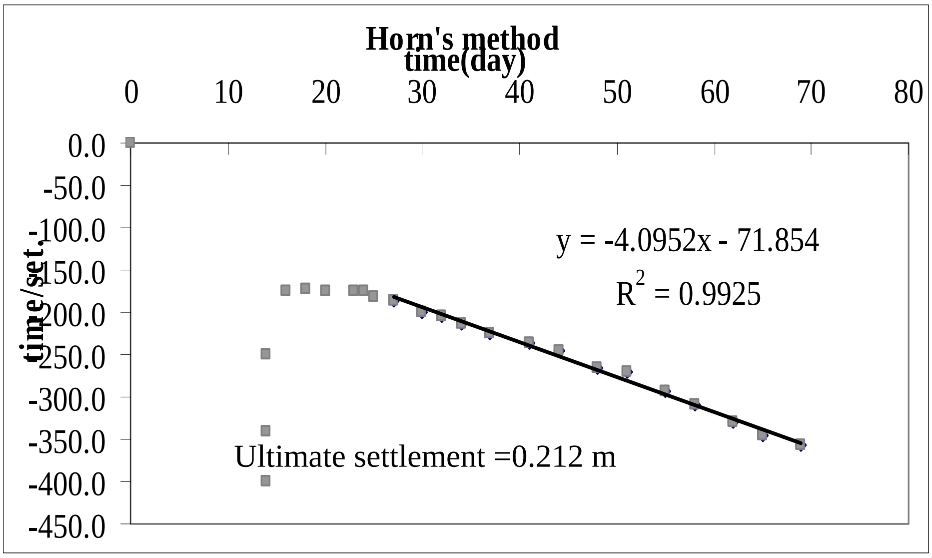


Figure D.20- Estimation of final settlement at SP16 due to the surcharge by using Horn's method

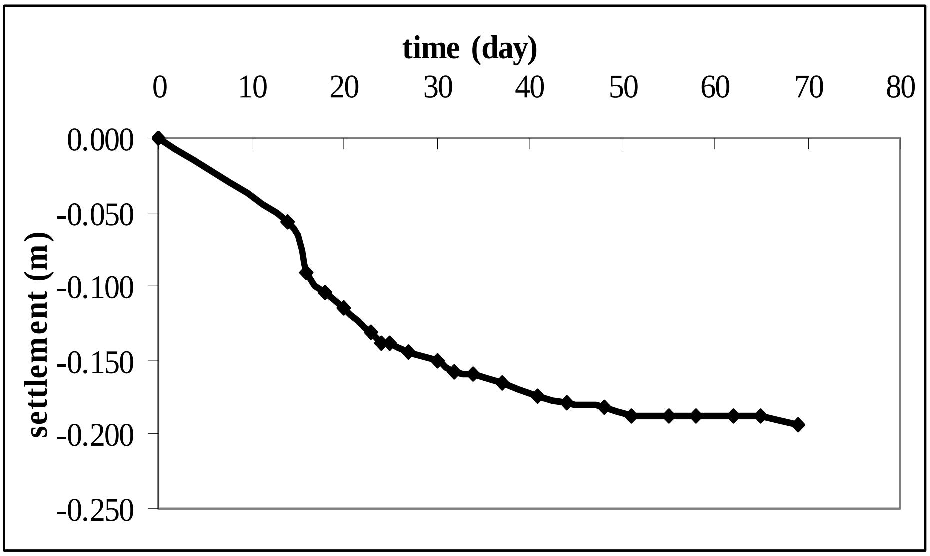


Figure D.21- The distribution of consolidation settlement due to the applied load with time at SP16

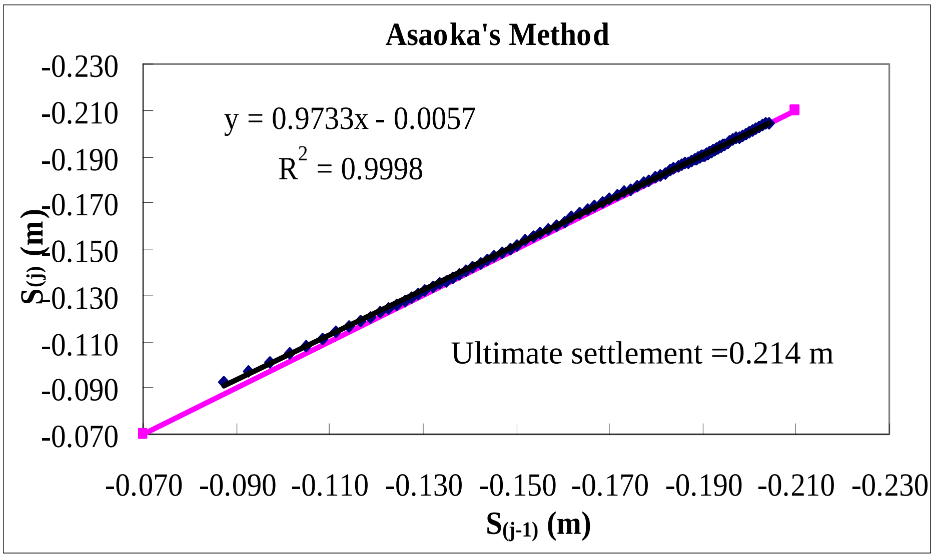


Figure D.22- Estimation of final settlement at SP17 due to the surcharge by using Asaoka's method

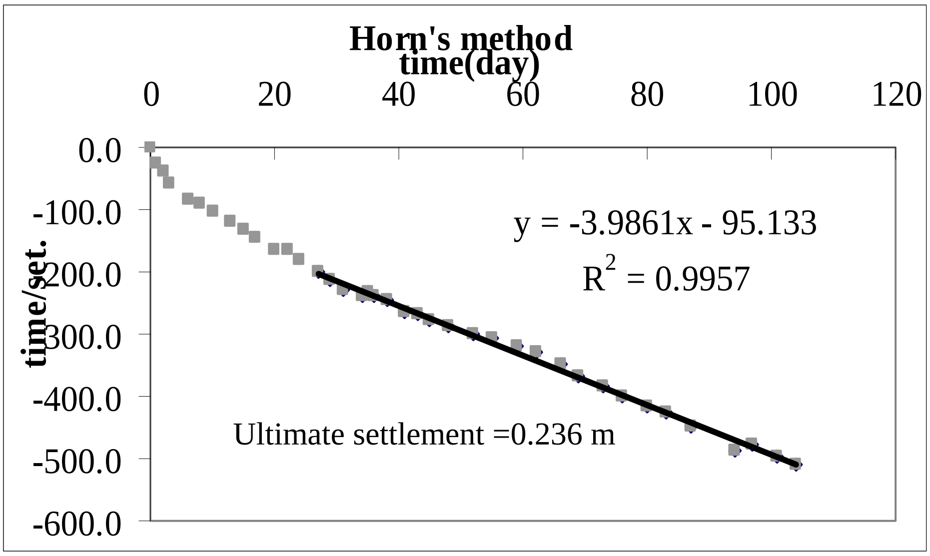


Figure D.23- Estimation of final settlement at SP17 due to the surcharge by using Horn's method

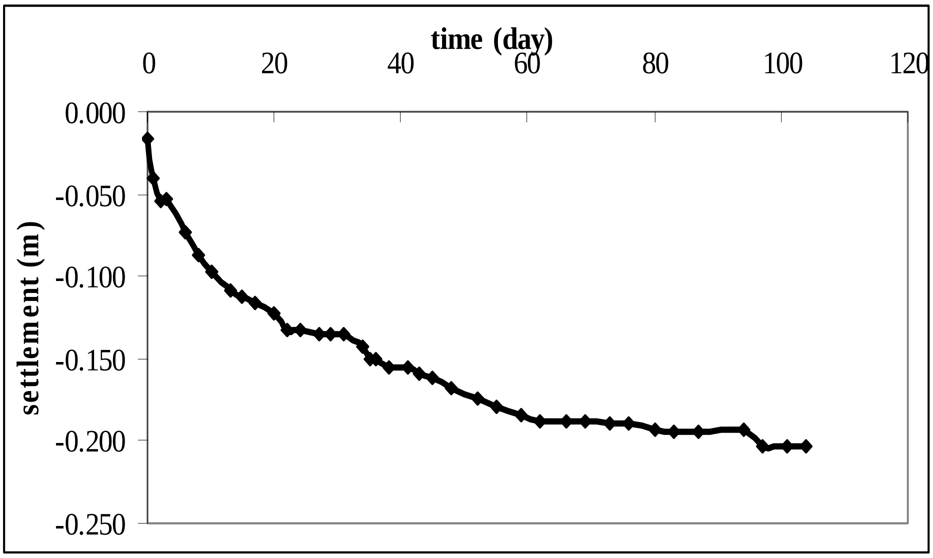


Figure D.24- The distribution of consolidation settlement due to the applied load with time at SP17

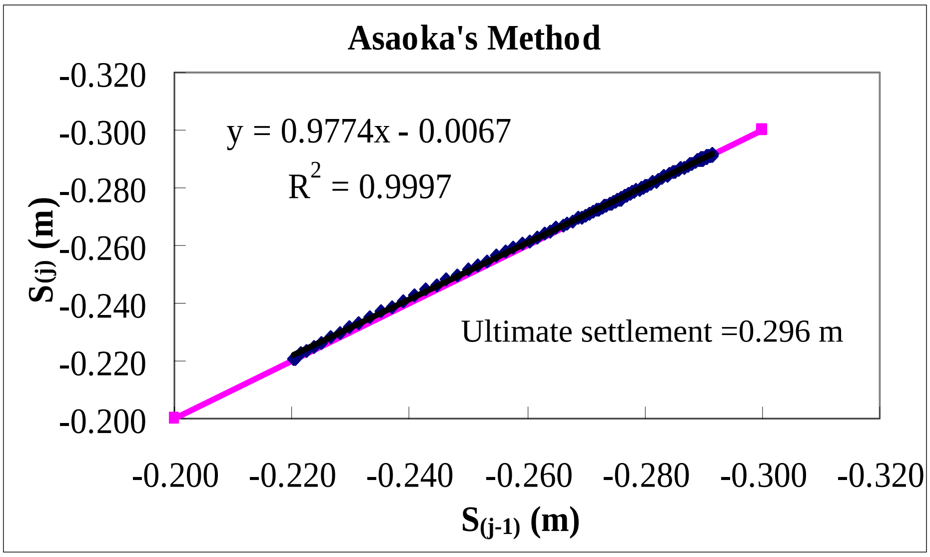


Figure D.25- Estimation of final settlement at SP18 due to the surcharge by using Asaoka's method

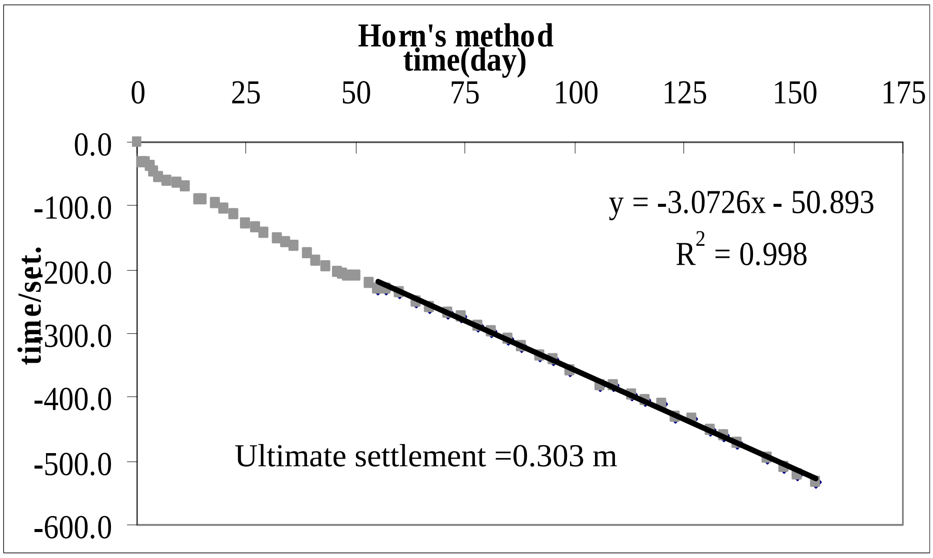


Figure D.26- Estimation of final settlement at SP18 due to the surcharge by using Horn's method

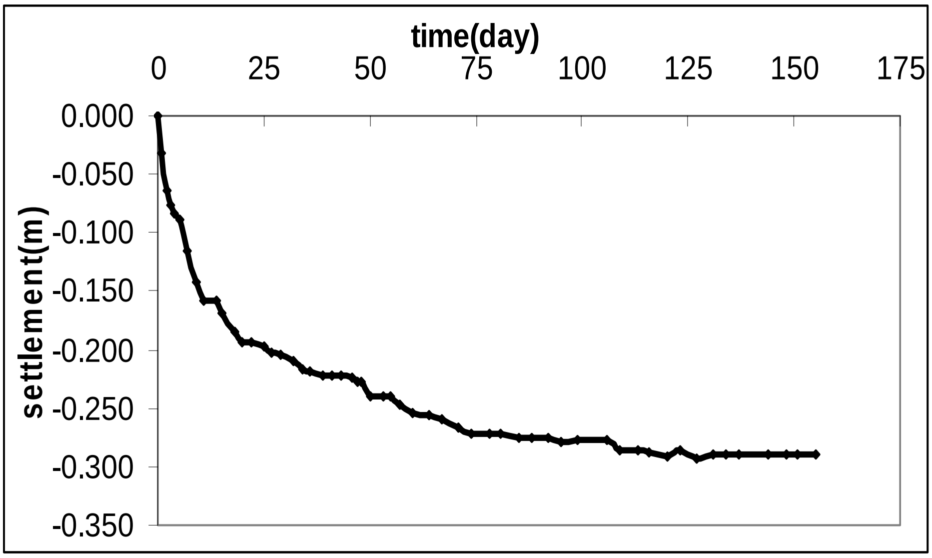


Figure D.27- The distribution of consolidation settlement due to the applied load with time at SP18

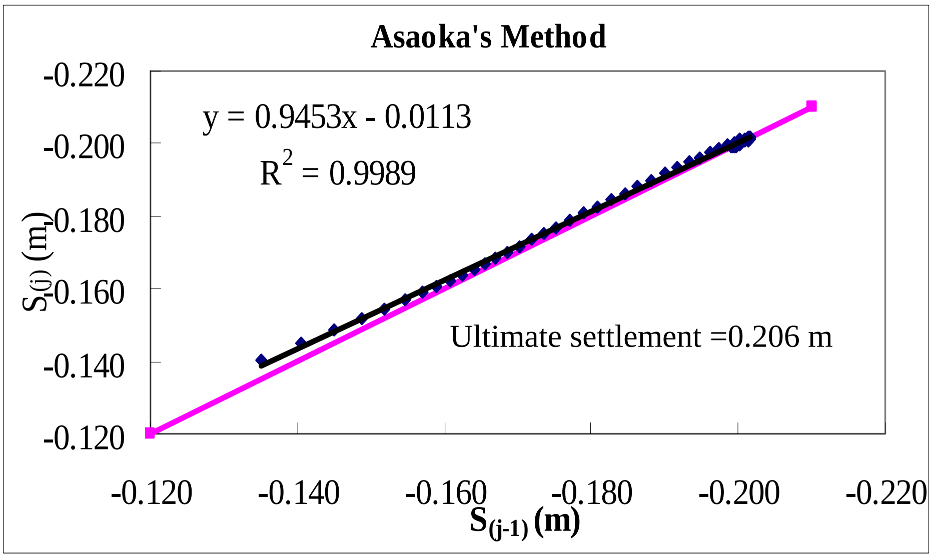


Figure D.28- Estimation of final settlement at SP22 due to the surcharge by using Asaoka's method

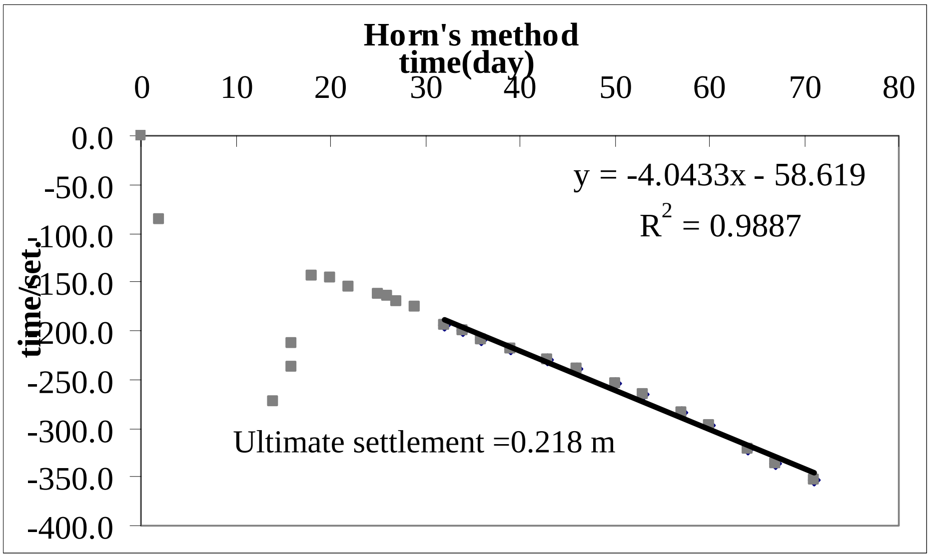


Figure D.29- Estimation of final settlement at SP22 due to the surcharge by using Horn's method

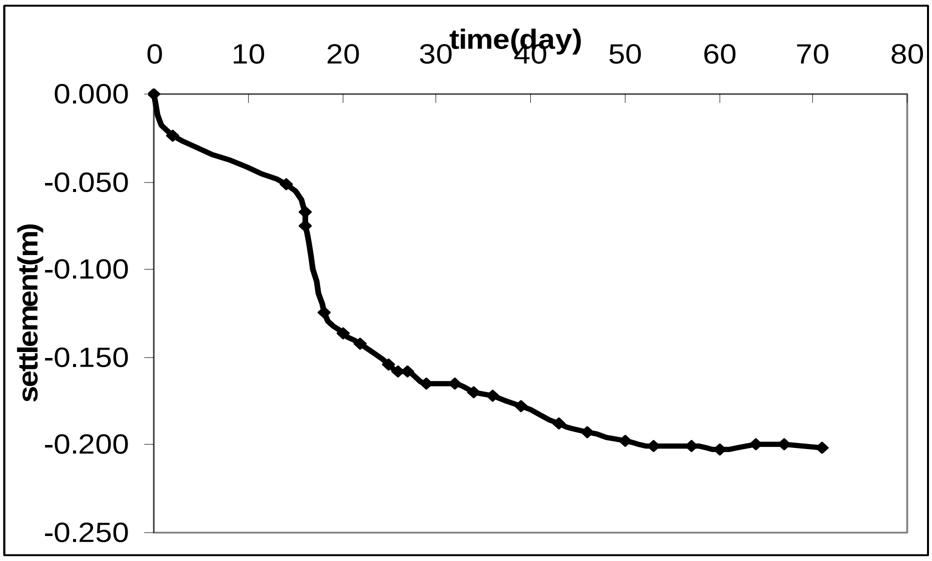


Figure D.30- The distribution of consolidation settlement due to the applied load with time at SP22

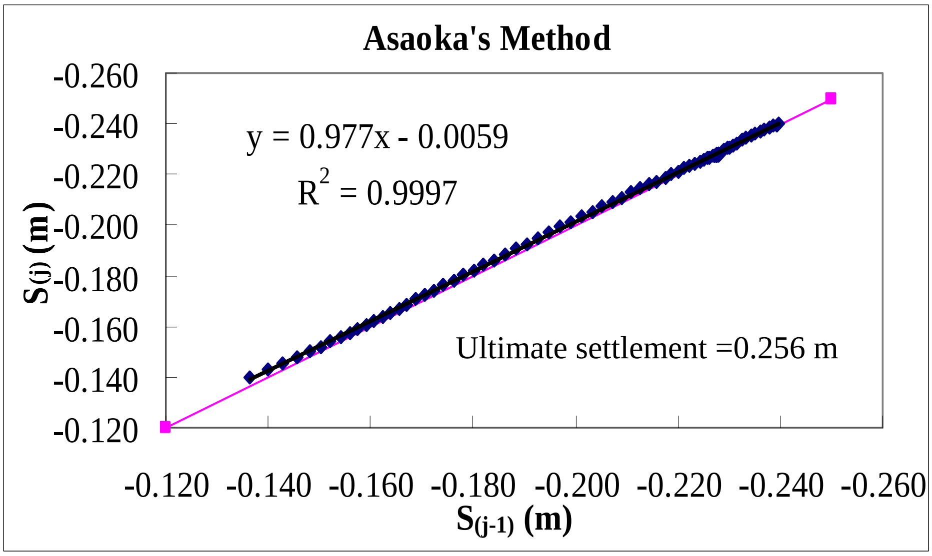


Figure D.31- Estimation of final settlement at SP23 due to the surcharge by using Asaoka's method

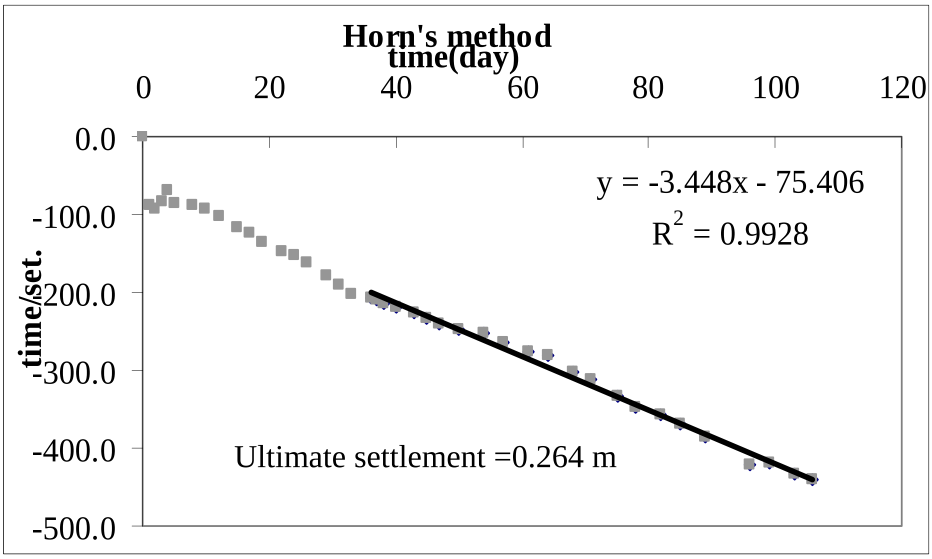


Figure D.31- Estimation of final settlement at SP23 due to the surcharge by using Horn's method

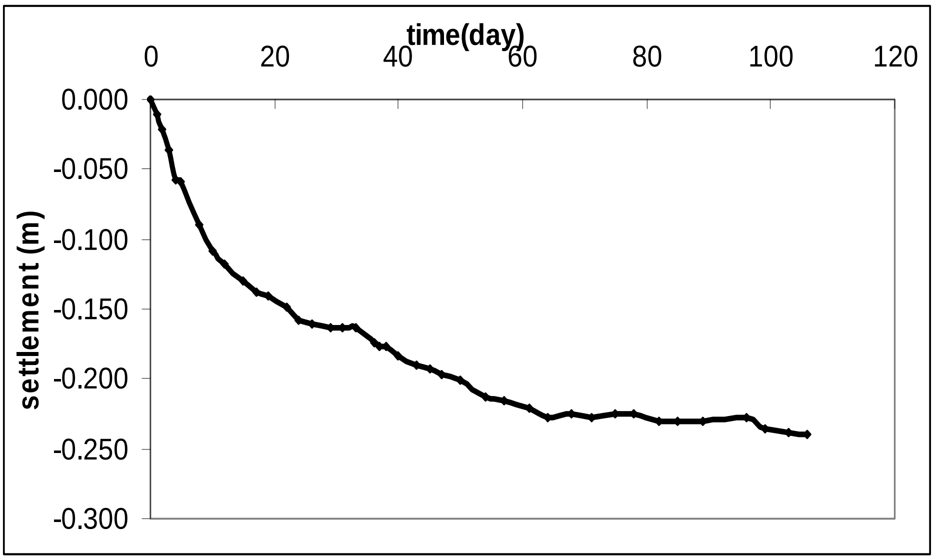


Figure D.33- The distribution of consolidation settlement due to the applied load with time at SP23

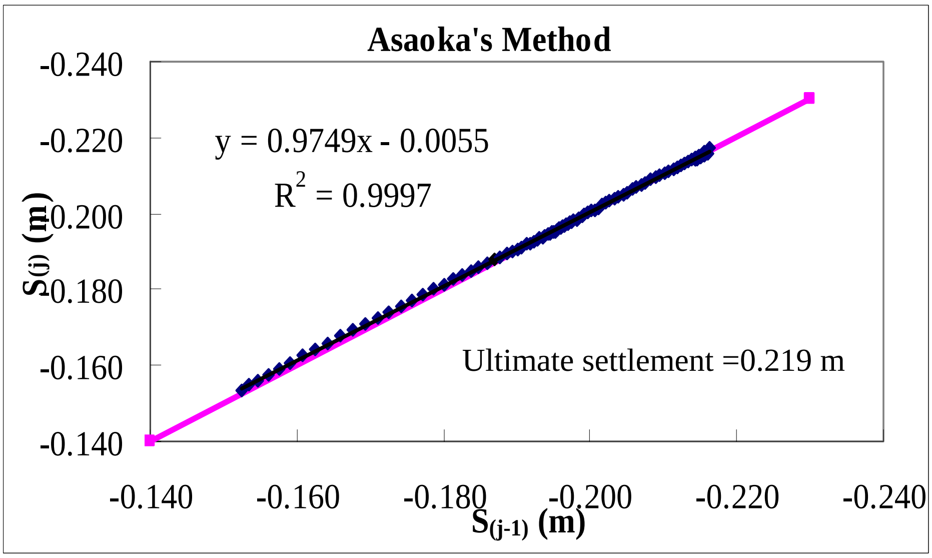


Figure D.34- Estimation of final settlement at SP24 due to the surcharge by using Asaoka's method

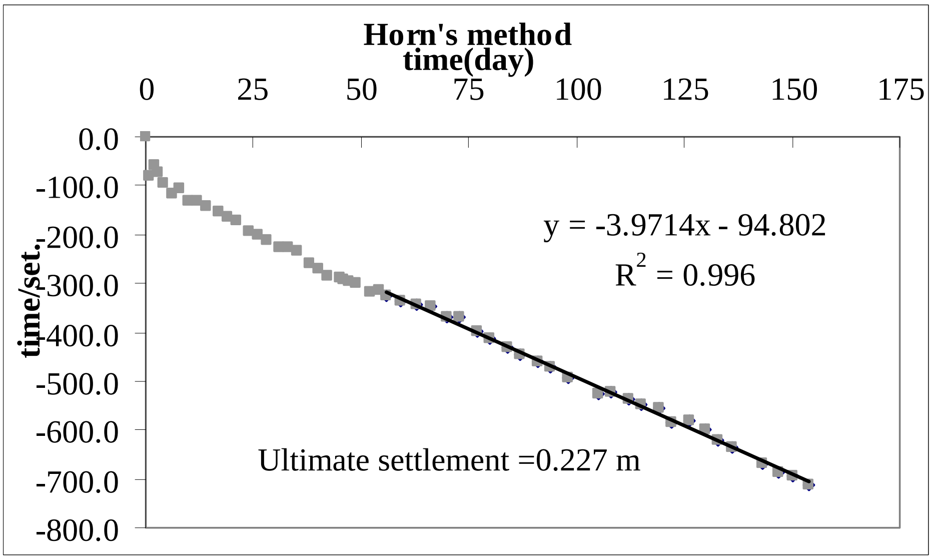


Figure D.35- Estimation of final settlement at SP24 due to the surcharge by using Horn's method

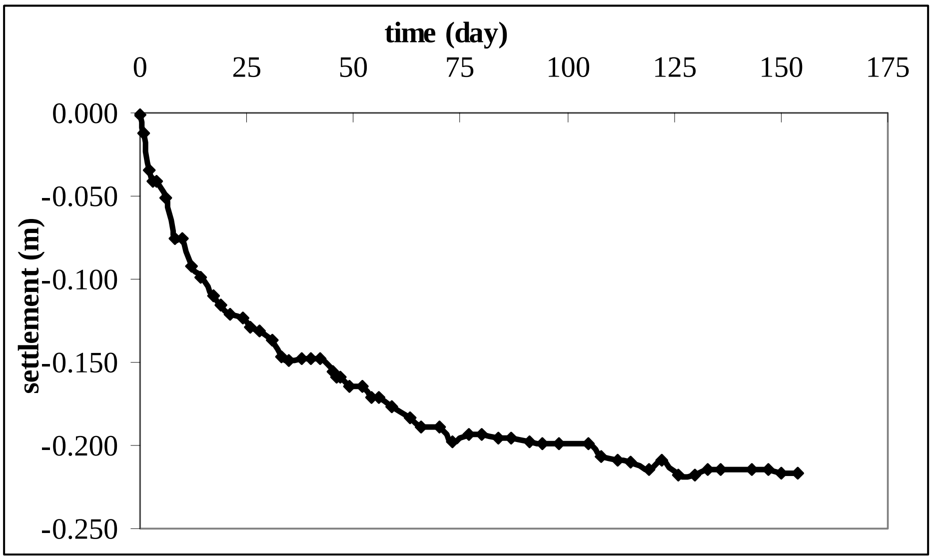


Figure D.36- The distribution of consolidation settlement due to the applied load with time at SP24

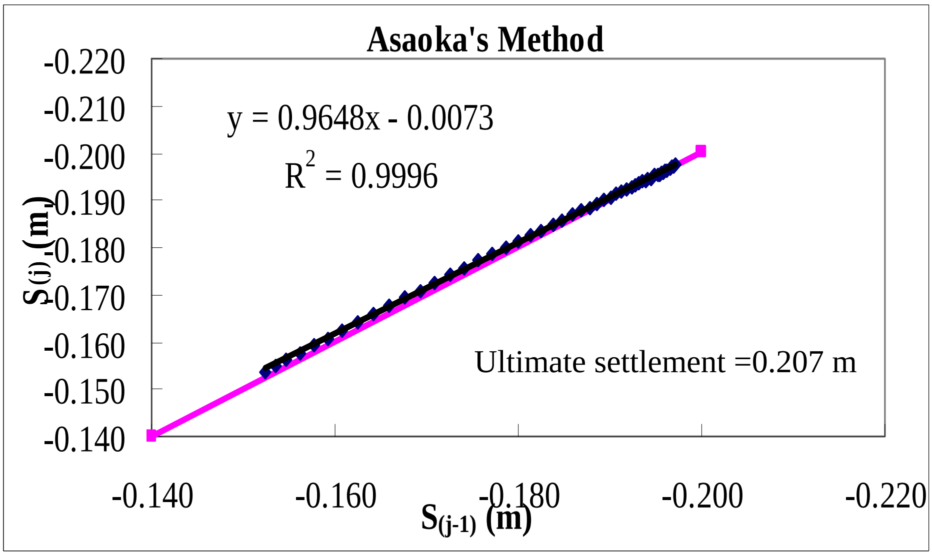


Figure D.37- Estimation of final settlement at SP28 due to the surcharge by using Asaoka's method

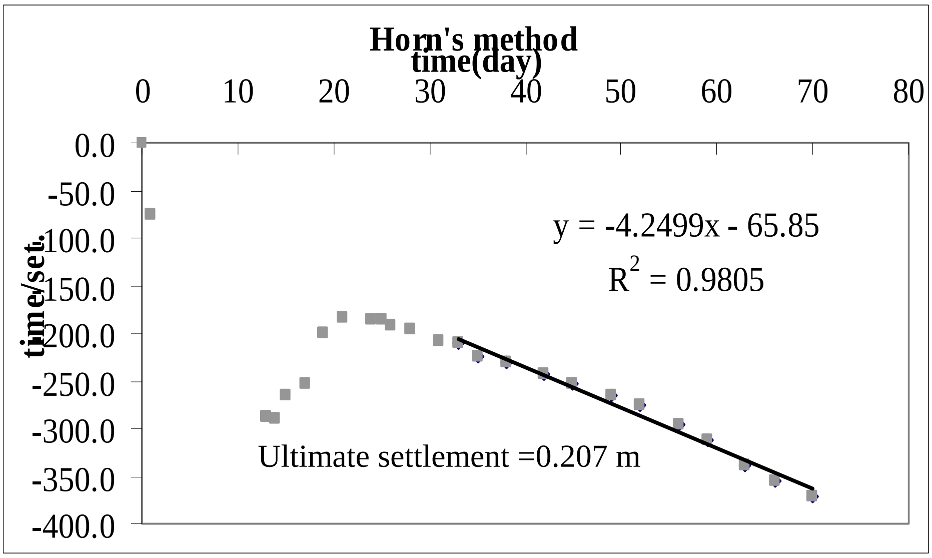


Figure D.38- Estimation of final settlement at SP28 due to the surcharge by using Horn's method

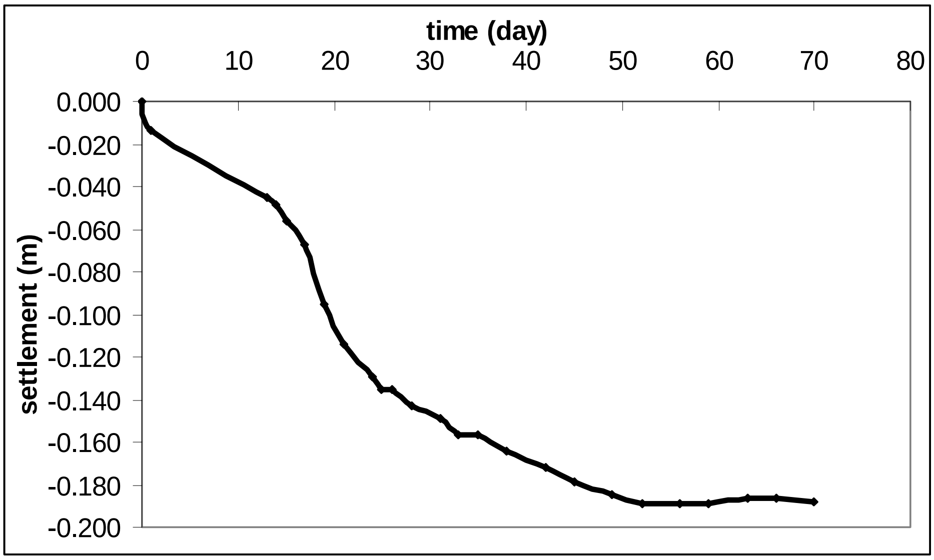


Figure D.39- The distribution of consolidation settlement due to the applied load with time at SP28

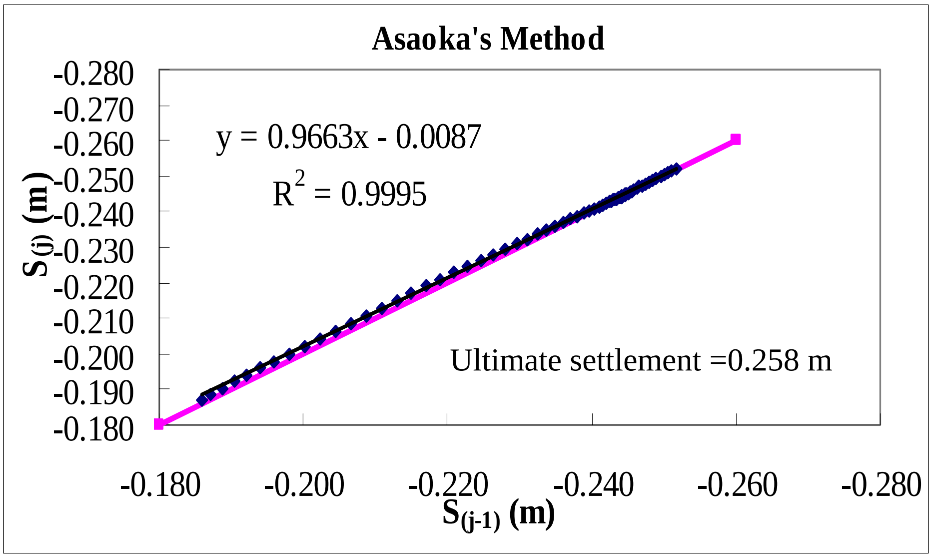


Figure D.40- Estimation of final settlement at SP29 due to the surcharge by using Asaoka's method

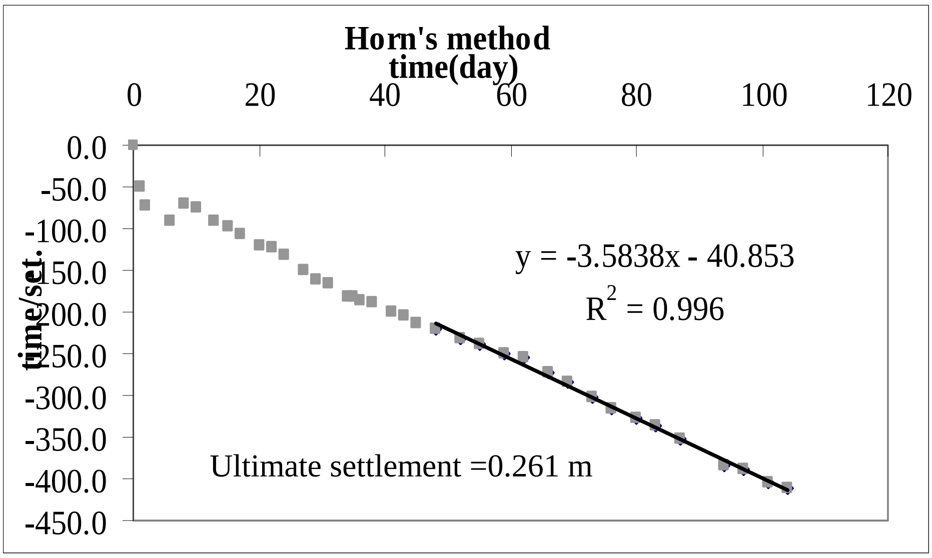


Figure D.41- Estimation of final settlement at SP29 due to the surcharge by using Horn's method

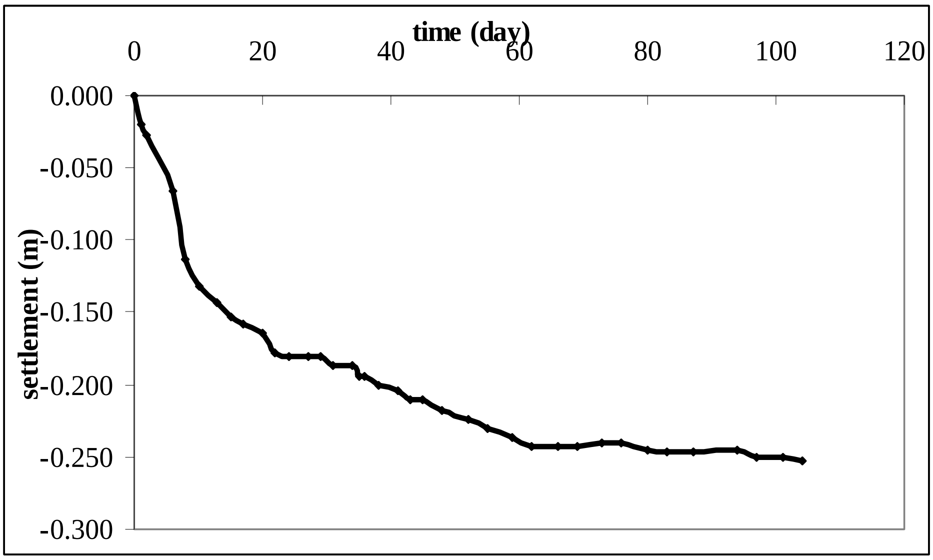


Figure D.42- The distribution of consolidation settlement due to the applied load with time at SP29

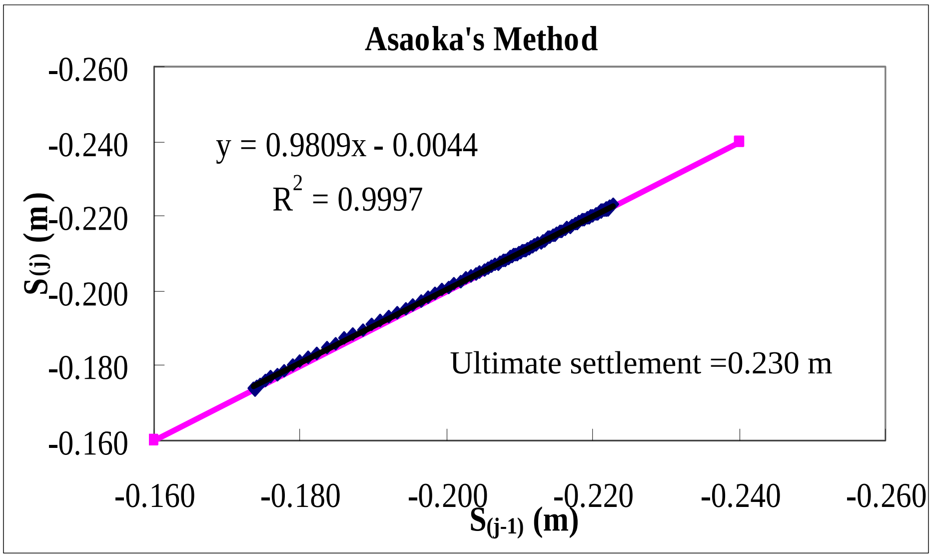


Figure D.43- Estimation of final settlement at SP30 due to the surcharge by using Asaoka's method

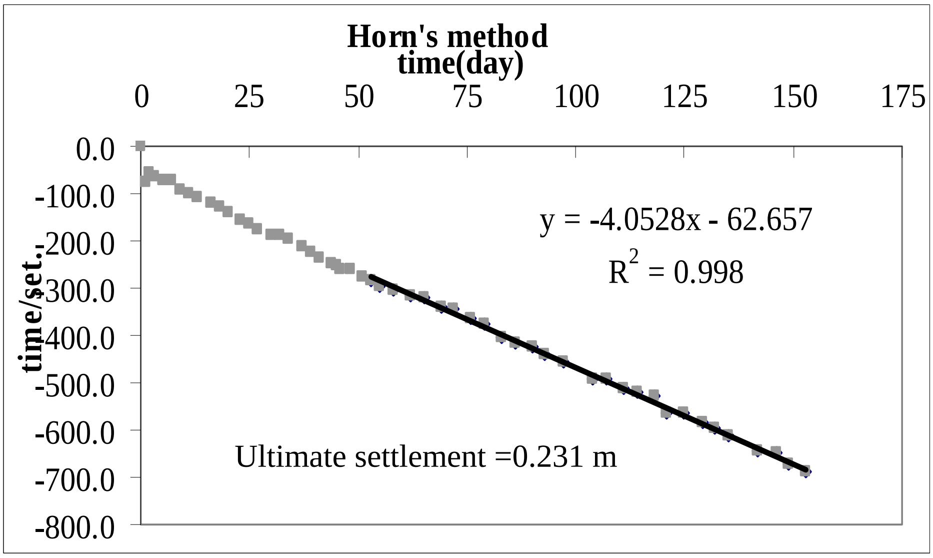


Figure D.44- Estimation of final settlement at SP30 due to the surcharge by using Horn's method

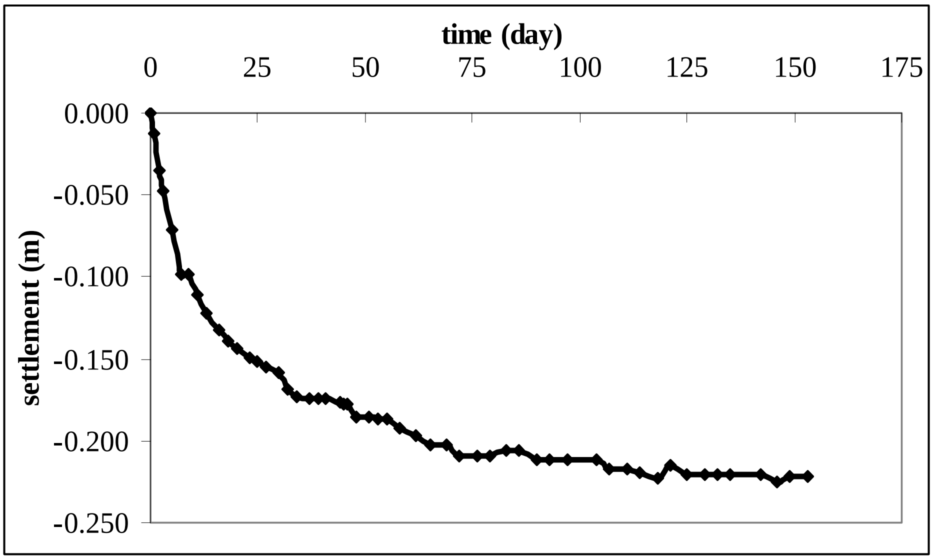


Figure D.45- The distribution of consolidation settlement due to the applied load with time at SP30

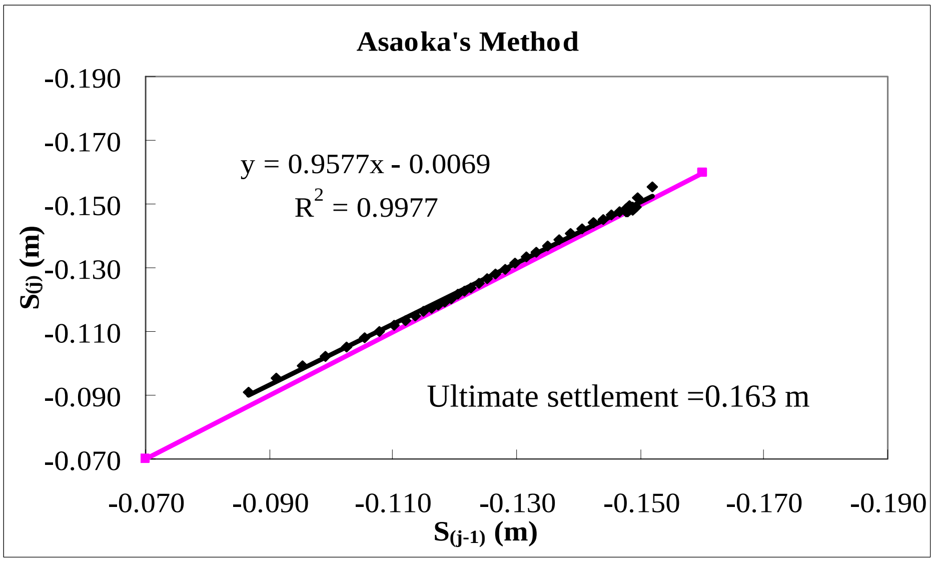


Figure D.46- Estimation of final settlement at SP33 due to the surcharge by using Asaoka's method

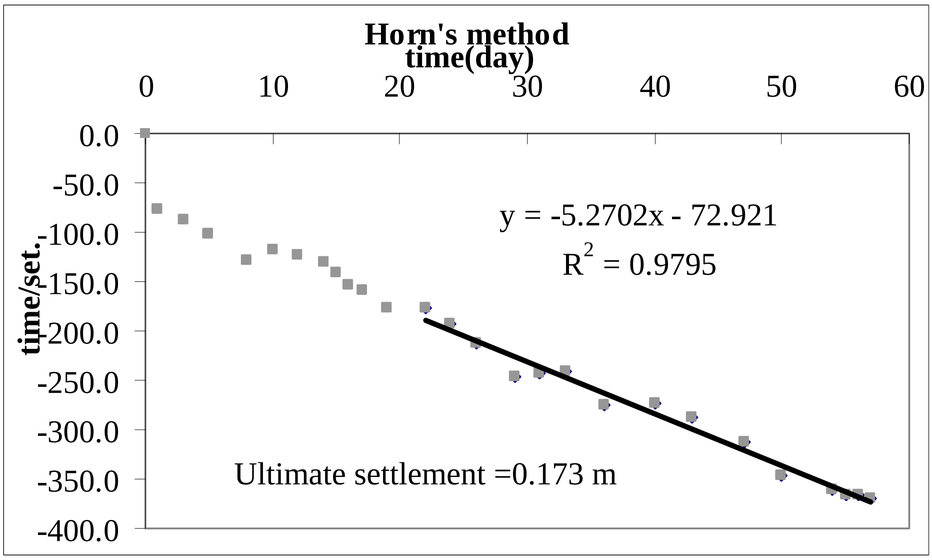


Figure D.47- Estimation of final settlement at SP33 due to the surcharge by using Horn's method

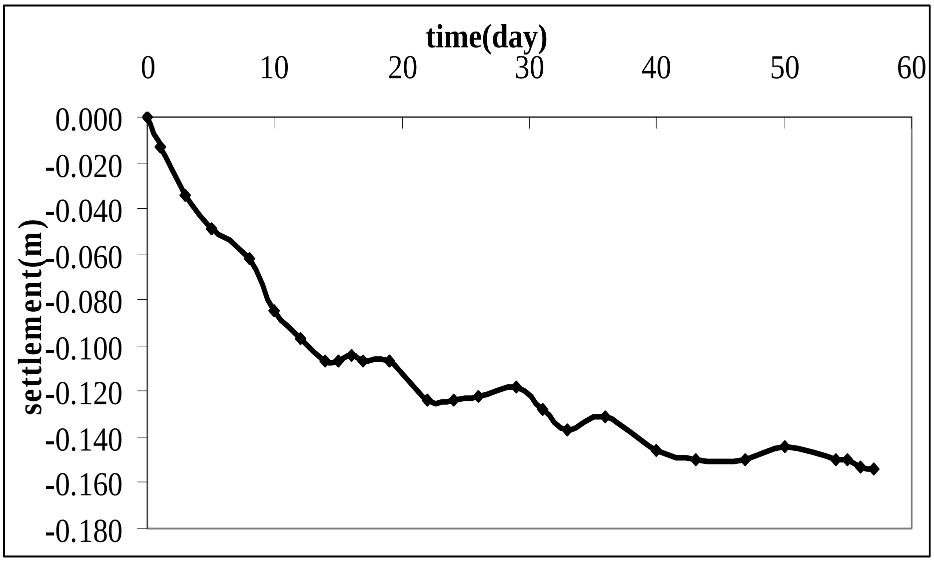


Figure D.48- The distribution of consolidation settlement due to the applied load with time at SP33

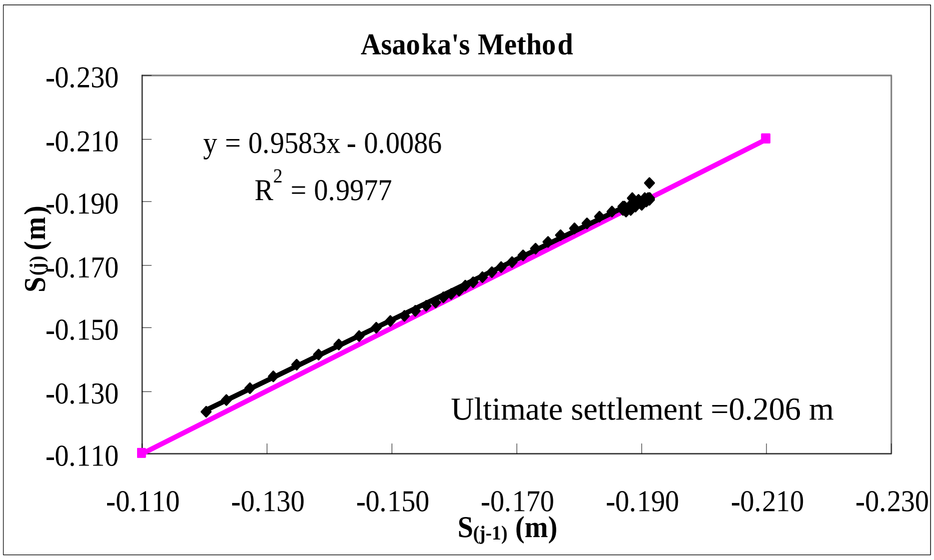


Figure D.49- Estimation of final settlement at SP34 due to the surcharge by using Asaoka's method

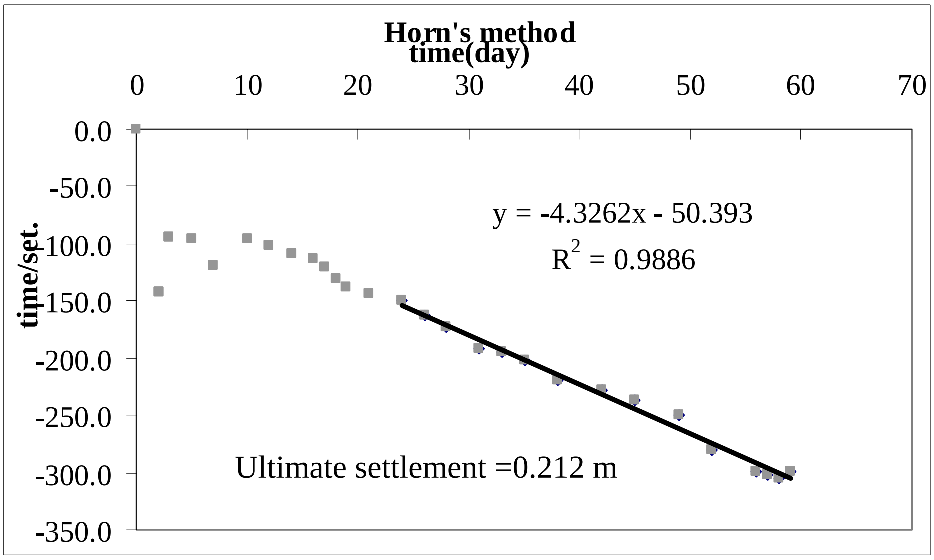


Figure D.50- Estimation of final settlement at SP34 due to the surcharge by using Horn's method

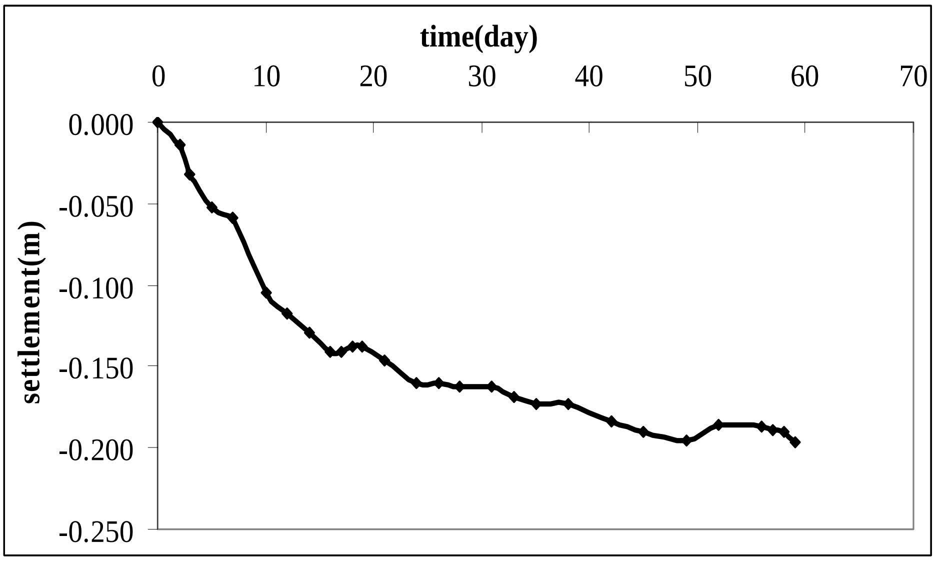


Figure D.51- Estimation of final settlement at SP34 due to the surcharge by using Asaoka's method

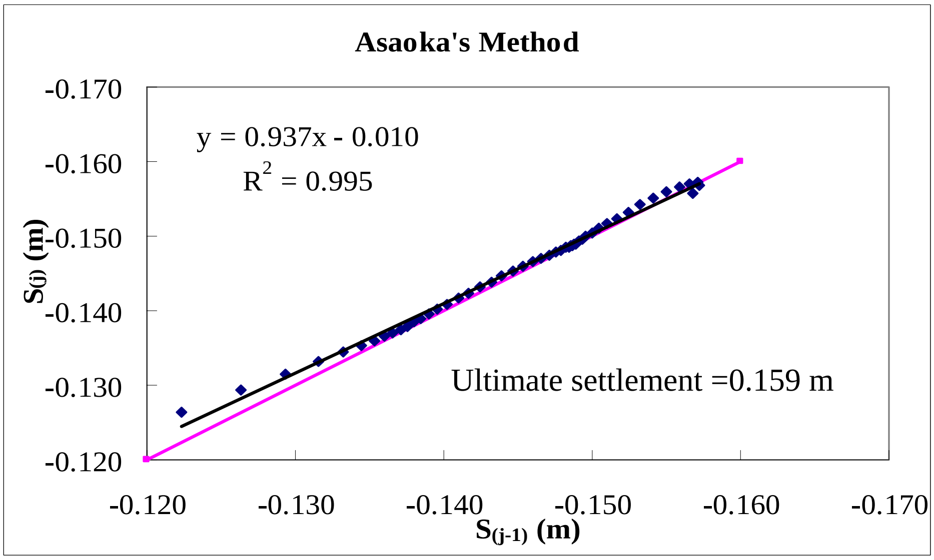


Figure D.52- Estimation of final settlement at SP35 due to the surcharge by using Asaoka's method

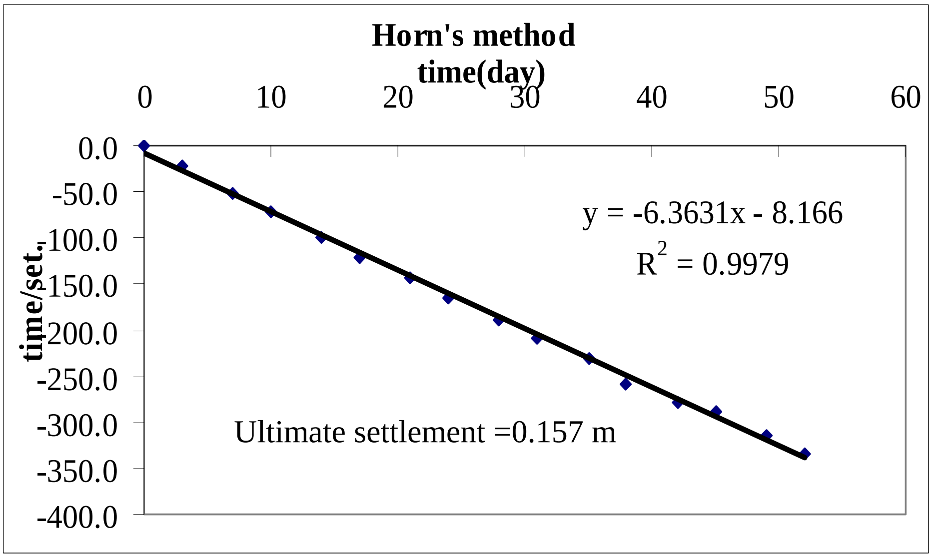


Figure D.53- Estimation of final settlement at SP35 due to the surcharge by using Horn's method

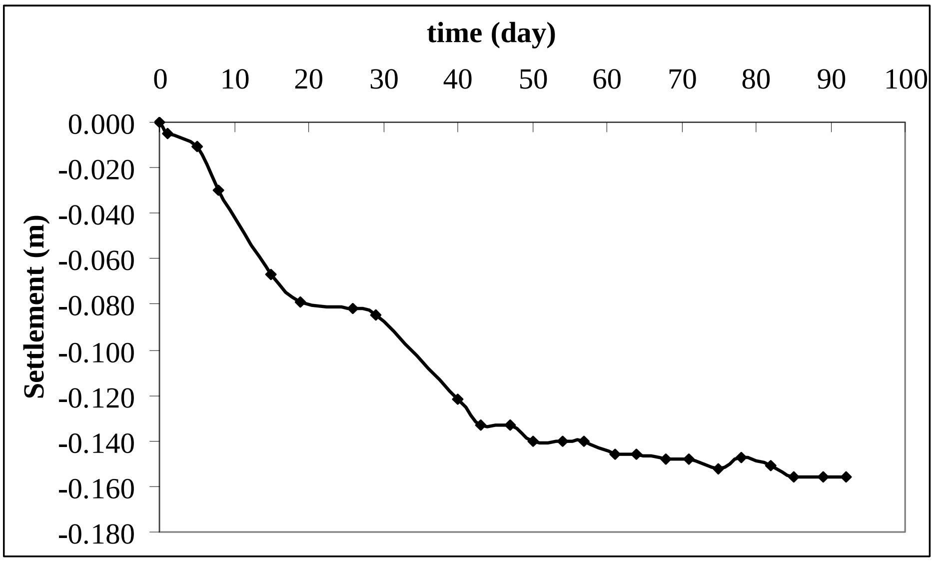


Figure D.54- The distribution of consolidation settlement due to the applied load with time at SP35

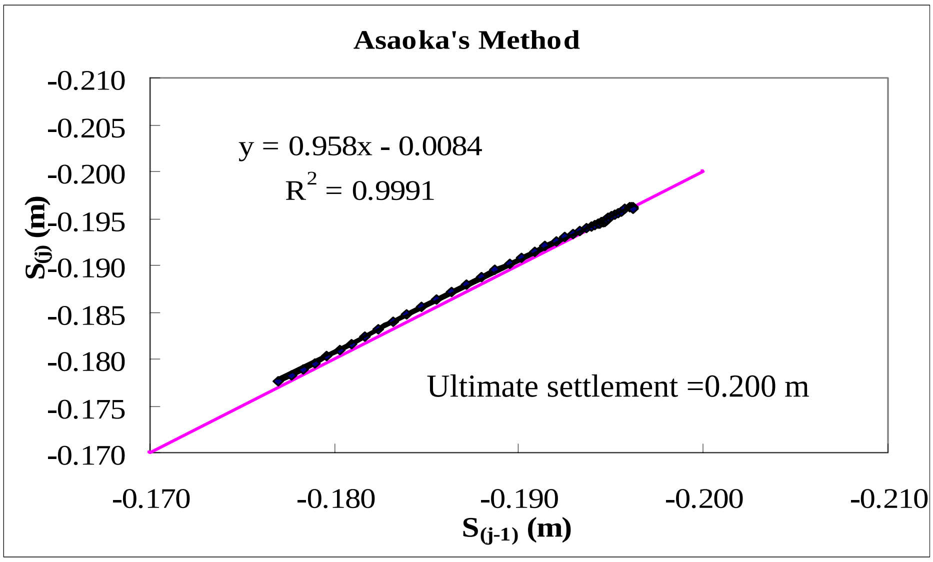


Figure D.55- Estimation of final settlement at SP36 due to the surcharge by using Asaoka's method

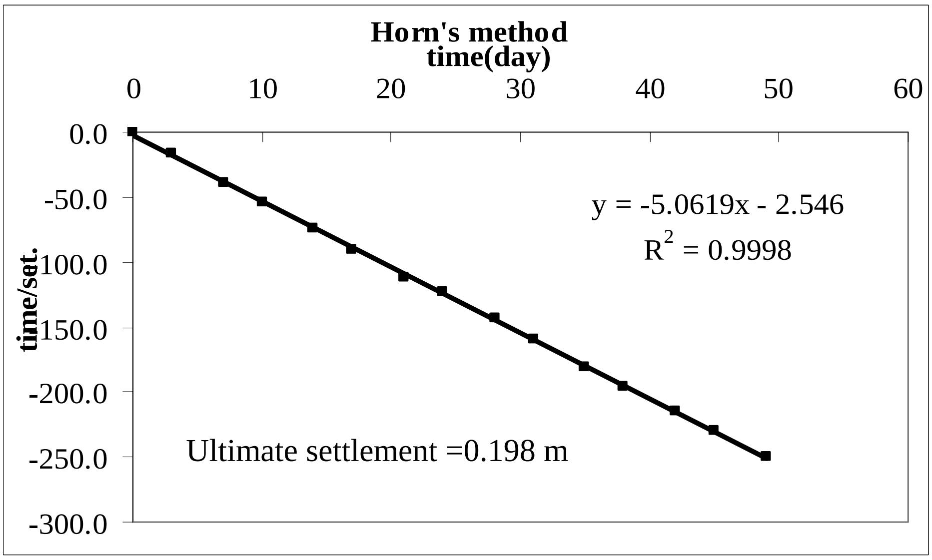


Figure D.56- Estimation of final settlement at SP36 due to the surcharge by using Horn's method

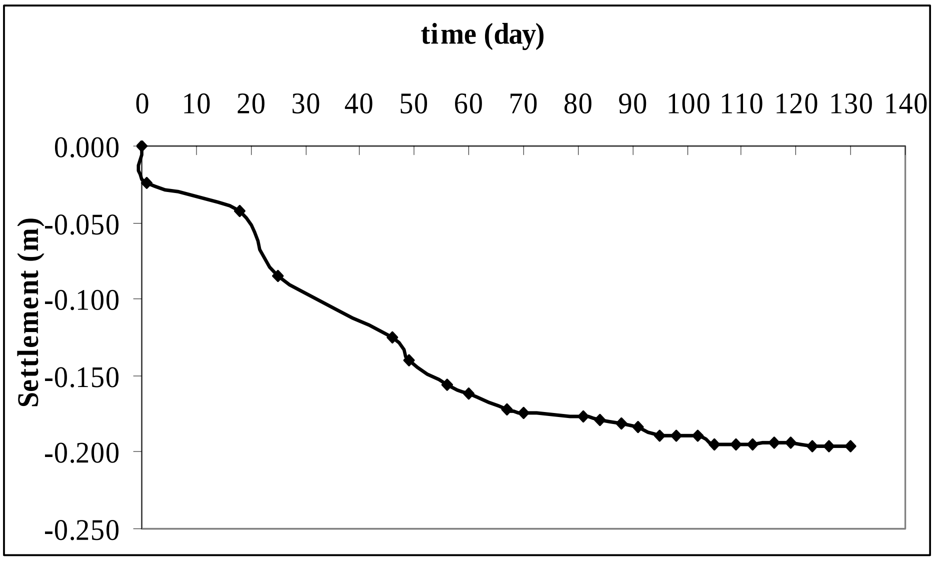


Figure D.57- The distribution of consolidation settlement due to the applied load with time at SP36

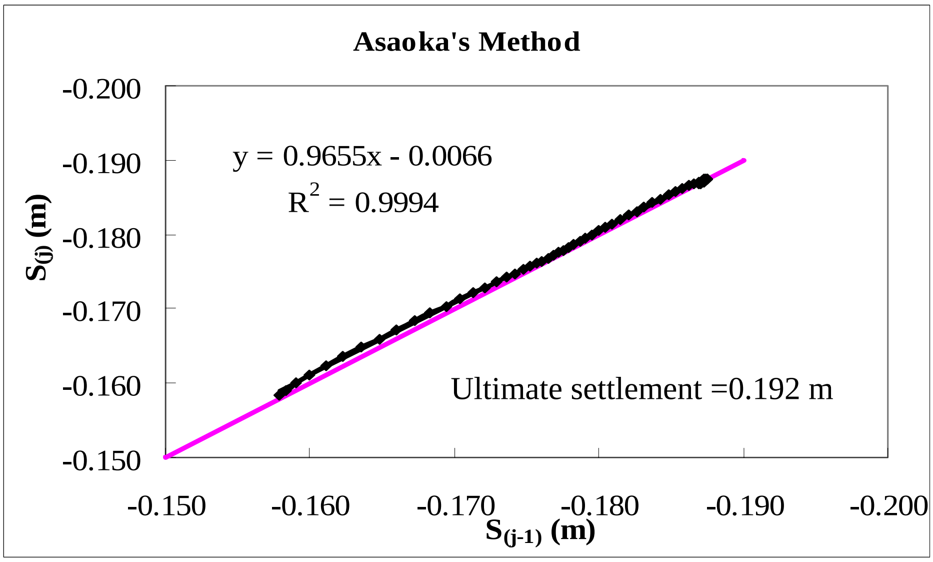


Figure D.58- Estimation of final settlement at SP37 due to the surcharge by using Asaoka's method

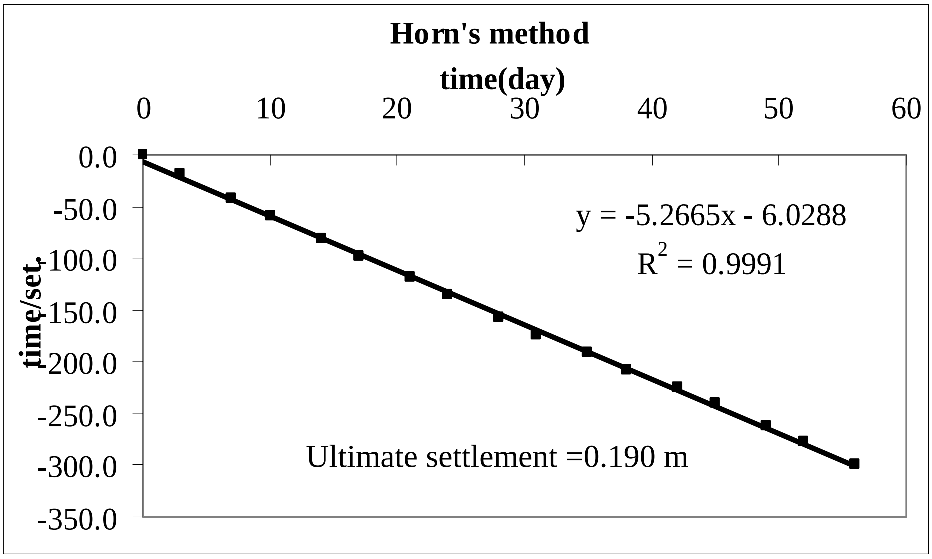


Figure D.59- Estimation of final settlement at SP37 due to the surcharge by using Horn's method

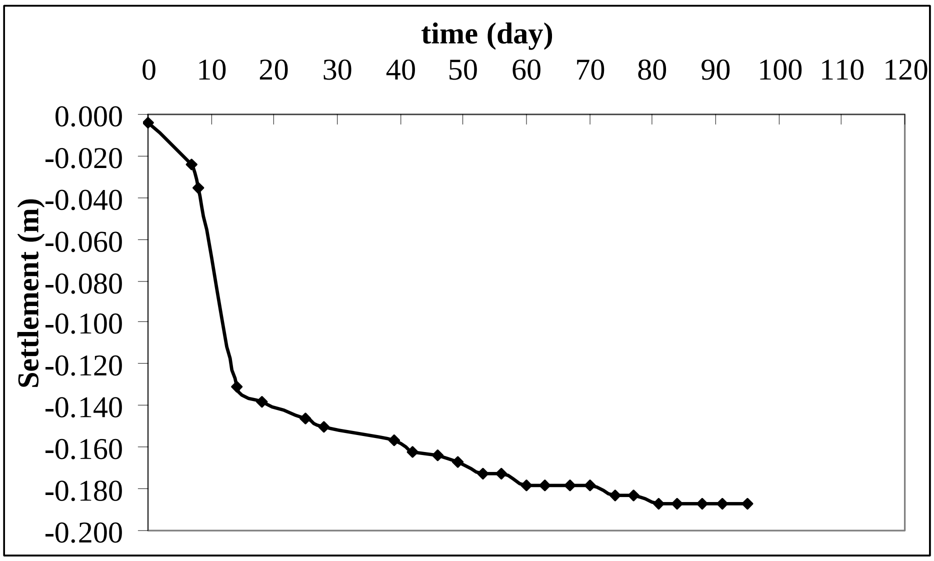


Figure D.60- The distribution of consolidation settlement due to the applied load with time at SP37

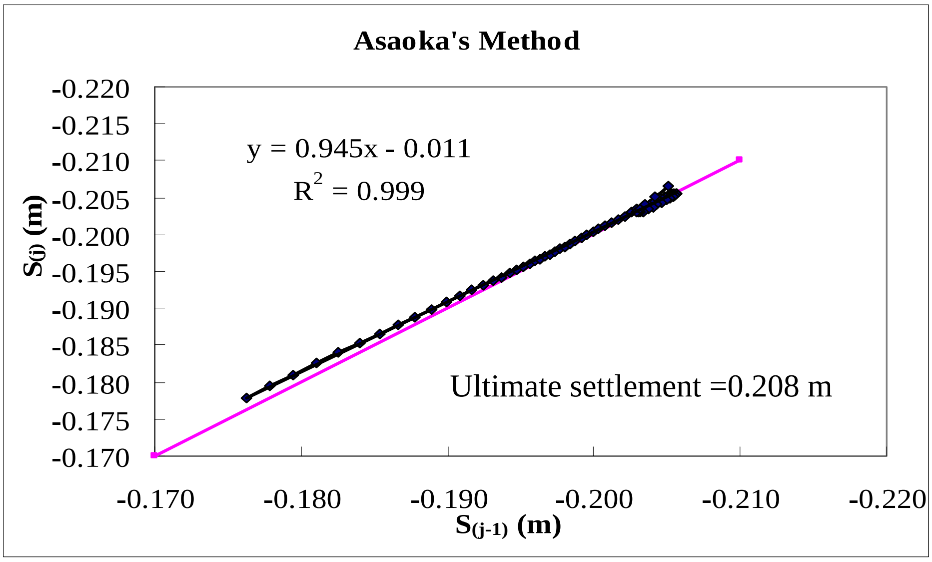


Figure D.61- Estimation of final settlement at SP38 due to the surcharge by using Asaoka's method

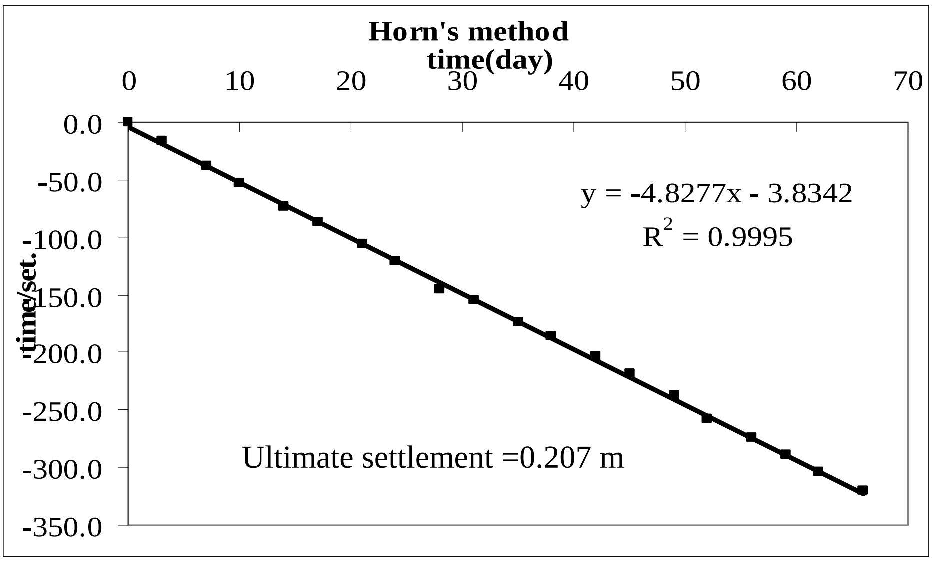


Figure D.62- Estimation of final settlement at SP38 due to the surcharge by using Horn's method

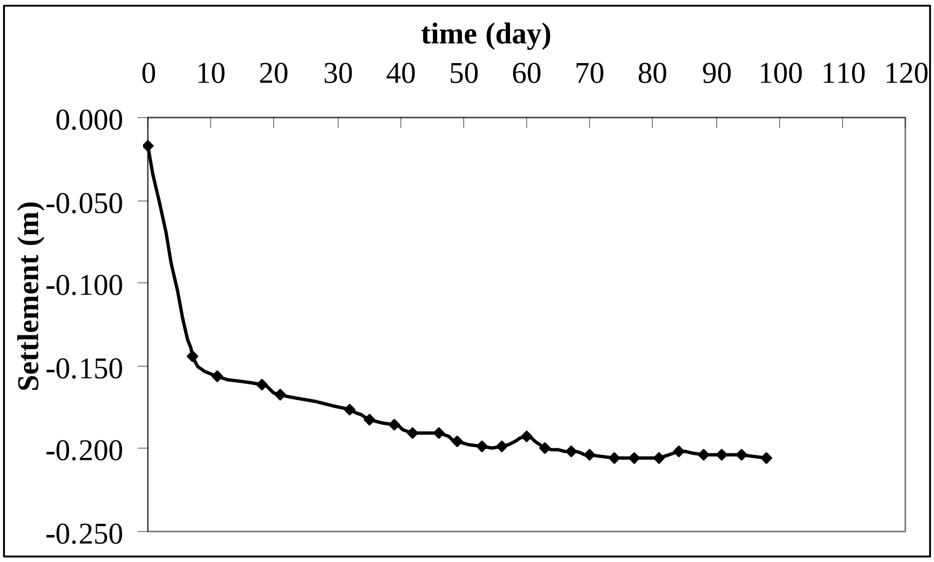


Figure D.63- The distribution of consolidation settlement due to the applied load with time at SP38

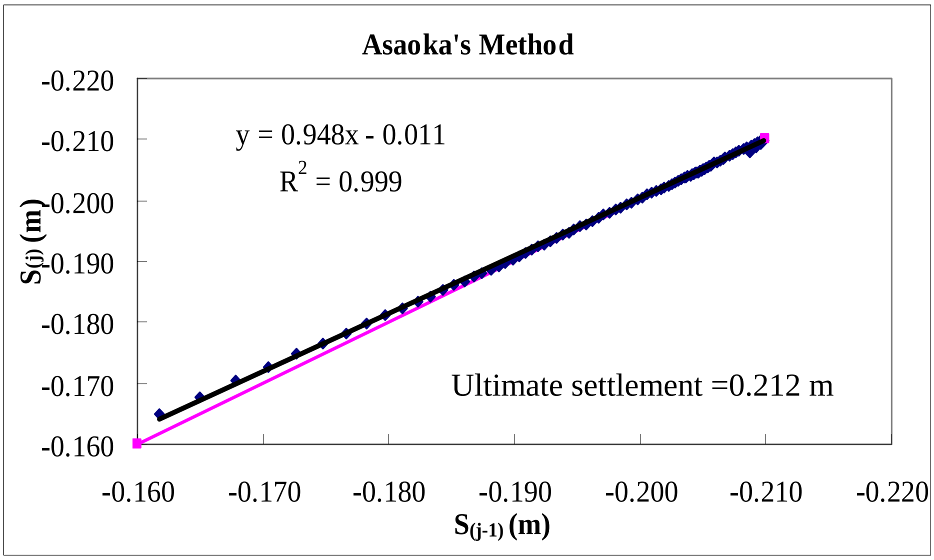


Figure D.64- Estimation of final settlement at SP39 due to the surcharge by using Asaoka's method

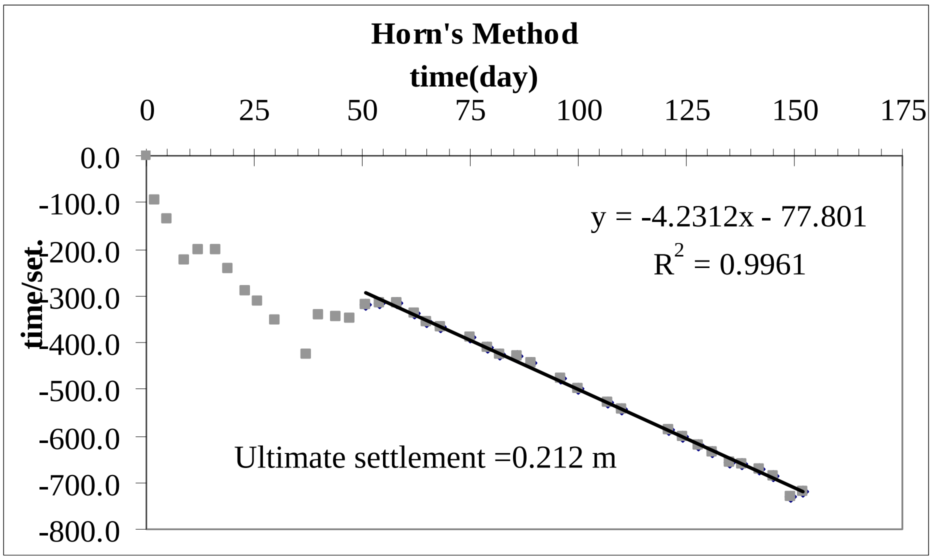


Figure D.65- Estimation of final settlement at SP39 due to the surcharge by using Horn's method

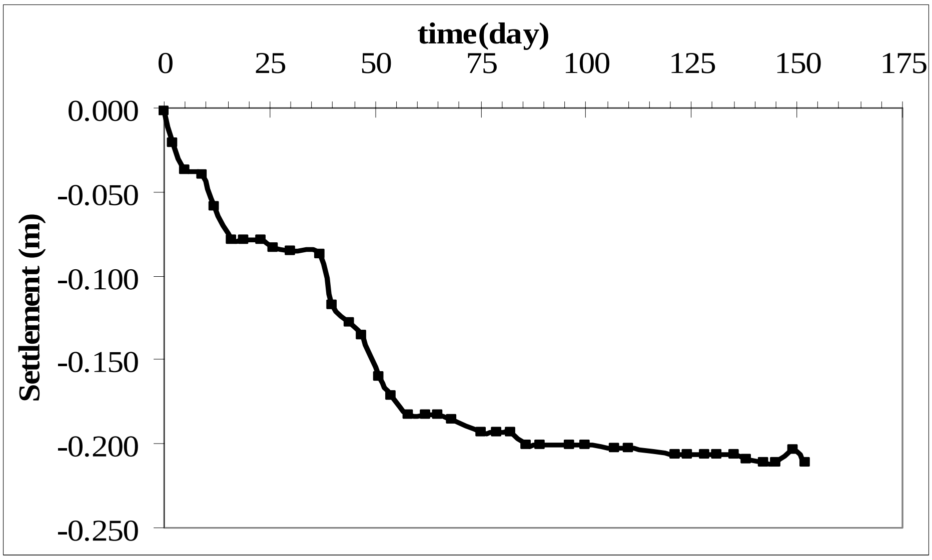


Figure D.66- The distribution of consolidation settlement due to the applied load with time at SP39

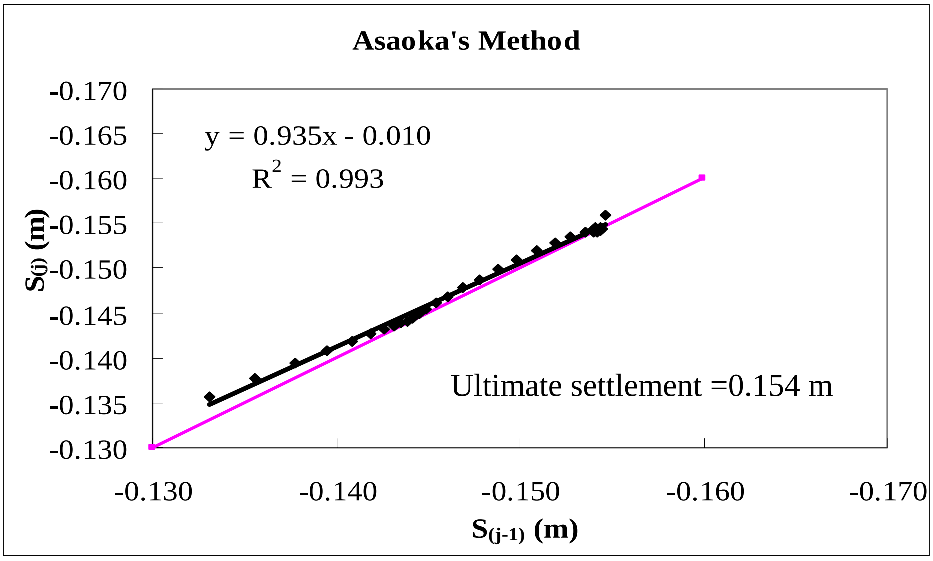


Figure D.67- Estimation of final settlement at SP40 due to the surcharge by using Asaoka's method

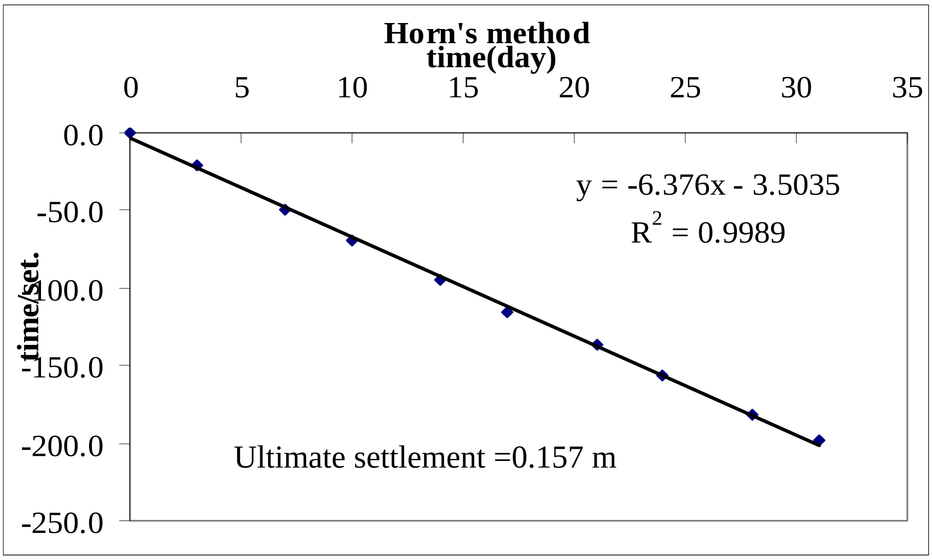


Figure D.68- Estimation of final settlement at SP40 due to the surcharge by using Horn's method

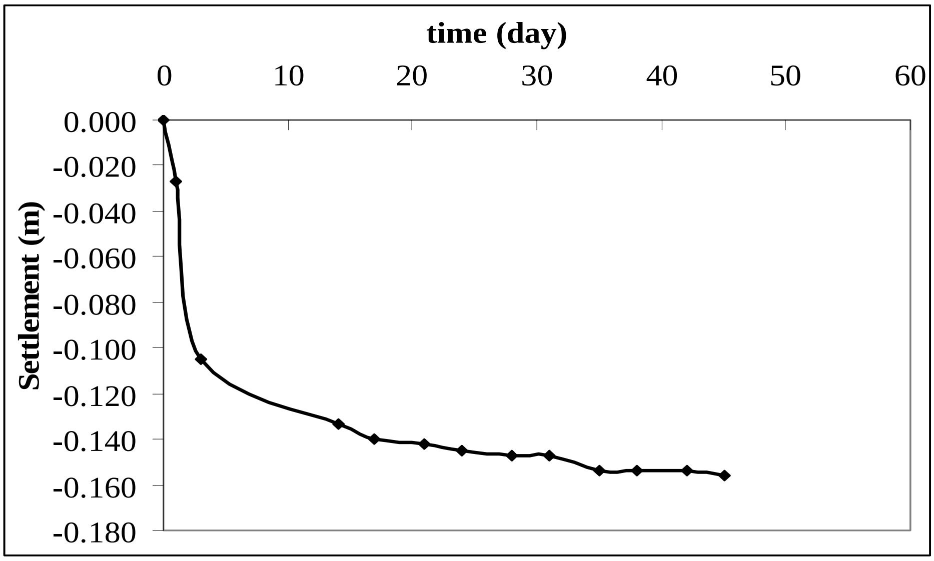


Figure D.69- The distribution of consolidation settlement due to the applied load with time at SP40

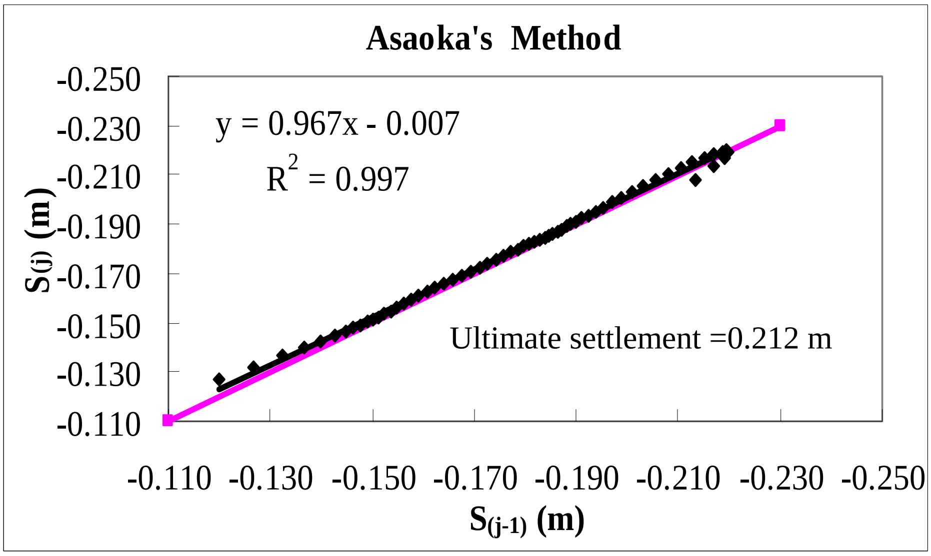


Figure D.70- Estimation of final settlement at SP41 due to the surcharge by using Asaoka's method

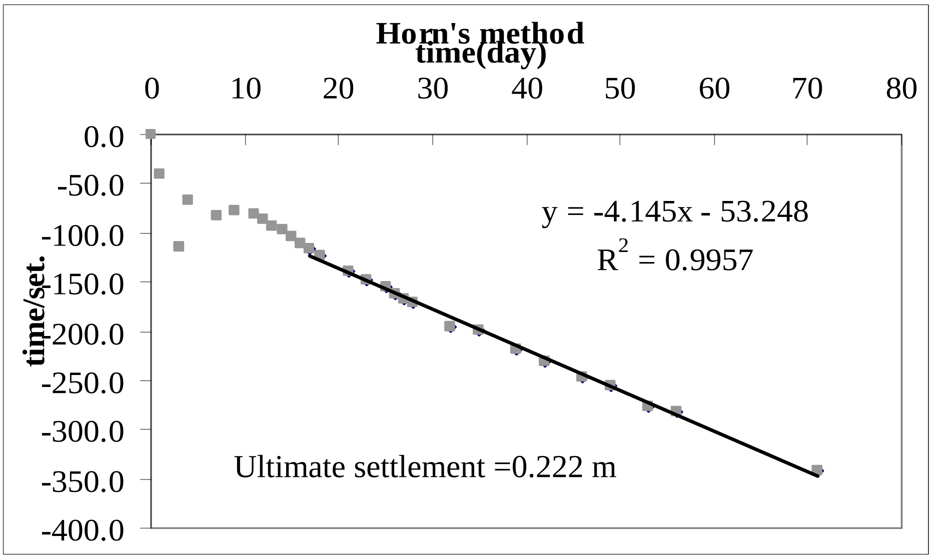


Figure D.71- Estimation of final settlement at SP41 due to the surcharge by using Horn's method

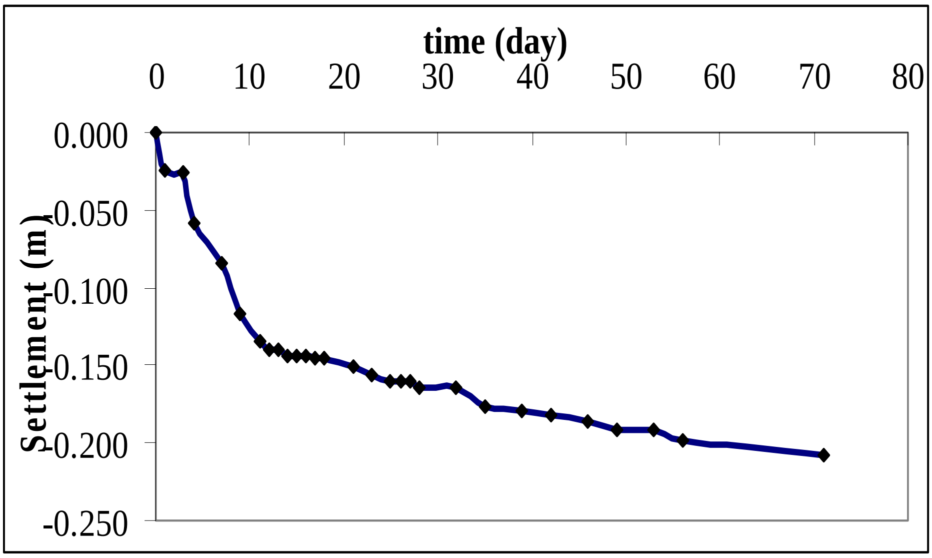


Figure D.72- The distribution of consolidation settlement due to the applied load with time at SP41

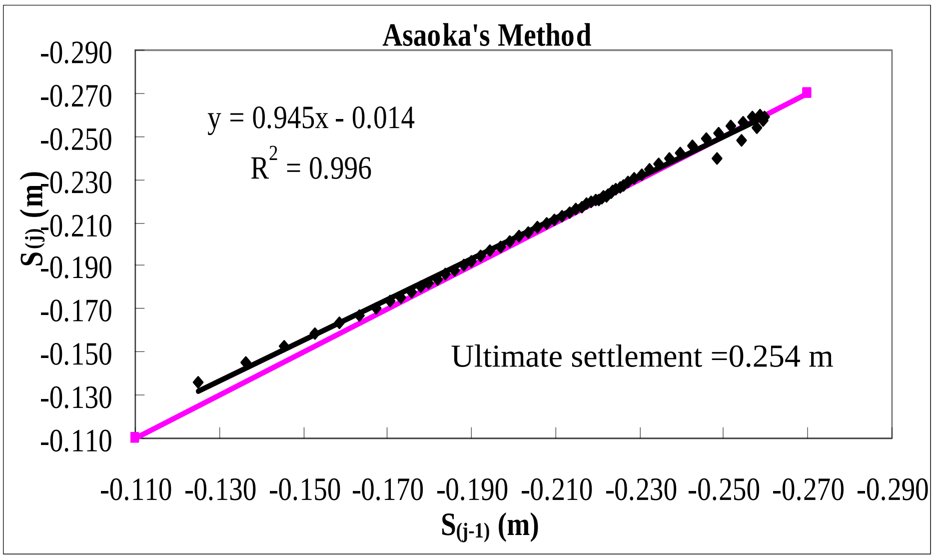


Figure D.73- Estimation of final settlement at SP42 due to the surcharge by using Asaoka's method

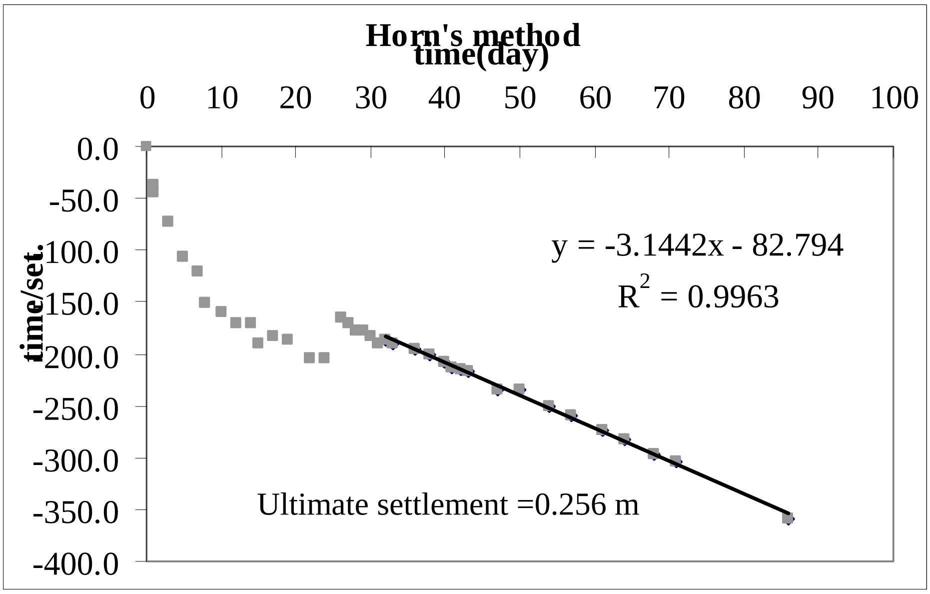


Figure D.74- Estimation of final settlement at SP42 due to the surcharge by using Horn's method

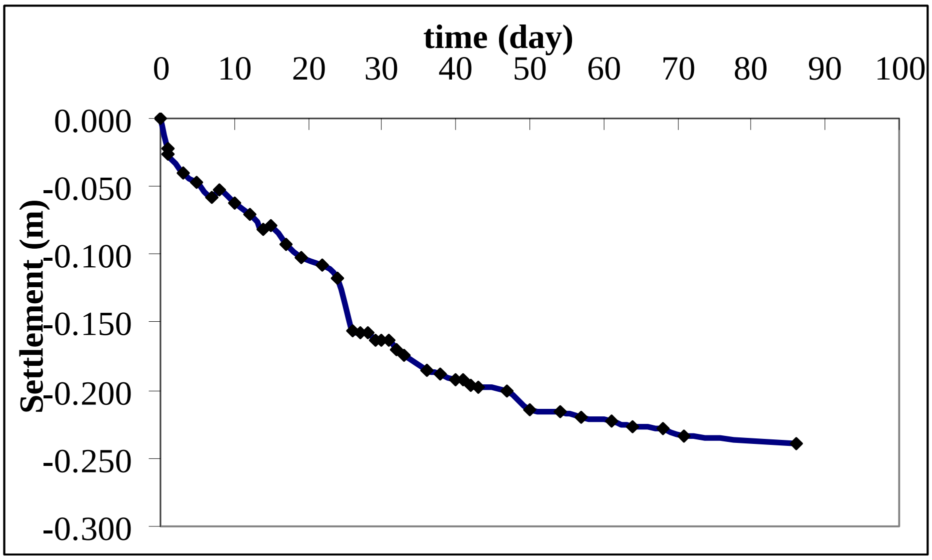


Figure D.75- The distribution of consolidation settlement due to the applied load with time at SP42

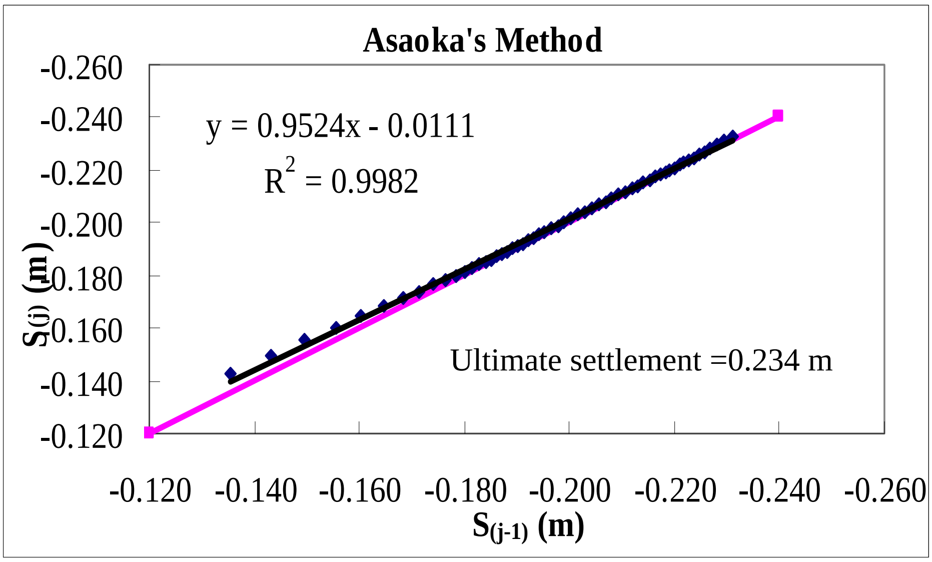


Figure D.76- Estimation of final settlement at SP43 due to the surcharge by using Asaoka's method

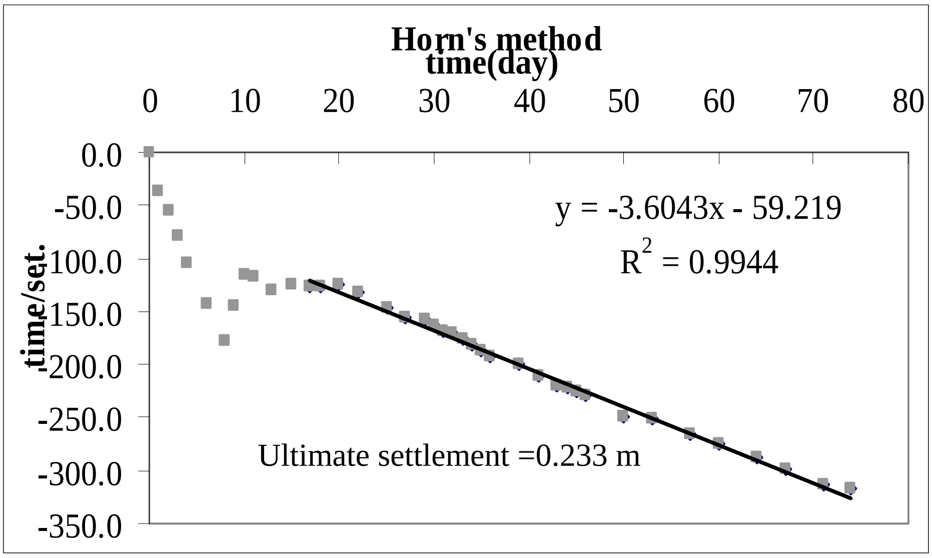


Figure D.77- Estimation of final settlement at SP43 due to the surcharge by using Horn's method

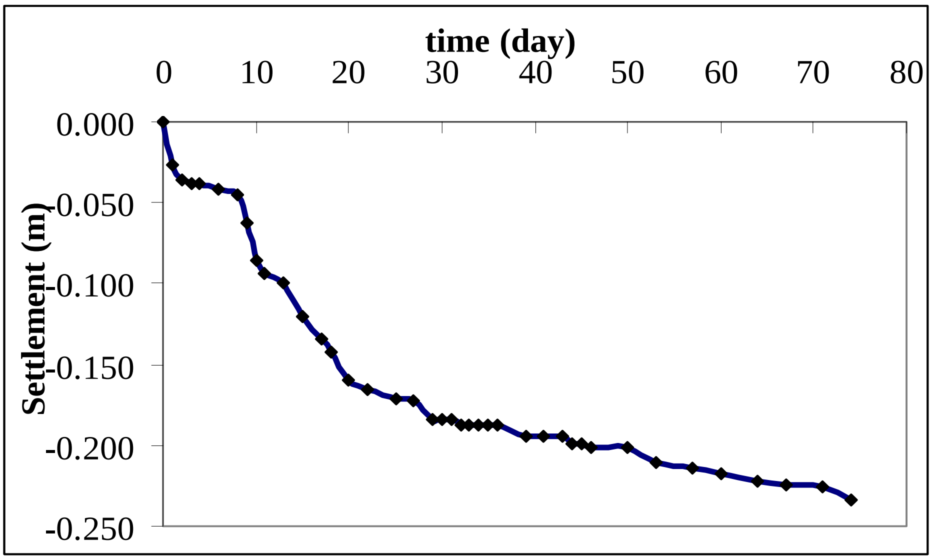


Figure D.78- The distribution of consolidation settlement due to the applied load with time at SP43

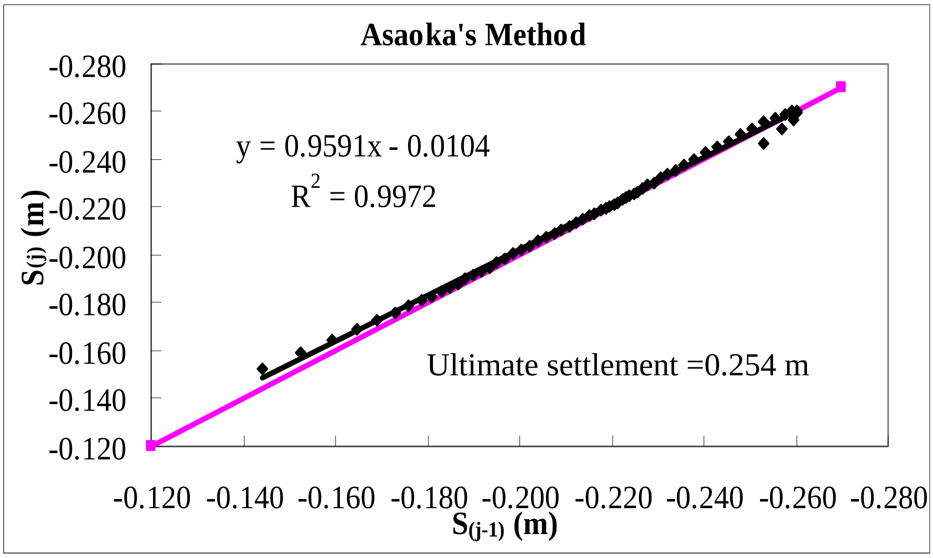


Figure D.79- Estimation of final settlement at SP44 due to the surcharge by using Asaoka's method

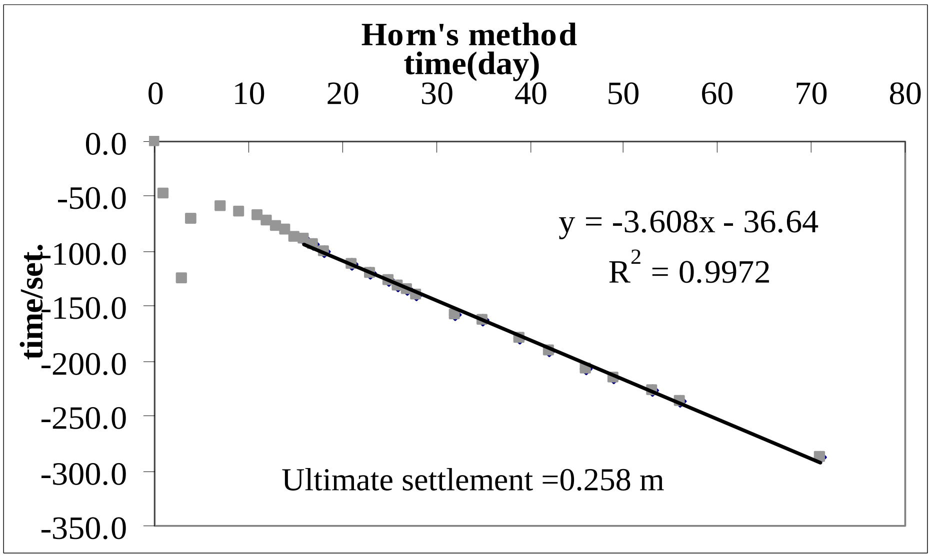


Figure D.80- Estimation of final settlement at SP44 due to the surcharge by using Horn's method

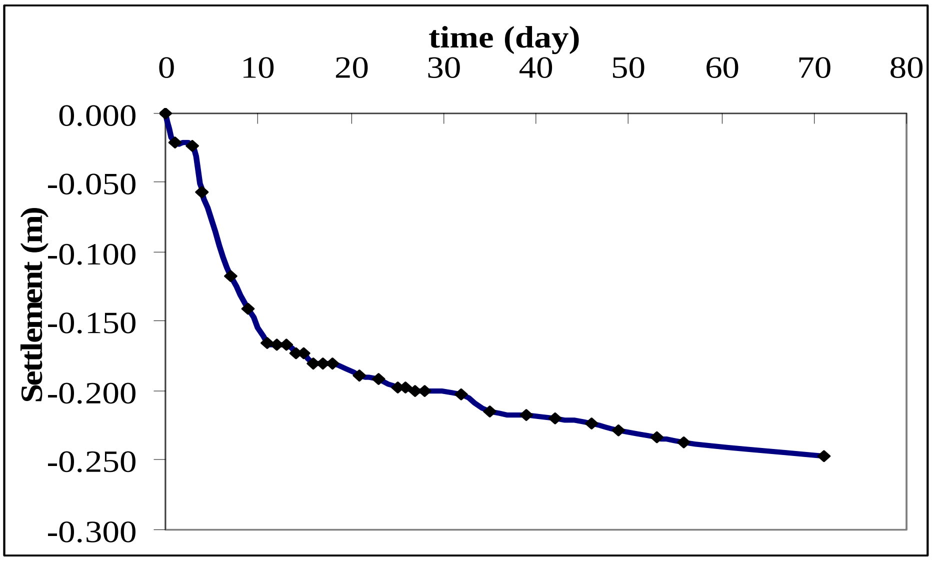


Figure D.81- The distribution of consolidation settlement due to the applied load with time at SP44

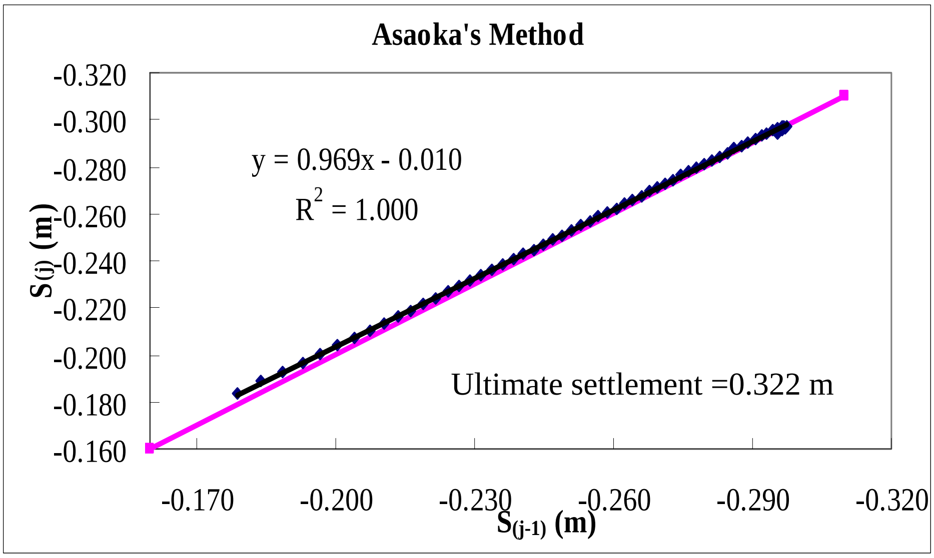


Figure D.82- Estimation of final settlement at SP45 due to the surcharge by using Asaoka's method

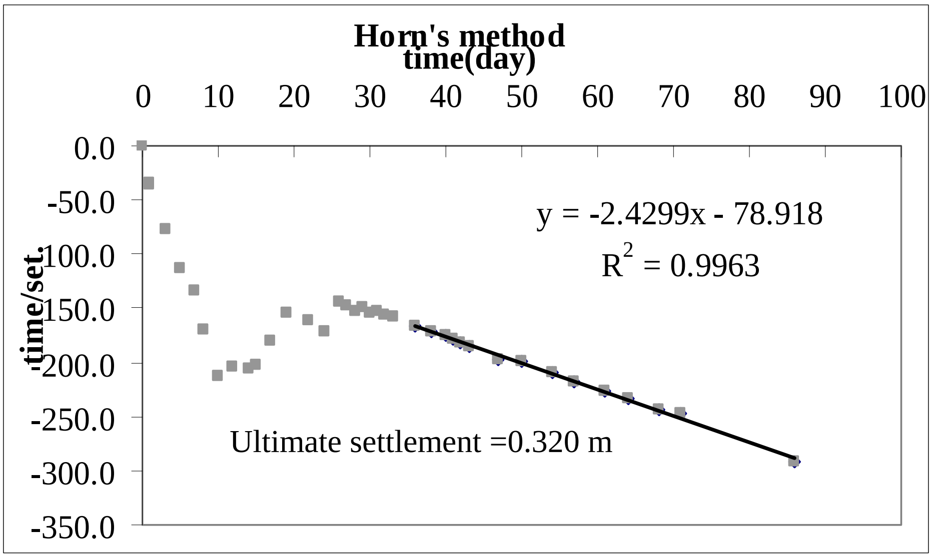


Figure D.83- Estimation of final settlement at SP45 due to the surcharge by using Horn's method

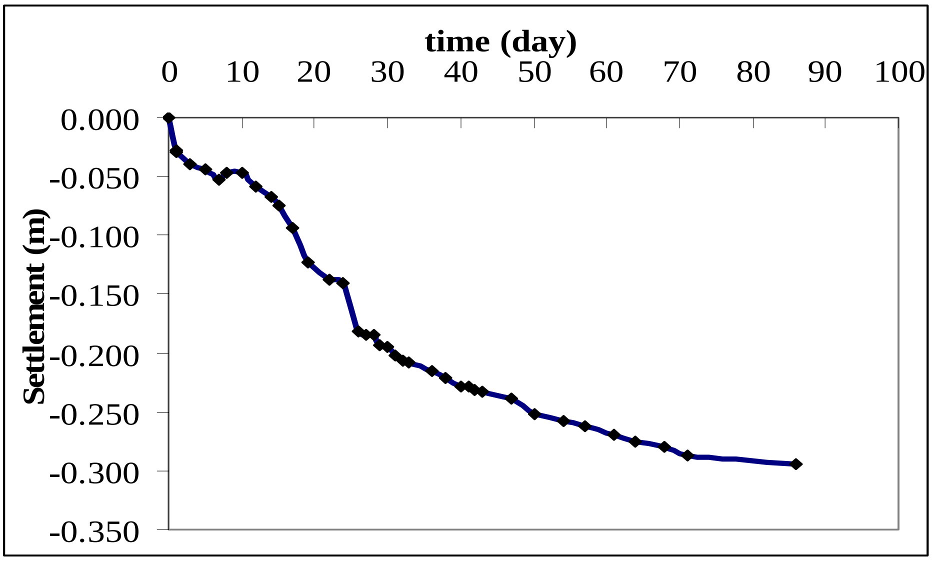


Figure D.84- The distribution of consolidation settlement due to the applied load with time at SP45

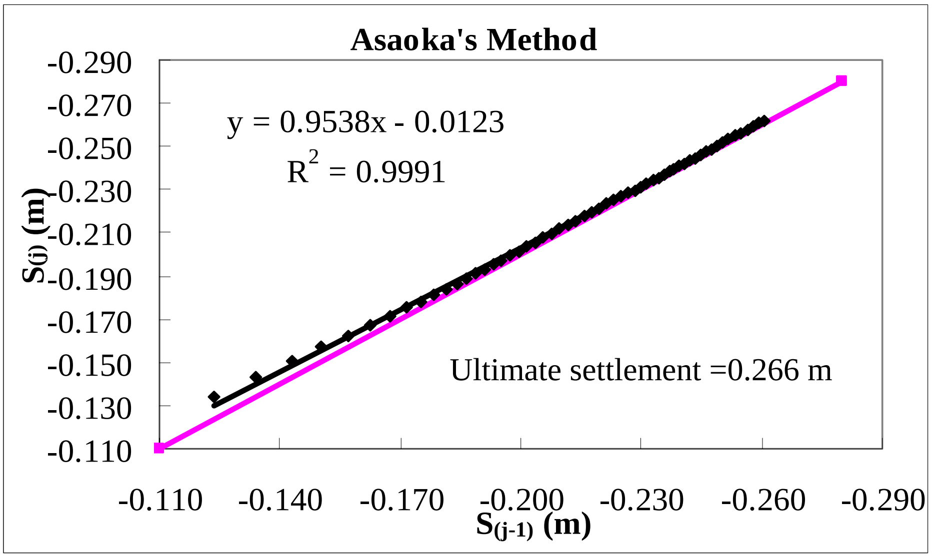


Figure D.85- Estimation of final settlement at SP46 due to the surcharge by using Asaoka's method

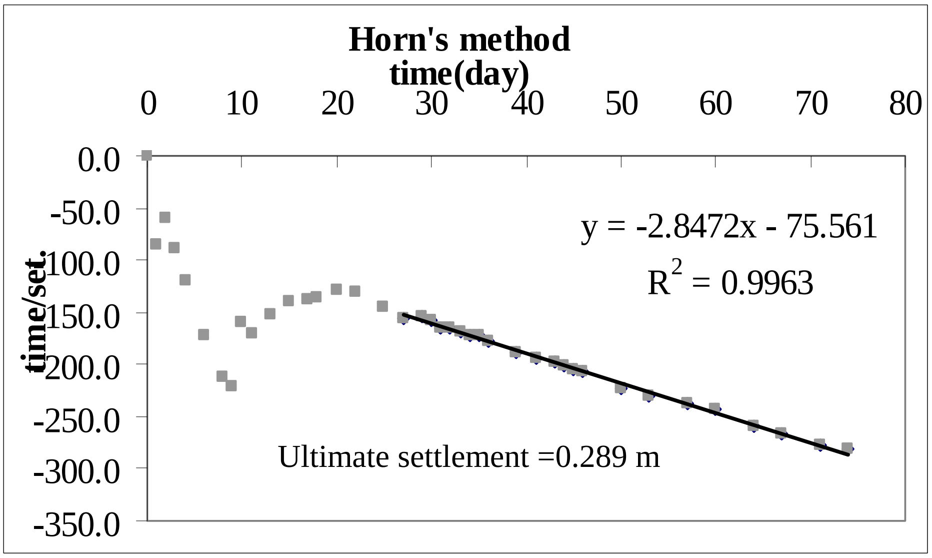


Figure D.86- Estimation of final settlement at SP46 due to the surcharge by using Horn's method

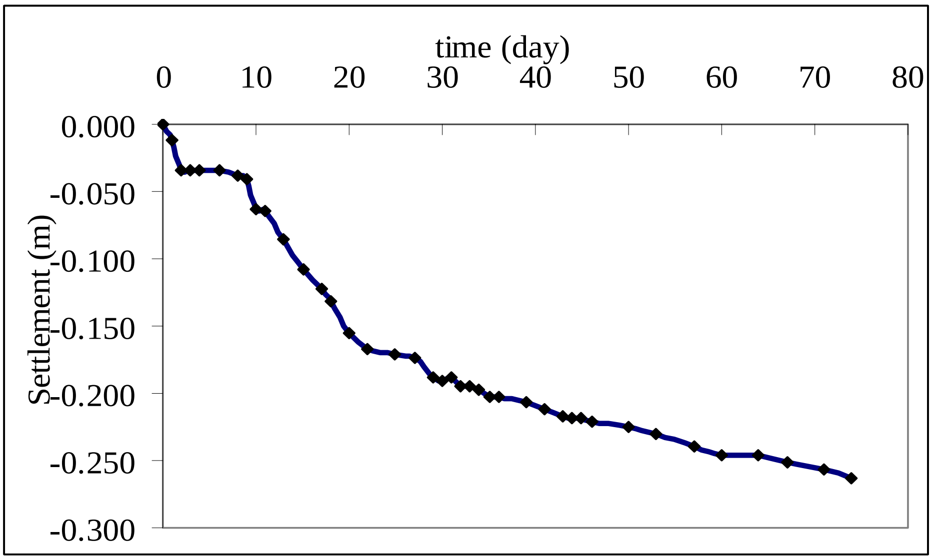


Figure D.87- The distribution of consolidation settlement due to the applied load with time at SP46

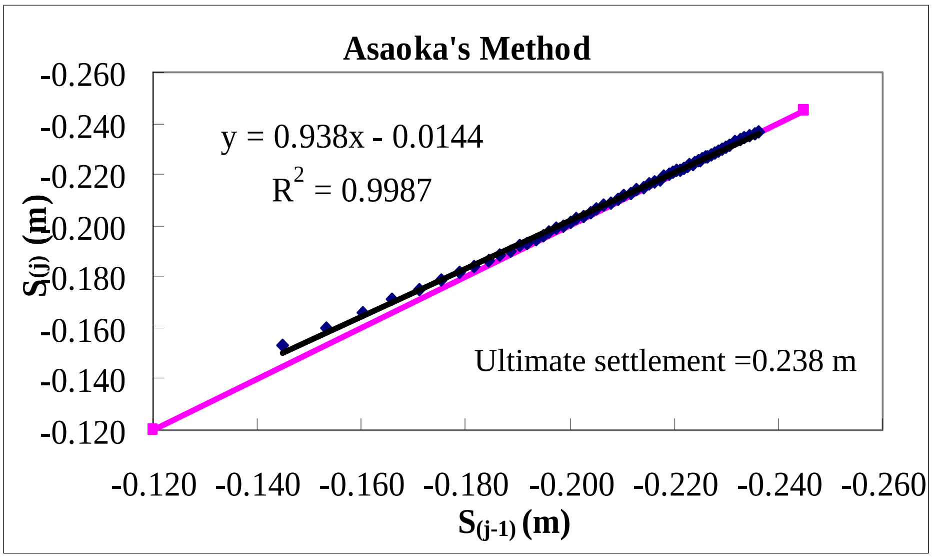


Figure D.88- Estimation of final settlement at SP47 due to the surcharge by using Asaoka's method

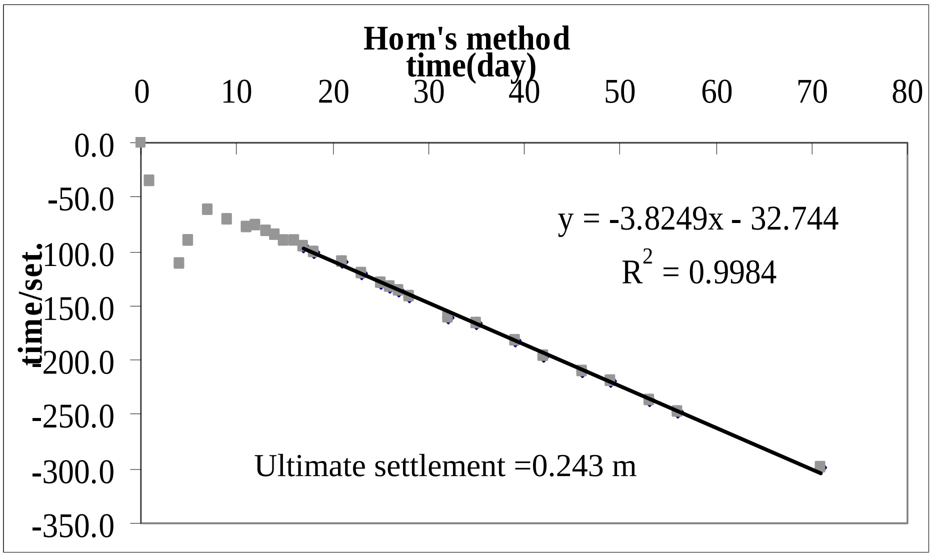


Figure D.89- Estimation of final settlement at SP47 due to the surcharge by using Horn’s method

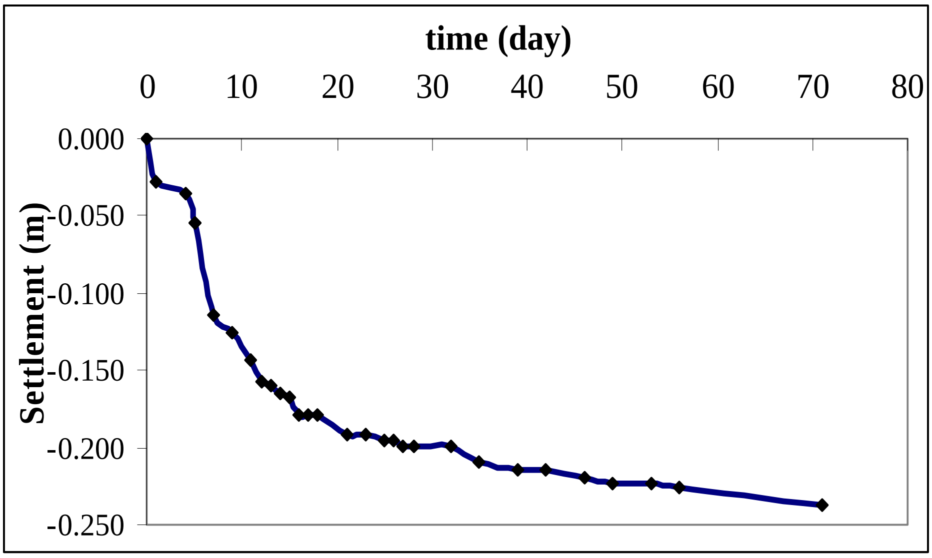


Figure D.90- The distribution of consolidation settlement due to the applied load with time at SP47

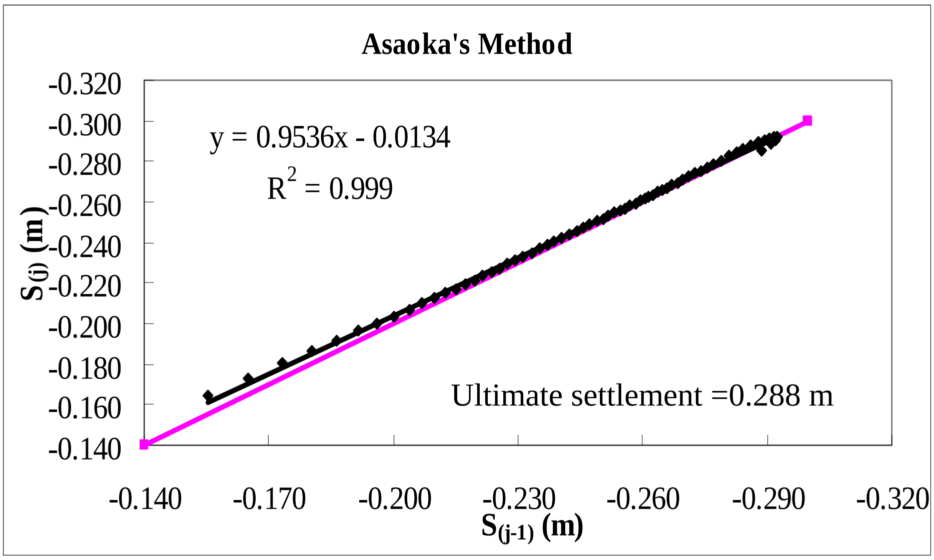


Figure D.91- Estimation of final settlement at SP48 due to the surcharge by using Asaoka's method

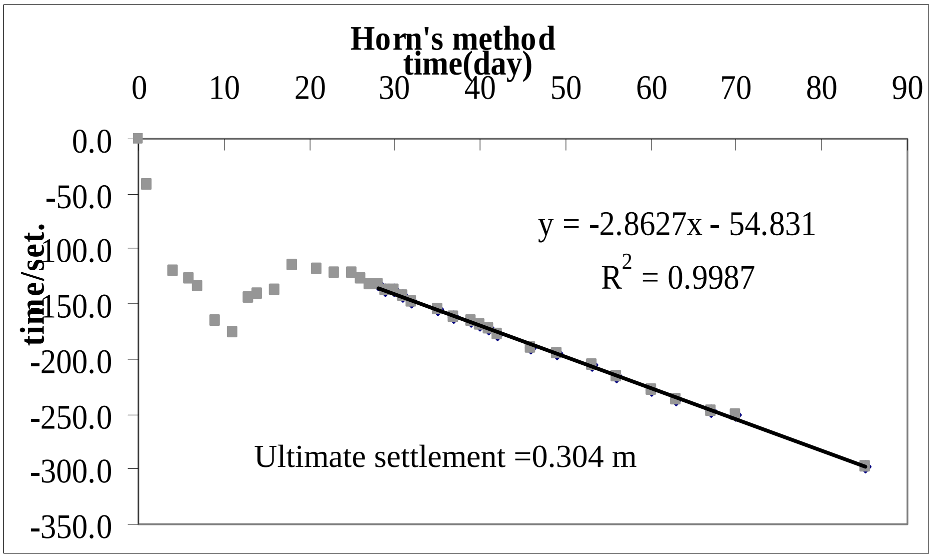


Figure D.92- Estimation of final settlement at SP48 due to the surcharge by using Horn's method

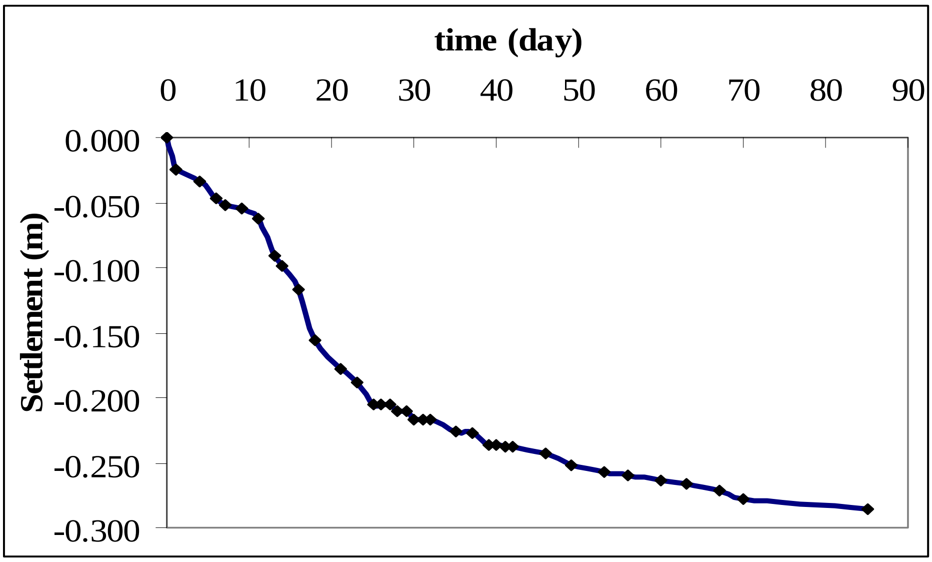


Figure D.93- The distribution of consolidation settlement due to the applied load with time at SP48

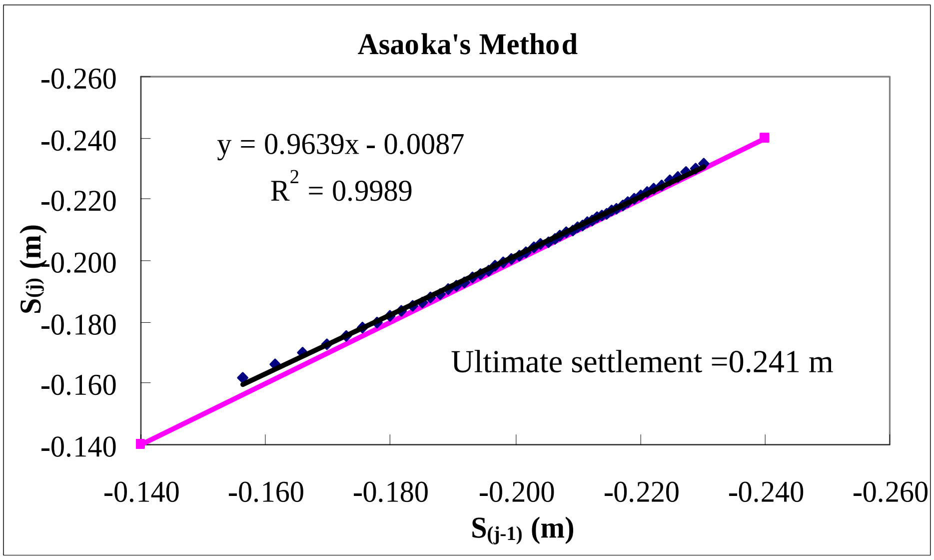


Figure D.94- Estimation of final settlement at SP49 due to the surcharge by using Asaoka's method

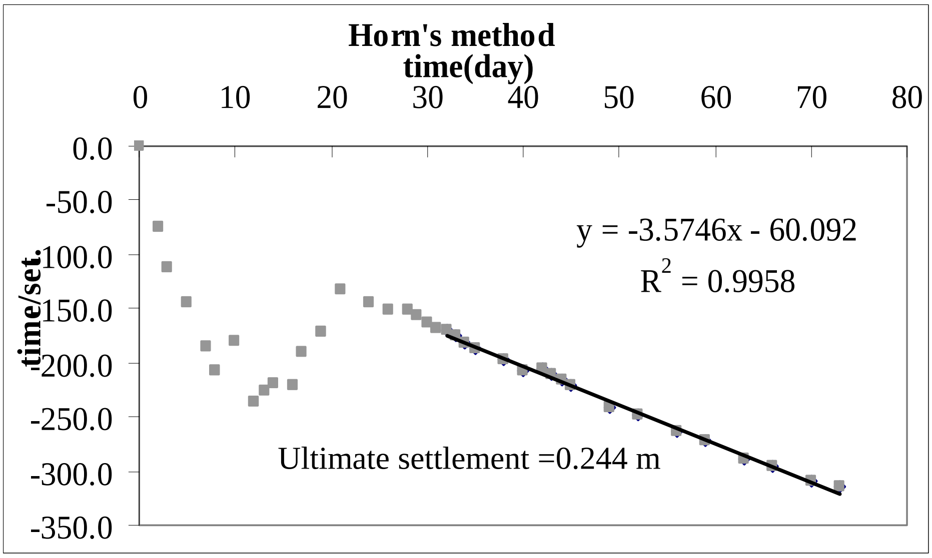


Figure D.95- Estimation of final settlement at SP49 due to the surcharge by using Horn's method

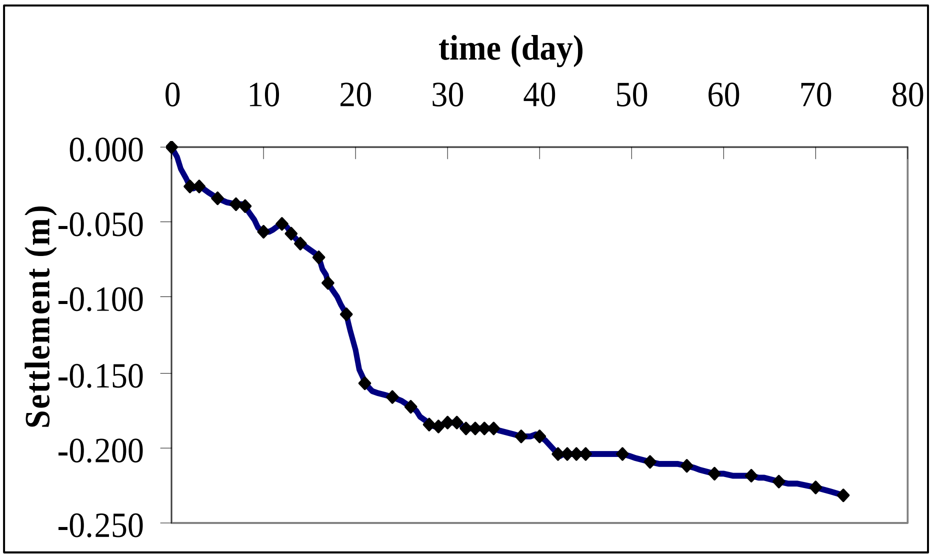


Figure D.96- The distribution of consolidation settlement due to the applied load with time at SP49

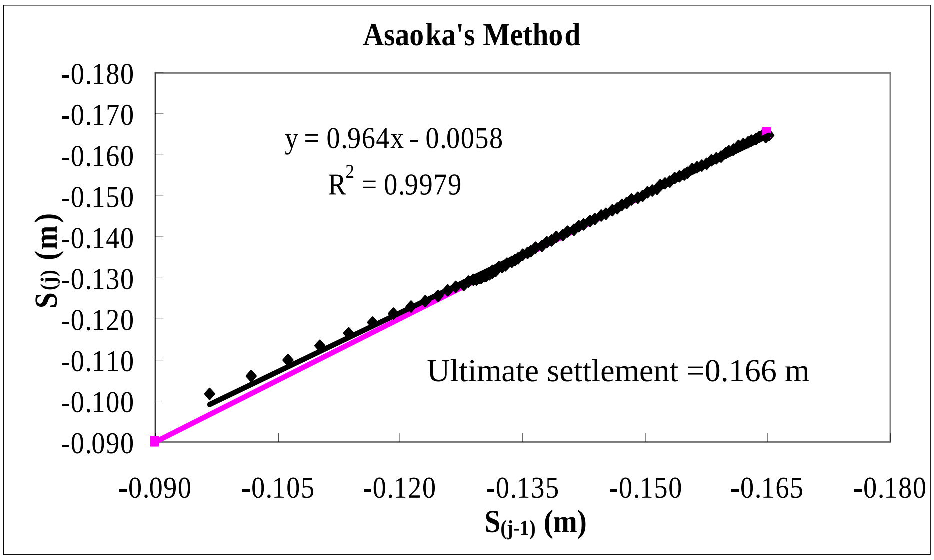


Figure D.97- Estimation of final settlement at SP50 due to the surcharge by using Asaoka's method

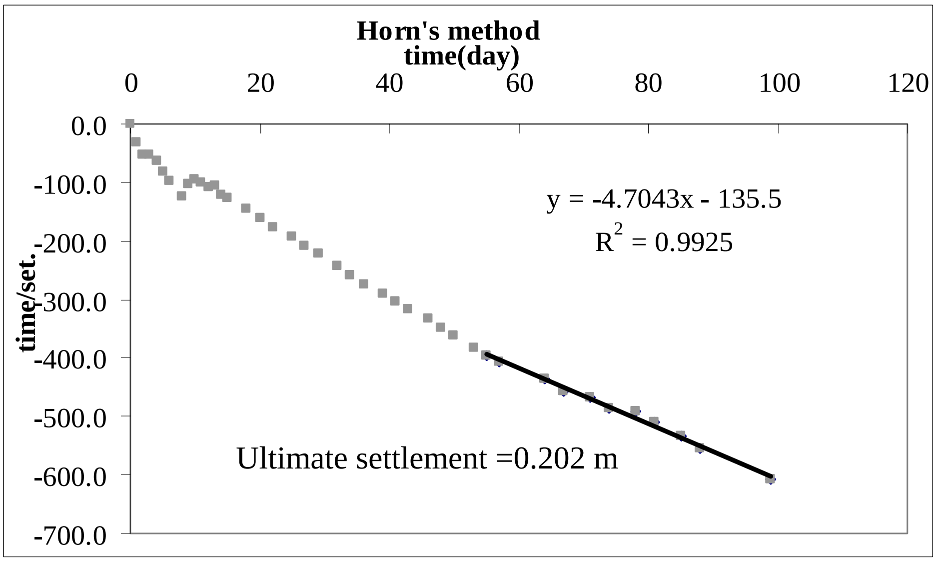


Figure D.98- Estimation of final settlement at SP50 due to the surcharge by using Horn's method

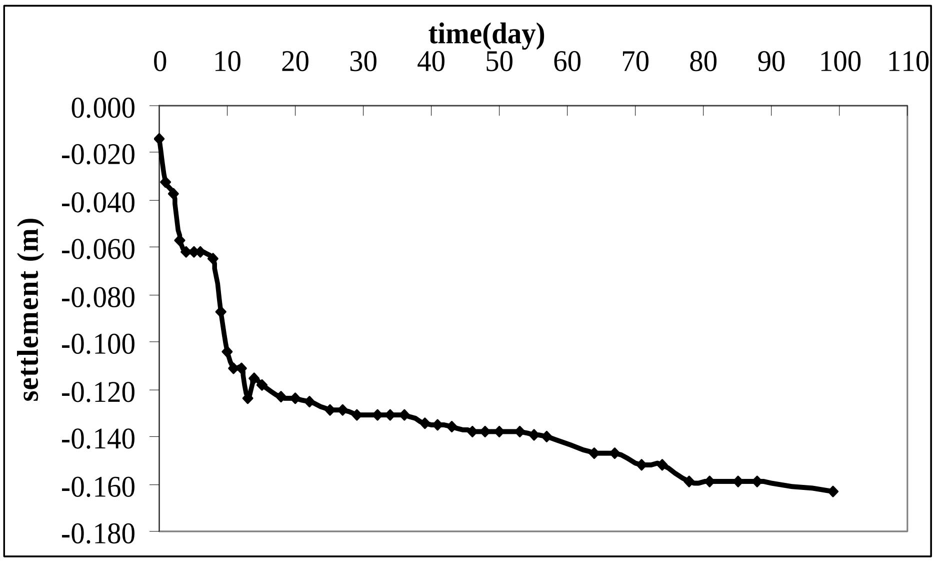


Figure D.99- The distribution of consolidation settlement due to the applied load with time at SP50

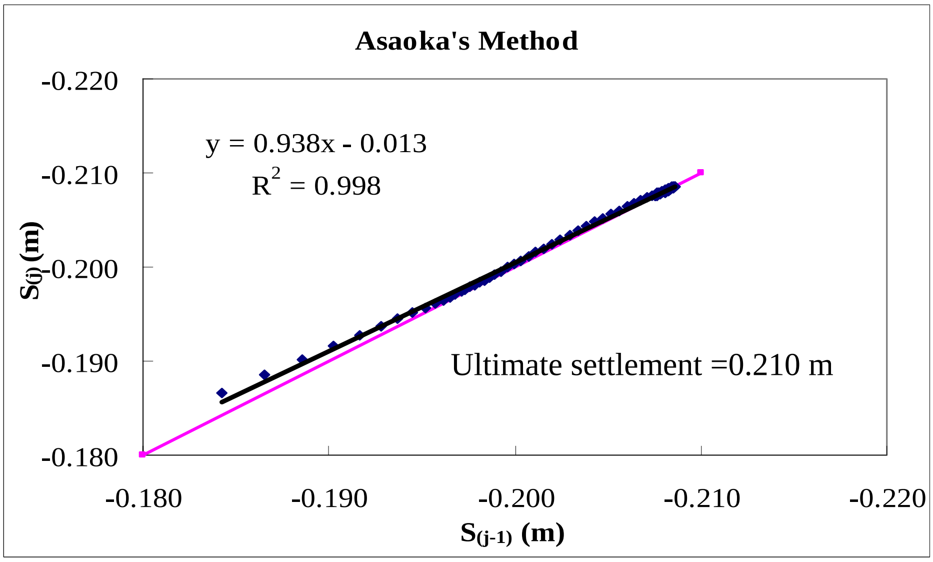


Figure D.100- Estimation of final settlement at SP54 due to the surcharge by using Asaoka's method

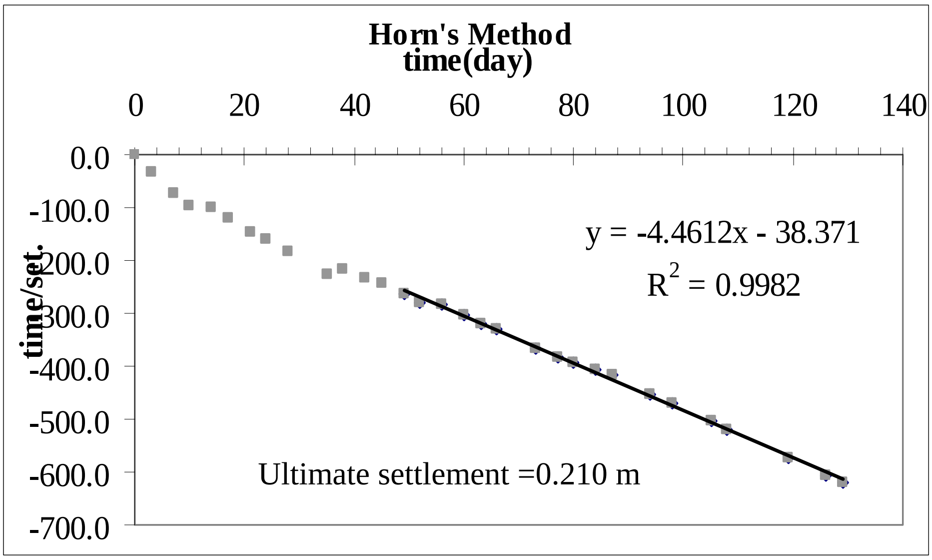


Figure D.101- Estimation of final settlement at SP54 due to the surcharge by using Horn’s method

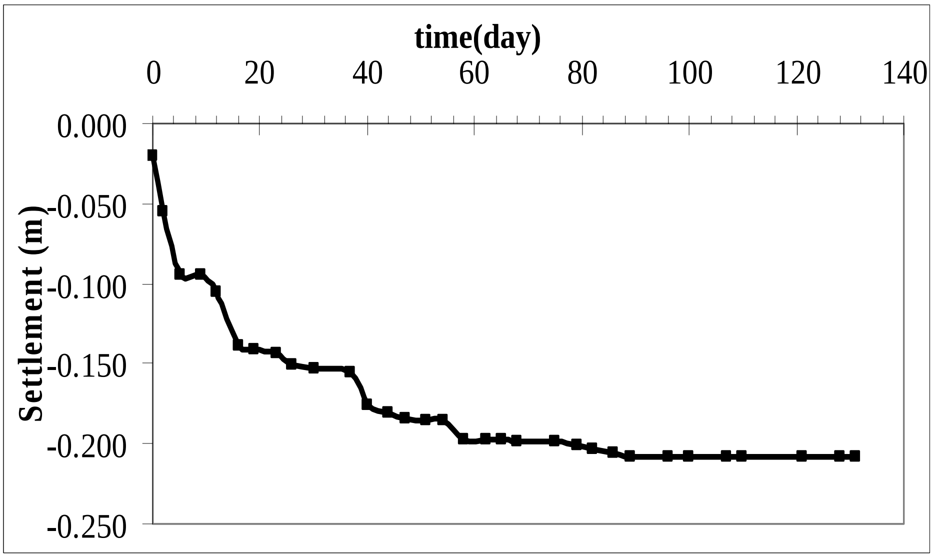


Figure D.102- The distribution of consolidation settlement due to the applied load with time at SP54

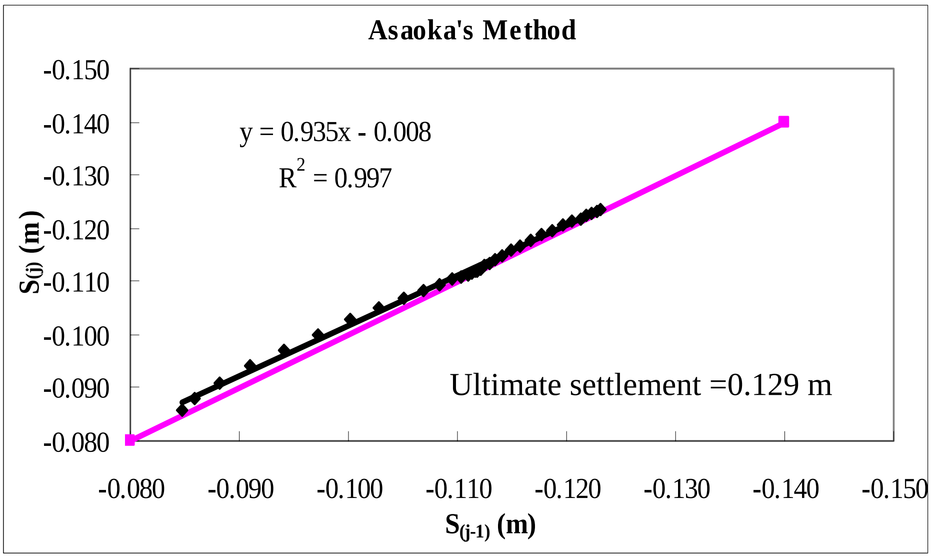


Figure D.103- Estimation of final settlement at SP13 due to the surcharge by using Asaoka's method

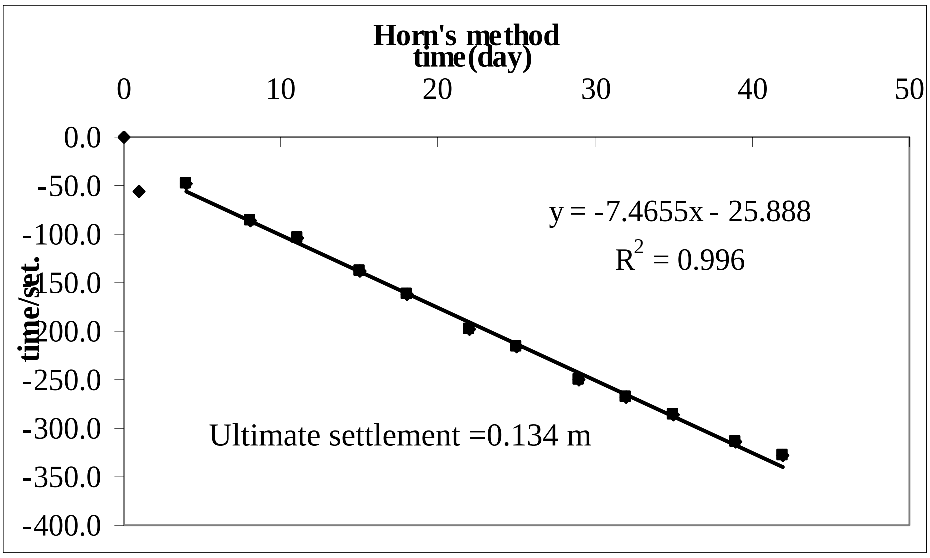


Figure D.104- Estimation of final settlement at SP13 due to the surcharge by using Horn's method

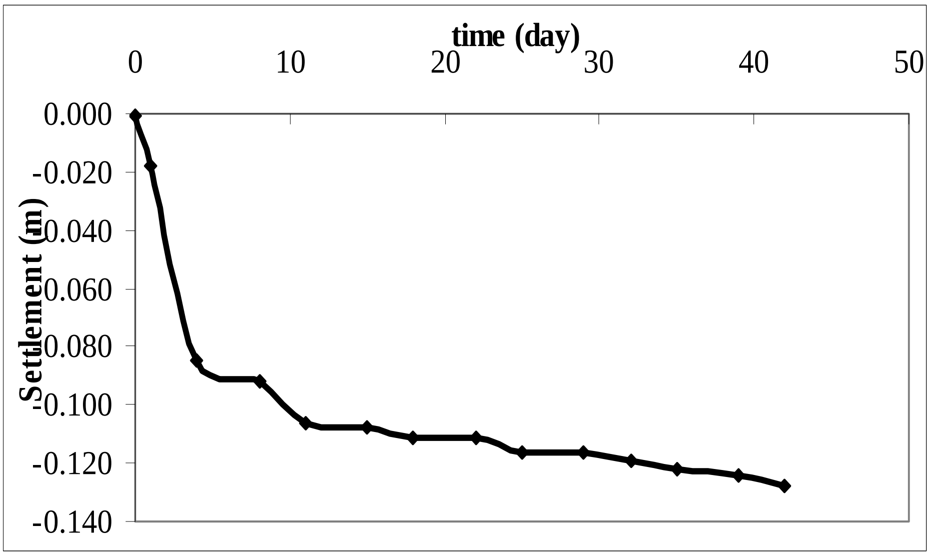


Figure D.105- The distribution of consolidation settlement due to the applied load with time at SP13

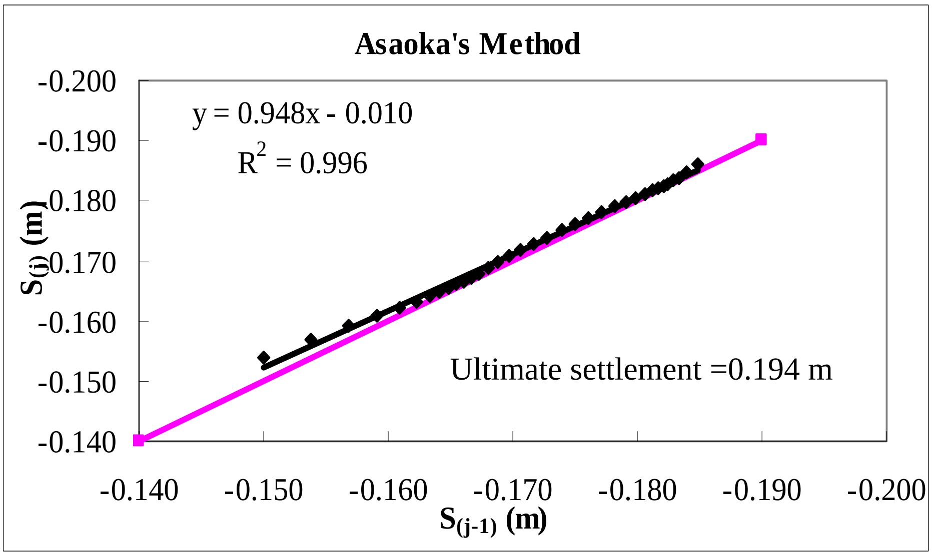


Figure D.106- Estimation of final settlement at SP14 due to the surcharge by using Asaoka's method

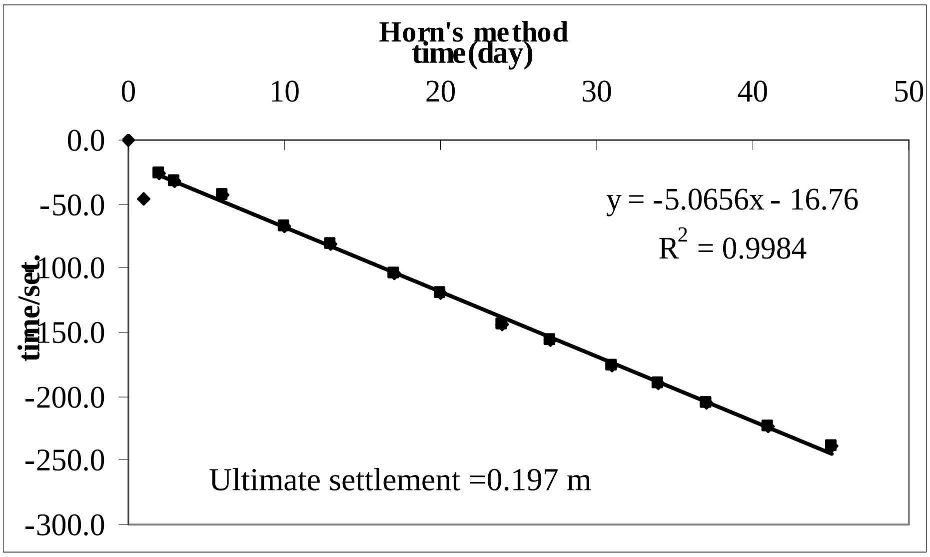


Figure D.107- Estimation of final settlement at SP14 due to the surcharge by using Horn's method

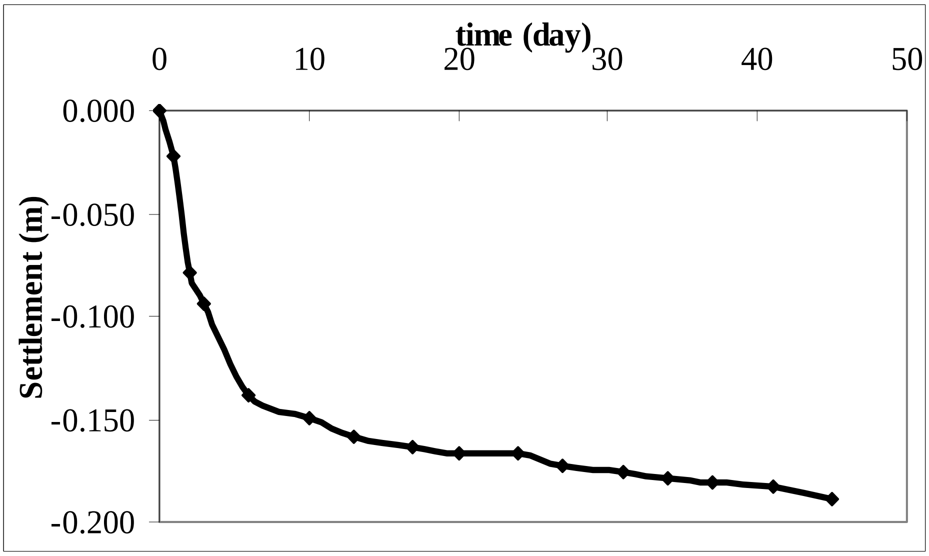


Figure D.108- The distribution of consolidation settlement due to the applied load with time at SP14

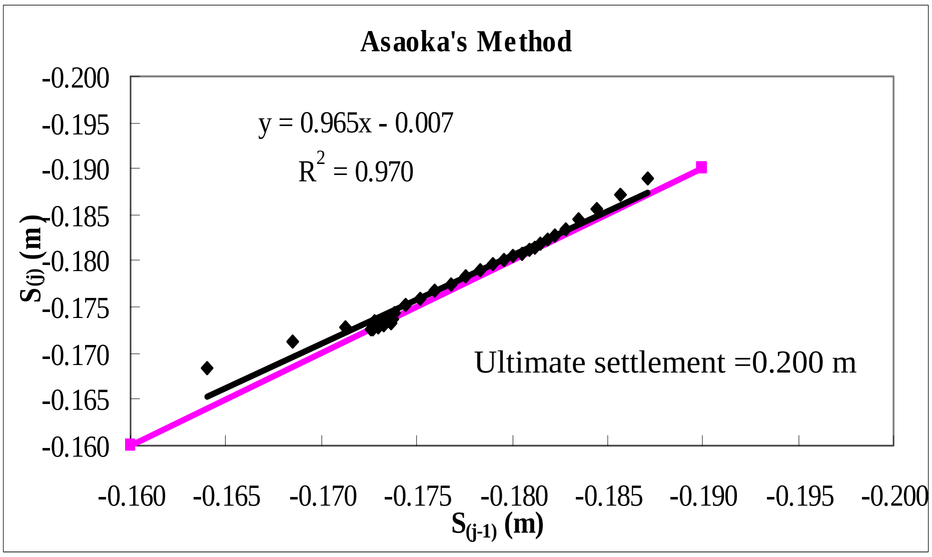


Figure D.109- Estimation of final settlement at SP15 due to the surcharge by using Asaoka's method

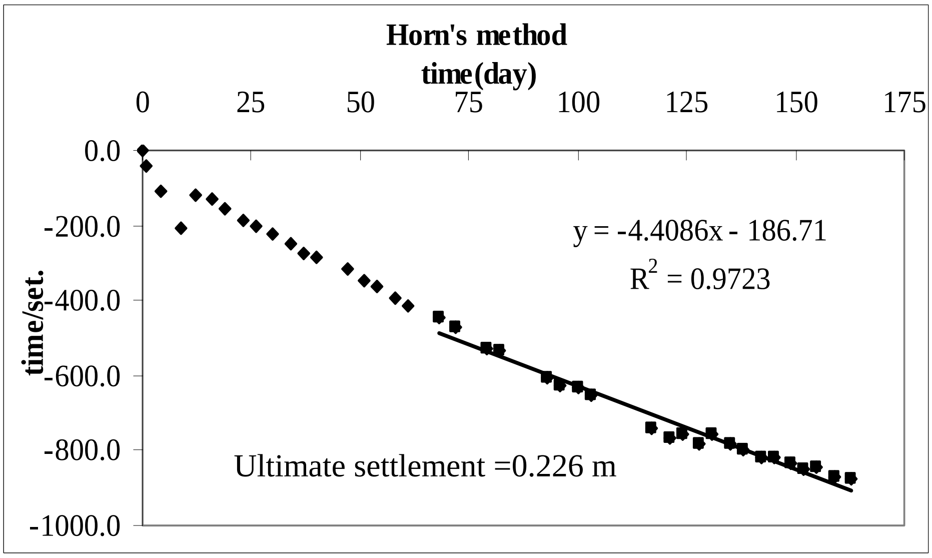


Figure D.110- Estimation of final settlement at SP15 due to the surcharge by using Horn's method

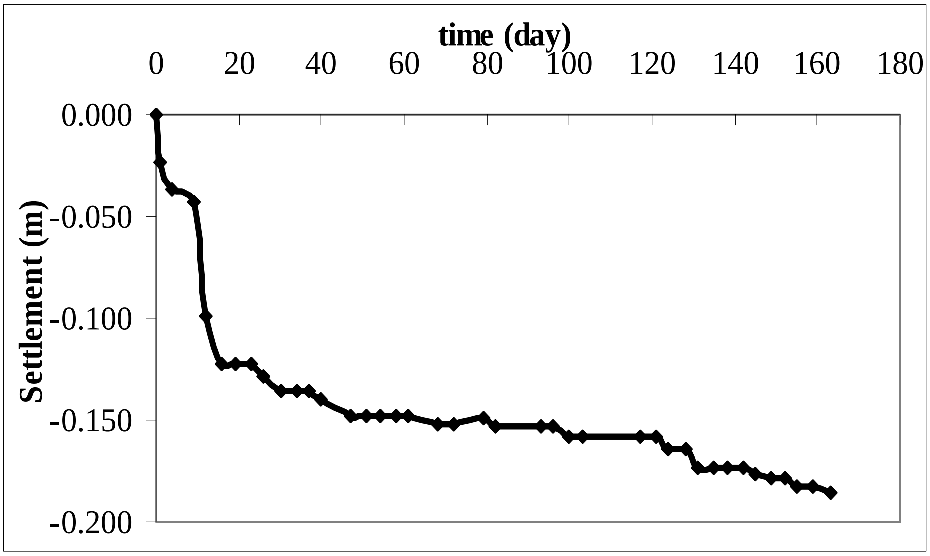


Figure D.111- The distribution of consolidation settlement due to the applied load with time at SP15

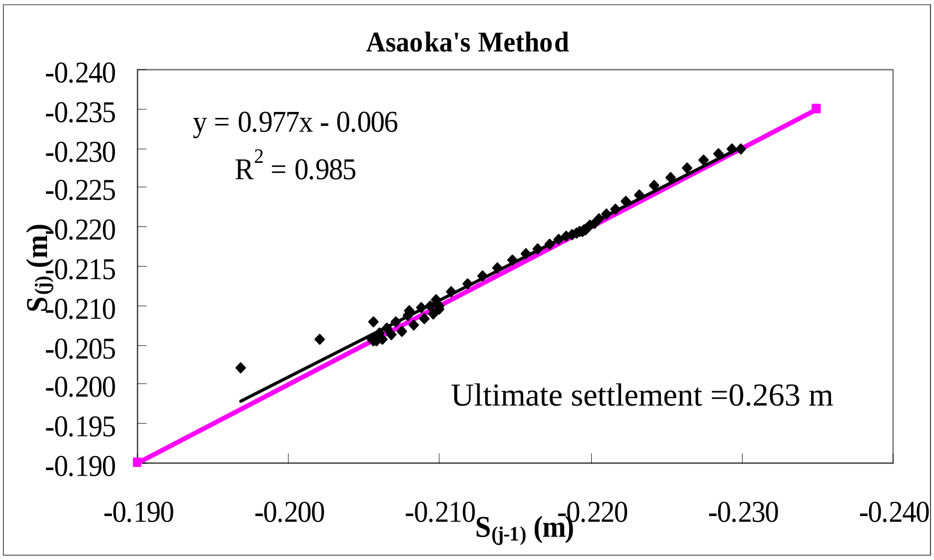


Figure D.112- Estimation of final settlement at SP20 due to the surcharge by using Asaoka's method

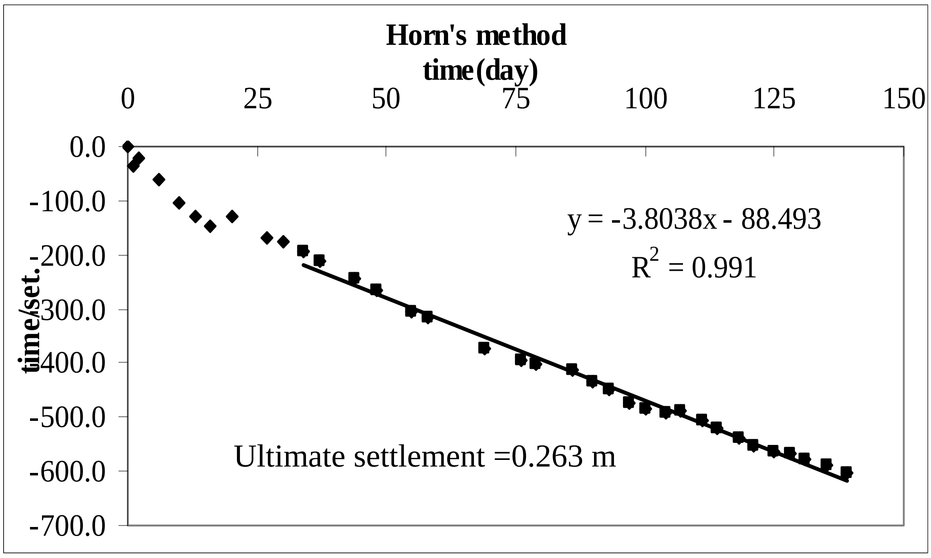


Figure D.113- Estimation of final settlement at SP20 due to the surcharge by using Horn's method

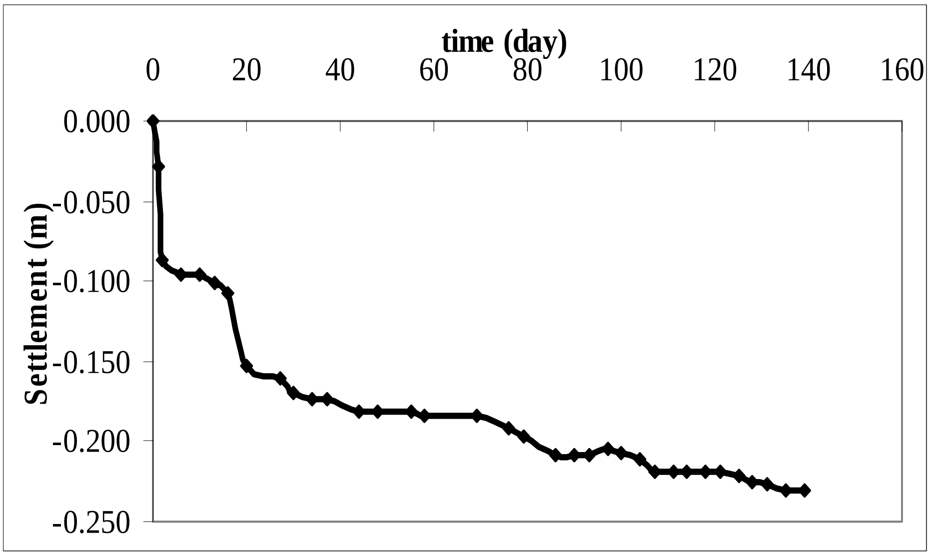


Figure D.114- The distribution of consolidation settlement due to the applied load with time at SP20

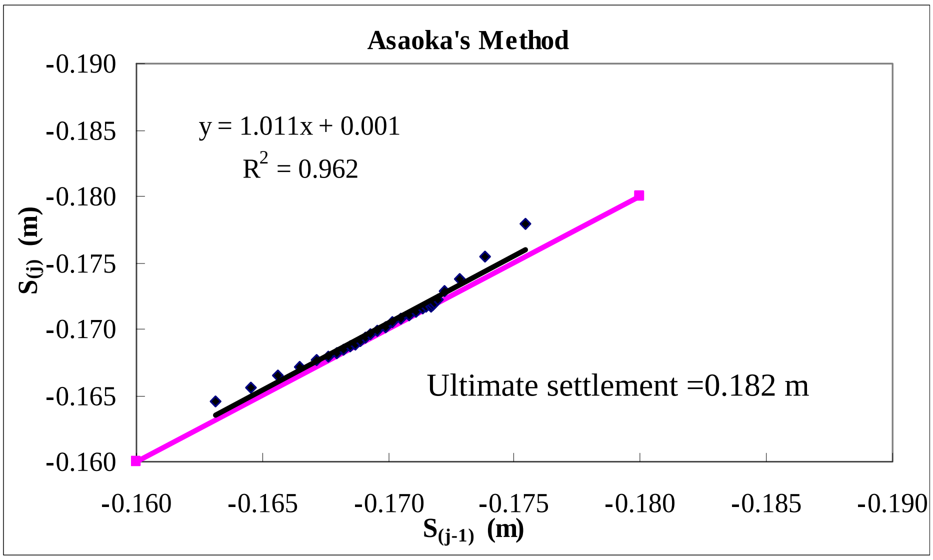


Figure D.115- Estimation of final settlement at SP21 due to the surcharge by using Asaoka's method

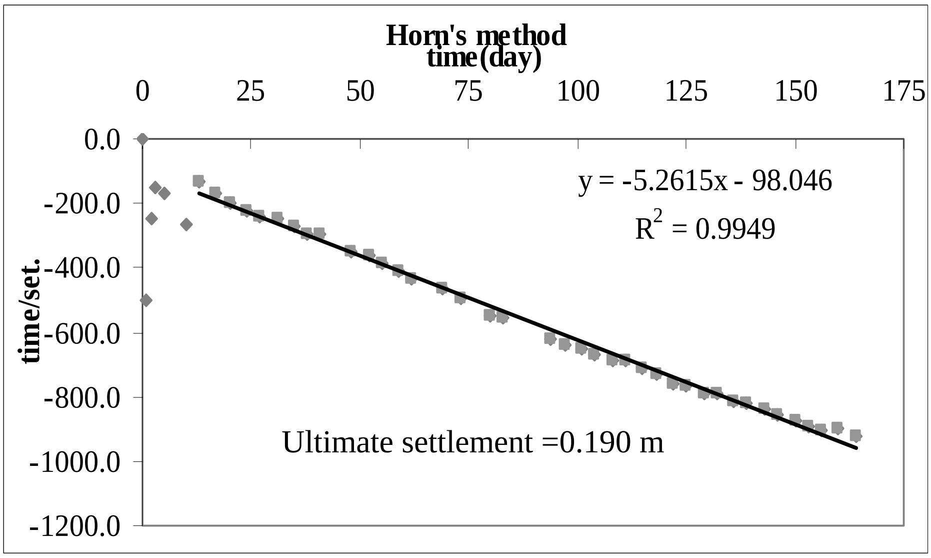


Figure D.116- Estimation of final settlement at SP21 due to the surcharge by using Horn's method

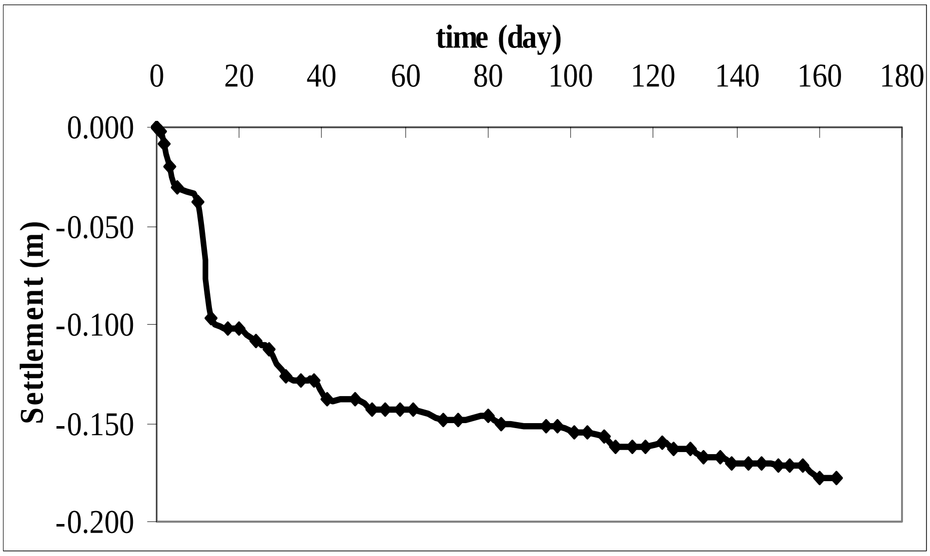


Figure D.117- The distribution of consolidation settlement due to the applied load with time at SP21

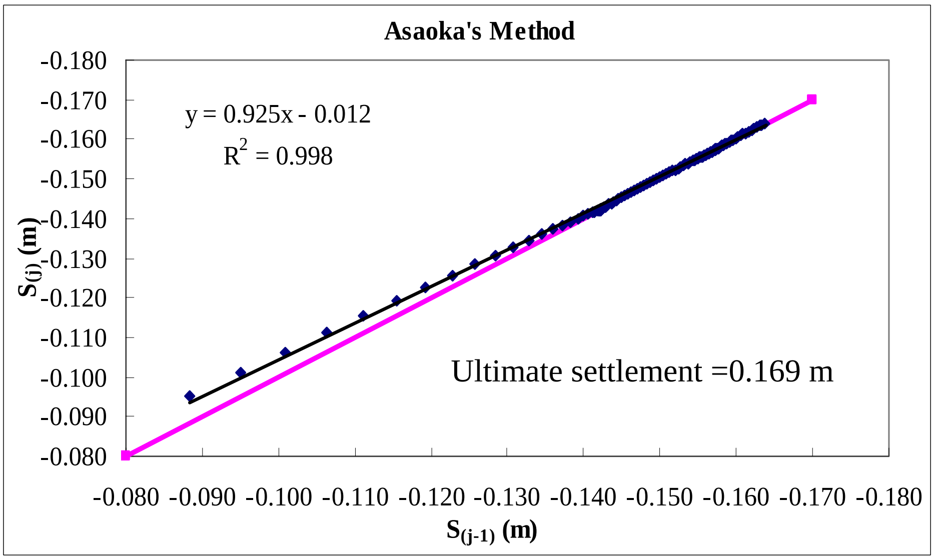


Figure D.118- Estimation of final settlement at SP25 due to the surcharge by using Asaoka's method

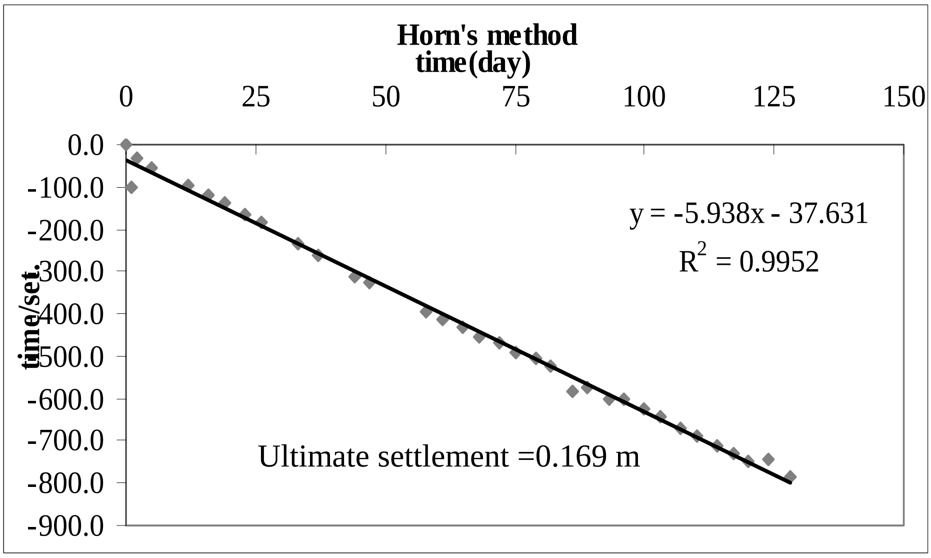


Figure D.119- Estimation of final settlement at SP25 due to the surcharge by using Horn’s method

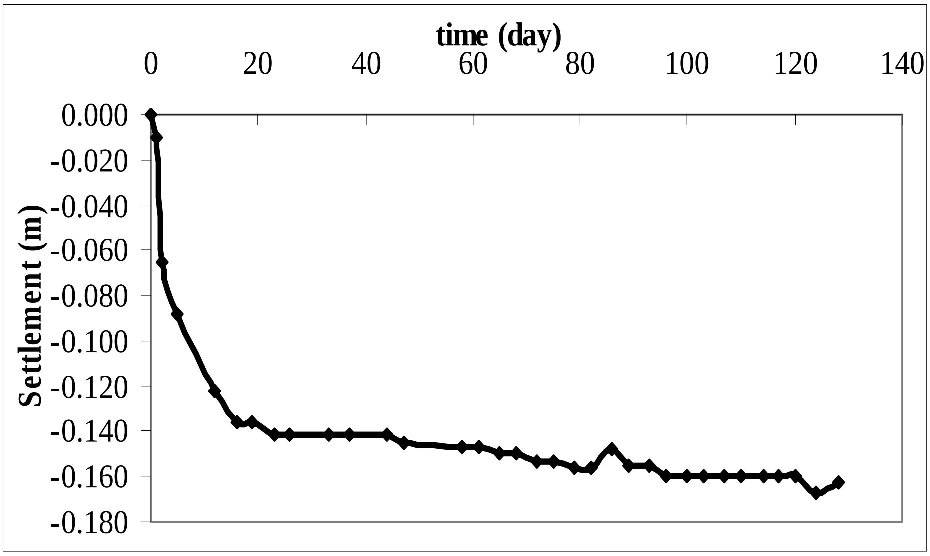


Figure D.120- The distribution of consolidation settlement due to the applied load with time at SP25

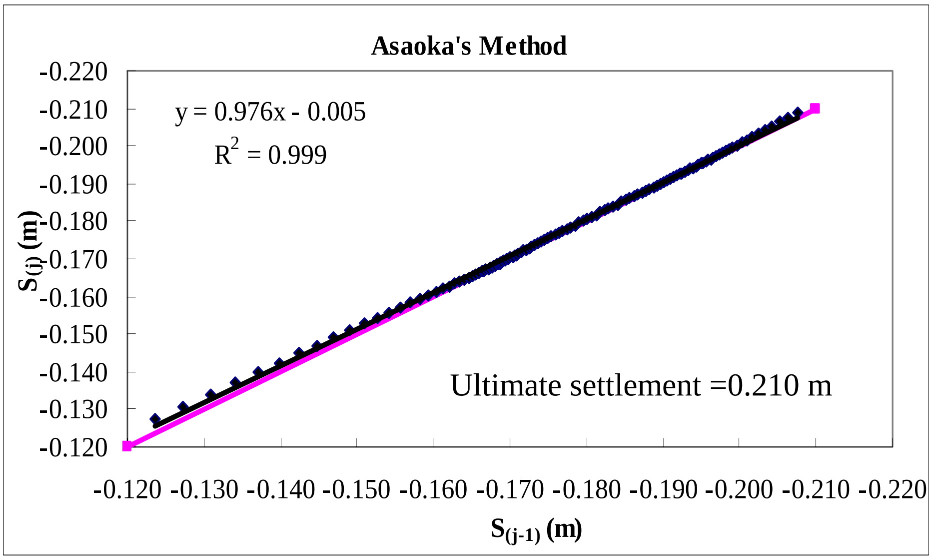


Figure D.121- Estimation of final settlement at SP26 due to the surcharge by using Asaoka's method

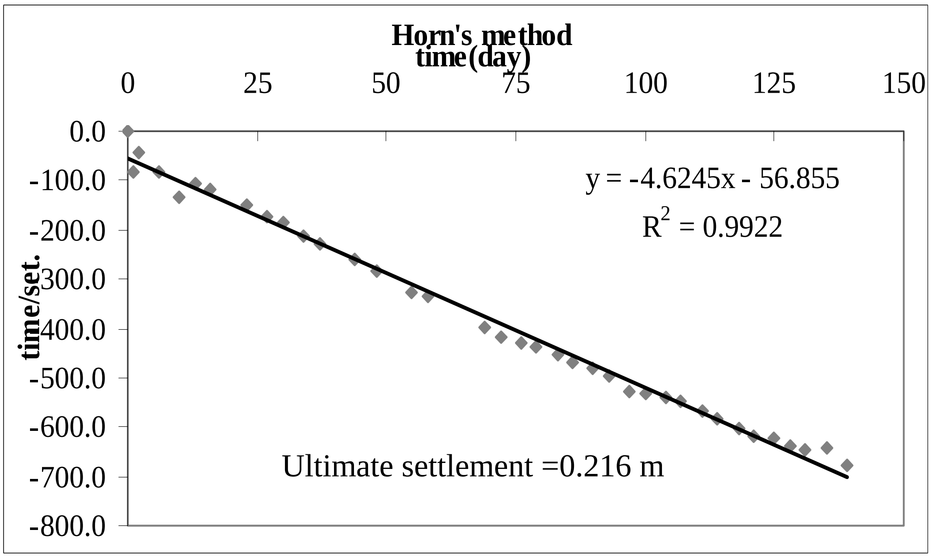


Figure D.122- Estimation of final settlement at SP26 due to the surcharge by using Horn's method

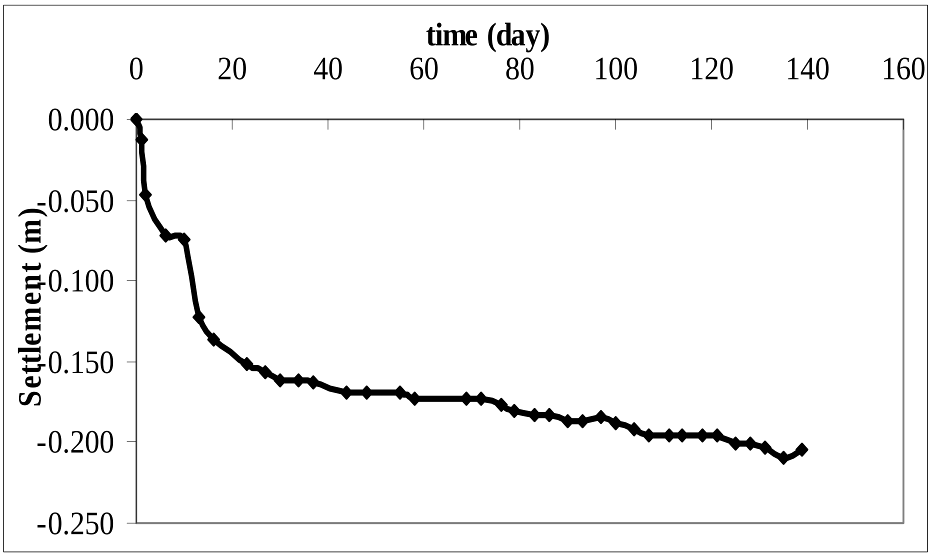


Figure D.123- The distribution of consolidation settlement due to the applied load with time at SP26

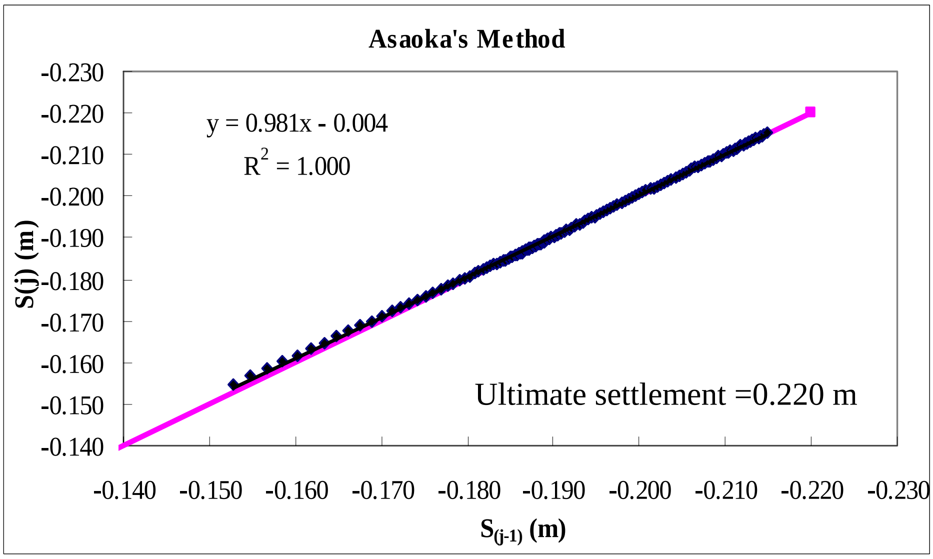


Figure D.124- Estimation of final settlement at SP27 due to the surcharge by using Asaoka's method

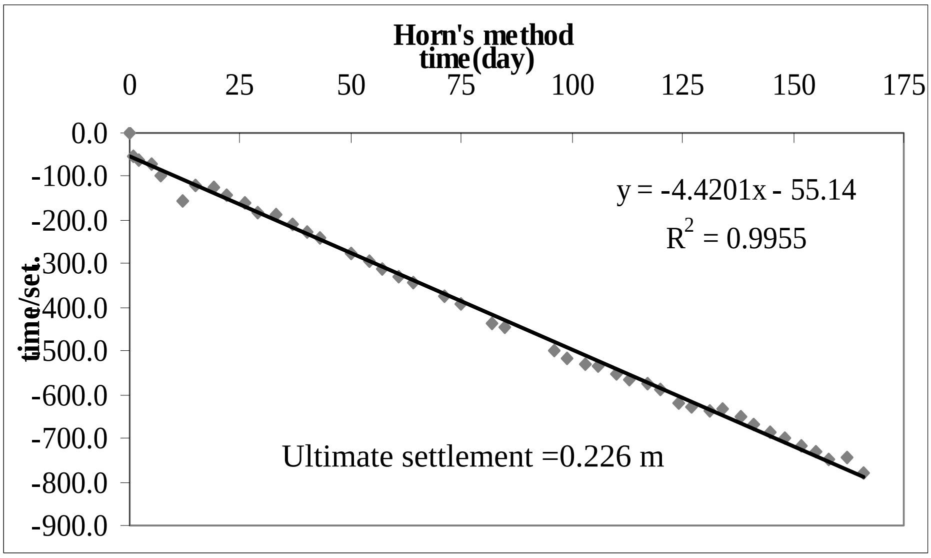


Figure D.125- Estimation of final settlement at SP27 due to the surcharge by using Horn's method

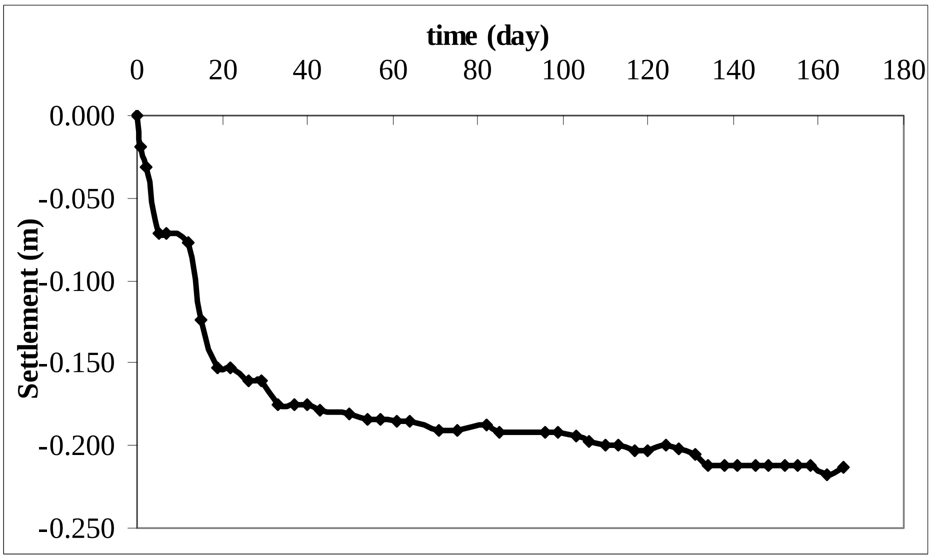


Figure D.126- The distribution of consolidation settlement due to the applied load with time at SP27

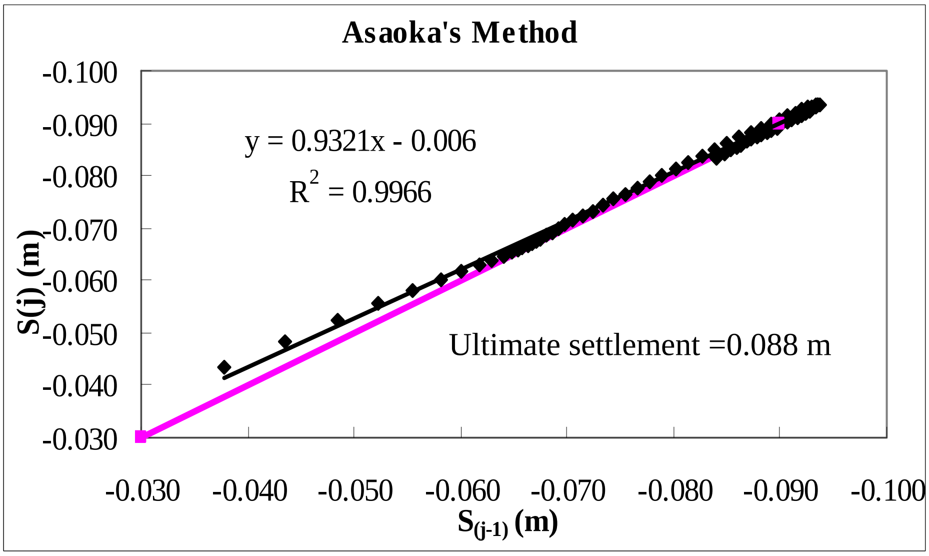


Figure D.127- Estimation of final settlement at BSP1 due to the surcharge by using Asaoka's method

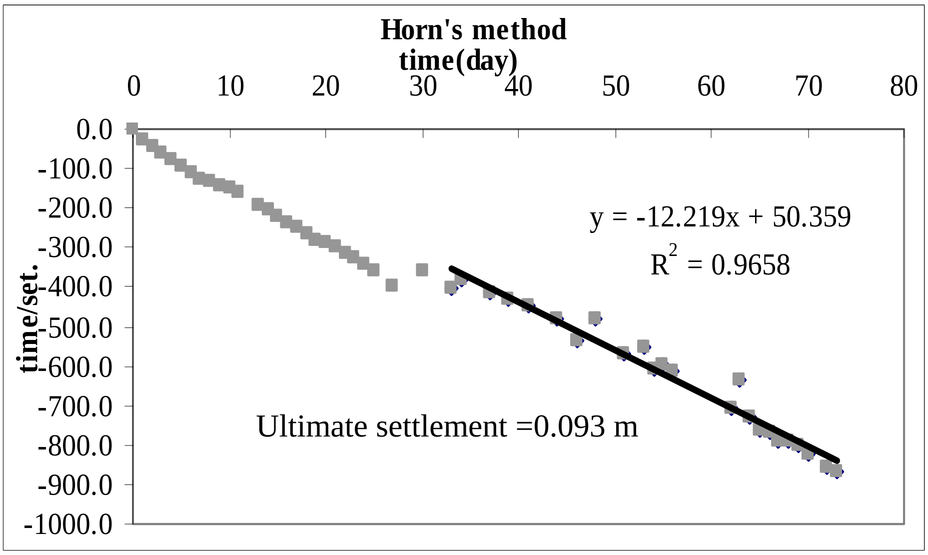


Figure D.128- Estimation of final settlement at BSP1 due to the surcharge by using Horn's method

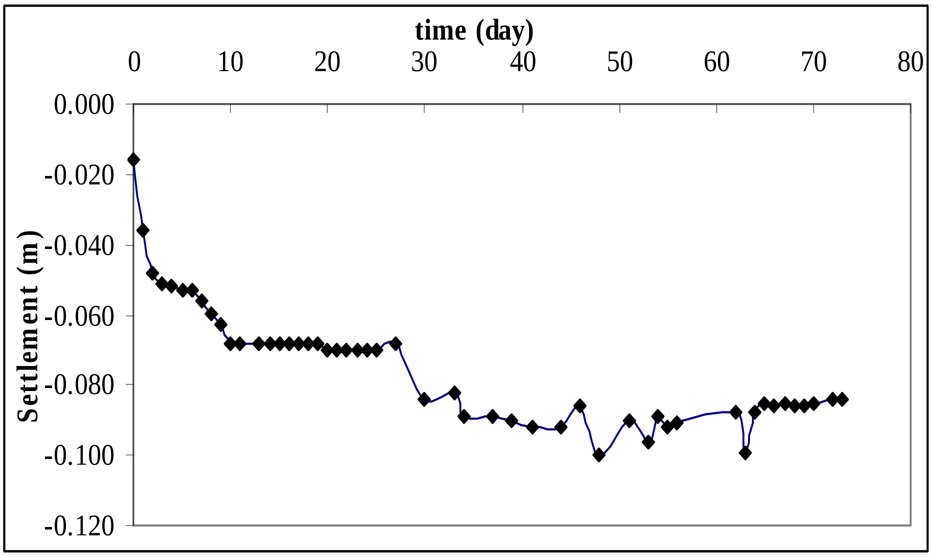


Figure D.129- The distribution of consolidation settlement due to the applied load with time at BSP1

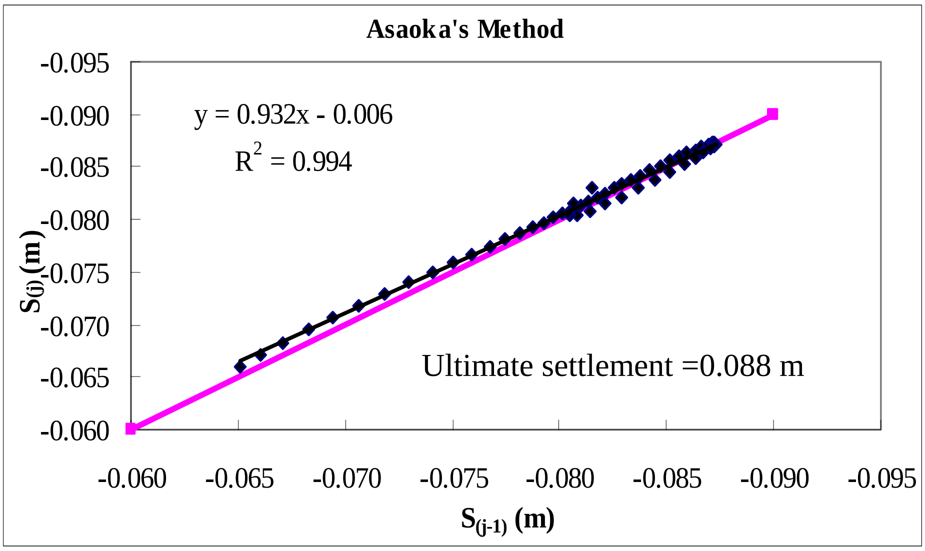


Figure D.130- Estimation of final settlement at BSP2 due to the surcharge by using Asaoka's method

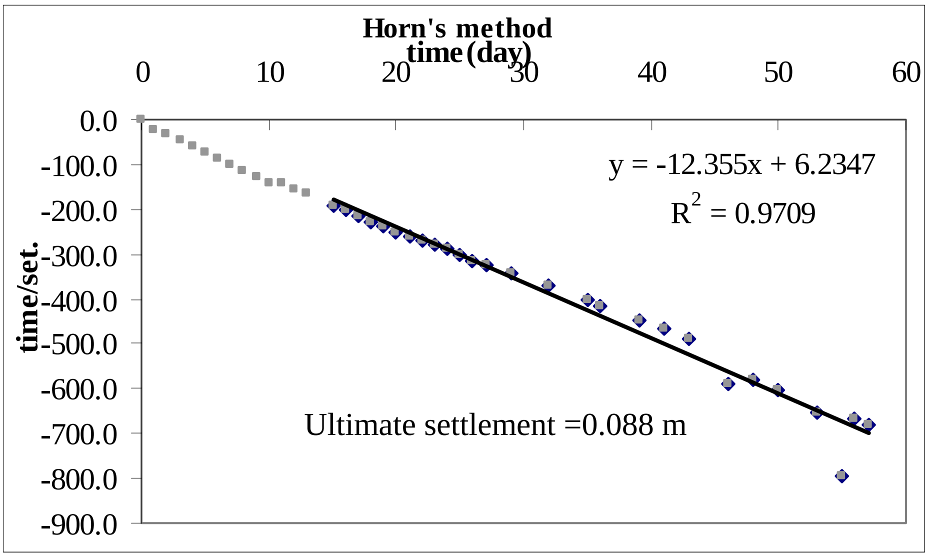


Figure D.131- Estimation of final settlement at BSP2 due to the surcharge by using Horn's method

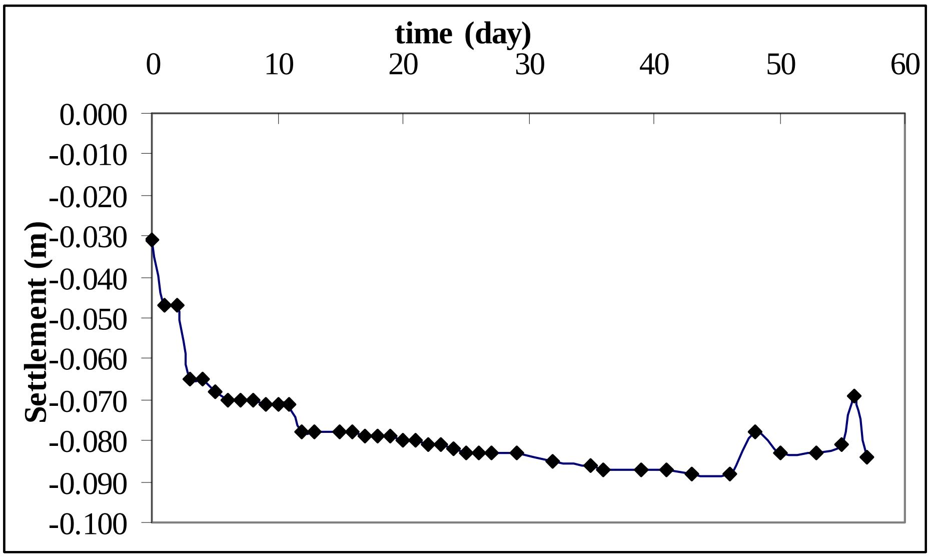


Figure D.132- The distribution of consolidation settlement due to the applied load with time at BSP2

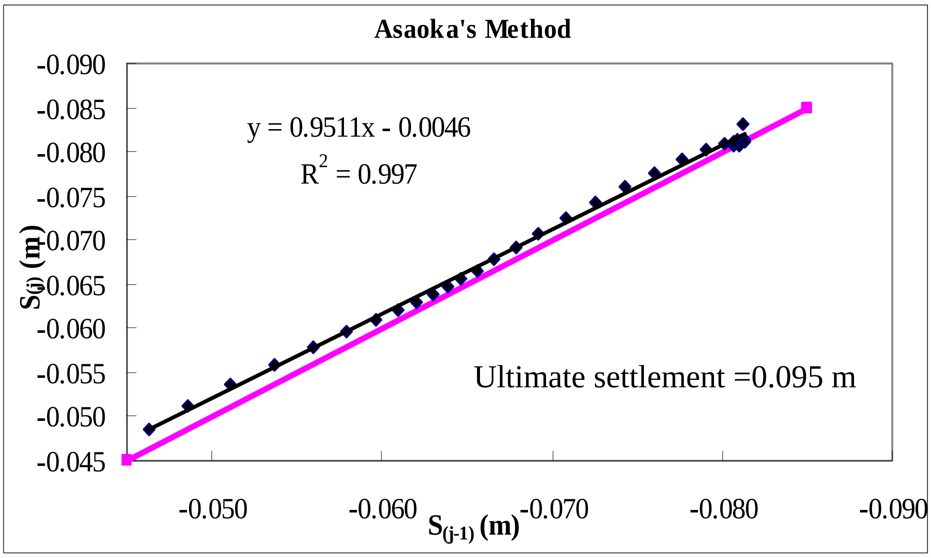


Figure D.133- Estimation of final settlement at BSP3 due to the surcharge by using Asaoka's method

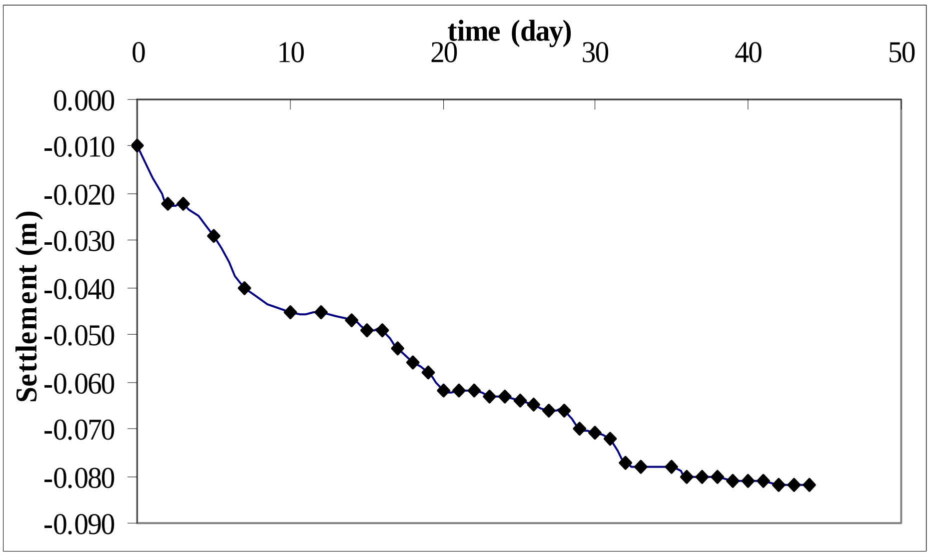


Figure D.134- The distribution of consolidation settlement due to the applied load with time at BSP3

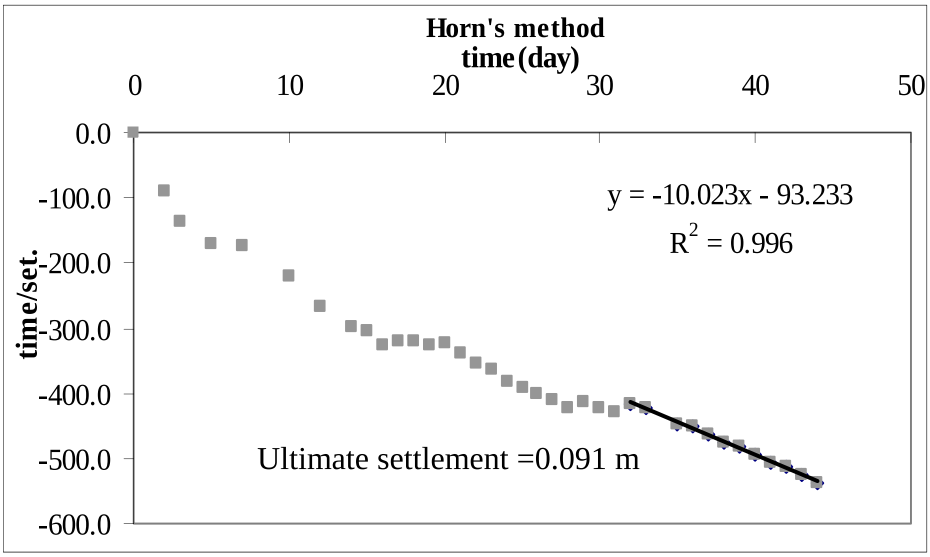


Figure D.135- Estimation of final settlement at BSP3 due to the surcharge by using Horn's method

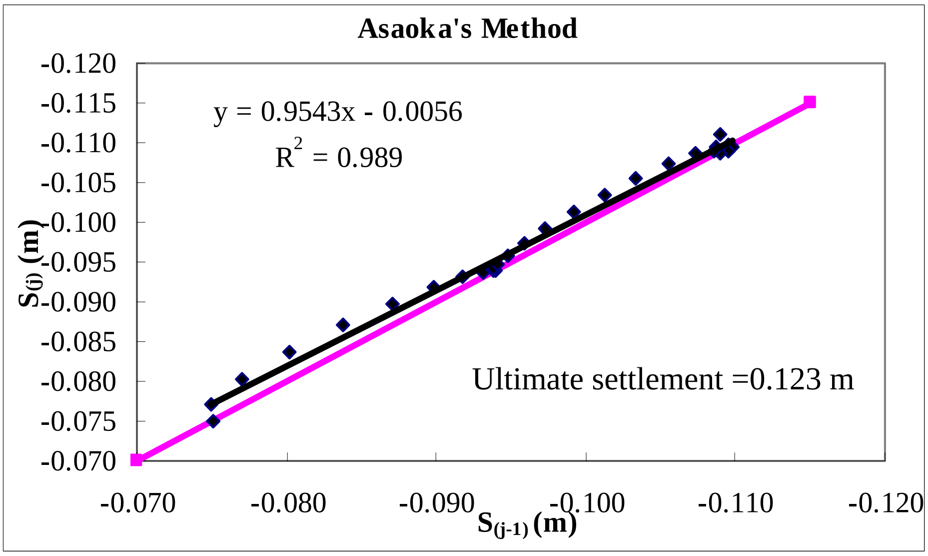


Figure D.136- Estimation of final settlement at BSP4 due to the surcharge by using Asaoka's method

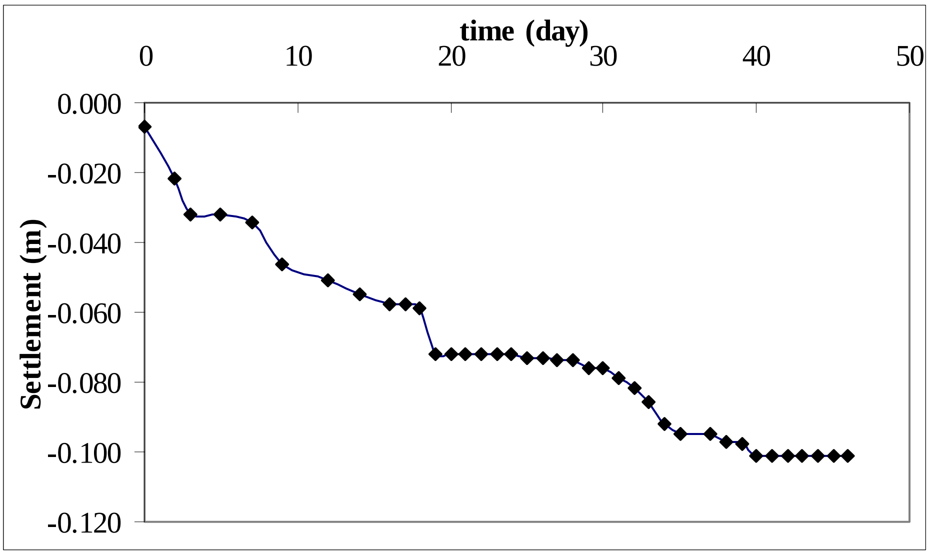


Figure D.137- The distribution of consolidation settlement due to the applied load with time at BSP4

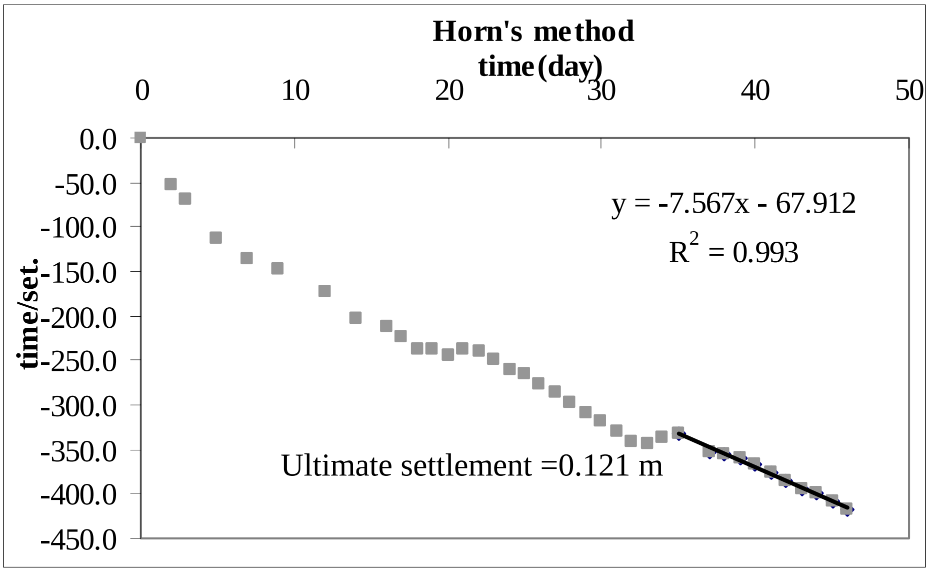


Figure D.138- Estimation of final settlement at BSP4 due to the surcharge by using Horn's method

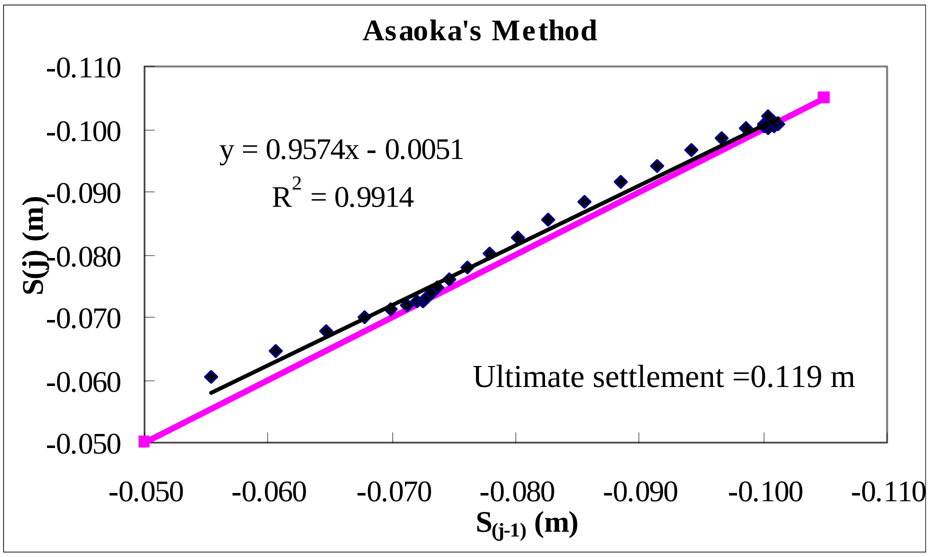


Figure D.139- Estimation of final settlement at BSP5 due to the surcharge by using Asaoka's method

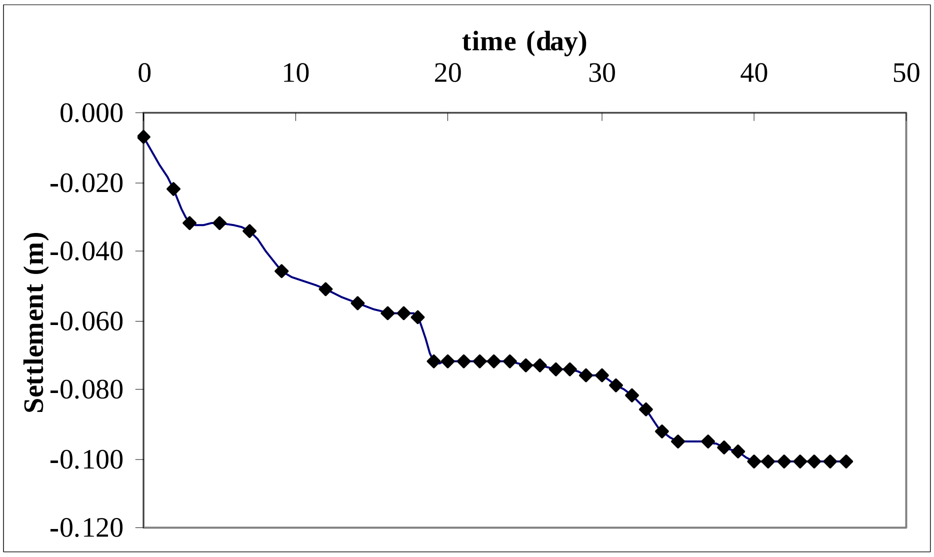


Figure D.140- The distribution of consolidation settlement due to the applied load with time at BSP5

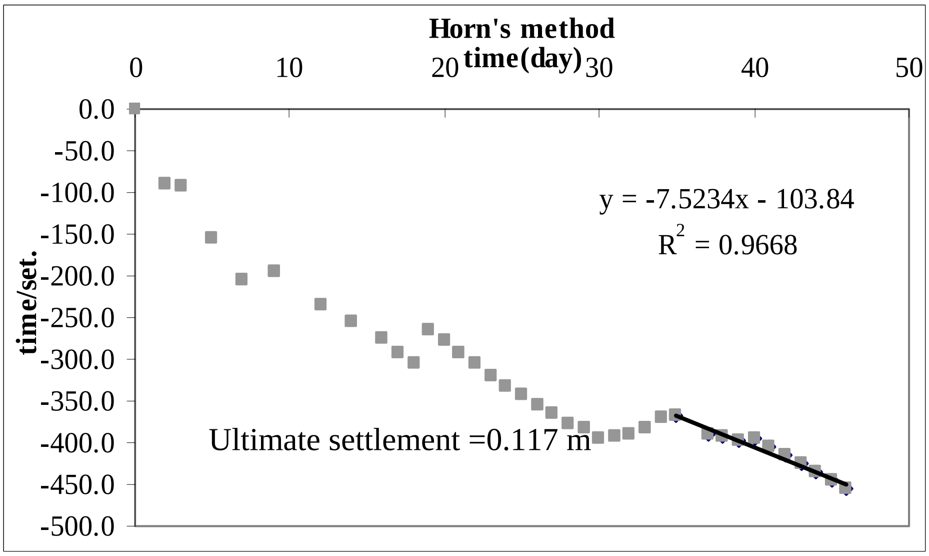


Figure D.141- Estimation of final settlement at BSP5 due to the surcharge by using Horn's method

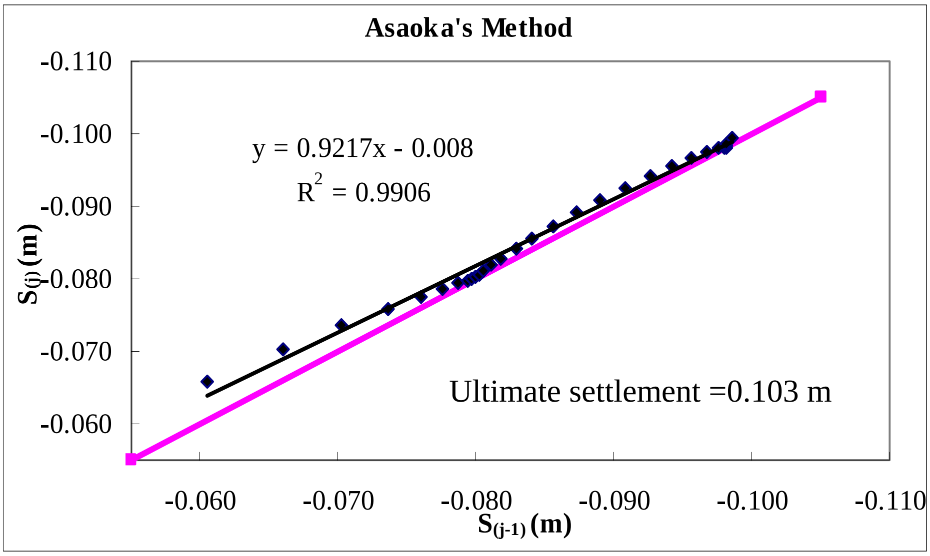


Figure D.142- Estimation of final settlement at BSP6 due to the surcharge by using Asaoka's method

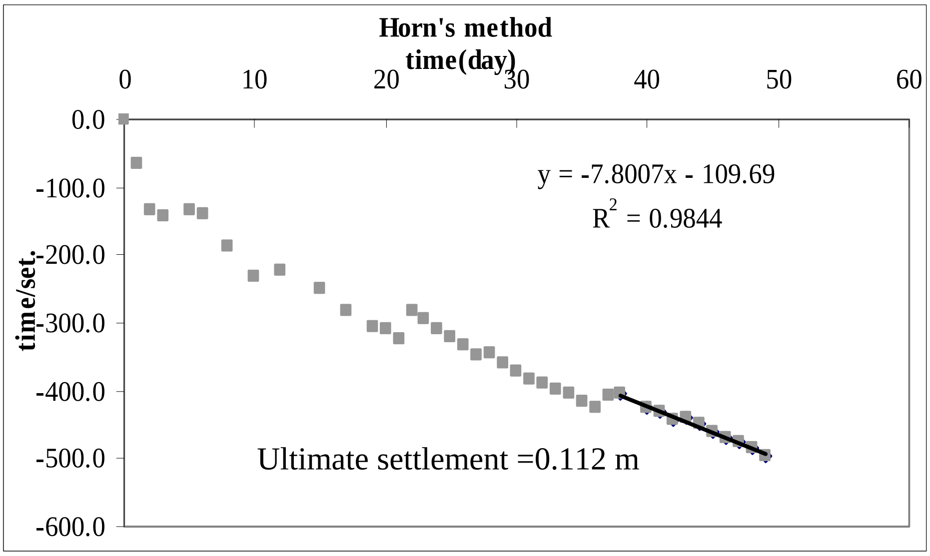


Figure D.143- Estimation of final settlement at BSP6 due to the surcharge by using Horn's method

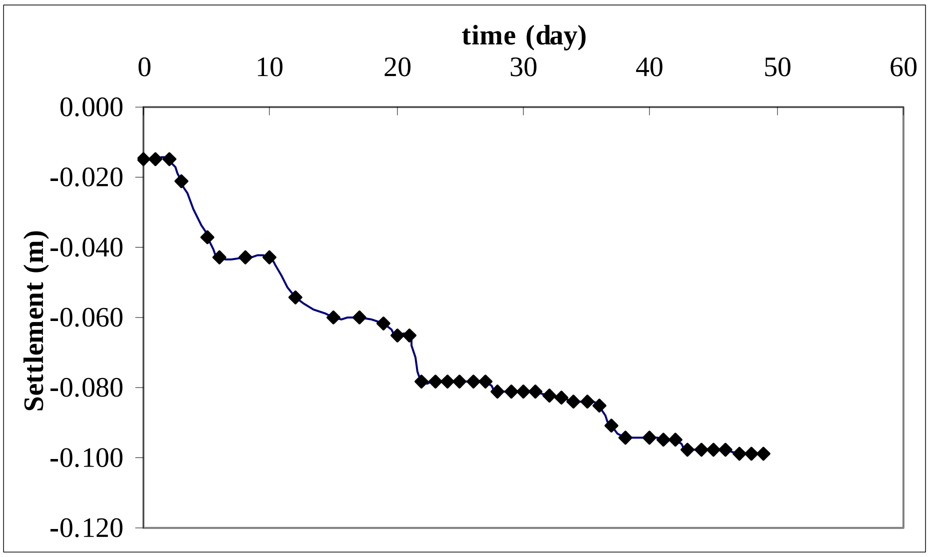


Figure D.144- The distribution of consolidation settlement due to the applied load with time at BSP6

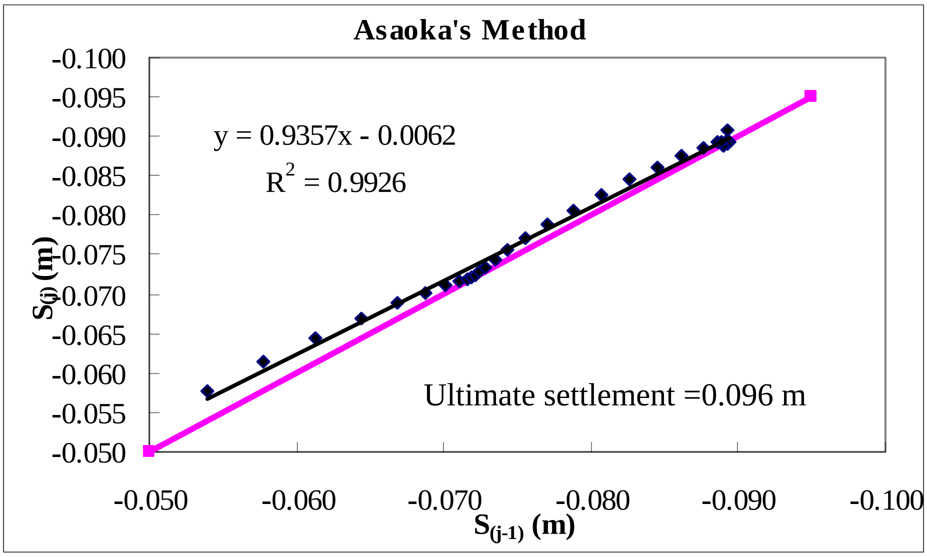


Figure D.145- Estimation of final settlement at BSP7 due to the surcharge by using Asaoka's method

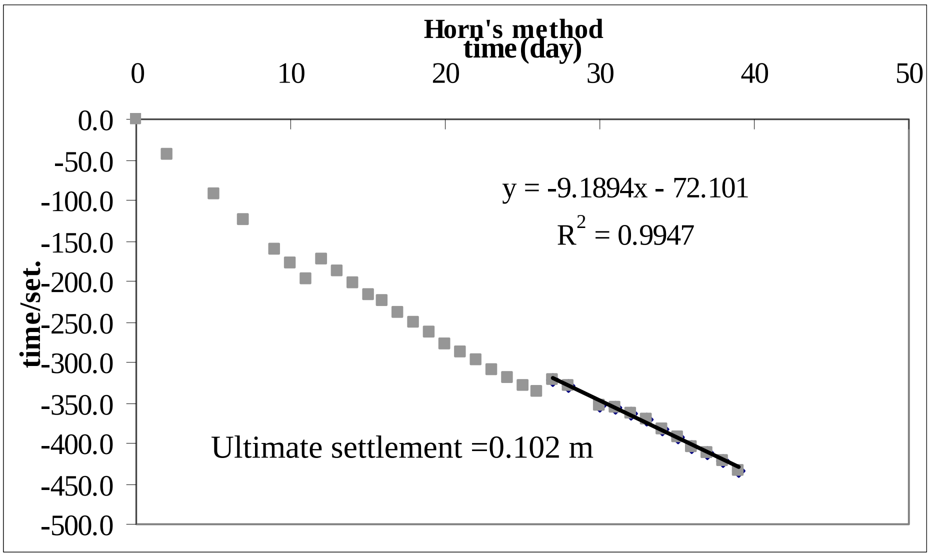


Figure D.146- Estimation of final settlement at BSP7 due to the surcharge by using Horn's method

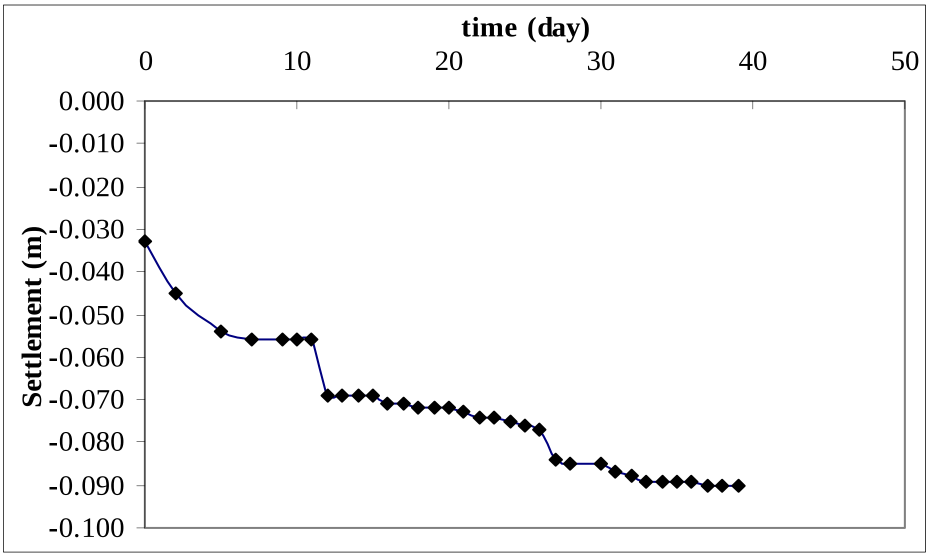


Figure D.147- The distribution of consolidation settlement due to the applied load with time at BSP7

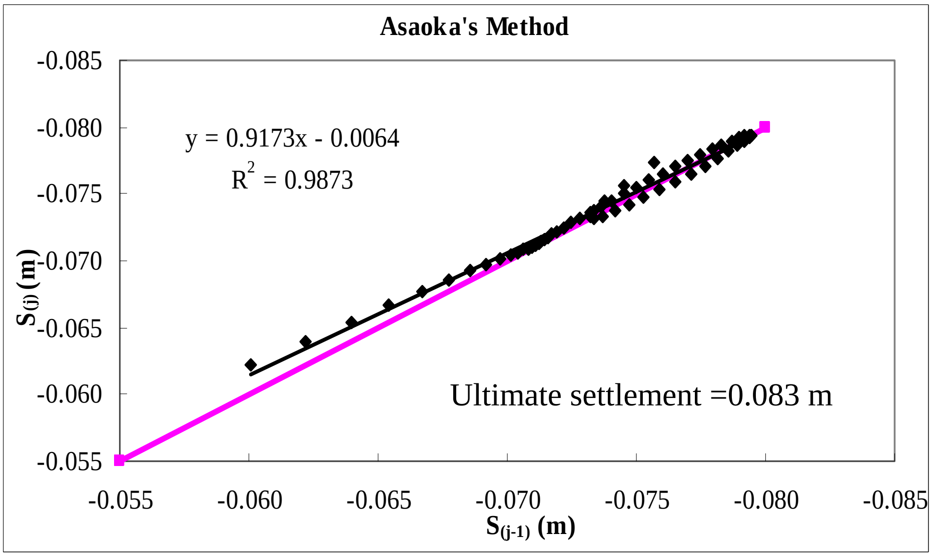


Figure D.148- Estimation of final settlement at BSP12 due to the surcharge by using Asaoka's method

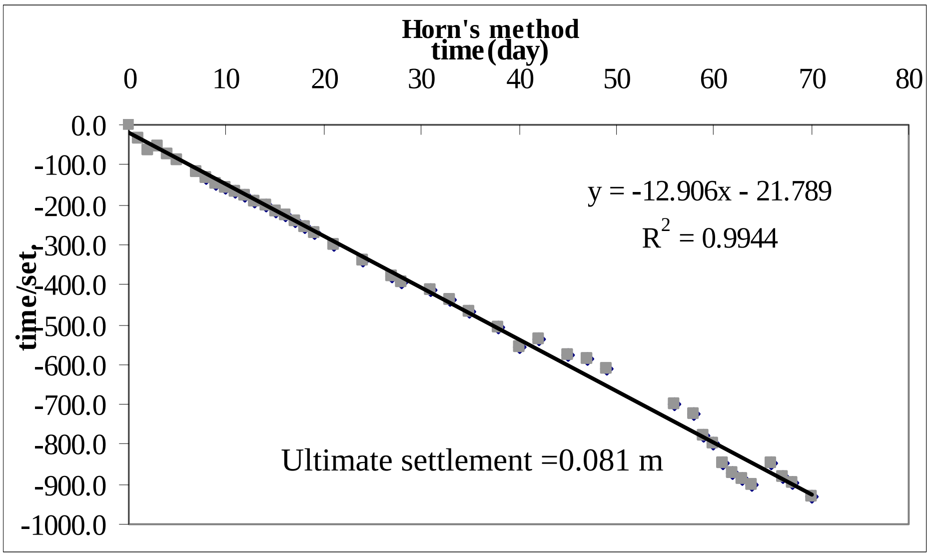


Figure D.149- Estimation of final settlement at BSP12 due to the surcharge by using Horn's method

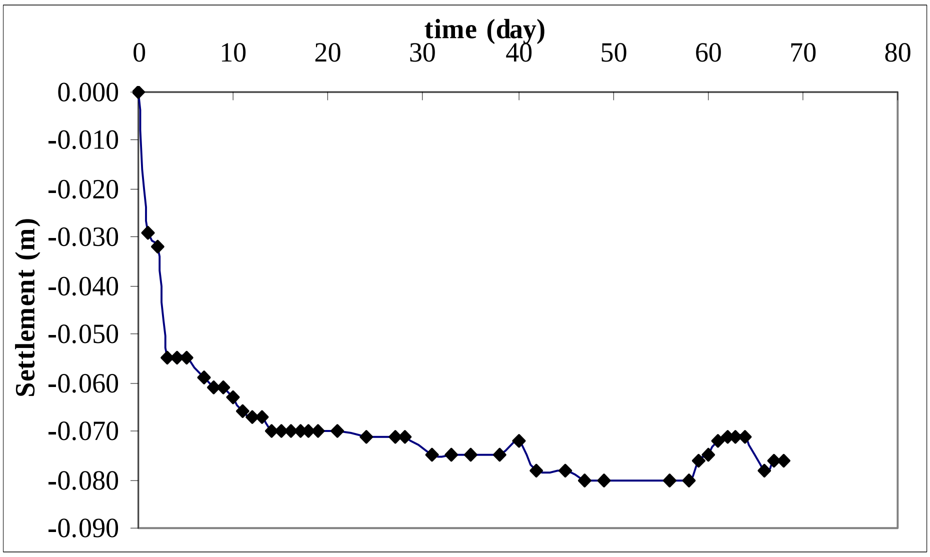


Figure D.150- The distribution of consolidation settlement due to the applied load with time at BSP12

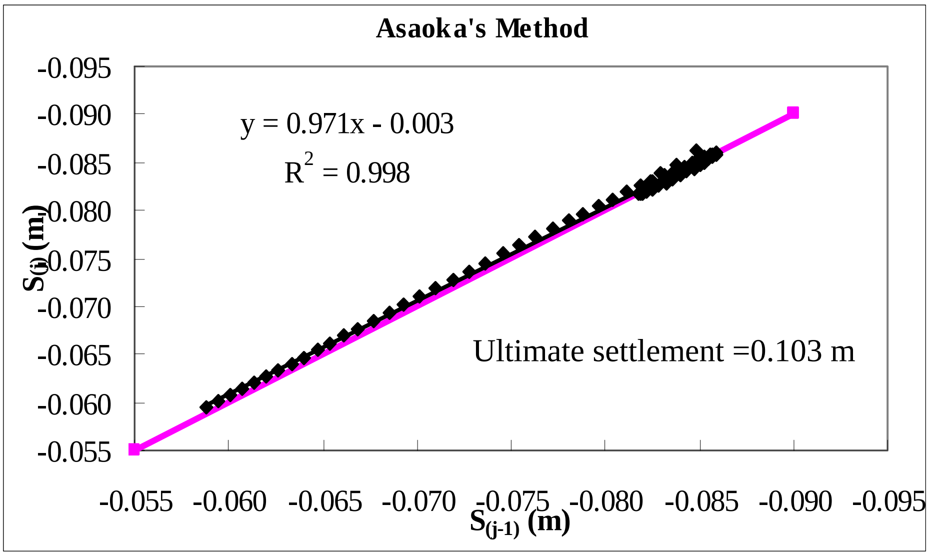


Figure D.151- Estimation of final settlement at BSP13 due to the surcharge by using Asaoka's method

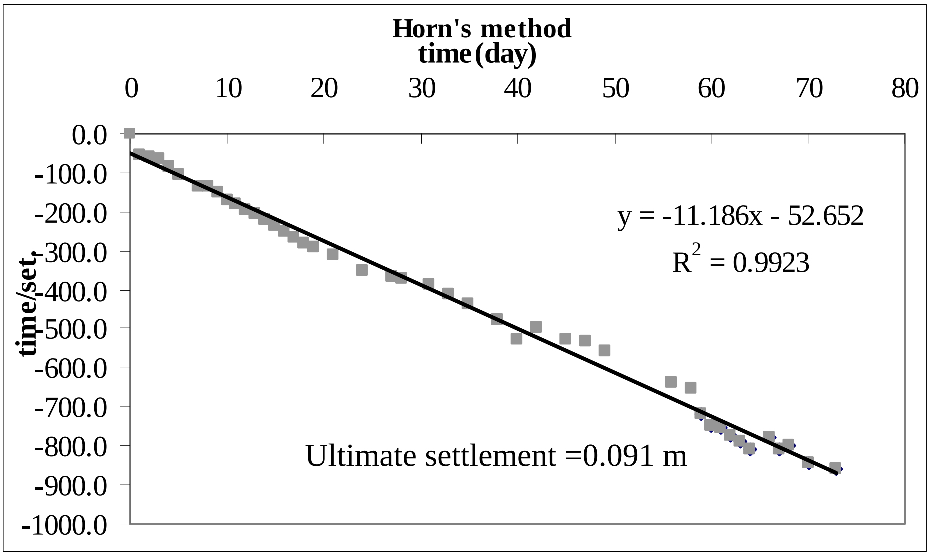


Figure D.152- Estimation of final settlement at BSP13 due to the surcharge by using Horn's method

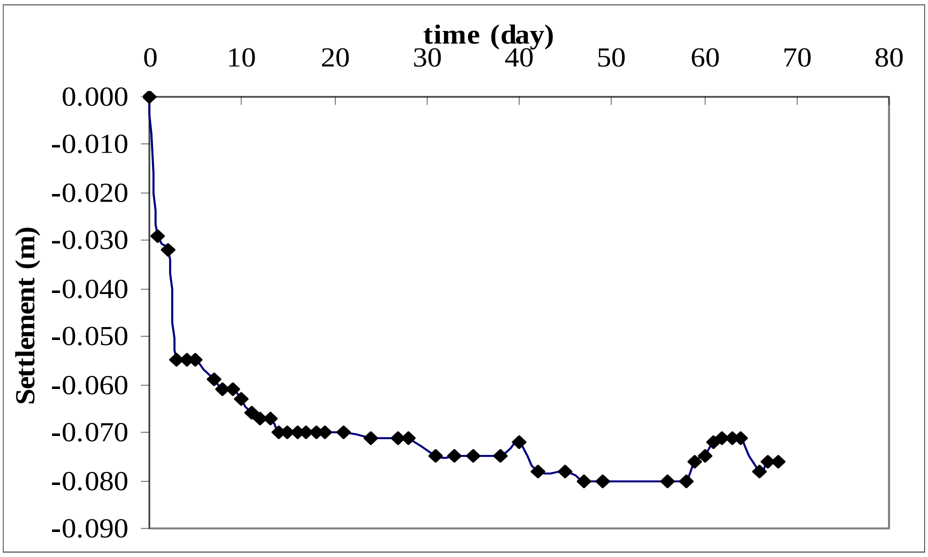


Figure D.153- The distribution of consolidation settlement due to the applied load with time at BSP13

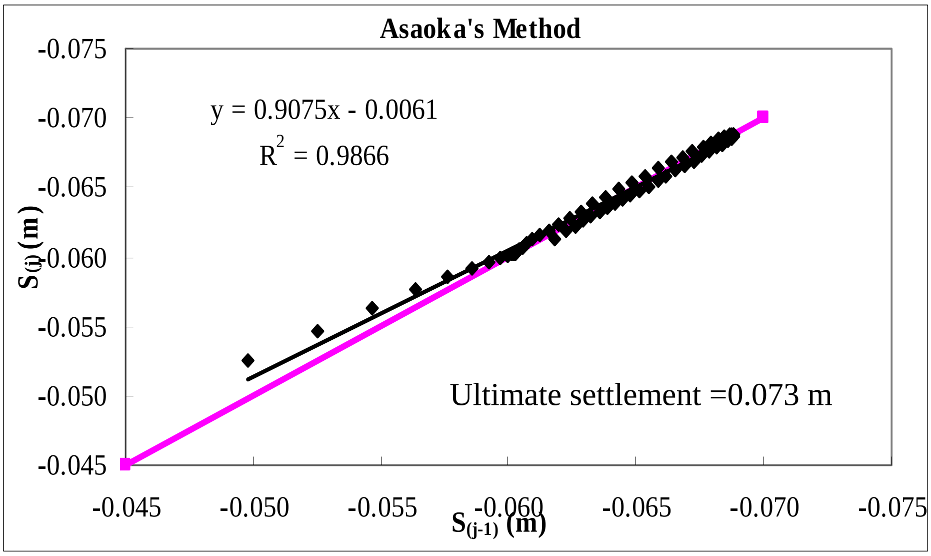


Figure D.154- Estimation of final settlement at BSP14 due to the surcharge by using Asaoka's method

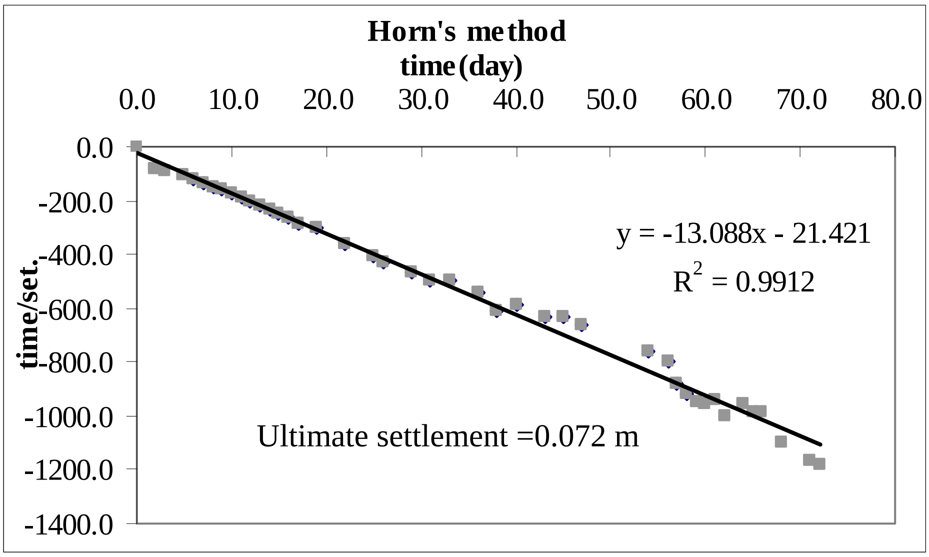


Figure D.155- Estimation of final settlement at BSP14 due to the surcharge by using Horn's method

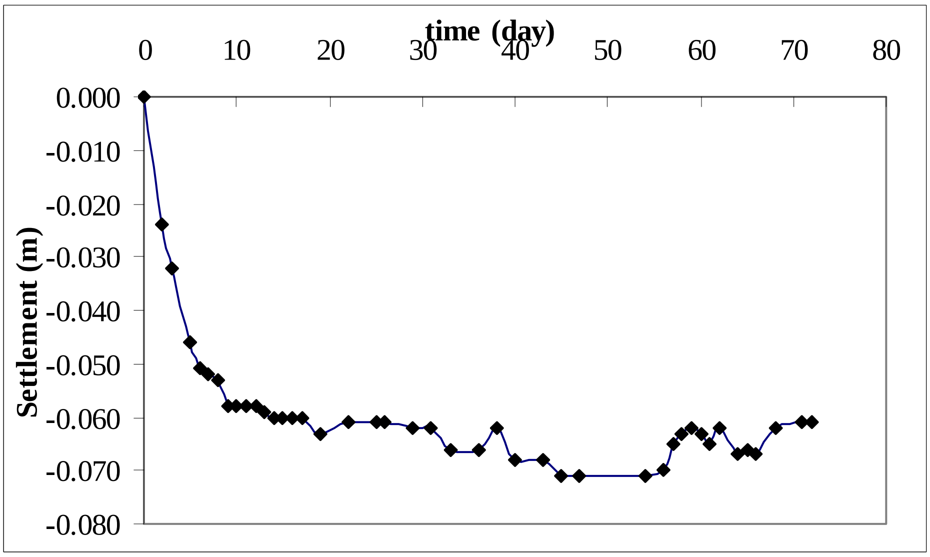


Figure D.156- The distribution of consolidation settlement due to the applied load with time at BSP14

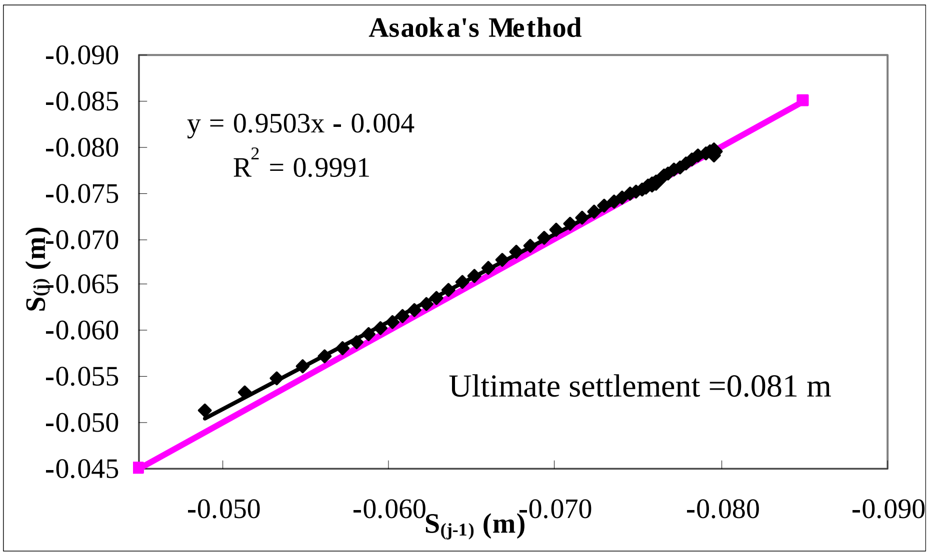


Figure D.157- Estimation of final settlement at BSP15 due to the surcharge by using Asaoka's method

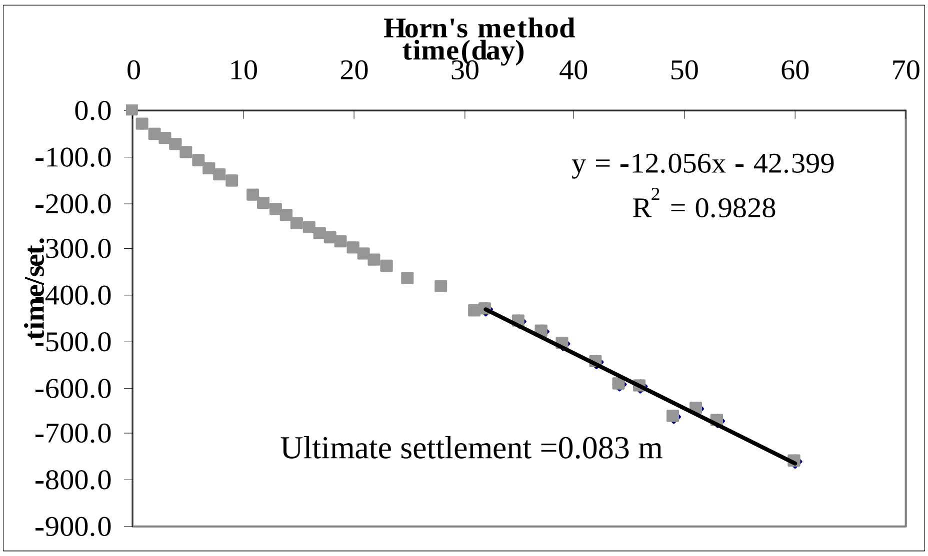


Figure D.158- Estimation of final settlement at BSP15 due to the surcharge by using Horn's method

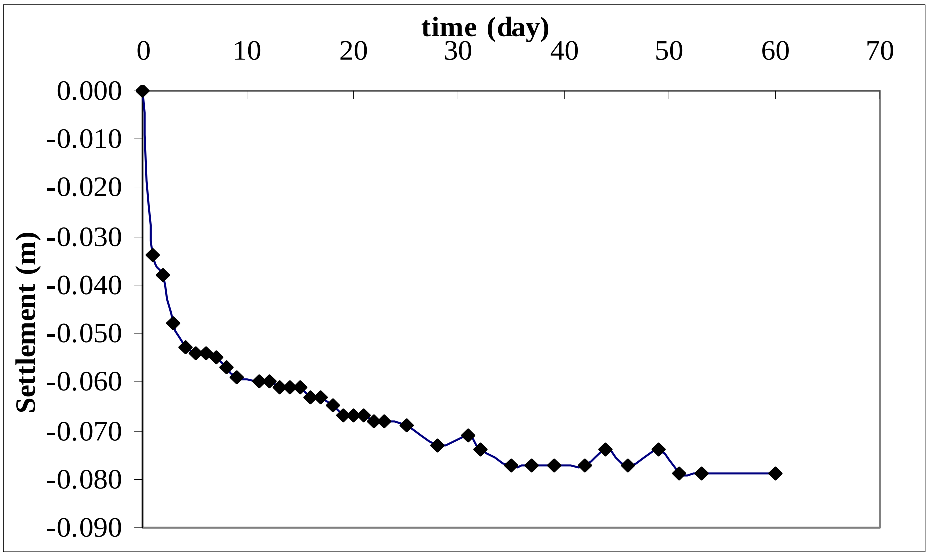


Figure D.159- The distribution of consolidation settlement due to the applied load with time at BSP15

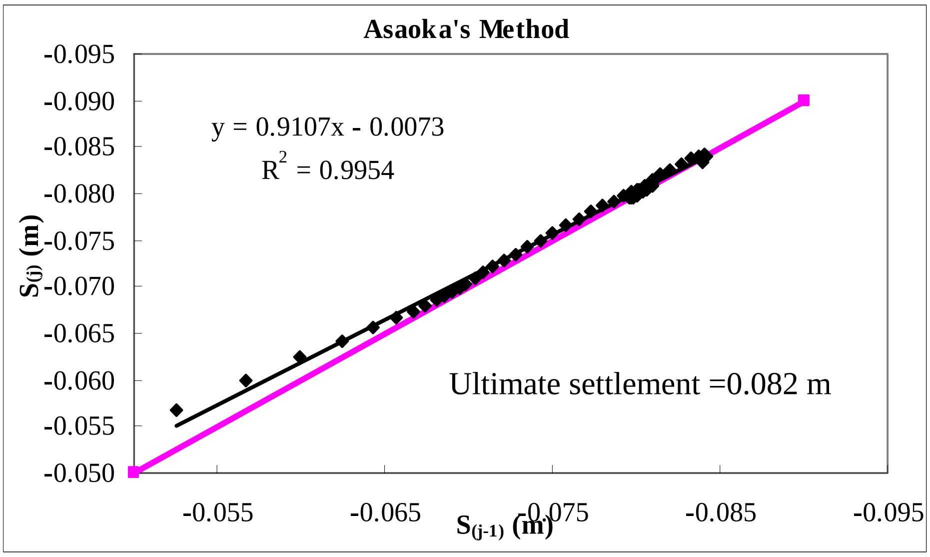


Figure D.160- Estimation of final settlement at BSP16 due to the surcharge by using Asaoka's method

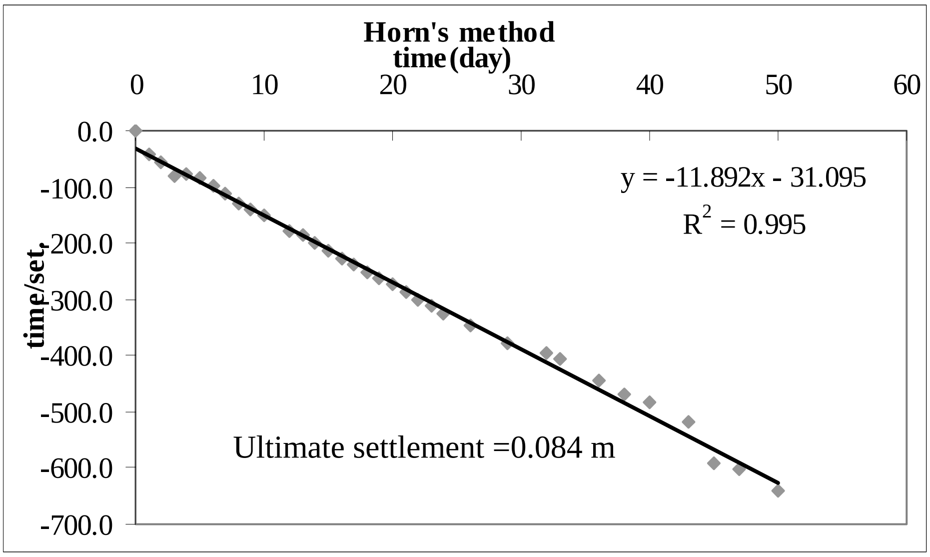


Figure D.161- Estimation of final settlement at BSP16 due to the surcharge by using Horn's method

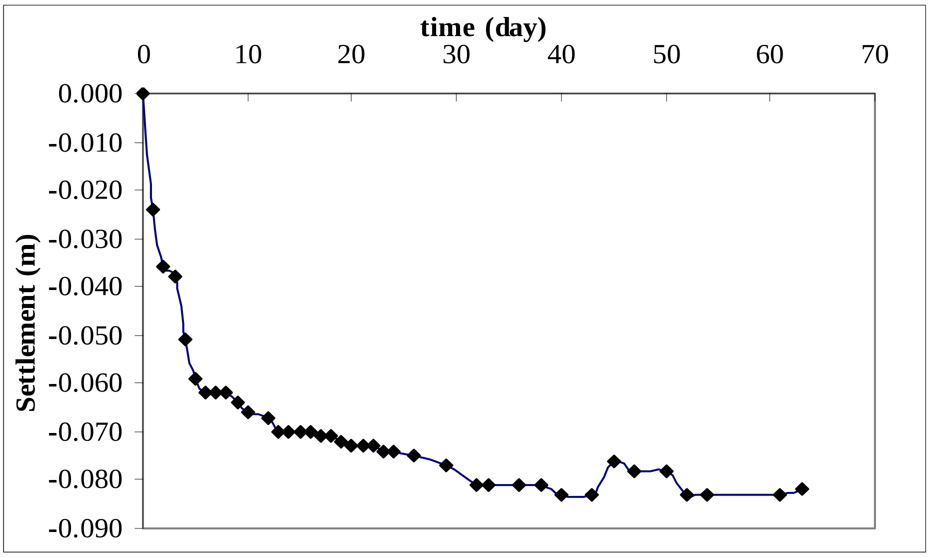


Figure D.162- The distribution of consolidation settlement due to the applied load with time at BSP16

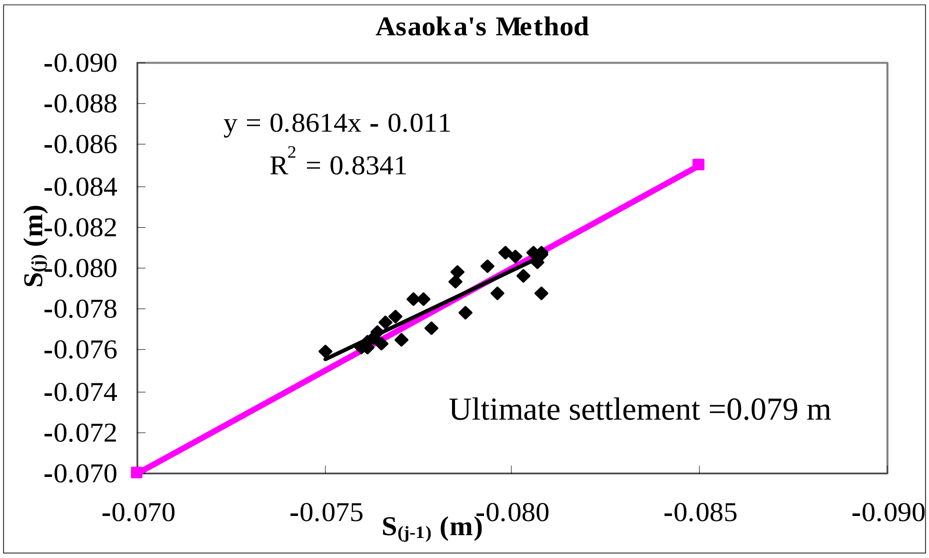


Figure D.163- Estimation of final settlement at BSP21 due to the surcharge by using Asaoka's method

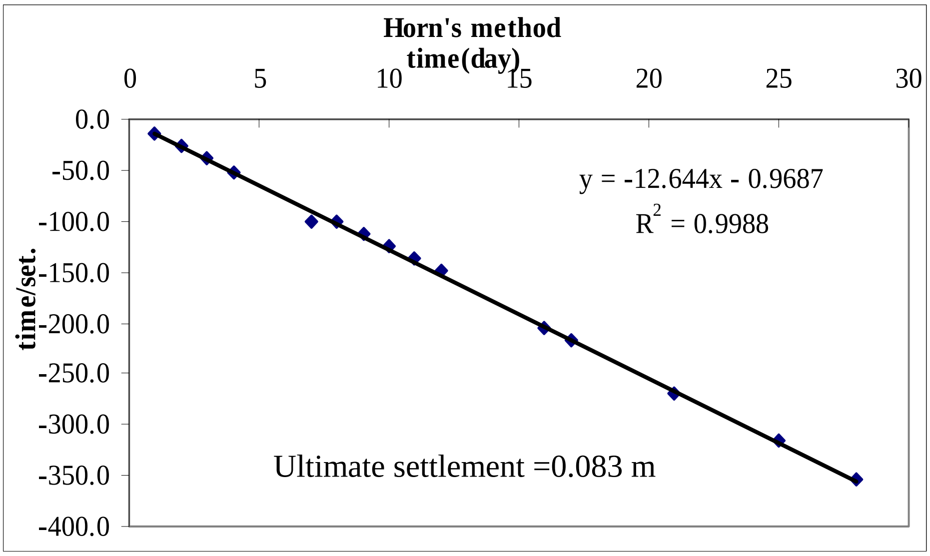


Figure D.164- Estimation of final settlement at BSP21 due to the surcharge by using Horn's method

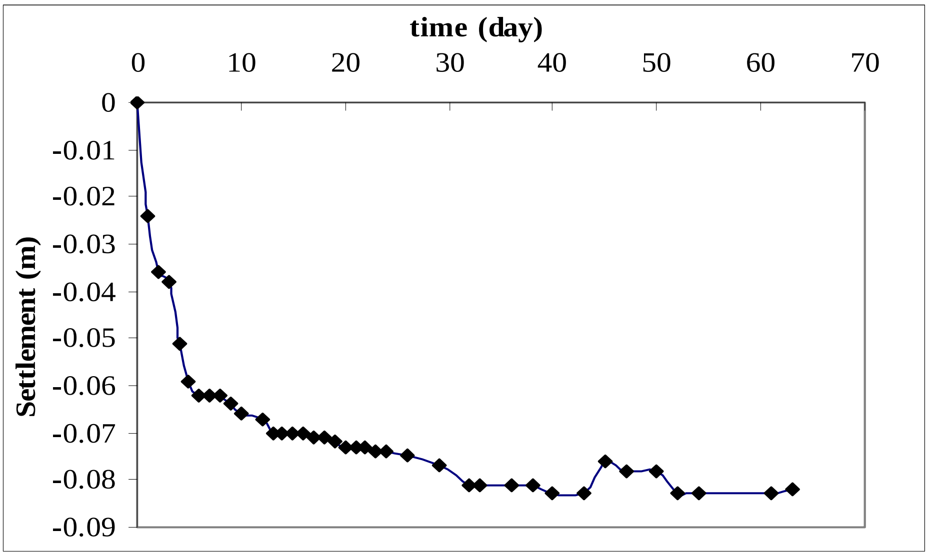


Figure D.165- The distribution of consolidation settlement due to the applied load with time at BSP21

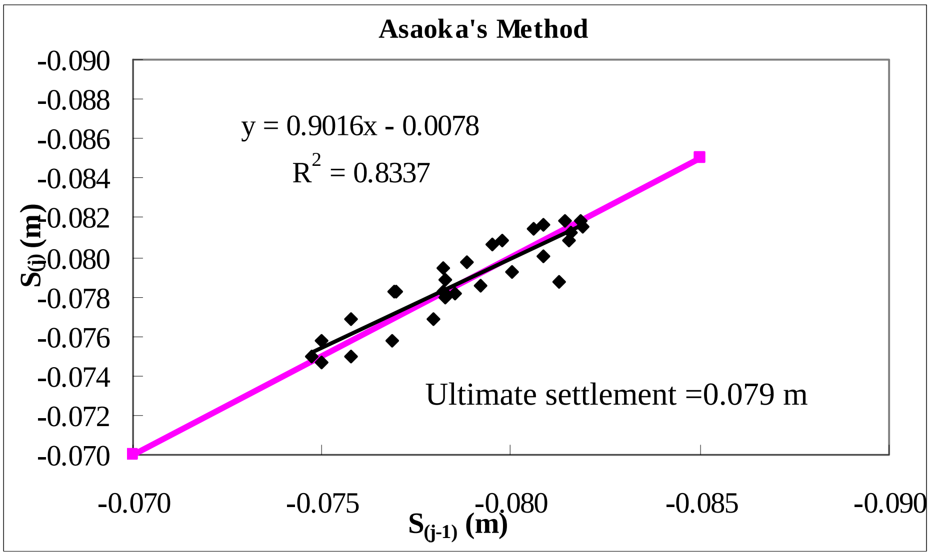


Figure D.166- Estimation of final settlement at BSP20 due to the surcharge by using Asaoka's method

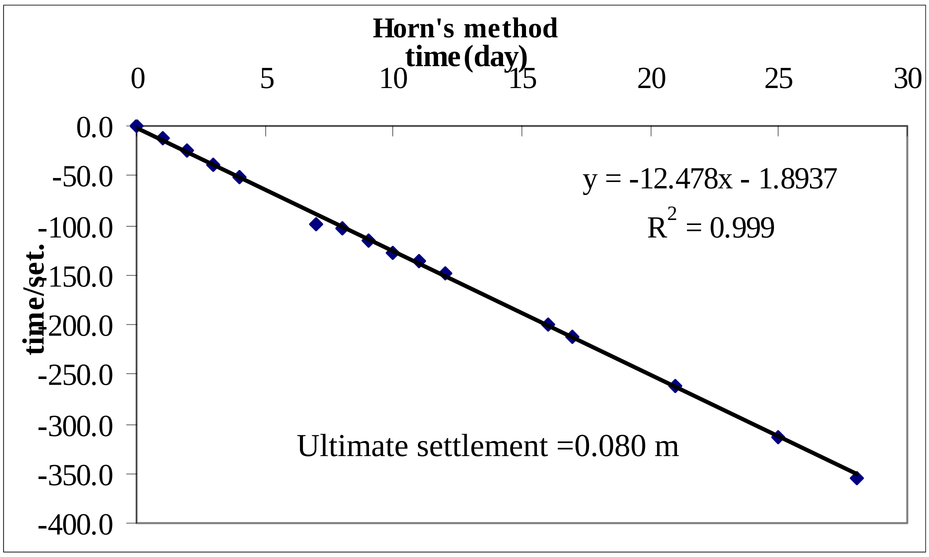


Figure D.167- Estimation of final settlement at BSP20 due to the surcharge by using Horn's method

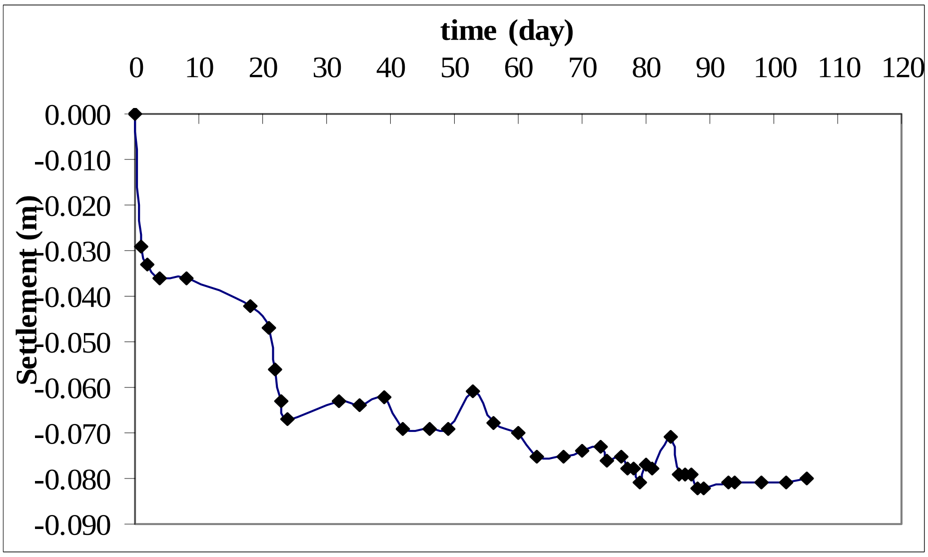


Figure D.168- The distribution of consolidation settlement due to the applied load with time at BSP20

APPENDIX E

Table 1 Database Summary of CPT-2

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-1	Δσ (Average) (kPa) SP-2	Δσ (Average) (kPa) SP-3	Δσ (Average) (kPa) SP-7
SP1- Obserced Settlemen =0.093m SP2- Obserced Settlemen =0.078m SP3- Obserced Settlemen =0.141m SP2- Obserced Settlemen =0.141m	0.00	0.08	3.55	0.96	Gravelly Sand to Dense Sand	64.00	62.45	63.98	63.98
	0.08	0.25	3.57	1.69	Sands:Clean Sand to Silty Sand	63.82	62.29	63.88	63.88
	0.25	0.60	1.43	2.44	Sand Mixture:Silty Sand to Sandy Silt	63.46	61.95	63.85	63.85
	0.60	2.50	0.85	2.73	Silt Mixture: Clayey Silt to Silty Clay	62.14	60.46	63.70	63.70
	2.50	2.60	0.76	2.55	Sand Mixture:Silty Sand to Sandy Silt	61.09	59.11	63.68	63.68
	2.60	3.30	0.87	2.74	Silt Mixture: Clayey Silt to Silty Clay	60.71	58.56	63.65	63.65
	3.30	3.68	3.41	2.33	Sand Mixture:Silty Sand to Sandy Silt	60.22	57.81	63.63	63.63
	3.68	3.90	1.50	2.79	Silt Mixture: Clayey Silt to Silty Clay	59.95	57.39	63.61	63.61
	3.90	4.15	2.32	2.39	Sand Mixture:Silty Sand to Sandy Silt	59.73	57.05	63.57	63.57
	4.15	4.70	1.10	2.85	Silt Mixture: Clayey Silt to Silty Clay	59.38	56.48	63.57	63.57
	4.70	5.10	1.30	2.96	Clays: Silty Clay to Clay	58.95	55.80	63.56	63.56
	5.10	5.43	1.58	2.90	Silt Mixture: Clayey Silt to Silty Clay	58.63	55.28	63.57	63.57
	5.43	5.58	1.25	3.01	Clays: Silty Clay to Clay	58.41	54.93	63.55	63.55
	5.58	5.98	1.07	2.83	Silt Mixture: Clayey Silt to Silty Clay	58.16	54.53	63.54	63.54
	5.98	6.13	1.85	2.45	Sand Mixture:Silty Sand to Sandy Silt	57.91	54.13	63.53	63.53
	6.13	6.53	1.06	2.78	Silt Mixture: Clayey Silt to Silty Clay	57.66	53.73	63.53	63.53
	6.53	6.60	1.74	2.56	Sand Mixture:Silty Sand to Sandy Silt	57.44	53.38	63.53	63.53
	6.60	7.20	1.18	2.83	Silt Mixture: Clayey Silt to Silty Clay	57.12	52.88	63.53	63.53
	7.20	7.28	1.08	2.98	Clays: Silty Clay to Clay	56.80	52.39	63.52	63.52
	7.28	7.50	1.32	2.89	Silt Mixture: Clayey Silt to Silty Clay	56.66	52.17	63.52	63.52
	7.50	8.15	0.82	3.13	Clays: Silty Clay to Clay	56.24	51.53	63.50	63.50
	8.15	8.38	1.08	2.78	Silt Mixture: Clayey Silt to Silty Clay	55.81	50.89	63.48	63.48
	8.38	8.60	3.38	2.26	Sand Mixture:Silty Sand to Sandy Silt	55.60	50.58	63.47	63.47
	8.60	8.73	5.54	2.04	Sands:Clean Sand to Silty Sand	55.42	50.31	63.46	63.46
	8.73	8.93	3.27	2.40	Sand Mixture:Silty Sand to Sandy Silt	55.26	50.08	63.45	63.45
	8.93	9.28	10.03	1.71	Sands:Clean Sand to Silty Sand	54.98	49.69	63.43	63.43
	9.28	9.68	23.38	1.24	Gravelly Sand to Dense Sand	54.60	49.15	63.40	63.40
	9.68	10.20	14.79	1.58	Sands:Clean Sand to Silty Sand	54.14	48.50	63.36	63.36
	10.20	10.55	1.84	2.89	Silt Mixture: Clayey Silt to Silty Clay	53.69	47.90	63.31	63.31
	10.55	11.73	1.29	3.22	Clays: Silty Clay to Clay	52.92	46.86	63.22	63.22
	11.73	11.88	3.60	2.39	Sand Mixture:Silty Sand to Sandy Silt	52.25	45.99	63.13	63.13
	11.88	12.20	2.72	2.76	Silt Mixture: Clayey Silt to Silty Clay	52.01	45.68	63.10	63.10

Table 2 Database Summary of CPT-2 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-1	Δσ (Average) (kPa) SP-2	Δσ (Average) (kPa) SP-3	Δσ (Average) (kPa) SP-7
SP1- Observed Settlemen =0.093m SP2- Observed Settlemen =0.078m SP3- Observed Settlemen =0.141m SP2- Observed Settlemen =0.141m	12.20	12.45	5.30	2.29	Sand Mixture:Silty Sand to Sandy Silt	51.72	45.31	63.05	63.05
	12.45	13.30	14.08	1.74	Sands:Clean Sand to Silty Sand	51.17	44.63	62.96	62.96
	13.30	14.63	18.15	1.59	Sands:clean sand to silty sand	50.89	44.28	62.52	62.91
	14.63	15.03	1.89	2.96	Silt Mixtures:clayey silt to silty clay	50.01	43.22	62.46	62.73
	15.03	15.90	13.79	1.72	Sand Mixtures:silty sand to sandy silt	49.31	42.40	62.39	62.57
	15.90	16.63	6.89	2.31	Sand Mixtures:silty sand to sandy silt	48.72	41.72	62.31	62.42
	16.63	18.43	1.53	3.24	Silt Mixtures:clayey silt to silty clay	48.00	40.90	62.16	62.20
	18.43	18.83	3.07	2.86	Silt Mixtures:clayey silt to silty clay	46.91	39.71	62.00	61.81
	18.83	19.33	1.66	3.23	Clays:silty clay to clay	45.99	38.73	61.60	61.43
	19.33	19.48	3.05	2.80	Silt Mixtures:clayey silt to silty clay	45.62	38.35	61.41	61.25
	19.48	19.73	8.44	2.12	Sand Mixtures:silty sand to sandy silt	45.36	38.08	61.27	61.12
	19.73	20.00	4.04	2.81	Silt Mixtures:clayey silt to silty clay	45.19	37.92	61.17	61.04
	20.00	20.63	1.68	3.24	Clays:silty clay to clay	44.98	37.71	61.05	60.93
	20.63	20.95	10.76	1.95	Sand Mixtures:silty sand to sandy silt	44.62	37.36	60.83	60.73
	20.95	21.20	2.31	3.03	Silt Mixtures:clayey silt to silty clay	44.24	36.99	60.58	60.51
	21.20	21.90	11.19	2.02	Sand Mixtures:silty sand to sandy silt	44.02	36.78	60.43	60.38
	21.90	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	43.62	36.41	60.15	60.14
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	42.73	35.59	59.46	59.56
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	42.00	34.96	58.87	59.06

Table 2 Database Summary of CPT-2a

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-7	Δσ (Average) (kPa) SP-8
SP7- Obserced Settlemen =0.141m SP8 Obserced Settlemen =0.134m	0.00	0.15	2.20	1.95	Sands:Clean Sand to Silty Sand	63.98	63.96
	0.15	0.83	1.74	2.37	Sand Mixture:Silty Sand to Sandy Silt	63.88	63.90
	0.83	1.80	1.15	2.72	Silt Mixture: Clayey Silt to Silty Clay	63.85	63.80
	1.80	2.18	0.55	3.10	Clays: Silty Clay to Clay	63.70	63.82
	2.18	2.53	0.45	2.91	Silt Mixture: Clayey Silt to Silty Clay	63.68	63.82
	2.53	2.63	0.46	2.97	Clays: Silty Clay to Clay	63.65	63.82
	2.63	2.85	0.65	2.81	Silt Mixture: Clayey Silt to Silty Clay	63.63	63.82
	2.85	2.98	0.67	3.01	Clays: Silty Clay to Clay	63.61	63.82
	2.98	3.18	1.32	2.73	Silt Mixture: Clayey Silt to Silty Clay	63.57	63.82
	3.18	3.28	0.97	2.99	Clays: Silty Clay to Clay	63.57	63.82
	3.28	3.48	1.06	2.85	Silt Mixture: Clayey Silt to Silty Clay	63.56	63.82
	3.48	3.75	2.79	2.51	Sand Mixture:Silty Sand to Sandy Silt	63.57	63.82
	3.75	3.85	1.05	3.08	Clays: Silty Clay to Clay	63.55	63.81
	3.85	3.93	1.41	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.54	63.81
	3.93	4.20	2.40	2.49	Sand Mixture:Silty Sand to Sandy Silt	63.53	63.81
	4.20	4.30	1.37	2.73	Silt Mixture: Clayey Silt to Silty Clay	63.53	63.81
	4.30	4.38	0.80	3.05	Clays: Silty Clay to Clay	63.53	63.80
	4.38	4.55	0.99	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.53	63.80
	4.55	4.93	1.07	3.05	Clays: Silty Clay to Clay	63.52	63.80
	4.93	5.03	1.26	2.92	Silt Mixture: Clayey Silt to Silty Clay	63.52	63.79
	5.03	5.28	1.47	2.96	Clays: Silty Clay to Clay	63.50	63.79
	5.28	5.50	1.72	2.92	Silt Mixture: Clayey Silt to Silty Clay	63.48	63.78
	5.50	8.25	1.33	3.12	Clays: Silty Clay to Clay	63.46	63.73
	8.25	8.58	1.29	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.46	63.65
	8.58	8.65	0.89	3.17	Clays: Silty Clay to Clay	63.45	63.64
	8.65	8.70	1.67	2.74	Silt Mixture: Clayey Silt to Silty Clay	63.43	63.64
	8.70	8.83	4.00	2.29	Sand Mixture:Silty Sand to Sandy Silt	63.40	63.63
	8.83	9.15	8.47	1.79	Sands:Clean Sand to Silty Sand	63.36	63.62
	9.15	9.33	5.04	2.16	Sand Mixture:Silty Sand to Sandy Silt	63.31	63.61
	9.33	9.78	7.92	1.79	Sands:Clean Sand to Silty Sand	63.22	63.59
	9.78	10.05	3.92	2.31	Sand Mixture:Silty Sand to Sandy Silt	63.13	63.56
	10.05	10.65	12.74	1.65	Sands:Clean Sand to Silty Sand	63.10	63.53

Table 2 Database Summary of CPT-2a (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-7	Δσ (Average) (kPa) SP-8
SP7- Obserced Settlemen =0.141m SP8 Obserced Settlemen =0.134m	10.65	10.73	2.09	2.81	Silt Mixture: Clayey Silt to Silty Clay	63.05	63.50
	10.73	11.75	1.20	3.26	Clays: Silty Clay to Clay	62.96	63.45
	11.75	11.83	0.72	3.64	Organic Soils Peat	62.91	63.40
	11.83	12.13	0.68	3.56	Clays: Silty Clay to Clay	62.84	63.38
	12.13	12.35	0.58	3.66	Organic Soils Peat	62.81	63.36
	12.35	12.45	0.57	3.59	Clays: Silty Clay to Clay	62.77	63.34
	12.45	12.73	0.59	3.64	Organic Soils Peat	62.75	63.32
	12.73	12.88	1.24	3.08	Clays: Silty Clay to Clay	62.72	63.29
	12.88	13.13	0.52	3.74	Organic Soils Peat	62.68	63.27
	13.13	13.43	7.61	1.87	Sands:Clean Sand to Silty Sand	62.65	63.24
	13.43	13.70	1.27	3.20	Clays: Silty Clay to Clay	62.60	63.20
	13.70	13.93	3.04	2.59	Sand Mixture:Silty Sand to Sandy Silt	62.54	63.17
	13.93	14.08	1.64	3.05	Clays: Silty Clay to Clay	62.49	63.14
	14.08	14.33	2.15	2.87	Silt Mixture: Clayey Silt to Silty Clay	62.45	63.11
	14.33	14.40	4.07	2.39	Sand Mixture:Silty Sand to Sandy Silt	62.41	63.09
	14.40	14.53	2.66	2.83	Silt Mixture: Clayey Silt to Silty Clay	62.38	63.07
	14.53	14.83	10.06	1.90	Sands:Clean Sand to Silty Sand	62.35	63.04
	14.83	15.15	1.07	3.37	Clays: Silty Clay to Clay	62.31	62.99
	15.15	15.28	2.60	2.60	Silt Mixture: Clayey Silt to Silty Clay	62.23	62.95
	15.28	15.38	1.52	3.13	Clays: Silty Clay to Clay	62.18	62.93
	15.38	15.40	1.52	3.13	Clays: Silty Clay to Clay	62.18	62.93
	15.40	15.58	2.77	2.81	Silt Mixture: Clayey Silt to Silty Clay	62.15	62.90
	15.58	15.60	2.77	2.81	Silt Mixture: Clayey Silt to Silty Clay	62.15	62.90
	15.60	15.70	1.50	3.29	Clays: Silty Clay to Clay	62.11	62.87
	15.70	15.73	1.50	3.29	Clays: Silty Clay to Clay	62.11	62.87
	15.73	15.78	2.64	2.76	Silt Mixture: Clayey Silt to Silty Clay	62.06	62.85
	15.78	15.80	2.64	2.76	Silt Mixture: Clayey Silt to Silty Clay	62.06	62.85
	15.80	15.85	4.72	2.40	Sand Mixture:Silty Sand to Sandy Silt	62.04	62.84
	15.85	15.88	4.72	2.40	Sand Mixture:Silty Sand to Sandy Silt	62.04	62.84
	15.88	15.90	3.55	2.68	Silt Mixture: Clayey Silt to Silty Clay	62.02	62.82
	15.90	15.93	3.55	2.68	Silt Mixture: Clayey Silt to Silty Clay	62.02	62.82
	15.93	16.00	2.20	3.03	Clays: Silty Clay to Clay	62.00	62.81

Table 2 Database Summary of CPT-2a (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-7	Δσ (Average) (kPa) SP-8
SP7- Obserced Settlemen =0.141m SP8 Obserced Settlemen =0.134m	16.00	16.03	2.20	3.03	Clays: Silty Clay to Clay	62.00	62.81
	16.03	16.58	13.16	1.80	Sands:Clean Sand to Silty Sand	61.98	62.74
	16.58	16.60	13.16	1.80	Sands:Clean Sand to Silty Sand	61.98	62.74
	16.60	17.15	1.22	3.29	Clays: Silty Clay to Clay	61.89	62.62
	17.15	17.18	1.22	3.29	Clays: Silty Clay to Clay	61.89	62.62
	17.18	17.28	3.97	2.38	Sand Mixture:Silty Sand to Sandy Silt	61.72	62.54
	17.28	17.30	3.97	2.38	Sand Mixture:Silty Sand to Sandy Silt	61.72	62.54
	17.30	17.45	2.03	3.20	Clays: Silty Clay to Clay	61.61	62.51
	17.45	17.48	2.03	3.20	Clays: Silty Clay to Clay	61.61	62.51
	17.48	17.53	2.50	2.84	Silt Mixture: Clayey Silt to Silty Clay	61.56	62.48
	17.53	17.55	2.50	2.84	Silt Mixture: Clayey Silt to Silty Clay	61.56	62.48
	17.55	18.28	1.49	3.29	Clays: Silty Clay to Clay	61.52	62.38
	18.28	18.30	1.49	3.29	Clays: Silty Clay to Clay	61.52	62.38
	18.30	18.43	6.19	2.33	Sand Mixture:Silty Sand to Sandy Silt	61.38	62.28
	18.43	18.83	3.07	2.86	Silt Mixtures:clayey silt to silty clay	61.81	62.25
	18.83	19.33	1.66	3.23	Clays:silty clay to clay	61.43	62.23
	19.33	19.48	3.05	2.80	Silt Mixtures:clayey silt to silty clay	61.25	62.21
	19.48	19.73	8.44	2.12	Sand Mixtures:silty sand to sandy silt	61.12	62.10
	19.73	20.00	4.04	2.81	Silt Mixtures:clayey silt to silty clay	61.04	61.95
	20.00	20.63	1.68	3.24	Clays:silty clay to clay	60.93	61.67
	20.63	20.95	10.76	1.95	Sand Mixtures:silty sand to sandy silt	60.73	61.40
	20.95	21.20	2.31	3.03	Silt Mixtures:clayey silt to silty clay	60.51	61.27
	21.20	21.90	11.19	2.02	Sand Mixtures:silty sand to sandy silt	60.38	61.18
	21.90	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	60.14	61.12
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	59.56	61.04
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	59.06	60.90

Table 3 Database Summary of CPT-3

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-8
SP8 Obserced Settlemen =0.134m	0.00	0.65	1.32	2.41	Sand Mixture:Silty Sand to Sandy Silt	62.98
	0.65	0.75	0.95	2.64	Silt Mixture: Clayey Silt to Silty Clay	62.99
	0.75	0.90	1.90	2.28	Sand Mixture:Silty Sand to Sandy Silt	62.99
	0.90	1.08	3.81	1.74	Sands:Clean Sand to Silty Sand	63.00
	1.08	1.23	15.60	1.15	Gravelly Sand to Dense Sand	63.00
	1.23	1.38	16.65	1.32	Sands:Clean Sand to Silty Sand	63.00
	1.38	1.45	14.36	1.25	Gravelly Sand to Dense Sand	63.01
	1.45	1.55	11.66	1.42	Sands:Clean Sand to Silty Sand	63.01
	1.55	1.65	10.72	1.30	Gravelly Sand to Dense Sand	63.01
	1.65	2.23	7.78	1.67	Sands:Clean Sand to Silty Sand	63.02
	2.23	2.33	1.71	2.55	Sand Mixture:Silty Sand to Sandy Silt	63.02
	2.33	2.68	0.48	3.06	Clays: Silty Clay to Clay	63.02
	2.68	2.75	1.00	2.71	Silt Mixture: Clayey Silt to Silty Clay	63.02
	2.75	3.18	4.03	2.24	Sand Mixture:Silty Sand to Sandy Silt	63.02
	3.18	3.25	2.13	2.64	Silt Mixture: Clayey Silt to Silty Clay	63.02
	3.25	3.40	2.75	2.47	Sand Mixture:Silty Sand to Sandy Silt	63.02
	3.40	3.48	1.41	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.02
	3.48	3.58	0.95	2.97	Clays: Silty Clay to Clay	63.02
	3.58	3.68	5.13	2.16	Sand Mixture:Silty Sand to Sandy Silt	63.01
	3.68	3.80	0.74	3.01	Clays: Silty Clay to Clay	63.01
	3.80	4.23	1.09	2.90	Silt Mixture: Clayey Silt to Silty Clay	63.01
	4.23	4.65	1.26	2.97	Clays: Silty Clay to Clay	63.00
	4.65	6.18	1.88	2.88	Silt Mixture: Clayey Silt to Silty Clay	62.98
	6.18	6.45	1.36	3.06	Clays: Silty Clay to Clay	62.95
	6.45	6.73	1.55	2.88	Silt Mixture: Clayey Silt to Silty Clay	62.94
	6.73	6.98	1.35	3.02	Clays: Silty Clay to Clay	62.93
	6.98	7.25	1.57	2.75	Silt Mixture: Clayey Silt to Silty Clay	62.92
	7.25	7.33	9.21	2.18	Sand Mixture:Silty Sand to Sandy Silt	62.47
	7.33	7.65	1.20	2.80	Silt Mixture: Clayey Silt to Silty Clay	62.90
	7.65	7.98	5.87	1.97	Sands:Clean Sand to Silty Sand	62.88
	7.98	8.35	3.03	2.34	Sand Mixture:Silty Sand to Sandy Silt	62.87
	8.35	8.48	2.17	2.61	Silt Mixture: Clayey Silt to Silty Clay	62.85

Table 3 Database Summary of CPT-3 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-8
SP8 Obserced Settlemen =0.134m	8.48	8.58	3.59	2.39	Sand Mixture:Silty Sand to Sandy Silt	62.85
	8.58	8.75	10.19	1.63	Sands:Clean Sand to Silty Sand	62.84
	8.75	8.83	16.93	1.30	Gravelly Sand to Dense Sand	62.83
	8.83	9.85	16.50	1.45	Sands:Clean Sand to Silty Sand	62.80
	9.85	9.93	4.28	2.30	Sand Mixture:Silty Sand to Sandy Silt	62.76
	9.93	10.18	2.03	2.90	Silt Mixture: Clayey Silt to Silty Clay	62.75
	10.18	11.08	5.06	2.41	Sand Mixture:Silty Sand to Sandy Silt	62.94
	11.08	11.15	2.10	2.76	Silt Mixture: Clayey Silt to Silty Clay	62.66
	11.15	11.75	4.15	2.40	Sand Mixture:Silty Sand to Sandy Silt	62.63
	11.75	11.88	2.45	2.81	Silt Mixture: Clayey Silt to Silty Clay	62.60
	11.88	11.95	3.40	2.47	Sand Mixture:Silty Sand to Sandy Silt	62.59
	11.95	12.20	2.19	2.78	Silt Mixture: Clayey Silt to Silty Clay	62.57
	12.20	13.25	10.11	1.88	Sands:Clean Sand to Silty Sand	62.50
	13.25	13.43	4.58	2.45	Sand Mixture:Silty Sand to Sandy Silt	62.43
	13.43	13.50	2.83	2.78	Silt Mixture: Clayey Silt to Silty Clay	62.41
	13.50	13.63	1.64	3.08	Clays: Silty Clay to Clay	62.40
	13.63	13.73	3.20	2.64	Silt Mixture: Clayey Silt to Silty Clay	62.38
	13.73	14.35	16.74	1.63	Sands:Clean Sand to Silty Sand	62.33
	14.35	14.58	10.38	2.16	Sand Mixture:Silty Sand to Sandy Silt	62.27
	14.58	14.65	11.47	2.01	Sands:Clean Sand to Silty Sand	62.24
	14.65	14.65	11.47	2.01	Sands:Clean Sand to Silty Sand	62.24
	14.65	14.90	8.26	2.20	Sand Mixture:Silty Sand to Sandy Silt	62.22
	14.90	14.90	8.26	2.20	Sand Mixture:Silty Sand to Sandy Silt	62.22
	14.90	16.70	17.69	1.74	Sands:Clean Sand to Silty Sand	62.03
	16.70	16.70	17.69	1.74	Sands:Clean Sand to Silty Sand	62.03
	16.70	16.93	8.47	2.22	Sand Mixture:Silty Sand to Sandy Silt	61.83
	16.93	16.93	8.47	2.22	Sand Mixture:Silty Sand to Sandy Silt	61.83
	16.93	17.28	1.96	3.10	Clays: Silty Clay to Clay	61.77
	17.28	17.28	1.96	3.10	Clays: Silty Clay to Clay	61.77
	17.28	17.33	9.83	2.06	Sand Mixture:Silty Sand to Sandy Silt	61.72
	17.33	18.43	1.53	3.24	Silt Mixtures:clayey silt to silty clay	61.67
	18.43	18.83	3.07	2.86	Silt Mixtures:clayey silt to silty clay	61.40

Table 3 Database Summary of CPT-3 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-8
SP8 Obserced Settlemen =0.134m	18.83	19.33	1.66	3.23	Clays:silty clay to clay	62.23
	19.33	19.48	3.05	2.80	Silt Mixtures:clayey silt to silty clay	62.21
	19.48	19.73	8.44	2.12	Sand Mixtures:silty sand to sandy silt	62.10
	19.73	20.00	4.04	2.81	Silt Mixtures:clayey silt to silty clay	61.95
	20.00	20.63	1.68	3.24	Clays:silty clay to clay	61.67
	20.63	20.95	10.76	1.95	Sand Mixtures:silty sand to sandy silt	61.40
	20.95	21.20	2.31	3.03	Silt Mixtures:clayey silt to silty clay	61.27
	21.20	21.90	11.19	2.02	Sand Mixtures:silty sand to sandy silt	61.18
	21.90	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	61.12
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	61.04
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	60.90

Table 4 Database Summary of CPT-5

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-9
SP9 Obserced Settlemen =0.175m	0.00	0.05	2.04	1.99	Sands:Clean Sand to Silty Sand	63.95
	0.05	0.90	1.78	2.36	Sand Mixture:Silty Sand to Sandy Silt	63.90
	0.90	1.60	0.79	2.70	Silt Mixture: Clayey Silt to Silty Clay	63.73
	1.60	1.73	1.78	2.45	Sand Mixture:Silty Sand to Sandy Silt	63.60
	1.73	2.00	0.94	2.81	Silt Mixture: Clayey Silt to Silty Clay	63.54
	2.00	2.28	0.59	2.99	Clays: Silty Clay to Clay	63.49
	2.28	2.73	0.56	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.42
	2.73	2.85	0.69	2.97	Clays: Silty Clay to Clay	63.33
	2.85	4.25	0.99	2.83	Silt Mixture: Clayey Silt to Silty Clay	63.30
	4.25	4.48	3.02	2.26	Sand Mixture:Silty Sand to Sandy Silt	63.29
	4.48	4.55	1.34	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.26
	4.55	4.68	0.88	3.08	Clays: Silty Clay to Clay	63.24
	4.68	4.85	1.40	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.23
	4.85	5.05	2.53	2.45	Sand Mixture:Silty Sand to Sandy Silt	63.22
	5.05	5.35	10.14	1.78	Sands:Clean Sand to Silty Sand	63.20
	5.35	5.63	1.38	3.04	Clays: Silty Clay to Clay	63.20
	5.63	6.48	1.73	2.92	Silt Mixture: Clayey Silt to Silty Clay	63.20
	6.48	7.73	1.60	3.04	Clays: Silty Clay to Clay	63.18
	7.73	8.10	7.01	2.02	Sands:Clean Sand to Silty Sand	63.15
	8.10	8.35	5.40	2.26	Sand Mixture:Silty Sand to Sandy Silt	63.13
	8.35	8.50	1.70	2.89	Silt Mixture: Clayey Silt to Silty Clay	63.12
	8.50	9.73	13.48	1.65	Sands:Clean Sand to Silty Sand	63.07
	9.73	9.83	3.07	2.28	Sand Mixture:Silty Sand to Sandy Silt	63.02
	9.83	9.93	0.86	3.22	Clays: Silty Clay to Clay	63.01
	9.93	10.00	0.40	3.77	Organic Soils Peat	63.00
	10.00	10.20	8.24	1.70	Sands:Clean Sand to Silty Sand	62.99
	10.20	10.48	2.93	2.55	Sand Mixture:Silty Sand to Sandy Silt	62.96
	10.48	10.93	14.14	1.68	Sands:Clean Sand to Silty Sand	62.92
	10.93	12.48	1.45	3.20	Clays: Silty Clay to Clay	62.78
	12.48	12.70	10.41	1.92	Sands:Clean Sand to Silty Sand	62.64
	12.83	13.55	6.52	2.20	Sand Mixtures:silty sand to sandy silt	62.53
	13.55	14.63	18.15	1.59	Sands:clean sand to silty sand	62.33

Table 4 Database Summary of CPT-5 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-9
SP9 Obserced Settlemen =0.175m	14.63	15.03	1.89	2.96	Silt Mixtures:clayey silt to silty clay	62.16
	15.03	15.90	13.79	1.72	Sand Mixtures:silty sand to sandy silt	61.99
	15.90	16.63	6.89	2.31	Sand Mixtures:silty sand to sandy silt	61.75
	16.63	18.43	1.53	3.24	Silt Mixtures:clayey silt to silty clay	61.34
	18.43	18.83	3.07	2.86	Silt Mixtures:clayey silt to silty clay	60.94
	18.83	19.33	1.66	3.23	Clays:silty clay to clay	60.76
	19.33	19.48	3.05	2.80	Silt Mixtures:clayey silt to silty clay	60.63
	19.48	19.73	8.44	2.12	Sand Mixtures:silty sand to sandy silt	60.55
	19.73	20.00	4.04	2.81	Silt Mixtures:clayey silt to silty clay	60.44
	20.00	20.63	1.68	3.24	Clays:silty clay to clay	60.25
	20.63	20.95	10.76	1.95	Sand Mixtures:silty sand to sandy silt	60.04
	20.95	21.20	2.31	3.03	Silt Mixtures:clayey silt to silty clay	59.92
	21.20	21.90	11.19	2.02	Sand Mixtures:silty sand to sandy silt	59.69
	21.90	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	59.17
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	58.75
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	58.21

Table 5 Database Summary of CPT-6

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-13	Δσ (Average) (kPa) SP-14	Δσ (Average) (kPa) SP-15
SP13- Obserced Settlemen =0.102m SP14- Obserced Settlemen =0.166m SP15- Obserced Settlemen =0.183m	0.00	0.33	2.09	1.84	Sands:Clean Sand to Silty Sand	63.95	63.99	64.02
	0.33	0.63	2.32	2.19	Sand Mixture:Silty Sand to Sandy Silt	63.91	63.97	63.99
	0.63	0.98	3.56	1.83	Sands:Clean Sand to Silty Sand	63.88	63.97	63.91
	0.98	1.10	1.46	2.38	Sand Mixture:Silty Sand to Sandy Silt	63.87	63.95	63.90
	1.10	2.95	2.51	2.01	Sands:Clean Sand to Silty Sand	63.91	63.94	63.77
	2.95	3.35	3.17	2.43	Sand Mixture:Silty Sand to Sandy Silt	63.90	63.94	63.48
	3.35	3.73	7.95	1.80	Sands:Clean Sand to Silty Sand	63.91	63.93	63.26
	3.73	4.10	4.18	2.27	Sand Mixture:Silty Sand to Sandy Silt	63.91	63.91	63.02
	4.10	4.70	0.86	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.91	63.91	62.67
	4.70	4.93	0.54	3.03	Clays: Silty Clay to Clay	63.89	63.90	62.36
	4.93	5.60	0.87	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.87	63.86	62.00
	5.60	6.53	4.22	2.27	Sand Mixture:Silty Sand to Sandy Silt	63.79	63.77	61.33
	6.53	7.13	8.27	1.80	Sands:Clean Sand to Silty Sand	63.68	63.66	60.66
	7.13	7.28	1.41	2.93	Silt Mixture: Clayey Silt to Silty Clay	63.61	63.60	60.32
	7.28	7.88	13.45	1.48	Sands:Clean Sand to Silty Sand	63.53	63.53	59.98
	7.88	7.98	4.64	2.27	Sand Mixture:Silty Sand to Sandy Silt	63.45	63.46	59.67
	7.98	8.10	1.87	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.42	63.44	59.56
	8.10	8.25	0.80	3.12	Clays: Silty Clay to Clay	63.39	63.41	59.44
	8.25	8.40	0.82	2.86	Silt Mixture: Clayey Silt to Silty Clay	63.35	63.38	59.30
	8.40	8.60	1.05	2.96	Clays: Silty Clay to Clay	63.30	63.35	59.15
	8.60	8.85	4.27	2.21	Sand Mixture:Silty Sand to Sandy Silt	63.24	63.30	58.94
	8.85	10.43	12.74	1.73	Sands:Clean Sand to Silty Sand	62.95	63.09	58.13
	10.43	10.70	2.04	2.76	Silt Mixture: Clayey Silt to Silty Clay	62.63	62.87	57.32
	10.70	10.90	3.43	2.43	Sand Mixture:Silty Sand to Sandy Silt	62.54	62.81	57.12
	10.90	11.30	10.14	1.92	Sands:Clean Sand to Silty Sand	62.42	62.73	56.87
	11.30	11.60	4.38	2.42	Sand Mixture:Silty Sand to Sandy Silt	62.28	62.63	56.57
	11.60	11.78	2.88	2.76	Silt Mixture: Clayey Silt to Silty Clay	62.19	62.57	56.38
	11.78	12.20	4.31	2.46	Sand Mixture:Silty Sand to Sandy Silt	62.07	62.48	56.13
	12.20	12.40	1.53	3.13	Clays: Silty Clay to Clay	61.94	62.40	55.87
	12.40	12.58	1.97	2.80	Silt Mixture: Clayey Silt to Silty Clay	61.86	62.34	55.72
	12.58	13.60	1.07	3.32	Clays: Silty Clay to Clay	61.61	62.17	55.25
	13.60	13.78	2.83	2.74	Silt Mixture: Clayey Silt to Silty Clay	61.35	61.99	54.78

Table 5 Database Summary of CPT-6 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-13	Δσ (Average) (kPa) SP-14	Δσ (Average) (kPa) SP-15
SP13- Obserced Settlemen =0.102m SP14- Obserced Settlemen =0.166m SP15- Obserced Settlemen =0.183m	13.78	13.90	4.38	2.47	Sand Mixture:Silty Sand to Sandy Silt	61.28	61.94	54.66
	13.90	14.83	1.58	3.08	Clays: Silty Clay to Clay	61.05	61.78	54.27
	14.83	15.03	5.39	2.29	Sand Mixture:Silty Sand to Sandy Silt	60.80	61.60	53.85
	15.03	15.20	3.39	2.73	Silt Mixture: Clayey Silt to Silty Clay	60.72	61.54	53.71
	15.20	15.65	6.37	2.26	Sand Mixture:Silty Sand to Sandy Silt	60.58	61.44	53.48
	15.65	15.95	2.06	3.04	Clays: Silty Clay to Clay	60.42	61.32	53.21
	15.95	16.08	4.15	2.45	Sand Mixture:Silty Sand to Sandy Silt	60.32	61.25	53.06
	16.08	16.23	3.86	2.78	Silt Mixture: Clayey Silt to Silty Clay	60.26	61.20	52.96
	16.23	16.43	9.65	1.94	Sands:Clean Sand to Silty Sand	60.18	61.15	52.84
	16.43	18.55	1.82	3.24	Clays: Silty Clay to Clay	59.65	60.75	52.04
	18.55	19.23	13.64	1.86	Sands:Clean Sand to Silty Sand	59.01	60.25	51.10
	19.23	20.28	1.80	3.21	Clays: Silty Clay to Clay	58.59	59.92	50.55
	20.28	20.75	5.32	2.54	Sand Mixture:Silty Sand to Sandy Silt	58.21	59.63	50.07
	20.75	20.85	5.11	2.72	Silt Mixture: Clayey Silt to Silty Clay	58.06	59.52	49.89
	20.85	21.63	9.18	2.25	Sand Mixture:Silty Sand to Sandy Silt	57.83	59.34	49.63
	21.63	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	56.76	58.15	47.18
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	56.14	57.69	46.54
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	55.62	57.32	46.05

Table 5 Database Summary of CPT-6 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	$\Delta\sigma$ (Average) (kPa) SP-19	$\Delta\sigma$ (Average) (kPa) SP-20	$\Delta\sigma$ (Average) (kPa) SP-21
SP19- Obserced Settlemen =0.142m SP20- Obserced Settlemen =0.233m SP21- Obserced Settlemen =0.156m	0.00	0.33	2.09	1.84	Sands:Clean Sand to Silty Sand	63.96	63.88	63.79
	0.33	0.63	2.32	2.19	Sand Mixture:Silty Sand to Sandy Silt	63.96	63.88	63.79
	0.63	0.98	3.56	1.83	Sands:Clean Sand to Silty Sand	63.95	63.87	63.76
	0.98	1.10	1.46	2.38	Sand Mixture:Silty Sand to Sandy Silt	63.94	63.87	63.76
	1.10	2.95	2.51	2.01	Sands:Clean Sand to Silty Sand	63.93	63.85	63.70
	2.95	3.35	3.17	2.43	Sand Mixture:Silty Sand to Sandy Silt	63.93	63.60	63.26
	3.35	3.73	7.95	1.80	Sands:Clean Sand to Silty Sand	63.92	63.53	63.09
	3.73	4.10	4.18	2.27	Sand Mixture:Silty Sand to Sandy Silt	63.92	63.48	62.90
	4.10	4.70	0.86	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.91	63.41	62.64
	4.70	4.93	0.54	3.03	Clays: Silty Clay to Clay	63.91	63.35	62.40
	4.93	5.60	0.87	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.90	63.29	62.13
	5.60	6.53	4.22	2.27	Sand Mixture:Silty Sand to Sandy Silt	63.88	63.21	61.61
	6.53	7.13	8.27	1.80	Sands:Clean Sand to Silty Sand	63.83	63.13	61.11
	7.13	7.28	1.41	2.93	Silt Mixture: Clayey Silt to Silty Clay	63.81	63.10	60.85
	7.28	7.88	13.45	1.48	Sands:Clean Sand to Silty Sand	63.78	63.07	60.60
	7.88	7.98	4.64	2.27	Sand Mixture:Silty Sand to Sandy Silt	63.75	63.04	60.36
	7.98	8.10	1.87	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.74	63.03	60.28
	8.10	8.25	0.80	3.12	Clays: Silty Clay to Clay	63.72	63.02	60.19
	8.25	8.40	0.82	2.86	Silt Mixture: Clayey Silt to Silty Clay	63.71	63.00	60.08
	8.40	8.60	1.05	2.96	Clays: Silty Clay to Clay	63.69	62.99	59.97
	8.60	8.85	4.27	2.21	Sand Mixture:Silty Sand to Sandy Silt	63.67	62.97	59.81
	8.85	10.43	12.74	1.73	Sands:Clean Sand to Silty Sand	63.56	62.88	59.19
	10.43	10.70	2.04	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.45	62.78	58.58
	10.70	10.90	3.43	2.43	Sand Mixture:Silty Sand to Sandy Silt	63.42	62.76	58.42
	10.90	11.30	10.14	1.92	Sands:Clean Sand to Silty Sand	63.37	62.72	58.23
	11.30	11.60	4.38	2.42	Sand Mixture:Silty Sand to Sandy Silt	63.32	62.67	58.00
	11.60	11.78	2.88	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.29	62.64	57.85
	11.78	12.20	4.31	2.46	Sand Mixture:Silty Sand to Sandy Silt	63.24	62.60	57.67
	12.20	12.40	1.53	3.13	Clays: Silty Clay to Clay	63.19	62.56	57.47
	12.40	12.58	1.97	2.80	Silt Mixture: Clayey Silt to Silty Clay	63.16	62.53	57.35
	12.58	13.60	1.07	3.32	Clays: Silty Clay to Clay	63.05	62.44	56.99
	13.60	13.78	2.83	2.74	Silt Mixture: Clayey Silt to Silty Clay	62.95	62.36	56.63

Table 5 Database Summary of CPT-6 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-19	Δσ (Average) (kPa) SP-20	Δσ (Average) (kPa) SP-21
SP19- Obserced Settlemen =0.142m SP20- Obserced Settlemen =0.233m SP21- Obserced Settlemen =0.156m	13.78	13.90	4.38	2.47	Sand Mixture:Silty Sand to Sandy Silt	62.92	62.34	56.54
	13.90	14.83	1.58	3.08	Clays: Silty Clay to Clay	62.81	62.26	56.24
	14.83	15.03	5.39	2.29	Sand Mixture:Silty Sand to Sandy Silt	62.70	62.19	55.92
	15.03	15.20	3.39	2.73	Silt Mixture: Clayey Silt to Silty Clay	62.66	62.17	55.82
	15.20	15.65	6.37	2.26	Sand Mixture:Silty Sand to Sandy Silt	62.59	62.13	55.64
	15.65	15.95	2.06	3.04	Clays: Silty Clay to Clay	62.51	62.09	55.44
	15.95	16.08	4.15	2.45	Sand Mixture:Silty Sand to Sandy Silt	62.46	62.07	55.32
	16.08	16.23	3.86	2.78	Silt Mixture: Clayey Silt to Silty Clay	62.43	62.05	55.25
	16.23	16.43	9.65	1.94	Sands:Clean Sand to Silty Sand	62.39	62.04	55.15
	16.43	18.55	1.82	3.24	Clays: Silty Clay to Clay	62.10	61.96	54.55
	18.55	19.23	13.64	1.86	Sands:Clean Sand to Silty Sand	61.72	61.88	53.85
	19.23	20.28	1.80	3.21	Clays: Silty Clay to Clay	61.46	61.81	53.43
	20.28	20.75	5.32	2.54	Sand Mixture:Silty Sand to Sandy Silt	61.23	61.69	53.08
	20.75	20.85	5.11	2.72	Silt Mixture: Clayey Silt to Silty Clay	61.13	61.63	52.95
	20.85	21.63	9.18	2.25	Sand Mixture:Silty Sand to Sandy Silt	60.99	61.49	52.75
	21.63	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	60.15	60.44	50.96
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	60.06	60.36	50.84
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	59.89	60.17	50.62

Table 6 Database Summary of CPT-7

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-13	Δσ (Average) (kPa) SP-14	Δσ (Average) (kPa) SP-15
SP13- Obserced Settlemen =0.102m SP14- Obserced Settlemen =0.166m SP15- Obserced Settlemen =0.183m	0.00	0.25	2.92	1.58	Sands:Clean Sand to Silty Sand	63.95	63.99	64.02
	0.25	0.83	1.91	2.31	Sand Mixture:Silty Sand to Sandy Silt	63.91	63.97	63.99
	0.83	1.83	0.94	2.69	Silt Mixture: Clayey Silt to Silty Clay	63.88	63.97	63.91
	1.83	2.10	0.73	3.08	Clays: Silty Clay to Clay	63.87	63.95	63.90
	2.10	2.25	0.77	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.91	63.94	63.77
	2.25	2.38	1.45	2.55	Sand Mixture:Silty Sand to Sandy Silt	63.90	63.94	63.48
	2.38	2.50	1.14	2.65	Silt Mixture: Clayey Silt to Silty Clay	63.91	63.93	63.26
	2.50	3.33	3.23	2.38	Sand Mixture:Silty Sand to Sandy Silt	63.91	63.91	63.02
	3.33	3.45	5.68	2.00	Sands:Clean Sand to Silty Sand	63.91	63.91	62.67
	3.45	3.70	3.96	2.26	Sand Mixture:Silty Sand to Sandy Silt	63.89	63.90	62.36
	3.70	3.95	5.94	2.01	Sands:Clean Sand to Silty Sand	63.87	63.86	62.00
	3.95	4.08	3.63	2.30	Sand Mixture:Silty Sand to Sandy Silt	63.79	63.77	61.33
	4.08	5.18	1.19	2.80	Silt Mixture: Clayey Silt to Silty Clay	63.68	63.66	60.66
	5.18	5.33	0.95	3.01	Clays: Silty Clay to Clay	63.61	63.60	60.32
	5.33	5.50	1.08	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.53	63.53	59.98
	5.50	6.43	3.67	2.33	Sand Mixture:Silty Sand to Sandy Silt	63.45	63.46	59.67
	6.43	7.78	8.93	1.77	Sands:Clean Sand to Silty Sand	63.42	63.44	59.56
	7.78	8.08	3.65	2.46	Sand Mixture:Silty Sand to Sandy Silt	63.39	63.41	59.44
	8.08	8.93	12.24	1.59	Sands:Clean Sand to Silty Sand	63.35	63.38	59.30
	8.93	9.15	3.60	2.47	Sand Mixture:Silty Sand to Sandy Silt	63.30	63.35	59.15
	9.15	10.20	11.71	1.73	Sands:Clean Sand to Silty Sand	63.24	63.30	58.94
	10.20	11.30	1.09	3.14	Clays: Silty Clay to Clay	62.95	63.09	58.13
	11.30	11.40	2.92	2.36	Sand Mixture:Silty Sand to Sandy Silt	62.63	62.87	57.32
	11.40	11.80	1.62	2.90	Silt Mixture: Clayey Silt to Silty Clay	62.54	62.81	57.12
	11.80	12.05	5.73	2.12	Sand Mixture:Silty Sand to Sandy Silt	62.42	62.73	56.87
	12.05	12.58	1.23	3.01	Clays: Silty Clay to Clay	62.28	62.63	56.57
	12.58	12.70	1.41	2.88	Silt Mixture: Clayey Silt to Silty Clay	62.19	62.57	56.38
	12.70	13.58	1.15	3.30	Clays: Silty Clay to Clay	62.07	62.48	56.13
	13.58	13.73	4.67	2.46	Sand Mixture:Silty Sand to Sandy Silt	61.94	62.40	55.87
	13.73	13.88	9.33	1.91	Sands:Clean Sand to Silty Sand	61.86	62.34	55.72
	13.88	14.08	3.60	2.55	Sand Mixture:Silty Sand to Sandy Silt	61.61	62.17	55.25
	14.08	14.88	1.04	3.31	Clays: Silty Clay to Clay	61.35	61.99	54.78

Table 6 Database Summary of CPT-7 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-13	Δσ (Average) (kPa) SP-14	Δσ (Average) (kPa) SP-15
SP13- Obserced Settlemen =0.102m SP14- Obserced Settlemen =0.166m SP15- Obserced Settlemen =0.183m	14.88	15.13	3.61	2.46	Sand Mixture:Silty Sand to Sandy Silt	61.28	61.94	54.66
	15.13	15.30	11.37	1.94	Sands:Clean Sand to Silty Sand	61.05	61.78	54.27
	15.30	15.45	8.18	2.13	Sand Mixture:Silty Sand to Sandy Silt	60.80	61.60	53.85
	15.45	15.58	11.14	1.94	Sands:Clean Sand to Silty Sand	60.72	61.54	53.71
	15.58	15.75	5.58	2.35	Sand Mixture:Silty Sand to Sandy Silt	60.58	61.44	53.48
	15.75	15.90	2.32	3.00	Clays: Silty Clay to Clay	60.42	61.32	53.21
	15.90	16.58	18.12	1.67	Sands:Clean Sand to Silty Sand	60.32	61.25	53.06
	16.58	16.73	4.36	2.56	Sand Mixture:Silty Sand to Sandy Silt	60.26	61.20	52.96
	16.73	18.90	1.58	3.24	Clays: Silty Clay to Clay	60.18	61.15	52.84
	18.90	19.33	7.82	2.22	Sand Mixture:Silty Sand to Sandy Silt	59.65	60.75	52.04
	19.33	19.83	1.45	3.36	Clays: Silty Clay to Clay	59.01	60.25	51.10
	14.88	15.13	3.61	2.46	Sand Mixture:Silty Sand to Sandy Silt	58.59	59.92	50.55
	15.13	15.30	11.37	1.94	Sands:Clean Sand to Silty Sand	58.21	59.63	50.07
	15.30	15.45	8.18	2.13	Sand Mixture:Silty Sand to Sandy Silt	58.06	59.58	49.89
	15.45	15.58	11.14	1.94	Sands:Clean Sand to Silty Sand	57.83	59.54	49.63
	15.58	16.63	6.89	2.31	Sand Mixtures:silty sand to sandy silt	59.30	59.40	50.62
	16.63	18.43	1.53	3.24	Silt Mixtures:clayey silt to silty clay	58.73	59.30	49.75
	18.43	18.83	3.07	2.86	Silt Mixtures:clayey silt to silty clay	58.22	59.27	49.01
	18.83	19.33	1.66	3.23	Clays:silty clay to clay	58.01	59.11	48.72
	19.33	19.48	3.05	2.80	Silt Mixtures:clayey silt to silty clay	57.85	58.98	48.51
	19.48	19.73	8.44	2.12	Sand Mixtures:silty sand to sandy silt	57.76	58.91	48.38
	19.73	20.00	4.04	2.81	Silt Mixtures:clayey silt to silty clay	57.63	58.81	48.21
	20.00	20.63	1.68	3.24	Clays:silty clay to clay	57.40	58.64	47.93
	20.63	20.95	10.76	1.95	Sand Mixtures:silty sand to sandy silt	57.16	58.45	47.64
	20.95	21.20	2.31	3.03	Silt Mixtures:clayey silt to silty clay	57.02	58.34	47.47
	21.20	21.90	11.19	2.02	Sand Mixtures:silty sand to sandy silt	56.76	58.15	47.18
	21.90	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	56.14	57.69	46.54
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	55.62	57.32	46.05
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	54.95	56.86	45.47

Table 6 Database Summary of CPT-7 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-19	Δσ (Average) (kPa) SP-20	Δσ (Average) (kPa) SP-21
SP19- Obserced Settlemen =0.142m SP20- Obserced Settlemen =0.233m SP21- Obserced Settlemen =0.156m	0.00	0.25	2.92	1.58	Sands:Clean Sand to Silty Sand	63.96	63.88	63.79
	0.25	0.83	1.91	2.31	Sand Mixture:Silty Sand to Sandy Silt	63.96	63.88	63.79
	0.83	1.83	0.94	2.69	Silt Mixture: Clayey Silt to Silty Clay	63.95	63.87	63.76
	1.83	2.10	0.73	3.08	Clays: Silty Clay to Clay	63.94	63.87	63.76
	2.10	2.25	0.77	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.93	63.85	63.70
	2.25	2.38	1.45	2.55	Sand Mixture:Silty Sand to Sandy Silt	63.93	63.60	63.26
	2.38	2.50	1.14	2.65	Silt Mixture: Clayey Silt to Silty Clay	63.92	63.53	63.09
	2.50	3.33	3.23	2.38	Sand Mixture:Silty Sand to Sandy Silt	63.92	63.48	62.90
	3.33	3.45	5.68	2.00	Sands:Clean Sand to Silty Sand	63.91	63.41	62.64
	3.45	3.70	3.96	2.26	Sand Mixture:Silty Sand to Sandy Silt	63.91	63.35	62.40
	3.70	3.95	5.94	2.01	Sands:Clean Sand to Silty Sand	63.90	63.29	62.13
	3.95	4.08	3.63	2.30	Sand Mixture:Silty Sand to Sandy Silt	63.88	63.21	61.61
	4.08	5.18	1.19	2.80	Silt Mixture: Clayey Silt to Silty Clay	63.83	63.13	61.11
	5.18	5.33	0.95	3.01	Clays: Silty Clay to Clay	63.81	63.10	60.85
	5.33	5.50	1.08	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.78	63.07	60.60
	5.50	6.43	3.67	2.33	Sand Mixture:Silty Sand to Sandy Silt	63.75	63.04	60.36
	6.43	7.78	8.93	1.77	Sands:Clean Sand to Silty Sand	63.74	63.03	60.28
	7.78	8.08	3.65	2.46	Sand Mixture:Silty Sand to Sandy Silt	63.72	63.02	60.19
	8.08	8.93	12.24	1.59	Sands:Clean Sand to Silty Sand	63.71	63.00	60.08
	8.93	9.15	3.60	2.47	Sand Mixture:Silty Sand to Sandy Silt	63.69	62.99	59.97
	9.15	10.20	11.71	1.73	Sands:Clean Sand to Silty Sand	63.67	62.97	59.81
	10.20	11.30	1.09	3.14	Clays: Silty Clay to Clay	63.56	62.88	59.19
	11.30	11.40	2.92	2.36	Sand Mixture:Silty Sand to Sandy Silt	63.45	62.78	58.58
	11.40	11.80	1.62	2.90	Silt Mixture: Clayey Silt to Silty Clay	63.42	62.76	58.42
	11.80	12.05	5.73	2.12	Sand Mixture:Silty Sand to Sandy Silt	63.37	62.72	58.23
	12.05	12.58	1.23	3.01	Clays: Silty Clay to Clay	63.32	62.67	58.00
	12.58	12.70	1.41	2.88	Silt Mixture: Clayey Silt to Silty Clay	63.29	62.64	57.85
	12.70	13.58	1.15	3.30	Clays: Silty Clay to Clay	63.24	62.60	57.67
	13.58	13.73	4.67	2.46	Sand Mixture:Silty Sand to Sandy Silt	63.19	62.56	57.47
	13.73	13.88	9.33	1.91	Sands:Clean Sand to Silty Sand	63.16	62.53	57.35
	13.88	14.08	3.60	2.55	Sand Mixture:Silty Sand to Sandy Silt	63.05	62.44	56.99
	14.08	14.88	1.04	3.31	Clays: Silty Clay to Clay	62.95	62.36	56.63

Table 6 Database Summary of CPT-7 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-19	Δσ (Average) (kPa) SP-20	Δσ (Average) (kPa) SP-21
SP19- Obserced Settlemen =0.142m SP20- Obserced Settlemen =0.233m SP21- Obserced Settlemen =0.156m	14.88	15.13	3.61	2.46	Sand Mixture:Silty Sand to Sandy Silt	62.92	62.34	56.54
	15.13	15.30	11.37	1.94	Sands:Clean Sand to Silty Sand	62.81	62.26	56.24
	15.30	15.45	8.18	2.13	Sand Mixture:Silty Sand to Sandy Silt	62.70	62.19	55.92
	15.45	15.58	11.14	1.94	Sands:Clean Sand to Silty Sand	62.66	62.17	55.82
	15.58	15.75	5.58	2.35	Sand Mixture:Silty Sand to Sandy Silt	62.59	62.13	55.64
	15.75	15.90	2.32	3.00	Clays: Silty Clay to Clay	62.51	62.09	55.44
	15.90	16.58	18.12	1.67	Sands:Clean Sand to Silty Sand	62.46	62.07	55.32
	16.58	16.73	4.36	2.56	Sand Mixture:Silty Sand to Sandy Silt	62.43	62.05	55.25
	16.73	18.90	1.58	3.24	Clays: Silty Clay to Clay	62.39	62.04	55.15
	18.90	19.33	7.82	2.22	Sand Mixture:Silty Sand to Sandy Silt	62.10	61.96	54.55
	19.33	19.83	1.45	3.36	Clays: Silty Clay to Clay	61.72	61.88	53.85
	14.88	15.13	3.61	2.46	Sand Mixture:Silty Sand to Sandy Silt	61.46	61.81	53.43
	15.13	15.30	11.37	1.94	Sands:Clean Sand to Silty Sand	61.23	61.69	53.08
	15.30	15.45	8.18	2.13	Sand Mixture:Silty Sand to Sandy Silt	61.13	61.63	52.95
	15.45	15.58	11.14	1.94	Sands:Clean Sand to Silty Sand	60.99	61.49	52.75
	15.58	16.63	6.89	2.31	Sand Mixtures:silty sand to sandy silt	61.41	60.85	53.20
	16.63	18.43	1.53	3.24	Silt Mixtures:clayey silt to silty clay	61.10	60.76	52.54
	18.43	18.83	3.07	2.86	Silt Mixtures:clayey silt to silty clay	60.80	60.70	51.99
	18.83	19.33	1.66	3.23	Clays:silty clay to clay	60.67	60.67	51.77
	19.33	19.48	3.05	2.80	Silt Mixtures:clayey silt to silty clay	60.58	60.65	51.61
	19.48	19.73	8.44	2.12	Sand Mixtures:silty sand to sandy silt	60.52	60.63	51.51
	19.73	20.00	4.04	2.81	Silt Mixtures:clayey silt to silty clay	60.44	60.60	51.39
	20.00	20.63	1.68	3.24	Clays:silty clay to clay	60.30	60.54	51.18
	20.63	20.95	10.76	1.95	Sand Mixtures:silty sand to sandy silt	60.15	60.44	50.96
	20.95	21.20	2.31	3.03	Silt Mixtures:clayey silt to silty clay	60.06	60.36	50.84
	21.20	21.90	11.19	2.02	Sand Mixtures:silty sand to sandy silt	59.89	60.17	50.62
	21.90	23.40	1.81	3.25	Silt Mixtures:clayey silt to silty clay	59.51	59.41	50.15
	23.40	23.65	5.86	2.60	Silt Mixtures:clayey silt to silty clay	59.20	58.43	49.79
	23.65	25.55	1.96	3.29	Clays:silty clay to clay	58.81	56.18	49.37

Table 7 Database Summary of CPT-8

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-16	Δσ (Average) (kPa) SP-17	Δσ (Average) (kPa) SP-18
SP16- Obserced Settlemen =0.205m SP17- Obserced Settlemen =0.195m SP18- Obserced Settlemen =0.250m	0.00	0.53	1.29	2.33	Sands:clean sand to silty sand	63.92	63.93	62.93
	0.53	1.45	3.14	1.80	Sands:clean sand to silty sand	63.87	63.93	62.92
	1.45	1.83	1.40	2.38	Sand Mixtures:silty sand to sandy silt	63.85	63.92	62.88
	1.83	2.03	1.16	2.74	Silt Mixtures:clayey silt to silty clay	63.86	63.91	62.79
	2.03	2.43	0.64	3.10	Clays:silty clay to clay	63.86	63.91	62.73
	2.43	3.25	1.10	2.79	Silt Mixtures:clayey silt to silty clay	63.88	63.88	62.55
	3.25	3.95	4.28	2.18	Sand Mixtures:silty sand to sandy silt	63.90	63.88	62.14
	3.95	4.23	1.02	2.88	Silt Mixtures:clayey silt to silty clay	63.90	63.87	61.82
	4.23	4.38	0.78	3.00	Clays:silty clay to clay	63.90	63.85	61.67
	4.38	4.83	1.02	2.85	Silt Mixtures:clayey silt to silty clay	63.89	63.84	61.45
	4.83	5.93	0.90	3.12	Clays:silty clay to clay	63.85	63.77	60.83
	5.93	6.28	2.78	2.43	Silt Mixtures:clayey silt to silty clay	63.78	63.68	60.22
	6.28	7.50	8.93	1.70	Sands:clean sand to silty sand	63.65	63.57	59.52
	7.50	8.70	11.16	1.59	Sands:clean sand to silty sand	63.39	63.35	58.43
	8.70	8.95	0.92	3.11	Silt Mixtures:clayey silt to silty clay	63.20	63.20	57.77
	8.95	9.45	11.90	1.55	Sand Mixtures:silty sand to sandy silt	63.08	63.12	57.44
	9.45	9.65	23.26	1.22	Gravelly sand to dense sand	62.97	63.04	57.13
	9.65	11.05	11.93	1.67	Sands:clean sand to silty sand	62.69	62.84	56.43
	11.05	12.40	14.24	1.69	Sands:clean sand to silty sand	62.16	62.48	55.27
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	61.80	62.23	54.55
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	61.56	62.07	54.11
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	61.17	61.79	53.41
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	60.85	61.56	52.86
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	60.57	61.36	52.39
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	60.21	61.09	51.82
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	59.64	60.66	50.95
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	59.13	60.27	50.21
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	58.92	60.11	49.92
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	58.76	59.98	49.71
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	58.67	59.91	49.58
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	58.54	59.81	49.41
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	58.31	59.64	49.13

Table 7 Database Summary of CPT-8 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-16	Δσ (Average) (kPa) SP-17	Δσ (Average) (kPa) SP-18
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	58.07	59.45	48.84
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	57.93	59.34	48.67
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	57.67	59.15	48.38
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	57.05	58.69	47.74
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	56.53	58.32	47.25
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	55.86	57.86	46.67

Table 7 Database Summary of CPT-8 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-22	Δσ (Average) (kPa) SP-23	Δσ (Average) (kPa) SP-24
SP22- Obserced Settlemen = 0.182 SP23- Obserced Settlemen =0.230m SP24- Obserced Settlemen =0.193m	0.00	0.53	1.29	2.33	Sands:clean sand to silty sand	63.96	63.96	63.98
	0.53	1.45	3.14	1.80	Sands:clean sand to silty sand	63.96	63.97	63.93
	1.45	1.83	1.40	2.38	Sand Mixtures:silty sand to sandy silt	63.95	63.92	63.92
	1.83	2.03	1.16	2.74	Silt Mixtures:clayey silt to silty clay	63.95	63.88	63.87
	2.03	2.43	0.64	3.10	Clays:silty clay to clay	63.95	63.84	63.80
	2.43	3.25	1.10	2.79	Silt Mixtures:clayey silt to silty clay	63.95	63.75	63.59
	3.25	3.95	4.28	2.18	Sand Mixtures:silty sand to sandy silt	63.94	63.62	63.26
	3.95	4.23	1.02	2.88	Silt Mixtures:clayey silt to silty clay	63.94	63.55	63.01
	4.23	4.38	0.78	3.00	Clays:silty clay to clay	63.92	63.52	62.89
	4.38	4.83	1.02	2.85	Silt Mixtures:clayey silt to silty clay	63.91	63.48	62.72
	4.83	5.93	0.90	3.12	Clays:silty clay to clay	63.90	63.38	62.25
	5.93	6.28	2.78	2.43	Silt Mixtures:clayey silt to silty clay	63.88	63.30	61.79
	6.28	7.50	8.93	1.70	Sands:clean sand to silty sand	63.83	63.23	61.26
	7.50	8.70	11.16	1.59	Sands:clean sand to silty sand	63.73	63.12	60.44
	8.70	8.95	0.92	3.11	Silt Mixtures:clayey silt to silty clay	63.66	63.06	59.94
	8.95	9.45	11.90	1.55	Sand Mixtures:silty sand to sandy silt	63.62	63.03	59.69
	9.45	9.65	23.26	1.22	Gravelly sand to dense sand	63.58	62.99	59.45
	9.65	11.05	11.93	1.67	Sands:clean sand to silty sand	63.48	62.91	58.92
	11.05	12.40	14.24	1.69	Sands:clean sand to silty sand	63.28	62.74	58.03
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	63.14	62.61	57.49
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	63.04	62.53	57.14
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	62.87	62.40	56.61
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	62.73	62.30	56.19
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	62.59	62.23	55.84
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	62.41	62.15	55.40
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	62.10	62.06	54.74
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	61.80	62.00	54.19
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	61.67	61.97	53.97
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	61.58	61.95	53.81
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	61.52	61.93	53.71
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	61.44	61.90	53.59
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	61.30	61.84	53.38

Table 7 Database Summary of CPT-8 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-22	Δσ (Average) (kPa) SP-23	Δσ (Average) (kPa) SP-24
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	61.15	61.74	53.16
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	61.06	61.66	53.04
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	60.89	61.47	52.82
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	60.51	60.71	52.35
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	60.20	59.73	51.99
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	59.81	57.48	51.57

Table 7 Database Summary of CPT-8 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-28	Δσ (Average) (kPa) SP-29	Δσ (Average) (kPa) SP-30
SP28- Obserced Settlemen = 0.177 SP29- Obserced Settlemen =0.220m SP30- Obserced Settlemen =0.201m	0.00	0.53	1.29	2.33	Sands:clean sand to silty sand	63.95	63.97	63.88
	0.53	1.45	3.14	1.80	Sands:clean sand to silty sand	63.91	63.96	64.00
	1.45	1.83	1.40	2.38	Sand Mixtures:silty sand to sandy silt	63.81	63.86	63.87
	1.83	2.03	1.16	2.74	Silt Mixtures:clayey silt to silty clay	63.74	63.79	63.74
	2.03	2.43	0.64	3.10	Clays:silty clay to clay	63.65	63.71	63.56
	2.43	3.25	1.10	2.79	Silt Mixtures:clayey silt to silty clay	63.42	63.49	63.07
	3.25	3.95	4.28	2.18	Sand Mixtures:silty sand to sandy silt	63.09	63.17	62.33
	3.95	4.23	1.02	2.88	Silt Mixtures:clayey silt to silty clay	62.84	62.93	61.78
	4.23	4.38	0.78	3.00	Clays:silty clay to clay	62.72	62.82	61.53
	4.38	4.83	1.02	2.85	Silt Mixtures:clayey silt to silty clay	62.55	62.66	61.17
	4.83	5.93	0.90	3.12	Clays:silty clay to clay	62.08	62.21	60.17
	5.93	6.28	2.78	2.43	Silt Mixtures:clayey silt to silty clay	61.60	61.77	59.21
	6.28	7.50	8.93	1.70	Sands:clean sand to silty sand	61.05	61.27	58.16
	7.50	8.70	11.16	1.59	Sands:clean sand to silty sand	60.17	60.48	56.55
	8.70	8.95	0.92	3.11	Silt Mixtures:clayey silt to silty clay	59.63	60.00	55.63
	8.95	9.45	11.90	1.55	Sand Mixtures:silty sand to sandy silt	59.35	59.76	55.16
	9.45	9.65	23.26	1.22	Gravelly sand to dense sand	59.08	59.53	54.73
	9.65	11.05	11.93	1.67	Sands:clean sand to silty sand	58.48	59.00	53.79
	11.05	12.40	14.24	1.69	Sands:clean sand to silty sand	57.46	58.12	52.28
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	56.82	57.58	51.38
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	56.42	57.23	50.83
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	55.78	56.69	49.99
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	55.28	56.26	49.33
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	54.85	55.89	48.79
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	54.32	55.44	48.12
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	53.52	54.76	47.13
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	52.83	54.18	46.29
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	52.56	53.95	45.96
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	52.36	53.78	45.73
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	52.24	53.68	45.59
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	52.08	53.55	45.40
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	51.82	53.33	45.09

Table 7 Database Summary of CPT-8 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	$\Delta\sigma$ (Average) (kPa) SP-28	$\Delta\sigma$ (Average) (kPa) SP-29	$\Delta\sigma$ (Average) (kPa) SP-30
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	51.53	53.10	44.77
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	51.37	52.97	44.58
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	51.08	52.74	44.26
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	50.44	52.24	43.58
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	49.94	51.85	43.06
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	49.34	51.41	42.48

Table 8 Database Summary of CPT-9

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-17	Δσ (Average) (kPa) SP-18	Δσ (Average) (kPa) SP-23
SP17- Obserced Settlemen = 0.195 SP18- Obserced Settlemen =0.250m SP23- Obserced Settlemen =0.233m	0.00	0.28	2.40	1.78	Sands:Clean Sand to Silty Sand	63.98	63.93	62.90
	0.28	0.58	1.75	2.40	Sand Mixture:Silty Sand to Sandy Silt	64.10	63.80	62.91
	0.58	1.85	0.88	2.71	Silt Mixture: Clayey Silt to Silty Clay	64.23	63.71	62.93
	1.85	3.03	0.96	2.77	Silt Mixture: Clayey Silt to Silty Clay	64.01	63.68	62.95
	3.03	3.58	5.37	1.99	Sand Mixture:Silty Sand to Sandy Silt	63.51	63.21	62.96
	3.58	3.80	3.35	2.33	Sands:Clean Sand to Silty Sand	63.38	63.08	62.96
	3.80	4.43	0.77	2.89	Sand Mixture:Silty Sand to Sandy Silt	63.10	62.80	62.95
	4.43	4.88	0.59	3.19	Silt Mixture: Clayey Silt to Silty Clay	62.71	62.41	62.94
	4.88	5.80	1.39	2.85	Clays: Silty Clay to Clay	62.16	61.86	62.91
	5.80	6.20	4.84	2.27	Silt Mixture: Clayey Silt to Silty Clay	61.60	61.30	62.88
	6.20	8.13	10.10	1.59	Sand Mixture:Silty Sand to Sandy Silt	60.57	60.27	62.81
	8.13	8.70	0.92	3.04	Sands:Clean Sand to Silty Sand	59.45	59.15	62.70
	8.70	9.13	7.31	1.75	Clays: Silty Clay to Clay	59.00	58.70	62.65
	9.13	10.33	10.89	1.74	Sands:Clean Sand to Silty Sand	58.20	57.90	62.54
	10.33	10.58	5.35	2.21	Sand Mixture:Silty Sand to Sandy Silt	57.64	57.34	62.46
	10.58	12.63	15.38	1.69	Sands:Clean Sand to Silty Sand	56.67	56.37	62.30
	12.63	14.68	15.71	1.69	Sand Mixture:Silty Sand to Sandy Silt	55.03	54.73	61.95
	14.68	15.55	12.39	1.85	Sands:Clean Sand to Silty Sand	53.85	53.55	61.64
	15.55	16.53	1.66	3.18	Sands:Clean Sand to Silty Sand	53.26	52.96	61.46
	16.53	16.98	4.93	2.47	Sand Mixture:Silty Sand to Sandy Silt	52.76	52.46	61.29
	16.98	18.08	1.80	3.18	Sands:Clean Sand to Silty Sand	52.23	51.93	61.09
	18.08	18.75	9.89	2.27	Clays: Silty Clay to Clay	51.63	51.33	60.85
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	51.42	50.73	60.70
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	50.73	50.46	60.67
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	50.46	50.26	60.65
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	50.26	50.14	60.63
	19.98	20.93	1.68	3.24	Clays:silty clay to clay	50.14	49.98	60.60
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	49.98	49.72	60.54
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	49.72	49.43	60.44
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	49.43	49.27	60.36
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	49.27	48.98	60.17
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	48.98	48.34	59.41

Table 8 Database Summary of CPT-9 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-24	Δσ (Average) (kPa) SP-30
	0.00	0.28	2.40	1.78	Sands:Clean Sand to Silty Sand	63.96	61.84
	0.28	0.58	1.75	2.40	Sand Mixture:Silty Sand to Sandy Silt	63.95	61.85
	0.58	1.85	0.88	2.71	Silt Mixture: Clayey Silt to Silty Clay	63.90	61.78
	1.85	3.03	0.96	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.72	61.47
	3.03	3.58	5.37	1.99	Sand Mixture:Silty Sand to Sandy Silt	63.44	61.17
	3.58	3.80	3.35	2.33	Sands:Clean Sand to Silty Sand	63.32	61.05
	3.80	4.43	0.77	2.89	Sand Mixture:Silty Sand to Sandy Silt	63.22	60.94
	4.43	4.88	0.59	3.19	Silt Mixture: Clayey Silt to Silty Clay	62.99	60.72
	4.88	5.80	1.39	2.85	Clays: Silty Clay to Clay	62.69	60.42
	5.80	6.20	4.84	2.27	Silt Mixture: Clayey Silt to Silty Clay	62.28	60.00
	6.20	8.13	10.10	1.59	Sand Mixture:Silty Sand to Sandy Silt	61.86	59.57
	8.13	8.70	0.92	3.04	Sands:Clean Sand to Silty Sand	61.08	58.75
	8.70	9.13	7.31	1.75	Clays: Silty Clay to Clay	60.22	57.84
	9.13	10.33	10.89	1.74	Sands:Clean Sand to Silty Sand	59.88	57.46
	10.33	10.58	5.35	2.21	Sand Mixture:Silty Sand to Sandy Silt	59.68	57.24
	10.58	12.63	15.38	1.69	Sands:Clean Sand to Silty Sand	59.28	56.79
	12.63	14.68	15.71	1.69	Sand Mixture:Silty Sand to Sandy Silt	58.85	56.31
	14.68	15.55	12.39	1.85	Sands:Clean Sand to Silty Sand	58.11	55.45
	15.55	16.53	1.66	3.18	Sands:Clean Sand to Silty Sand	56.86	53.98
	16.53	16.98	4.93	2.47	Sand Mixture:Silty Sand to Sandy Silt	56.20	53.19
	16.98	18.08	1.80	3.18	Sands:Clean Sand to Silty Sand	55.95	52.89
	18.08	18.75	9.89	2.27	Clays: Silty Clay to Clay	55.51	52.35
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	55.13	51.89
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	54.73	51.40
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	54.28	50.85
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	53.99	48.88
	19.98	20.93	1.68	3.24	Clays:silty clay to clay	53.64	47.98
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	53.20	47.43
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	52.54	46.59
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	51.99	45.93
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	51.77	45.39
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	51.61	44.72

Table 9 Database Summary of CPT-11

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-28	Δσ (Average) (kPa) SP-29	Δσ (Average) (kPa) SP-30
SP28- Obserced Settlemen = 0.177 SP29- Obserced Settlemen =0.220m SP30- Obserced Settlemen =0.201m	0.00	0.25	2.55	1.68	Sands:Clean Sand to Silty Sand	63.94	63.88	63.78
	0.25	1.03	1.94	2.23	Sand Mixture:Silty Sand to Sandy Silt	63.94	63.86	63.76
	1.03	1.70	1.05	2.66	Silt Mixture: Clayey Silt to Silty Clay	63.86	63.81	63.61
	1.70	2.05	2.35	2.44	Sand Mixture:Silty Sand to Sandy Silt	63.75	63.71	63.56
	2.05	2.53	0.64	3.04	Clays: Silty Clay to Clay	63.63	63.59	63.31
	2.53	3.20	0.68	2.89	Silt Mixture: Clayey Silt to Silty Clay	63.41	63.38	62.86
	3.20	4.00	0.70	3.05	Clays: Silty Clay to Clay	63.08	63.07	62.13
	4.00	4.78	4.18	2.29	Sand Mixture:Silty Sand to Sandy Silt	62.67	62.67	61.22
	4.78	5.55	0.61	3.11	Clays: Silty Clay to Clay	62.21	62.24	60.25
	5.55	5.78	6.54	2.44	Sand Mixture:Silty Sand to Sandy Silt	57.63	58.19	52.61
	5.78	5.95	6.58	1.98	Sands:Clean Sand to Silty Sand	61.76	61.82	59.33
	5.95	6.10	5.63	2.14	Sand Mixture:Silty Sand to Sandy Silt	61.65	61.72	59.11
	6.10	6.53	9.70	1.83	Sands:Clean Sand to Silty Sand	61.46	61.54	58.73
	6.53	6.80	4.35	2.23	Sand Mixture:Silty Sand to Sandy Silt	61.21	61.32	58.26
	6.80	10.75	12.60	1.60	Sands:Clean Sand to Silty Sand	59.66	59.94	55.53
	10.75	10.98	3.03	2.53	Sand Mixture:Silty Sand to Sandy Silt	58.10	58.57	53.01
	10.98	12.33	0.73	3.46	Clays: Silty Clay to Clay	57.51	58.07	52.16
	12.33	13.18	8.10	2.14	Sand Mixture:Silty Sand to Sandy Silt	56.71	57.38	51.03
	13.18	13.65	1.07	3.29	Clays: Silty Clay to Clay	56.24	56.98	50.39
	13.65	13.83	3.11	2.89	Silt Mixture: Clayey Silt to Silty Clay	55.92	56.71	49.97
	13.83	14.50	5.98	2.30	Sand Mixture:Silty Sand to Sandy Silt	55.71	56.53	49.70
	14.50	14.85	2.21	3.02	Clays: Silty Clay to Clay	55.36	56.23	49.24
	14.85	15.00	0.69	3.66	Organic Soils Peat	55.19	56.08	49.02
	15.00	15.68	1.12	3.31	Clays: Silty Clay to Clay	54.92	55.85	48.67
	15.68	15.78	7.20	2.22	Sand Mixture:Silty Sand to Sandy Silt	54.66	55.63	48.35
	15.78	16.10	10.21	2.00	Sands:Clean Sand to Silty Sand	54.52	55.51	48.17
	16.10	17.58	1.25	3.34	Clays: Silty Clay to Clay	53.94	55.01	47.44
	17.58	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	53.14	54.72	47.43
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	52.46	54.32	46.59
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	51.88	53.68	45.93
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	51.65	53.18	45.39
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	51.48	52.75	44.72

Table 9 Database Summary of CPT-11 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-28	Δσ (Average) (kPa) SP-29	Δσ (Average) (kPa) SP-30
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	50.73	51.88	43.73
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	50.46	51.65	42.89
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	50.26	51.48	42.56
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	50.14	51.38	42.33
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	49.98	51.25	42.19
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	49.72	51.03	42.00
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	49.43	50.80	43.73

Table 10 Database Summary of CPT-12

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-37	Δσ (Average) (kPa) SP-38	Δσ (Average) (kPa) SP-39
SP37- Obserced Settlemen = 0.161 SP38- Obserced Settlemen =0.178m SP39- Obserced Settlemen =0.182m	0.00	0.53	4.30	1.67	Sands:Clean Sand to Silty Sand	63.90	63.87	63.91
	0.53	0.93	1.73	2.32	Sand Mixture:Silty Sand to Sandy Silt	63.87	63.87	63.76
	0.93	1.15	0.69	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.85	63.86	63.66
	1.15	3.90	0.53	3.13	Clays: Silty Clay to Clay	63.74	63.87	63.30
	3.90	4.43	2.76	2.41	Sand Mixture:Silty Sand to Sandy Silt	63.55	63.85	62.91
	4.43	6.33	0.58	3.24	Clays: Silty Clay to Clay	63.33	63.84	62.57
	6.33	6.50	0.80	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.09	63.83	62.24
	6.50	6.95	3.60	2.22	Sand Mixture:Silty Sand to Sandy Silt	63.01	63.81	62.13
	6.95	7.18	1.28	2.81	Silt Mixture: Clayey Silt to Silty Clay	62.92	63.75	62.01
	7.18	8.28	9.36	1.82	Sands:Clean Sand to Silty Sand	62.71	63.62	61.74
	8.28	8.40	5.12	2.28	Sand Mixture:Silty Sand to Sandy Silt	62.51	63.35	61.48
	8.40	8.53	1.78	2.85	Silt Mixture: Clayey Silt to Silty Clay	62.47	63.06	61.42
	8.53	8.68	4.53	2.24	Sand Mixture:Silty Sand to Sandy Silt	62.42	62.99	61.36
	8.68	11.20	13.77	1.77	Sands:Clean Sand to Silty Sand	61.92	62.87	60.71
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	60.76	62.85	60.38
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	60.19	62.52	60.21
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	59.81	62.19	59.81
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	59.57	62.05	59.08
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	59.17	61.94	58.60
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	58.84	61.88	58.28
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	58.55	61.79	57.78
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	58.19	61.63	57.36
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	57.62	61.46	57.00
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	57.13	61.36	56.55
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	56.92	61.17	55.85
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	56.78	60.75	55.23
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	56.68	60.40	54.98
	20.60	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	56.56	59.97	54.80
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	56.36	59.17	54.69
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	56.14	58.84	54.54
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	56.01	58.55	54.28
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	55.78	58.19	54.01

Table 10 Database Summary of CPT-12 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-40	Δσ (Average) (kPa) SP-54
SP40- Obserced Settlemen = 0.153 SP54- Obserced Settlemen =0.180m	0.00	0.53	4.30	1.67	Sands:Clean Sand to Silty Sand	63.86	63.80
	0.53	0.93	1.73	2.32	Sand Mixture:Silty Sand to Sandy Silt	63.77	63.50
	0.93	1.15	0.69	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.69	63.32
	1.15	3.90	0.53	3.13	Clays: Silty Clay to Clay	63.19	62.46
	3.90	4.43	2.76	2.41	Sand Mixture:Silty Sand to Sandy Silt	62.47	61.48
	4.43	6.33	0.58	3.24	Clays: Silty Clay to Clay	61.81	60.70
	6.33	6.50	0.80	2.87	Silt Mixture: Clayey Silt to Silty Clay	61.22	60.00
	6.50	6.95	3.60	2.22	Sand Mixture:Silty Sand to Sandy Silt	61.03	59.79
	6.95	7.18	1.28	2.81	Silt Mixture: Clayey Silt to Silty Clay	60.82	59.54
	7.18	8.28	9.36	1.82	Sands:Clean Sand to Silty Sand	60.40	59.06
	8.28	8.40	5.12	2.28	Sand Mixture:Silty Sand to Sandy Silt	60.02	58.61
	8.40	8.53	1.78	2.85	Silt Mixture: Clayey Silt to Silty Clay	59.94	58.52
	8.53	8.68	4.53	2.24	Sand Mixture:Silty Sand to Sandy Silt	59.85	58.41
	8.68	11.20	13.77	1.77	Sands:Clean Sand to Silty Sand	58.99	57.40
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	58.14	57.36
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	57.62	57.00
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	56.74	56.55
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	56.19	55.85
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	55.85	55.23
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	55.30	54.98
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	54.86	54.80
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	54.48	54.69
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	54.02	54.54
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	53.30	54.28
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	52.69	54.01
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	52.44	53.85
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	52.26	53.57
	20.60	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	52.15	52.91
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	52.01	52.38
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	51.76	51.71
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	51.49	51.39
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	51.34	51.14

Table 11 Database Summary of CPT-12a

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-37	Δσ (Average) (kPa) SP-39	Δσ (Average) (kPa) SP-40	Δσ (Average) (kPa) SP-54
SP39- Obserced Settlemen =0.182m SP54- Obserced Settlemen =0..180m	0.00	0.55	3.35	1.71	Sands:Clean Sand to Silty Sand	63.70	63.91	63.76	63.89
	0.55	0.80	1.62	2.39	Sand Mixture:Silty Sand to Sandy Silt	63.64	63.77	63.55	63.64
	0.80	1.63	0.68	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.29	63.61	62.27	63.31
	1.63	1.78	1.21	2.89	Silt Mixture: Clayey Silt to Silty Clay	63.60	62.86	63.35	61.50
	1.78	1.93	0.76	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.59	63.45	63.30	62.94
	1.93	2.10	0.63	3.07	Clays: Silty Clay to Clay	63.57	63.41	63.24	62.85
	2.10	2.28	0.75	2.91	Silt Mixture: Clayey Silt to Silty Clay	63.55	63.37	63.13	62.75
	2.28	2.65	0.65	3.03	Clays: Silty Clay to Clay	63.50	63.31	62.93	62.59
	2.65	3.23	0.75	2.79	Silt Mixture: Clayey Silt to Silty Clay	63.43	63.20	62.65	62.30
	3.23	3.95	0.64	3.11	Clays: Silty Clay to Clay	63.35	63.05	62.35	61.93
	3.95	4.45	3.27	2.34	Sand Mixture:Silty Sand to Sandy Silt	63.24	62.90	62.01	61.56
	4.45	5.25	0.59	3.16	Clays: Silty Clay to Clay	63.15	62.73	61.76	61.15
	5.25	5.38	0.63	2.79	Silt Mixture: Clayey Silt to Silty Clay	63.12	62.60	61.69	60.85
	5.38	5.50	0.60	3.07	Clays: Silty Clay to Clay	63.10	62.56	61.62	60.77
	5.50	5.60	0.69	2.93	Silt Mixture: Clayey Silt to Silty Clay	63.07	62.53	61.54	60.69
	5.60	5.80	0.62	3.22	Clays: Silty Clay to Clay	63.02	62.48	61.42	60.59
SP37- Obserced Settlemen =0.161m SP40- Obserced Settlemen =0.53m	5.80	6.00	0.89	2.80	Silt Mixture: Clayey Silt to Silty Clay	62.95	62.42	61.26	60.46
	6.00	6.35	0.82	3.05	Clays: Silty Clay to Clay	62.88	62.33	61.09	60.27
	6.35	6.55	0.80	2.76	Silt Mixture: Clayey Silt to Silty Clay	62.48	62.23	60.25	60.08
	6.55	9.05	9.81	1.80	Sands:Clean Sand to Silty Sand	62.01	61.70	59.36	59.10
	9.05	9.35	0.62	3.31	Clays: Silty Clay to Clay	61.90	61.08	59.18	58.06
	9.35	9.63	7.87	1.83	Sands:Clean Sand to Silty Sand	61.77	60.94	58.96	57.84
	9.63	10.03	2.15	2.83	Silt Mixture: Clayey Silt to Silty Clay	61.66	60.78	58.78	57.59
	10.03	10.18	4.20	2.31	Sand Mixture:Silty Sand to Sandy Silt	61.59	60.64	58.67	57.38
	10.18	10.38	1.29	3.16	Clays: Silty Clay to Clay	61.40	60.55	58.36	57.24
	10.38	11.40	10.46	1.71	Sands:Clean Sand to Silty Sand	61.19	60.30	58.04	56.88
	11.40	11.73	2.05	2.91	Silt Mixture: Clayey Silt to Silty Clay	61.06	59.87	57.85	56.27
	11.73	12.50	5.28	2.38	Sand Mixture:Silty Sand to Sandy Silt	60.83	59.57	57.50	55.86
	12.50	13.10	13.83	1.84	Sands:Clean Sand to Silty Sand	60.53	59.18	57.07	55.36
	13.10	13.25	2.09	3.03	Clays: Silty Clay to Clay	60.36	58.97	56.84	55.10
	13.25	14.00	11.35	1.85	Sands:Clean Sand to Silty Sand	60.16	58.72	56.56	54.78
	14.00	14.18	2.84	2.72	Silt Mixture: Clayey Silt to Silty Clay	59.96	58.46	56.28	54.46

Table 11 Database Summary of CPT-12a (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-37	Δσ (Average) (kPa) SP-39	Δσ (Average) (kPa) SP-40	Δσ (Average) (kPa) SP-54
	14.18	15.30	58.09	54.03	Clays: Silty Clay to Clay	59.67	58.09	55.89	54.03
	15.30	16.08	57.56	53.42	Sands:Clean Sand to Silty Sand	59.24	57.56	55.34	53.42
	16.08	17.38	56.98	52.79	Clays: Silty Clay to Clay	58.77	56.98	54.74	52.79
	17.38	17.75	56.51	52.30	Silt Mixture: Clayey Silt to Silty Clay	58.40	56.51	54.27	52.30
	17.75	17.85	56.38	52.17	Sand Mixture:Silty Sand to Sandy Silt	58.29	56.38	54.14	52.17
	17.85	18.28	56.23	52.02	Sand Mixture:Silty Sand to Sandy Silt	58.17	56.23	53.99	52.02
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	58.19	57.36	54.48	54.69
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	57.62	57.00	54.02	54.54
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	57.13	56.55	53.30	54.28
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	56.92	55.85	52.69	54.01
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	56.78	55.23	52.44	53.85
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	56.68	54.98	52.26	53.57
	20.60	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	56.56	54.80	52.15	52.91
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	56.36	54.69	52.01	52.38
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	56.14	54.54	51.76	51.71
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	56.01	54.28	51.49	51.39
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	55.78	54.01	51.34	51.14

Table 12 Database Summary of CPT-14

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-33	Δσ (Average) (kPa) SP-34
SP33- Obserced Settlemen = 0.139 SP34- Obserced Settlemen =0.179m	0.00	0.38	2.67	1.70	Sands:Clean Sand to Silty Sand	63.87	63.86
	0.38	0.63	1.06	2.42	Sand Mixture:Silty Sand to Sandy Silt	63.87	63.86
	0.63	1.50	0.81	2.79	Silt Mixture: Clayey Silt to Silty Clay	63.87	63.86
	1.50	2.60	1.00	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.84	63.86
	2.60	2.95	2.25	2.45	Sand Mixture:Silty Sand to Sandy Silt	63.84	63.85
	2.95	3.23	1.14	2.83	Silt Mixture: Clayey Silt to Silty Clay	63.81	63.84
	3.23	4.03	3.12	2.38	Sand Mixture:Silty Sand to Sandy Silt	63.81	63.84
	4.03	4.95	0.76	3.08	Clays: Silty Clay to Clay	63.77	63.83
	4.95	5.23	1.34	2.80	Silt Mixture: Clayey Silt to Silty Clay	63.76	63.82
	5.23	6.05	1.21	3.02	Clays: Silty Clay to Clay	63.69	63.81
	6.05	6.48	3.46	2.25	Sand Mixture:Silty Sand to Sandy Silt	63.68	63.80
	6.48	7.30	4.97	2.08	Sand Mixture:Silty Sand to Sandy Silt	63.65	63.79
	7.30	7.48	1.46	2.84	Silt Mixture: Clayey Silt to Silty Clay	63.62	63.78
	7.48	8.43	9.17	1.75	Sands:Clean Sand to Silty Sand	63.58	63.78
	8.43	8.70	23.80	1.20	Gravelly Sand to Dense Sand	63.51	63.77
	8.70	9.50	13.17	1.64	Sands:Clean Sand to Silty Sand	63.50	63.73
	9.50	10.00	0.69	3.38	Clays: Silty Clay to Clay	63.39	63.68
	10.00	10.20	0.54	3.65	Organic Soils Peat	63.33	63.65
	10.20	11.78	13.09	1.63	Sands:Clean Sand to Silty Sand	63.31	63.55
	11.78	12.38	1.31	3.05	Clays: Silty Clay to Clay	63.31	63.42
	12.38	12.68	5.67	2.14	Sand Mixture:Silty Sand to Sandy Silt	63.21	63.36
	12.68	12.93	1.56	2.97	Clays: Silty Clay to Clay	63.15	63.31
	12.93	13.38	6.18	2.19	Sand Mixture:Silty Sand to Sandy Silt	63.07	63.26
	13.38	13.68	1.86	2.99	Clays: Silty Clay to Clay	62.98	63.20
	13.68	13.88	8.15	1.92	Sands:Clean Sand to Silty Sand	62.91	63.15
	13.88	14.80	1.02	3.34	Clays: Silty Clay to Clay	62.76	63.05
	14.80	14.93	3.74	2.33	Sand Mixture:Silty Sand to Sandy Silt	62.61	62.95
	14.93	15.10	2.62	2.77	Silt Mixture: Clayey Silt to Silty Clay	62.56	62.91
	15.10	16.40	10.83	1.99	Sands:Clean Sand to Silty Sand	62.32	62.75
	16.40	17.83	1.43	3.22	Clays: Silty Clay to Clay	61.84	62.41
	17.83	19.25	1.39	3.33	Clays: Silty Clay to Clay	61.27	62.00
	19.25	19.70	3.33	2.69	Silt Mixture: Clayey Silt to Silty Clay	60.85	61.70

Table 12 Database Summary of CPT-14 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-33	Δσ (Average) (kPa) SP-34
	19.70	20.08	5.66	2.47	Sand Mixture:Silty Sand to Sandy Silt	60.65	61.56
	20.08	20.58	13.47	1.83	Sands:Clean Sand to Silty Sand	60.43	61.40
	20.58	21.25	2.81	2.98	Clays: Silty Clay to Clay	60.13	61.18
	21.25	21.83	10.51	2.02	Sands:Clean Sand to Silty Sand	59.79	60.93
	21.83	23.20	1.73	3.31	Clays: Silty Clay to Clay	59.22	60.52
	23.20	24.58	1.71	3.36	Clays: Silty Clay to Clay	58.36	59.89

Table 13 Database Summary of CPT-17

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-35	Δσ (Average) (kPa) SP-37	Δσ (Average) (kPa) SP-38	Δσ (Average) (kPa) SP-40
SP37- Obserced Settlemen =0.161m SP40- Obserced Settlemen =0.153m	0.00	0.18	3.15	1.65	Sands:Clean Sand to Silty Sand	63.93	63.92	63.87	63.89
	0.18	0.98	1.18	2.48	Sand Mixture:Silty Sand to Sandy Silt	63.86	63.88	63.87	63.80
	0.98	1.85	0.90	2.83	Silt Mixture: Clayey Silt to Silty Clay	63.79	63.83	63.87	63.59
	1.85	2.10	2.34	2.45	Sand Mixture:Silty Sand to Sandy Silt	63.76	63.79	63.85	63.41
	2.10	2.40	1.27	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.76	63.77	63.81	63.31
	2.40	2.88	0.70	3.05	Clays: Silty Clay to Clay	63.75	63.73	63.80	63.16
	2.88	3.28	0.62	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.74	63.69	63.77	62.98
	3.28	3.95	0.69	3.15	Clays: Silty Clay to Clay	63.74	63.63	63.73	62.74
	3.95	4.35	2.76	2.30	Sand Mixture:Silty Sand to Sandy Silt	63.73	63.56	63.70	62.48
	4.35	4.75	1.07	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.72	63.49	63.67	62.27
	4.75	4.95	0.89	3.00	Clays: Silty Clay to Clay	63.71	63.44	63.64	62.11
	4.95	5.28	1.11	2.91	Silt Mixture: Clayey Silt to Silty Clay	63.70	63.39	63.62	61.97
	5.28	5.78	0.69	3.10	Clays: Silty Clay to Clay	63.68	63.30	63.55	61.74
	5.78	6.33	1.31	2.72	Silt Mixture: Clayey Silt to Silty Clay	63.65	63.18	63.49	61.43
	6.33	8.05	13.74	1.44	Sands:Clean Sand to Silty Sand	63.54	62.87	63.47	60.74
	8.05	8.23	22.04	1.27	Gravelly Sand to Dense Sand	63.42	62.58	63.39	60.14
SP35- Obserced Settlemen =0.128m SP38- Obserced Settlemen =0.178m	8.23	8.48	11.76	1.66	Sands:Clean Sand to Silty Sand	63.39	62.51	63.38	60.01
	8.48	8.65	1.18	3.15	Clays: Silty Clay to Clay	63.36	62.44	63.32	59.87
	8.65	11.10	12.03	1.65	Sands:Clean Sand to Silty Sand	63.10	61.94	63.29	59.03
	11.10	12.78	1.03	3.17	Clays: Silty Clay to Clay	62.62	61.10	63.26	57.71
	12.78	13.30	2.36	2.79	Silt Mixture: Clayey Silt to Silty Clay	62.32	60.62	63.21	57.02
	13.30	14.13	1.09	3.31	Clays: Silty Clay to Clay	62.13	60.32	63.15	56.61
	14.13	14.38	3.49	2.66	Silt Mixture: Clayey Silt to Silty Clay	61.97	60.08	63.15	56.28
	14.38	14.88	1.70	3.05	Clays: Silty Clay to Clay	61.85	59.92	63.10	56.06
	14.88	15.03	2.13	2.77	Silt Mixture: Clayey Silt to Silty Clay	61.75	59.77	62.99	55.87
	15.03	15.30	5.09	2.34	Sand Mixture:Silty Sand to Sandy Silt	61.68	59.68	62.95	55.74
	15.30	16.08	12.63	1.83	Sands:Clean Sand to Silty Sand	61.51	59.44	62.82	55.44
	16.08	17.38	1.21	3.26	Clays: Silty Clay to Clay	61.16	58.97	62.73	54.84
	17.38	18.63	1.28	3.41	Clays: Silty Clay to Clay	60.70	58.40	62.37	54.12
	18.63	18.85	3.90	2.70	Silt Mixture: Clayey Silt to Silty Clay	60.42	58.07	62.15	53.71
	18.85	19.20	1.54	3.33	Clays: Silty Clay to Clay	60.31	57.94	62.06	53.55

Table 13 Database Summary of CPT-17 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-35	Δσ (Average) (kPa) SP-37	Δσ (Average) (kPa) SP-38	Δσ (Average) (kPa) SP-40
	19.35	21.10	1.68	3.28	Clays: Silty Clay to Clay	59.81	57.38	61.65	52.89
	21.10	21.63	8.82	2.31	Sand Mixture:Silty Sand to Sandy Silt	59.30	56.85	61.24	52.26
	21.63	22.10	2.92	3.13	Clays: Silty Clay to Clay	59.06	56.62	61.05	51.98
	22.10	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	58.97	56.14	60.62	51.76
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	58.40	56.01	60.32	51.49
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	58.07	55.78	60.08	51.34

Table 15 Database Summary of CPT-18

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-35	Δσ (Average) (kPa) SP-36
SP35- Obserced Settlemen = 0.128 SP34- Obserced Settlemen =0.169m	0.00	0.43	2.80	1.66	Sands:Clean Sand to Silty Sand	63.76	63.86
	0.43	0.80	1.39	2.41	Sand Mixture:Silty Sand to Sandy Silt	63.71	63.86
	0.80	1.73	0.89	2.72	Silt Mixture: Clayey Silt to Silty Clay	63.65	63.85
	1.73	1.93	0.74	2.99	Clays: Silty Clay to Clay	63.62	63.85
	1.93	2.28	0.99	2.79	Silt Mixture: Clayey Silt to Silty Clay	63.61	63.82
	2.28	2.68	0.70	3.02	Clays: Silty Clay to Clay	63.60	63.80
	2.68	3.20	0.70	2.83	Silt Mixture: Clayey Silt to Silty Clay	63.60	63.80
	3.20	4.05	0.74	3.10	Clays: Silty Clay to Clay	63.59	63.78
	4.05	4.65	3.72	2.16	Sand Mixture:Silty Sand to Sandy Silt	63.58	63.77
	4.65	5.08	0.80	2.90	Silt Mixture: Clayey Silt to Silty Clay	63.56	63.74
	5.08	6.15	0.71	3.08	Clays: Silty Clay to Clay	63.53	63.74
	6.15	7.13	11.01	1.69	Sands:Clean Sand to Silty Sand	63.45	63.71
	7.13	7.83	21.40	1.29	Gravelly Sand to Dense Sand	63.36	63.69
	7.83	8.70	11.16	1.59	Sands:clean sand to silty sand	63.12	63.16
	8.70	8.95	0.92	3.11	Silt Mixtures:clayey silt to silty clay	63.08	63.15
	8.95	9.45	11.90	1.55	Sand Mixtures:silty sand to sandy silt	63.07	63.14
	9.45	9.65	23.26	1.22	Gravelly sand to dense sand	63.06	63.13
	9.65	11.05	11.93	1.67	Sands:clean sand to silty sand	63.05	63.12
	11.05	12.40	14.24	1.69	Sands:clean sand to silty sand	63.04	63.09
	12.40	12.80	1.90	2.80	Silt Mixtures:clayey silt to silty clay	63.03	63.09
	12.80	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	63.03	63.07
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	63.02	63.06
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	62.99	63.02
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	62.95	63.00
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	62.88	62.98
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	62.73	62.90
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	62.61	62.85
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	62.54	62.80
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	62.48	62.67
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	62.31	62.41
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	61.98	62.23
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	61.75	62.10

Table 15 Database Summary of CPT-18 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-35	Δσ (Average) (kPa) SP-36
	20.60	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	61.59	61.89
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	61.32	61.70
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	61.10	61.53
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	60.89	61.31
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	60.63	60.94

Table 16 Database Summary of CPT-18a

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	$\Delta\sigma$ (Average) (kPa) SP-35	$\Delta\sigma$ (Average) (kPa) SP-36
SP35- Obserced Settlemen = 0.128 SP34- Obserced Settlemen =0.169m	0.00	0.25	3.80	1.56	Sands:Clean Sand to Silty Sand	64.07	63.96
	0.25	0.73	1.73	2.34	Sand Mixture:Silty Sand to Sandy Silt	64.02	63.96
	0.73	2.18	0.86	2.78	Silt Mixture: Clayey Silt to Silty Clay	63.94	63.96
	2.18	2.90	0.66	3.06	Clays: Silty Clay to Clay	63.90	63.94
	2.90	3.05	0.68	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.90	63.94
	3.05	4.03	0.64	3.16	Clays: Silty Clay to Clay	63.89	63.93
	4.03	4.55	3.54	2.17	Sand Mixture:Silty Sand to Sandy Silt	63.88	63.92
	4.55	4.80	1.15	2.76	Silt Mixture: Clayey Silt to Silty Clay	63.87	63.90
	4.80	5.80	0.75	3.15	Clays: Silty Clay to Clay	63.84	63.89
	5.80	6.03	1.27	2.73	Silt Mixture: Clayey Silt to Silty Clay	63.81	63.85
	6.03	6.18	2.97	2.31	Sand Mixture:Silty Sand to Sandy Silt	63.80	63.80
	6.18	7.58	11.73	1.66	Sands:Clean Sand to Silty Sand	63.73	63.79
	7.83	8.70	11.16	1.59	Sands:clean sand to silty sand	63.12	63.16
	8.70	8.95	0.92	3.11	Silt Mixtures:clayey silt to silty clay	63.08	63.15
	8.95	9.45	11.90	1.55	Sand Mixtures:silty sand to sandy silt	63.07	63.14
	9.45	9.65	23.26	1.22	Gravelly sand to dense sand	63.06	63.13
	9.65	11.05	11.93	1.67	Sands:clean sand to silty sand	63.05	63.12
	11.05	12.40	14.24	1.69	Sands:clean sand to silty sand	63.04	63.09
	12.40	13.53	6.52	2.20	Sand Mixtures:silty sand to sandy silt	63.03	63.09
	13.53	14.60	18.15	1.59	Sands:clean sand to silty sand	63.03	63.07
	14.60	15.00	1.89	2.96	Silt Mixtures:clayey silt to silty clay	63.02	63.06
	15.00	15.88	13.79	1.72	Sand Mixtures:silty sand to sandy silt	62.99	63.02
	15.88	16.60	6.89	2.31	Sand Mixtures:silty sand to sandy silt	62.95	63.00
	16.60	18.40	1.53	3.24	Silt Mixtures:clayey silt to silty clay	62.88	62.98
	18.40	19.30	1.66	3.23	Clays:silty clay to clay	62.73	62.90
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	62.61	62.85
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	62.54	62.80
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	62.48	62.67
	19.98	21.88	1.68	3.24	Clays:silty clay to clay	62.31	62.41
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	61.98	62.23
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	61.10	61.53
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	60.89	61.31

Table 17 Database Summary of CPT-19

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-41	Δσ (Average) (kPa) SP-42	Δσ (Average) (kPa) SP-43	Δσ (Average) (kPa) SP-44
SP42- Obserced Settlemen =0.225m SP44- Obserced Settlemen =0.226m	0.00	0.15	3.27	1.08	Gravelly Sand to Dense Sand	63.94	63.96	63.96	63.97
	0.15	0.30	2.52	1.81	Sands:Clean Sand to Silty Sand	63.94	63.95	63.93	63.95
	0.30	0.55	1.70	2.15	Sand Mixture:Silty Sand to Sandy Silt	63.89	63.93	63.92	63.94
	0.55	0.90	2.44	1.89	Sands:Clean Sand to Silty Sand	63.88	63.92	63.88	63.89
	0.90	1.25	1.01	2.35	Sand Mixture:Silty Sand to Sandy Silt	63.83	63.88	63.85	63.88
	1.25	2.88	0.86	2.85	Silt Mixture: Clayey Silt to Silty Clay	63.80	63.86	63.84	63.84
	2.88	3.05	1.64	2.42	Sand Mixture:Silty Sand to Sandy Silt	63.78	63.83	63.80	63.83
	3.05	3.23	6.05	2.43	Sand Mixture:Silty Sand to Sandy Silt	63.74	63.80	63.77	63.78
	3.23	4.05	0.77	3.03	Clays: Silty Clay to Clay	63.71	63.79	63.73	63.74
	4.05	4.70	3.23	2.23	Sand Mixture:Silty Sand to Sandy Silt	63.71	63.78	63.63	63.74
	4.70	5.10	1.01	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.54	63.76	63.44	63.71
	5.10	6.30	1.10	3.04	Clays: Silty Clay to Clay	63.38	63.70	63.26	63.64
	6.30	6.50	2.34	2.29	Sand Mixture:Silty Sand to Sandy Silt	63.30	63.66	63.18	63.60
	6.50	6.83	1.41	2.74	Silt Mixture: Clayey Silt to Silty Clay	63.20	63.60	63.08	63.54
	6.83	7.20	2.68	2.33	Sand Mixture:Silty Sand to Sandy Silt	63.07	63.52	62.94	63.47
	7.20	7.73	6.40	1.88	Sands:Clean Sand to Silty Sand	62.95	63.45	62.81	63.40
SP41- Obserced Settlemen =0.187m SP43- Obserced Settlemen =0.204m	7.73	7.95	4.76	2.35	Sand Mixture:Silty Sand to Sandy Silt	62.71	63.30	62.57	63.27
	7.95	9.15	12.30	1.63	Sands:Clean Sand to Silty Sand	62.45	63.14	62.31	63.13
	9.15	9.35	19.91	1.24	Gravelly Sand to Dense Sand	62.27	63.03	62.13	63.03
	9.35	10.10	13.11	1.65	Sands:Clean Sand to Silty Sand	61.99	62.86	61.86	62.88
	10.10	10.78	1.23	3.00	Clays: Silty Clay to Clay	61.80	62.74	61.68	62.78
	10.78	11.00	6.19	1.96	Sands:Clean Sand to Silty Sand	61.72	62.69	61.59	62.74
	11.00	11.18	1.52	2.90	Silt Mixture: Clayey Silt to Silty Clay	61.62	62.63	61.50	62.69
	11.18	11.45	2.49	2.56	Sand Mixture:Silty Sand to Sandy Silt	61.49	62.55	61.38	62.62
	11.45	11.78	5.57	2.07	Sand Mixture:Silty Sand to Sandy Silt	61.34	62.49	61.26	62.52
	11.78	13.05	1.22	3.18	Clays: Silty Clay to Clay	61.13	62.34	61.03	62.43
	13.05	13.20	6.00	2.22	Sand Mixture:Silty Sand to Sandy Silt	60.80	62.15	60.72	62.25
	13.20	14.75	13.60	1.76	Sands:Clean Sand to Silty Sand	60.40	61.92	60.33	62.03
	14.75	15.10	1.55	3.21	Clays: Silty Clay to Clay	59.93	61.65	59.88	61.77
	15.10	15.70	17.43	1.51	Sands:Clean Sand to Silty Sand	59.69	61.52	59.65	61.63
	15.70	16.28	4.37	2.59	Sand Mixture:Silty Sand to Sandy Silt	59.39	61.35	59.36	61.46
	16.28	16.45	13.33	1.86	Sands:Clean Sand to Silty Sand	59.19	61.24	59.17	61.34

Table 17 Database Summary of CPT-19 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-41	Δσ (Average) (kPa) SP-42	Δσ (Average) (kPa) SP-43	Δσ (Average) (kPa) SP-44
					Sand Mixture:Silty Sand to Sandy Silt				
	16.73	18.25	1.65	3.11	Clays: Silty Clay to Clay	58.59	60.90	58.59	60.98
	18.25	18.65	9.54	2.21	Sand Mixture:Silty Sand to Sandy Silt	58.06	60.59	58.06	60.66
	18.65	18.83	5.13	2.75	Silt Mixture: Clayey Silt to Silty Clay	57.90	60.50	57.90	60.56
	18.83	19.43	9.21	2.23	Sand Mixture:Silty Sand to Sandy Silt	57.68	60.37	57.68	60.42
	19.43	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	57.49	59.84	57.49	59.92
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	57.18	59.67	57.19	59.73
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	56.74	59.40	56.75	59.46
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	56.42	59.21	56.43	59.25

Table 17 Database Summary of CPT-19 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-45	Δσ (Average) (kPa) SP-46	Δσ (Average) (kPa) SP-47
SP45- Obserced Settlemen =0.271m SP46- Obserced Settlemen =0.238m SP47- Obserced Settlemen =0.211m	0.00	0.15	3.27	1.08	Gravelly Sand to Dense Sand	63.97	63.82	63.99
	0.15	0.30	2.52	1.81	Sands:Clean Sand to Silty Sand	63.95	63.82	63.99
	0.30	0.55	1.70	2.15	Sand Mixture:Silty Sand to Sandy Silt	63.94	63.79	63.96
	0.55	0.90	2.44	1.89	Sands:Clean Sand to Silty Sand	63.89	63.79	63.96
	0.90	1.25	1.01	2.35	Sand Mixture:Silty Sand to Sandy Silt	63.88	63.76	63.94
	1.25	2.88	0.86	2.85	Silt Mixture: Clayey Silt to Silty Clay	63.84	63.74	63.91
	2.88	3.05	1.64	2.42	Sand Mixture:Silty Sand to Sandy Silt	63.83	63.73	63.91
	3.05	3.23	6.05	2.43	Sand Mixture:Silty Sand to Sandy Silt	63.78	63.72	63.90
	3.23	4.05	0.77	3.03	Clays: Silty Clay to Clay	63.74	63.71	63.88
	4.05	4.70	3.23	2.23	Sand Mixture:Silty Sand to Sandy Silt	63.74	63.68	63.87
	4.70	5.10	1.01	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.71	63.58	63.78
	5.10	6.30	1.10	3.04	Clays: Silty Clay to Clay	63.64	63.48	63.68
	6.30	6.50	2.34	2.29	Sand Mixture:Silty Sand to Sandy Silt	63.60	63.44	63.64
	6.50	6.83	1.41	2.74	Silt Mixture: Clayey Silt to Silty Clay	63.54	63.38	63.59
	6.83	7.20	2.68	2.33	Sand Mixture:Silty Sand to Sandy Silt	63.47	63.30	63.51
	7.20	7.73	6.40	1.88	Sands:Clean Sand to Silty Sand	63.40	63.23	63.44
	7.73	7.95	4.76	2.35	Sand Mixture:Silty Sand to Sandy Silt	63.27	63.09	63.28
	7.95	9.15	12.30	1.63	Sands:Clean Sand to Silty Sand	63.13	62.95	63.12
	9.15	9.35	19.91	1.24	Gravelly Sand to Dense Sand	63.03	62.84	63.00
	9.35	10.10	13.11	1.65	Sands:Clean Sand to Silty Sand	62.88	62.68	62.81
	10.10	10.78	1.23	3.00	Clays: Silty Clay to Clay	62.78	62.58	62.68
	10.78	11.00	6.19	1.96	Sands:Clean Sand to Silty Sand	62.74	62.54	62.62
	11.00	11.18	1.52	2.90	Silt Mixture: Clayey Silt to Silty Clay	62.69	62.49	62.55
	11.18	11.45	2.49	2.56	Sand Mixture:Silty Sand to Sandy Silt	62.62	62.42	62.46
	11.45	11.78	5.57	2.07	Sand Mixture:Silty Sand to Sandy Silt	62.52	62.38	62.21
	11.78	13.05	1.22	3.18	Clays: Silty Clay to Clay	62.43	62.23	62.19
	13.05	13.20	6.00	2.22	Sand Mixture:Silty Sand to Sandy Silt	62.25	62.06	61.94
	13.20	14.75	13.60	1.76	Sands:Clean Sand to Silty Sand	62.03	61.86	61.61
	14.75	15.10	1.55	3.21	Clays: Silty Clay to Clay	61.77	61.63	61.23
	15.10	15.70	17.43	1.51	Sands:Clean Sand to Silty Sand	61.63	61.51	61.03
	15.70	16.28	4.37	2.59	Sand Mixture:Silty Sand to Sandy Silt	61.46	61.35	60.77
	16.28	16.45	13.33	1.86	Sands:Clean Sand to Silty Sand	61.34	61.25	60.60

Table 17 Database Summary of CPT-19 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-45	Δσ (Average) (kPa) SP-46	Δσ (Average) (kPa) SP-47
	16.45	16.73	5.92	2.39	Sand Mixture:Silty Sand to Sandy Silt	61.27	61.19	60.50
	16.73	18.25	1.65	3.11	Clays: Silty Clay to Clay	60.98	60.94	60.07
	18.25	18.65	9.54	2.21	Sand Mixture:Silty Sand to Sandy Silt	60.66	60.65	59.60
	18.65	18.83	5.13	2.75	Silt Mixture: Clayey Silt to Silty Clay	60.56	60.56	59.45
	18.83	19.43	9.21	2.23	Sand Mixture:Silty Sand to Sandy Silt	60.42	60.44	59.25
	19.43	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	60.36	60.27	59.72
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	60.12	60.06	59.37
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	59.92	59.89	59.08
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	59.73	59.72	58.81

Table 17 Database Summary of CPT-19 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-48	Δσ (Average) (kPa) SP-49	Δσ (Average) (kPa) SP-50
SP48- Obserced Settlemen =0.246m SP49- Obserced Settlemen =0.203m SP50- Obserced Settlemen =0.1544m	0.00	0.15	3.27	1.08	Gravelly Sand to Dense Sand	64.00	63.88	63.98
	0.15	0.30	2.52	1.81	Sands:Clean Sand to Silty Sand	63.99	63.88	63.92
	0.30	0.55	1.70	2.15	Sand Mixture:Silty Sand to Sandy Silt	63.98	63.87	63.85
	0.55	0.90	2.44	1.89	Sands:Clean Sand to Silty Sand	63.96	63.87	63.71
	0.90	1.25	1.01	2.35	Sand Mixture:Silty Sand to Sandy Silt	63.94	63.86	63.53
	1.25	2.88	0.86	2.85	Silt Mixture: Clayey Silt to Silty Clay	63.91	63.84	62.82
	2.88	3.05	1.64	2.42	Sand Mixture:Silty Sand to Sandy Silt	63.90	63.84	62.04
	3.05	3.23	6.05	2.43	Sand Mixture:Silty Sand to Sandy Silt	63.89	63.81	61.31
	3.23	4.05	0.77	3.03	Clays: Silty Clay to Clay	63.88	63.80	60.44
	4.05	4.70	3.23	2.23	Sand Mixture:Silty Sand to Sandy Silt	63.87	63.78	59.76
	4.70	5.10	1.01	2.82	Silt Mixture: Clayey Silt to Silty Clay	63.86	63.75	58.64
	5.10	6.30	1.10	3.04	Clays: Silty Clay to Clay	63.85	63.71	57.60
	6.30	6.50	2.34	2.29	Sand Mixture:Silty Sand to Sandy Silt	63.84	63.71	57.20
	6.50	6.83	1.41	2.74	Silt Mixture: Clayey Silt to Silty Clay	63.83	63.70	56.65
	6.83	7.20	2.68	2.33	Sand Mixture:Silty Sand to Sandy Silt	63.81	63.70	55.94
	7.20	7.73	6.40	1.88	Sands:Clean Sand to Silty Sand	63.79	63.70	55.33
	7.73	7.95	4.76	2.35	Sand Mixture:Silty Sand to Sandy Silt	63.75	63.70	54.15
	7.95	9.15	12.30	1.63	Sands:Clean Sand to Silty Sand	63.71	63.62	52.98
	9.15	9.35	19.91	1.24	Gravelly Sand to Dense Sand	63.67	63.55	52.18
	9.35	10.10	13.11	1.65	Sands:Clean Sand to Silty Sand	63.60	63.42	50.99
	10.10	10.78	1.23	3.00	Clays: Silty Clay to Clay	63.56	63.34	50.23
	10.78	11.00	6.19	1.96	Sands:Clean Sand to Silty Sand	63.54	63.30	49.90
	11.00	11.18	1.52	2.90	Silt Mixture: Clayey Silt to Silty Clay	63.51	63.25	49.74
	11.18	11.45	2.49	2.56	Sand Mixture:Silty Sand to Sandy Silt	63.48	63.18	49.52
	11.45	11.78	5.57	2.07	Sand Mixture:Silty Sand to Sandy Silt	63.37	62.99	49.03
	11.78	13.05	1.22	3.18	Clays: Silty Clay to Clay	63.28	62.87	47.73
	13.05	13.20	6.00	2.22	Sand Mixture:Silty Sand to Sandy Silt	63.27	62.80	46.59
	13.20	14.75	13.60	1.76	Sands:Clean Sand to Silty Sand	63.12	62.55	45.28
	14.75	15.10	1.55	3.21	Clays: Silty Clay to Clay	62.95	62.25	43.86
	15.10	15.70	17.43	1.51	Sands:Clean Sand to Silty Sand	62.85	62.09	43.18
	15.70	16.28	4.37	2.59	Sand Mixture:Silty Sand to Sandy Silt	62.72	61.88	42.35
	16.28	16.45	13.33	1.86	Sands:Clean Sand to Silty Sand	62.63	61.74	41.84

Table 17 Database Summary of CPT-19 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-48	Δσ (Average) (kPa) SP-49	Δσ (Average) (kPa) SP-50
	16.45	16.73	5.92	2.39	Sand Mixture:Silty Sand to Sandy Silt	62.58	61.66	41.54
	16.73	18.25	1.65	3.11	Clays: Silty Clay to Clay	62.35	61.30	40.37
	18.25	18.65	9.54	2.21	Sand Mixture:Silty Sand to Sandy Silt	62.08	60.88	39.17
	18.65	18.83	5.13	2.75	Silt Mixture: Clayey Silt to Silty Clay	62.00	60.75	38.82
	18.83	19.43	9.21	2.23	Sand Mixture:Silty Sand to Sandy Silt	61.88	60.57	38.36
	19.43	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	60.91	60.13	37.92
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	60.74	59.86	34.80
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	60.59	59.63	36.83
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	59.54	58.01	35.30

Table 18 Database Summary of CPT-20

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-41	Δσ (Average) (kPa) SP-42	Δσ (Average) (kPa) SP-43	Δσ (Average) (kPa) SP-44
SP42- Obserced Settlemen =0.225m SP44- Obserced Settlemen =0.226m	0.00	0.50	0.00	0.50	Sands:Clean Sand to Silty Sand	63.46	63.45	63.37	63.47
	0.50	0.63	0.50	0.63	Sand Mixture:Silty Sand to Sandy Silt	63.45	63.44	63.36	63.46
	0.63	1.03	0.63	1.03	Silt Mixture: Clayey Silt to Silty Clay	63.43	63.42	63.36	63.45
	1.03	1.48	1.03	1.48	Clays: Silty Clay to Clay	63.42	63.42	63.34	63.43
	1.48	1.68	1.48	1.68	Silt Mixture: Clayey Silt to Silty Clay	63.40	63.40	63.30	63.40
	1.68	2.05	1.68	2.05	Clays: Silty Clay to Clay	63.35	63.38	63.29	63.40
	2.05	2.53	2.05	2.53	Silt Mixture: Clayey Silt to Silty Clay	63.32	63.36	63.26	63.35
	2.53	3.98	2.53	3.98	Clays: Silty Clay to Clay	63.30	63.34	63.21	63.32
	3.98	4.53	3.98	4.53	Sand Mixture:Silty Sand to Sandy Silt	63.24	63.31	63.16	63.31
	4.53	5.63	4.53	5.63	Clays: Silty Clay to Clay	63.18	63.28	62.99	63.24
	5.63	6.03	5.63	6.03	Sand Mixture:Silty Sand to Sandy Silt	63.02	63.28	62.81	63.22
	6.03	6.23	6.03	6.23	Silt Mixture: Clayey Silt to Silty Clay	62.95	63.24	62.73	63.18
	6.23	6.50	6.23	6.50	Sand Mixture:Silty Sand to Sandy Silt	62.89	63.21	62.67	63.15
	6.50	8.40	6.50	8.40	Sands:Clean Sand to Silty Sand	62.57	63.02	62.33	62.97
	8.40	9.20	8.40	9.20	Silt Mixture: Clayey Silt to Silty Clay	61.73	62.51	61.50	62.51
	9.20	10.45	9.20	10.45	Sands:Clean Sand to Silty Sand	61.45	62.33	61.22	62.36
SP41- Obserced Settlemen =0.187m SP43- Obserced Settlemen =0.204m	10.45	10.63	10.45	10.63	Sand Mixture:Silty Sand to Sandy Silt	61.29	62.23	61.06	62.27
	10.63	11.23	10.63	11.23	Clays: Silty Clay to Clay	61.04	62.08	60.82	62.14
	11.23	11.78	11.23	11.78	Sands:Clean Sand to Silty Sand	60.86	61.98	60.66	62.05
	11.78	12.03	11.78	12.03	Sand Mixture:Silty Sand to Sandy Silt	60.73	61.90	60.53	61.98
	12.03	12.38	12.03	12.38	Sands:Clean Sand to Silty Sand	60.44	61.73	60.25	61.82
	12.38	13.28	12.38	13.28	Clays: Silty Clay to Clay	60.17	61.57	60.00	61.68
	13.28	13.53	13.28	13.53	Sand Mixture:Silty Sand to Sandy Silt	60.00	61.47	59.83	61.58
	13.53	14.00	13.53	14.00	Silt Mixture: Clayey Silt to Silty Clay	59.82	61.37	59.66	61.48
	14.00	14.28	14.00	14.28	Clays: Silty Clay to Clay	59.64	61.27	59.49	61.39
	14.28	14.73	14.28	14.73	Sands:Clean Sand to Silty Sand	59.53	61.22	59.37	61.28
	14.73	15.53	14.73	15.53	Clays: Silty Clay to Clay	59.33	61.09	59.19	61.21
	15.53	15.98	15.53	15.98	Sand Mixture:Silty Sand to Sandy Silt	59.01	60.92	58.88	61.03
	15.98	16.18	15.98	16.18	Silt Mixture: Clayey Silt to Silty Clay	58.84	60.82	58.72	60.93
	16.18	16.40	16.18	16.40	Sand Mixture:Silty Sand to Sandy Silt	58.73	60.76	58.61	60.87
	16.40	17.48	16.40	17.48	Clays: Silty Clay to Clay	58.39	60.57	58.28	60.66
	17.48	18.85	17.48	18.85	Clays: Silty Clay to Clay	57.72	60.18	57.62	60.26

Table 18 Database Summary of CPT-20

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-41	Δσ (Average) (kPa) SP-42	Δσ (Average) (kPa) SP-43	Δσ (Average) (kPa) SP-44
	18.85	19.43	3.49	2.73	Silt Mixture: Clayey Silt to Silty Clay	57.17	59.86	57.08	59.91
	19.43	20.60	1.40	3.43	Clays: Silty Clay to Clay	56.67	59.55	56.57	59.59
	20.60	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	56.16	59.05	56.16	59.08
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	55.58	58.68	55.58	58.76
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	54.72	58.08	54.69	58.16
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	54.41	57.75	54.38	57.92

Table 18 Database Summary of CPT-20 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-45	Δσ (Average) (kPa) SP-46	Δσ (Average) (kPa) SP-47
SP45- Obserced Settlemen =0.271m SP46- Obserced Settlemen =0.238m SP47- Obserced Settlemen =0.211m	0.00	0.50	0.00	0.50	Sands:Clean Sand to Silty Sand	63.37	63.32	63.50
	0.50	0.63	0.50	0.63	Sand Mixture:Silty Sand to Sandy Silt	63.36	63.32	63.49
	0.63	1.03	0.63	1.03	Silt Mixture: Clayey Silt to Silty Clay	63.35	63.31	63.48
	1.03	1.48	1.03	1.48	Clays: Silty Clay to Clay	63.33	63.30	63.48
	1.48	1.68	1.48	1.68	Silt Mixture: Clayey Silt to Silty Clay	63.30	63.30	63.47
	1.68	2.05	1.68	2.05	Clays: Silty Clay to Clay	63.30	63.27	63.44
	2.05	2.53	2.05	2.53	Silt Mixture: Clayey Silt to Silty Clay	63.25	63.25	63.43
	2.53	3.98	2.53	3.98	Clays: Silty Clay to Clay	63.22	63.25	63.42
	3.98	4.53	3.98	4.53	Sand Mixture:Silty Sand to Sandy Silt	63.21	63.23	63.40
	4.53	5.63	4.53	5.63	Clays: Silty Clay to Clay	63.14	63.16	63.35
	5.63	6.03	5.63	6.03	Sand Mixture:Silty Sand to Sandy Silt	63.12	63.07	63.26
	6.03	6.23	6.03	6.23	Silt Mixture: Clayey Silt to Silty Clay	63.08	63.03	63.22
	6.23	6.50	6.23	6.50	Sand Mixture:Silty Sand to Sandy Silt	63.05	62.99	63.19
	6.50	8.40	6.50	8.40	Sands:Clean Sand to Silty Sand	62.87	62.80	63.00
	8.40	9.20	8.40	9.20	Silt Mixture: Clayey Silt to Silty Clay	62.41	62.32	62.48
	9.20	10.45	9.20	10.45	Sands:Clean Sand to Silty Sand	62.26	62.16	62.28
	10.45	10.63	10.45	10.63	Sand Mixture:Silty Sand to Sandy Silt	62.17	62.07	62.17
	10.63	11.23	10.63	11.23	Clays: Silty Clay to Clay	62.04	61.94	61.99
	11.23	11.78	11.23	11.78	Sands:Clean Sand to Silty Sand	61.95	61.85	61.86
	11.78	12.03	11.78	12.03	Sand Mixture:Silty Sand to Sandy Silt	61.88	61.78	61.76
	12.03	12.38	12.03	12.38	Sands:Clean Sand to Silty Sand	61.72	61.63	61.55
	12.38	13.28	12.38	13.28	Clays: Silty Clay to Clay	61.58	61.50	61.34
	13.28	13.53	13.28	13.53	Sand Mixture:Silty Sand to Sandy Silt	61.48	61.41	61.20
	13.53	14.00	13.53	14.00	Silt Mixture: Clayey Silt to Silty Clay	61.38	61.32	61.05
	14.00	14.28	14.00	14.28	Clays: Silty Clay to Clay	61.29	61.23	60.91
	14.28	14.73	14.28	14.73	Sands:Clean Sand to Silty Sand	61.18	61.17	60.73
	14.73	15.53	14.73	15.53	Clays: Silty Clay to Clay	61.11	61.07	60.65
	15.53	15.98	15.53	15.98	Sand Mixture:Silty Sand to Sandy Silt	60.93	60.92	60.38
	15.98	16.18	15.98	16.18	Silt Mixture: Clayey Silt to Silty Clay	60.83	60.83	60.23
	16.18	16.40	16.18	16.40	Sand Mixture:Silty Sand to Sandy Silt	60.77	60.77	60.13
	16.40	17.48	16.40	17.48	Clays: Silty Clay to Clay	60.56	60.60	59.83
	17.48	18.85	17.48	18.85	Clays: Silty Clay to Clay	60.16	60.24	59.24

Table 18-Database Summary of CPT-20 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-45	Δσ (Average) (kPa) SP-46	Δσ (Average) (kPa) SP-47
	18.85	19.43	3.49	2.73	Silt Mixture: Clayey Silt to Silty Clay	59.81	59.93	58.75
	19.43	20.60	1.40	3.43	Clays: Silty Clay to Clay	59.49	59.63	58.29
	20.60	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	59.08	59.13	57.88
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	58.71	58.76	57.35
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	58.12	58.16	56.56
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	57.52	57.92	56.28

Table 18 Database Summary of CPT-20 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-48	Δσ (Average) (kPa) SP-49	Δσ (Average) (kPa) SP-50
SP48- Obserced Settlemen =0.246m SP49- Obserced Settlemen =0.203m SP50- Obserced Settlemen =0.1544m	0.00	0.50	0.00	0.50	Sands:Clean Sand to Silty Sand	63.44	63.53	63.61
	0.50	0.63	0.50	0.63	Sand Mixture:Silty Sand to Sandy Silt	63.42	63.53	63.49
	0.63	1.03	0.63	1.03	Silt Mixture: Clayey Silt to Silty Clay	63.41	63.53	63.36
	1.03	1.48	1.03	1.48	Clays: Silty Clay to Clay	63.39	63.52	63.12
	1.48	1.68	1.48	1.68	Silt Mixture: Clayey Silt to Silty Clay	63.37	63.51	62.91
	1.68	2.05	1.68	2.05	Clays: Silty Clay to Clay	63.37	63.47	62.70
	2.05	2.53	2.05	2.53	Silt Mixture: Clayey Silt to Silty Clay	63.36	63.46	62.36
	2.53	3.98	2.53	3.98	Clays: Silty Clay to Clay	63.34	63.42	61.43
	3.98	4.53	3.98	4.53	Sand Mixture:Silty Sand to Sandy Silt	63.33	63.39	60.29
	4.53	5.63	4.53	5.63	Clays: Silty Clay to Clay	63.32	63.38	59.21
	5.63	6.03	5.63	6.03	Sand Mixture:Silty Sand to Sandy Silt	63.31	63.36	58.16
	6.03	6.23	6.03	6.23	Silt Mixture: Clayey Silt to Silty Clay	63.30	63.35	57.72
	6.23	6.50	6.23	6.50	Sand Mixture:Silty Sand to Sandy Silt	63.30	63.35	57.36
	6.50	8.40	6.50	8.40	Sands:Clean Sand to Silty Sand	63.26	63.35	55.65
	8.40	9.20	8.40	9.20	Silt Mixture: Clayey Silt to Silty Clay	63.11	63.18	51.72
	9.20	10.45	9.20	10.45	Sands:Clean Sand to Silty Sand	63.04	63.05	50.52
	10.45	10.63	10.45	10.63	Sand Mixture:Silty Sand to Sandy Silt	63.00	62.98	49.87
	10.63	11.23	10.63	11.23	Clays: Silty Clay to Clay	62.94	62.86	48.91
	11.23	11.78	11.23	11.78	Sands:Clean Sand to Silty Sand	62.89	62.76	48.26
	11.78	12.03	11.78	12.03	Sand Mixture:Silty Sand to Sandy Silt	62.85	62.69	47.77
	12.03	12.38	12.03	12.38	Sands:Clean Sand to Silty Sand	62.76	62.53	46.76
	12.38	13.28	12.38	13.28	Clays: Silty Clay to Clay	62.67	62.37	45.86
	13.28	13.53	13.28	13.53	Sand Mixture:Silty Sand to Sandy Silt	62.61	62.27	45.30
	13.53	14.00	13.53	14.00	Silt Mixture: Clayey Silt to Silty Clay	62.55	62.16	44.72
	14.00	14.28	14.00	14.28	Clays: Silty Clay to Clay	62.48	62.04	44.57
	14.28	14.73	14.28	14.73	Sands:Clean Sand to Silty Sand	62.35	61.84	44.18
	14.73	15.53	14.73	15.53	Clays: Silty Clay to Clay	62.33	61.84	43.27
	15.53	15.98	15.53	15.98	Sand Mixture:Silty Sand to Sandy Silt	62.22	61.62	42.38
	15.98	16.18	15.98	16.18	Silt Mixture: Clayey Silt to Silty Clay	62.15	61.50	41.93
	16.18	16.40	16.18	16.40	Sand Mixture:Silty Sand to Sandy Silt	62.10	61.42	41.64
	16.40	17.48	16.40	17.48	Clays: Silty Clay to Clay	61.94	61.17	40.78
	17.48	18.85	17.48	18.85	Clays: Silty Clay to Clay	61.61	60.66	39.22

Table 18 Database Summary of CPT-20 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-48	Δσ (Average) (kPa) SP-49	Δσ (Average) (kPa) SP-50
	18.85	19.43	3.49	2.73	Silt Mixture: Clayey Silt to Silty Clay	61.33	60.22	38.05
	19.43	20.60	1.40	3.43	Clays: Silty Clay to Clay	61.05	59.79	37.04
	20.60	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	60.26	59.12	36.83
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	59.73	58.32	35.30
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	59.54	58.01	34.80
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	59.31	57.67	34.14

Table 19 Database Summary of CPT-23

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-25	Δσ (Average) (kPa) SP-26	Δσ (Average) (kPa) SP-27
SP25- Obserced Settlemen =0.139m SP26- Obserced Settlemen =0.183m SP27- Obserced Settlemen =0.193m	0.00	0.40	5.96	1.60	Sands:Clean Sand to Silty Sand	63.85	63.68	63.80
	0.40	0.68	12.87	1.30	Gravelly Sand to Dense Sand	63.85	63.67	63.78
	0.68	1.55	8.67	1.68	Sands:Clean Sand to Silty Sand	63.80	63.64	63.65
	1.55	1.85	2.45	2.35	Sand Mixture:Silty Sand to Sandy Silt	63.69	63.55	63.65
	1.85	2.25	0.87	2.99	Clays: Silty Clay to Clay	63.60	63.46	63.47
	2.25	3.60	1.11	2.83	Silt Mixture: Clayey Silt to Silty Clay	63.28	63.15	62.78
	3.60	4.78	4.47	2.24	Sand Mixture:Silty Sand to Sandy Silt	62.68	62.57	61.46
	4.78	5.88	0.74	3.13	Clays: Silty Clay to Clay	62.01	61.94	60.04
	5.88	6.23	1.18	2.82	Silt Mixture: Clayey Silt to Silty Clay	61.54	61.50	59.08
	6.23	6.35	3.02	2.30	Sand Mixture:Silty Sand to Sandy Silt	61.37	61.35	58.76
	6.35	8.43	9.46	1.76	Sands:Clean Sand to Silty Sand	60.59	60.65	57.29
	8.43	8.63	1.11	3.20	Clays: Silty Clay to Clay	59.76	59.90	55.80
	8.63	13.00	15.70	1.65	Sands:Clean Sand to Silty Sand	58.04	58.41	53.12
	13.00	14.63	1.24	3.22	Clays: Silty Clay to Clay	55.86	56.54	50.02
	14.63	14.85	4.45	2.44	Sand Mixture:Silty Sand to Sandy Silt	55.22	55.99	49.19
	14.85	15.80	1.42	3.33	Clays: Silty Clay to Clay	54.83	55.66	48.68
	15.80	16.25	6.44	2.30	Sand Mixture:Silty Sand to Sandy Silt	54.36	55.26	48.10
	16.25	18.48	1.43	3.33	Clays: Silty Clay to Clay	53.51	54.53	47.04
	18.48	18.75	3.52	2.82	Silt Mixture: Clayey Silt to Silty Clay	52.73	53.87	46.08
	18.75	19.08	13.28	1.97	Sands:Clean Sand to Silty Sand	52.54	53.72	45.86
	19.08	19.25	9.86	2.21	Sand Mixture:Silty Sand to Sandy Silt	52.39	53.59	45.68
	19.25	20.55	1.62	3.29	Clays: Silty Clay to Clay	51.95	53.22	45.16
	20.60	21.45	14.16	1.83	Sand Mixtures:silty sand to sandy silt	51.42	52.46	44.72
	21.45	23.45	1.51	3.33	Silt Mixtures:clayey silt to silty clay	50.73	51.88	43.73
	23.45	23.63	5.92	2.32	Sand Mixtures:silty sand to sandy silt	50.46	51.65	42.89
	23.63	25.50	1.80	3.40	Silt Mixtures:clayey silt to silty clay	50.26	51.48	42.56

Table 20 Database Summary of CPT-24

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-16	Δσ (Average) (kPa) SP-17	Δσ (Average) (kPa) SP-18
SP16- Obserced Settlemen =0.205m SP17- Obserced Settlemen =0.195m SP18- Obserced Settlemen =0.250m	0.00	1.03	1.15	2.50	Sand Mixture:Silty Sand to Sandy Silt	63.29	63.33	63.35
	1.03	1.28	0.60	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.29	63.33	63.34
	1.28	1.65	0.33	3.12	Clays: Silty Clay to Clay	63.28	63.32	63.28
	1.65	2.13	0.67	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.27	63.32	63.21
	2.13	2.48	0.90	2.96	Clays: Silty Clay to Clay	63.27	63.31	63.17
	2.48	2.80	5.19	2.05	Sands:Clean Sand to Silty Sand	63.26	63.31	63.04
	2.80	3.08	4.08	2.26	Sand Mixture:Silty Sand to Sandy Silt	63.25	63.29	62.91
	3.08	3.70	0.94	3.00	Clays: Silty Clay to Clay	63.25	63.26	62.66
	3.70	5.15	1.25	2.91	Silt Mixture: Clayey Silt to Silty Clay	63.24	63.25	61.97
	5.15	6.45	1.03	3.11	Clays: Silty Clay to Clay	63.20	63.12	60.87
	6.45	6.68	1.21	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.10	63.02	60.21
	6.68	7.08	0.69	3.09	Clays: Silty Clay to Clay	63.05	62.97	59.93
	7.08	7.65	3.37	2.33	Sand Mixture:Silty Sand to Sandy Silt	62.96	62.89	59.49
	7.65	8.00	7.29	1.77	Sands:Clean Sand to Silty Sand	62.85	62.80	59.08
	8.00	8.23	2.63	2.39	Sand Mixture:Silty Sand to Sandy Silt	62.78	62.75	58.82
	8.23	10.60	14.84	1.51	Sands:Clean Sand to Silty Sand	62.40	62.46	57.65
	10.60	10.90	3.59	2.56	Sand Mixture:Silty Sand to Sandy Silt	61.94	62.14	56.48
	10.90	11.18	7.94	2.00	Sands:Clean Sand to Silty Sand	61.83	62.06	56.24
	11.18	11.75	1.05	3.18	Clays: Silty Clay to Clay	61.66	61.95	55.88
	11.75	11.93	4.80	2.36	Sand Mixture:Silty Sand to Sandy Silt	61.51	61.85	55.57
	11.93	12.83	1.29	3.28	Clays: Silty Clay to Clay	61.29	61.69	55.13
	12.83	13.15	6.82	2.26	Sand Mixture:Silty Sand to Sandy Silt	61.03	61.52	54.64
	13.15	13.63	1.63	3.16	Clays: Silty Clay to Clay	60.86	61.40	54.33
	13.63	14.38	0.65	3.66	Organic Soils Peat	60.59	61.21	53.86
	14.38	14.55	0.85	3.48	Clays: Silty Clay to Clay	60.39	61.07	53.51
	14.55	14.90	10.06	1.96	Sands:Clean Sand to Silty Sand	60.27	60.99	53.32
	14.90	15.38	3.61	2.63	Silt Mixture: Clayey Silt to Silty Clay	60.09	60.85	53.01
	15.38	17.45	1.26	3.42	Clays: Silty Clay to Clay	59.52	60.43	52.10
	17.45	17.68	0.90	3.71	Organic Soils Peat	59.00	60.04	51.30
	17.68	17.98	2.57	2.96	Clays: Silty Clay to Clay	58.88	59.95	51.13
	17.98	18.25	7.09	2.28	Sand Mixture:Silty Sand to Sandy Silt	58.75	59.85	50.93
	18.25	18.55	2.09	3.24	Clays: Silty Clay to Clay	58.62	59.74	50.74

Table 20 Database Summary of CPT-24 Continued

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-16	Δσ (Average) (kPa) SP-17	Δσ (Average) (kPa) SP-18
	18.55	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	58.22	59.27	49.01
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	58.01	59.11	48.72
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	57.85	58.98	48.51
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	57.76	58.91	48.38
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	57.63	58.81	48.21
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	57.40	58.64	47.93
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	57.16	58.45	47.64
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	57.02	58.34	47.47
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	56.76	58.15	47.18
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	56.14	57.69	46.54
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	55.62	57.32	46.05
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	54.95	56.86	45.47

Table 20 Database Summary of CPT-24 (Contibued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-19	Δσ (Average) (kPa) SP-20	Δσ (Average) (kPa) SP-21
SP19- Obserced Settlemen =0.142m SP20- Obserced Settlemen =0.233m SP21- Obserced Settlemen =0.156m SP22- Obserced Settlemen =0.182m SP23- Obserced Settlemen =0.230m SP24- Obserced Settlemen =0.193m	0.00	1.03	1.15	2.50	Sand Mixture:Silty Sand to Sandy Silt	63.26	63.27	63.38
	1.03	1.28	0.60	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.26	63.26	63.36
	1.28	1.65	0.33	3.12	Clays: Silty Clay to Clay	63.26	63.24	63.35
	1.65	2.13	0.67	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.25	63.19	63.28
	2.13	2.48	0.90	2.96	Clays: Silty Clay to Clay	63.25	63.13	63.17
	2.48	2.80	5.19	2.05	Sands:Clean Sand to Silty Sand	63.24	63.08	63.06
	2.80	3.08	4.08	2.26	Sand Mixture:Silty Sand to Sandy Silt	63.24	63.03	62.95
	3.08	3.70	0.94	3.00	Clays: Silty Clay to Clay	63.23	62.96	62.76
	3.70	5.15	1.25	2.91	Silt Mixture: Clayey Silt to Silty Clay	63.21	62.80	62.22
	5.15	6.45	1.03	3.11	Clays: Silty Clay to Clay	63.19	62.63	61.38
	6.45	6.68	1.21	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.15	62.56	60.88
	6.68	7.08	0.69	3.09	Clays: Silty Clay to Clay	63.13	62.53	60.67
	7.08	7.65	3.37	2.33	Sand Mixture:Silty Sand to Sandy Silt	63.09	62.49	60.34
	7.65	8.00	7.29	1.77	Sands:Clean Sand to Silty Sand	63.05	62.45	60.03
	8.00	8.23	2.63	2.39	Sand Mixture:Silty Sand to Sandy Silt	63.03	62.42	59.83
	8.23	10.60	14.84	1.51	Sands:Clean Sand to Silty Sand	62.89	62.30	58.95
	10.60	10.90	3.59	2.56	Sand Mixture:Silty Sand to Sandy Silt	62.72	62.16	58.06
	10.90	11.18	7.94	2.00	Sands:Clean Sand to Silty Sand	62.68	62.13	57.87
	11.18	11.75	1.05	3.18	Clays: Silty Clay to Clay	62.62	62.07	57.60
	11.75	11.93	4.80	2.36	Sand Mixture:Silty Sand to Sandy Silt	62.56	62.02	57.36
	11.93	12.83	1.29	3.28	Clays: Silty Clay to Clay	62.48	61.95	57.02
	12.83	13.15	6.82	2.26	Sand Mixture:Silty Sand to Sandy Silt	62.37	61.86	56.65
	13.15	13.63	1.63	3.16	Clays: Silty Clay to Clay	62.30	61.80	56.41
	13.63	14.38	0.65	3.66	Organic Soils Peat	62.19	61.71	56.05
	14.38	14.55	0.85	3.48	Clays: Silty Clay to Clay	62.09	61.65	55.78
	14.55	14.90	10.06	1.96	Sands:Clean Sand to Silty Sand	62.04	61.61	55.63
	14.90	15.38	3.61	2.63	Silt Mixture: Clayey Silt to Silty Clay	61.95	61.56	55.40
	15.38	17.45	1.26	3.42	Clays: Silty Clay to Clay	61.66	61.44	54.71
	17.45	17.68	0.90	3.71	Organic Soils Peat	61.38	61.35	54.11
	17.68	17.98	2.57	2.96	Clays: Silty Clay to Clay	61.31	61.34	53.97
	17.98	18.25	7.09	2.28	Sand Mixture:Silty Sand to Sandy Silt	61.24	61.32	53.83
	18.25	18.55	2.09	3.24	Clays: Silty Clay to Clay	61.16	61.31	53.68

Table 20 Database Summary of CPT-24 (Contibued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)		Δσ (Average) (kPa) SP-19	Δσ (Average) (kPa) SP-20	Δσ (Average) (kPa) SP-21
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	61.10	60.76	52.54
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	60.80	60.70	51.99
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	60.67	60.67	51.77
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	60.58	60.65	51.61
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	60.52	60.63	51.51
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	60.44	60.60	51.39
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	60.30	60.54	51.18
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	60.15	60.44	50.96
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	60.06	60.36	50.84
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	59.89	60.17	50.62
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	59.51	59.41	50.15
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	59.20	58.43	49.79

Table 20 Database Summary of CPT-24 (Contibued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-25	Δσ (Average) (kPa) SP-26	Δσ (Average) (kPa) SP-27
SP25- Obserced Settlemen =0.139m SP27- Obserced Settlemen =0.193 m SP29- Obserced Settlemen =0.220 m SP26- Obserced Settlemen =0.183 m SP28- Obserced Settlemen =0.177 m SP30- Obserced Settlemen =0.201 m	0.00	1.03	1.15	2.50	Sand Mixture:Silty Sand to Sandy Silt	63.34	63.27	63.41
	1.03	1.28	0.60	2.87	Silt Mixture: Clayey Silt to Silty Clay	63.30	63.24	63.34
	1.28	1.65	0.33	3.12	Clays: Silty Clay to Clay	63.24	63.20	63.33
	1.65	2.13	0.67	2.77	Silt Mixture: Clayey Silt to Silty Clay	63.14	63.10	63.15
	2.13	2.48	0.90	2.96	Clays: Silty Clay to Clay	63.02	62.98	62.91
	2.48	2.80	5.19	2.05	Sands:Clean Sand to Silty Sand	62.90	62.87	62.65
	2.80	3.08	4.08	2.26	Sand Mixture:Silty Sand to Sandy Silt	62.79	62.76	62.39
	3.08	3.70	0.94	3.00	Clays: Silty Clay to Clay	62.59	62.56	61.95
	3.70	5.15	1.25	2.91	Silt Mixture: Clayey Silt to Silty Clay	62.04	62.04	60.77
	5.15	6.45	1.03	3.11	Clays: Silty Clay to Clay	61.20	61.25	59.01
	6.45	6.68	1.21	2.77	Silt Mixture: Clayey Silt to Silty Clay	60.68	60.78	57.99
	6.68	7.08	0.69	3.09	Clays: Silty Clay to Clay	60.46	60.58	57.57
	7.08	7.65	3.37	2.33	Sand Mixture:Silty Sand to Sandy Silt	60.11	60.26	56.92
	7.65	8.00	7.29	1.77	Sands:Clean Sand to Silty Sand	59.78	59.96	56.31
	8.00	8.23	2.63	2.39	Sand Mixture:Silty Sand to Sandy Silt	59.56	59.77	55.94
	8.23	10.60	14.84	1.51	Sands:Clean Sand to Silty Sand	58.59	58.92	54.31
	10.60	10.90	3.59	2.56	Sand Mixture:Silty Sand to Sandy Silt	57.58	58.04	52.73
	10.90	11.18	7.94	2.00	Sands:Clean Sand to Silty Sand	57.37	57.86	52.41
	11.18	11.75	1.05	3.18	Clays: Silty Clay to Clay	57.05	57.59	51.95
	11.75	11.93	4.80	2.36	Sand Mixture:Silty Sand to Sandy Silt	56.78	57.35	51.56
	11.93	12.83	1.29	3.28	Clays: Silty Clay to Clay	56.38	57.01	51.01
	12.83	13.15	6.82	2.26	Sand Mixture:Silty Sand to Sandy Silt	55.94	56.64	50.40
	13.15	13.63	1.63	3.16	Clays: Silty Clay to Clay	55.66	56.39	50.02
	13.63	14.38	0.65	3.66	Organic Soils Peat	55.23	56.03	49.45
	14.38	14.55	0.85	3.48	Clays: Silty Clay to Clay	54.91	55.75	49.03
	14.55	14.90	10.06	1.96	Sands:Clean Sand to Silty Sand	54.73	55.60	48.80
	14.90	15.38	3.61	2.63	Silt Mixture: Clayey Silt to Silty Clay	54.45	55.36	48.44
	15.38	17.45	1.26	3.42	Clays: Silty Clay to Clay	53.61	54.65	47.39
	17.45	17.68	0.90	3.71	Organic Soils Peat	52.88	54.02	46.48
	17.68	17.98	2.57	2.96	Clays: Silty Clay to Clay	52.71	53.88	46.27
	17.98	18.25	7.09	2.28	Sand Mixture:Silty Sand to Sandy Silt	52.53	53.73	46.06
	18.25	18.55	2.09	3.24	Clays: Silty Clay to Clay	52.36	53.58	45.84

Table 20 Database Summary of CPT-24 (Contibued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-25	Δσ (Average) (kPa) SP-26	Δσ (Average) (kPa) SP-27
	18.40	18.80	3.07	2.86	Silt Mixtures:clayey silt to silty clay	52.22	53.14	44.72
	18.80	19.30	1.66	3.23	Clays:silty clay to clay	51.42	52.46	43.73
	19.30	19.45	3.05	2.80	Silt Mixtures:clayey silt to silty clay	50.73	51.88	42.89
	19.45	19.70	8.44	2.12	Sand Mixtures:silty sand to sandy silt	50.46	51.65	42.56
	19.70	19.98	4.04	2.81	Silt Mixtures:clayey silt to silty clay	50.26	51.48	42.33
	19.98	20.60	1.68	3.24	Clays:silty clay to clay	50.14	51.38	42.19
	20.60	20.93	10.76	1.95	Sand Mixtures:silty sand to sandy silt	49.98	51.25	42.00
	20.93	21.18	2.31	3.03	Silt Mixtures:clayey silt to silty clay	49.72	51.03	41.69
	21.18	21.88	11.19	2.02	Sand Mixtures:silty sand to sandy silt	49.43	50.80	41.37
	21.88	23.38	1.81	3.25	Silt Mixtures:clayey silt to silty clay	49.27	50.67	41.18
	23.38	23.63	5.86	2.60	Silt Mixtures:clayey silt to silty clay	48.98	50.44	40.86
	23.63	25.50	1.96	3.29	Clays:silty clay to clay	48.34	49.94	40.18

Table 21 Database Summary of BCPT-2

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-4	Δσ (Average) (kPa) SP-5	Δσ (Average) (kPa) SP-7
BSP5- Obserced Settlemen =0.118m BSP7- Obserced Settlemen =0.099 m BSP4- Obserced Settlemen =0.122 m	0.00	0.18	3.27	1.74	Sands:clean sand to silty sand	63.83	63.70	63.73
	0.18	0.60	1.33	2.43	Sand Mixtures:silty sand to sandy silt	63.83	63.70	63.69
	0.60	5.28	1.54	2.80	Silt Mixtures:clayey silt to silty clay	63.83	63.64	63.68
	5.28	5.74	1.04	3.02	Clays:silty clay to clay	63.82	63.50	63.67
	5.74	5.92	1.43	2.89	Silt Mixtures:clayey silt to silty clay	63.81	63.48	63.65
	5.92	6.20	4.07	2.34	Sand Mixtures:silty sand to sandy silt	63.80	63.46	63.64
	6.20	6.72	0.92	3.10	Silt Mixtures:clayey silt to silty clay	63.80	63.43	63.61
	6.72	6.82	1.66	2.87	Silt Mixtures:clayey silt to silty clay	63.78	63.40	63.59
	6.82	6.98	1.21	3.03	Clays:silty clay to clay	63.77	63.39	63.58
	6.98	7.10	1.55	2.91	Silt Mixtures:clayey silt to silty clay	63.77	63.38	63.56
	7.10	7.34	1.81	2.95	Clays:silty clay to clay	63.76	63.36	63.55
	7.34	8.14	2.04	2.89	Silt Mixtures:clayey silt to silty clay	63.75	63.32	63.50
	8.14	11.06	1.18	3.20	Clays:silty clay to clay	63.75	63.18	63.32
	11.06	11.58	2.39	2.91	Silt Mixtures:clayey silt to silty clay	63.73	63.00	63.03
	11.58	11.80	1.92	2.99	Clays:silty clay to clay	63.72	62.97	62.97
	11.80	12.12	3.41	2.74	Silt Mixtures:clayey silt to silty clay	63.70	62.94	62.93
	12.12	12.44	7.22	2.34	Sand Mixtures:silty sand to sandy silt	63.70	62.92	62.88
	12.44	12.76	3.83	2.79	Silt Mixtures:clayey silt to silty clay	63.66	62.89	62.82
	12.76	14.00	2.24	3.01	Clays:silty clay to clay	63.59	62.82	62.67
	14.00	14.26	2.45	2.94	Silt Mixtures:clayey silt to silty clay	63.54	62.76	62.53
	14.26	14.96	2.27	2.99	Clays:silty clay to clay	63.53	62.71	62.42
	14.96	15.62	3.83	2.83	Silt Mixtures:clayey silt to silty clay	63.49	62.65	62.27
	15.62	15.70	8.96	2.43	Sand Mixtures:silty sand to sandy silt	63.46	62.61	62.18
	15.70	15.76	5.69	2.83	Silt Mixtures:clayey silt to silty clay	63.37	62.61	62.17
	15.76	16.78	2.51	3.09	Clays:silty clay to clay	63.34	62.55	62.03
	16.78	16.86	4.42	2.80	Silt Mixtures:clayey silt to silty clay	63.29	62.49	61.89
	16.86	17.20	2.54	3.10	Clays:silty clay to clay	63.23	62.47	61.83
	17.20	17.34	4.67	2.81	Silt Mixtures:clayey silt to silty clay	63.19	62.44	61.76
	17.34	17.84	2.94	3.03	Clays:silty clay to clay	63.17	62.40	61.67
	17.84	17.94	3.65	2.88	Silt Mixtures:clayey silt to silty clay	63.14	62.36	61.58
	17.94	18.06	3.03	3.05	Clays:silty clay to clay	63.14	62.35	61.54
	18.06	18.12	2.99	2.95	Silt Mixtures:clayey silt to silty clay	63.13	62.33	61.51

Table 21 Database Summary of BCPT-2 (Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-4	Δσ (Average) (kPa) SP-5	Δσ (Average) (kPa) SP-7
	18.12	18.28	2.85	2.99	Clays:silty clay to clay	63.10	62.32	61.48
	18.28	19.26	3.91	2.89	Silt Mixtures:clayey silt to silty clay	62.97	62.24	61.29
	19.26	19.62	2.72	3.01	Clays:silty clay to clay	62.79	62.13	61.06
	19.62	19.68	2.94	2.93	Silt Mixtures:clayey silt to silty clay	62.73	62.10	60.98
	19.68	20.94	2.51	3.08	Clays:silty clay to clay	62.53	61.98	60.72
	20.94	21.08	4.64	2.60	Silt Mixtures:clayey silt to silty clay	62.31	61.85	60.44
	21.08	21.42	1.69	3.16	Clays:silty clay to clay	62.22	61.80	60.33

Table 22 Database Summary of BCPT-3

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-6	Δσ (Average) (kPa) SP-7
BSP7- Obserced Setlemen =0.099 m BSP6- Obserced Setlemen =0.108 m	0.00	0.40	1.35	1.93	Sands:clean sand to silty sand	63.58	63.57
	0.40	5.85	2.23	2.42	Sand Mixtures:silty sand to sandy silt	63.50	63.53
	5.85	8.90	2.05	2.71	Silt Mixtures:clayey silt to silty clay	63.48	63.38
	8.90	9.50	1.11	3.07	Clays:silty clay to clay	63.32	63.19
	9.50	9.70	1.90	2.76	Silt Mixtures:clayey silt to silty clay	63.27	63.13
	9.70	9.90	3.96	2.38	Sand Mixtures:silty sand to sandy silt	63.25	63.11
	9.90	10.25	2.45	2.67	Silt Mixtures:clayey silt to silty clay	63.21	63.07
	10.25	10.95	3.25	2.50	Sand Mixtures:silty sand to sandy silt	63.13	63.00
	10.95	13.00	2.55	2.72	Silt Mixtures:clayey silt to silty clay	62.90	62.78
	13.00	13.25	1.49	2.96	Clays:silty clay to clay	62.68	62.58
	13.25	14.10	1.90	2.86	Silt Mixtures:clayey silt to silty clay	62.56	62.47
	14.10	14.45	7.15	2.00	Sands:clean sand to silty sand	62.42	62.35
	14.45	14.63	1.99	2.80	Silt Mixtures:clayey silt to silty clay	62.34	62.29

Table 23 Database Summary of BCPT-4

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-4	Δσ (Average) (kPa) SP-5
BSP4- Obserced Setllemen =0.122m BSP3- Obserced Setllemen =0.094 m	0.00	0.16	0.95	1.97	Sands:clean sand to silty sand	63.88	63.94
	0.16	0.54	1.41	2.10	Sand Mixtures:silty sand to sandy silt	63.82	63.98
	0.54	0.64	1.65	1.94	Sands:clean sand to silty sand	63.80	64.02
	0.64	3.16	1.97	2.33	Sand Mixtures:silty sand to sandy silt	63.73	64.19
	3.16	4.26	0.95	1.97	Silt Mixtures:clayey silt to silty clay	63.61	64.38
	4.26	4.40	1.95	2.57	Sand Mixtures:silty sand to sandy silt	63.45	64.43
	4.40	9.48	1.89	2.77	Silt Mixtures:clayey silt to silty clay	63.35	64.56
	9.48	9.86	1.26	2.99	Clays:silty clay to clay	63.24	64.64
	9.86	14.22	2.83	2.78	Silt Mixtures:clayey silt to silty clay	63.20	64.60
	14.22	14.36	6.10	2.36	Sand Mixtures:silty sand to sandy silt	63.15	64.49
	14.36	15.66	3.73	2.68	Silt Mixtures:clayey silt to silty clay	63.13	64.42
	15.66	15.74	3.05	3.06	Clays:silty clay to clay	63.09	64.34
	15.74	16.92	2.88	2.88	Silt Mixtures:clayey silt to silty clay	63.02	64.25

Table 23 Database Summary of BCPT-4(Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-1	Δσ (Average) (kPa) SP-2
BSP1- Obserced Setllemen =0.091m BSP2- Obserced Setllemen =0.088 m	0.00	0.16	0.95	1.97	Sands:clean sand to silty sand	63.91	63.94
	0.16	0.54	1.41	2.10	Sand Mixtures:silty sand to sandy silt	63.57	63.60
	0.54	0.64	1.65	1.94	Sands:clean sand to silty sand	63.26	63.31
	0.64	3.16	1.97	2.33	Sand Mixtures:silty sand to sandy silt	61.60	61.99
	3.16	4.26	0.95	1.97	Silt Mixtures:clayey silt to silty clay	59.32	60.44
	4.26	4.40	1.95	2.57	Sand Mixtures:silty sand to sandy silt	58.55	59.97
	4.40	9.48	1.89	2.77	Silt Mixtures:clayey silt to silty clay	55.36	57.92
	9.48	9.86	1.26	2.99	Clays:silty clay to clay	52.17	55.66
	9.86	14.22	2.83	2.78	Silt Mixtures:clayey silt to silty clay	49.76	53.63
	14.22	14.36	6.10	2.36	Sand Mixtures:silty sand to sandy silt	47.68	51.75
	14.36	15.66	3.73	2.68	Silt Mixtures:clayey silt to silty clay	47.11	51.19
	15.66	15.74	3.05	3.06	Clays:silty clay to clay	46.58	50.67
	15.74	16.92	2.88	2.88	Silt Mixtures:clayey silt to silty clay	46.12	50.21

Table 24 Database Summary of BCPT-5

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-1	Δσ (Average) (kPa) SP-2	Δσ (Average) (kPa) SP-16
BSP1- Obserced Settlemen =0.091m BSP2- Obserced Settlemen =0.088 m BSP16- Obserced Settlemen =0.083 m	0.00	0.08	0.73	1.95	Sands:clean sand to silty sand	63.86	63.99	63.80
	0.08	0.28	0.79	2.18	Sand Mixtures:silty sand to sandy silt	63.69	63.82	63.77
	0.28	0.38	0.97	1.91	Sands:clean sand to silty sand	63.50	63.62	63.74
	0.38	2.96	2.04	2.40	Sand Mixtures:silty sand to sandy silt	61.79	62.21	63.72
	2.96	5.24	1.85	2.67	Silt Mixtures:clayey silt to silty clay	58.73	60.15	63.69
	5.24	5.66	3.26	2.45	Sand Mixtures:silty sand to sandy silt	57.06	59.11	63.57
	5.66	6.12	1.58	2.82	Silt Mixtures:clayey silt to silty clay	56.51	58.77	63.56
	6.12	6.20	1.13	2.97	Clays:silty clay to clay	56.18	58.56	63.55
	6.20	8.86	2.03	2.79	Silt Mixtures:clayey silt to silty clay	54.54	57.46	63.55
	8.86	9.60	1.21	3.01	Clays:silty clay to clay	52.56	56.04	63.26
	9.60	9.82	2.78	2.78	Silt Mixtures:clayey silt to silty clay	52.03	55.63	63.16
	9.82	10.10	1.33	3.07	Clays:silty clay to clay	51.76	55.41	63.11
	10.10	10.20	1.53	2.89	Silt Mixtures:clayey silt to silty clay	51.55	55.25	63.06
	10.20	10.44	1.56	2.99	Clays:silty clay to clay	51.37	55.10	63.02
	10.44	13.26	2.05	2.82	Silt Mixtures:clayey silt to silty clay	49.82	53.78	62.62
	13.26	13.38	5.12	2.44	Sand Mixtures:silty sand to sandy silt	48.42	52.54	62.21
	13.38	13.84	2.72	2.77	Silt Mixtures:clayey silt to silty clay	48.16	52.30	62.12
	13.84	14.06	1.87	3.02	Clays:silty clay to clay	47.87	52.03	62.02
	14.06	15.72	2.78	2.89	Silt Mixtures:clayey silt to silty clay	47.11	51.29	61.72
	15.72	16.56	2.55	2.98	Clays:silty clay to clay	46.16	50.35	61.30
	16.56	16.66	3.12	2.91	Silt Mixtures:clayey silt to silty clay	45.82	50.01	61.13
	16.66	16.92	2.55	2.99	Clays:silty clay to clay	45.70	49.89	61.07
	16.92	17.02	2.68	2.94	Silt Mixtures:clayey silt to silty clay	45.58	49.76	61.00
	17.02	17.10	2.61	2.96	Clays:silty clay to clay	45.52	49.70	60.97
	17.10	17.88	3.00	2.92	Silt Mixtures:clayey silt to silty clay	45.24	49.41	60.81
	17.88	17.98	2.54	3.08	Clays:silty clay to clay	44.96	49.11	60.65
	17.98	18.10	2.67	2.91	Silt Mixtures:clayey silt to silty clay	44.89	49.04	60.60
	18.10	20.26	2.26	3.05	Clays:silty clay to clay	44.21	48.31	60.15
	20.26	20.58	3.26	2.89	Silt Mixtures:clayey silt to silty clay	43.52	47.53	59.62
	20.58	20.84	2.87	2.99	Clays:silty clay to clay	43.36	47.35	59.49
	20.84	20.94	2.87	2.82	Silt Mixtures:clayey silt to silty clay	43.26	47.24	59.40

Table 25 Database Summary of BCPT-6

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-1	Δσ (Average) (kPa) SP-2	Δσ (Average) (kPa) SP-15
BSP1- Obserced Settlemen =0.091m BSP2- Obserced Settlemen =0.088 m BSP15- Obserced Settlemen =0.082 m	0.00	3.22	1.67	2.45	Sand Mixtures:silty sand to sandy silt	63.16	63.28	63.21
	3.22	3.72	2.50	2.64	Silt Mixtures:clayey silt to silty clay	60.82	61.63	63.13
	3.72	4.02	2.40	2.39	Sand Mixtures:silty sand to sandy silt	60.32	61.32	63.12
	4.02	5.22	1.76	2.73	Silt Mixtures:clayey silt to silty clay	59.38	60.75	63.08
	5.22	5.42	6.90	2.25	Sand Mixtures:silty sand to sandy silt	58.52	60.21	63.04
	5.42	5.62	8.91	1.84	Sands:clean sand to silty sand	58.27	60.06	63.03
	5.62	5.68	4.09	2.43	Sand Mixtures:silty sand to sandy silt	58.11	59.96	63.02
	5.68	7.78	1.79	2.83	Silt Mixtures:clayey silt to silty clay	56.79	59.11	62.92
	7.78	8.26	1.12	3.04	Clays:silty clay to clay	55.25	58.06	62.77
	8.26	8.46	1.80	2.84	Silt Mixtures:clayey silt to silty clay	54.86	57.78	62.72
	8.46	8.60	1.10	3.04	Clays:silty clay to clay	54.66	57.63	62.70
	8.60	8.70	1.24	2.93	Silt Mixtures:clayey silt to silty clay	54.52	57.53	62.68
	8.70	9.82	1.05	3.05	Clays:silty clay to clay	53.83	57.01	62.58
	9.82	10.22	6.07	2.27	Sand Mixtures:silty sand to sandy silt	52.99	56.36	62.44
	10.22	10.28	1.71	3.02	Clays:silty clay to clay	52.74	56.16	62.39
	10.28	11.78	2.52	2.80	Silt Mixtures:clayey silt to silty clay	51.93	55.48	62.22
	11.78	11.86	1.47	3.00	Clays:silty clay to clay	51.13	54.80	62.04
	11.86	11.96	1.97	2.84	Silt Mixtures:clayey silt to silty clay	51.04	54.73	62.02
	11.96	12.20	6.69	2.22	Sand Mixtures:silty sand to sandy silt	50.87	54.58	61.98
	12.20	12.32	8.62	2.01	Sands:clean sand to silty sand	50.70	54.43	61.93
	12.32	12.42	6.42	2.11	Sand Mixtures:silty sand to sandy silt	50.59	54.33	61.90
	12.42	12.64	11.04	1.93	Sands:clean sand to silty sand	50.44	54.20	61.86
	12.64	12.72	4.03	2.30	Sand Mixtures:silty sand to sandy silt	50.30	54.07	61.82
	12.72	14.02	2.11	2.64	Silt Mixtures:clayey silt to silty clay	49.68	53.50	61.62
	14.02	15.36	2.93	2.43	Sand Mixtures:silty sand to sandy silt	48.56	52.44	61.22
	15.36	15.44	2.60	2.61	Silt Mixtures:clayey silt to silty clay	48.00	51.90	60.98
	15.44	15.68	2.72	2.46	Sand Mixtures:silty sand to sandy silt	47.88	51.78	60.93
	15.68	15.80	2.66	2.61	Silt Mixtures:clayey silt to silty clay	47.75	51.64	60.87
	15.80	15.92	2.75	2.46	Sand Mixtures:silty sand to sandy silt	47.66	51.55	60.82
	15.92	16.02	2.71	2.60	Silt Mixtures:clayey silt to silty clay	47.58	51.47	60.78
	16.02	16.20	3.43	2.38	Sand Mixtures:silty sand to sandy silt	47.48	51.37	60.73
	16.20	16.30	4.21	2.82	Silt Mixtures:clayey silt to silty clay	47.38	51.27	60.68

Table 25 Database Summary of BCPT-6(Continued)

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-1	Δσ (Average) (kPa) SP-2	Δσ (Average) (kPa) SP-15
	16.72	16.90	3.22	2.92	Silt Mixtures:clayey silt to silty clay	47.19	51.08	60.59
	16.90	17.02	3.01	2.96	Clays:silty clay to clay	46.99	50.87	60.47
	17.02	18.40	3.26	2.89	Silt Mixtures:clayey silt to silty clay	46.89	50.77	60.42
	18.40	18.60	2.67	2.97	Clays:silty clay to clay	46.40	50.26	60.12
	18.60	18.70	2.94	2.93	Silt Mixtures:clayey silt to silty clay	45.91	49.74	59.79
	18.70	19.04	2.67	2.98	Clays:silty clay to clay	45.82	49.64	59.73
	19.04	19.08	2.39	2.63	Silt Mixtures:clayey silt to silty clay	45.69	49.50	59.63
	16.72	16.90	3.22	2.92	Silt Mixtures:clayey silt to silty clay	45.57	49.37	59.54

Table 26 Database Summary of BCPT-7

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-13	Δσ (Average) (kPa) SP-14
BSP13- Obserced Settlemen =0.097m BSP14- Obserced Settlemen =0.073 m	0.00	0.12	1.20	1.84	Sands:clean sand to silty sand	63.82	63.90
	0.12	1.36	1.35	2.50	Sand Mixtures:silty sand to sandy silt	63.82	63.86
	1.36	2.34	1.51	2.64	Silt Mixtures:clayey silt to silty clay	63.82	63.81
	2.34	3.30	2.47	2.58	Sand Mixtures:silty sand to sandy silt	63.79	63.76
	3.30	5.06	2.14	2.62	Silt Mixtures:clayey silt to silty clay	63.74	63.71
	5.06	5.14	1.89	2.58	Sand Mixtures:silty sand to sandy silt	63.69	63.68
	5.14	5.22	1.92	2.62	Silt Mixtures:clayey silt to silty clay	63.67	63.68
	5.22	5.52	3.76	2.48	Sand Mixtures:silty sand to sandy silt	63.66	63.67
	5.52	11.00	2.20	2.76	Silt Mixtures:clayey silt to silty clay	63.61	63.54
	11.00	11.08	4.77	2.54	Sand Mixtures:silty sand to sandy silt	63.21	63.40
	11.08	11.18	4.45	2.67	Silt Mixtures:clayey silt to silty clay	63.19	63.39
	11.18	11.24	5.48	2.53	Sand Mixtures:silty sand to sandy silt	63.18	63.39
	11.24	11.30	4.87	2.62	Silt Mixtures:clayey silt to silty clay	63.17	63.38
	11.30	11.52	8.41	2.33	Sand Mixtures:silty sand to sandy silt	63.13	63.37
	11.52	11.62	11.16	1.95	Sands:clean sand to silty sand	63.09	63.36
	11.62	11.70	8.68	2.19	Sand Mixtures:silty sand to sandy silt	63.07	63.35
	11.70	11.82	7.91	2.07	Sands:clean sand to silty sand	63.05	63.35
	11.82	11.94	3.26	2.68	Silt Mixtures:clayey silt to silty clay	63.02	63.34
	11.94	12.12	1.71	2.99	Clays:silty clay to clay	62.99	63.33
	12.12	12.30	1.97	2.93	Silt Mixtures:clayey silt to silty clay	62.95	63.31
	12.30	12.46	1.93	2.97	Clays:silty clay to clay	62.91	63.30
	12.46	12.68	2.07	2.93	Silt Mixtures:clayey silt to silty clay	62.86	63.28
	12.68	13.12	1.97	2.98	Clays:silty clay to clay	62.77	63.26
	13.12	14.86	2.75	2.87	Silt Mixtures:clayey silt to silty clay	62.48	63.15
	14.86	14.90	2.69	2.32	Sand Mixtures:silty sand to sandy silt	62.21	63.06

Table 27 Database Summary of BCPT-8

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-13
BSP13- Obserced Settlemen =0.097m	0.00	1.40	0.80	2.43	Sands:clean sand to silty sand	63.42
	1.40	5.08	1.13	2.74	Silt Mixtures:clayey silt to silty clay	63.42
	5.08	5.14	2.62	2.52	Sand Mixtures:silty sand to sandy silt	63.42
	5.14	5.20	1.46	2.80	Silt Mixtures:clayey silt to silty clay	63.42
	5.20	5.30	0.98	2.98	Clays:silty clay to clay	63.41
	5.30	5.46	1.03	2.94	Silt Mixtures:clayey silt to silty clay	63.41
	5.46	5.58	1.02	2.96	Clays:silty clay to clay	63.36
	5.58	6.44	1.13	2.91	Silt Mixtures:clayey silt to silty clay	63.35
	6.44	7.66	0.67	3.18	Clays:silty clay to clay	63.26
	7.66	8.70	0.71	3.23	Clays:silty clay to clay	63.26
	8.70	9.94	0.68	3.23	Clays:silty clay to clay	63.11
	9.94	10.28	2.14	2.77	Silt Mixtures:clayey silt to silty clay	62.99
	10.28	10.38	1.41	3.05	Clays:silty clay to clay	62.95
	10.38	10.46	1.74	2.92	Silt Mixtures:clayey silt to silty clay	62.93
	10.46	10.60	1.58	3.00	Clays:silty clay to clay	62.91
	10.60	10.68	2.60	2.74	Silt Mixtures:clayey silt to silty clay	62.89
	10.68	10.88	1.53	3.00	Clays:silty clay to clay	62.86
	10.88	11.38	1.78	2.91	Silt Mixtures:clayey silt to silty clay	62.79
	11.38	11.98	1.01	3.14	Clays:silty clay to clay	62.67
	11.98	12.10	2.30	2.81	Silt Mixtures:clayey silt to silty clay	62.59
	12.10	12.20	3.14	2.42	Sand Mixtures:silty sand to sandy silt	62.56
	12.20	14.66	1.20	3.22	Clays:silty clay to clay	62.23
	14.66	14.70	1.34	2.87	Silt Mixtures:clayey silt to silty clay	61.88

Table 28 Database Summary of BCPT-15

	Depth 1 (m)	Depth 2 (m)	q_t (Average) (MPa)	I_c(Average)	Soil Classification	Δσ (Average) (kPa) SP-20	Δσ (Average) (kPa) SP-21
BSP20- Obserced Settlemen =0.080m BSP21- Obserced Settlemen =0.081 m	0.00	3.10	1.56	5.05	Sands:clean sand to silty sand	62.64	62.61
	3.10	7.70	1.76	4.08	Silt Mixtures:clayey silt to silty clay	60.49	61.92
	7.70	7.90	2.65	5.00	Sand Mixtures:silty sand to sandy silt	58.23	61.17
	7.90	8.65	1.69	4.00	Silt Mixtures:clayey silt to silty clay	57.74	60.97
	8.65	8.80	1.15	3.00	Clays:silty clay to clay	57.28	60.77
	8.80	9.55	1.72	4.07	Silt Mixtures:clayey silt to silty clay	56.82	60.56
	9.55	9.75	4.85	5.00	Sand Mixtures:silty sand to sandy silt	56.33	60.34
	9.75	14.00	2.69	4.05	Silt Mixtures:clayey silt to silty clay	54.12	59.14
	14.00	14.15	4.88	4.80	Sand Mixtures:silty sand to sandy silt	51.96	57.84
	0.00	3.10	1.56	5.05	Sands:clean sand to silty sand	62.64	62.61
	3.10	7.70	1.76	4.08	Silt Mixtures:clayey silt to silty clay	60.49	61.92
	7.70	7.90	2.65	5.00	Sand Mixtures:silty sand to sandy silt	58.23	61.17
	7.90	8.65	1.69	4.00	Silt Mixtures:clayey silt to silty clay	57.74	60.97
	8.65	8.80	1.15	3.00	Clays:silty clay to clay	57.28	60.77
	8.80	9.55	1.72	4.07	Silt Mixtures:clayey silt to silty clay	56.82	60.56
	9.55	9.75	4.85	5.00	Sand Mixtures:silty sand to sandy silt	56.33	60.34
	9.75	14.00	2.69	4.05	Silt Mixtures:clayey silt to silty clay	54.12	59.14
	14.00	14.15	4.88	4.80	Sand Mixtures:silty sand to sandy silt	51.96	57.84