

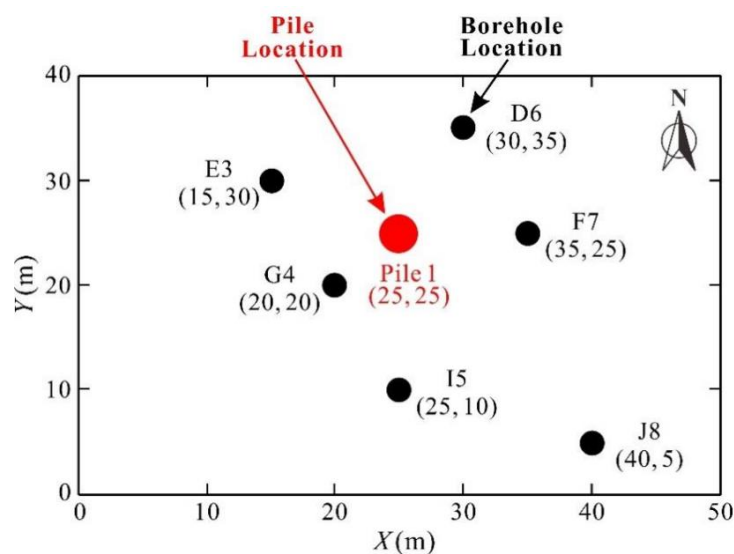
# TC304/TC309 Student Contest Analysis Paper

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## 1 Question Description

A small structure is supported on one pile founded entirely in clay soil, and the diameter and length of the pile are 0.4 m and 4.5 m, respectively. This pile is bored dry, without a casing, and concrete is poured on the same day. The location of this pile is shown in Figure 1.1. For ease of the design of this pile foundation, a site investigation consisting of a set of cone penetration tests (CPTs) is conducted, and the locations of these tests are illustrated in Figure 1.1. The participants are required to select appropriate methods for interpreting the tip resistance ( $q_c$ ) and side friction ( $f_s$ ) at the pile location based on the available CPT data and then evaluate the ultimate bearing capacity of the pile foundation.

Since all the CPT locations were provided, the necessary data could be downloaded from the A-CPT/232/2500m<sup>2</sup> dataset (Jaksa, 1995). First, an appropriate method should be chosen to perform the data interpolation to obtain the data at the target location of borehole F5, and then the data could be used to interpret the bearing capacity of the pile through different methods.



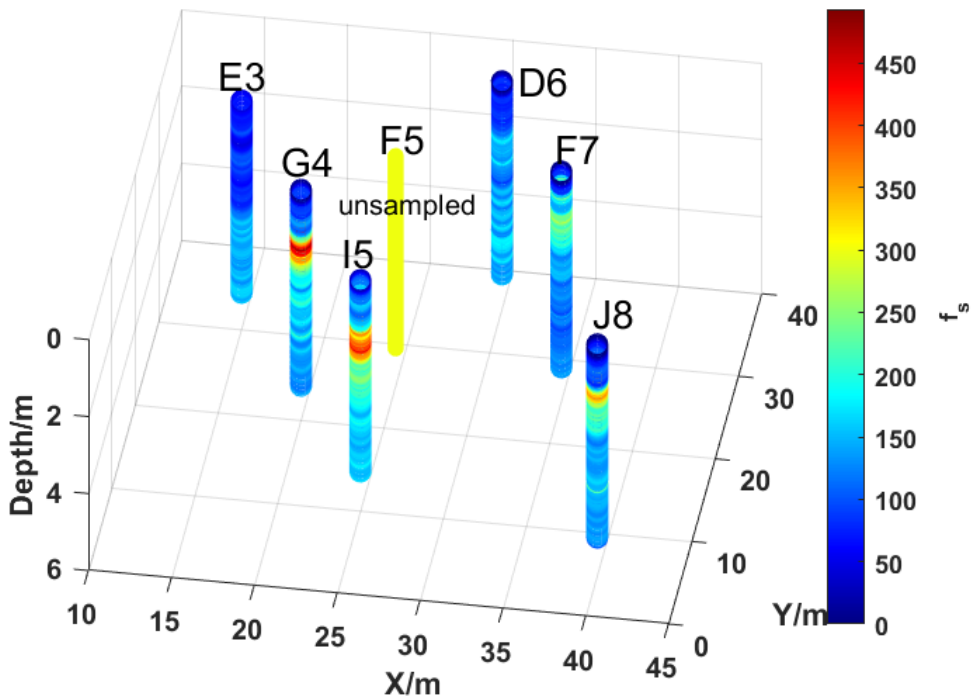
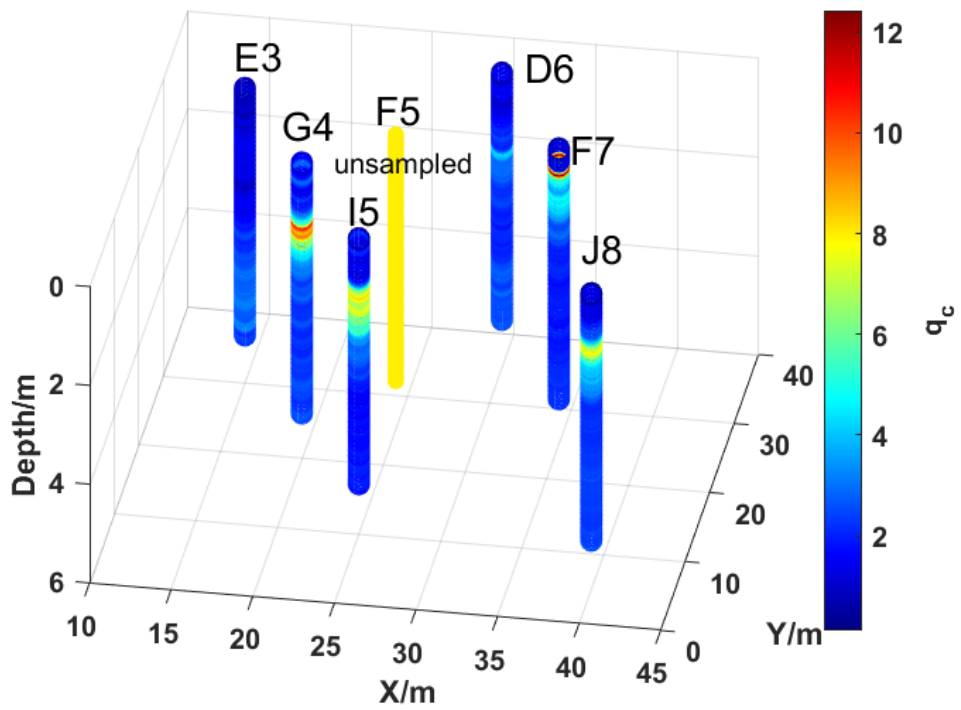


Figure 1.1 Locations of the pile and CPTs

## 2 Project Review

The dataset A-CPT/232/2500m<sup>2</sup> was set up by Jaksa for his PhD thesis when he

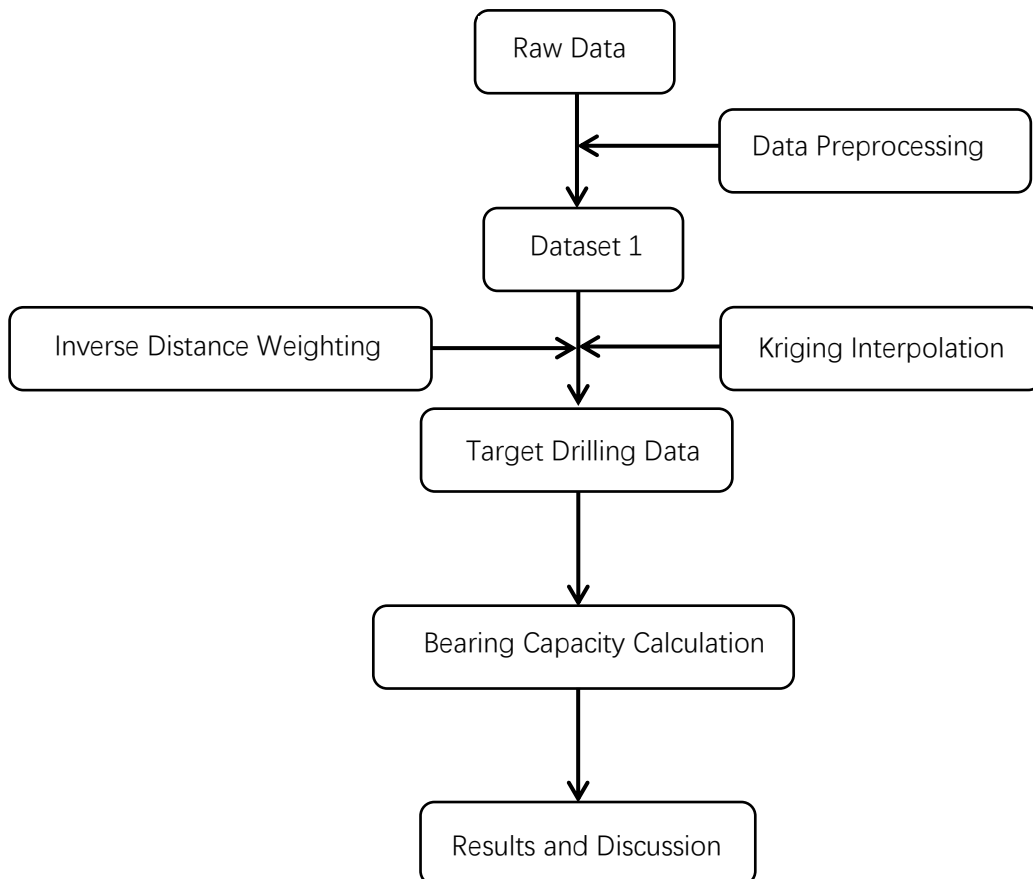
was at the University of Adelaide in Australia. His research focused on quantifying and modeling the spatial variability of two widely distributed clays at the site, and he selected a site with an area of 2500 m<sup>2</sup>, as shown in Figure 1.1, to conduct more than 200 CPT experiments in both the vertical and horizontal directions.

Since all the CPT locations have been provided and the sounding data could be downloaded from the A-CPT/232/2500m<sup>2</sup> dataset (Jaksa, 1995), the following steps are needed: First, an appropriate method should be chosen to perform the data processing to obtain the data for the target location of borehole F5, and then the data can be used to interpret the bearing capacity of the pile through different methods.

In Section 3, the data processing methods are described, including data preprocessing and kriging interpolation, and the processed data are shown in the attachment.

In Section 4, the calculation methods of the ultimate bearing capacity of the pile based on the data obtained in Section 3 are described. In this paper, five methods are selected, including the LCPC method, European method and Schmertmann method.

In Section 5, the calculation results are analyzed, and the limitations of the interpolation method and CPT calculation method are presented. The overall technical scheme is shown in the figure below.



**Figure 2.1** The overall technical scheme

### 3 Data Interpolation

The interpolation methods commonly used in geological research are the inverse-distance weighting method (IDW) and Kriging method. Both methods consider the influence of the distance between sampled variables and unsampled variables on the weight. In this study, two interpolation methods will be used to predict the CPT data of unsampled points, and their prediction results will be compared and analyzed.

#### 3.1 Data Preprocessing

The raw CPT data require preprocessing before they can be used in the interpolation program.

The first step is to remove the outliers from the data. Outliers are mainly caused by measurement errors or procedural errors such as rod adding, which is mainly characterized by the value of one or a small group of points being substantially far away from the surrounding sampled points. Outliers do not reflect the actual CPT characteristics of the sampled points but affect the estimation accuracy, so they need to be removed first. The specific process is shown below in Figure 3.1.

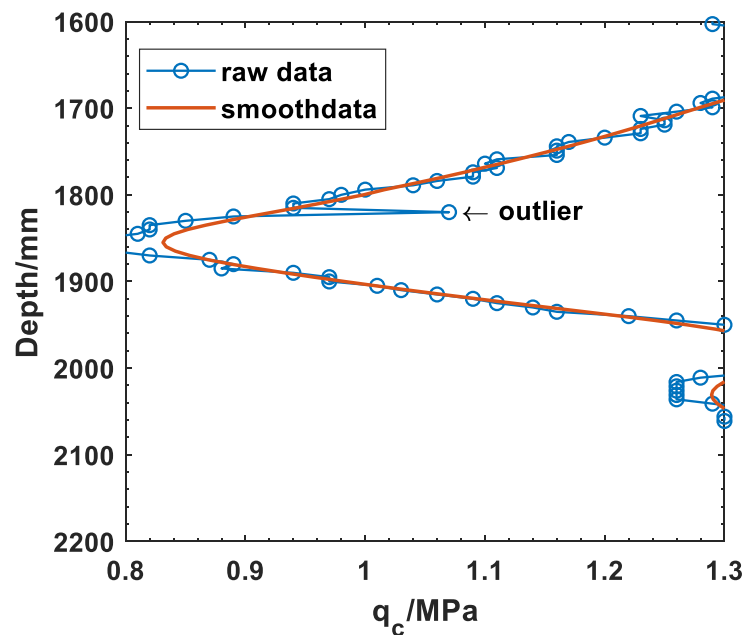


Figure 3.1 Outliers of the raw data

The second step is to correctly shift the  $f_s$  data. Schmertmann (1978) and AS 1289.F5.1 Australia (1977) emphasized that incorrect calculations will be made unless a depth correction, or shift, is applied to the  $f_s$  measurements. This correction is required since the cone tip resistance and sleeve friction load cells are physically separated by a given distance, and hence the measurements of  $q_c$  do not refer to the same soil as that at which the measurements of  $f_s$  are taken. Schmertmann (1978)

recommended that this shift distance should be the distance between the base of the cone and the mid-height of the sleeve, which, for standard electric cone penetrometers, is approximately 75 mm. Campanella et al. (1983) argued that the shift distance, also termed the friction-bearing offset, should be 100 mm and is dependent on the type of soil that is being penetrated. The cross-correlation function (CCF) was recommended by Jaksa (1995) to determine the shift distance because of its superiority in demonstrating the correlation between  $f_s$  and  $q_c$ .

MATLAB provides the `xcorr()` function for cross-correlation calculations. Taking the  $q_c$  and  $f_s$  data of borehole F7 as an example, the result is shown in Figure 3.2.

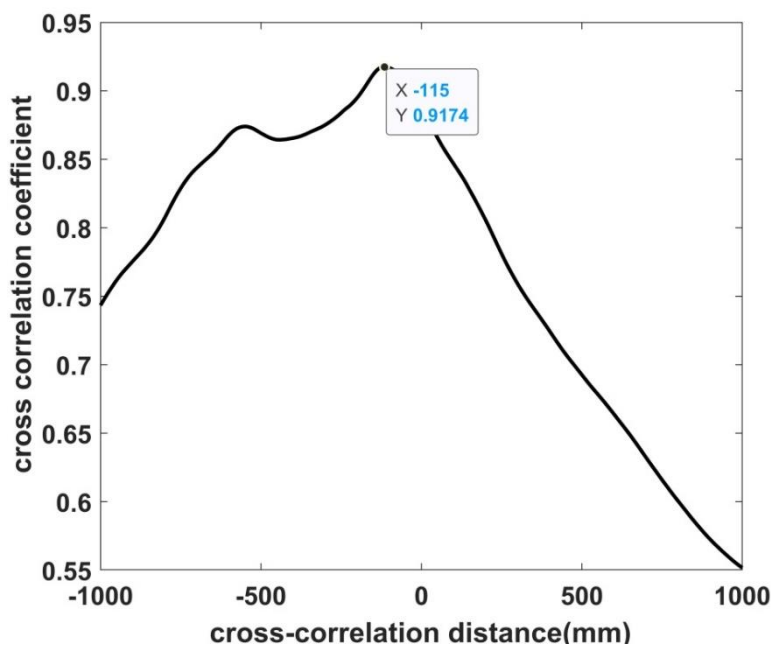


Figure 3.2 CCF of borehole F7

Figure 3.2 clearly shows that the maximum value of the cross-correlation coefficient occurs at a spacing of 115 mm. This implies that the optimal shift distance is 115 mm, which is somewhat higher than the actual physical spacing of 75 mm. The same process is applied to the other five boreholes, and the final shift distance result is shown in Table 3.1.

Table 3.1 Shift distance of the six boreholes

Number	E3	G4	I5	D6	F7	J8
Shift distance (mm)	0	90	230	0	115	130

Based on the results, the  $f_s$  data will shift upward, resulting in a decrease in the maximum available drilling depth of each borehole. The smallest depth belongs to the I5 borehole, which has an available depth of  $f_s$  of 4775 mm; therefore, in the interpolation part, the maximum interpolation depth is 4775 mm.

### 3.2 Kriging Interpolation

The kriging interpolation was named after Krige (1953), a gold mine engineer in South Africa, in honor of his pioneering work using regression methods to predict space fields. Li et al. (2016a) estimated the CPT data of unsampled points using 2D kriging interpolation. In the same year, Li et al. (2016b) extended the kriging method to 3D space but did not consider the anisotropy of the CPT data of soil. This paper will elaborate the basic principle of the kriging interpolation and use the DACE toolbox developed based on MATLAB to complete the 2D and 3D interpolation estimations.

### 3.2.1 Regionalized Variables

When the value of a variable changes with its spatial position, it is called a regionalized variable, that is, the variable is a function of its spatial position. Regionalized variables are the main body of semivariogram function research, and all variables mentioned below are regionalized variables. Regionalized variables have the following properties: randomness, structure, spatial limitation, continuity, and anisotropy.

Randomness indicates that a variable has the characteristics of random variables. The value of the variable is not fixed and is affected by its probability distribution. Structure represents a variable  $z(x)$  at  $x$  that has some degree of similarity with the variable  $z(x+h)$  at  $x+h$ , namely, autocorrelation. The autocorrelation depends on the distance  $h$  and the variable characteristics between two points. The estimated value of unsampled variables is affected by both its mathematical expectation and the influence from surrounding sampled data, so in most cases, the optimal estimate value is not the same as the mathematical expectation. Variables have continuity, but this continuity varies depending on the attributes of the variable. For example, soil thickness has strong continuity, but the content of a soil element has poor continuity. CPT data have good continuity in the same soil layer and poor continuity at the boundary of the soil layer. If the semivariogram of a variable is the same in all directions, it is called isotropy; if not, it is called anisotropy. CPT data show obvious anisotropy in the horizontal and vertical directions. Spatial limitation indicates that the above properties are valid within a certain range beyond which they may fail.

### 3.2.2 Intrinsic Hypothesis

Considering the calculation feasibility, the variables used for kriging interpolation must satisfy the intrinsic hypothesis. The hypothesis contains two conditions:

(1) In the whole study area, the following formula is satisfied for any  $x$  and  $h$ .

$$E[Z(x) - Z(x+h)] = 0 \quad \forall x, h \quad (1)$$

where  $E$  is the mathematical expectation,  $Z(x)$  is the variable at  $x$ , and  $Z(x+h)$  is the variable at  $x+h$ . This condition implies that different  $Z(x)$  values at different locations in the study area have the same expectation.

(2) In the whole study area, the following formula is satisfied for any  $x$  and  $h$ .

$$\text{Var}[Z(x) - Z(x+h)] = E[Z(x) - Z(x+h)]^2 = 2\gamma(x, h) = 2\gamma(h) \quad \forall x, h \quad (2)$$

where  $Var$  is the variance and  $\gamma$  is the semivariogram function. This hypothesis implies that the nature of the semivariogram function is half the variance of  $Z(x)$  and  $Z(x + h)$ , two points separated by  $h$  and that the variance is independent of  $x$ .

In fact, the hypothesis is an ideal case, and it is difficult for this hypothesis to fully conform to reality. For example,  $Z(x_1)$ ,  $Z(x_2)$ , and  $Z(x_3)$  are variables at different depths in the same CPT borehole,  $|x_1 - x_2| = |x_3 - x_2|$ , that is, the distance from  $x_2$  to  $x_1$  and  $x_2$  to  $x_3$  is the same.  $x_2$  should have the same effect on the other two points, but if  $x_2$  and  $x_1$  are in the same layer and  $x_3$  is in another layer, then  $x_2$  will obviously have different effects on the other two points. Although this hypothesis is difficult to meet, the kriging interpolation under the intrinsic hypothesis is still a reasonable estimation method under the condition that the information of the soil layer at the estimation point is unknown.

### 3.2.3 Semivariogram Function

Half of the variance of the variables  $Z(x)$  and  $Z(x + h)$  at  $x$  and  $x + h$  in the study area is defined as the semivariogram function, denoted as  $\gamma(x, h)$

$$\gamma(x, h) = \frac{1}{2}Var[Z(x) - Z(x + h)] \quad (3)$$

The variables fit the intrinsic hypothesis, and eq. (2) is substituted into eq. (3) to obtain:

$$\gamma(x, h) = \gamma(h) = \frac{1}{2}E[Z(x) - Z(x + h)]^2 \quad (4)$$

The mathematical expectation ( $E[Z(x) - Z(x + h)]^2$ ) involved in eq. (4) can be obtained by the mean approximation of the variance of the sampled variable pairs with spacing  $h$ :

$$\gamma(h) = \frac{1}{2}E[Z(x) - Z(x + h)]^2 = \frac{1}{2n}\sum_{i=1}^n[Z(x_i) - Z(x_i + h)]^2 \quad (5)$$

where  $n$  is the number of data pairs with distance  $h$ . The semivariogram function can reflect the relationship between the mutual influence and the distance between the variables. The greater the value of the function is, the smaller the interaction between the variables is. Three parameters are used to characterize the semivariogram function: the nugget, sill, and range.

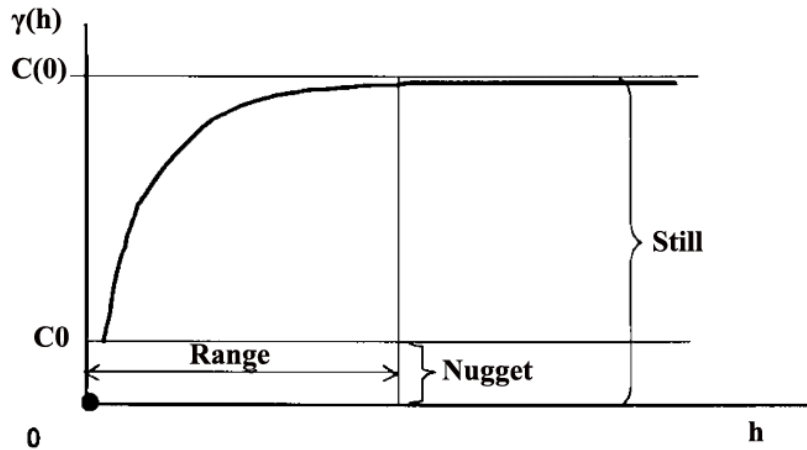


Figure 3.3 Semivariogram function

The nugget reflects the spatial variability of the data, and its value is usually expressed by  $C_0$ . The nugget demonstrates that two variables can differ in value even if they are close to each other. The following diagram shows the vertical spatial variability of the CPT data.

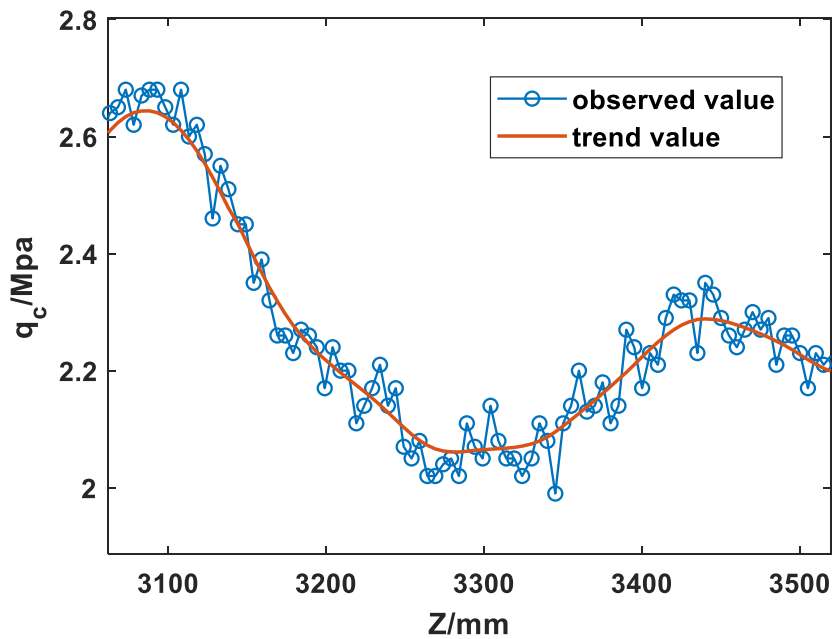


Figure 3.4 Spatial variability of the CPT data

The range represents the influence range of the variables, and its value is usually expressed by  $a$ . When the distance between the variables is greater than  $a$ , the correlation between the two variables disappears. The still represents the maximum variance between two variables, namely, the prior variance of the research area, whose value is usually expressed by  $C(0)$ . The difference in the semivariogram function in different directions reflects the anisotropy of the regionalized variables, and the CPT data show obvious anisotropy in the horizontal and vertical directions.

Some values of a single point in the semivariogram function can be obtained from

several sampled variables, but the optimal fitting of these points is needed if the complete function is to be obtained. The commonly used fitting models include the spherical model, exponential model, Gaussian model, and linear model. In this paper, the Gaussian model is used as the optimal fitting model of the semivariogram function of the CPT data.

### 3.2.4 Kriging Interpolation

The kriging interpolation is an optimal unbiased estimation method based on a semivariogram function. It assigns different weights to the sampled variables and then combines those variables to obtain the value of the estimated point. The kriging method is unbiased, implying that the mathematical expectation of the estimated variable is equal to the mathematical expectation of the sampled variables, which is specified by eq. (6). The optimality of the kriging method means that the variance between the estimated value and the mathematical expectation of the sampled variables can be minimized by choosing the optimal weights, which can be specified by eq. (7).

$$\sum_{i=1}^n \lambda_i = 1 \quad (6)$$

$$K = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \dots & \gamma_{1n} & 1 \\ \gamma_{21} & \gamma_{22} & \dots & \gamma_{2n} & 1 \\ \dots & \dots & \dots & \dots & 1 \\ \gamma_{n1} & \gamma_{n2} & \dots & \gamma_{nn} & 1 \\ 1 & 1 & 1 & 1 & 0 \end{bmatrix}, \lambda = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \dots \\ \lambda_n \\ \mu \end{bmatrix}, D = \begin{bmatrix} \gamma_{1e} \\ \gamma_{2e} \\ \dots \\ \gamma_{ne} \\ 1 \end{bmatrix}$$

$$K\lambda = D \rightarrow \lambda = K^{-1}D \quad (7)$$

where  $\lambda_i$  is the weight of the  $i$ th sampled variable,  $n$  is the number of sampled variables,  $e$  represents the estimated variable,  $\mu$  is the Lagrange constant and  $\gamma_{ij}$  is the value of the semivariogram function corresponding to the distance between the  $i$ th and  $j$ th variables.

### 3.2.5 Program Implementation

This paper uses the DACE toolbox developed in MATLAB to complete the 2D and 3D interpolation estimations of the CPT data. Lophaven et al. (2002) established this toolbox to easily estimate the values of unsampled variables based on sampled data. This toolbox consists of two main functions for building the kriging interpolation model and using the model to estimate the values of unsampled variables.

$$[dmodel, perf] = dacefit(S, Y, regr, corr, theta0, lob, upb) \quad (8)$$

**Table 3.2** Description of code (8)

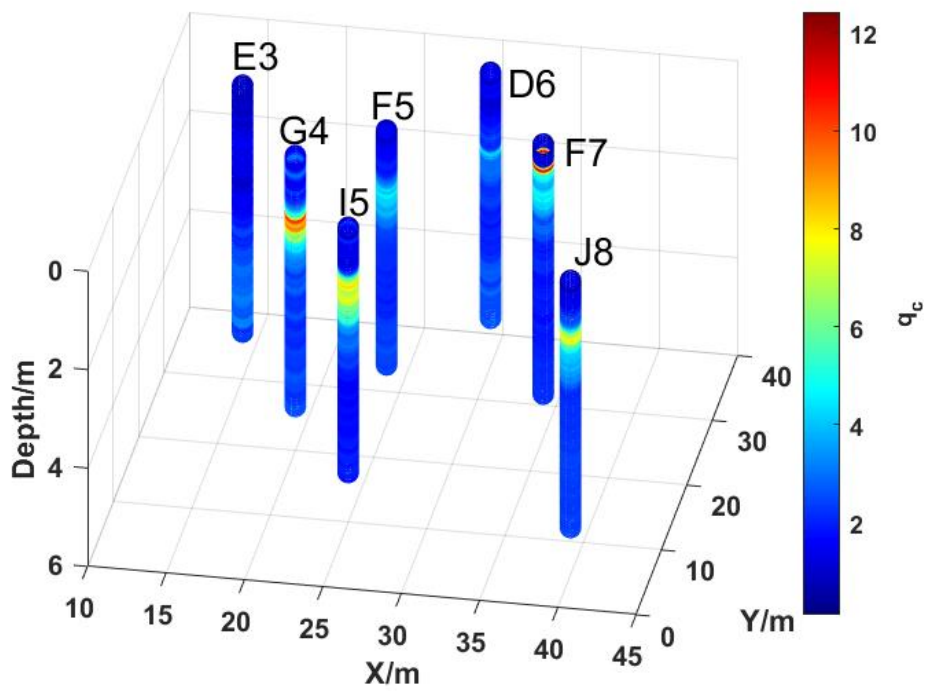
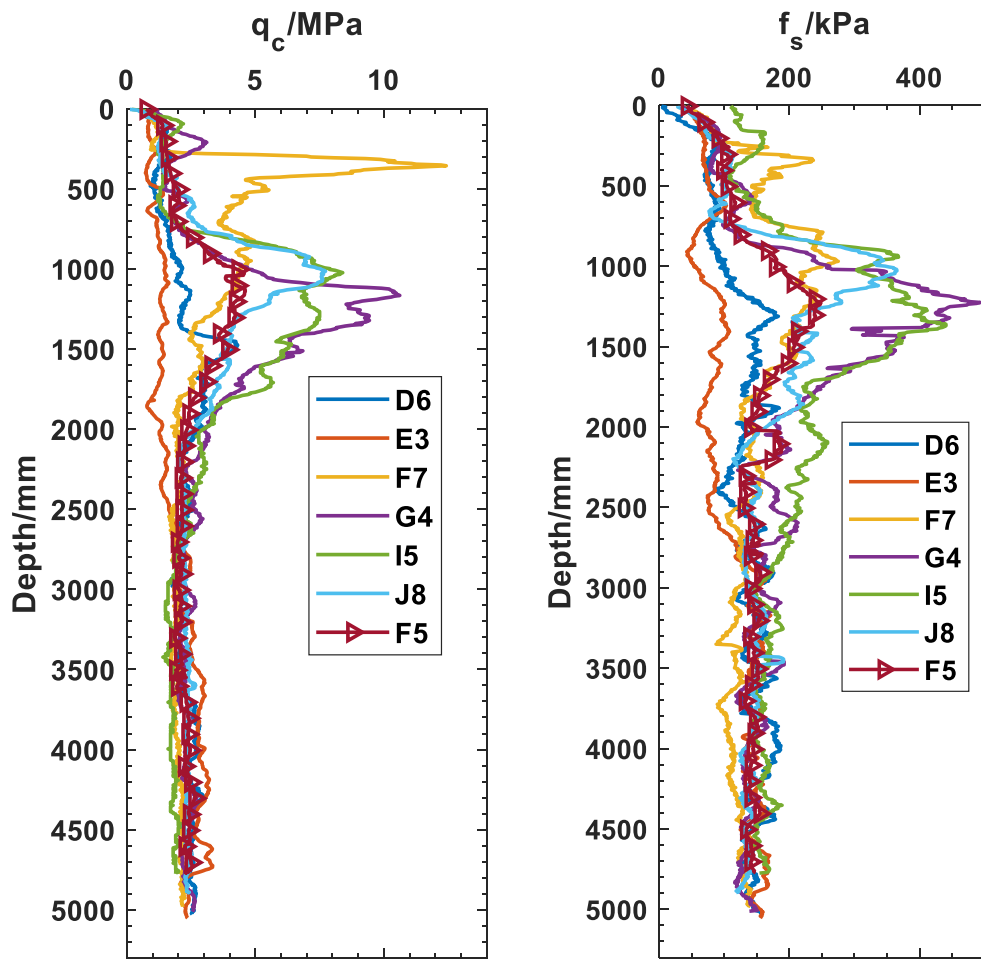
Name	Description	Options
<i>S</i>	Location of the sampled CPT borehole	
<i>Y</i>	Value of sampled CPT borehole	
<i>regr</i>	Regression model	*regpoly0, regpoly2 and regpoly3
<i>corr</i>	Correlation model	*correxp, correpg, corrgauss, corrlin, corrspherical and corrspline
<i>theta0</i>	Initial guess of the correlation parameter	
<i>lob</i>	Lower limit of the correlation parameter	
<i>upb</i>	Upper limit of the correlation parameter	
<i>dmodel</i>	DACE model	
<i>perf</i>	Information about the optimization	

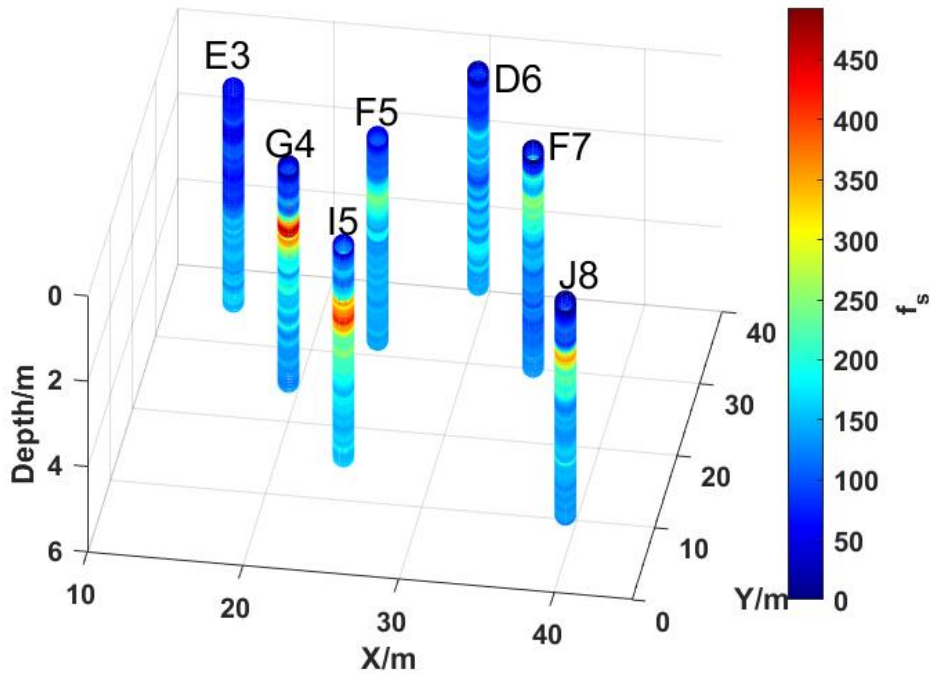
Note: regpoly0, regpoly2 and regpoly3 represent a zero order polynomial, first polynomial and second order polynomial; correxp, correpg, corrgauss, corrlin, corrspherical and corrspline represent the exponential model, generalized exponential model, Gaussian model, linear model, spherical model and cubic spline model.

$$y = \text{predictor}(x, dmodel) \quad (9)$$

where  $x$  is the location data of the target CPT borehole,  $dmodel$  is a structure element of the DACE model, and  $y$  represents the predicted CPT data. Code (8) is used to build the model, and code (9) is used to predict the result.

Since the original CPT data are not completely distributed on the same horizontal plane, before 2D interpolation, the soil should be divided into many horizontal slices, and then the CPT data for each slice should be obtained. In this study, a total of 956 sections are obtained from the ground at increments of 5 mm until a depth of 4775 mm is reached. The CPT data for each slice are obtained by linear interpolations of the sampled boreholes. Then, the DACE toolbox is used, and the prediction results can be obtained by completing an interpolation calculation for each slice.





**Figure 3.5** Interpolation results and original data

$q_c$  is the cone tip resistance,  $f_s$  is the sleeve resistance,  $F5$  is the unsampled borehole and the other six lines represent the data of the sampled boreholes. As shown in Figure 3.5, the line  $F5$  roughly reflects the trend of six sampled data points. There is a fluctuation between depths of 700-2000 mm for both  $q_c$  and  $f_s$ . The data tend to remain stable and approximately the same in the other locations.

Because the horizontal scale of the soil layer is much larger than the vertical scale, the 2D interpolation results in the horizontal direction can roughly reflect the 3D interpolation results. In this paper, the DACE toolbox is also used to directly conduct the 3D interpolation. The results show that the semivariogram trend of the predicted values is similar to that of the 2D interpolation results. However, the specific values of the 3D interpolation results are greatly affected by the parameter  $upb$  shown in Table 3.2, which cannot accurately reflect the true values. Therefore, the CPT interpolation results used in the following sections are all from the 2D interpolation.

### 3.3 Inverse-Distance Weighting Method

The inverse-distance weighting (IDW) method, as a common spatial interpolation technique, is also used in this study. The basic concept is that the attribute values of unsampled points are correlated with the attribute values of sampled points, and the correlation will become weak with the increase in the distance between the points. Previous studies have shown that this decay relationship is not simply proportional to the distance (Fotheringham and O'Kelly, 1989) but is generally expressed as a power function of the distance, as follows:

$$\hat{y}(S_0) = \sum_1^n \lambda_i y(S_i) \quad (10)$$

$$\lambda_i = d_{0i}^{-\alpha} / \sum_i^n d_{0i}^{-\alpha} \quad (11)$$

$$\sum_{i=1}^n \lambda_i = 1 \quad (12)$$

where  $\hat{y}(S_0)$  is the predicted attribute value of the unsampled point  $S_0$ ,  $y(S_i)$  is the observed attribute value of the sampled point  $S_i$ ,  $\lambda_i$  is the weight of  $y(S_i)$  and  $\alpha$  is a power parameter greater than 0. When a greater value of  $\alpha$  is used, greater weights will be given to sampled points that are closer together.

The spatial pattern of the sampled points in the neighborhood should be considered in the selection of the  $\alpha$  value. When the sampled points are highly clustered, to avoid the overwhelming influence of the closer points on the attribute value of the unsampled point, the smaller  $\alpha$  value should be selected; otherwise, when the sampled points are relatively scattered, the larger  $\alpha$  value can be selected (Lu and Wong, 2008). This method is called the adaptive inverse-distance weighting method, which can be used when there are more than two unsampled points or when the position of the unsampled point is not fixed. However, there is only one unsampled point, and its position is fixed in this study, so the adaptive inverse-distance weighting method is not used.

According to general statistical recommendations,  $\alpha=2$  is used in this study. Then, the calculation is carried out in four steps using MATLAB. First, the data of  $q_c$  and  $f_s$  of each sampled point from 30 mm to 4775 mm with an interval of 5 mm are obtained by interpolation. Next, the distance from each sampled point to the unsampled point is calculated. After that, the weight of each sampled point is determined according to eq. (11). It should be noted that the weight of each sampled point in the range of 5-30 mm below the ground is different from that in the range of 30 mm below the ground because sample point E3 lacks the data of  $q_c$  and  $f_s$  within the range of 5-30 mm below the ground. Finally, according to eq. (10), the values of  $q_c$  and  $f_s$  at different depths at the unsampled point are calculated. The results are given as follows:

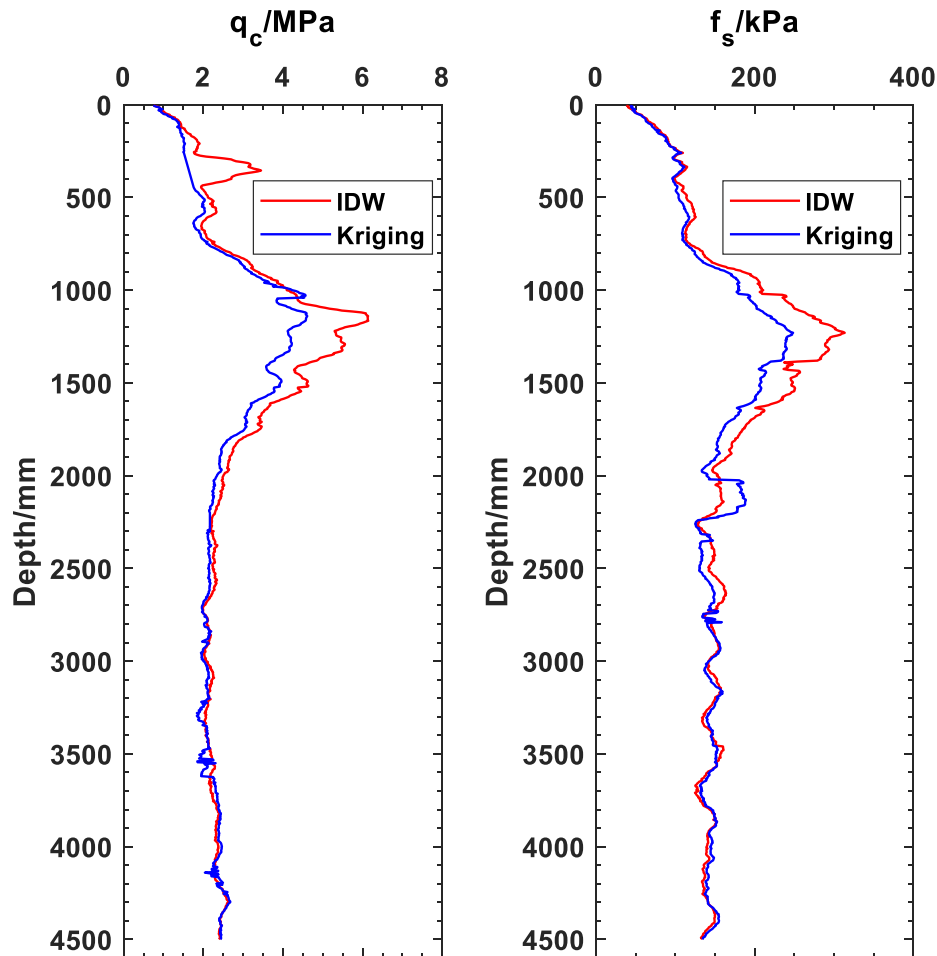


Figure 3.6 Comparison between the IDW and kriging methods

As shown in Figure 3.6, the interpolation results of the kriging method and inverse-distance weighting method are similar, but the peak value of the latter is slightly larger. According to the research performed by Jaksa (1995), the kriging method is superior to the inverse-distance weighting method; hence, the interpolation result obtained by the kriging method is selected as the final result in this study.

## 4 Bearing Capacity Calculation

### 4.1 Introduction and Assessment of CPT-based Methods

The cone penetration test (CPT) has a long history and was first applied to identify the soil layer boundaries and determine the soil type in terms of the grain size. Then, because of the similarities between the cone penetrometer and the pile, researchers determined that the cone penetrometer could be considered to be a mini-pile foundation, whereby the measured tip stress and sleeve resistance would correspond to the pile end bearing and the component of side friction. As commonly reported (Ardalan, Eslami, and Nariman-Zadeh, 2009; Cai, Liu, Tong, and Du, 2009), there are

two main approaches to perform an axial pile capacity analysis from CPT data: (a) “rational (or indirect) methods” and (b) “direct methods.”

- (a) Indirect method: The CPT or CPTU data ( $q_c$  and  $f_s$ ) are first used to evaluate the soil strength parameters, such as the undrained shear strength ( $S_u$ ) and the interface friction between the soil and pile material ( $\delta$ ). Then, the unit end bearing capacity of the pile ( $q_b$ ) and the unit skin friction of the pile ( $f_p$ ) can be evaluated from these strength parameters by the  $\alpha$ -method based on the total stress or the  $\beta$ -method based on the effective stress.
- (b) Direct method: The unit end bearing capacity of the pile ( $q_b$ ) is evaluated from the cone tip resistance ( $q_c$ ), and the unit skin friction of the pile ( $f_p$ ) is evaluated from either the cone sleeve friction ( $f_s$ ) profile or the  $q_c$  profile.

Cai et al. (2009) evaluated and graded ten CPT-based methods by comparing the measured capacity from in situ static load tests of PTC, CFG and PHC piles with the estimated result from different pile capacity prediction methods, plotting curves of the estimated ultimate capacity ( $Q_p$ ) versus the measured ( $Q_m$ ) ultimate capacity and ranking them depending on the prediction accuracy. The results showed that the CPT method was reliable, but different methods had a tendency to overestimate or underestimate the bearing capacity of the pile, as shown in Table 4.1. The best methods were the Schmertmann method (1978), Dutch method (1979), and LCPC or French method (Bustamante and Gianceselli, 1982). Another study conducted by Titi and Abu-Farsakh (1999) obtained the same result when different CPT methods were applied to predict the ultimate load carrying capacity of square precast prestressed concrete (PPC) piles driven into Louisiana soil. In addition, Jaksa (1995) recommended the LCPC method as the best prediction method.

Based on the recommendation and interpolated data, our team chose five CPT-based methods, including direct and indirect approaches, to calculate the bearing capacity of the drilled pile using MATLAB and Microsoft Excel. Niazi and Mayne (2013) reviewed 35 CPT-based methods, and the specific details of each selected method are shown in Table 4.2.

**Table 4.1** Evaluation of different CPT prediction methods (Cai et al., 2009)

Pile capacity method	Best fit calculations		Final rank
	$Q_{fit}/Q_m$	$R^2$	
De Kuitert and Beringen, (1979)	1.03	0.98	1
LCPC	0.96	0.98	2
Schmertmann Method (1978)	1.18	0.93	3

Note: Regression analysis was conducted to obtain the line of best fit for  $Q_{fit}/Q_m$ , where  $Q_{fit}$  is the best fit value of  $Q_p$ .

**Table 4.2** Details for the selected method (Niazi and Mayne, 2013)

Methods	Design equations	
	$f_p$	$q_b$
Schmertmann Method (1978)	$f_p = \alpha_{\text{clay}} f_s \leq 120 \text{ kPa}$ $\alpha_{\text{clay}} = \text{fctn}(f_s) = 0.2 - 1.25$ (see Figure 4.2) 25% reduction in skin friction for bored or cast in place piling	$q_b = (q_{c1} + q_{c2})/2$ $\leq 15 \text{ MPa}$ (see Figure 4.1 for $q_{c1}$ and $q_{c2}$ )
De Kuiter and Beringen (1979)	$f_p = \alpha S_u(\text{side}) \leq 120 \text{ kPa}$ $\alpha = 1$ for NC clay $\alpha = 0.5$ for OC clay	$q_b = 9 S_u(\text{tip})$
LCPC	$f_p = q_{c(\text{side})}/k_s \leq f_{p(\text{max})}$ $k_s = 30 - 150$ depending on the soil type, pile type and installation procedure	$q_b = k_b q_{\text{eq}(\text{tip})}$ $k_b = 0.375$ for clay and silt $q_{\text{eq}(\text{tip})}$ is the average $q_c$ value over a zone ranging from $1.5D$ below the pile tip to $1.5D$ above the pile tip.
Lopes and Laprovitera (1988), Salgado(2008)	$f_p = c_s q_c$ $c_s = 0.011$ for silty clay	$q_b = c_b q_{cb}$ $c_b = 0.9 - 1.0$ $q_{cb}$ is the average cone tip resistance in the zones ranging from $D$ above the pile tip to $1.5D$ below the pile tip
Salgado(2006), Hu and Randolph (2002)	$f_p = \alpha S_u$ $\alpha = 0.4[1 - 0.12 \ln(S_u/p_A)]$	$q_b = 9.6 S_u$

Note:  $D$  is the diameter of the pile, and  $p_A = 100 \text{ kPa}$ .

## 4.2 Determination of the Undrained Shear Strength

As shown in Table 4.2, the Dutch method and Hu and Randolph method use the undrained shear strength  $S_u$  of the clay. The cone tip resistance  $q_c$  is generally related to the undrained shear strength  $S_u$  by eq. (13) (Schmertmann, 1978).

$$S_u = \frac{q_c - \sigma_{v0}}{N_k} \quad (13)$$

where  $q_c$  is the cone tip resistance,  $\sigma_{v0}$  is the total in situ vertical overburden stress, and  $N_k$  is the cone factor from 5 to 70. Jaksa (1995) suggested that the clay in

Adelaide was overconsolidated and saturated with no free water table. In addition, the volume weight was approximately  $19 \text{ kN/m}^3$ . Since the value range of  $N_k$  was wide and different values had a substantial influence on the results, it was necessary to determine a reasonable formula to determine the value.

Many studies have been conducted at Adelaide to determine  $N_k$  (Teh, Houlsby, and Goh, 1992), and the results showed that compared with other methods, eq. (14) yielded the best comparison of the measured, predicted, and undrained shear strengths.

$$N_k = 12 + \ln(I_r) - 2f \quad (14)$$

where  $f$  is defined as the initial shear stress ratio and was originally proposed by Davis and Poulos (1968) and  $I_r$  is the rigidity index. The values of  $f = -0.4$  and  $I_r = 100$  are determined to be appropriate for highly overconsolidated fissured plastic clays and very stiff silty and sandy clays (Mitchell and Kay, 1985). The final value of  $N_k$  is determined to be 17.5.

### 4.3 Calculation of the Pile Bearing Capacity

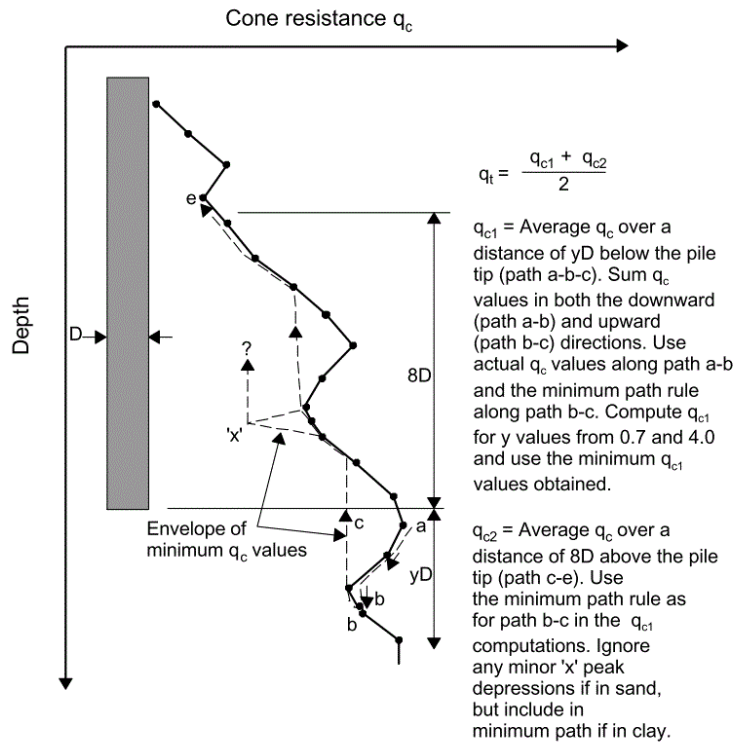
#### 4.3.1 Schmertmann (1978)

Schmertmann (1978) proposed the following relationship to predict the unit tip bearing capacity  $q_b$ .

$$q_b = q_t = \frac{q_{c1} + q_{c2}}{2} \leq 15 \text{MPa} \quad (15)$$

where  $q_b$  is the end bearing resistance,  $q_{c1}$  is the average cone tip resistance of the zones ranging from  $0.7D$  to  $4D$  below the pile tip, and  $q_{c2}$  is the average cone tip resistance over a distance of  $8D$  above the pile tip ( $D$  is the pile diameter). Since  $D = 0.4 \text{ m}$ , four times the pile diameter under the pile bottom is  $6.1 \text{ m}$  below the ground surface, which cannot be achieved due to the insufficient drilling depth. Therefore, we choose  $0.7D$  as the lower bound and  $8D$  as the upper bound, that is, from  $1.3 \text{ m}$  to  $4.78 \text{ m}$  below the ground surface. More details are given on this procedure in Figure 4.1.

As shown in Figure 4.1, this method divides the  $q_c$  path into three parts (a-b, b-c, and c-e).  $q_{c1}$  is the average  $q_c$  value over a distance of  $0.7D$  below the pile tip (path a-b-c) by summing the  $q_c$  values in both the downward (path a-b) and upward (path b-c) directions, using actual  $q_c$  values along path a-b and the minimum path rule along path b-c.  $q_{c2}$  is the average  $q_c$  value over a distance of  $8D$  above the pile tip (path c-e), using the same minimum path rule as that for path b-c in the  $q_{c1}$  computations. The final unit bearing capacity equals the average value of  $q_{c1}$  and  $q_{c2}$ .



**Figure 4.1** Procedure for the calculation of  $q_b$  by the Schmertmann method

The minimum path rule records the minimum value on the  $q_c$  path to consider the most unfavorable factors in the upper and lower soil layers to avoid overestimating the bearing capacity of the pile. The process can be achieved by using MATLAB. Based on the processed data, the minimum values on the  $q_c$  path from  $0.7D$  below the pile tip to  $8D$  above the pile tip are presented in Table 4.3.

**Table 4.3** Minimum  $q_c$  value from  $0.7D$  below to  $8D$  above

	b-c				c-e					
Distance to ground (mm)	4780	4770	4760	4645	4145	4140	3620	3545	3540	3295
Value (MPa)	2.318	2.2878	2.2708	2.1954	2.189	2.039	1.9443	1.855	1.8484	1.8363

From a-b, the sum of the actual  $q_c$  values is 137.2215 MPa, and the value number is 57. The calculation process is as follows:

$$q_{c1} = \frac{137.2215 + 2.318 + 2.2878 + 2.2708 + 2.1954}{57 + 4} = 2.33 \text{ MPa}$$

$$q_{c2} = \frac{2.189 + 2.0387 + 1.944 + 1.855 + 1.8484 + 1.8363}{6} = 1.95 \text{ MPa}$$

$$q_b = \frac{2.33 + 1.95}{2} = 2.141 \text{ MPa}$$

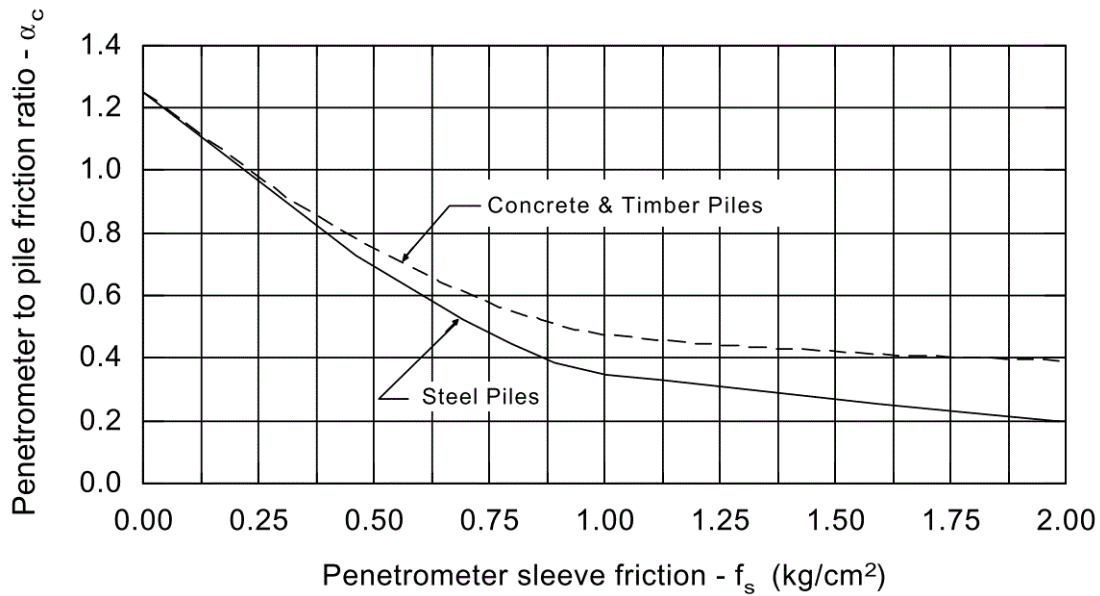
The total end bearing capacity is as follows:

$$Q_b = q_b A_b = 2.141 \text{MPa} * \frac{\pi}{4} (0.4\text{m})^2 = 269 \text{kN}$$

According to the Schmertmann method, the unit skin friction of the pile ( $f_p$ ) is given by:

$$f_p = \alpha_{\text{clay}} f_s \leq 120 \text{kPa} \quad (16)$$

where  $\alpha_{\text{clay}}$  varies from 0.2 to 1.25 for clayey soil, as shown in Figure 4.2, and  $f_s$  is the sleeve friction



**Figure 4.2** Design curves for the pile side friction in clay (Schmertmann, 1978)

The analytical formula of this curve is obtained using MATLAB fitting, and since the pile is a drilled pile,  $\alpha_c$  can be obtained from the dashed line in the figure above. The fitting result is given below:

$$\alpha_c = (-1.358e - 7)f_s^3 + (7.479e - 5)f_s^2 - 0.01387f_s + 1.25 \quad (17)$$

Then, the corresponding  $\alpha_{\text{clay}}$  value is determined based on the measured value of  $f_s$ , and the total skin friction calculation is performed using the following equation:

$$Q_s = \sum_{i=1}^n f_{pi} A_{si} \quad (18)$$

When the value of  $n$  is large, the above formula can be transformed into the following formula:

$$Q_s = 0.4\pi \int_0^l f_p dl \quad (19)$$

The function *trapz()* in MATLAB is used for calculations based on interpolated data, and the result is 396.4 kN. However, the author recommended a 25% reduction in the skin friction for bored or cast-in-place piles compared to driven piles (Schmertmann, 1978). Therefore, the ultimate pile side friction equals

$$Q_{s,ult} = 0.75 * 396.4\text{kN} = 297.3\text{kN}$$

The total bearing capacity is:

$$Q_u = Q_b + Q_{s,ult} = 269\text{kN} + 297.3\text{kN} = 566.3\text{kN}$$

As shown in Table 4.1, the Schmertmann method tends to overestimate the actual bearing capacity, so  $Q_u$  is divided by 1.18, and the final value is 479.9 kN.

### 4.3.2 De Kuiter and Beringen (1979)

The following method was proposed by De Kuiter and Beringen (1979) and is based on the experience gained in the North Sea. This method is also sampled as the European method and uses different procedures for clay and sand.

In clay, the undrained shear strength ( $S_u$ ) for each soil layer is first evaluated from the cone tip resistance ( $q_c$ ). Then, the unit end bearing capacity and the unit skin friction are computed by applying suitable multiplying factors. The unit tip bearing capacity is given by:

$$q_b = 9S_u(tip) \quad (20)$$

$$S_u(tip) = \frac{q_t}{N_k} \quad (21)$$

where  $N_k$  is the cone factor ranging from 15-20 and  $q_t$  is the average of the cone tip resistances around the pile tip computed in a manner similar to the Schmertmann method, as shown in Figure 4.1.  $S_u$  can be calculated by eq. (13), but for reliability considerations, the value calculated using eq. (21) is relatively conservative. Therefore, eq. (21) is used to calculate  $S_u$  using  $N_k$  equal to 20. The calculation process is as follows:

$$q_b = 9 \frac{2.141}{20} = 0.963\text{MPa}$$

$$Q_b = 0.963\pi \left(\frac{d}{2}\right)^2 = 121.07\text{kN}$$

The unit skin friction of the pile is given by:

$$f_p = 0.5S_u(side) \quad (22)$$

where  $S_u(side)$  is determined in the same way as  $S_u(tip)$ . Excel is used to calculate  $f_p$  from the ground surface to the pile tip, and MATLAB is used to calculate the total pile skin friction  $Q_s$  with eq. (18) and eq. (19). The calculation result is 346.533 kN, so the total pile bearing capacity is:

$$Q_u = Q_b + Q_s = 121.07\text{kN} + 346.53\text{kN} = 467.6\text{kN}$$

As shown in Table 4.1, the European method tends to overestimate the actual bearing capacity, so  $Q_u$  is divided by 1.03, and the final value is 454 kN.

### 4.3.3 LCPC Method

Bustamante and Gianeselli (1982) proposed a method based on the analysis of 197

full-scale static load tests (including compression and uplift) on 96 pile foundations from 48 sites, which was commonly referred to as the Laboratoire Central des Ponts et Chaussée (LCPC) method or French method. The approach offers versatility in the variety and types of different deep foundation systems and geomaterials that can be accommodated. As shown in Table 4.2, this method uses  $q_c$  only because of the lack of credibility of  $f_s$ .

The unit tip bearing capacity of the pile ( $q_b$ ) is predicted from the following equation:

$$q_b = k_b q_{eq(tip)} \quad (23)$$

where  $k_b = 0.375$  for a bored pile in clay or silt and  $q_{eq(tip)}$  is the equivalent average cone tip resistance from  $1.5D$  above the pile tip to  $1.5D$  below the pile tip. Due to the data insufficiency and stability of the  $q_c$  values around the pile tip,  $q_{eq(tip)}$  is determined by averaging the  $q_c$  values from  $1.5D$  above the pile tip to the last available value, and the result is 2.45 MPa. Now, the end bearing capacity can be determined as:

$$Q_b = q_b A_b = 115.45 \text{ kN}$$

The pile unit skin friction is estimated by:

$$f_p = \frac{q_{c(side)}}{k_s} \quad (24)$$

where  $k_s$  is the skin friction coefficient ranging from 30-150, which is equal to 40 for plain bored piles in moderately compact clay ( $q_c$  range 1 MPa-5 MPa). Bustamante and Gianselli (1982) also imposed different upper limits for  $f_p$  depending on the pile and soil typology as well as the installation methods. In this case, the upper limit is 80 kPa. The  $q_c$  data are first transformed to  $f_p$  using Excel and MATLAB, and the data over 80 kPa are replaced with 80 kPa. Then, the data are used to calculate the total pile skin friction with eq. (18) and eq. (19). The  $Q_s$  is calculated to be 329.45 kN, so the total bearing capacity of the pile is as follows:

$$Q_u = Q_b + Q_s = 115.45 \text{ kN} + 329.45 \text{ kN} = 444.9 \text{ kN}$$

As shown in Table 4.1, the LCPC method tends to underestimate the actual bearing capacity, so  $Q_u$  is divided by 0.96, and the final value is 463.44 kN.

#### 4.3.4 Lopes and Laprovitera (1988) and Salgado (2008)

Lopes and Laprovitera (1988) provided a method to calculate the limit pile skin friction of nondisplacement piles directly using  $q_c$  data based on noninstrumented pile load tests. The unit skin friction of the pile ( $f_p$ ) is predicted as follows:

$$f_p = c_s q_c \quad (25)$$

where  $q_c$  is the cone tip resistance of the corresponding soil layer, and the parameter  $c_s$  is related to the soil type, which can be estimated by:

$$c_s = \begin{cases} 0.012 & \text{for pure clay} \\ 0.011 & \text{for silty clay} \\ 0.010 & \text{for silty clay with sand} \\ 0.0087 & \text{for sandy clay with silt} \\ 0.0077 & \text{for sandy clay} \end{cases} \quad (26)$$

In this study,  $c_s = 0.011$  is selected according to the geotechnical characteristics of Keswick clay.

After calculating the unit skin friction of the pile ( $f_p$ ) with eq. (25), the total limit skin friction of the pile can be calculated by eq. (19), which equals 152.58 kN.

Salgado (2008) pointed out that the unit tip bearing capacity of nondisplacement piles ( $q_b$ ) in clay is almost as large as the cone resistance at the bottom of the pile ( $q_{cb}$ ), except in stiff clays, when the unit tip bearing capacity may be somewhat less than the cone resistance at the bottom of the pile ( $q_{cb}$ ). Accordingly, the method for evaluating the unit tip bearing capacity of a pile ( $q_b$ ) is expressed as follows:

$$q_b = c_b q_{cb} \quad (27)$$

$$c_b = 0.9 - 1.0 \quad (28)$$

where  $q_{cb}$  is the average cone tip resistance of the zones ranging from  $D$  above the pile tip to  $1.5D$  below the pile tip,  $D$  is the diameter of the pile, and  $c_b$  is selected as 0.95 in this study. The following is the calculation process of the end bearing capacity:

$$q_b = 0.95 * 2.43 = 2.31 \text{MPa}$$

$$Q_b = q_b A_b = 290.56 \text{kN}$$

Then, the total pile bearing capacity is obtained by adding the limit shaft capacity ( $Q_s$ ) to the end bearing capacity ( $Q_b$ ):

$$Q_u = Q_s + Q_b = 152.58 \text{kN} + 290.56 \text{kN} = 443.14 \text{kN}$$

#### 4.3.5 Salgado (2006) and Hu and Randolph (2002)

Salgado (2006a) pointed out that the unit skin friction of a pile ( $f_p$ ) is related to the undrained shear strength  $S_u$  of undisturbed soil and revealed the relationship between the ratio of  $f_p$  to  $S_u$  and  $S_u$  for soil with a clay fraction exceeding 50% and OCR in the 3-5 range by data fitting. This relationship is shown in the following equations:

$$f_p = \alpha S_u \quad (29)$$

$$\alpha = 0.4[1 - 0.12 \ln\left(\frac{S_u}{p_A}\right)] \quad (30)$$

where  $p_A$  equals 100 kPa and  $S_u$  can be obtained from eq. (13).

The calculation of the total skin friction of the pile is carried out first by eq. (29) and eq. (30), then by eq. (18) or eq. (19). The final result is 297.83 kN. Hu and Randolph (2002) studied the correlation between the ultimate unit tip bearing capacity

( $q_b$ ) corresponding to a relative settlement of 10% and the undrained shear strength ( $S_u$ ) and found that the ratio of  $q_b$  to  $S_u$  was within a range of 9.3 to 9.9 for a preinstalled foundation. Therefore, the average value of 9.6 can be used for nondisplacement piles (Salgado, 2006b). The formula is given as follows:

$$q_b = 9.6S_u \quad (31)$$

where  $S_u$  is equal to 133.83 kPa at the bottom of the pile obtained by eq. (13). Then, the ultimate unit tip bearing capacity ( $q_b$ ) can be calculated:

$$q_b = 9.6 * 133.83 = 1284.65\text{kPa}$$

Next, the end bearing capacity is:

$$Q_b = q_b A_b = 161.43\text{kN}$$

Finally, the total pile bearing capacity is:

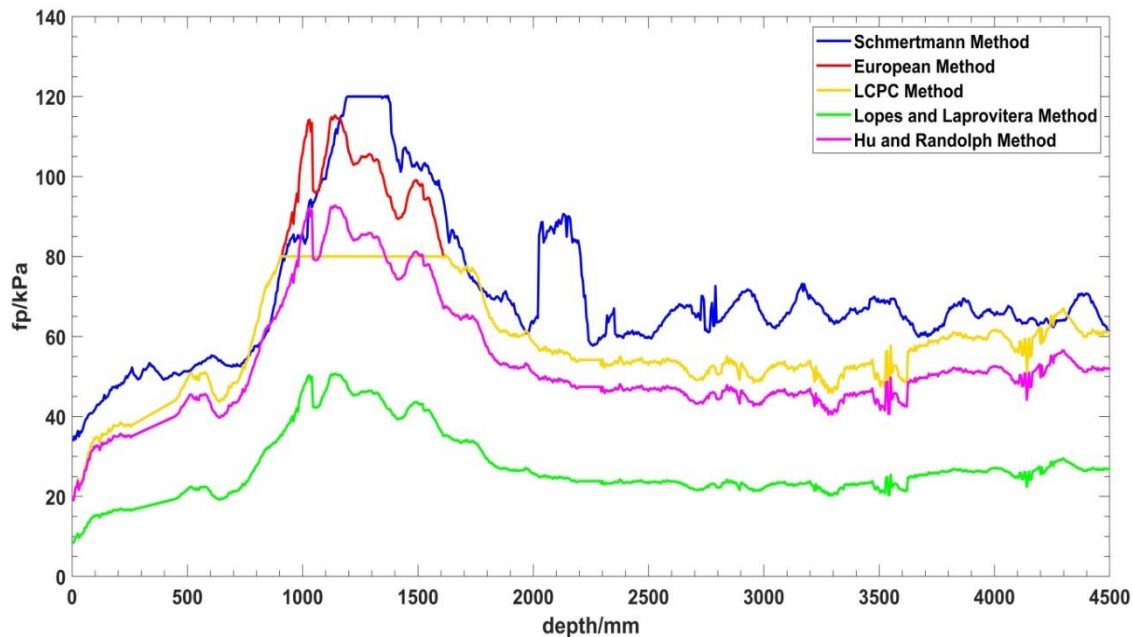
$$Q_u = Q_s + Q_b = 297.83\text{kN} + 161.43\text{kN} = 459.26\text{kN}$$

## 5 Results and Discussion

Section 4 provides a detailed introduction and gives the calculation process for these five CPT-based methods. The results are summarized in the table below.

**Table 5.1** Summary of the CPT-based result

Name	Schmertmann Method	LCPC	European Method	Lopes and Laprovitera	Salgado(2006)
Results(kN)	479.9	444.9	467.6	443.14	459.26



**Figure 5.1** Pile skin friction ( $f_p$ ) along the pile body

As listed above, the calculation results using different methods are similar, indicating that the calculation results have certain credibility, and the bearing capacity of the bored pile ranges from 455 kN-480 kN. The distribution of the skin friction ( $f_p$ ) along the pile body and the comparison of the end bearing capacity ( $Q_b$ ) calculated by different methods are discussed as follows.

**Table 5.2** End bearing capacity ( $Q_b$ ) calculated by different methods

Method	Schmertmann	European	LCPC	Lopes and Laprovitera	Hu and Randolph
$Q_b$ (kN)	269	121.07	115.45	290.56	161.43

As presented in Figure 5.1, the unit skin friction values along the pile body calculated by different methods are different. Among the five methods, the Lopes and Laprovitera Method is the most conservative, and the other four methods give similar estimates. The LCPC method and European method have the same calculation value, and the only difference is that the LCPC method sets an upper limit of 80 kPa for the  $f_p$  value. Although the Schmertmann method has the largest calculation value, the total skin friction results need to be reduced, as presented in 4.3.1. In addition, when applied to a specific design, an appropriate safety factor should be selected according to local regulations to reduce the value to a proper value. The values of the end bearing capacity vary greatly; the Schmertmann method and Lopes and Laprovitera method tend to overestimate the end bearing capacity, and the other three methods give relatively similar results.

The methods listed above have the following limitations:

The kriging method is selected in data processing for which semivariograms need to be determined. However, the drilling data are limited, leading to uncertainty of the result (Jaksa, 1995). For each horizontal slice, at least 30 points need to be known so that the semivariogram can be relatively accurate. However, compared with other interpolation methods, the kriging method is still more suitable.

Due to the shift of  $f_s$ , the maximum interpolation depth is 4775 mm, which cannot meet the requirement for the calculating depth in the selected methods as stated in Section 4, so the calculation may have errors.

CPT methods are locally developed; that is, they are based on limited types of piles and soils and may not be relevant outside the local area. For example, the European method is proposed based on offshore piles in the North Sea, which may differ from the conditions of this study. Moreover, the LCPC method, Schmertmann method, and European method all pose upper limits for  $q_c$  and  $f_s$ , which may cause data filtering and underestimation of the total bearing capacity, and the influence distance above and below the pile tip used in the  $q_b$  calculation is different for different methods. Cai et al. (2009) suggested that the influence distance may be improper and needs to be revised further depending on the soil. Silvey (2018) demonstrated that different methods have different prediction accuracies for the end resistance and side resistance, so combining different methods may produce better results.

The CPT method has been continually developed, and its accuracy has been

continuously improved. However, most of the methods used in this paper have been proposed before calibration with more accurate measurements from modern cone penetrometers, so the parameters may need to be revised. The CPT methods employ total stress values, whereas effective stress governs the long-term behavior of piles. The addition of pore water pressure measurements also makes CPTs evolve into the currently widely used CPTU method, for which the calculation accuracy has been improved.

## 6 Acknowledgments

The authors would like to thank Professor Guoliang Dai and Professor Wenni Deng for their patient guidance and effective advice, as well as the valuable platform provided by the competition organizers.

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# Appendix

## 1 Codes Used in MATLAB for Kriging Interpolation

```
clear; clc
e3=[15 30];%% Input boreholes coordinates
g4=[20,20];
i5=[25,10];
d6=[30,35];
f7=[35,25];
j8=[40,5];
f5=[25,25];

depth=[-30:-5:-4775];%% Set up vertical slice,E3,G4,I5,D6,F7,J8 are known matrixes.
qce3=interp1(E3(:,1),E3(:,2),depth);
fse3=interp1(E3(:,1),E3(:,3),depth);
qcg4=interp1(G4(:,1),G4(:,2),depth);
fsg4=interp1(G4(:,1),G4(:,3),depth);
qci5=interp1(I5(:,1),I5(:,2),depth);
fsi5=interp1(I5(:,1),I5(:,3),depth);
qcd6=interp1(D6(:,1),D6(:,2),depth);
fsd6=interp1(D6(:,1),D6(:,3),depth);
qcf7=interp1(F7(:,1),F7(:,2),depth);
fsf7=interp1(F7(:,1),F7(:,3),depth);
qcj8=interp1(J8(:,1),J8(:,2),depth);
fsj8=interp1(J8(:,1),J8(:,3),depth);

theta=[10 10];lob=[1e-1 1e-1];upb=[20 20];%% Set calculation parameters

for i=[1:size(depth,2)]
[dmodel,perf]=dacefit([e3;g4;i5;d6;f7;j8],[qce3(i);qcg4(i);qci5(i);qcd6(i);qcf7(i);qcj8(i)],@regpoly1,@corrgauss,theta,lob,upb);
[qcf5(i),MSE]=predictor(f5,dmodel);
end

for i=[1:size(depth,2)]
[dmodel,perf]=dacefit([e3;g4;i5;d6;f7;j8],[fse3(i);fsg4(i);fsi5(i);fsd6(i);fsf7(i);fsj8(i)],@regpoly1,@corrgauss,theta,lob,upb);
[fsf5(i),MSE]=predictor(f5,dmodel);
End

%%qcf5 and fsf5 are the unsampled point data which have been calculated
```

## 2 Results of Interpolation

### 2.1 Results from Kriging Interpolation

Depth(mm)	qc(MPa)	fs(kPa)	Depth(mm)	qc(MPa)	fs(kPa)	Depth(mm)	qc(MPa)	fs(kPa)
5	0.75	43.08	1595	3.36	198.60	3190	2.14	154.12
10	0.81	45.85	1600	3.29	198.05	3195	2.13	152.43
15	0.90	44.28	1605	3.27	196.61	3200	2.16	154.32
20	0.91	46.60	1610	3.19	194.65	3205	2.10	153.00
25	0.98	49.22	1615	3.19	192.16	3210	2.08	152.81
30	0.87	45.89	1620	3.21	189.12	3215	2.04	152.04
35	0.93	48.73	1625	3.20	185.75	3220	1.95	151.37
40	0.94	48.25	1630	3.20	181.04	3225	2.10	150.23
45	0.97	49.91	1635	3.18	177.56	3230	1.98	149.78
50	1.00	52.57	1640	3.17	179.85	3235	2.04	150.23
55	1.10	55.59	1645	3.13	182.41	3240	2.01	149.62
60	1.10	57.75	1650	3.11	182.66	3245	2.02	149.12
65	1.15	58.54	1655	3.11	181.64	3250	1.95	148.40
70	1.23	60.76	1660	3.10	179.36	3255	1.92	147.52
75	1.22	61.98	1665	3.08	180.03	3260	1.96	145.41
80	1.30	62.51	1670	3.09	179.99	3265	1.89	144.60
85	1.33	62.59	1675	3.09	178.18	3270	1.92	144.63
90	1.34	63.03	1680	3.06	175.87	3275	1.91	143.59
95	1.38	64.81	1685	3.03	175.44	3280	1.84	143.68
100	1.37	66.00	1690	3.05	175.09	3285	1.88	140.76
105	1.39	68.65	1695	3.07	173.33	3290	1.88	142.04
110	1.40	70.45	1700	3.08	170.51	3295	1.84	140.50
115	1.38	70.35	1705	3.07	169.02	3300	1.86	140.40
120	1.34	71.04	1710	3.10	166.78	3305	1.90	138.95
125	1.39	72.90	1715	3.10	165.78	3310	1.90	139.76
130	1.43	73.75	1720	3.05	164.26	3315	1.87	140.77
135	1.41	74.81	1725	3.05	163.01	3320	1.89	139.67
140	1.42	80.17	1730	3.05	162.24	3325	1.97	139.99
145	1.43	76.51	1735	3.09	162.81	3330	2.00	140.67
150	1.42	78.05	1740	3.07	160.95	3335	2.02	141.12
155	1.44	78.61	1745	3.04	161.05	3340	2.02	142.15
160	1.48	81.66	1750	3.03	160.27	3345	1.98	142.62
165	1.45	85.39	1755	3.01	159.97	3350	2.09	141.73
170	1.46	85.38	1760	2.99	159.02	3355	2.08	143.05
175	1.48	88.36	1765	2.93	157.97	3360	2.10	144.13
180	1.51	88.28	1770	2.90	156.81	3365	2.08	144.74
185	1.51	88.11	1775	2.86	157.41	3370	2.07	145.14

190	1.51	89.33	1780	2.83	157.46	3375	2.11	147.38
195	1.51	87.30	1785	2.77	156.37	3380	2.09	146.92
200	1.50	90.26	1790	2.73	155.86	3385	2.07	146.78
205	1.52	90.38	1795	2.68	155.69	3390	2.11	146.64
210	1.54	90.58	1800	2.68	153.70	3395	2.10	147.48
215	1.53	92.57	1805	2.63	154.06	3400	2.07	145.49
220	1.51	92.06	1810	2.59	154.31	3405	2.09	144.67
225	1.52	93.45	1815	2.58	153.17	3410	2.09	145.45
230	1.50	96.70	1820	2.58	152.50	3415	2.10	146.07
235	1.52	99.35	1825	2.54	152.48	3420	2.12	146.11
240	1.51	97.97	1830	2.53	152.21	3425	2.11	146.04
245	1.52	100.41	1835	2.50	152.52	3430	2.12	147.21
250	1.52	102.24	1840	2.50	153.58	3435	2.10	147.71
255	1.50	103.92	1845	2.48	153.58	3440	2.12	147.88
260	1.51	107.60	1850	2.47	153.05	3445	2.13	147.60
265	1.52	102.88	1855	2.45	152.32	3450	2.13	147.10
270	1.53	100.47	1860	2.44	151.15	3455	2.13	147.69
275	1.53	99.69	1865	2.45	152.47	3460	2.14	152.12
280	1.54	98.10	1870	2.46	154.97	3465	2.12	152.47
285	1.55	96.45	1875	2.45	155.29	3470	2.17	152.47
290	1.55	96.72	1880	2.46	156.20	3475	2.08	153.20
295	1.56	97.74	1885	2.45	154.51	3480	2.00	153.46
300	1.57	100.06	1890	2.44	152.47	3485	1.97	151.99
305	1.57	103.57	1895	2.42	151.89	3490	2.03	151.05
310	1.58	106.16	1900	2.41	151.50	3495	2.02	152.42
315	1.59	105.48	1905	2.41	150.06	3500	1.96	150.89
320	1.59	105.61	1910	2.41	149.12	3505	1.90	150.83
325	1.60	107.33	1915	2.42	150.00	3510	1.95	151.61
330	1.61	108.66	1920	2.40	146.92	3515	1.95	151.00
335	1.61	111.34	1925	2.42	144.35	3520	1.92	151.90
340	1.62	110.67	1930	2.41	144.34	3525	1.89	150.31
345	1.63	108.85	1935	2.39	143.67	3530	2.24	151.11
350	1.63	108.80	1940	2.40	142.03	3535	2.26	151.51
355	1.64	107.73	1945	2.41	139.83	3540	1.85	150.72
360	1.64	105.84	1950	2.41	138.17	3545	1.85	149.88
365	1.65	104.36	1955	2.42	137.23	3550	2.31	152.45
370	1.66	103.97	1960	2.41	135.89	3555	2.03	152.42
375	1.66	102.34	1965	2.46	134.75	3560	2.07	152.44
380	1.67	100.90	1970	2.46	133.36	3565	2.11	152.46
385	1.68	99.62	1975	2.44	133.35	3570	2.11	151.64
390	1.68	97.84	1980	2.43	133.73	3575	2.10	149.47
395	1.69	96.38	1985	2.38	136.83	3580	2.06	148.08
400	1.70	96.11	1990	2.37	139.64	3585	2.00	147.87

405	1.70	97.41	1995	2.35	140.54	3590	1.99	145.60
410	1.71	97.18	2000	2.34	139.26	3595	1.98	143.74
415	1.72	97.47	2005	2.33	140.59	3600	1.96	143.09
420	1.72	98.73	2010	2.31	142.07	3605	1.97	141.59
425	1.73	99.74	2015	2.31	143.08	3610	1.95	142.96
430	1.74	99.41	2020	2.29	142.35	3615	1.95	143.12
435	1.74	100.86	2025	2.26	180.41	3620	1.94	141.47
440	1.75	102.68	2030	2.26	182.82	3625	2.25	140.74
445	1.76	102.53	2035	2.27	185.64	3630	2.25	140.51
450	1.77	102.26	2040	2.28	185.75	3635	2.28	138.47
455	1.78	101.73	2045	2.26	177.63	3640	2.27	139.25
460	1.80	100.78	2050	2.30	179.06	3645	2.26	138.97
465	1.81	100.45	2055	2.29	179.57	3650	2.26	135.74
470	1.85	101.40	2060	2.25	182.24	3655	2.31	134.50
475	1.88	102.17	2065	2.26	182.10	3660	2.26	133.02
480	1.89	103.25	2070	2.27	182.58	3665	2.30	132.12
485	1.90	104.14	2075	2.25	183.99	3670	2.29	131.07
490	1.93	104.13	2080	2.25	183.46	3675	2.31	131.30
495	1.96	104.10	2085	2.22	182.71	3680	2.30	133.14
500	1.98	103.97	2090	2.25	181.30	3685	2.31	132.21
505	2.00	104.24	2095	2.25	184.01	3690	2.31	133.36
510	2.03	104.88	2100	2.24	185.74	3695	2.31	132.30
515	2.04	105.05	2105	2.23	184.08	3700	2.32	133.94
520	2.03	106.23	2110	2.27	186.61	3705	2.30	132.11
525	1.99	107.61	2115	2.25	185.64	3710	2.31	131.24
530	2.00	108.54	2120	2.26	185.02	3715	2.36	132.75
535	1.97	109.77	2125	2.25	187.05	3720	2.34	132.09
540	2.01	110.10	2130	2.24	188.91	3725	2.34	132.67
545	1.97	110.17	2135	2.22	188.70	3730	2.36	133.79
550	1.96	111.34	2140	2.24	188.00	3735	2.35	133.83
555	2.03	111.32	2145	2.24	188.00	3740	2.35	136.05
560	2.03	110.82	2150	2.23	187.89	3745	2.36	135.05
565	2.03	112.62	2155	2.23	188.00	3750	2.36	136.02
570	2.03	112.81	2160	2.21	187.00	3755	2.33	135.11
575	2.04	113.20	2165	2.18	181.59	3760	2.37	137.17
580	2.04	113.87	2170	2.17	177.67	3765	2.37	137.56
585	2.02	115.00	2175	2.18	178.94	3770	2.38	137.27
590	1.99	115.59	2180	2.18	178.20	3775	2.39	138.70
595	1.95	115.95	2185	2.15	178.57	3780	2.40	137.91
600	1.93	115.73	2190	2.15	177.56	3785	2.38	140.72
605	1.87	117.64	2195	2.15	178.34	3790	2.38	143.00
610	1.84	117.19	2200	2.17	175.90	3795	2.37	144.99
615	1.82	117.16	2205	2.17	171.90	3800	2.38	145.74

620	1.81	116.59	2210	2.17	163.66	3805	2.41	147.86
625	1.78	115.67	2215	2.17	161.03	3810	2.40	147.24
630	1.77	115.22	2220	2.17	153.35	3815	2.41	148.31
635	1.76	113.23	2225	2.17	154.10	3820	2.44	148.08
640	1.75	113.69	2230	2.17	142.99	3825	2.44	149.77
645	1.76	113.72	2235	2.17	139.03	3830	2.43	149.11
650	1.77	111.80	2240	2.17	128.57	3835	2.42	148.86
655	1.77	111.79	2245	2.17	127.30	3840	2.43	149.40
660	1.78	110.48	2250	2.17	125.85	3845	2.41	150.63
665	1.81	110.00	2255	2.17	125.59	3850	2.44	150.78
670	1.81	109.53	2260	2.17	125.00	3855	2.43	148.89
675	1.84	109.33	2265	2.17	126.00	3860	2.40	150.99
680	1.90	109.28	2270	2.17	125.79	3865	2.39	152.63
685	1.89	109.11	2275	2.17	126.21	3870	2.40	152.26
690	1.89	108.61	2280	2.17	127.59	3875	2.42	151.20
695	1.93	108.41	2285	2.17	130.30	3880	2.39	150.90
700	1.94	109.98	2290	2.17	129.15	3885	2.39	151.47
705	1.93	108.99	2295	2.11	130.28	3890	2.39	150.62
710	1.94	108.93	2300	2.17	130.98	3895	2.39	148.90
715	1.94	110.50	2305	2.11	131.95	3900	2.39	147.00
720	1.96	109.34	2310	2.09	131.23	3905	2.37	145.60
725	1.98	109.02	2315	2.13	133.14	3910	2.37	145.01
730	2.02	108.81	2320	2.12	143.68	3915	2.39	143.67
735	2.03	110.88	2325	2.11	139.86	3920	2.39	143.09
740	2.11	111.19	2330	2.11	141.83	3925	2.40	142.74
745	2.07	112.63	2335	2.12	143.35	3930	2.40	142.21
750	2.09	114.14	2340	2.11	144.31	3935	2.39	142.49
755	2.15	113.70	2345	2.13	144.61	3940	2.39	143.81
760	2.15	115.51	2350	2.13	147.52	3945	2.39	143.28
765	2.20	117.41	2355	2.15	132.99	3950	2.37	145.03
770	2.25	117.66	2360	2.15	132.26	3955	2.38	145.76
775	2.30	120.55	2365	2.13	130.98	3960	2.38	145.77
780	2.35	121.03	2370	2.14	131.87	3965	2.37	146.37
785	2.39	121.38	2375	2.20	131.54	3970	2.39	146.91
790	2.42	124.23	2380	2.19	131.30	3975	2.42	146.38
795	2.49	124.63	2385	2.15	131.04	3980	2.44	147.10
800	2.52	124.76	2390	2.12	130.26	3985	2.45	145.52
805	2.55	124.23	2395	2.12	132.34	3990	2.46	145.42
810	2.59	125.61	2400	2.14	132.98	3995	2.46	144.96
815	2.66	126.81	2405	2.14	132.71	4000	2.47	143.93
820	2.72	127.09	2410	2.15	134.21	4005	2.45	144.31
825	2.75	128.96	2415	2.13	132.92	4010	2.46	145.66
830	2.80	129.81	2420	2.12	133.25	4015	2.46	144.65

835	2.85	131.40	2425	2.13	133.99	4020	2.45	144.59
840	2.90	132.72	2430	2.16	134.76	4025	2.45	144.30
845	2.90	134.78	2435	2.15	132.62	4030	2.45	144.65
850	2.94	134.52	2440	2.15	132.97	4035	2.43	144.46
855	2.93	137.61	2445	2.16	133.84	4040	2.41	144.48
860	2.97	139.37	2450	2.17	132.84	4045	2.39	145.56
865	2.99	142.35	2455	2.17	133.88	4050	2.39	146.33
870	3.02	145.51	2460	2.16	133.27	4055	2.38	147.69
875	3.04	148.43	2465	2.18	131.80	4060	2.37	148.80
880	3.03	150.13	2470	2.18	132.13	4065	2.36	148.29
885	3.06	155.16	2475	2.15	132.09	4070	2.35	148.01
890	3.11	156.41	2480	2.14	131.36	4075	2.30	147.35
895	3.13	161.55	2485	2.14	130.37	4080	2.29	145.24
900	3.17	163.67	2490	2.14	130.65	4085	2.27	144.07
905	3.21	166.22	2495	2.14	130.19	4090	2.24	142.47
910	3.20	168.52	2500	2.12	131.10	4095	2.27	141.03
915	3.27	171.24	2505	2.15	130.58	4100	2.26	140.68
920	3.31	170.12	2510	2.15	129.88	4105	2.24	141.39
925	3.34	172.42	2515	2.14	130.53	4110	2.35	141.29
930	3.39	173.41	2520	2.14	132.17	4115	2.34	140.49
935	3.45	176.68	2525	2.16	133.99	4120	2.21	139.13
940	3.46	176.44	2530	2.15	134.06	4125	2.21	139.50
945	3.50	178.44	2535	2.14	134.66	4130	2.37	139.63
950	3.58	179.21	2540	2.14	135.51	4135	2.36	139.35
955	3.64	179.70	2545	2.15	137.50	4140	2.04	139.41
960	3.53	180.84	2550	2.12	137.98	4145	2.19	140.43
965	3.67	177.90	2555	2.13	137.75	4150	2.38	141.51
970	3.74	178.59	2560	2.17	139.88	4155	2.20	142.07
975	3.83	179.31	2565	2.17	140.67	4160	2.21	141.86
980	3.75	180.55	2570	2.14	141.76	4165	2.39	142.28
985	3.99	179.29	2575	2.16	142.78	4170	2.39	141.62
990	4.10	180.07	2580	2.18	143.06	4175	2.41	141.29
995	4.19	179.17	2585	2.17	144.38	4180	2.42	140.65
1000	4.23	181.02	2590	2.17	144.27	4185	2.45	138.65
1005	4.33	178.41	2595	2.15	146.15	4190	2.47	137.99
1010	4.39	177.14	2600	2.16	146.74	4195	2.49	138.67
1015	4.41	178.75	2605	2.15	146.36	4200	2.33	139.77
1020	4.51	179.65	2610	2.15	146.66	4205	2.48	139.52
1025	4.56	191.45	2615	2.16	146.95	4210	2.34	139.27
1030	4.57	193.89	2620	2.15	148.13	4215	2.36	139.70
1035	4.45	194.45	2625	2.13	148.03	4220	2.40	141.21
1040	4.54	191.53	2630	2.14	149.22	4225	2.44	142.01
1045	3.86	193.41	2635	2.14	149.79	4230	2.48	141.13

1050	3.85	193.59	2640	2.11	148.96	4235	2.48	139.41
1055	3.84	194.81	2645	2.11	149.22	4240	2.49	139.10
1060	3.84	195.96	2650	2.11	148.36	4245	2.61	138.85
1065	3.84	197.85	2655	2.07	147.81	4250	2.58	138.12
1070	3.88	197.96	2660	2.08	148.16	4255	2.51	137.00
1075	3.90	200.41	2665	2.07	149.13	4260	2.61	138.12
1080	3.99	200.90	2670	2.04	149.10	4265	2.60	139.53
1085	4.07	202.49	2675	2.02	148.53	4270	2.62	140.97
1090	4.10	202.18	2680	2.00	149.26	4275	2.63	140.59
1095	4.18	202.49	2685	2.01	148.70	4280	2.64	140.80
1100	4.21	202.41	2690	1.99	144.89	4285	2.64	140.85
1105	4.29	205.75	2695	1.99	144.97	4290	2.65	140.93
1110	4.35	207.45	2700	1.97	144.61	4295	2.67	140.92
1115	4.47	210.13	2705	1.97	142.68	4300	2.68	141.32
1120	4.56	211.18	2710	1.96	143.12	4305	2.64	140.93
1125	4.59	212.44	2715	1.96	144.98	4310	2.62	141.63
1130	4.57	214.73	2720	1.97	143.29	4315	2.62	142.99
1135	4.59	215.68	2725	1.98	141.13	4320	2.59	144.07
1140	4.61	220.07	2730	1.98	153.88	4325	2.58	145.85
1145	4.59	221.81	2735	1.97	153.72	4330	2.58	147.64
1150	4.58	220.12	2740	2.00	151.58	4335	2.56	148.51
1155	4.58	223.54	2745	2.01	135.15	4340	2.53	149.44
1160	4.58	225.65	2750	2.03	135.83	4345	2.53	150.34
1165	4.57	227.14	2755	2.06	134.29	4350	2.51	151.92
1170	4.53	227.75	2760	2.03	133.82	4355	2.48	151.75
1175	4.49	227.60	2765	2.09	134.45	4360	2.48	152.99
1180	4.45	230.29	2770	2.09	146.54	4365	2.45	154.75
1185	4.44	233.66	2775	2.10	150.41	4370	2.45	154.16
1190	4.40	235.98	2780	2.11	137.89	4375	2.45	154.83
1195	4.30	238.08	2785	2.10	137.75	4380	2.44	155.01
1200	4.24	238.20	2790	2.08	158.64	4385	2.40	154.06
1205	4.22	239.43	2795	2.03	139.75	4390	2.40	154.29
1210	4.18	240.11	2800	2.02	140.10	4395	2.40	154.88
1215	4.15	241.49	2805	2.02	140.07	4400	2.40	155.04
1220	4.12	243.76	2810	2.03	140.84	4405	2.43	154.78
1225	4.12	245.24	2815	2.04	140.66	4410	2.43	154.36
1230	4.13	248.49	2820	2.13	142.56	4415	2.43	152.91
1235	4.13	246.71	2825	2.12	142.43	4420	2.43	150.62
1240	4.14	247.22	2830	2.13	143.51	4425	2.47	151.21
1245	4.15	244.42	2835	2.14	144.88	4430	2.45	149.81
1250	4.17	241.41	2840	2.20	145.31	4435	2.44	148.37
1255	4.20	240.21	2845	2.15	146.03	4440	2.44	147.59
1260	4.20	239.73	2850	2.13	147.29	4445	2.42	146.18

1265	4.19	240.70	2855	2.17	147.66	4450	2.45	144.31
1270	4.20	238.84	2860	2.16	148.42	4455	2.42	142.87
1275	4.20	239.99	2865	2.13	148.98	4460	2.43	141.58
1280	4.20	239.34	2870	2.15	150.45	4465	2.44	140.42
1285	4.22	238.76	2875	2.12	151.13	4470	2.42	138.60
1290	4.22	238.65	2880	2.13	151.38	4475	2.46	138.62
1295	4.22	238.86	2885	2.06	152.28	4480	2.44	137.71
1300	4.21	238.68	2890	2.01	151.94	4485	2.44	137.48
1305	4.17	238.38	2895	1.97	154.38	4490	2.45	135.00
1310	4.16	240.01	2900	2.12	154.40	4495	2.45	134.81
1315	4.16	240.52	2905	2.13	155.85	4500	2.43	134.01
1320	4.17	240.35	2910	2.10	155.74	4505	2.40	134.18
1325	4.17	238.92	2915	2.09	155.90	4510	2.40	134.40
1330	4.15	238.43	2920	2.06	155.97	4515	2.41	134.32
1335	4.09	236.58	2925	2.05	156.59	4520	2.42	133.89
1340	4.04	236.74	2930	2.01	157.00	4525	2.40	133.90
1345	4.02	235.59	2935	2.00	156.56	4530	2.39	133.96
1350	3.98	236.21	2940	1.99	156.51	4535	2.41	133.72
1355	3.93	236.25	2945	1.99	156.05	4540	2.42	133.29
1360	3.88	236.65	2950	1.99	153.74	4545	2.44	134.09
1365	3.83	235.83	2955	1.94	154.65	4550	2.43	135.11
1370	3.81	236.73	2960	1.97	154.18	4555	2.44	137.27
1375	3.80	234.48	2965	1.95	151.13	4560	2.45	137.26
1380	3.80	233.16	2970	1.96	151.39	4565	2.46	138.17
1385	3.73	220.39	2975	1.96	149.02	4570	2.40	136.65
1390	3.68	218.50	2980	1.95	146.73	4575	2.38	140.06
1395	3.66	217.00	2985	1.98	146.10	4580	2.39	140.88
1400	3.65	215.25	2990	1.96	144.64	4585	2.42	141.67
1405	3.60	212.31	2995	2.00	144.03	4590	2.39	141.97
1410	3.58	209.30	3000	2.00	142.29	4595	2.30	140.66
1415	3.58	209.69	3005	2.04	141.11	4600	2.26	141.41
1420	3.59	207.60	3010	2.05	140.69	4605	2.26	141.46
1425	3.59	205.14	3015	2.05	138.53	4610	2.26	140.85
1430	3.59	206.85	3020	2.08	139.12	4615	2.23	141.54
1435	3.63	213.41	3025	2.07	139.25	4620	2.28	141.19
1440	3.64	214.19	3030	2.10	138.87	4625	2.20	141.60
1445	3.67	214.52	3035	2.09	137.68	4630	2.21	141.66
1450	3.74	213.34	3040	2.12	136.91	4635	2.49	143.21
1455	3.79	212.39	3045	2.09	136.98	4640	2.31	143.44
1460	3.83	212.61	3050	2.11	136.32	4645	2.20	144.11
1465	3.86	211.04	3055	2.11	137.91	4650	2.48	143.27
1470	3.89	208.79	3060	2.14	137.94	4655	2.45	143.28
1475	3.90	207.13	3065	2.13	137.95	4660	2.44	144.91

1480	3.94	207.62	3070	2.12	140.18	4665	2.44	145.94
1485	3.96	207.11	3075	2.13	140.59	4670	2.44	145.24
1490	3.96	207.99	3080	2.13	140.76	4675	2.44	144.59
1495	3.96	208.68	3085	2.12	142.55	4680	2.48	143.64
1500	3.93	207.66	3090	2.15	142.78	4685	2.47	143.38
1505	3.92	206.62	3095	2.11	143.88	4690	2.48	142.02
1510	3.91	206.13	3100	2.10	145.20	4695	2.49	142.78
1515	3.92	205.60	3105	2.07	145.11	4700	2.50	141.60
1520	3.92	207.05	3110	2.09	144.69	4705	2.50	140.71
1525	3.78	208.08	3115	2.08	145.91	4710	2.50	140.67
1530	3.77	208.45	3120	2.10	147.51	4715	2.52	140.80
1535	3.77	207.29	3125	2.09	148.79	4720	2.54	142.11
1540	3.78	207.58	3130	2.05	149.92	4725	2.56	139.75
1545	3.79	206.86	3135	2.09	150.54	4730	2.55	140.52
1550	3.77	204.51	3140	2.08	152.00	4735	2.54	141.75
1555	3.72	204.54	3145	2.08	154.90	4740	2.52	142.46
1560	3.69	203.62	3150	2.10	156.20	4745	2.49	143.30
1565	3.62	202.01	3155	2.11	157.34	4750	2.47	144.32
1570	3.59	201.35	3160	2.12	158.09	4755	2.47	145.08
1575	3.55	200.40	3165	2.11	159.69	4760	2.27	146.60
1580	3.50	201.29	3170	2.11	156.25	4765	2.40	145.54
1585	3.44	200.10	3175	2.11	159.54	4770	2.29	145.91
1590	3.38	201.76	3180	2.12	157.11	4775	2.34	144.47
			3185	2.12	156.40			

## 2.2 Results from IDW Interpolation

Depth(mm)	qc(MPa)	fs(kPa)	Depth(mm)	qc(MPa)	fs(kPa)	Depth(mm)	qc(MPa)	fs(kPa)
5	0.76	38.19	1505	4.59	246.95	3005	2.12	141.48
10	0.84	40.93	1510	4.60	246.08	3010	2.11	141.86
15	0.90	40.70	1515	4.64	246.47	3015	2.11	140.43
20	0.91	42.83	1520	4.62	249.42	3020	2.14	141.39
25	0.96	45.15	1525	4.37	250.57	3025	2.15	142.52
30	0.92	46.88	1530	4.37	251.00	3030	2.19	142.37
35	0.99	49.89	1535	4.40	250.12	3035	2.17	141.05
40	1.02	48.99	1540	4.43	250.40	3040	2.20	140.83
45	1.04	50.95	1545	4.46	249.78	3045	2.19	141.60
50	1.09	53.61	1550	4.41	246.46	3050	2.22	142.09
55	1.16	57.44	1555	4.34	245.65	3055	2.22	143.74
60	1.17	58.52	1560	4.30	244.15	3060	2.25	143.92
65	1.22	59.33	1565	4.22	239.75	3065	2.24	144.38
70	1.29	61.44	1570	4.17	237.98	3070	2.24	147.72
75	1.26	63.73	1575	4.14	235.10	3075	2.25	149.07

80	1.35	64.55	1580	4.09	236.01	3080	2.25	149.08
85	1.38	65.15	1585	4.02	233.90	3085	2.25	150.65
90	1.38	65.55	1590	3.95	235.57	3090	2.27	150.85
95	1.42	68.52	1595	3.91	232.36	3095	2.23	152.42
100	1.42	69.74	1600	3.83	230.67	3100	2.22	152.60
105	1.44	72.77	1605	3.78	227.95	3105	2.20	152.31
110	1.44	74.13	1610	3.68	223.95	3110	2.22	151.99
115	1.45	74.44	1615	3.67	220.06	3115	2.20	152.47
120	1.42	75.39	1620	3.68	217.60	3120	2.22	153.32
125	1.48	76.94	1625	3.65	212.32	3125	2.19	154.56
130	1.53	77.90	1630	3.64	205.13	3130	2.15	154.88
135	1.53	79.04	1635	3.61	200.68	3135	2.19	155.17
140	1.56	81.07	1640	3.61	207.11	3140	2.17	155.94
145	1.57	80.14	1645	3.55	211.66	3145	2.16	157.57
150	1.59	82.44	1650	3.53	212.36	3150	2.17	156.78
155	1.62	82.46	1655	3.52	211.40	3155	2.16	157.12
160	1.68	84.69	1660	3.49	208.30	3160	2.18	157.60
165	1.68	87.50	1665	3.46	207.84	3165	2.15	158.90
170	1.71	87.02	1670	3.46	207.56	3170	2.13	155.28
175	1.76	89.09	1675	3.46	203.96	3175	2.12	158.44
180	1.79	90.04	1680	3.43	201.19	3180	2.13	155.80
185	1.81	89.87	1685	3.38	200.66	3185	2.13	154.12
190	1.84	90.92	1690	3.40	199.22	3190	2.15	152.28
195	1.85	88.90	1695	3.43	197.20	3195	2.13	150.22
200	1.85	91.60	1700	3.42	194.74	3200	2.13	151.15
205	1.89	91.13	1705	3.42	194.66	3205	2.19	149.83
210	1.91	91.01	1710	3.47	193.08	3210	2.14	149.34
215	1.87	93.37	1715	3.44	192.58	3215	2.13	148.74
220	1.87	92.54	1720	3.37	190.59	3220	2.10	147.95
225	1.86	93.98	1725	3.37	189.52	3225	2.12	147.07
230	1.84	97.35	1730	3.42	188.69	3230	2.11	146.87
235	1.86	100.51	1735	3.47	188.61	3235	2.12	146.47
240	1.82	99.14	1740	3.46	187.06	3240	2.12	145.39
245	1.82	102.27	1745	3.44	187.38	3245	2.11	144.08
250	1.83	103.97	1750	3.42	184.70	3250	2.09	143.00
255	1.76	105.88	1755	3.38	184.68	3255	2.08	142.35
260	1.77	109.60	1760	3.36	183.43	3260	2.09	140.70
265	1.78	105.21	1765	3.30	183.30	3265	2.07	139.27
270	1.84	102.04	1770	3.26	181.30	3270	2.05	139.12
275	1.92	100.96	1775	3.22	181.13	3275	2.07	137.72
280	2.07	99.64	1780	3.15	180.58	3280	2.03	137.82
285	2.32	98.43	1785	3.09	179.39	3285	2.06	135.53
290	2.53	98.13	1790	3.06	179.04	3290	2.08	137.34

295	2.70	98.82	1795	3.00	178.76	3295	2.05	135.78
300	2.75	101.65	1800	2.98	175.51	3300	2.06	135.54
305	2.82	105.81	1805	2.94	175.81	3305	2.07	133.50
310	2.99	108.65	1810	2.89	175.28	3310	2.06	134.34
315	3.12	107.94	1815	2.87	173.39	3315	2.04	134.95
320	3.17	108.58	1820	2.86	171.65	3320	2.04	133.84
325	3.19	110.64	1825	2.83	171.36	3325	2.02	133.76
330	3.15	112.46	1830	2.83	171.06	3330	2.04	134.62
335	3.13	114.93	1835	2.81	171.00	3335	2.07	134.74
340	3.20	114.33	1840	2.80	171.60	3340	2.04	135.77
345	3.26	113.12	1845	2.76	171.26	3345	2.01	135.99
350	3.38	112.67	1850	2.76	170.74	3350	2.06	136.55
355	3.45	111.38	1855	2.75	169.34	3355	2.06	138.55
360	3.37	109.84	1860	2.74	167.67	3360	2.08	140.97
365	3.22	108.05	1865	2.75	168.10	3365	2.06	141.81
370	3.07	107.15	1870	2.75	169.26	3370	2.05	142.75
375	2.92	105.30	1875	2.72	169.69	3375	2.09	145.76
380	2.82	103.82	1880	2.72	171.00	3380	2.06	144.82
385	2.76	102.47	1885	2.71	169.84	3385	2.08	146.03
390	2.71	100.19	1890	2.70	167.90	3390	2.11	145.88
395	2.70	98.42	1895	2.66	166.42	3395	2.09	147.13
400	2.71	98.19	1900	2.66	165.05	3400	2.05	144.99
405	2.63	99.78	1905	2.67	163.46	3405	2.09	144.86
410	2.57	99.90	1910	2.66	162.62	3410	2.08	146.17
415	2.46	100.72	1915	2.67	162.91	3415	2.11	147.62
420	2.32	101.89	1920	2.63	159.70	3420	2.13	147.96
425	2.23	104.91	1925	2.64	156.92	3425	2.12	148.29
430	2.10	106.20	1930	2.63	156.55	3430	2.13	149.58
435	1.98	107.84	1935	2.62	154.58	3435	2.09	151.50
440	1.95	110.24	1940	2.62	152.72	3440	2.14	151.26
445	1.94	110.09	1945	2.62	151.50	3445	2.14	151.19
450	1.96	110.27	1950	2.62	149.68	3450	2.13	150.50
455	1.98	109.73	1955	2.60	148.34	3455	2.12	151.03
460	2.00	108.00	1960	2.60	147.51	3460	2.12	160.03
465	2.02	108.22	1965	2.65	147.44	3465	2.13	160.23
470	2.04	109.82	1970	2.64	146.34	3470	2.17	160.24
475	2.06	111.17	1975	2.62	146.89	3475	2.18	160.65
480	2.06	112.57	1980	2.61	147.53	3480	2.18	160.76
485	2.08	113.81	1985	2.54	149.81	3485	2.16	158.67
490	2.11	114.65	1990	2.53	152.09	3490	2.19	157.90
495	2.11	114.12	1995	2.51	153.45	3495	2.20	158.10
500	2.12	113.67	2000	2.51	152.30	3500	2.19	156.96
505	2.15	114.21	2005	2.49	153.77	3505	2.17	156.38

510	2.20	114.80	2010	2.48	155.40	3510	2.21	156.86
515	2.23	115.31	2015	2.49	156.06	3515	2.21	155.96
520	2.26	116.87	2020	2.49	154.95	3520	2.22	157.20
525	2.22	118.75	2025	2.46	154.91	3525	2.22	154.60
530	2.24	119.90	2030	2.47	154.89	3530	2.20	154.59
535	2.17	120.70	2035	2.50	156.95	3535	2.21	154.82
540	2.24	120.84	2040	2.50	157.82	3540	2.19	153.06
545	2.22	120.81	2045	2.48	152.53	3545	2.15	150.78
550	2.23	121.84	2050	2.53	150.54	3550	2.22	152.31
555	2.31	121.89	2055	2.52	153.38	3555	2.23	152.10
560	2.32	121.51	2060	2.48	155.01	3560	2.27	151.86
565	2.32	123.53	2065	2.48	156.19	3565	2.29	152.07
570	2.32	123.11	2070	2.50	157.50	3570	2.29	151.35
575	2.33	122.53	2075	2.48	156.89	3575	2.29	149.23
580	2.33	123.24	2080	2.46	156.86	3580	2.29	147.21
585	2.31	124.05	2085	2.42	156.80	3585	2.25	146.50
590	2.27	124.71	2090	2.46	157.41	3590	2.23	144.26
595	2.22	124.49	2095	2.47	157.85	3595	2.23	141.48
600	2.19	123.96	2100	2.45	157.32	3600	2.22	140.52
605	2.13	125.82	2105	2.43	157.83	3605	2.19	138.90
610	2.09	124.80	2110	2.46	157.01	3610	2.17	138.97
615	2.07	123.63	2115	2.43	157.81	3615	2.18	138.64
620	2.06	122.68	2120	2.45	157.75	3620	2.18	136.89
625	2.02	120.60	2125	2.43	158.13	3625	2.15	136.40
630	1.99	120.26	2130	2.42	158.29	3630	2.15	135.80
635	1.98	117.93	2135	2.39	158.94	3635	2.18	133.02
640	1.96	117.95	2140	2.40	161.01	3640	2.17	133.15
645	1.96	117.93	2145	2.39	159.90	3645	2.16	133.44
650	1.95	115.97	2150	2.38	157.90	3650	2.15	130.01
655	1.94	115.90	2155	2.39	157.30	3655	2.21	128.98
660	1.96	114.80	2160	2.37	156.56	3660	2.14	127.53
665	1.97	114.46	2165	2.34	154.24	3665	2.18	126.83
670	1.95	113.69	2170	2.32	151.98	3670	2.17	125.21
675	1.99	114.21	2175	2.33	151.62	3675	2.21	125.48
680	2.04	113.19	2180	2.34	150.49	3680	2.19	127.89
685	2.04	112.74	2185	2.31	152.12	3685	2.19	127.15
690	2.03	112.86	2190	2.30	152.10	3690	2.18	128.18
695	2.05	112.26	2195	2.30	151.55	3695	2.18	126.41
700	2.07	114.23	2200	2.29	149.94	3700	2.19	129.28
705	2.07	113.40	2205	2.29	148.21	3705	2.19	126.86
710	2.08	113.05	2210	2.27	144.75	3710	2.19	124.72
715	2.08	114.23	2215	2.24	143.37	3715	2.24	125.92
720	2.10	113.30	2220	2.23	139.66	3720	2.23	126.56

725	2.13	112.68	2225	2.22	139.09	3725	2.22	127.42
730	2.18	113.17	2230	2.22	134.24	3730	2.24	129.00
735	2.20	114.63	2235	2.19	135.93	3735	2.23	128.82
740	2.28	114.93	2240	2.20	132.39	3740	2.23	131.23
745	2.22	116.36	2245	2.22	130.50	3745	2.24	130.53
750	2.23	118.38	2250	2.19	129.14	3750	2.26	131.92
755	2.30	119.09	2255	2.22	129.54	3755	2.24	131.24
760	2.30	121.06	2260	2.17	128.40	3760	2.28	133.68
765	2.37	124.15	2265	2.20	128.73	3765	2.30	134.26
770	2.42	125.21	2270	2.22	128.04	3770	2.32	134.07
775	2.45	128.61	2275	2.17	129.73	3775	2.32	135.50
780	2.49	130.54	2280	2.21	130.55	3780	2.34	135.49
785	2.53	131.20	2285	2.19	133.39	3785	2.34	138.15
790	2.57	134.01	2290	2.17	132.92	3790	2.33	140.28
795	2.66	134.63	2295	2.19	134.45	3795	2.33	142.44
800	2.70	134.99	2300	2.26	136.12	3800	2.34	143.17
805	2.71	134.77	2305	2.21	137.28	3805	2.37	145.56
810	2.75	136.22	2310	2.20	137.46	3810	2.36	145.83
815	2.84	137.37	2315	2.24	139.39	3815	2.37	147.25
820	2.90	137.01	2320	2.24	141.76	3820	2.40	146.74
825	2.95	139.23	2325	2.24	141.89	3825	2.40	149.93
830	3.01	140.65	2330	2.25	143.25	3830	2.38	148.74
835	3.05	142.17	2335	2.25	144.35	3835	2.37	148.95
840	3.10	143.75	2340	2.25	144.28	3840	2.39	149.02
845	3.11	145.49	2345	2.28	143.88	3845	2.36	150.17
850	3.16	145.66	2350	2.28	145.57	3850	2.38	150.96
855	3.16	149.58	2355	2.30	145.33	3855	2.37	147.80
860	3.18	152.20	2360	2.30	144.79	3860	2.34	150.44
865	3.22	155.46	2365	2.29	144.34	3865	2.32	152.50
870	3.23	159.36	2370	2.30	145.19	3870	2.33	151.94
875	3.24	164.09	2375	2.35	145.70	3875	2.36	150.78
880	3.20	165.73	2380	2.35	146.03	3880	2.32	150.10
885	3.23	173.80	2385	2.32	146.88	3885	2.32	149.88
890	3.27	176.27	2390	2.28	145.64	3890	2.31	148.69
895	3.30	182.18	2395	2.27	148.32	3895	2.32	147.21
900	3.36	184.29	2400	2.29	149.00	3900	2.32	145.81
905	3.41	187.80	2405	2.28	148.78	3905	2.32	144.27
910	3.40	191.13	2410	2.29	149.20	3910	2.30	143.37
915	3.48	195.51	2415	2.26	148.91	3915	2.33	142.20
920	3.54	194.56	2420	2.25	149.22	3920	2.31	141.86
925	3.59	197.26	2425	2.25	149.02	3925	2.32	141.44
930	3.62	198.75	2430	2.27	150.18	3930	2.33	140.61
935	3.71	202.10	2435	2.25	146.73	3935	2.32	140.32

940	3.70	202.84	2440	2.24	147.73	3940	2.32	141.31
945	3.77	204.14	2445	2.25	149.04	3945	2.32	140.07
950	3.87	204.77	2450	2.28	147.21	3950	2.30	141.16
955	3.87	205.92	2455	2.28	149.09	3955	2.31	140.94
960	3.85	206.38	2460	2.28	147.68	3960	2.31	140.51
965	3.89	203.68	2465	2.29	145.92	3965	2.29	140.93
970	3.94	206.38	2470	2.29	145.14	3970	2.31	141.27
975	4.00	206.14	2475	2.24	145.28	3975	2.34	141.24
980	3.95	207.31	2480	2.23	143.90	3980	2.36	141.46
985	4.03	206.75	2485	2.23	142.97	3985	2.36	140.39
990	4.09	208.87	2490	2.25	142.36	3990	2.37	140.35
995	4.10	208.55	2495	2.24	141.47	3995	2.38	140.14
1000	4.09	210.84	2500	2.23	143.57	4000	2.38	139.43
1005	4.18	208.83	2505	2.27	142.30	4005	2.37	139.03
1010	4.18	206.34	2510	2.25	142.08	4010	2.38	140.65
1015	4.27	208.82	2515	2.26	142.51	4015	2.36	139.25
1020	4.29	209.28	2520	2.26	144.75	4020	2.36	139.24
1025	4.34	234.77	2525	2.30	145.90	4025	2.37	139.29
1030	4.34	239.43	2530	2.31	146.20	4030	2.37	139.58
1035	4.33	240.20	2535	2.29	147.36	4035	2.36	139.00
1040	4.38	235.13	2540	2.29	148.97	4040	2.33	138.69
1045	4.36	237.36	2545	2.30	151.23	4045	2.32	139.32
1050	4.37	237.59	2550	2.28	151.81	4050	2.33	140.47
1055	4.37	238.70	2555	2.30	152.33	4055	2.32	141.72
1060	4.41	240.02	2560	2.34	153.95	4060	2.31	142.90
1065	4.43	241.85	2565	2.34	154.99	4065	2.30	142.64
1070	4.48	243.01	2570	2.30	155.64	4070	2.29	142.75
1075	4.56	246.05	2575	2.30	156.93	4075	2.31	142.08
1080	4.70	246.91	2580	2.33	158.02	4080	2.32	140.45
1085	4.84	248.48	2585	2.31	159.72	4085	2.30	139.30
1090	4.92	248.33	2590	2.31	159.88	4090	2.28	137.67
1095	5.06	249.51	2595	2.28	161.50	4095	2.30	136.42
1100	5.17	250.18	2600	2.28	161.71	4100	2.30	135.68
1105	5.35	253.92	2605	2.26	161.17	4105	2.29	136.20
1110	5.48	256.24	2610	2.27	161.28	4110	2.28	136.75
1115	5.75	260.03	2615	2.28	161.53	4115	2.26	136.02
1120	5.97	263.70	2620	2.26	163.22	4120	2.27	134.30
1125	6.08	264.78	2625	2.23	162.47	4125	2.28	134.64
1130	6.08	266.54	2630	2.23	163.64	4130	2.28	135.32
1135	6.11	268.41	2635	2.23	164.02	4135	2.26	135.60
1140	6.14	274.06	2640	2.20	162.73	4140	2.27	135.68
1145	6.12	275.91	2645	2.20	163.83	4145	2.29	136.46
1150	6.13	273.13	2650	2.20	161.91	4150	2.29	137.38

1155	6.13	276.76	2655	2.15	161.16	4155	2.29	137.55
1160	6.12	281.42	2660	2.17	160.34	4160	2.30	137.08
1165	6.14	283.77	2665	2.14	161.61	4165	2.29	137.69
1170	6.08	282.40	2670	2.12	160.62	4170	2.29	136.45
1175	6.01	282.67	2675	2.10	159.42	4175	2.30	136.22
1180	5.94	286.86	2680	2.08	159.73	4180	2.30	135.91
1185	5.89	292.08	2685	2.08	157.82	4185	2.34	133.86
1190	5.81	295.25	2690	2.05	154.04	4190	2.35	133.50
1195	5.66	297.86	2695	2.06	154.25	4195	2.39	134.16
1200	5.56	299.28	2700	2.02	154.12	4200	2.39	134.88
1205	5.50	301.86	2705	2.01	151.78	4205	2.38	134.90
1210	5.42	301.17	2710	1.99	151.85	4210	2.40	135.00
1215	5.37	303.56	2715	1.99	153.24	4215	2.41	135.01
1220	5.30	306.61	2720	1.99	151.56	4220	2.42	135.96
1225	5.30	311.25	2725	1.99	148.80	4225	2.46	137.22
1230	5.33	313.57	2730	2.00	144.26	4230	2.49	136.89
1235	5.33	309.73	2735	1.97	142.36	4235	2.49	135.51
1240	5.33	308.18	2740	2.00	140.75	4240	2.49	135.48
1245	5.34	303.92	2745	2.01	137.99	4245	2.53	135.78
1250	5.40	298.16	2750	2.05	138.50	4250	2.50	135.53
1255	5.46	295.29	2755	2.07	136.85	4255	2.51	134.07
1260	5.46	294.39	2760	2.07	135.91	4260	2.54	135.66
1265	5.46	294.58	2765	2.10	137.19	4265	2.54	137.41
1270	5.45	291.50	2770	2.11	138.53	4270	2.57	138.13
1275	5.45	292.02	2775	2.11	139.32	4275	2.58	138.67
1280	5.47	291.51	2780	2.12	141.31	4280	2.58	139.64
1285	5.52	289.72	2785	2.11	142.07	4285	2.59	140.29
1290	5.56	288.75	2790	2.09	144.04	4290	2.61	140.79
1295	5.55	288.85	2795	2.09	145.04	4295	2.63	140.96
1300	5.54	288.89	2800	2.09	145.59	4300	2.63	141.72
1305	5.48	290.19	2805	2.10	145.06	4305	2.60	141.60
1310	5.46	292.34	2810	2.13	145.71	4310	2.59	142.06
1315	5.47	293.00	2815	2.12	145.13	4315	2.59	143.05
1320	5.49	293.91	2820	2.11	147.11	4320	2.57	144.40
1325	5.49	293.02	2825	2.14	147.31	4325	2.56	145.74
1330	5.45	291.98	2830	2.15	147.40	4330	2.57	146.53
1335	5.37	289.39	2835	2.17	148.52	4335	2.55	147.26
1340	5.27	289.19	2840	2.19	148.91	4340	2.53	147.73
1345	5.28	287.57	2845	2.16	148.81	4345	2.53	148.18
1350	5.22	285.54	2850	2.14	149.65	4350	2.50	149.22
1355	5.10	284.54	2855	2.16	149.35	4355	2.48	148.67
1360	5.02	284.14	2860	2.19	149.02	4360	2.48	149.46
1365	4.94	282.57	2865	2.18	149.66	4365	2.45	150.51

1370	4.91	283.79	2870	2.18	150.52	4370	2.45	149.62
1375	4.88	281.24	2875	2.17	150.85	4375	2.46	149.99
1380	4.85	279.07	2880	2.15	150.84	4380	2.45	149.94
1385	4.74	253.75	2885	2.16	151.65	4385	2.43	149.08
1390	4.67	237.09	2890	2.15	151.44	4390	2.41	149.23
1395	4.62	241.27	2895	2.12	153.24	4395	2.42	149.39
1400	4.57	248.17	2900	2.13	153.03	4400	2.42	149.45
1405	4.44	245.10	2905	2.15	154.11	4405	2.44	149.57
1410	4.37	240.51	2910	2.11	153.66	4410	2.43	149.22
1415	4.35	242.35	2915	2.11	153.89	4415	2.43	147.36
1420	4.33	240.63	2920	2.09	154.28	4420	2.43	145.86
1425	4.29	236.42	2925	2.08	154.91	4425	2.46	145.67
1430	4.28	242.02	2930	2.05	154.95	4430	2.45	144.31
1435	4.31	255.95	2935	2.04	154.69	4435	2.44	142.22
1440	4.29	257.26	2940	2.04	154.82	4440	2.42	141.67
1445	4.31	257.02	2945	2.05	153.99	4445	2.40	140.42
1450	4.36	254.88	2950	2.06	151.85	4450	2.43	139.34
1455	4.41	253.27	2955	2.00	152.19	4455	2.40	137.68
1460	4.44	253.43	2960	2.03	151.71	4460	2.39	137.66
1465	4.46	251.06	2965	2.02	149.09	4465	2.40	136.84
1470	4.47	247.71	2970	2.03	148.81	4470	2.39	135.14
1475	4.48	245.24	2975	2.03	146.76	4475	2.42	134.96
1480	4.56	245.78	2980	2.04	144.87	4480	2.41	134.35
1485	4.60	245.65	2985	2.06	144.64	4485	2.42	134.50
1490	4.62	246.80	2990	2.04	143.34	4490	2.42	132.29
1495	4.62	248.13	2995	2.07	142.96	4495	2.41	132.92
1500	4.60	248.13	3000	2.08	141.82	4500	2.39	132.31

### 3 results of unit skin friction of the pile ( $f_p/KPa$ )

Depth (mm)	LCPC	European	Scherman	L&L	H&R
5	18.65	18.65	33.84	8.21	18.80
10	20.17	20.17	35.02	8.88	20.15
15	22.46	22.46	34.36	9.88	22.17
20	22.69	22.69	35.33	9.98	22.37
25	24.38	24.38	36.37	10.73	23.84
30	21.85	21.85	35.04	9.61	21.63
35	23.28	23.28	36.18	10.24	22.88
40	23.56	23.56	35.99	10.37	23.12
45	24.36	24.36	36.63	10.72	23.82
50	25.03	25.03	37.60	11.02	24.40
55	27.43	27.43	38.64	12.07	26.46
60	27.51	27.51	39.34	12.10	26.53

65	28.86	28.86	39.59	12.70	27.68
70	30.72	30.72	40.28	13.52	29.25
75	30.57	30.57	40.64	13.45	29.12
80	32.46	32.46	40.80	14.28	30.71
85	33.24	33.24	40.82	14.63	31.36
90	33.45	33.45	40.95	14.72	31.53
95	34.52	34.52	41.45	15.19	32.42
100	34.28	34.28	41.78	15.08	32.22
105	34.85	34.85	42.50	15.33	32.69
110	34.89	34.89	42.97	15.35	32.72
115	34.53	34.53	42.95	15.19	32.42
120	33.56	33.56	43.12	14.77	31.61
125	34.71	34.71	43.60	15.27	32.57
130	35.69	35.69	43.81	15.70	33.38
135	35.22	35.22	44.08	15.50	32.99
140	35.59	35.59	45.39	15.66	33.29
145	35.66	35.66	44.50	15.69	33.35
150	35.53	35.53	44.87	15.63	33.24
155	36.06	36.06	45.01	15.87	33.67
160	36.92	36.92	45.74	16.25	34.38
165	36.26	36.26	46.63	15.95	33.83
170	36.43	36.43	46.63	16.03	33.97
175	36.99	36.99	47.34	16.27	34.43
180	37.86	37.86	47.32	16.66	35.14
185	37.74	37.74	47.28	16.60	35.04
190	37.67	37.67	47.57	16.57	34.99
195	37.64	37.64	47.09	16.56	34.96
200	37.62	37.62	47.80	16.55	34.94
205	38.06	38.06	47.83	16.74	35.30
210	38.53	38.53	47.87	16.95	35.68
215	38.22	38.22	48.35	16.82	35.42
220	37.83	37.83	48.23	16.65	35.11
225	37.88	37.88	48.57	16.67	35.14
230	37.52	37.52	49.37	16.51	34.84
235	37.97	37.97	50.04	16.71	35.22
240	37.73	37.73	49.69	16.60	35.02
245	37.92	37.92	50.31	16.69	35.17
250	38.00	38.00	50.79	16.72	35.24
255	37.44	37.44	51.24	16.47	34.77
260	37.83	37.83	52.25	16.64	35.09
265	37.99	37.99	50.96	16.72	35.22
270	38.15	38.15	50.33	16.79	35.35
275	38.32	38.32	50.13	16.86	35.49

280	38.48	38.48	49.73	16.93	35.62
285	38.65	38.65	49.31	17.01	35.75
290	38.81	38.81	49.38	17.08	35.88
295	38.98	38.98	49.63	17.15	36.02
300	39.14	39.14	50.23	17.22	36.15
305	39.31	39.31	51.15	17.30	36.28
310	39.47	39.47	51.85	17.37	36.42
315	39.64	39.64	51.66	17.44	36.55
320	39.80	39.80	51.70	17.51	36.68
325	39.97	39.97	52.17	17.59	36.81
330	40.13	40.13	52.55	17.66	36.95
335	40.30	40.30	53.32	17.73	37.08
340	40.46	40.46	53.12	17.80	37.21
345	40.63	40.63	52.60	17.88	37.34
350	40.79	40.79	52.58	17.95	37.47
355	40.96	40.96	52.28	18.02	37.61
360	41.12	41.12	51.76	18.09	37.74
365	41.29	41.29	51.36	18.17	37.87
370	41.45	41.45	51.25	18.24	38.00
375	41.62	41.62	50.82	18.31	38.13
380	41.78	41.78	50.44	18.38	38.27
385	41.95	41.95	50.11	18.46	38.40
390	42.11	42.11	49.66	18.53	38.53
395	42.28	42.28	49.29	18.60	38.66
400	42.44	42.44	49.22	18.67	38.79
405	42.61	42.61	49.55	18.75	38.92
410	42.77	42.77	49.49	18.82	39.05
415	42.94	42.94	49.57	18.89	39.19
420	43.10	43.10	49.89	18.96	39.32
425	43.27	43.27	50.14	19.04	39.45
430	43.43	43.43	50.06	19.11	39.58
435	43.60	43.60	50.43	19.18	39.71
440	43.76	43.76	50.91	19.25	39.84
445	43.93	43.93	50.87	19.33	39.97
450	44.19	44.19	50.80	19.44	40.18
455	44.53	44.53	50.66	19.59	40.45
460	44.89	44.89	50.41	19.75	40.74
465	45.30	45.30	50.33	19.93	41.07
470	46.22	46.22	50.57	20.34	41.80
475	46.92	46.92	50.78	20.65	42.36
480	47.18	47.18	51.06	20.76	42.56
485	47.60	47.60	51.30	20.94	42.89
490	48.24	48.24	51.30	21.22	43.40

495	48.91	48.91	51.29	21.52	43.93
500	49.38	49.38	51.25	21.73	44.30
505	49.99	49.99	51.33	21.99	44.78
510	50.77	50.77	51.50	22.34	45.40
515	50.90	50.90	51.54	22.39	45.50
520	50.70	50.70	51.87	22.31	45.34
525	49.81	49.81	52.25	21.92	44.64
530	49.89	49.89	52.51	21.95	44.70
535	49.28	49.28	52.86	21.68	44.21
540	50.14	50.14	52.96	22.06	44.89
545	49.30	49.30	52.98	21.69	44.22
550	49.12	49.12	53.32	21.61	44.08
555	50.66	50.66	53.31	22.29	45.30
560	50.81	50.81	53.17	22.36	45.41
565	50.68	50.68	53.70	22.30	45.30
570	50.71	50.71	53.75	22.31	45.33
575	51.04	51.04	53.87	22.46	45.59
580	50.90	50.90	54.08	22.40	45.47
585	50.57	50.57	54.42	22.25	45.22
590	49.73	49.73	54.60	21.88	44.54
595	48.83	48.83	54.71	21.48	43.83
600	48.31	48.31	54.65	21.25	43.41
605	46.79	46.79	55.25	20.59	42.20
610	45.96	45.96	55.10	20.22	41.54
615	45.49	45.49	55.09	20.02	41.16
620	45.31	45.31	54.92	19.94	41.01
625	44.41	44.41	54.63	19.54	40.30
630	44.15	44.15	54.49	19.43	40.08
635	43.93	43.93	53.88	19.33	39.90
640	43.66	43.66	54.02	19.21	39.68
645	44.09	44.09	54.03	19.40	40.03
650	44.37	44.37	53.46	19.52	40.25
655	44.17	44.17	53.45	19.43	40.09
660	44.56	44.56	53.07	19.61	40.40
665	45.17	45.17	52.93	19.87	40.89
670	45.15	45.15	52.79	19.87	40.87
675	46.06	46.06	52.74	20.27	41.59
680	47.56	47.56	52.72	20.93	42.79
685	47.32	47.32	52.67	20.82	42.60
690	47.34	47.34	52.53	20.83	42.61
695	48.13	48.13	52.48	21.18	43.23
700	48.45	48.45	52.92	21.32	43.49
705	48.26	48.26	52.64	21.23	43.34

710	48.49	48.49	52.62	21.34	43.52
715	48.52	48.52	53.08	21.35	43.54
720	48.97	48.97	52.74	21.55	43.89
725	49.42	49.42	52.65	21.75	44.25
730	50.54	50.54	52.59	22.24	45.13
735	50.78	50.78	53.18	22.34	45.32
740	52.69	52.69	53.28	23.18	46.82
745	51.85	51.85	53.70	22.82	46.17
750	52.14	52.14	54.16	22.94	46.39
755	53.83	53.83	54.02	23.68	47.71
760	53.87	53.87	54.58	23.70	47.74
765	54.89	54.89	55.17	24.15	48.53
770	56.36	56.36	55.25	24.80	49.68
775	57.52	57.52	56.20	25.31	50.58
780	58.66	58.66	56.36	25.81	51.46
785	59.80	59.80	56.48	26.31	52.34
790	60.59	60.59	57.45	26.66	52.95
795	62.16	62.16	57.59	27.35	54.14
800	62.99	62.99	57.64	27.72	54.78
805	63.84	63.84	57.45	28.09	55.43
810	64.65	64.65	57.94	28.44	56.04
815	66.62	66.62	58.37	29.31	57.54
820	68.10	68.10	58.47	29.97	58.66
825	68.78	68.78	59.16	30.26	59.17
830	70.06	70.06	59.48	30.83	60.14
835	71.31	71.31	60.09	31.38	61.08
840	72.53	72.53	60.61	31.91	61.99
845	72.40	72.40	61.43	31.85	61.89
850	73.50	73.50	61.32	32.34	62.71
855	73.18	73.18	62.60	32.20	62.47
860	74.26	74.26	63.34	32.67	63.28
865	74.64	74.64	64.64	32.84	63.56
870	75.44	75.44	66.08	33.19	64.16
875	76.11	76.11	67.45	33.49	64.65
880	75.74	75.74	68.27	33.33	64.38
885	76.51	76.51	70.78	33.66	64.95
890	77.77	77.77	71.43	34.22	65.88
895	78.20	78.20	74.17	34.41	66.20
900	79.21	79.21	75.34	34.85	66.95
905	80.36	80.36	76.77	35.36	67.80
910	79.98	79.98	78.08	35.19	67.51
915	80.00	81.75	79.67	35.97	68.81
920	80.00	82.81	79.01	36.44	69.59

925	80.00	83.44	80.37	36.71	70.05
930	80.00	84.83	80.96	37.33	71.07
935	80.00	86.20	82.93	37.93	72.07
940	80.00	86.60	82.79	38.10	72.37
945	80.00	87.54	84.01	38.52	73.05
950	80.00	89.46	84.49	39.36	74.45
955	80.00	91.00	84.79	40.04	75.56
960	80.00	88.15	85.50	38.79	73.49
965	80.00	91.82	83.68	40.40	76.15
970	80.00	93.62	84.10	41.19	77.45
975	80.00	95.71	84.55	42.11	78.95
980	80.00	93.67	85.32	41.22	77.48
985	80.00	99.75	84.54	43.89	81.85
990	80.00	102.62	85.02	45.15	83.89
995	80.00	104.71	84.46	46.07	85.37
1000	80.00	105.76	85.61	46.53	86.11
1005	80.00	108.13	83.99	47.58	87.79
1010	80.00	109.65	83.21	48.25	88.86
1015	80.00	110.15	84.20	48.46	89.21
1020	80.00	112.64	84.76	49.56	90.96
1025	80.00	114.01	92.26	50.17	91.92
1030	80.00	114.18	93.84	50.24	92.04
1035	80.00	111.27	94.21	48.96	89.99
1040	80.00	113.39	92.31	49.89	91.48
1045	80.00	96.45	93.53	42.44	79.46
1050	80.00	96.32	93.65	42.38	79.37
1055	80.00	95.91	94.44	42.20	79.07
1060	80.00	96.06	95.19	42.26	79.17
1065	80.00	96.09	96.43	42.28	79.20
1070	80.00	96.90	96.50	42.64	79.78
1075	80.00	97.53	98.11	42.91	80.22
1080	80.00	99.72	98.43	43.88	81.79
1085	80.00	101.86	99.47	44.82	83.31
1090	80.00	102.59	99.27	45.14	83.84
1095	80.00	104.59	99.47	46.02	85.26
1100	80.00	105.25	99.42	46.31	85.72
1105	80.00	107.21	101.60	47.17	87.11
1110	80.00	108.80	102.71	47.87	88.23
1115	80.00	111.73	104.45	49.16	90.29
1120	80.00	114.09	105.12	50.20	91.94
1125	80.00	114.85	105.94	50.53	92.47
1130	80.00	114.27	107.39	50.28	92.07
1135	80.00	114.75	108.00	50.49	92.39

1140	80.00	115.24	110.73	50.71	92.74
1145	80.00	114.87	111.79	50.54	92.48
1150	80.00	114.51	110.76	50.39	92.23
1155	80.00	114.44	112.83	50.35	92.17
1160	80.00	114.40	114.08	50.33	92.14
1165	80.00	114.17	114.95	50.24	91.98
1170	80.00	113.23	115.30	49.82	91.32
1175	80.00	112.24	115.21	49.38	90.62
1180	80.00	111.21	116.73	48.93	89.90
1185	80.00	111.05	118.57	48.86	89.79
1190	80.00	109.95	119.78	48.38	89.01
1195	80.00	107.54	120.00	47.32	87.31
1200	80.00	106.09	120.00	46.68	86.28
1205	80.00	105.53	120.00	46.43	85.88
1210	80.00	104.42	120.00	45.94	85.10
1215	80.00	103.63	120.00	45.60	84.54
1220	80.00	102.93	120.00	45.29	84.03
1225	80.00	103.11	120.00	45.37	84.16
1230	80.00	103.25	120.00	45.43	84.25
1235	80.00	103.30	120.00	45.45	84.29
1240	80.00	103.39	120.00	45.49	84.36
1245	80.00	103.87	120.00	45.70	84.69
1250	80.00	104.36	120.00	45.92	85.04
1255	80.00	105.01	120.00	46.20	85.50
1260	80.00	105.01	120.00	46.20	85.49
1265	80.00	104.86	120.00	46.14	85.39
1270	80.00	104.97	120.00	46.19	85.46
1275	80.00	104.88	120.00	46.15	85.40
1280	80.00	105.09	120.00	46.24	85.54
1285	80.00	105.51	120.00	46.43	85.85
1290	80.00	105.52	120.00	46.43	85.85
1295	80.00	105.45	120.00	46.40	85.80
1300	80.00	105.25	120.00	46.31	85.65
1305	80.00	104.15	120.00	45.83	84.88
1310	80.00	103.88	120.00	45.71	84.68
1315	80.00	104.06	120.00	45.79	84.81
1320	80.00	104.27	120.00	45.88	84.95
1325	80.00	104.19	120.00	45.85	84.90
1330	80.00	103.68	120.00	45.62	84.53
1335	80.00	102.23	120.00	44.98	83.50
1340	80.00	100.98	120.00	44.43	82.60
1345	80.00	100.58	119.57	44.26	82.32
1350	80.00	99.62	119.90	43.83	81.63

1355	80.00	98.18	119.92	43.20	80.60
1360	80.00	97.01	120.12	42.69	79.76
1365	80.00	95.78	119.70	42.14	78.87
1370	80.00	95.19	120.16	41.88	78.45
1375	80.00	94.98	119.00	41.79	78.29
1380	80.00	94.90	118.30	41.75	78.23
1385	80.00	93.33	110.93	41.07	77.10
1390	80.00	92.05	109.76	40.50	76.17
1395	80.00	91.57	108.82	40.29	75.82
1400	80.00	91.30	107.72	40.17	75.63
1405	80.00	90.02	105.85	39.61	74.69
1410	80.00	89.48	103.91	39.37	74.30
1415	80.00	89.43	104.16	39.35	74.26
1420	80.00	89.64	102.81	39.44	74.41
1425	80.00	89.78	101.21	39.50	74.51
1430	80.00	89.87	102.32	39.54	74.58
1435	80.00	90.68	106.56	39.90	75.16
1440	80.00	90.91	107.05	40.00	75.32
1445	80.00	91.74	107.26	40.37	75.93
1450	80.00	93.43	106.51	41.11	77.14
1455	80.00	94.83	105.90	41.72	78.15
1460	80.00	95.86	106.04	42.18	78.90
1465	80.00	96.62	105.04	42.51	79.44
1470	80.00	97.18	103.58	42.76	79.84
1475	80.00	97.50	102.50	42.90	80.07
1480	80.00	98.50	102.82	43.34	80.78
1485	80.00	98.90	102.49	43.52	81.07
1490	80.00	99.05	103.06	43.58	81.17
1495	80.00	99.02	103.51	43.57	81.15
1500	80.00	98.30	102.84	43.25	80.63
1505	80.00	98.08	102.17	43.15	80.47
1510	80.00	97.65	101.85	42.97	80.16
1515	80.00	98.05	101.51	43.14	80.45
1520	80.00	97.95	102.45	43.10	80.38
1525	80.00	94.44	103.12	41.55	77.85
1530	80.00	94.26	103.36	41.48	77.72
1535	80.00	94.30	102.61	41.49	77.75
1540	80.00	94.56	102.79	41.61	77.93
1545	80.00	94.75	102.33	41.69	78.06
1550	80.00	94.35	100.80	41.52	77.78
1555	80.00	92.97	100.81	40.91	76.78
1560	80.00	92.27	100.21	40.60	76.27
1565	80.00	90.54	99.16	39.84	75.02

1570	80.00	89.84	98.72	39.53	74.51
1575	80.00	88.83	98.10	39.09	73.77
1580	80.00	87.47	98.68	38.49	72.78
1585	80.00	86.06	97.90	37.87	71.75
1590	80.00	84.46	98.99	37.16	70.57
1595	80.00	83.92	96.92	36.93	70.18
1600	80.00	82.37	96.56	36.24	69.03
1605	80.00	81.76	95.62	35.97	68.58
1610	79.86	79.86	94.34	35.14	67.17
1615	79.84	79.84	92.72	35.13	67.16
1620	80.35	80.35	90.75	35.36	67.54
1625	80.08	80.08	88.59	35.23	67.33
1630	79.91	79.91	85.62	35.16	67.21
1635	79.39	79.39	83.47	34.93	66.82
1640	79.18	79.18	84.89	34.84	66.66
1645	78.29	78.29	86.48	34.45	66.00
1650	77.83	77.83	86.64	34.25	65.66
1655	77.87	77.87	86.00	34.26	65.69
1660	77.45	77.45	84.58	34.08	65.37
1665	77.11	77.11	84.99	33.93	65.12
1670	77.34	77.34	84.97	34.03	65.28
1675	77.21	77.21	83.85	33.97	65.19
1680	76.56	76.56	82.44	33.69	64.71
1685	75.87	75.87	82.18	33.38	64.19
1690	76.22	76.22	81.97	33.54	64.45
1695	76.80	76.80	80.91	33.79	64.87
1700	77.03	77.03	79.24	33.89	65.05
1705	76.68	76.68	78.37	33.74	64.79
1710	77.55	77.55	77.09	34.12	65.43
1715	77.44	77.44	76.52	34.07	65.35
1720	76.26	76.26	75.66	33.56	64.47
1725	76.25	76.25	74.97	33.55	64.46
1730	76.36	76.36	74.55	33.60	64.53
1735	77.17	77.17	74.86	33.96	65.14
1740	76.69	76.69	73.84	33.75	64.78
1745	76.09	76.09	73.90	33.48	64.33
1750	75.84	75.84	73.48	33.37	64.14
1755	75.35	75.35	73.31	33.15	63.77
1760	74.77	74.77	72.80	32.90	63.34
1765	73.36	73.36	72.25	32.28	62.29
1770	72.59	72.59	71.64	31.94	61.71
1775	71.60	71.60	71.95	31.51	60.96
1780	70.80	70.80	71.98	31.15	60.35

1785	69.26	69.26	71.41	30.47	59.19
1790	68.29	68.29	71.15	30.05	58.46
1795	67.08	67.08	71.06	29.52	57.54
1800	66.96	66.96	70.04	29.46	57.44
1805	65.87	65.87	70.22	28.98	56.61
1810	64.79	64.79	70.35	28.51	55.79
1815	64.51	64.51	69.78	28.38	55.57
1820	64.62	64.62	69.44	28.43	55.65
1825	63.58	63.58	69.43	27.98	54.86
1830	63.36	63.36	69.29	27.88	54.69
1835	62.49	62.49	69.45	27.50	54.02
1840	62.54	62.54	69.98	27.52	54.06
1845	61.88	61.88	69.98	27.23	53.55
1850	61.70	61.70	69.71	27.15	53.41
1855	61.26	61.26	69.35	26.95	53.07
1860	61.10	61.10	68.77	26.88	52.94
1865	61.36	61.36	69.42	27.00	53.14
1870	61.59	61.59	70.69	27.10	53.32
1875	61.22	61.22	70.85	26.93	53.03
1880	61.50	61.50	71.32	27.06	53.24
1885	61.13	61.13	70.45	26.90	52.96
1890	61.08	61.08	69.42	26.88	52.92
1895	60.43	60.43	69.13	26.59	52.41
1900	60.25	60.25	68.94	26.51	52.28
1905	60.36	60.36	68.23	26.56	52.36
1910	60.18	60.18	67.78	26.48	52.22
1915	60.60	60.60	68.21	26.67	52.54
1920	60.05	60.05	66.73	26.42	52.12
1925	60.57	60.57	65.54	26.65	52.52
1930	60.18	60.18	65.54	26.48	52.21
1935	59.86	59.86	65.23	26.34	51.96
1940	60.08	60.08	64.50	26.43	52.13
1945	60.25	60.25	63.54	26.51	52.26
1950	60.32	60.32	62.83	26.54	52.31
1955	60.41	60.41	62.44	26.58	52.38
1960	60.33	60.33	61.88	26.54	52.31
1965	61.40	61.40	61.42	27.02	53.14
1970	61.50	61.50	60.86	27.06	53.21
1975	60.99	60.99	60.86	26.83	52.81
1980	60.83	60.83	61.01	26.76	52.69
1985	59.58	59.58	62.27	26.22	51.73
1990	59.31	59.31	63.46	26.10	51.52
1995	58.73	58.73	63.85	25.84	51.07

2000	58.60	58.60	63.29	25.78	50.96
2005	58.22	58.22	63.87	25.61	50.66
2010	57.86	57.86	64.52	25.46	50.39
2015	57.68	57.68	64.97	25.38	50.25
2020	57.37	57.37	64.64	25.24	50.00
2025	56.53	56.53	85.23	24.87	49.34
2030	56.45	56.45	86.74	24.84	49.28
2035	56.78	56.78	88.53	24.98	49.54
2040	57.02	57.02	88.59	25.09	49.72
2045	56.55	56.55	83.51	24.88	49.35
2050	57.40	57.40	84.40	25.26	50.01
2055	57.25	57.25	84.71	25.19	49.90
2060	56.36	56.36	86.37	24.80	49.20
2065	56.58	56.58	86.29	24.90	49.37
2070	56.82	56.82	86.59	25.00	49.56
2075	56.32	56.32	87.48	24.78	49.16
2080	56.16	56.16	87.14	24.71	49.04
2085	55.54	55.54	86.67	24.44	48.55
2090	56.35	56.35	85.78	24.79	49.18
2095	56.37	56.37	87.49	24.80	49.19
2100	55.98	55.98	88.59	24.63	48.89
2105	55.78	55.78	87.53	24.54	48.73
2110	56.75	56.75	89.14	24.97	49.49
2115	56.18	56.18	88.53	24.72	49.04
2120	56.46	56.46	88.13	24.84	49.26
2125	56.17	56.17	89.42	24.72	49.03
2130	56.02	56.02	90.62	24.65	48.91
2135	55.60	55.60	90.48	24.47	48.58
2140	56.04	56.04	90.03	24.66	48.93
2145	56.03	56.03	84.98	24.65	48.91
2150	55.67	55.67	89.97	24.49	48.63
2155	55.70	55.70	90.03	24.51	48.65
2160	55.20	55.20	89.39	24.29	48.26
2165	54.45	54.45	85.97	23.96	47.67
2170	54.15	54.15	83.54	23.82	47.43
2175	54.45	54.45	84.32	23.96	47.67
2180	54.58	54.58	83.87	24.01	47.77
2185	53.73	53.73	84.09	23.64	47.10
2190	53.63	53.63	83.47	23.60	47.02
2195	53.86	53.86	83.95	23.70	47.20
2200	54.15	54.15	82.46	23.83	47.42
2205	54.15	54.15	80.06	23.83	47.42
2210	54.15	54.15	75.33	23.83	47.42

2215	54.15	54.15	73.88	23.83	47.42
2220	54.15	54.15	69.86	23.83	47.42
2225	54.15	54.15	70.24	23.83	47.41
2230	54.15	54.15	64.93	23.83	47.41
2235	54.15	54.15	63.20	23.83	47.41
2240	54.15	54.15	59.02	23.83	47.41
2245	54.15	54.15	58.55	23.83	47.41
2250	54.15	54.15	58.03	23.83	47.41
2255	54.15	54.15	57.93	23.83	47.40
2260	54.15	54.15	57.72	23.83	47.40
2265	54.15	54.15	58.08	23.83	47.40
2270	54.15	54.15	58.00	23.83	47.40
2275	54.15	54.15	58.16	23.83	47.40
2280	54.15	54.15	58.66	23.83	47.39
2285	54.15	54.15	59.67	23.83	47.39
2290	54.15	54.15	59.23	23.83	47.39
2295	52.67	52.67	59.66	23.17	46.23
2300	54.25	54.25	59.93	23.87	47.47
2305	52.85	52.85	60.31	23.25	46.36
2310	52.22	52.22	60.03	22.98	45.87
2315	53.18	53.18	60.77	23.40	46.62
2320	52.94	52.94	65.24	23.30	46.43
2325	52.80	52.80	63.55	23.23	46.32
2330	52.74	52.74	64.41	23.21	46.27
2335	53.06	53.06	65.09	23.35	46.52
2340	52.84	52.84	65.53	23.25	46.34
2345	53.18	53.18	65.66	23.40	46.61
2350	53.24	53.24	67.02	23.43	46.66
2355	53.86	53.86	60.71	23.70	47.14
2360	53.80	53.80	60.42	23.67	47.09
2365	53.29	53.29	59.93	23.45	46.68
2370	53.61	53.61	60.28	23.59	46.94
2375	55.02	55.02	60.15	24.21	48.04
2380	54.71	54.71	60.06	24.07	47.80
2385	53.82	53.82	59.95	23.68	47.10
2390	53.08	53.08	59.66	23.35	46.51
2395	53.08	53.08	60.46	23.36	46.51
2400	53.45	53.45	60.71	23.52	46.80
2405	53.55	53.55	60.60	23.56	46.87
2410	53.66	53.66	61.20	23.61	46.96
2415	53.29	53.29	60.69	23.45	46.67
2420	53.12	53.12	60.81	23.37	46.54
2425	53.28	53.28	61.11	23.44	46.66

2430	54.00	54.00	61.42	23.76	47.22
2435	53.78	53.78	60.57	23.66	47.04
2440	53.78	53.78	60.71	23.66	47.04
2445	53.97	53.97	61.05	23.74	47.19
2450	54.17	54.17	60.65	23.84	47.35
2455	54.28	54.28	61.07	23.88	47.43
2460	53.98	53.98	60.83	23.75	47.20
2465	54.50	54.50	60.25	23.98	47.60
2470	54.58	54.58	60.37	24.01	47.66
2475	53.71	53.71	60.36	23.63	46.98
2480	53.50	53.50	60.08	23.54	46.81
2485	53.44	53.44	59.70	23.51	46.76
2490	53.57	53.57	59.80	23.57	46.86
2495	53.38	53.38	59.63	23.49	46.71
2500	52.97	52.97	59.98	23.31	46.39
2505	53.69	53.69	59.78	23.62	46.95
2510	53.70	53.70	59.51	23.63	46.96
2515	53.57	53.57	59.76	23.57	46.85
2520	53.56	53.56	60.39	23.57	46.84
2525	53.96	53.96	61.11	23.74	47.15
2530	53.77	53.77	61.14	23.66	47.00
2535	53.42	53.42	61.38	23.50	46.72
2540	53.56	53.56	61.73	23.56	46.83
2545	53.69	53.69	62.55	23.62	46.93
2550	52.97	52.97	62.75	23.30	46.36
2555	53.30	53.30	62.65	23.45	46.63
2560	54.15	54.15	63.56	23.82	47.29
2565	54.28	54.28	63.90	23.88	47.39
2570	53.62	53.62	64.38	23.59	46.87
2575	53.95	53.95	64.83	23.74	47.13
2580	54.56	54.56	64.96	24.01	47.61
2585	54.20	54.20	65.56	23.85	47.32
2590	54.17	54.17	65.51	23.83	47.29
2595	53.80	53.80	66.37	23.67	47.00
2600	54.05	54.05	66.65	23.78	47.19
2605	53.79	53.79	66.47	23.67	46.99
2610	53.81	53.81	66.61	23.68	47.01
2615	53.99	53.99	66.75	23.75	47.14
2620	53.87	53.87	67.30	23.70	47.05
2625	53.36	53.36	67.26	23.48	46.64
2630	53.42	53.42	67.83	23.50	46.69
2635	53.48	53.48	68.11	23.53	46.74
2640	52.71	52.71	67.70	23.19	46.13

2645	52.81	52.81	67.83	23.24	46.20
2650	52.70	52.70	67.42	23.19	46.12
2655	51.70	51.70	67.16	22.75	45.33
2660	52.12	52.12	67.32	22.93	45.65
2665	51.74	51.74	67.78	22.76	45.35
2670	51.04	51.04	67.77	22.46	44.80
2675	50.45	50.45	67.50	22.20	44.33
2680	50.04	50.04	67.84	22.02	44.00
2685	50.18	50.18	67.58	22.08	44.11
2690	49.86	49.86	65.79	21.94	43.86
2695	49.83	49.83	65.83	21.93	43.84
2700	49.34	49.34	65.66	21.71	43.44
2705	49.13	49.13	64.79	21.62	43.27
2710	49.09	49.09	64.99	21.60	43.24
2715	49.11	49.11	65.83	21.61	43.26
2720	49.34	49.34	65.06	21.71	43.44
2725	49.58	49.58	64.10	21.82	43.63
2730	49.57	49.57	70.13	21.81	43.61
2735	49.13	49.13	70.05	21.62	43.27
2740	49.91	49.91	68.98	21.96	43.88
2745	50.26	50.26	61.58	22.12	44.16
2750	50.87	50.87	61.85	22.38	44.64
2755	51.48	51.48	61.23	22.65	45.12
2760	50.72	50.72	61.04	22.32	44.52
2765	52.26	52.26	61.29	22.99	45.73
2770	52.35	52.35	66.55	23.03	45.79
2775	52.56	52.56	68.40	23.12	45.96
2780	52.73	52.73	62.71	23.20	46.09
2785	52.48	52.48	62.65	23.09	45.90
2790	51.97	51.97	72.60	22.87	45.49
2795	50.68	50.68	63.50	22.30	44.47
2800	50.46	50.46	63.65	22.20	44.29
2805	50.55	50.55	63.64	22.24	44.36
2810	50.73	50.73	63.98	22.32	44.50
2815	50.95	50.95	63.90	22.42	44.67
2820	53.14	53.14	64.74	23.38	46.40
2825	52.93	52.93	64.68	23.29	46.23
2830	53.34	53.34	65.16	23.47	46.55
2835	53.59	53.59	65.79	23.58	46.74
2840	54.98	54.98	65.98	24.19	47.84
2845	53.68	53.68	66.32	23.62	46.82
2850	53.20	53.20	66.90	23.41	46.43
2855	54.37	54.37	67.08	23.92	47.35

2860	54.08	54.08	67.44	23.80	47.13
2865	53.13	53.13	67.71	23.38	46.38
2870	53.73	53.73	68.42	23.64	46.84
2875	52.89	52.89	68.76	23.27	46.18
2880	53.19	53.19	68.88	23.40	46.42
2885	51.62	51.62	69.33	22.71	45.18
2890	50.34	50.34	69.16	22.15	44.16
2895	49.19	49.19	70.38	21.65	43.25
2900	53.09	53.09	70.40	23.36	46.33
2905	53.28	53.28	71.14	23.44	46.48
2910	52.39	52.39	71.08	23.05	45.78
2915	52.19	52.19	71.17	22.96	45.62
2920	51.62	51.62	71.20	22.71	45.17
2925	51.17	51.17	71.53	22.52	44.81
2930	50.37	50.37	71.74	22.16	44.18
2935	49.89	49.89	71.51	21.95	43.79
2940	49.72	49.72	71.48	21.88	43.65
2945	49.76	49.76	71.24	21.90	43.69
2950	49.75	49.75	70.06	21.89	43.68
2955	48.49	48.49	70.52	21.33	42.67
2960	49.19	49.19	70.28	21.64	43.23
2965	48.84	48.84	68.76	21.49	42.95
2970	49.05	49.05	68.89	21.58	43.11
2975	49.03	49.03	67.73	21.57	43.09
2980	48.80	48.80	66.65	21.47	42.91
2985	49.52	49.52	66.35	21.79	43.48
2990	49.02	49.02	65.67	21.57	43.08
2995	50.04	50.04	65.40	22.02	43.89
3000	49.99	49.99	64.62	22.00	43.85
3005	50.90	50.90	64.10	22.39	44.56
3010	51.20	51.20	63.91	22.53	44.80
3015	51.34	51.34	62.98	22.59	44.91
3020	51.94	51.94	63.24	22.86	45.38
3025	51.80	51.80	63.29	22.79	45.27
3030	52.58	52.58	63.13	23.13	45.88
3035	52.20	52.20	62.62	22.97	45.58
3040	52.93	52.93	62.30	23.29	46.15
3045	52.33	52.33	62.33	23.03	45.68
3050	52.76	52.76	62.06	23.21	46.01
3055	52.86	52.86	62.72	23.26	46.09
3060	53.42	53.42	62.73	23.50	46.53
3065	53.33	53.33	62.74	23.47	46.46
3070	53.07	53.07	63.69	23.35	46.25

3075	53.37	53.37	63.87	23.48	46.49
3080	53.34	53.34	63.94	23.47	46.46
3085	53.08	53.08	64.73	23.36	46.26
3090	53.77	53.77	64.84	23.66	46.79
3095	52.63	52.63	65.33	23.16	45.89
3100	52.44	52.44	65.93	23.07	45.74
3105	51.87	51.87	65.89	22.82	45.29
3110	52.16	52.16	65.70	22.95	45.52
3115	52.03	52.03	66.26	22.89	45.42
3120	52.51	52.51	67.01	23.10	45.79
3125	52.35	52.35	67.62	23.03	45.66
3130	51.35	51.35	68.17	22.59	44.88
3135	52.14	52.14	68.47	22.94	45.49
3140	51.98	51.98	69.19	22.87	45.37
3145	51.95	51.95	70.65	22.86	45.34
3150	52.56	52.56	71.32	23.13	45.82
3155	52.85	52.85	71.91	23.26	46.05
3160	53.10	53.10	72.31	23.36	46.24
3165	52.64	52.64	73.16	23.16	45.88
3170	52.65	52.65	71.35	23.17	45.89
3175	52.65	52.65	73.08	23.17	45.88
3180	52.88	52.88	71.80	23.27	46.06
3185	52.92	52.92	71.42	23.29	46.09
3190	53.53	53.53	70.25	23.55	46.57
3195	53.29	53.29	69.40	23.45	46.38
3200	54.01	54.01	70.36	23.76	46.94
3205	52.38	52.38	69.69	23.05	45.66
3210	51.98	51.98	69.59	22.87	45.34
3215	51.09	51.09	69.21	22.48	44.64
3220	48.64	48.64	68.88	21.40	42.69
3225	52.52	52.52	68.31	23.11	45.76
3230	49.46	49.46	68.10	21.76	43.34
3235	50.93	50.93	68.32	22.41	44.51
3240	50.13	50.13	68.02	22.06	43.87
3245	50.38	50.38	67.78	22.17	44.06
3250	48.72	48.72	67.43	21.44	42.74
3255	48.12	48.12	67.01	21.17	42.26
3260	49.02	49.02	66.03	21.57	42.98
3265	47.15	47.15	65.66	20.74	41.48
3270	47.96	47.96	65.67	21.10	42.13
3275	47.80	47.80	65.20	21.03	42.00
3280	45.94	45.94	65.24	20.21	40.51
3285	46.98	46.98	63.94	20.67	41.34

3290	46.94	46.94	64.50	20.65	41.30
3295	45.91	45.91	63.83	20.20	40.48
3300	46.45	46.45	63.79	20.44	40.91
3305	47.44	47.44	63.16	20.88	41.70
3310	47.43	47.43	63.51	20.87	41.69
3315	46.71	46.71	63.94	20.55	41.12
3320	47.15	47.15	63.47	20.75	41.47
3325	49.26	49.26	63.61	21.68	43.15
3330	50.10	50.10	63.90	22.04	43.81
3335	50.50	50.50	64.10	22.22	44.12
3340	50.43	50.43	64.55	22.19	44.06
3345	49.48	49.48	64.76	21.77	43.31
3350	52.17	52.17	64.37	22.95	45.44
3355	52.04	52.04	64.95	22.90	45.33
3360	52.44	52.44	65.44	23.07	45.65
3365	52.03	52.03	65.72	22.89	45.32
3370	51.80	51.80	65.90	22.79	45.14
3375	52.63	52.63	66.95	23.16	45.79
3380	52.28	52.28	66.73	23.00	45.51
3385	51.83	51.83	66.67	22.81	45.16
3390	52.81	52.81	66.60	23.24	45.93
3395	52.46	52.46	66.99	23.08	45.65
3400	51.74	51.74	66.07	22.76	45.08
3405	52.28	52.28	65.69	23.00	45.50
3410	52.36	52.36	66.05	23.04	45.57
3415	52.57	52.57	66.34	23.13	45.73
3420	52.98	52.98	66.35	23.31	46.05
3425	52.81	52.81	66.32	23.24	45.92
3430	53.12	53.12	66.87	23.37	46.16
3435	52.48	52.48	67.10	23.09	45.65
3440	53.10	53.10	67.19	23.36	46.14
3445	53.13	53.13	67.06	23.38	46.16
3450	53.13	53.13	66.82	23.38	46.16
3455	53.19	53.19	67.10	23.40	46.20
3460	53.39	53.39	69.25	23.49	46.36
3465	53.11	53.11	69.42	23.37	46.14
3470	54.19	54.19	69.42	23.84	46.98
3475	52.03	52.03	69.79	22.90	45.29
3480	50.03	50.03	69.92	22.01	43.70
3485	49.30	49.30	69.18	21.69	43.11
3490	50.85	50.85	68.72	22.37	44.34
3495	50.62	50.62	69.40	22.27	44.16
3500	49.12	49.12	68.64	21.61	42.97

3505	47.46	47.46	68.61	20.88	41.64
3510	48.79	48.79	69.00	21.47	42.70
3515	48.70	48.70	68.69	21.43	42.63
3520	48.11	48.11	69.14	21.17	42.15
3525	47.31	47.31	68.35	20.82	41.52
3530	56.12	56.12	68.75	24.69	48.47
3535	56.41	56.41	68.95	24.82	48.70
3540	46.21	46.21	68.56	20.33	40.62
3545	46.37	46.37	68.14	20.40	40.76
3550	57.73	57.73	69.41	25.40	49.71
3555	50.75	50.75	69.40	22.33	44.24
3560	51.64	51.64	69.41	22.72	44.94
3565	52.78	52.78	69.42	23.22	45.84
3570	52.70	52.70	69.01	23.19	45.77
3575	52.55	52.55	67.95	23.12	45.65
3580	51.54	51.54	67.28	22.68	44.85
3585	49.98	49.98	67.18	21.99	43.62
3590	49.84	49.84	66.12	21.93	43.50
3595	49.56	49.56	65.26	21.81	43.28
3600	48.94	48.94	64.97	21.54	42.79
3605	49.28	49.28	64.30	21.68	43.05
3610	48.65	48.65	64.92	21.41	42.55
3615	48.79	48.79	64.99	21.47	42.66
3620	48.61	48.61	64.25	21.39	42.51
3625	56.27	56.27	63.93	24.76	48.56
3630	56.15	56.15	63.83	24.70	48.46
3635	57.01	57.01	62.96	25.09	49.13
3640	56.73	56.73	63.29	24.96	48.91
3645	56.50	56.50	63.17	24.86	48.72
3650	56.41	56.41	61.82	24.82	48.65
3655	57.64	57.64	61.31	25.36	49.61
3660	56.47	56.47	60.72	24.85	48.69
3665	57.40	57.40	60.37	25.26	49.42
3670	57.24	57.24	59.97	25.18	49.29
3675	57.87	57.87	60.05	25.46	49.78
3680	57.61	57.61	60.77	25.35	49.57
3685	57.74	57.74	60.41	25.40	49.67
3690	57.68	57.68	60.86	25.38	49.63
3695	57.73	57.73	60.44	25.40	49.66
3700	57.92	57.92	61.09	25.48	49.81
3705	57.61	57.61	60.37	25.35	49.57
3710	57.85	57.85	60.03	25.46	49.75
3715	59.09	59.09	60.62	26.00	50.71

3720	58.56	58.56	60.36	25.77	50.30
3725	58.54	58.54	60.59	25.76	50.28
3730	58.93	58.93	61.03	25.93	50.58
3735	58.66	58.66	61.05	25.81	50.37
3740	58.79	58.79	61.95	25.87	50.47
3745	58.89	58.89	61.54	25.91	50.54
3750	58.98	58.98	61.94	25.95	50.61
3755	58.25	58.25	61.56	25.63	50.05
3760	59.15	59.15	62.41	26.03	50.75
3765	59.32	59.32	62.57	26.10	50.87
3770	59.55	59.55	62.45	26.20	51.05
3775	59.82	59.82	63.06	26.32	51.25
3780	59.91	59.91	62.72	26.36	51.32
3785	59.39	59.39	63.93	26.13	50.92
3790	59.46	59.46	64.93	26.16	50.97
3795	59.37	59.37	65.84	26.12	50.90
3800	59.62	59.62	66.18	26.23	51.09
3805	60.23	60.23	67.17	26.50	51.56
3810	60.01	60.01	66.89	26.40	51.39
3815	60.37	60.37	67.39	26.56	51.66
3820	61.00	61.00	67.28	26.84	52.15
3825	61.00	61.00	68.09	26.84	52.15
3830	60.77	60.77	67.78	26.74	51.97
3835	60.44	60.44	67.66	26.59	51.71
3840	60.82	60.82	67.92	26.76	52.00
3845	60.25	60.25	68.51	26.51	51.56
3850	60.89	60.89	68.59	26.79	52.06
3855	60.65	60.65	67.67	26.69	51.87
3860	60.11	60.11	68.69	26.45	51.45
3865	59.65	59.65	69.50	26.25	51.09
3870	60.12	60.12	69.32	26.45	51.45
3875	60.53	60.53	68.79	26.63	51.77
3880	59.76	59.76	68.65	26.29	51.17
3885	59.83	59.83	68.93	26.32	51.22
3890	59.68	59.68	68.51	26.26	51.10
3895	59.68	59.68	67.68	26.26	51.11
3900	59.79	59.79	66.77	26.31	51.19
3905	59.35	59.35	66.12	26.11	50.84
3910	59.14	59.14	65.85	26.02	50.68
3915	59.72	59.72	65.24	26.28	51.13
3920	59.72	59.72	64.97	26.28	51.12
3925	59.90	59.90	64.82	26.36	51.26
3930	60.08	60.08	64.58	26.43	51.40

3935	59.66	59.66	64.70	26.25	51.07
3940	59.87	59.87	65.30	26.34	51.23
3945	59.66	59.66	65.06	26.25	51.07
3950	59.30	59.30	65.86	26.09	50.78
3955	59.57	59.57	66.19	26.21	51.00
3960	59.52	59.52	66.20	26.19	50.96
3965	59.20	59.20	66.48	26.05	50.70
3970	59.68	59.68	66.73	26.26	51.07
3975	60.45	60.45	66.48	26.60	51.67
3980	60.99	60.99	66.82	26.84	52.09
3985	61.26	61.26	66.08	26.95	52.29
3990	61.39	61.39	66.03	27.01	52.38
3995	61.55	61.55	65.82	27.08	52.51
4000	61.69	61.69	65.35	27.14	52.61
4005	61.37	61.37	65.52	27.00	52.37
4010	61.56	61.56	66.15	27.08	52.51
4015	61.41	61.41	65.68	27.02	52.40
4020	61.18	61.18	65.65	26.92	52.21
4025	61.29	61.29	65.52	26.97	52.30
4030	61.30	61.30	65.68	26.97	52.30
4035	60.78	60.78	65.59	26.74	51.90
4040	60.32	60.32	65.60	26.54	51.54
4045	59.82	59.82	66.10	26.32	51.15
4050	59.86	59.86	66.46	26.34	51.19
4055	59.59	59.59	67.10	26.22	50.97
4060	59.27	59.27	67.63	26.08	50.73
4065	58.97	58.97	67.38	25.95	50.49
4070	58.72	58.72	67.25	25.84	50.29
4075	57.42	57.42	66.93	25.27	49.29
4080	57.30	57.30	65.95	25.21	49.18
4085	56.67	56.67	65.42	24.94	48.70
4090	56.10	56.10	64.70	24.68	48.25
4095	56.79	56.79	64.06	24.99	48.78
4100	56.54	56.54	63.91	24.88	48.59
4105	56.01	56.01	64.22	24.65	48.17
4110	58.86	58.86	64.17	25.90	50.39
4115	58.62	58.62	63.83	25.79	50.20
4120	55.28	55.28	63.24	24.32	47.60
4125	55.32	55.32	63.40	24.34	47.63
4130	59.37	59.37	63.45	26.12	50.78
4135	59.11	59.11	63.33	26.01	50.57
4140	50.97	50.97	63.36	22.43	44.19
4145	54.73	54.73	63.80	24.08	47.15

4150	59.57	59.57	64.27	26.21	50.92
4155	54.97	54.97	64.52	24.19	47.34
4160	55.14	55.14	64.43	24.26	47.47
4165	59.70	59.70	64.61	26.27	51.02
4170	59.86	59.86	64.32	26.34	51.14
4175	60.30	60.30	64.17	26.53	51.48
4180	60.59	60.59	63.89	26.66	51.70
4185	61.23	61.23	63.03	26.94	52.20
4190	61.73	61.73	62.76	27.16	52.58
4195	62.36	62.36	63.04	27.44	53.06
4200	58.13	58.13	63.51	25.58	49.79
4205	62.02	62.02	63.41	27.29	52.79
4210	58.53	58.53	63.30	25.75	50.10
4215	59.03	59.03	63.48	25.97	50.48
4220	59.94	59.94	64.14	26.37	51.19
4225	61.08	61.08	64.49	26.87	52.06
4230	61.91	61.91	64.11	27.24	52.70
4235	62.02	62.02	63.36	27.29	52.79
4240	62.28	62.28	63.23	27.40	52.98
4245	65.18	65.18	63.12	28.68	55.21
4250	64.51	64.51	62.81	28.39	54.69
4255	62.75	62.75	62.34	27.61	53.34
4260	65.34	65.34	62.81	28.75	55.32
4265	64.98	64.98	63.41	28.59	55.04
4270	65.57	65.57	64.03	28.85	55.49
4275	65.80	65.80	63.87	28.95	55.67
4280	65.96	65.96	63.96	29.02	55.79
4285	66.04	66.04	63.98	29.06	55.85
4290	66.26	66.26	64.02	29.16	56.01
4295	66.87	66.87	64.01	29.42	56.48
4300	66.94	66.94	64.19	29.45	56.53
4305	66.11	66.11	64.02	29.09	55.90
4310	65.59	65.59	64.32	28.86	55.49
4315	65.39	65.39	64.93	28.77	55.34
4320	64.82	64.82	65.42	28.52	54.90
4325	64.60	64.60	66.23	28.42	54.73
4330	64.45	64.45	67.07	28.36	54.62
4335	63.93	63.93	67.49	28.13	54.21
4340	63.31	63.31	67.93	27.86	53.74
4345	63.22	63.22	68.37	27.81	53.66
4350	62.67	62.67	69.15	27.57	53.24
4355	62.01	62.01	69.06	27.28	52.73
4360	61.99	61.99	69.68	27.28	52.71

4365	61.30	61.30	70.58	26.97	52.19
4370	61.14	61.14	70.27	26.90	52.06
4375	61.21	61.21	70.62	26.93	52.11
4380	60.90	60.90	70.71	26.79	51.86
4385	60.12	60.12	70.23	26.45	51.26
4390	59.94	59.94	70.34	26.37	51.12
4395	60.08	60.08	70.64	26.44	51.23
4400	59.95	59.95	70.72	26.38	51.12
4405	60.85	60.85	70.59	26.77	51.82
4410	60.74	60.74	70.37	26.72	51.73
4415	60.71	60.71	69.64	26.71	51.70
4420	60.86	60.86	68.51	26.78	51.82
4425	61.73	61.73	68.80	27.16	52.49
4430	61.31	61.31	68.11	26.97	52.16
4435	61.04	61.04	67.42	26.86	51.95
4440	61.12	61.12	67.05	26.89	52.01
4445	60.48	60.48	66.39	26.61	51.52
4450	61.28	61.28	65.52	26.96	52.13
4455	60.54	60.54	64.87	26.64	51.56
4460	60.66	60.66	64.30	26.69	51.65
4465	61.02	61.02	63.79	26.85	51.93
4470	60.52	60.52	63.01	26.63	51.54
4475	61.40	61.40	63.02	27.01	52.22
4480	61.05	61.05	62.64	26.86	51.95
4485	61.07	61.07	62.54	26.87	51.96
4490	61.13	61.13	61.52	26.90	52.01
4495	61.18	61.18	61.44	26.92	52.04
4500	60.68	60.68	61.12	26.70	51.66