STABILITY OF SEGMENTAL EXCAVATION DEPTH FOR A NOVEL EXCAVATION METHOD BY ROBOTIC SYSTEM FOR CAISSON CONSTRUCTION

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Stability of Segmental Excavation Depth for a Novel Excavation Method by Robotic System for Caisson Construction

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CERTIFICATE OF ORIGINALITY

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ABSTRACT

Large diameter reinforced concrete pile was a foundation system widely and popularly used at a city where numbers of high-rise buildings were built, such as Hong Kong. The construction method of this type of circular pile was somehow constructed by manual method in the past in Hong Kong. The use of this manual method was criticized as being too dangerous and harmful to the workers since numbers of accidents-had been frequently recorded.

Shaft collapse during the segmental excavation by hand of the whole caisson was identified as one of the common hazards or accidents recorded. Meanwhile, a lack of researches regarding assessing the stability condition of the shaft during segmental excavation were able to be located.

As a matter of fact, this manual method of construction actually owns numbers of important advantages, such as low mobilization difficulty and construction cost, etc. These advantages are very beneficial and competitive according to the geographical condition in Hong Kong. The introduction of robotic system to replace the manual tasks was therefore proposed in order to re-popularize this construction method by eliminating the mentioned shortcoming. Concurrent to the prototyping of this new excavation system, a study to the subject hazards of shaft collapse during excavation phase was launched.

This research was performed to realize the safety level of the segmental vertical excavation by adopting simulation method using Finite Element software followed by regression analysis to the computed results from Finite Element programming. This approach was justified to be effective since numbers of previous researches have also adopted a similar method to investigate geotechnical problems. A dataset of FOS from 400 FE models were firstly created according to the combination from ranges of various geometrical and geotechnical parameters as variables. Statistical software was then used to analyze the dataset.

Certain relationships between the variables including geometric parameters of the subject caisson (such as caisson diameters, overall caisson depth from the ground, segmental excavation depth, etc.) as well as geotechnical parameters (including cohesion and friction angle of the soil) and the values of Factor of Safety (FOS) were firstly examined and then presented. After associated regression analysis to the computed outcome, empirical equations

enabling for predicting or assessing the FOS of each segmental vertical circular excavation with respect to the known geometric and geotechnical parameters were eventually formulated. one of the formulated equations were examined and tested during the full-scale site trial of the prototyped excavation system. Afterwards, the regression equations were comprehensively compared to the prediction of FOS according to the method/table/chart/equations from previous researches so as to visualize the phenomena, reliability/functionality owning by the regression equations developed by the author.

The contribution of this research in academic point of view is the availability of predicting FOS of a segment of a vertically excavated circular shaft. This prediction is able to ensure a minimum safety standard of a maximum excavation depth allowed without inducing potential hazard to person or surrounding. Another academic contribution from this study is the reflection to the deficiency owning the previous research outcomes since some of the important factors (such as segmental excavation interval, arching effect related to the caisson diameter, etc.) influencing the prediction of FOS of a segmental excavation interval of a vertical-circular shaft have not been fully incorporated.

Another implication and benefit in a long-term basis from this research project to construction industry of foundation in Hong Kong is regarding the development of prototype excavation robot replacing the manual digging task responsible by caisson workers. This replacement of excavation tasks from manual to machine-aided provides an alternative solution for foundation works to be built in a site with limited working space or logistic assess. This alternative solution may eventually improve the competitiveness among different construction methods and achieve the purpose of cost-saving or cost-effectiveness.

PUBLICATIONS ARISING FROM THE THESIS

1. Dong Guan**, Nan Yang, **Jerry Lai**, Ming Fung Francis Siu*, Xingjian Jing, Chi-Keung Lau, 2021. Kinematic modeling and constraint analysis for robotic excavator operations in piling construction. *Journal of Automation in Construction*, 126 (2021). http://doi.org/10.1016/j.autcon.2021.103666.

2. **H.K. Lai***, D.D. Li, Y.K. Lam, M.F. Siu, P.C. Chan, C.H. Yam, X.J. Jing, C.K. Lau, C.W. Lau, 2021. Productivity of robotic excavators for caisson construction. *Proceeding of the CIB International Conference on Smart Built Environment, ICSBE 2021*. p303-311.

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LIST OF ABBREVIATIONS

2D	Two-dimension / Two-dimensional
3D	Three-dimension / Three-dimensional
BD	Buildings Department
CDG/HDG	Completely/Highly Decomposed Granite
CEDD	Civil Engineering and Development Department
Dia.	Diameter
Ep	Excavation Depth / Excavation Interval
EBS	Excavation before Support
E values	Elastic Modulus of Soil
FE	Finite Element
FEM	Finite Element Method
FOS	Factor of Safety
HKIE	Hong Kong Institution of Engineers
HS	Hardening Soil
HSS	Hardening Soil Small Strain
MC	Mohr-Coulumb
OSHC	Occupational Safety & Health Council
RCD	Reserve Circular Drill
SBE	Support before Excavation
SF	Strength Factor (defined as $c * \phi$)
SPT	Standard Penetration Test
SPT-N	N values of Standard Penetration Test

LIST OF SYMBOLS

c	Cohesion of Soil
Dia.	Diameter
$E_{50'ref}$	Elastic Modulus for PLAXIS
Es	Elastic Modulus of Soil / Soil for the Shaft Resistance
Eb	Elastic Modulus of Soil for the Base Resistance
Ep	Excavation Depth / Excavation Interval
Ns	Stability Numbers
SF	Strength Factor (defined as c * ϕ)
ϕ / phi	Friction Angle of Soil
γ	Unit Weight of Soil
v	Poisson Ratio of Soil

CHAPTER 1 INTRODUCTION

High-rise buildings in Hong Kong generally require large-diameter reinforced concrete piles as their foundation system to satisfy the structural stability of the buildings. A number of high-rise buildings were built on a foundation system of large-diameter reinforced concrete pile from 19700s to 1990s whilst portion of the foundation systems were of hand-dug caisson.

Hand-dug caisson was not only frequently applied as a foundation system of high-rise buildings, but also adopted as an earth retaining structures for creating lands from hilly terrain for building development. These two applications caused the popularity of construction of hand-dug caisson in the period from 1970s to 1990s.

1.1 Government's Restriction on Application and Hand-dug Caisson's Pros & Cons

Hand-dug caisson is a circular concrete structure which provides a high axial capacity against gravity loading from the super-structures built on top. The construction method of hand-dug caisson mainly requires on human resource with minimal resource of light-duty equipment and plant. That is the reason of "hand-dug caisson" so named.

Hand-dug caisson was also commonly adopted as an earth-retaining structures (Figure 1.1) other than as a foundation system of high-rise buildings in view of the characteristic of hilly terrain of territory of Hong Kong. The reason of the common adoption is because hand-dug caisson owns sufficient resistance against bending moment and shear force induced from the lateral earth pressure.

The usage and the commonality of hand-dug caisson in Hong Kong is thus high as a matter of the above situation and/or characteristics.

The use of hand-dug caisson in Hong Kong is, however, highly restricted under current statutory requirement (BD, 1993 and CEDD, 1994). The reason of the high restriction is because of the potential hazards on workers' health and safety caused by the construction method of hand-dug caisson. As it may be imagined from Figures 1.2a to 1.2c, the worker is required to perform excavation tasks in a rather confined space. The typical diameter of a hand-dug caisson ranges from 1.2m to 3m (HKIE, 1981). This limited working space or environment would result the worker in suffering from safety and health hazards as listed in Table 1.1 (Wong, 1987 & 1990).

Table 1.2 (Wong, 1987 & 1990) shows the numbers of accidents occurred in the progress of construction using hand-dug method recorded in the period from 1987 to 1990. In addition to safety issue, the health issue caused by this construction method is also found severe and listed in Table 1.2, which involves severe lung disease suffered by the workers who perform excavation task inside the shaft. Chui et al. (1988) studied that caisson workers are exposed to a high concentration of silica generated in the progress of rock drilling tasks inside the caisson shaft. Persons working in the environment with a high concentration of silica are likely suffering from Silicosis. Silicosis has been classified as a severe occupational disease because it would cause unrecoverable damage to the lung. No effective treatment has been identified up to the present.

Although this method of caisson construction owns certain disadvantages, this construction method requires minimal resources in terms of machinery, unlike heavy-duty equipment and plant, such as oscillator, RCD (reserve-circular drill) and mobile crane, for constructing large-diameter bored pile. The strengths of using hand-dug method are elaborated in Table 1.3 (GEO, 2006 & Siu, 2018). A comparison of the strength and weakness of construction method of hand-dug caisson with respect to various aspect is summarized in Table 1.3 (GEO, 2006 & Siu, 2018).

Figure 1.1: Earth Retaining Structures by Caissons

Figure 1.2a: Starting of a Caisson (Law 1981)(redrawn)

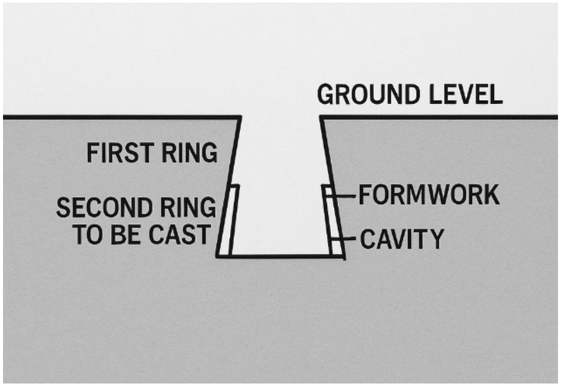


Figure 1.2b: Procedure for placing concrete rings (Law 1981)(redrawn)

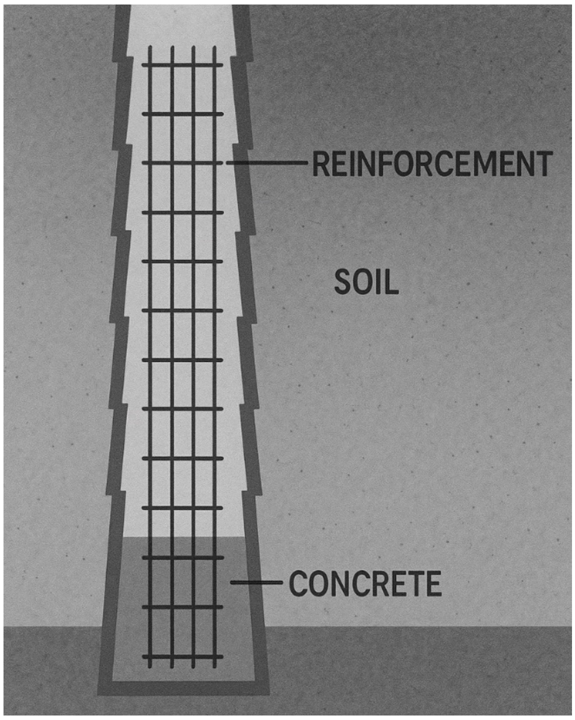


Figure 1.2c: Diagrammatic view of a caisson (Law 1981)(redrawn)

Table 1.1: Hazards of Hand-dug Caisson by Wong (1987 & 1990)

Health Hazards	Safety Hazards
◆ Lung disease ◆ Silicosis ◆ Pneumoconiosis	◆ Fall of person ◆ Falling object ◆ Electrocution ◆ Gassing ◆ In rush of mud/water

Table 1.2: Accidents of Hand-dug Caisson by Wong (1987 & 1990)

Categories	Fatal Accidents	Non-fatal Accidents
Fall of person	12	47
Falling object	11	39
Electrocution	5	0
Gassing	4	2
In rush of mud/water	3	0
Others	0	9
Total	**35**	**97**

Table 1.3: Strength and Weakness of Construction Method of Hand-dug Caisson

Strength	
Engineering Point of View **(GEO, 2006)**	Construction Point of View **(Siu, 2018)**
◆ Base material can be inspected. ◆ Removal of obstructions or boulders is relatively easy through the use of pneumatic drills or, in some cases, explosives. ◆ The method is suitable for complex geological condition. ◆ Piles can be constructed to large-diameter (more than 3.5m diameter and up to 10m diameter). ◆ Structural capacity is not dependent on handling or driving conditions. ◆ Piles can be installed with less noise and vibration compared to displacement piles.	◆ Comparatively low construction cost to a similar size of pile. ◆ Comparatively high mobilization capacity to other types of pile foundation. ◆ Comparatively low mechanical resource to a similar size of pile. ◆ Generally conducive to simultaneous excavation by different gangs of workers. ◆ Suitable for limited working area such as steep slope terrain. ◆ Not susceptible to programme delay arising from machine down time.
Weakness (GEO, 2006)	
◆ Hazardous working conditions for workers and the construction method have a poor safety record in the past. ◆ The method is liable to base heave or piping during excavation, particularly where the groundwater table is high. ◆ The method owns possible adverse effects of dewatering on adjoining land and structures. ◆ Health hazards to workers, as reflected by a high incidence rate of pneumoconiosis and damage to hearing is suffered from caisson workers.	

1.2 Literature Review of Hand-dug Caisson

This sub-chapter presents the literatures related to hand-dug caisson in various aspects including construction/operation, safety and health, structural engineering and geotechnical engineering, etc.

1.2.1 General Principle and Practice

Hong Kong Institution of Engineers (HKIE, 1981) published a “guidance notes on hand-dug caissons” that list-out a comprehensive explanation to various aspects relating to hand-dug caisson construction in terms of construction sequence, equipment and resource, general design principle, dewatering technique, concreting lining construction, general site supervision, precautionary measure, special treatment to particular site such as pre-grouting and use of explosive, etc.. This publication is referred as the baseline of caisson construction in Hong Kong.

Faber (1972) discussed that the Hong Kong caisson was initially used at where bedrock layer was investigated at a shallow depth. Further extended use of caisson founding on firm residual soil, usually CDG/HDG (completely decomposed granite / highly decomposed granite) was happened thereafter. Faber also expressed that the mechanism of caisson to transfer loads is usually by end bearing as chosen by Hong Kong's engineers since there are difficulties in assessing the frictional resistance because of uncertainty on the determining coefficient of lateral earth pressure.

Mak (1993) highlighted the technical viability to succeed caisson excavation is about the ability of leaving the sub-soil freestanding for an appreciable height during excavation. The geotechnical formation of Hong Kong territory is decomposed granite in major, which is rather permeable. The site with low groundwater table, such as hillside terrain easily found in Hong Kong, is therefore favourable to the success of caisson construction. The researcher therefore reckoned that the caisson is very beneficial for application to where the development, such as a high-rise building on hill slope, because the construction cost is under control. Because of the wide application of caisson foundation, the market stakes of caisson foundation was about HK$800M in 1991 and HK$600M in 1992. The researcher illustrated a typical caisson construction as shown on Figure 1.3.

Apart from the previous discussions about the caisson used a foundation, Choy et al, (2007) opted that hand-dug caisson can also be applied a retaining structure as a measure for site formation works for a development at hill slope terrain. A series of caissons were to be built while a deep excavation works at the developed side was carried out. The series of caissons would then be functions as a cantilevered retaining wall, so called caisson walls as shown on Figure 1.1. This application is found structurally viable and cost effective because the engineer took advantages of the combination of bending moment and axial load capacity of the caisson reinforced with by high-yield steel bars to resist the external applied from the retained soil.

1.2.2 Design Principle

General design considerations were outlined in the previous literatures of HKIE (1981) & Choy (2007). First of all, site investigation by means of desk study, trial pit or vertical borehole shall be conducted to visualize and forecast if any construction difficulties would be encountered during shaft excavation. The adjustment to the caisson diameter and founding level could then be considered based on the investigated information so as to achieve an economical design with respect to design and construction.

Caisson designed as an end-bearing pile, while omitting the frictional resistance from the shaft, was a common practice in Hong Kong (HKIE 1981, GEO 2006). For caisson founded on soil (likely on completely or highly decomposed material), the allowable bearing capacity at 1200kPa was usually adopted. For caisson founded on bedrock (i.e. Grade III or better rock in accordance with Code or Practice for Foundation) (BD 2004), the allowable bearing capacity may be increased to 5000kPa.

Research works regarding the loading capacity provided by end-bearing or pile head settlement estimation could be even found back-dating to 1970s. Faber (1972) discussed and quoted a design chart for a caisson founding on cohesionless soil (Figure 1.4). Poulos (1972) summarized theoretical approaches to estimate the caisson head settlement using elastic theory, constructed load-settlement curves and suggested average values of Es for sand material.

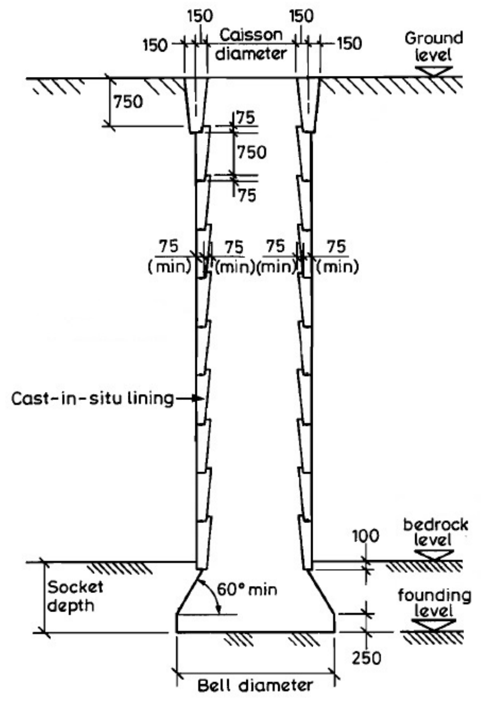


Figure 1.3: Caisson Wall in Hong Kong (redrawn)

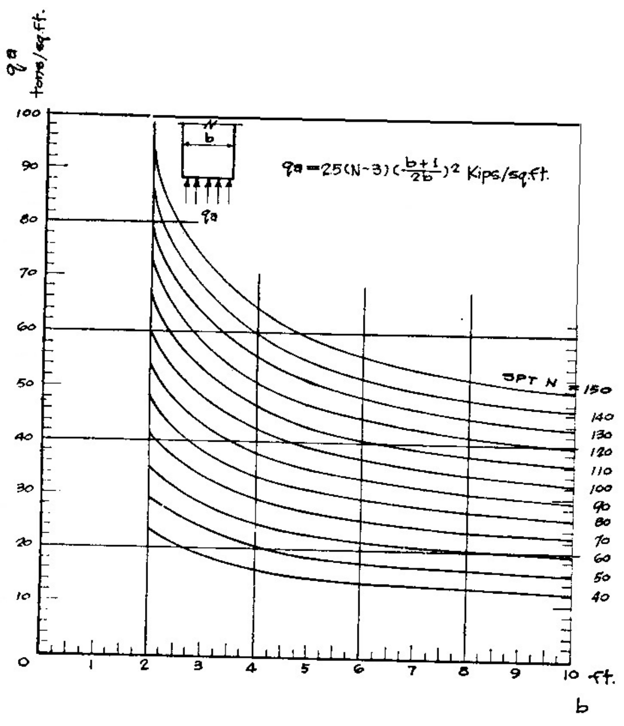


Figure 1.4: Design chart for a caisson founding on cohesionless soil (Faber 1972)(redrawn)

Although the shaft frictional resistance was usually omitted from the total capacity as a common practice in Hong Kong as mentioned above, Sayer and Leung (1987) conducted an in-situ experiment throughout the progress of the construction project of public housing, to monitor the actual distribution of the applied load resisted by the end-bearing soil and the shaft resistance. The caissons were founded on dense soil in this experiment. At the end of the monitoring, Sayer and Leung stated that 100% of the applied load was resisted by the shaft at the time of 75% completion of the construction. From that time on, an increase of the reading from the pressure cell to measure loading at the caisson base was recorded. The researchers eventually concluded that the shaft resistance may probably resist 75% of the total applied load before the load was transferred to the soil at the caisson base.

Literatures regarding structural or geotechnical design of a caisson were found and briefly discussed in the above paragraphs. However, the structural and geotechnical design specifically related to the caisson lining was not retrieved.

1.2.3 Safety and Health Issue

Several literatures (HKIE, 1981; Mak, 1993; Choy et al 2007) have briefly discussed the safety and health issues/hazards related to the construction of hand-dug caisson in Hong Kong. Whilst, Law (1981) discussed the hazards of hand-dug caisson construction in details with respect to the following categories;

(i) Ventilation and toxic gas

Fresh air could only be supplied to the worker inside the caisson shaft by a blower at the ground. The fresh air supply became weaker and weaker when the caisson went deeper and deeper. The supplied fresh air may then be just sufficient for the worker but insufficient to dilute the toxic gases generated from the excavation tasks. This therefore created hazards to the worker.

(ii) Heaving of soil and in-rush of water

Excavation inside a caisson shaft below groundwater table was rather common. Continuous pumping to remove groundwater at the base of the shaft was sometimes required. Improper control to the pumping may lead to excessive groundwater draw-down causing shaft base heaving and in-rush of water. These occurrences were the potential hazards encountered by the workers.

(iii) Shaft instability / Cave-in

Workers may overlook the problem of shaft instability or cave-ins in particular when passing through rock layer, because the rock may be only a boulder which is misleading the worker.

The researcher therefore suggested all exposed shaft shall be concrete-lined no matter of what material is encountered so as to minimize the risks.

(iv) Falling of persons

Caisson workers assessing inside and outside the shaft of a small diameter caisson was usually by climbing up and down with hand-holds and foot-holds cast on the concrete lining. Climbing along the shaft (especially a deep shaft more than 30m) easily caused fatigue to worker who may slip and lose his balance resulting in injury/fatality by falling from height. Some other cases of falling from height involved workers who lost balance in a lifting bracket when riding upward from the shaft base. Falling of persons may also resulted from an unnecessary or accidental removal of safety barrier around the caisson shaft.

(v) Falling of objects

Lifting bucket is compulsory for the job, such as lifting boulder or soil spoil. This operation was dangerous because the chain could swing to cause the spoil falling from the bucket. The worker was then easily hurt since the space inside the shaft is so confined and has no shelter at all. Even worse, the lifting system (i.e. the chain block and bucket) may fall into the shaft to cause serious accidents if the system was damaged and overloaded.

(vi) Hearing system

Pneumatic drilling to rock or boulder is common for a caisson construction. High level of noise from the drilling task likely cause damage to the hearing system of the worker.

Law (1981) finally concluded that safety precautions measures are not so difficult to be carried out. However, the serious safety and health impact was still inevitable since this job involved large amount of manual tasks. The researcher then suggested one of the effective solutions, which was to replace the whole manual operation system by mechanized system, which in turn tally with the theme of this research.

Some more literatures about safety and health issues of hand-dug caisson are presented below.

Chui et al. (1988) conducted a 3-year experiment to investigate the characteristics of dust generated from the rock drilling process inside a caisson shaft. The aim of the experiment was to collect engineering data to design an effective and efficient cleanup system. First of all, the researcher observed from the experiment that the dust cloud formation inside the shaft may reach the breathing zone of the rock-drilling operator as rapid as about 10 seconds. The level of dust loading at the breathing zone was about 8g/m where 12.5% of the dust in size under 5 microns was recorded. This observed data indicated that dust generated from the rock drilling definite caused health hazards to the drilling operator and the researcher highly suggested the need of a cleaning system to alleviate the hazardous level. The particle size from sub-micron to 2000 microns was recorded from the dust loading experiments where 70% and 10% of the dusts were over 75 microns and 1000 microns in aerodynamic diameter respectively. The researcher therefore suggested that a pre-cleaner should be used to knock out larger non-respirable particles to reduce the load on the transport line while the respirable dusts may be controlled by a high efficiency cleaner.

Occupational Safety & Health Council (OSHC, 1993) published a code of practice in view of serious safety and health impact on caisson workers recorded up to the time. The publication detailed the practicable safety and health measures which shall be adopted so as to minimize risks and impacts to the workers. General responsibilities of both employers and employees were also stated clearly.

Fang (1996) conducted an experiment to field-test a dust abatement system for hand-dug caisson construction. The researcher firstly quoted his previous finding that the rock-drilling operators may contract silicosis within 1 year of working, since they exposed to a crystalline silica-containing dust environment where the thresholds limit exceeded as high as 2000 times. The researcher designed and field-tested the abatement system by using wet scrubbing and ventilation methods. The system was found to be capable of reducing up to 98% and 51% of dust in a 1m and 3m diameter caisson respectively.

1.2.4 Specific Construction Issue

Use of explosives inside a caisson for excavation would expedite the work in some situations, in particular to encountering fresh granite (HKIE, 1981). Special attention should be paid to avoid damaging or cracking to the in-situ concrete lining cast. Water-resistant explosives was also recommended in this publication.

Water draw-down and associated ground settlement was not uncommon for caisson construction. Settlement resulting from groundwater draw-down may be predicted with reference to conventional theory. Morton et al. (1981) investigated the level of applicability of conventional theory and further suggested some modifications for a better estimation of settlement due to the draw-down. Morton finally opted that the use of recharge-well would be an effective measure to mitigate the effect from the groundwater draw-down.

Pre-grouting works before shaft excavation of a caisson was sometimes required for a site in urban area in order to reduce the effect of ground lost or excessive ground settlement due to the dewatering. Shirlaw (1987) discussed the choice of grout used for hand-dug caisson construction, and concluded his major finding in relation to the particle size of soil as shown on Figure 1.5.

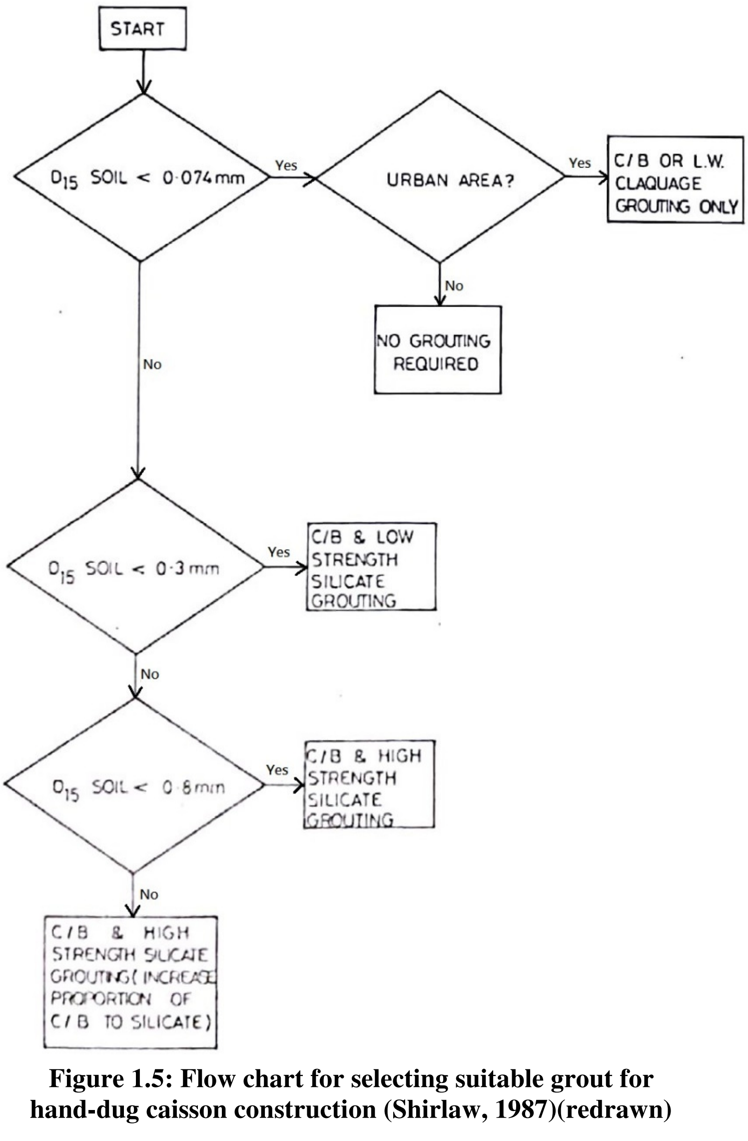


Figure 1.5: Flow chart for selecting suitable grout for hand-dug caisson construction (Shirlaw, 1987)(redrawn)

1.2.5 Previous Field Testing, Experiment or Monitoring conducted

Previous scholars have conducted some field testing or experiments to investigate actual behaviour or performance of hand-dug caisson in difficult aspects. For examples, Evans et al. (1982) field-examined the load settlement behaviour and the ratio of caisson capacity contributed between base and shaft resistance of three hand-dug caissons. Evans et al. used a series of rod type extensometers to measure the strain changes along the caisson so as to estimate the shaft resistance. Whilst, the researchers used a hand-operated probe to measure the base resistance. Evans et al. concluded that the shat resistance built up substantially at the beginning. The percentage of base resistance increased when the test load increased. Evans et al. also observed the correlation of E values to SPT-N values was about 1.3N for the Es (soil for the shaft resistance) and 2N for the Eb (soil for the base resistance) respectively.

Powell et al. (1988) conducted field measurements to realize the skin friction provided by soil and rock layer of hand-dug caissons. Powell et al. installed vibrating wire strain gauges on the reinforcing bars of the caisson to complete the measurement and the researchers observed that the skin friction for different materials was in Table 1.4. Powell et al. also found that the contribution of end bearing capacity of the caisson is rather small, typically ranging from one-tenth to one-seventh of the test load.

Table 1.4: Measured Skin Friction from Soil or Rock Material (Powell et al, 1988)

Soil		**Rock**	
Grade V	**Grade IV**	**Grade III**	**Grade II**
0 kPa	250 kPa	400 kPa	400 kPa

Ho and Mak (2001) also used vibrating wire strain gauges to perform a long-term monitoring to a 12m high rock-socketed caisson wall built in 1988. The long-term monitoring commenced at the beginning of the construction stage of the caisson wall and extended for more than 2 years after the construction completed. The purpose of the long-term monitoring was to evaluate the actual behaviour of the wall under working load condition and to verify the design assumptions. Ho and Mak finally established a correlation of 1.2 between the E-value of soil and the SPT-N value.

Choy et al. (2007) discussed that pneumatic drilling test was sometimes used for verifying the quality of the bearing stratum of a hand-dug caisson. The procedure was to use a pneumatic hammer to record the rate of penetrating the bearing stratum for 4.5m depth. The integrity of the bearing stratum could then be verified by calibrating the rate of penetration.

Observing from the above literatures, on-site testing or experiment were somehow common and useful for research work related hand-dug caisson. This application of on-site testing/experiment is under consideration of the researcher when developing the research framework. Further discussion about the method of this research is presented in Chapter 3 and Chapter 4.4.

1.3 Excavation of a Caisson Shaft performed by Robotic Method

With reference to the literatures (HKIE 1981, Mak 1993, GEO 2006) and Figure 1.2a~1.2c, the method of constructing a caisson involves a manual-digging operation to create a cylindrical shaft from the ground level down the required founding level. It is further elaborated that the digging is not in one-goal but segment by segment. A segmental concrete lining is cast to retain the sub-soil, i.e. the exposed soil of the vertical cutting face, to be collapsed towards the shaft centre in the progress of segmental digging.

The author is one of the members of a research team who proposing and aiming to prototype a robotic excavator being able to perform excavation task of a caisson shaft. The robotic system has been designed and manufactured by modifying a conventional excavator by the research team.

Although the prototyped excavator transforming the digging task from manual to robotic method is able to alleviate original dangerous level on workers, the risk of the shaft collapse is still a potential hazard. The author is therefore motivated to study the feasibility of predicting hazardous level originated from the potential collapse of the partially unsupported surface in the progress of caisson shaft excavation. The author also intends to check and verify the outcome after his study of predicting the FOS against collapse from the partially unsupported shaft. These intention resulted in the problem statement, research aim and research objectives presented in the following sub-chapters.

1.3.1 Discussion on currently existing excavation method comparing to robotic-dug method (also hand-dug method)

The shaft of a large-diameter concrete pile was usually formed by using the hand-dug method from 1970s to late of 1980s. Bored-pile excavation method became more popular from early of 1990s, and also up-to-date, when the hand-dug method was about to be restricted by the Government departments from mid of 1990s. The bored-pile method certainly owns advantages, such as higher productivity for a single shaft excavation, greater capability for much deeper shaft excavation (e.g. more than 75m deep) and less hazards to construction workers, outperforming than the hand-dug method. Nevertheless, the bored-pile method is less-competitive than the hand-dug method (or robotic-dug method) for some situations in particular to construction site at hilly terrain or sloping ground.

An ex-caisson worker owning more than 30 years' experience of applying the hand-dug method was interviewed by the author. The content of the entire interview was appended in Appendix D of this Thesis. One of the most important information gathered from this interview was about the comparison between the bored-pile method and the hand-dug method at an initial base when Table 1.5 summarized the comparisons in terms of method/technology, cost, mobilization and time. The table is able to highlight the valuable strength/advantage of the hand-dug method (or robotic-dug method) comparing to the bored-pile method, that the research aim presented in the following chapter is probably substantiated and supported.

Table 1.5: Comparison between Bored-pile Method and Hand-dug Method according to previous caisson worker

Item	Bored-pile Method	Hand-dug Method (or Robotic-dug Method)
Method / Technology	Expensive and difficult for construction because of requiring heavy-duty machines together with experienced machine operators	Good, cheap and easier because of requiring less construction resource
Cost	High	Lower than the bored-pile method by; • 1/3 for a site of flat ground. • 1/7 for a site of sloping ground or hilly terrain.
Mobilization	Difficult	Much easier than the bored-pile method because no dismantling and reassembly of heavy-duty machine is required.
Time	Faster than the hand-dug method for a case of a single construction	Outperforming than the bored-pile method for more numbers of pile because of concurrent construction allowed

1.4 Problem Statement, Research Aim and Objectives

1.4.1 Problem Statement

Having realized the background, fundamental design principle, construction issue, equipment and resources, advantages and disadvantages, this traditional construction method of hand-dug caisson is classified as a valuable construction method and technique for construction industry, or foundation industry in particular (HKIE 1981, Mak 1993, GEO 2006, Choy 2007, etc.).

This construction method is especially beneficial and valuable to the construction industry (or foundation industry) for construction sites or development areas which have limited logistic assess for construction plant/equipment or hilly terrain unsuitable for heavy-duty machinery, such as Hong Kong. It is because this method requires minimal resources in terms of machinery and human as well as flexible mobilization.

The fatal disadvantage resulted from the use of this construction method is the irreversible impact on the workers' safety and health (CEDD 1994, BD 1993). This disadvantage causes a serious impact on the sustainability of this method. This disadvantage eventually resulted in a high restriction to the use of this method in Hong Kong since 1995.

If applying robotic technique to replace the manual tasks by workers inside the caisson shaft, such as soil digging, this fatal disadvantage is able to be alleviated, or even minimized. The use of this modified traditional method definitely provides an alternative to the choice of construction method for some developments in Hong Kong. The further benefit from the re-use of this modified method is able to increase the competitiveness to the construction methods currently available in the industry in Hong Kong and finally achieving cost-saving to some developments.

1.4.2 Research Aim

This research aims to design and develop a new excavation method for caisson construction by prototyping a robotic system so that the original manual excavation procedure of a hand-dug caisson could be completed by the robotic system, and thus alleviating the hazardous level suffered by caisson workers, and eventually providing a safer and healthier working environment.

1.4.3 Research Objectives

The research objectives are outlined as follows;

1. To theoretically investigate the optimum depth or interval of each segmental excavation along the depth of caisson with respect to ranges of geometrical and geotechnical parameters, and so to predict the factor of safety (FOS) of a vertically excavated and partially-unsupported shaft in construction safety point of view.
2. To test and validate the optimum segmental depth or interval predicted by the above theoretical study by on-site monitoring or measurement of the soil stresses surrounding the excavated and partially-unsupported shaft.

1.4.4 Implication and Values

Caisson manually constructed is a traditional technique which owns advantages of cost-effectiveness, high capacity on overcoming complex geological condition and high flexibility catering for limited working space and logistic assess of a construction site, such as hilly or steep slope terrain.

The above advantages became on longer available from 1995 because departments of Hong Kong Government issued guidance notes to prohibit the use of this manually method of construction. The prohibition is due to serious impact on the workers' health and safety when they are working inside the caisson shaft.

Rapid advancement and introduction of robotic technology into construction industry was common in recent years. The use of robotic machinery is found possible to replace the excavation tasks traditionally carried out by human. The modified method with the adoption of robotics shall greatly reduce the hazardous level to the caisson workers in terms of health and safety since the workers are no longer required to enter the shaft to perform construction tasks. This is the main and the first contribution of this research undoubtedly.

The second contribution is expected to be a long-term implication to the foundation industry of Hong Kong because this modified construction method provides an alternative construction solution to some sites having limited working space and logistic assess with respect to the heavy-duty construction plant and equipment. The author would even expect that this contribution is able to increase the competitiveness among various construction methods and achieve cost-saving of a development eventually.

This research is also expected to provide academic contribution other than practical contribution to the construction industry. Throughout the completion of the research objectives, contributions to body of knowledge include empirical equations to determine the FOS of the optimum and safe excavation depth for each segmental excavation without shaft instability in relation to geometrical and geotechnical parameters about a caisson.

CHAPTER 2 LITERATURE REVIEW

The excavation is the first step of the entire caisson construction. The vertically excavated surface of the cylindrical shaft should be sufficiently stable so as to allow the next procession of casting the concrete lining. Visual examination on any signal of distress observed from the excavated surface would be performed in the past. This practice is certainly considered to be scientifically insufficient when there were chances of missing and causing a failure or shaft collapse resulting in damage of safety and economy eventually.

Since the visual examination lacked of scientific justification, the author intended a research for proposing a simple method for the interested/concerned person to predict a safe and/or optimum excavation depth/interval without relying on visual examination in the past.

2.1 Circular or Cylindrical Shaft

Numbers of literature related to circular or cylindrical shaft excavation have been firstly identified.

2.1.1 Lateral Earth Pressure & Arching Effect

Construction of a circular shaft is highly related to geotechnical behaviour of lateral earth pressure and arching effect, because the shaft to be vertically excavated created an underground space/void which allows the sub-soil to be mobilized into the shaft. The allowance is an active displacement such that the sub-soil would impose pressure onto the shaft surface so called lateral earth pressure. However, the sub-soil would be self-retained due to the arching effect since the shaft is circular in shape. This geometry lead the sub-soil to be subject to a “compression” when the sub-soil mobilized towards the centre of the shaft.

In 2013, Kim (Kim et al, 2013) performed a study to investigate the effect of arching pressure on a vertical circular shaft. The most important research outcome from this literature was about a more significant arching effect occurring at deep excavation than that of shallow excavation. The researcher also found that the magnitude and distribution of the lateral earth pressure is not linearly increasing along the depth of excavation. Further to these outcomes, it was concluded that the lateral earth pressure imposed on the shaft at a deep location would be up to

80% smaller than the values estimated according to Rankine theory (Table 2.1). The observations from this literature provided crucial insight to the author that this phenomenon may be beneficial to the shaft excavation of a caisson when at a deep location is reached. In other words, the excavated shaft may be become less dangerous from collapse point of view since the arching effect is retaining the soil of the shaft.

Table 2.1: Summary of R_f values for vertical circular shaft (Kim et al, 2013)

Soil	Values	z/D				
		0.2	0.5	0.7	1	1.7
c-ϕ soil	Measured earth pressure (kPa)	18.16	24.26	19.80	13.71	10.89
	Rankine earth pressure (kPa)	21.09	375	45.7	51.56	70.31
	R_f (%)	13.89	35.31	56.67	73.41	84.5

While in 2014, Cho (Cho et al, 2015) conducted quite a similar study to that of Kim in 2013 and concluded a similar research outcome.

In 2017, Georgiannou (Georgiannou et al, 2017) investigated the stress distribution around the circular shaft according to the method of construction called "Underpin" method. This method involved a staged excavation and an installation of segmental ring throughout the construction process. The Underpin method is compared to own a high similarity to the sequence of caisson construction as described in Chapter 1. The researcher established a set of 2D FE models (of Axisymmetric) of PLAXIS to perform the analysis while a set of 3D FE models (by PLAXIS 3D) to validate the analyzed results from 2D models. The researcher, first of all, drew a conclusion that the computed outcome from both models were consistent from one another. Thereafter, the researcher observed that the highest values of hoop stress occurred at the deepest section of the shaft (Figure 2.1). The author's attention was drawn to clarify if this observation may be inter-related to the finding from Kim (Kim et al, 2013) or Cho (Cho et al, 2014) about the lateral earth pressure distribution along the depth of the shaft.

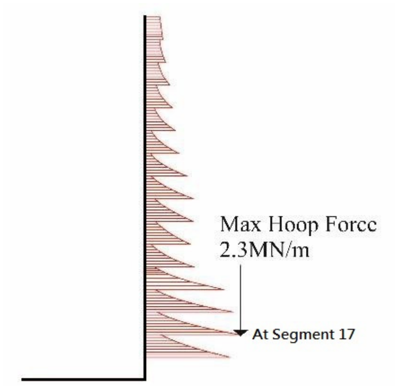


Figure 2.1: Distribution of 'hoop forces' along segments; stage 17 (Georgiannou et al, 2017)(redrawn)

In 2019, Chehadeh (Chehadeh et al, 2019) performed another kind of study, by using 3D non-linear finite element analysis approach, to particularly identify the magnitude and distribution of lateral earth pressure on the circular shaft induced by a surcharge loading on the ground. The researcher conducted a series of calculation and analysis to observe that the pressure distribution along the depth of the shaft was found to be different between the calculated values and theoretical. In particular, the researcher criticized that the calculated stresses were larger than the theoretical estimates at the large depth. The observation is crucial since this may show the discrepancy of the past theory regarding the underestimation of the lateral stresses at the large depth. The author reckons from this literature that the research direction may not be highly related to the research objectives but this shows that the generality and applicability of using FE software to study geotechnical problem and compute reliable results for practical use.

2.1.2 Stability or Construction Issue of Circular Shaft

Circular shaft inevitably involves the stability and construction issues. They were studied by previous scholars because of the reasons of cost/design-effectiveness or safety concern from research as well as practical point of view.

Goh (2017) investigated the basal heave behaviour/stability issue of supported circular shaft of clay soil. Goh used PLAXIS's axisymmetric model to study the basal heave characteristic of clay soil under cylindrical excavation with or without wall embedment. The researcher has shown in his paper the relationship among the basal heave factor of safety, the undrained shear strength of the clay, the geometrical properties of the excavation as well as the thickness of the clay layer. The researcher finally proposed a simplified method of using charts and equations to assess the basal heave factor of safety for an axisymmetric supported excavation in clay soil (Figure 2.2). This study has also highlighted the use of reduced strength parameter as the approach to calculate critical strength reduction value which is also considered as the shaft basal heave factor of safety FS_{FE}. This method of reducing strength parameter is also applicable for the research study by the author since the author is also investigating the strength reduction value meaning for a new equilibrium stage for a reduced soil strength. However, the study by Goh (2017) is with respect to basal heave failure rather than unsupported or partially-supported shaft as per author's research focus.

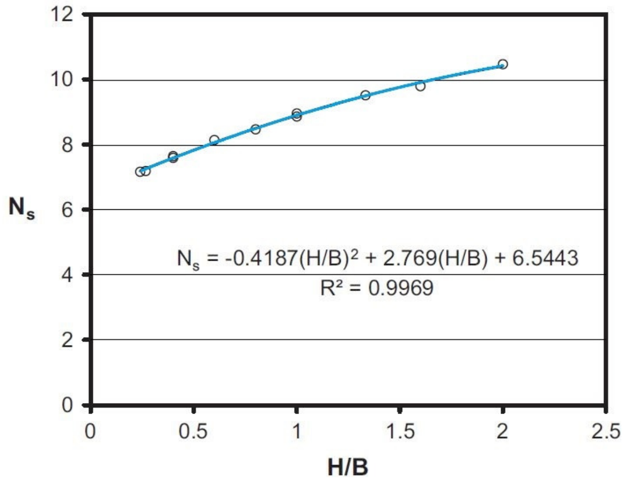


Figure 2.2: Stability Number Ns (Goh, 2017)(redrawn)

Faustin (Faustin et al, 2018) referred to the limited data available from real-life construction project of 27 nos. of circular shaft built in London. The researcher categorized all 27 projects data into 2 groups, which were "support before excavation ~ SBE" and "excavation before support ~ EBS". The researcher firstly observed that settlement induced by the shaft excavation activities was highly related to the construction method, i.e. SEB or EBS. The researcher also concluded that the settlements during shaft construction stage were much more obvious for EBS method than the SBE method. The researcher's second observation was that insignificant concern to the ground settlement was to be expected for the case where SBE method was adopted in a stiff ground. The researcher finally concluded that the size of the shaft was an important influence parameter related to the magnitude of the ground movement. The author critically observed from this literature that the EBS method is rather similar to the construction sequence of what caisson construction. Also, the author was remarked that the size of the shaft, i.e. similar to the diameter of a caisson in other words, would be a critical factor affecting the research outcome.

Le (Le et al, 2019) has referred from previous published case studies from 1980 to 2016 about circular shaft construction in order to provide a clearer insight to the surface and sub-surface soil displacement induced by circular shaft construction. The researcher retrieved the data of the surface soil displacement from these case studies reported while performing a centrifuge test to investigate the relationship. The researcher finally found a good agreement between the field data and the centrifuge test results with an example (Figure 2.3) and formulated two novel empirical equations below;

$$\frac{S_v^{dz}}{S_{vmax}^d} = 1.15 - \frac{0.15}{1 - \frac{z}{H}} \tag{1}$$

$$\frac{S_h^{dz}}{S_{hmax}^d} = \exp\left[-\left(\frac{\frac{z}{H} - a}{b}\right)^2\right] \tag{2}$$

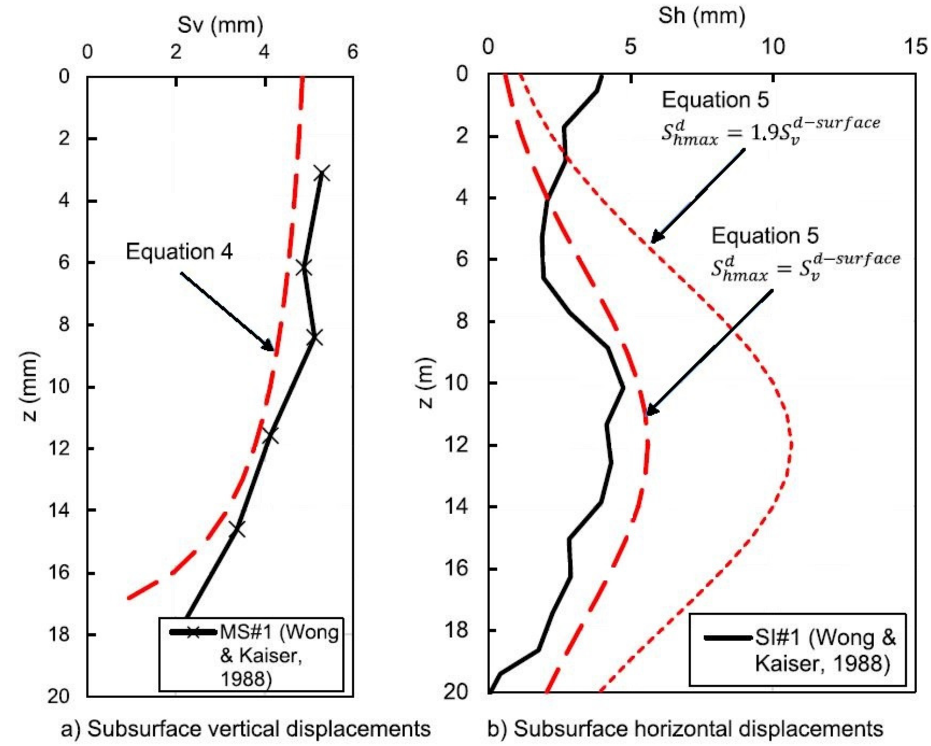


Figure 2.3: Comparison of subsurface soil displacement in Wong & Kaiser (1988) and back analysis using Eqs (1) & (2) (Le et al, 2019)(redrawn)

The author is enlightened from this research paper that the author envisioned to develop similar kind of design charts for his research questions. Establishment of empirical equations may also be considered to be feasible and applicable.

Zhao (Zhao et al 2020) conducted a full-scale field test and numerical analysis to analyses the base failure of a circular shaft with confined groundwater. The researcher adopted finite element software to simulate the process of step-by-step excavation of shaft and layer-by-layer assembly of pre-stressed structure. Full-scale test was then performed at the shaft to monitor the change of groundwater at the base of the shaft, any water inrush as well as the stability of the base. This research methodology is considered to be highly applicable for the research objectives from the author. Zhao (Zhao et al 2020) drew conclusion from his research;

1. Finite element software is able to provide a good agreement about with the phenomena observed from full-scale test for a geotechnical problem.
2. Size effect of the shaft dominant and contributes much to the anti-inrushing stability.
3. The soil strength contributes to resisting hydraulic uplift, but the downward shear strength along the soil-wall interface should be partially considered in the theoretical calculation according to the degree of the distribution of the soil.

Zhang (Zhang et al 2021) referred to Goh (2017) to conduct a further probabilistic analysis to review the basal heave safety factor. Zhang adopted three different methods for the probabilistic analysis, including Polynomial Chaos Kriging, Monte-Carlo Simulation and Global sensitivity analysis. Zhang observed from these three analysis that the coefficient of variation, soil-wall adhesion factor and soil non-homogeneity coefficient have remarkable influence on the circular shaft stability. The author considered and envisioned from the study of Zhang that a probabilistic analysis to the developed design charts may be another future research direction of research gap identified.

In view of the above literatures, a research gap is identified as the above studies are only with respect to the circular shaft which is fully supported by vertical element or retaining structures (such as concrete rings, diaphragm wall, steel sheet pile, etc.) instead of the excavation being partially supported due to the method of construction.

2.1.3 Unsupported Vertical Circular or Conical Excavation

Numbers of researchers have performed study regarding the stability of unsupported vertical circular excavation or conical excavation since 1980s. The researches focused on the stability number of the vertical excavation with respect to (i) various kind of soil type, such as cohesive soil such as clay, non-cohesive soil, under either drained or undrained condition, or (ii) ratio of height to radius of the excavation (H/b). The following are somehow more recent researches reviewed.

Khatri and Kumar (2010) found that the previous literatures have not covered the consideration of linear increase of cohesion under undrained condition when determining the stability numbers of the unsupported circular excavation of clay soil. The researcher therefore performed a study to determine the stability numbers ($\gamma H / c_o$) with due consideration of increase of cohesion of clay soil along the depth of excavation by introducing “m” which is a dimensionless parameter accounting for the rate of the increase of cohesion with depth. The researcher adopted finite element limit analysis as the computational approach. The final research outcome by the researcher was about the linear increase of stability numbers with respect to the increase of H/b and the cohesion increased with depth. The researcher finally counter-compared his outcome to previous literatures and found reasonable agreement.

Kumar and Chakraborty (2012) conducted a very similar study with reference to Khatri and Kumar (2010) but for c- γ soil.

Kumar (Kumar et al, 2014) further summarized the research findings based on Khatri and Kumar (2010) and Kumar & Chakraborty (2012) and concluded a reasonable agreement between the findings and previous literatures. The researcher extra investigated and observed that the movement of the soil mass was generally vertically downward and laterally towards the axis of the axisymmetric FE model in view of the nodal velocity pattern (Figure 2.4).

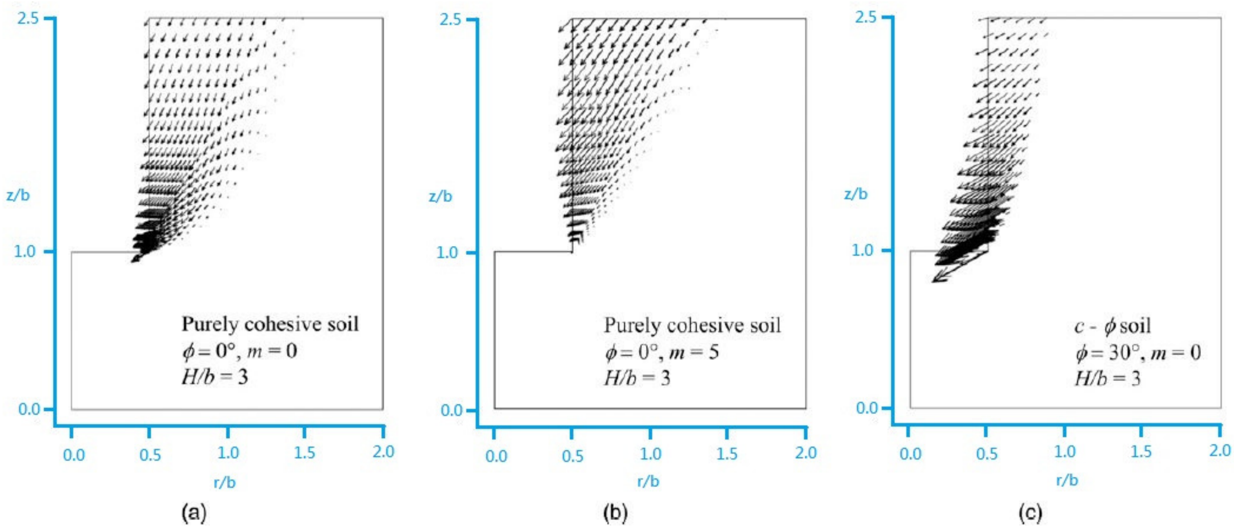
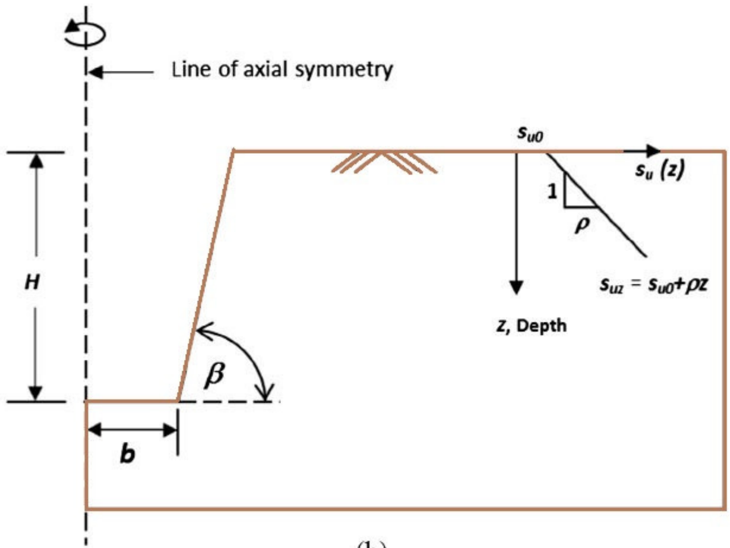


Figure 2.4: Nodal Velocity Patterns for H/b=3 in (a) purely cohesive soil with m=0; (b) purely cohesive soil with m=5; (c) cohesive-frictional soil with ϕ=30^o (Kumar et al, 2014)(redrawn)

Keawsawasvong (2017) conducted a theoretical study relating to stability issue of unsupported conical excavation performed in homogeneous or non-homogeneous clay soil. The researcher has taken three parameters including excavated height ratios, slope inclinations and dimensionless strength gradients of soil into account for formulating a relationship among the parameters. Figure 2.5a illustrated the research question by the researcher. The researcher has adopted OptimG2 as the finite element software to resolve his research questions. The researcher has finally formulated graphs showing the relationship among the parameters (Figure 2.5b). However, this study by Keawsawasvong (2017) has not involved any practical test as a validation. This study focused on unsupported shaft which somehow highly related to the author's study. However, Keawsawasvong's study only focused on single excavation process rather than a progressive excavation process as characterized from caisson shaft construction.



(b)

Figure2.5a: Problem Notation of an Unsupported Conical Excavation (Keawsawasvong, 2017)(redrawn)

2.1.4 Soil Model available for Finite Element Analysis

Literatures related to soil model used in finite element model have also been reviewed by the author. Soil models commonly adopted in finite element software, such as PLAXIS include;

1. Mohr-Coulomb (MC) Model (Figure 2.6)
2. Hardening Soil (HS) Model (Figure 2.7)
3. Hardening Soil Small Strain (HSS) Model

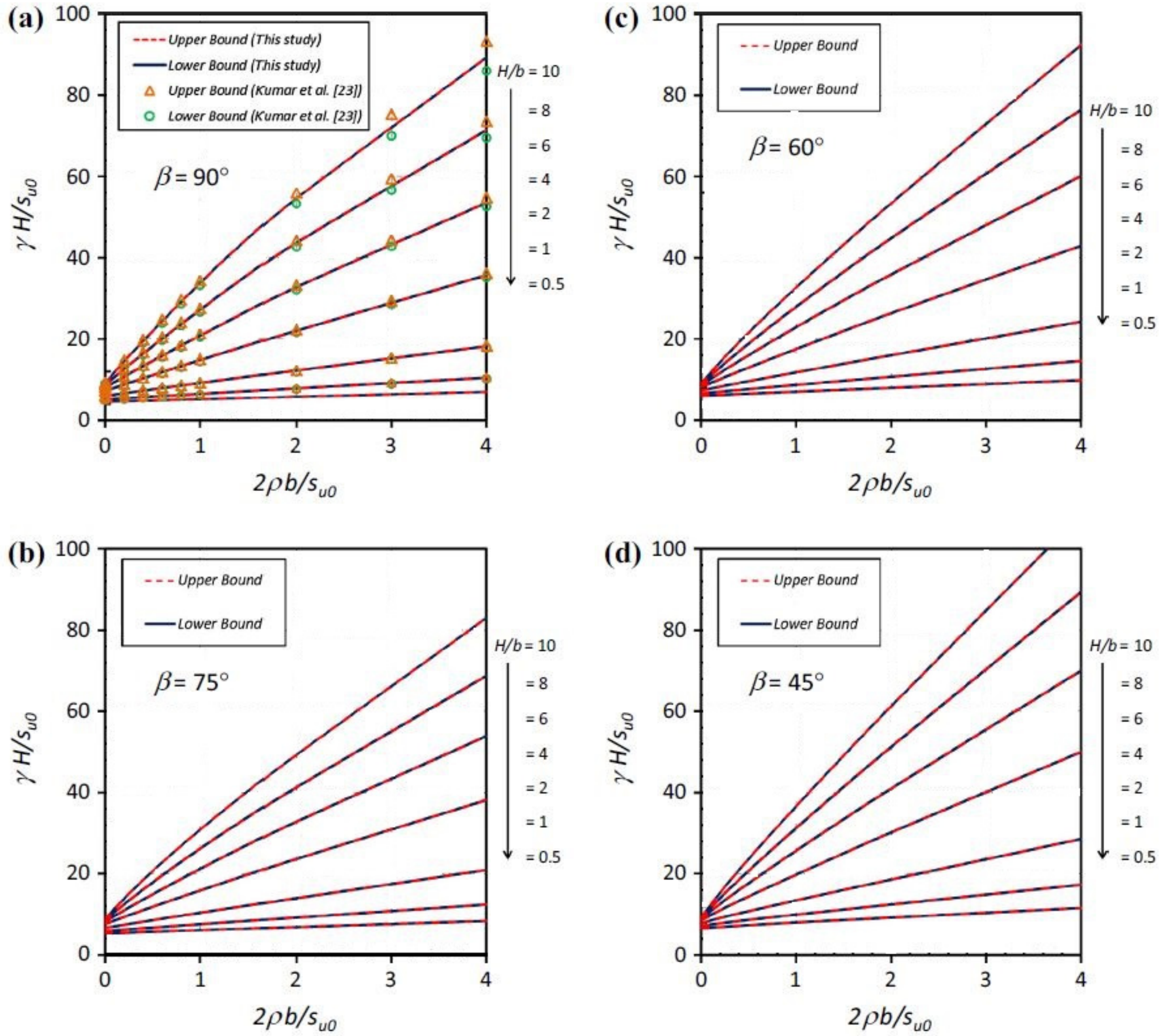


Figure 2.5b: Relationship between the stability factor and excavated height ratio at conical slope (β) values of (a) 90º, (b) 75º, (c) 60º and (d) 45º (Keawsawasvong, 2017)(redrawn)

Previous scholars (Gouw, 2014; Hsiung and Dao, 2014, Gaur and Sahay 2017) briefly discussed applicability of these models. MC Model is the simplest model and familiar by global practicing engineers. MC model formed the non-linear behaviour of the soil into two bilinear lines as shown in Figure 2.6. Gouw (2014) critically reviewed that MC Model is unlikely applicable for geotechnical problem involving unloading and reloading. The soil loading stiffness is constant according to MC model while the unloading-reloading stiffness can be easily higher than the loading stiffness by a factor of 2 to 5. The characteristic results that MC Model will normally give an over-predicted soil heaving movement and even unrealistic value sometimes.

Hardening soil model was developed with reference to the non-linear stress-strain behaviour by hyperbolic model developed by Duncan & Chang, 1970. The formulation of the model is illustrated in Figure 2.7. This formulated characteristic is able to automatically cater for soil stiffness for isotropic loading, shearing and unloading-reloading scenario. HS model is therefore able to predict a more realistic wall deformations, bottom heave, and settlement behind the wall during the excavation process (Gouw, 2014).

HSS model is an improved versions of HS model (Guow, 2014). HSS model can even cater for far field small strain behaviour. This enables HSS model to predict a more representative settlement values or behaviour behind the retaining wall, especially for a comparatively narrower or deeper shaft.

The author consolidated the above discussion about various soil model available in finite element software and eventually adopt HSS model for his formulation of simulation model for his research question.

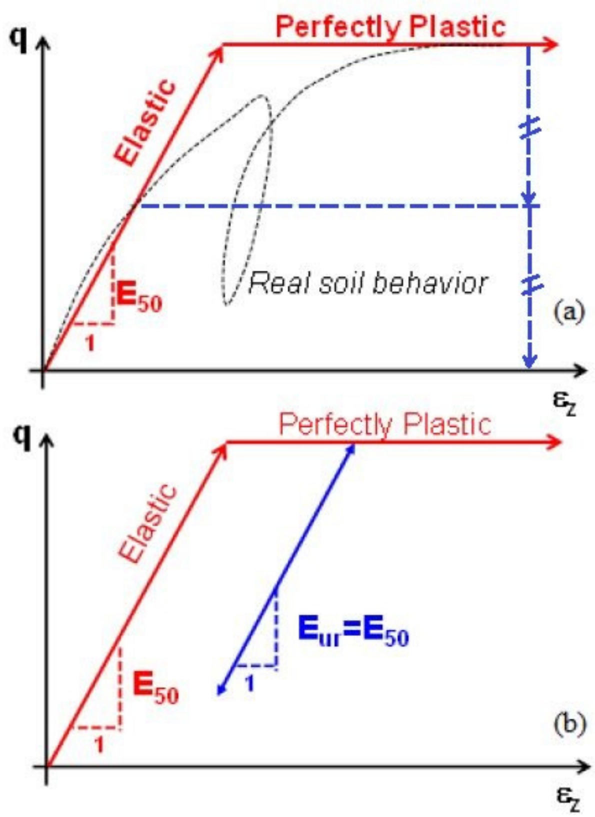


Figure 2.6: Mohr-Coulomb Model (Gouw, 2014)(redrawn)

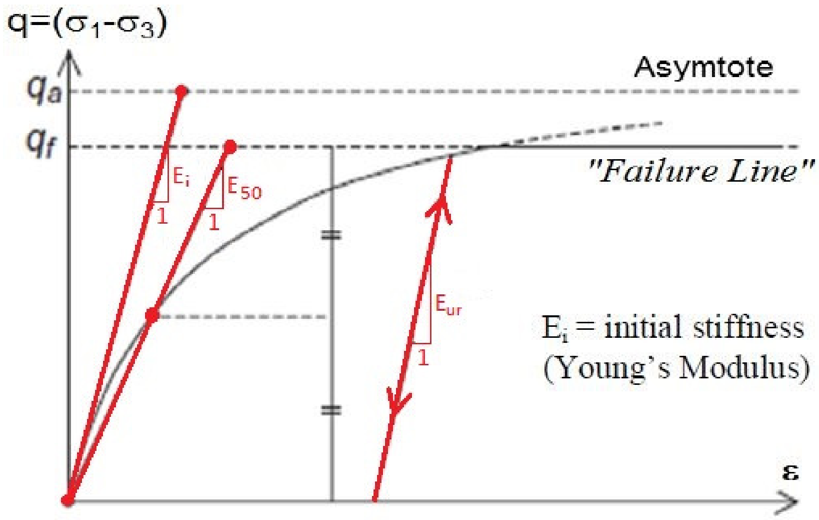


Figure 2.7: Formulation of Hardening Soil Model (Gouw, 2014)(redrawn)

2.2 Summary and Research Gap

The literatures discussed above have been reviewed to be relating to circular shaft under various aspects including ~ lateral earth pressure, construction or stability issue, unsupported vertical excavation, etc. However, limited studies have been identified to be regarding as assessment of factor of safety (FOS) of a vertically excavated and partially unsupported circular shaft especially in the progress of shaft excavation according to the method of construction of caisson. Table 2.2 summarized the focus of the literatures and identification of the research gap.

Therefore, the current research gap is identified as an insufficient study related to the prediction of stability numbers or FOS of a vertically excavated and partially unsupported circular shaft during the construction of a caisson according to the construction method for a hand-dug caisson.

Given this context, this research aim is recapped as to conduct a theoretical investigation to the optimum depth or interval of each segmental excavation along the depth of caisson with respect to ranges of geometrical and geotechnical parameters, and so to predict the FOS of a vertically excavated and partially unsupported circular shaft in construction safety point of view.

Table 2.2: Summary of Literatures and Identification of Research Gap

Subject	Focus related to this Study	Identification from the Focus and Implication to this Study	Research Gap Identified
<u>Chapter 2.1.1</u> Lateral Earth Pressure & Arching Effect	The behaviour or distribution of lateral earth pressure on a vertical circular shaft.	Understanding of the use and applicability of Finite Element analysis for studying geotechnical problems	According to the identifications and implication observed, the research gap is therefore identified as: To carry out a research to predict the stability numbers or factor of safety for a progressively vertically excavated and partially unsupported circular shaft during the construction of a caisson by using finite element and regression analysis approach.
	The effect of arching effect to the soil body due to the excavation in shape of circular.		
<u>Chapter 2.1.2</u> Stability of Construction Issue of Circular Shaft	Understanding of the possible stability issue from the construction of circular shaft, including basal heave or settlement of surrounding ground due to excavation of the shaft.	Understanding possible research outcome, such as empirical design charts, regression equations that previous researchers like to establish.	
		Understanding to the use of site measurement or testing as the validation approach to the developed design charts or regression equations.	
<u>Chapter 2.1.3</u> Unsupported Vertical Circular or Conical Excavation	The scope of study related to estimation of stability level of a vertically unsupported circular or conical excavation.	Coverage and limitation of the previous studies regarding the estimation to the stability level of to a vertically unsupported circular or conical excavation.	
	The approach or method for studying stability issue of a vertically unsupported circular or conical excavation.	Understanding of the use and applicability of Finite Element analysis for studying geotechnical problems	
<u>Chapter 2.1.4</u> Soil Model available for Finite Element Analysis	Understanding to the currently available soil models adopted by previous researchers.	Selection of the most suitable soil model for Finite Element analysis of this study	
	Understanding the pros and cons as well as applicability and limitation of various soil models.		

CHAPTER 3 RESEARCH METHODOLOGY

While the discussed literatures primarily addressed shafts that are either fully supported or unsupported, there is a significant gap regarding the study of partially supported shafts. This absence of research motivated the author to conduct a new study focused on developing design methodologies that assess the stability of partially supported shafts, particularly those arising from the caisson construction process. The author aimed to create a systematic design method that not only justifies the stability of these shafts but also predicts FOS against potential hazard from shaft collapse during excavation activities.

The focus of this chapter is to introduce and elaborate the research method adopted and associated procedure in this study. Figure 3.1 illustrates the flow chart of the research methodology.

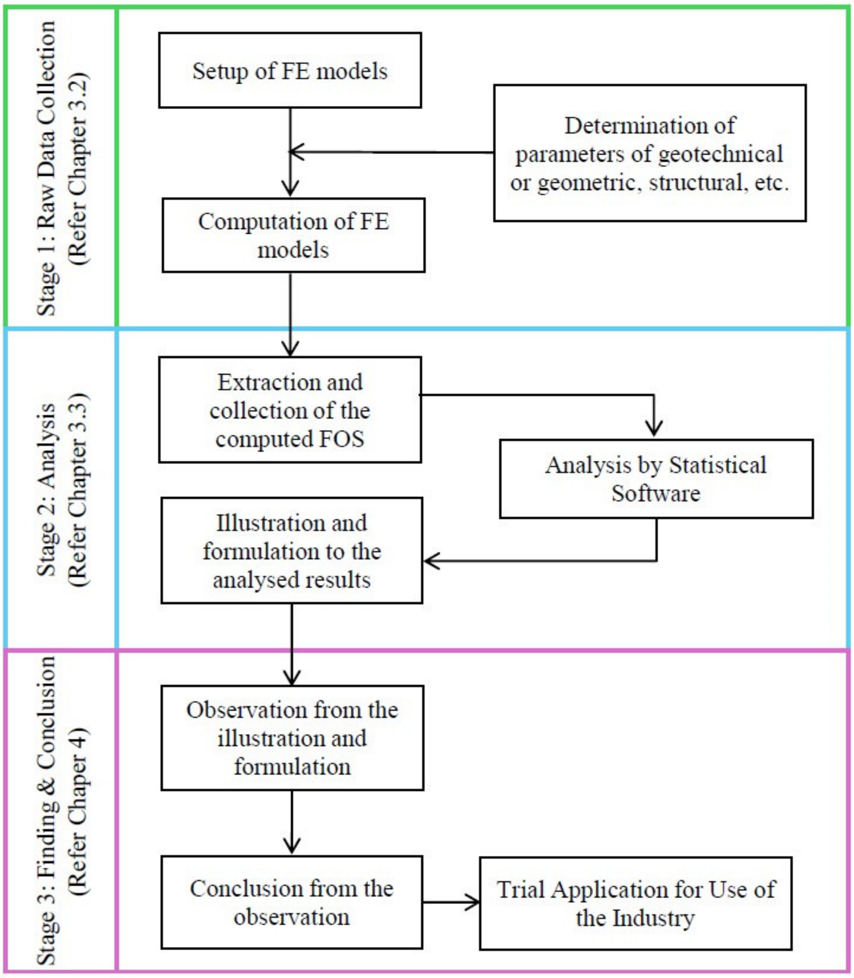


Figure 3.1: Flow Chart of Research Methodology

3.1 Adoption of Finite Element Method plus Validation by Field Measurement

The majority of scholars employed numerical simulations using the Finite Element Method (FEM) to explore their research objectives as observed from the literatures mentioned in Chapter 2. The adoption of FEM allows for a detailed analysis of complex structures and behaviors under various conditions. Some researchers also considered to supplement their simulations with field measurements or full-scale tests so as to provide a critical validation of their simulated results. This combination of methods enhances the credibility and robustness of their findings, ensuring that theoretical models align closely with real-world conditions.

The author reviewed the above research scenarios and eventually assessed that this research approach by adopting FE modelling is suitable and applicable to achieve the research objective of this study and this approach was so adopted.

In addition to the theoretical aspects of those researches, previous scholars have often emphasized the importance of validating their findings through on-site measurements and testing. This practice not only reinforces their conclusions but also provides practical insights that theoretical models alone may overlook.

In line with this practice, the author also intended to conduct field testing or measurement to validate the adequacy of the outcome established from the findings. This process will involve field data collection and measurement activities on-site, serving as a critical validation step for the theoretical results. By integrating both theoretical and empirical approaches, the author is allowed to strengthen the established outcome to produce a well-rounded study related to the understanding of partially supported shaft stability in caisson construction.

3.2 FE Model ~ Procedure and Scope of Analysis

PLAXIS and OptumG2 are widely recognized finite element software programs for addressing a variety of challenges in geotechnical engineering. Numerous scholars have favored the use of axisymmetric models to analyze the behavior of circular shafts due to their efficiency, accuracy, and simplicity (Goh, 2017; Keawsawasvong, 2017; Le et al., 2019; Zhao et al., 2020). The author eventually selected the use of axisymmetric model within PLAXIS (version V22) for finite element simulation.

It is essential to first gather comprehensive baseline data related to soil properties and geotechnical engineering principles in order to effectively establish and formulate these finite element models. This foundational data is systematically presented in Table 3.1 and illustrated in Figure 3.2. The parameters listed in Table 3.1 are all compulsory information for the execution of the Finite Element software. The compulsory information is classified into 3 groups which are about soil (i.e. geotechnical), geometry and concrete lining. The cohesion and friction angle of soil are in range as on Table 3.2. The unit weight, elastic modulus and poison ratio are of typical value suggested in previous literatures (GEO 1982). Soil model is also identified and set at Hardening Soil – Small Strain (HSS) as discussed in Chapter 2.1.4. Parameters categorized into Geometry are also in range, in which Chapter 4 and Figure 4.1 have discussed with. Whilst, Figure 3.2 is the illustration defining these components in graphs in relation to the parameters of Table 3.1. Homogenous soil condition without consideration of increase of shear strength parameters along the depth of the soil body is modelled in this study.

Among the various parameters, the shear strength characteristics of the soil are particularly critical, as they may significantly influence the outcomes of the simulations. Shear strength parameters can vary considerably between different soil types and geographic/geological locations, fundamentally determining the stability of the soil body against shear failure (CRAIG, 1974). Table 3.2 provides typical shear strength parameters for soils in Hong Kong, specifically detailing cohesion (c value) and friction angle (ϕ angle) as reported by GEO (1982).

Figure 3.2 has also shown the boundary condition of the FE model. The vertical boundary at the right hand side of the circular shaft was set at least 6 times of the radius (Dia./2) of the shaft, while this boundary was configured to allow the vertical movement but not for horizontal direction. This configuration was to simulate the situation where the soil surrounding the shaft is allowed to settle during the excavation in progress. The horizontal boundary at the bottom of the FE model was set at the depth extending by 1.0H from the base of the shaft (i.e. at 30m deep). This boundary was configured as fixed in both horizontal and vertical direction so as to simulate the behaviour of a relatively stiff layer of soil strata.

Certain assumptions were also made, other than the boundary condition, for the success of the execution of FE models, including that;

1. Elastic modulus and Poisson ratio of the soil are a constant for the homogeneous soil in the model.
2. The soil is assumed as "dry" when the groundwater level is assumed to be lower than the base of the shaft excavated.
3. Despite of the above, the drain condition in the FE model is set as "drained" to suit the real-world situation because the groundwater if encountered during the excavation is to be pumped out from the shaft.
4. The concrete lining is assumed to be 75mm thick minimum according to the previous practice about the hand-dug caisson from the literatures retrieved.

The completed input of geotechnical parameters into PLAXIS is thereafter documented in Figures 3.3a through 3.3d, providing a clear overview of the parameters utilized in the simulations. Figure 3.3a mainly shows the input of parameters of soil including soil model, drain condition and unit weight, and while Figure 3.3b shows the input of elastic modules, poison ration cohesion and friction angle.

Figures 3.4a through 3.4k depict the schematic cross-sections of the shaft, illustrating various stages of partial support during caisson shaft excavation. This series of figures is with respect to the case of 2.0m diameter caisson shaft excavation in a 15m overall depth with segmental excavation interval at 3m each. The most important attention drawn from this series of figures is about the demonstration of the progressive excavation from ground level, i.e. segmental excavation, and then followed by the installation of the partial support of concrete lining to the shaft. The overall depth is set as 15m with a segmental interval of 3m each, so five excavation cycles are required to be modelled to complete the FS model as shown from the figures.

The progression of excavation as illustrated poses potential hazards associated with shaft collapse, particularly once excavation activities have been finished but the concrete lining has not been completely cast. Such failures represent significant safety concerns as highlighted in Chapter 1. To cross-reference to Chapter 1, the excavation tasks could be either performed by manual method in an original/traditional manner or by robotic system anticipated by the author and the research team. However, FE models are not required to be specifically configured to cater for the method of excavation because this is independent from FE modelling. Alternatively, the FE models can perform satisfactory/adequate analysis for both hand-dug method and robotic-dug method.

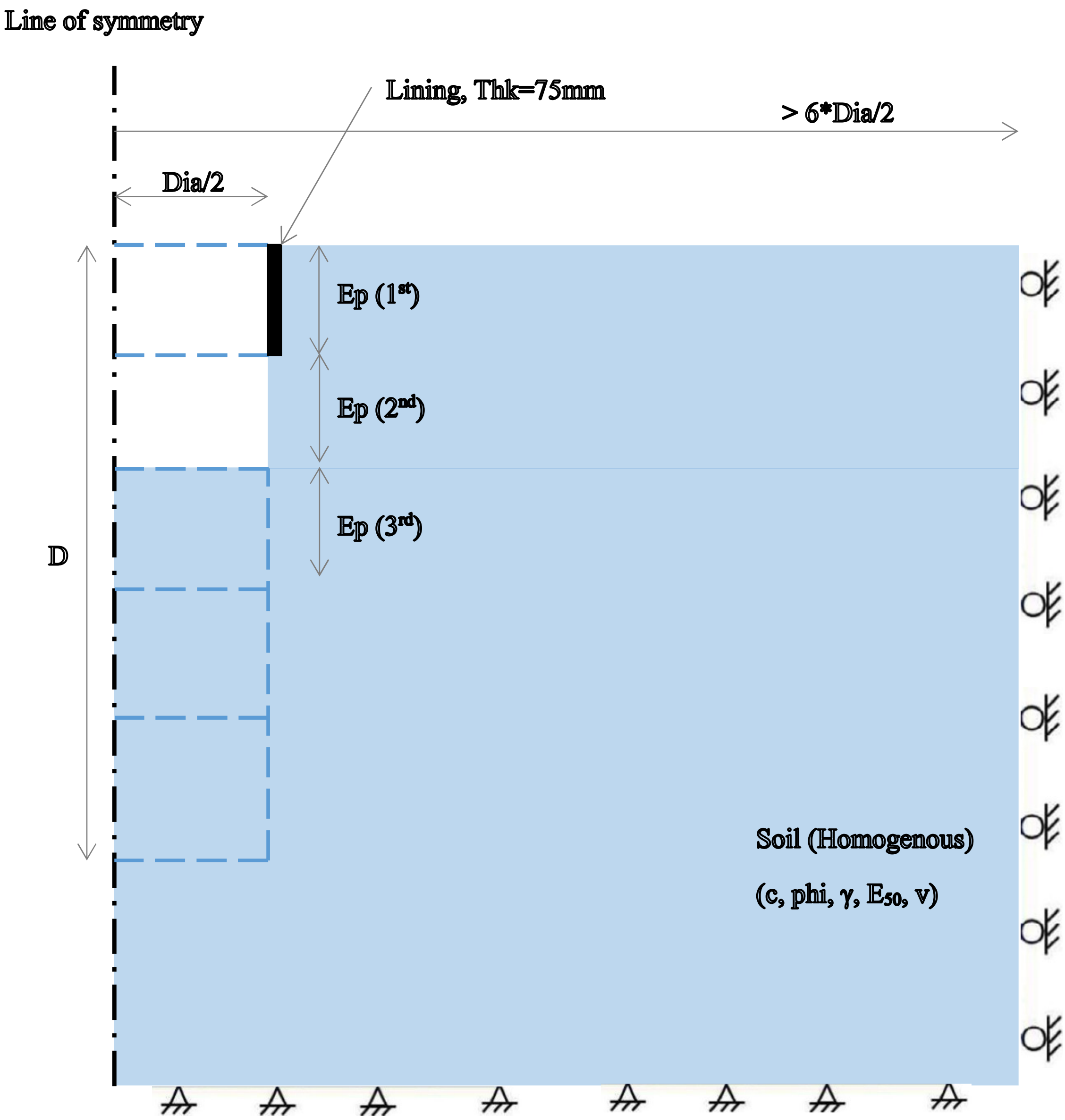


Figure 3.2: Illustration of Soil Model for PLAXIS

Table 3.1: Summary of Parameters or Properties of Soil, Lining and Geotechnics

Group	Parameter	Symbol & Unit	Range of Value
Soil	Cohesion	c , kPa	2 ~ 5
	Friction Angle	ϕ , degree	33° ~ 39°
	Unit Weight	γ , kN/m^3	19
	Elastic Modulus	$E_{50'ref}$, MPa	20000
	Poisson ratio	v	0.2
	Model	----	Hardening Soil (small strain)
	Drain Condition	----	Drained
Geometry	Diameter	Dia , m	1.5, 2.0, 2.5, 3.0
	Excavation Depth	Ep , m	1.0, 1.5, 2.0, 2.5, 3.0
	Overall Caisson Depth	D , m	1 ~ 15
Concrete Lining	Thickness	Thk , mm	75
	Stiffness	EI , KNm^2/2	780.5

Table 3.2: Typical Range of Shear Strength Parameters of Soil in Hong Kong (GEO 1982)

In-situ Soil	Bulk Unit Weight (kN/m3)	Dry Unit Weight (kN/m3)	Shear Strength Parameter	
			Φ (degree)	c (kPa)
Completely decomposed granites	16 ~ 21	14 ~ 19	35° ~ 44°	5 ~ 15
Completely decomposed volcanics	16 ~ 21	14 ~ 19	32° ~ 38°	5 ~ 10
Colluvium	15 ~ 21	13 ~ 19	26° ~ 40°	0 ~ 10

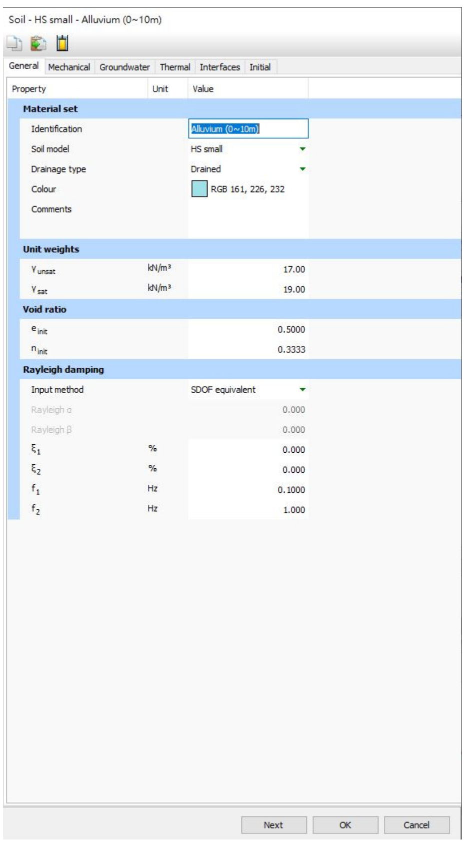


Figure 3.3a: Input Data in PLAXIS

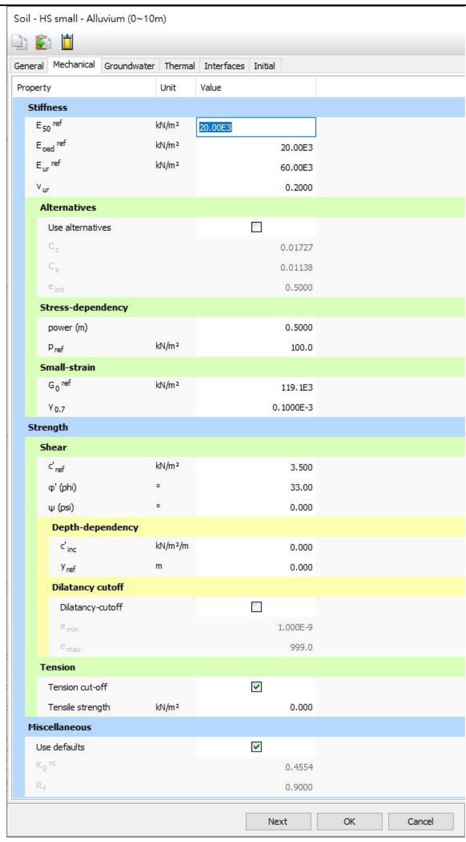


Figure 3.3b: Input Data in PLAXIS

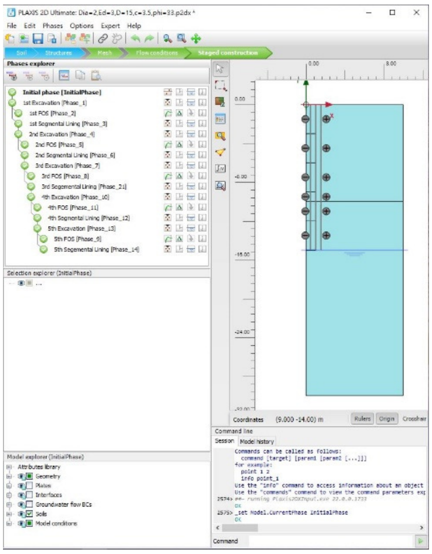


Figure 3.4a ~ Initial Stage

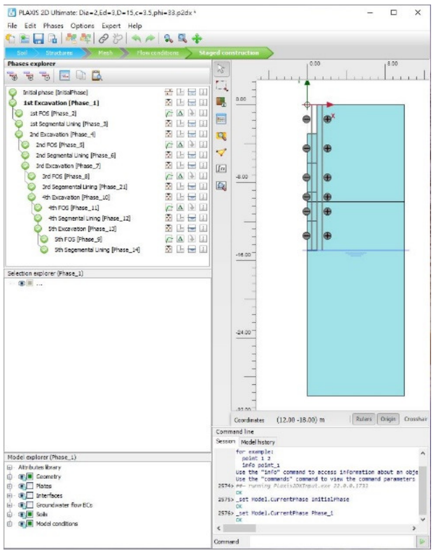


Figure 3.4b: 1st Excavation

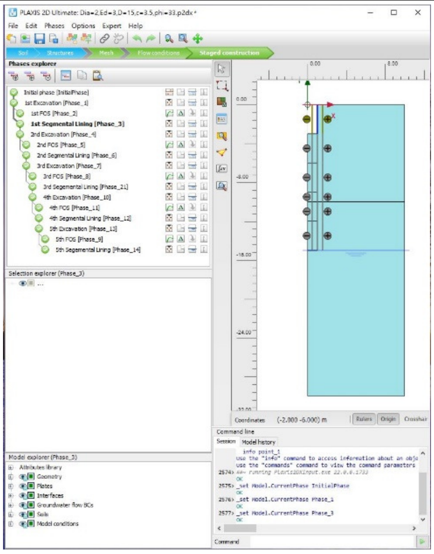


Figure 3.4c: 1st Layer of Lining Cast

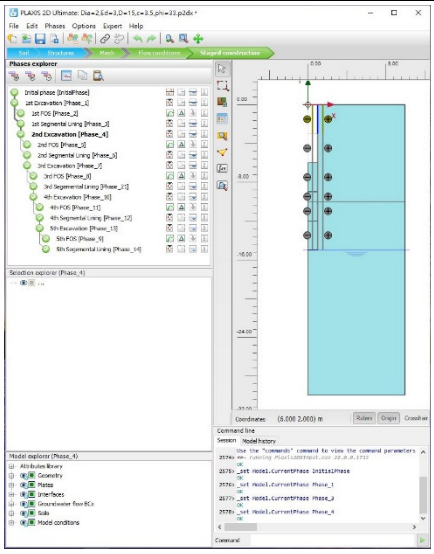


Figure 3.4d: 2nd Excavation

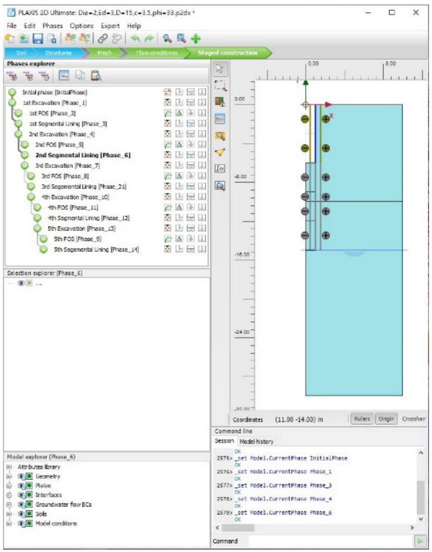


Figure 3.4e: 2nd Layer of Lining Cast

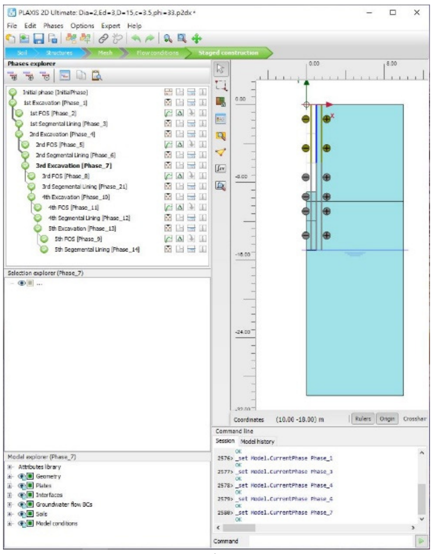


Figure 3.4f: 3rd Excavation

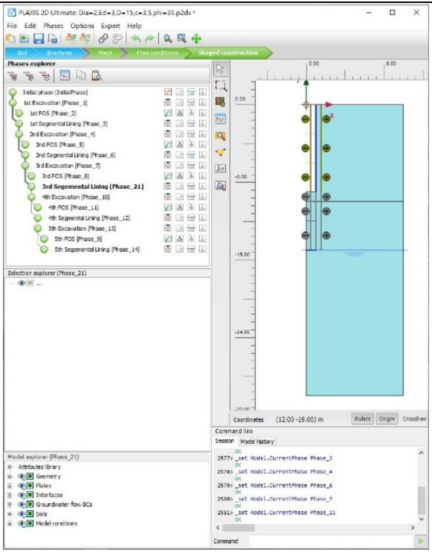


Figure 3.4g ~ 3rd Layer of Lining Cast

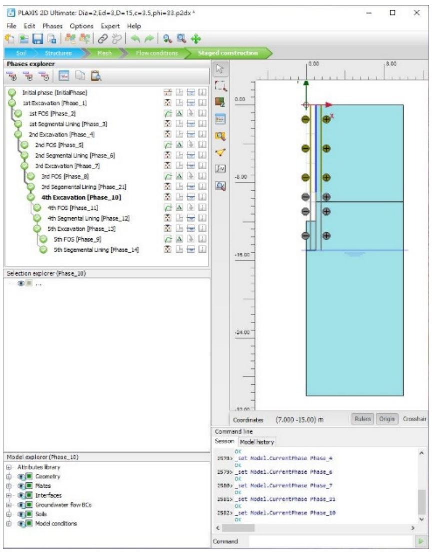


Figure 3.4h: 4th Excavation

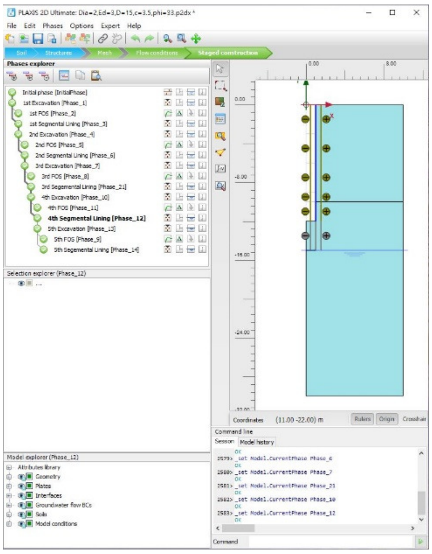


Figure 3.4i: 4th Layer of Lining Cast

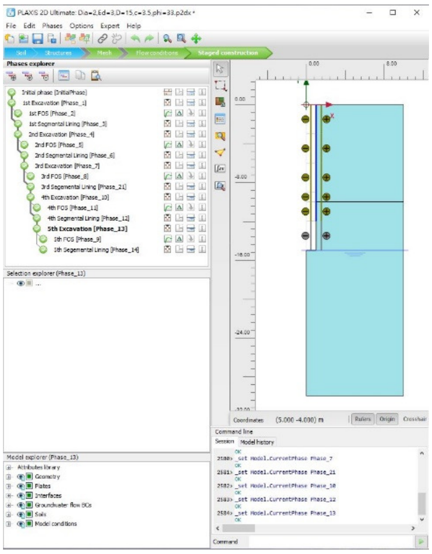


Figure 3.4j: 5th Excavation

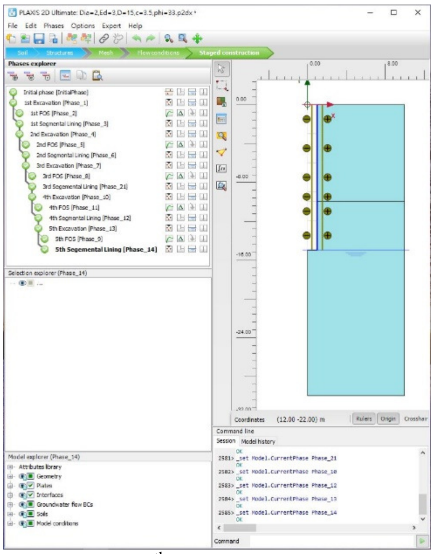


Figure 3.4k: 5th Layer of Lining Cast

By consolidating and integrating ranges of parameters mentioned in Table 3.1 and Table 3.2 complete with the overall depth of caisson and excavation interval to be studied, a combination of total 400 FE models is therefore concluded or created. This extensive modeling effort aims to encompass the typical range of shear strength parameters outlined and ultimately to develop empirical equations aligned with the research objective.

3.3 Further Analysis to the Results/Data from FE Models

After establishing the data set from 400 Nos. of FE models, the FOS values from data set were extracted to be further analyzed with statistic software MATLAB to visualize the variation/fluctuation of FOS in the progress of the excavation activities with respect to various factors including caisson diameter, depth of excavation in place, excavation interval, soil strength of cohesion and friction angle.

The author has a goal of observing a mathematical/empirical relationship between FOS vs Dia.+Depth+Ep+SF through regression analysis. The author then simplified the establishment by omitting the variable of Dia. (i.e. caisson diameter). The reason for the omission is because once the caisson diameter is fixed and the associated excavation is commenced, the value of diameter would become constant. Hence, one may want to know how the FOS varies along the depth of caisson in the progress of excavation. Therefore, the regression analysis becomes to determine the relationship between FOS vs Depth+Ep+SF.

The author also performed other observations to find out if any other individual relationship between FOS and variables such as;

$$FOS = f(Dia) \quad (3)$$

$$FOS = f(Ep) \quad (4)$$

$$FOS = f(SF) \quad (5)$$

The author reckons that the observation of the above individual relationship possibly facilitates the author to formulate the final mathematical equation, understand the most important variable, simplify the equation by omitting unnecessary variable if found and reduce formulation error.

CHAPTER 4 STUDY ON SAFE EXCAVATION DEPTH/INTERVAL

4.1 Overview of this Chapter

The chapter firstly outlined the setup and collection of raw data from the creation of FE models further to the methodology in Chapter 3, so as to investigate a safe excavation depth/interval in the progress of caisson shaft excavation. The content is then followed by presentation of the observed relationships between the predicted FOS and various factors/variables influenced from the aspects of geometric and geotechnics. The final discussion falls onto the development of empirical equations which aims for predicting progressive FOS of the unsupported shaft. The chapter is concluded by discussion of the validation of the developed equation with reference to on-site measurement/monitoring of a trial caisson shaft excavation.

4.2 Setup of Group of Finite Element Models

Finite element software, PLAXIS, was adopted in this study to simulate and estimate the values of FOS in the progress of the shaft excavation from the commencement down to the required depth with respect to various combinations of factors including caisson diameters, overall caisson depth, excavation interval and shear strength parameters of the soil to be dug. In view of the range of geometric factors and geotechnical parameters, the structures of the database of the raw data set of FOS were structured and shown in Figure 4.1.

The range of the variable of Cohesion (c) is from 2kPa to 5kPa with reference to Table 3.1. The range of Cohesion is then divided in a step of 1kPa. This division aims to balance between the minimum numbers of data obtained from FE software and the identifiability of the tendency of this variable. The Cohesion of 3.5kPa is a particular case suiting for the collected data from the real project, which is to be further elaborated in Chapter 4.4.

The range of the variable of Friction Angle (ϕ, phi) is from 33^{o} to 39^{o} with reference to Table 3.1. Similar to Cohesion, the range of Friction Angle is divided in a step of 2 degree, which is also to maintain the sufficiency of raw data computed from FE software and the ability to track the variation induced from this variable for forthcoming statistical analysis.

The caisson diameter (Dia.) is a value suiting for practical aspect of design and construction. The author selected 1.5m, 2.0m, 2.5m and 3.0m, which is the most popular and common size of caisson for construction in Hong Kong, being the variable of caisson diameter.

The excavation depth is a kind of variable managed or controlled by the construction team. The author had experience of caisson construction and finally proposed that the adoption of excavation interval at 1.0m, 1.5m, 2.0m, 2.5m and 3.0m would be able to provide a wide flexibility and coverage catering for the practical application from the construction team.

The combination as a result from the range of variables discussed above generated a series of 400 FE models as the dataset as elaborated in Figure 4.1. Figure 4.2 is an illustration of one typical set of raw data of FOS values. This typical set is with respect to the combination of Cohesion (c) at 2kPa, Friction Angle (phi) at 35^{o}, Caisson Diameter (Dia) at 2m. The table shows 5 sets of FOS values created by 5 FE models according to 5 different sets of excavation depth (i.e. of 1.0m, 1.5m, 2.0m, 2.5m and 3.0m). The entire dataset according to the format as on Figure 4.2 of all FOS values obtained from the 400 FE models is appended in Appendix A.

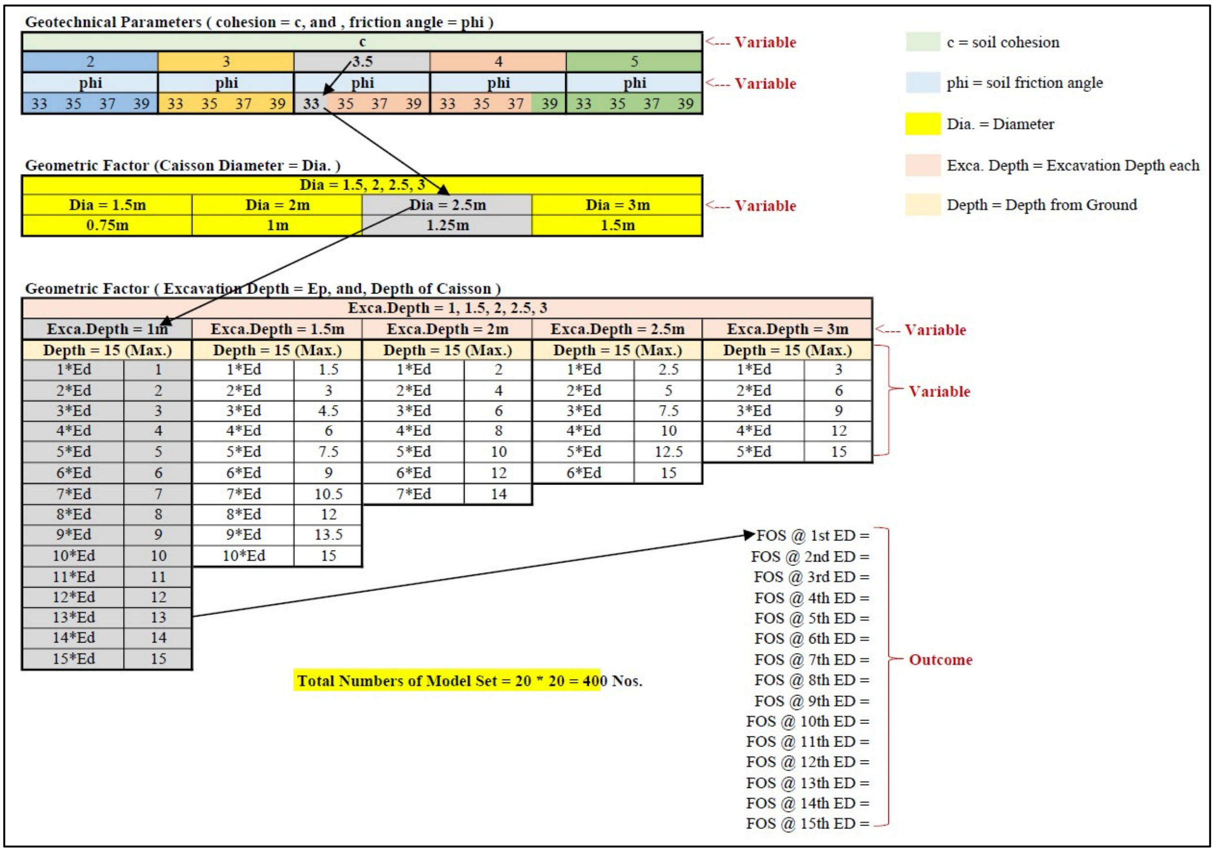


Figure 4.1: Structures of Raw Dataset of FOS

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3	35	105	2	1	1	1.588	1.5	1.5	1.376									
3	35	105	2	2	1	1.431				2	2	1.265	2.5	2.5	1.188			
3	35	105	2	3	1	1.427	3	1.5	1.260							3	3	1.104
3	35	105	2	4	1	1.556	4.5	1.5	1.342	4	2	1.223						
3	35	105	2	5	1	1.555							5	2.5	1.158			
3	35	105	2	6	1	1.599	6	1.5	1.387	6	2	1.268				6	3	1.109
3	35	105	2	7	1	1.630	7.5	1.5	1.423				7.5	2.5	1.203			
3	35	105	2	8	1	1.668				8	2	1.299						
3	35	105	2	9	1	1.648	9	1.5	1.421							9	3	1.159
3	35	105	2	10	1	1.677	10.5	1.5	1.413	10	2	1.318	10	2.5	1.232			
3	35	105	2	11	1	1.648												
3	35	105	2	12	1	1.557	12	1.5	1.398	12	2	1.310	12.5	2.5	1.223	12	3	1.147
3	35	105	2	13	1	1.679	13.5	1.5	1.351									
3	35	105	2	14	1	1.691				14	2	1.360						
3	35	105	2	15	1	1.653	15	1.5	1.407				15	2.5	1.207	15	3	1.146

Figure 4.2: One Typical Set of Raw Data of FOS

4.3 Analysis of Raw Data and Discussion on Finding

The theme of this sub-chapter is about the exploration to find out if any individual relationship or characteristic among the mentioned factors complete with discussion. Another important part of this study is regarding the author who anticipates investigating and developing an empirical equation so that the FOS may become predictable if the mentioned factors are once known. This predictability of FOS hence becomes a measure to ensure the construction safety and achieve the research aim and/or objective eventually.

4.3.1 Individual Relationship between Factors

Chapter 3.3 has introduced a preview that the FOS values vary from the combination of factors. The author therefore intended to first observe the relationships or characteristics among FOS and those factors by 3D illustrations using statistic software MATLAB. Two sets of 3D plots were hence developed as shown in Figure 4.3a~e and Figure 4.4a~d.

The author first observed from Figure 4.3a~e that FOS was approximately to be directly proportional to SF along the depth of caisson (maximum 15m deep) applicable for caisson diameter from 1.5m to 3.0m. The linearity of the direct proportion is particularly obvious for the scenario of a larger excavation depth (Ep). This observation is critically reviewed as being rather logical. The FOS certainly increases in view of the increase of the shear strength of the soil. However, the nature of this linear proportionality is meaningful instead. This as-found nature of linearity is relatively useful because this data set may then be extrapolated further from both upper and lower limit to cover the prediction of FOS induced from the SF out of the current coverage.

The author also observed from Figure 4.3a~e that the smaller caisson diameter (Dia), the higher FOS along the depth of caisson (maximum 15m) under the scenario of same excavation depth (Ep). The reason for this observation / phenomenon is probably resulted from the contribution of the arching effect from the unsupported soil (Kumar & Chakraborty 2012 and Cho et al, 2015). When the diameter of the unsupported shaft is being reduced, the arching effect becomes stronger and stronger which therefore stiffens the soil body against collapse.

Further to the second observation, FOS was also observed to be more fluctuated for a smaller excavation interval (Ep) along the depth of a caisson. The fluctuation becomes less severe for the excavation interval equal to or more than 2.0m. This observation may be supportive the author's encouragement to recommend the excavation interval to be from 2m to 3m because the FOS of the unsupported shaft may be more controllable with respect to prediction purpose. Although lower FOS values are forecasted for a larger caisson diameter, those FOS values are steadier or more stable. The author still recommends the adoption or selection of a larger excavation interval in real practice because the predictability of the FOS is more guaranteed and controllable.

The final observation by the author according to Figure 4.4a~d is the smaller excavation depth (Ep), the higher FOS along the depth of caisson (maximum 15m) under the scenario of same caisson diameter (Dia.). This observation is rather logical and similar with respect to the second observation. If this observation and the third observation are jointly discussed, the behaviour of fluctuation of FOS is hence found to be mainly dependent on excavation interval (Ep) and independent from the caisson diameter. This observation additionally enhances the author's recommendation to encourage the adoption of the optimum excavation interval from 2.0m to 3.0m for all kinds of caisson diameters. Excavation intervals of more than 3.0m have not been explored in this study so the adoption of the interval more than 3.0m is not recommended by the author because of the limited scope of this study.

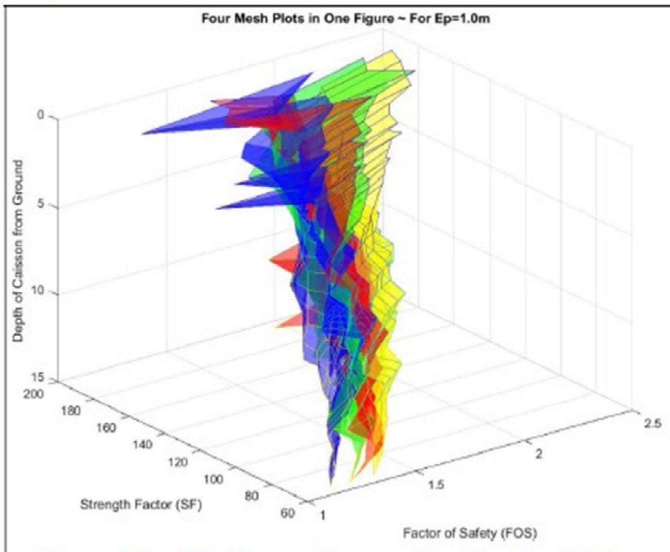


Figure 4.3a: Plot for an Excavation Depth at 1.0m

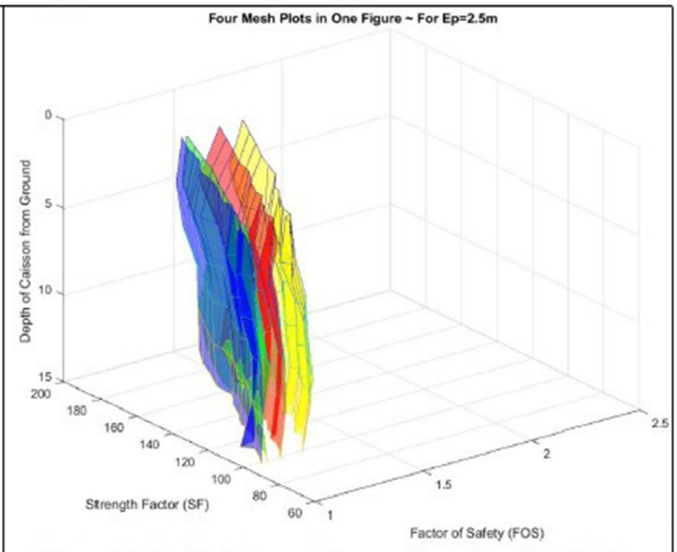


Figure 4.3d: Plot for an Excavation Depth at 2.5m

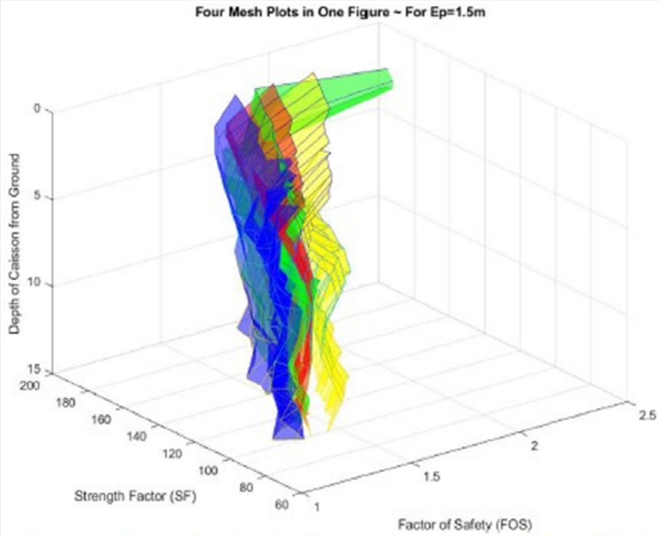


Figure 4.3b: Plot for an Excavation Depth at 1.5m

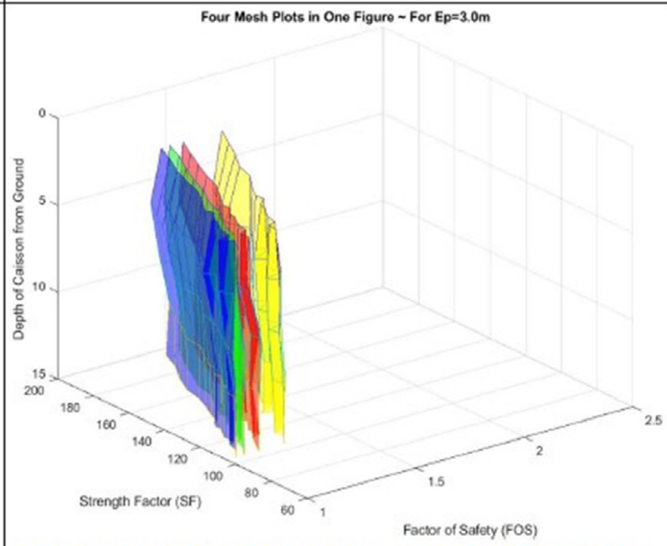


Figure 4.3e: Plot for an Excavation Depth at 3.0m

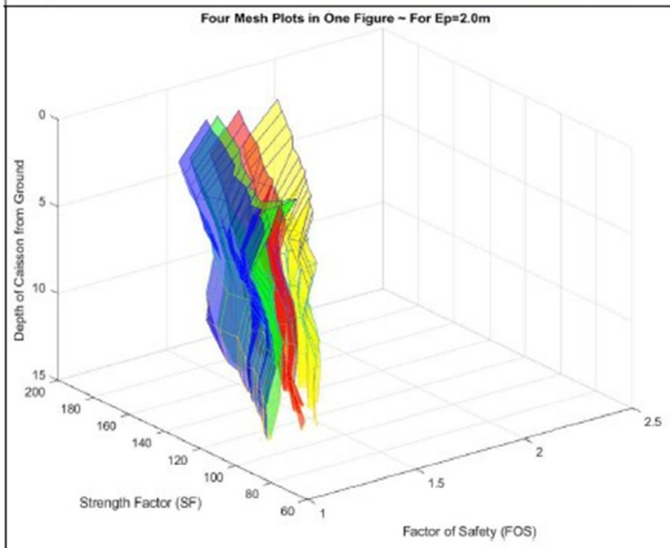


Figure 4.3c: Plot for an Excavation Depth at 2.0m

Yellow / Red / Green / Blue: for Caisson Diameter at **1.5m / 2.0m / 2.5m / 3.0m**

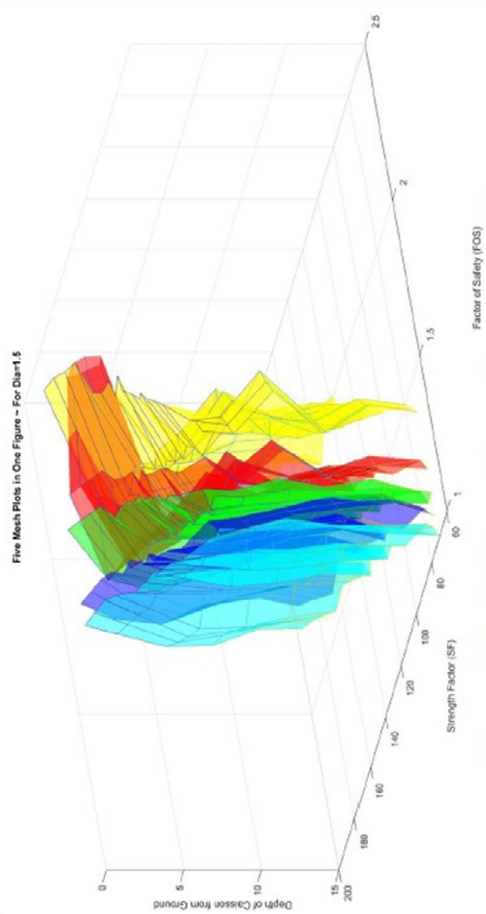


Figure 4.4a: Plot for a Caisson Diameter at 1.5m

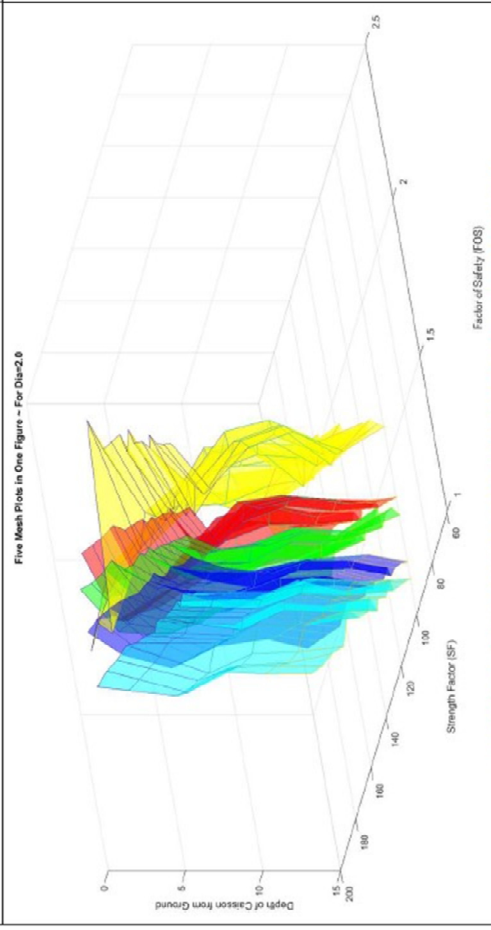


Figure 4.4b: Plot for a Caisson Diameter at 2.0m

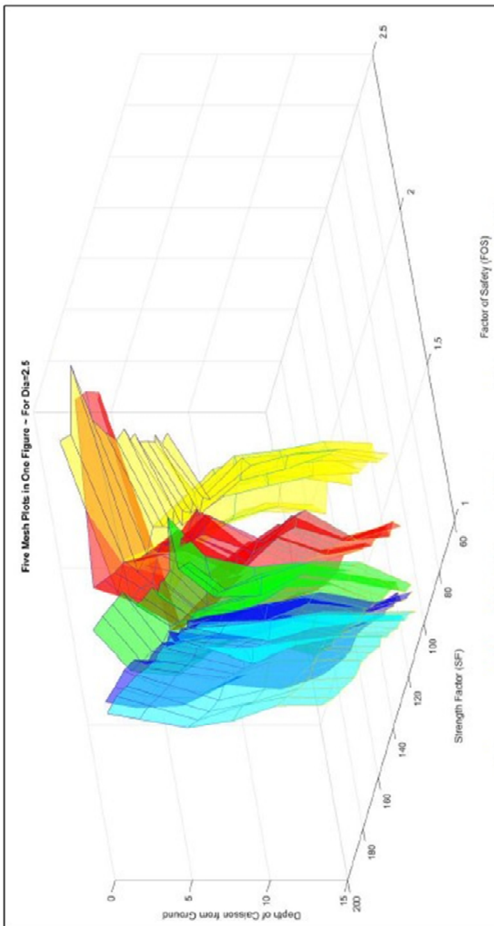


Figure 4.4c: Plot for a Caisson Diameter at 2.5m

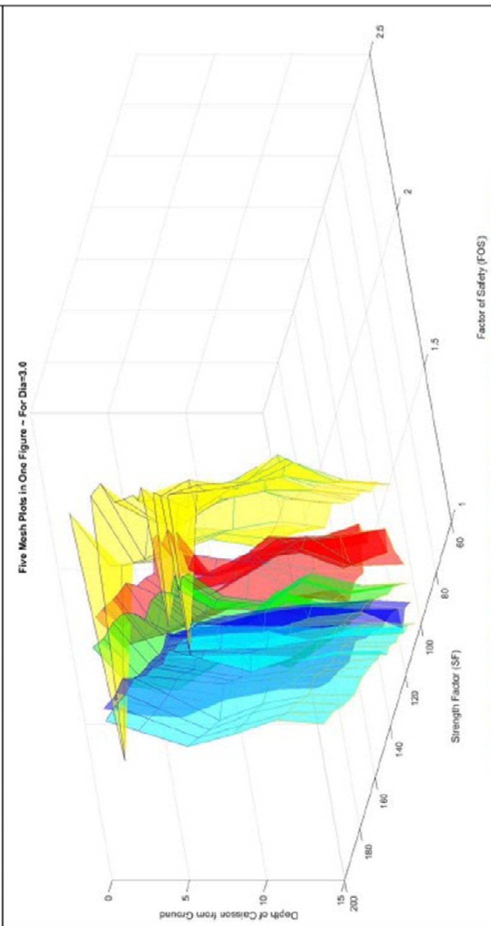


Figure 4.4d: Plot for a Caisson Diameter at 3.0m

Yellow / Red / Green / Blue / Cyan: for **Excavation Depth** at **1.0m / 1.5m / 2.0m / 2.5m / 3.0m**

4.3.2 Empirical Equation by Regression Analysis for FOS Prediction

The author thereafter investigated the feasibility of developing equations for FOS prediction. As such, the entire data set was further extracted and analyzed by linear regression analysis method using statistical software MATLAB. The author first anticipates the form of the equation as in Equation. 6;

$$FOS = Intercept + x1 \times SF + x2 \times Depth + x3 \times Ep + x4 \times Dia \quad (6)$$

Where	*SF*	= *Strength Factor* ($c * \phi$)
	Depth	= *Overall Depth*
	Ep	= *Segmental Excavation Depth / Interval*
	Dia	= *Caisson Diameter*
	x1	= *coefficient for SF*
	x2	= *coefficient for Depth*
	x3	= *coefficient for Ep*
	x4	= *coefficient for Dia*
	Intercept	= *a constant value from the regression analysis*

When further structuring the equation, the author reckoned that the caisson diameter may be set as independent variable and to be excluded from the regression analysis. This exclusion is based on the situation where the caisson diameter is once fixed when the caisson was designed or the excavation of the caisson shaft was commenced. This practical scenario leads to the caisson diameter becoming a constant. Therefore, the form of the equation is simplified as on Equation 7 while there would be 4 equations for each of the diameters (i.e. 1.5m, 2.0m, 2.5m and 3.0m) to be formulated by regression analysis.

$$FOS = Intercept + x1 \times SF + x2 \times Depth + x3 \times Ep \quad (7)$$

The author then set up the regression analysis that the analyzed results are detailed in Table 4.1. Figure 4.5 to 4.8 are the graphical presentations of the regression results for caisson diameter from 1.5m to 3.0m respectively.

		Caisson Diameter			
		1.5m	2.0m	2.5m	3.0m
Intercept	Estimate	1.1987	1.1243	1.1646	1.1332
	SE	0.0090898	0.0090391	0.11411	0.010809
	tStat	1.3187E+02	124.38	102.06	104.84
	pValue	0	0	0	0
x1	Estimate	0.0060065	0.0056998	0.0055929	0.005212
	SE	5.1152E-05	5.4183E-05	7.0345E-05	6.688E-05
	tStat	117.42	105.2	79.508	79.931
	pValue	0	0	0	0
x2	Estimate	0.0031731	0.0069021	0.0039906	0.0049319
	SE	0.00043001	0.00042854	0.00051089	0.00047217
	tStat	7.3792	16.107	7.8111	10.445
	pValue	2.6564E-13	1.3184E-13	1.1795E-14	1.5512E-24
x3	Estimate	-0.22138	-0.23482	-0.26674	-0.25045
	SE	0.0026307	0.0026726	0.0031442	0.0028759
	tStat	-84.153	-87.86	-84.836	-87.085
	pValue	0	0	0	0
R^2		0.9324	0.9238	0.9017	0.9054
R^2 Adjusted		0.9223	0.9236	0.9015	0.9052

Table 4.1: Regression Results from MATLAB

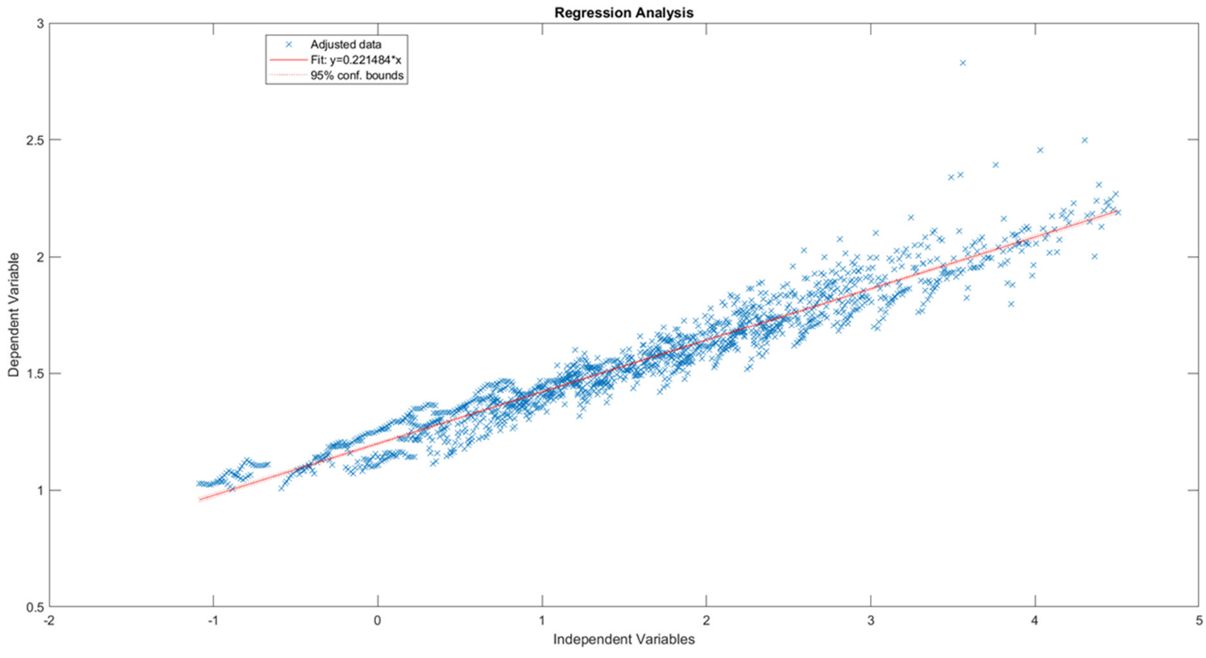


Figure 4.5: Graphical Results of Regression Analysis for Caisson Diameter at 1.5m

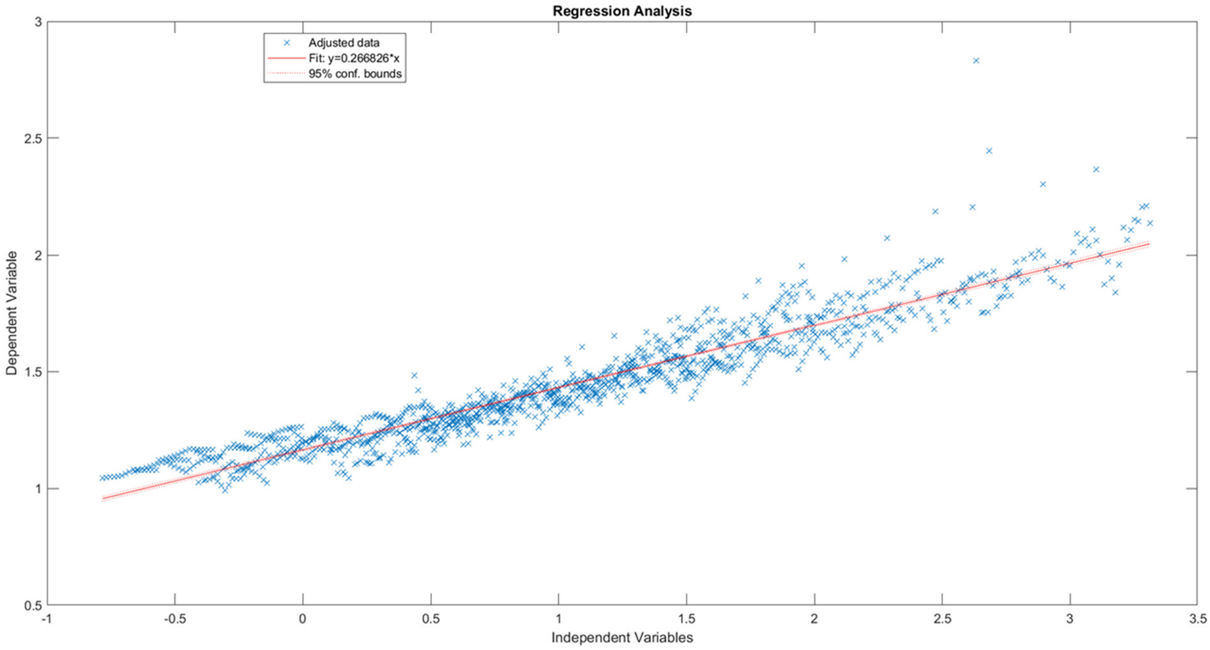


Figure 4.6: Graphical Results of Regression Analysis for Caisson Diameter at 2.0m

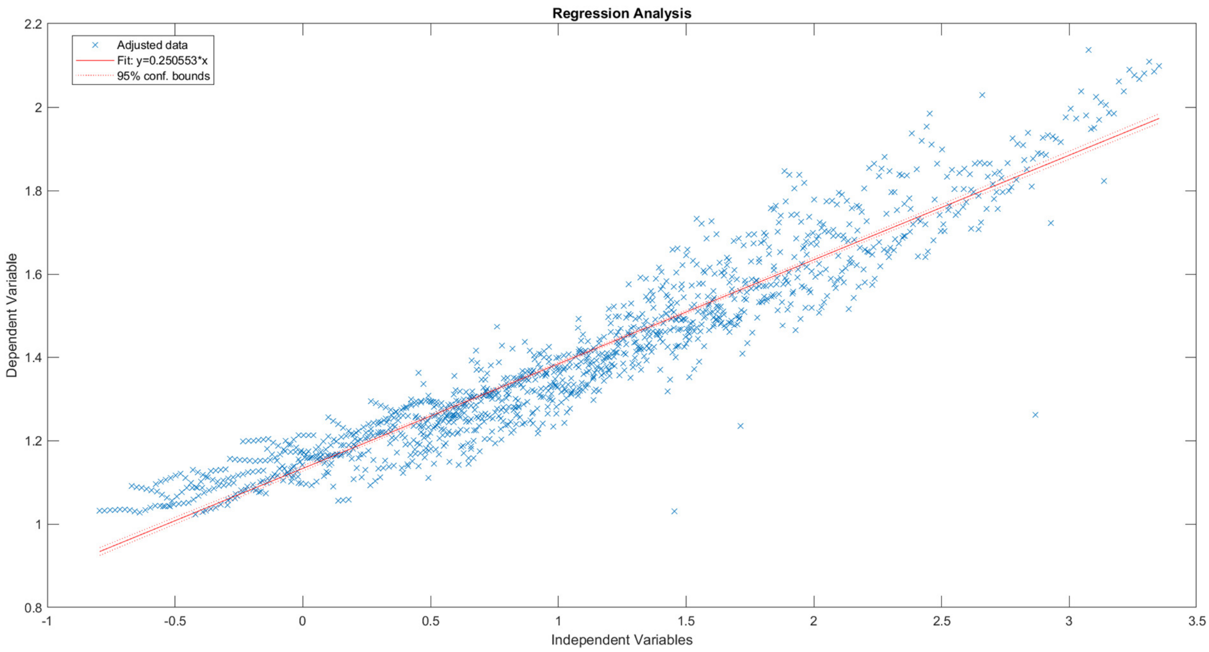


Figure 4.7: Graphical Results of Regression Analysis for Caisson Diameter at 2.5m

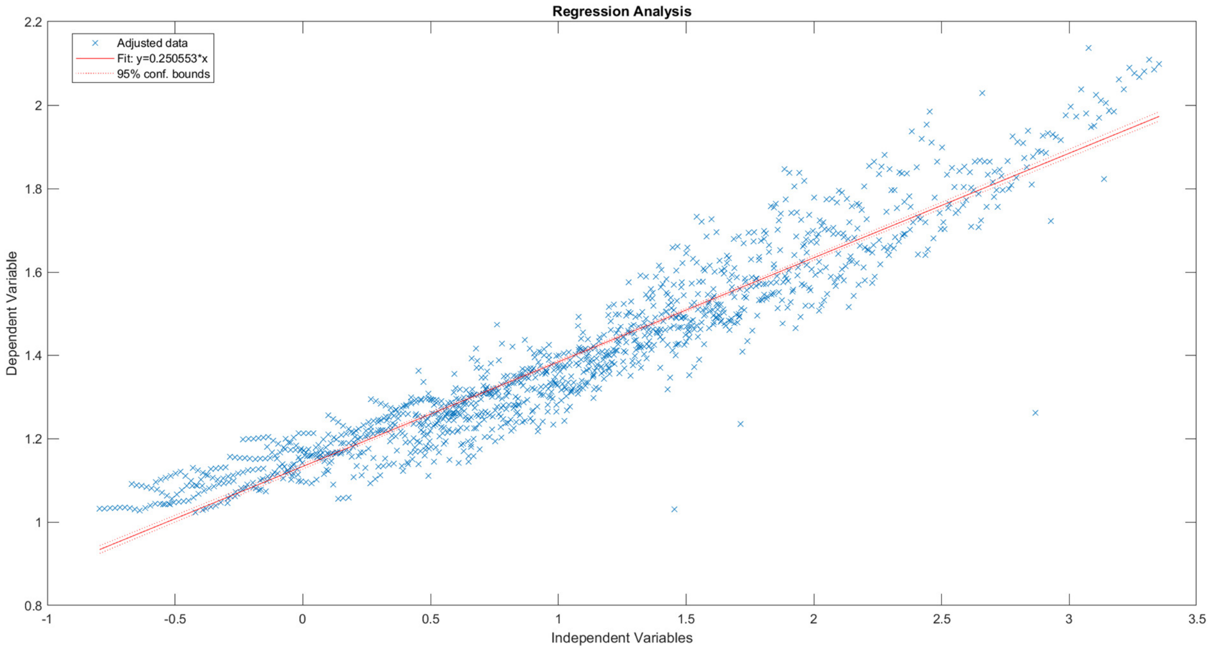


Figure 4.8: Graphical Results of Regression Analysis for Caisson Diameter at 3.0m

The equations for each size of caisson diameter studied are thus formulated as follows;

For Caisson Diameter at 1.5m

$$FOS = 1.1987 + 0.0060065 \times SF + 0.0031731 \times Depth - 0.22138 \times Ep \quad (8)$$

For Caisson Diameter at 2.0m

$$FOS = 1.1243 + 0.0056998 \times SF + 0.0069021 \times Depth - 0.23482 \times Ep \quad (9)$$

For Caisson Diameter at 2.5m

$$FOS = 1.1646 + 0.0055929 \times SF + 0.0039906 \times Depth - 0.26674 \times Ep \quad (10)$$

For Caisson Diameter at 3.0m

$$FOS = 1.1332 + 0.005212 \times SF + 0.0049319 \times Depth - 0.25045 \times Ep \quad (11)$$

The indicators of R^2 and R^2 adjusted for the above four equations all exceed 90% as on Table 4.1. These percentages showed that the regression analysis shall have reached the purpose of satisfactory prediction regarding the progressive FOS of unsupported shaft.

4.3.3 Further Discussion to the Developed Empirical Equations

The author created the four empirical equations aiming for a practical prediction of the FOS before and/or in the progress of the segmental excavation of a caisson shaft. The development of the equations is according to the results from regression analysis based on a dataset of FOS generated from 400 FE models. In fact, the approach of developing charts or equations by regression analysis from a set of data generated from simulation software/programme is commonly adopted by previous researchers including Salmasi et al. (2019) and Sampa & Schorr (2024) when handling geotechnical engineering problems, such as slope.

(a) Salmasi et al. 2019

Salmasi et al. (2019) conducted a study to investigate the estimation of slope safety factor using linear and non-linear regression equations. Salmasi et al. (2019) first referred to the design charts created by Michalowski (2002) to prepare linear and non-linear regression equations (Table 4.2 as shown below) so as to facilitate the estimation of FOS of a general slope. Salmais et al. (2019) thereafter compared the FOSs obtained from these two equations to the computed outcome from a geotechnical engineering software SLOPE/W. The scholars' conclusion was drawn that the non-linear equation probably computes a more representative FOS value of a slope than that from linear equation.

Table 4.2: R^2 values of Regression Analysis for FOS of Slope (Salmasi et al. 2019)

Equation	R^2	RMSE
$\frac{F_s}{\tan Ø} = 5.584 \times \left(\frac{c}{\gamma H \tan Ø}\right) - 0.077 \times (\beta) + 6.281$	0.95	0.993
$\frac{F_s}{\tan Ø} = 47.681 \times \left(\frac{c}{\gamma H \tan Ø}\right)^{0.704} \times (\beta)^{-0.452}$	0.97	0.776

Salmais et al. (2019) performed further comparison regarding the obtainment of FOS of a general slope by methods developed by various scholars including Morgenstern-Price, Janbu, Bishop and Ordinary Method. Salmais et al. (2019) adopted linear regression equations again to compare the FOSs values obtained among these four methods. Table 4.3 is the summary of the regression equations and associated indicators.

Table 4.3: R^2 values of Regression Analysis for Various Type of Methods (Salmasi et al. 2019)

Method	Equations	R^2	RMSE
Morgenstern–Price	$F_s = 1.861 - 0.047 \times \gamma + 0.043 \times C + 0.032 \times \emptyset - 0.019 \times \beta$	0.968	0.0850
Janbu	$F_s = 1.701 - 0.046 \times \gamma + 0.042 \times C + 0.029 \times \emptyset - 0.016 \times \beta$	0.969	0.0751
Bishop	$F_s = 1.969 - 0.047 \times \gamma + 0.043 \times C + 0.03 \times \emptyset - 0.021 \times \beta$	0.945	0.1001
Ordinary	$F_s = 1.739 - 0.047 \times \gamma + 0.041 \times C + 0.031 \times \emptyset - 0.017 \times \beta$	0.97	0.0785

The author critically reviewed and would comment that more discussion about the significance of each variables/coefficient of the equations by emphasizing the most important variable affecting the calculated outcome may enhance the values of this research.

(b) Sampa & Schorr (2024)

Sampa & Schorr (2024) investigated and introduced a regression equation enabling a quick estimation of FOS of homogeneous dry finite slopes with circular failure surfaces as illustrated in Figure 4.9. Sampa & Schorr (2024) developed the below equations by linking the FOS to the Stability Number (c'/ γ H).

$$FS = N_1 + N_2\left(\frac{c'}{\gamma H}\right)^{N_3}$$

$$N_1 = A\left(\frac{\tan\phi'}{\tan\beta}\right)$$

$$N_2 = 3.758167043 + 2.781\left(\frac{\tan\phi'}{\tan\beta}\right)^{0.41}$$

$$N_3 = 0.612 + 0.1238209944\left(\frac{\tan\phi'}{\tan\beta}\right)^{-0.226}$$

$$A = \begin{matrix} 0.667 + 0.186(\cos\beta)^{-1.455} & \text{for } \beta > 45° \\ 1 & \text{for } \beta \leq 45° \end{matrix}$$

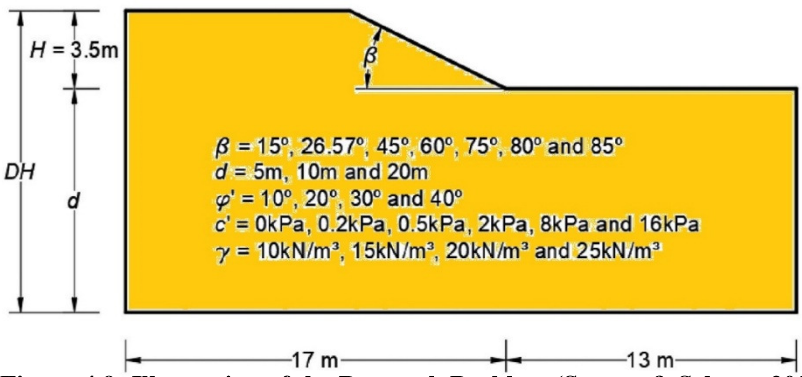


Figure 4.9: Illustration of the Research Problem (Sampa & Schorr, 2024)

A conclusion was drawn by the scholar that the equation reached a reliable level of estimation purpose with respect to the FOS generated by geotechnical software according to Morgenstern-Price with reference to the following indicators;

- Mean error: -1.45%;
- Standard deviation: 2.264%
- R^2 ~ 1.0
- Error comparing to the Morgenstern-Price's result: +/- 5%

The above indicators demonstrate a high reliability and applicability of using regression analysis to handle geotechnical study.

In view of the above research work by Salamis et al. (2019) and Sampa & Schorr (2024), the author accordingly reckons that the adoption of regression analysis for creating equations to resolve geotechnical problems, especially for estimation of FOSs of slopes/excavations, is on a reliable and firm basis in view of research aspect. The regression results of the equations developed by the author are individually discussed in the following sub-sections.

(i) Discussion on tStat, p-value and significance of each variable

The author firstly reviewed the regression results between *tStat* and *p-value*. One of the observations is that *Intercept* is the most crucial coefficient affecting the FOS prediction by the equation because the *tStat* values of *Intercept* are the highest among all. The coefficients of *x1* and *x3* relating to SF and Ep respectively are observed to be of a similar importance because the *tStat* are either at the second and third place. In other words, SF and Ep are also crucially affecting the prediction of FOS. The *x2* with respect to Depth is so considered to be the least important because of the lowest *tStat* values.

It is reviewed to be true and correct that the *tStat* of *x1* and *x2* are of positive magnitude because of the observation presented in sub-chapter 4.3.1. Simply speaking, the SF (i.e. related coefficient *x1*) increases, the FOS increases. Similarly, the overall depth of the caisson increases, the FOS also increases. On the contrary, the coefficient of *x3* with respect to segmental excavation interval (Ep) increases, the FOS decreases. It is true that the FOS would be reduced when the excavation depth is larger and larger.

All three variables are observed to be statistically significant or related to the regression equation because the *p-value* of them are zero or very close to zero.

Further observation is that *Intercept* and *x1* (of SF) are decreasing when the caisson diameter increases. This phenomenon is considered relating to the soil arching effect previously discussed in Chapter 4.3.1. Alternatively, this finding counter-substantiates the observations discussed in Chapter 4.3.1 because the arching effect become less influencing when the diameter of the excavation is larger and larger.

The *x3* (of Ep) was observed to be rather stable (values ranging from 84.153 to 87.86 with 4.45% difference in percentage) among the four caisson diameters, possibly implying that EP is independent from caisson diameter when predicting the FOS.

The *x2* (of overall caisson depth) was comparatively fluctuated (values ranging from 7.3792 to 16.107 with 218% difference in percentage) among the four caisson diameters. However, the Depth is also considered to be independent from caisson diameter when predicting the FOS because the values are relatively fluctuated and the *tStat* is the lowest among all variables.

Since the *x1* (of SF) and *x3* (of Ep) are observed to be so crucial to the regression results, further study to these two variables are recommended as discussed the Chapter 5.

(ii) Discussion on R^2 and R^2 adjusted with respect to similar Geotechnical study/problem

It is essential to justify by the author the confidence level or reliability of the regression equations for real-life application. The values of R^2 and *Adjusted* R^2 are certainly an important indicator of justifying the confidence level or reliability. The current values of the R^2 and *Adjusted* R^2 from the regression analysis by the author as shown on Table 4.1 range from 0.902 to 0.932 overall. The author ought to justify if these values are acceptable in view of the field of geotechnical problems studied by previous scholars.

A general idea about the range of R^2 was to be first realized. Marrapu & Jakka (2017) suggested the R^2 value greater 0.8 was considered to be sufficient and good. Whilst, the range of R^2 from 0.7 to 0.99 is generally acceptable for research in physic (Gupta et al. 2024). More specifically, the author further retrieved R^2 values of previous studies relating to various fields of geotechnical aspects and Table 4.4 is a summary.

Table 4.4: R^2 values of Regression Analysis in Various Field by Previous Scholars

Scholar	Field of Study	Type of Regression Analysis	R^2 Values
Marrapu and Jakka (2016)	FOS for Slope	Linear	0.835
	FOS for Slope by Chart Method	Linear	0.949
	FOS for Slope by Morgenstern-Price	Linear	0.9282
Puri et al. (2018)	Bulk Density of Coarse Grain Soil by SPT N-value	Linear	0.91
	Dry Density of Coarse Grain Soil by SPT N-value	Linear	0.96
	Bulk Density of Fine Grain Soil by SPT N-value	Linear	0.97
	Dry Density of Fine Grain Soil by SPT N-value	Linear	0.90
	Internal Friction Angle by SPT N-value	Linear	0.98
	Cohesion by SPT N-value	Linear	0.93
Salmasi et al. (2019)	FOS of Slope by Michalowski (2002)	Linear	0.95
		Non-linear	0.97
	FOS of Slope by Morgenstern-Price	Linear	0.968
	FOS of Slope by Janbu	Linear	0.969
	FOS of Slope by Bishop	Linear	0.945
	FOS for Slope by Ordinary Method	Linear	0.97
Sampa & Schorr (2024)	Correlation between FOS and Sn	Non-linear	~ 1
This Thesis	FOS of Vertically Excavated Surface of a Circular Shaft at 1.5m Diameter	Linear	0.9324
	FOS of Vertically Excavated Surface of a Circular Shaft at 2.0m Diameter	Linear	0.9238
	FOS of Vertically Excavated Surface of a Circular Shaft at 2.5m Diameter	Linear	0.9017
	FOS of Vertically Excavated Surface of a Circular Shaft at 3.0m Diameter	Linear	0.9054

Table 4.4 demonstrated that R^2 value at or above 0.9 shall have been justified and considered as a reasonable value with respect to various types of geotechnical problems accepted by previous scholars. The R^2 values of the four regression equations obtained by the author in this study all exceed 0.9, which is then reasonably and satisfactorily justified

4.4 Application of the Developed Equations

The author is in fact one of the members of a research team which aims to prototype a robotic arm to perform the excavation task of caisson shaft construction. Therefore, the author intends to validate the above developed equations to check the applicability and adequacy for a real-life project or situation.

4.4.1 Excavation Robot Prototype

The Hong Kong Polytechnic University (PolyU) and Fong On Constriction Ltd (FO) have collaborated and formed a team to carry out research on the feasibility of robotic excavator to perform the excavator task of caisson construction. The team has then initiated an idea of prototyping a robotic excavator by making use of and modifying from an existing conventional excavator to form the major element of the robotic system to execute the excavation task. A "platform" which functions to uphold the excavator is also considered to be a compulsory element to complete the entire robotic system. As a result, the initial configuration of the robotic system was consolidated as illustrated on Figure 4.10. The team envisioned that the prototype shall be fully-tested to verify the construction feasibility. The team then set out the size of caisson at 2.5m diameter, which a typical size for a caisson in Hong Kong (HKIE 1981), for the full-scale test later.

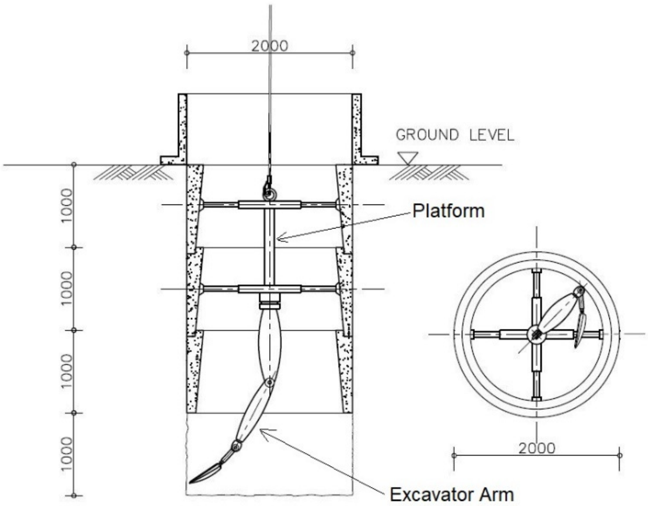


Figure 4.10: Robotic Excavator ~ Soil Material (Siu, 2018)

4.4.2 Design and Manufacturing of Excavation Robot

After consolidating the initial idea of the formation of the robotic system, the team further researched conventional excavators available from the market such as model and size. The tiny size excavator was found to be the most suitable one. A tiny size excavator (Figure 4.11a) was then purchased of which the excavator arm was dismantled and re-installed onto the platform. A platform was then designed after the selection of conventional excavator. The platform was designed to be used as a lateral support to the arm during excavation because it is anticipated the effect of "action and reaction" during the arm's excavation to soil (in particular to stiff soil layer) may be significant. The platform shall then be rigid enough against the tendency of shifting or rotation of the entire platform during the excavation. The platform was eventually designed to include 8 hydraulic jacks as lateral supports to the whole system. These jacks are at 2 layers in orthogonal directions (Figure 4.11b). This configuration is able to provide restraint against lateral and rotational movement when the arm is performing excavation inside a shaft in the manner of 360°. The prototype of the arm and platform (Figure 4.11c) was finally manufactured in China and transported to Hong Kong for full-scale test.

Figure 4.11a: Tiny Size Excavator

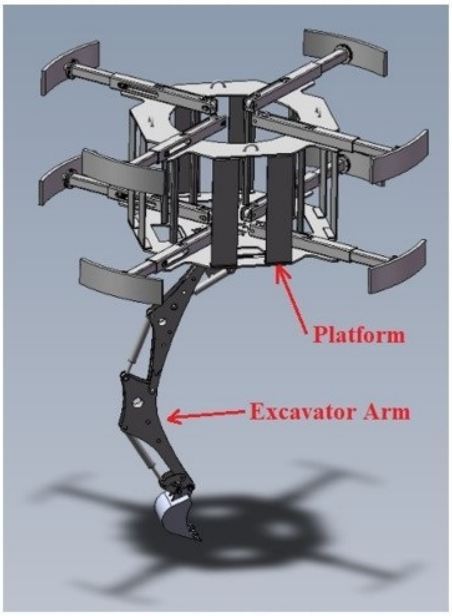


Figure 4.11b: Robotic Excavator

Figure 4.11c: Prototype of Robotic Excavator

4.4.3 Full Scale Test Setup

The robotic system was safely delivered to the test site and successfully re-assembled for the full-scale test (Figure 4.12a and 4.12b). The team envisioned that difficulties of construction feasibility of the new excavator shall be firstly overcome in order to succeed the research. One of the expected difficulties is regarding to the excavation performance by the arm. The team therefore designed and erected a steel gantry which enables the excavator to perform the excavation to a shallow ground. The principle of the function of the steel gantry is to simulate the working environment where the new excavator is conducting excavation task inside a shaft. As illustrated in Figure 4.12b, the robotic system is hung by chain-block on the monorail beam fixed on the steel gantry. The chain-block and the monorail beam function to provide mobilization to the system enabling vertically transported along the shaft and horizontally moved toward and away from the shaft. The platform is to provide lateral support to the excavator arm as previously explained. The team therefore intentionally installed 4 sets of steel members from the gantry columns to simulate the situation of "caisson shaft with lining". The steel members are to act as "lining" where the hydraulic jacks on the platform may jack on them and gain lateral supports to the system during excavation.

Figure 4.12a: Record Photo of Installation

Figure 4.12b: Record Photo of Setup

The gantry finally designed is about 6m high which allows the entire system to be vertically transported. The vertical transportation aims to simulate and validate the mobilization of the entire system along the depth of the shaft. The gantry is 3.5m square in size on plan which allows the new excavator to dig a caisson shaft at 2.5m diameter.

4.4.4 Estimation of FOS with On-site Measurement

The trial involved a shaft excavation of a 2.5m diameter caisson as mentioned. Before the commencement of trial excavation, the geological information of the site was explored of which the finding was tabled in Table 4.5. In view of the known and collected information, Equation 10 was with respect to the caisson diameter at 2.5m and so adopted to predict the progressive FOS for the trial excavation. The author thereafter used the equation to predict the

FOS at the depth of 1.5m and 2.5m from the existing ground and the predicted FOS was summarized in Table 4.2.

Table 4.5: Summary of Parameter or Properties of Soil, Lining and Geotechnics of the Site Trial

Soil Type	Shear Strength		Caisson Diameter	Excavation Interval (Ep)	Progressive Exca. Depth (Depth)	Predicted FOS (according to Eq. 10)
	c	ϕ				
Alluvium	3.5kPa	36°	2.5m	1.5m	1.5m	1.475
				2.5m	2.5m	1.212

The excavation reached the depth of 1.5m and 2.5m respectively. Monitoring any stress change at each progressive excavation depth was performed to check if any sign of collapse of the unsupported shaft. The configuration of the measurement through monitoring stations of the unsupported excavated shaft was illustrated in Figure 4.13. The placement of the monitoring stations is with reference to the zone with a high-stress change according to the simulated outcome from Finite Element models as shown in Figure 4.14. This figure not only shows the zone of high stress-change locating at the toe of the excavation, but also the potential failure surface of the collapsed soil body. This phenomenon is reviewed as being similar to the research outcome by Kumar et al. (2014) as of Figure 2.4 and Keawsawasvong (2017) as of Figure 4.15. In this regard, the author placed the monitoring stations at the toe so as to monitor if any sign of distress or collapse by measuring the stress-change.

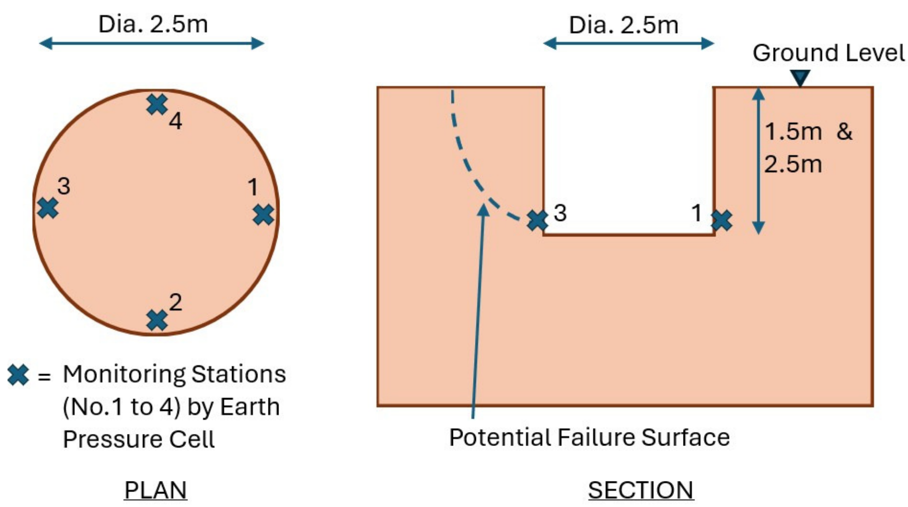


Figure 4.13: Monitoring Stations

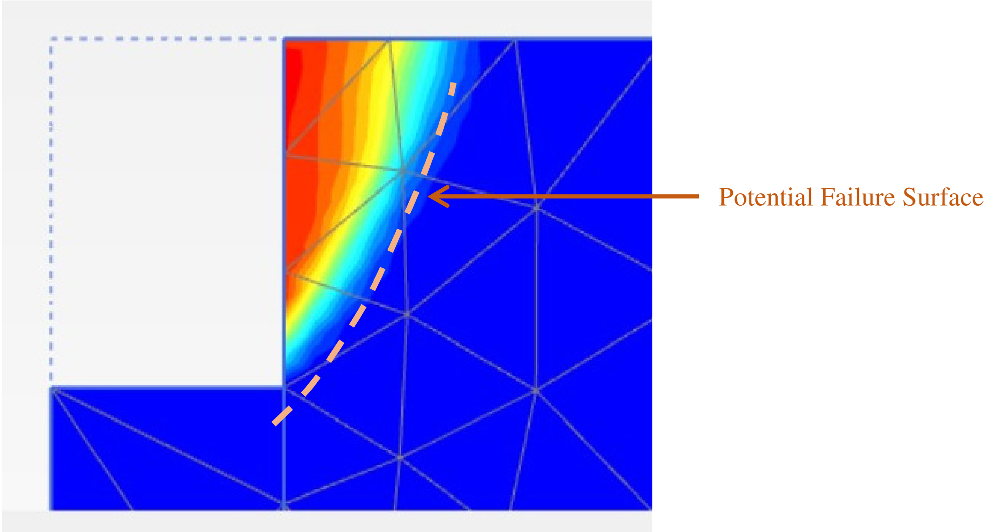


Figure 4.14: Potential Failure Surface simulated by PLAXIS

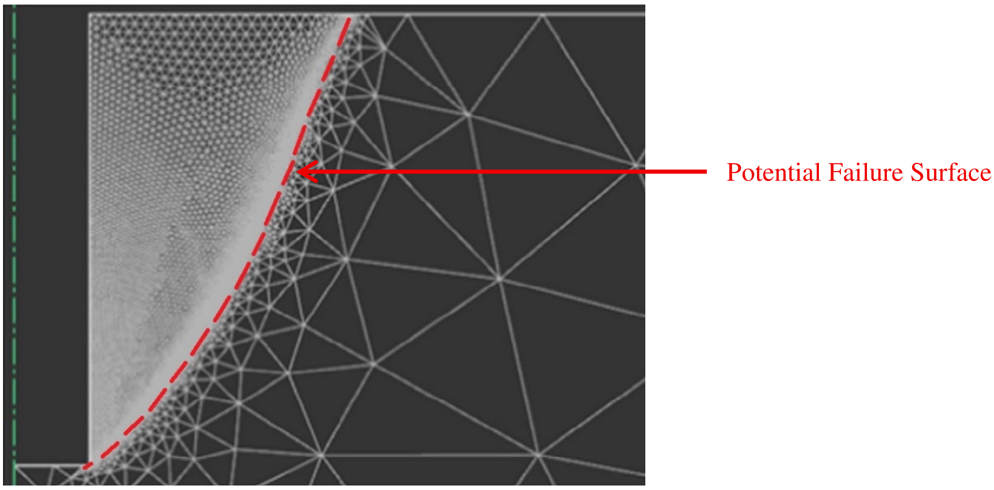


Figure 4.15: Potential Failure Surface (Keawsawsavong, 2017)

The complete set of monitoring values obtained by the author is appended in Appendix B. The monitoring values as shown include the measurement of the stress-change of those four locations (refer Figure 4.13) by earth pressure cell embedded into the soil. The pressure cell also concurrently records the temperature-change. The temperature-change recorded is a component to interpret/calculate the corresponding stress-change.

The graphical presentations of the stress change and temperature difference of each progressive excavation depth are on Figure 4.16a and 4.16b. The monitoring period for each depth is over 24 hours. This period aims to tally with the mindset that the unsupported shaft would be retained by concrete lining within 24 hours according to the conventional construction practice of hand-dug caisson as presented in Chapter 1. Therefore, the monitoring shall cover the period when the shaft is at the stage of self-standing alone.

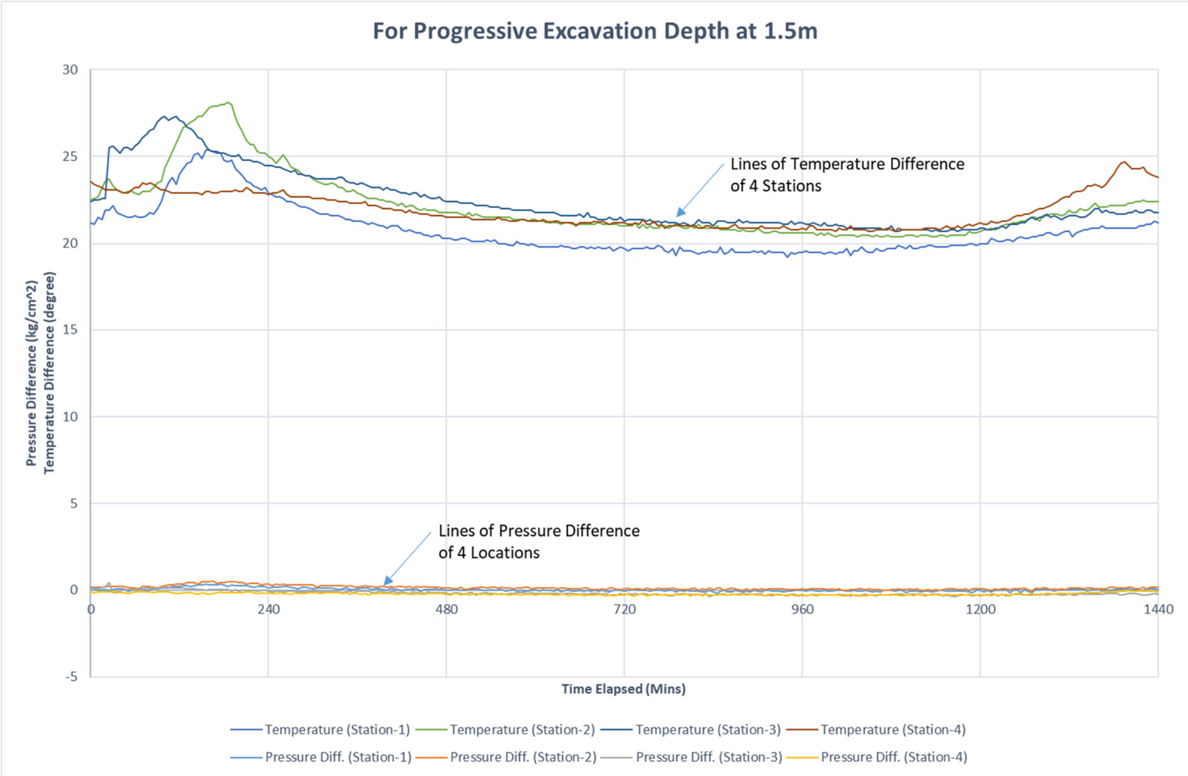


Figure 4.16a: Monitoring Results of Temperature and Stress Change for Progressive Excavation Depth at 1.5m

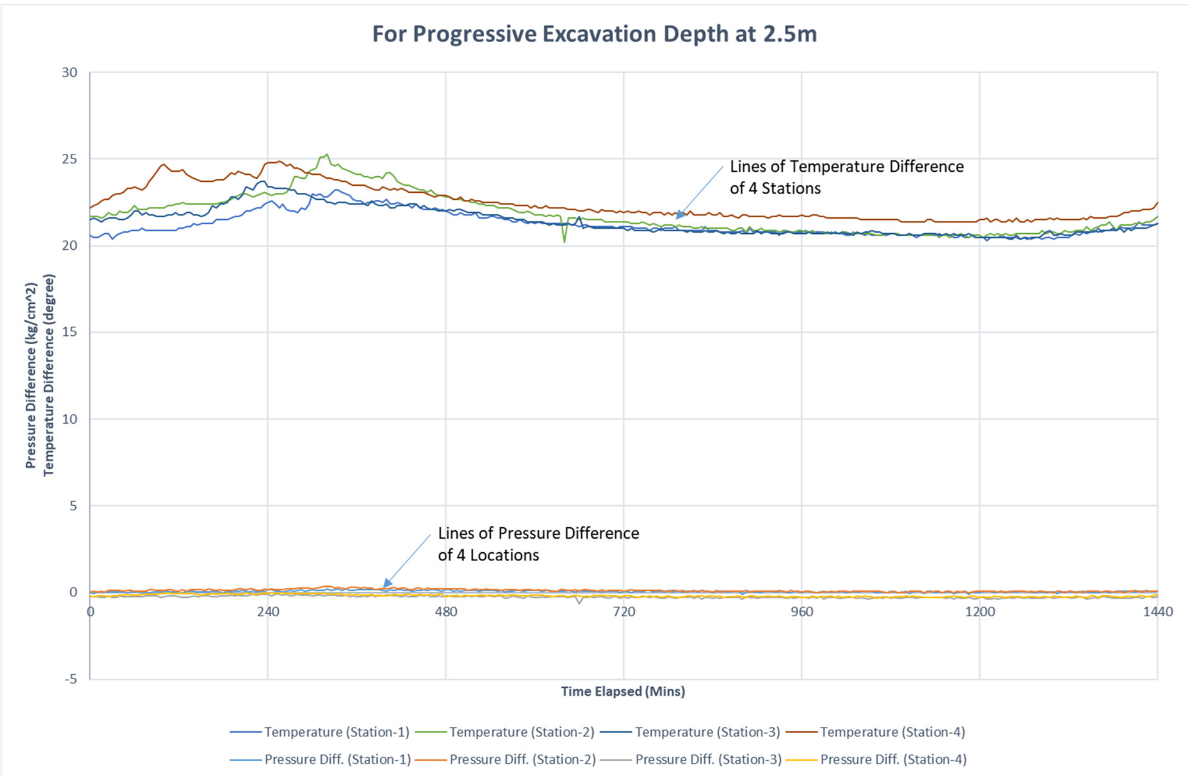


Figure 4.16b: Monitoring Results of Temperature and Stress Change for Progressive Excavation Depth at 2.5m

The above results showed that the unsupported shaft of each progressive excavation depth is rather stable without any sign of collapse or distress observed, because the stress-change was measured to be close to zero. This measurement is probably in line with the predicted FOS from the equation because these two FOS values are both greater than 1 by around 21% to 47%. This observation could substantiate that the developed equation may be useful for determining or predicting an optimum excavation depth and applicable for real life projects.

4.5 Comparison of Prediction by Previous Researchers

The sub-chapter 4.4 has demonstrated a real case where a vertically unsupported circular excavation of a 2.5m diameter caisson at 1.5m and 2.5m deep excavation from the ground was formed without collapse. However, this application may only partially reflect the validity of the equations.

The author therefore performed another comprehensive comparison between the estimated FOS values from the developed regression equations and the prediction by proposed previous researchers including (a) Khatri & Kumar 2010 and (b) Keawsawasyong 2017.

Khatri & Kumar (2010) and Keawsawasvong (2017) individually established charts or equations to predict the level of stability of vertically unsupported circular excavation through an expression of Stability Number (Sn), instead of Factor of Safety (FOS).

Sn was introduced by Taylor (1937) and was defined as $c / \gamma H$. Sn is aimed to describe and evaluate the level of stability of a slope according to slope geometry of height (H) and soil property of unit weight (γ) and cohesion (c). Instead, FOS is a ratio of shear resistance against shear stress of a slope as a quantification of how stable a slope is. A higher FOS value implies a more stable condition of a slope.

FOS was adopted by the author as the index of the regression equations in this study because FOS is more understandable by site supervisors in Hong Kong. FOS is also more practical and convenient for a site supervisor to manage on-site since the regression equations developed as in sub-chapter 4.3 are aimed to be applied by the site supervisor.

The author hence refers to literatures to realize the conversion from Sn to FOS so as to establish the comparison. Michalowski (2002) and Huang & Ji (2024) were so referred to since they have separately developed equations or chart for conversion from Sn to FOS.

Once the conversion from Sn to FOS is established according these literatures, the author thereafter calculated Sn according to Khatri & Kumar (2010) and Keawsawasvong (2017) with respect to the configuration as descripted in Chapter 3 and Chapter 4. The set of Sn values were then converted to FOS with reference to Michalowski (2010) and Huang & Ji (2024). The author thereafter created a comprehensive comparison so as to observe if any phenomenon regarding the prediction of stability level between the developed regression equations and previous research outcome of Sn.

4.5.1 Calculating Sn according to Khatri & Kumar (2010) and Keawsawasvong (2017)

The captioned two researchers have studied the issue of the stability number (Sn) regarding an unsupported vertical-circular or conical shaft. Both researchers have successfully established the relation between the H/b ratio of the shaft and Sn.

Khatri & Kumar (2010) analyzed with the use of finite element program the variation of the stability number with changes in H/b and m (a dimensionless factor defining the rate at which the cohesion increases linearly along the depth the shaft). Khatri & Kumar (2010) conducted a series of analysis and finally concluded the relationship between H/b (ranged from 1 to 10) and Sn as illustrated in Figure 4.17. This figure could be easily used to find out the Sn from the specific H/b ratio with due consideration of m.

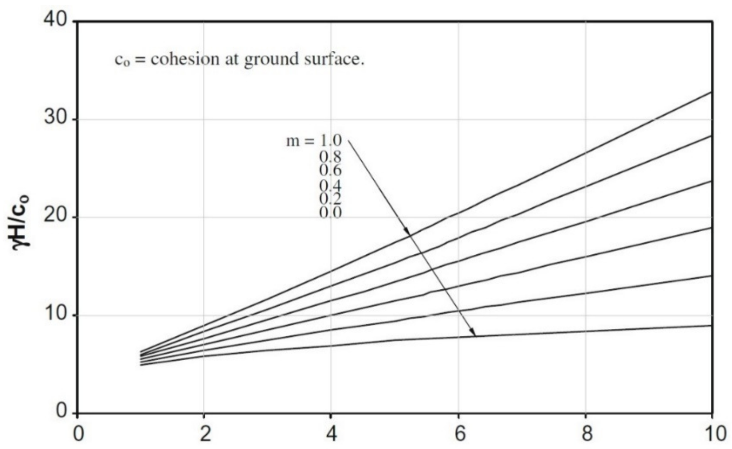


Figure 4.17: The variation of stability number ($\gamma H/c_o$) with H/b and m (Khatri & Kumar, 2010)

Keawsawasvong (2017) also conducted a similar research to link up the relationship between H/b and Sn but with an additional consideration catering for the inclination of the circular excavation (i.e. from cylindrical shaft to conical shaft). Keaswsawasvong (2017) not only developed numbers of graphs to illustrate the relationship from H/b to Sn together with the consideration of various inclination angle of the excavation (e.g. 45°, 60°, 75° and 90°), but also proposed a closed-form solution so as to facilitate the application without interpolation when using graphs. The closed-form solution is presented as follows:

$$N_c = F_{\beta 1} + F_{\beta 2}\sqrt{\frac{H}{b}} + F_{\beta 3}\frac{H}{b}$$

where $F_{\beta 1} = a_1 + \frac{10}{3}\cos(\beta) - \frac{1}{2}\cos^2(\beta)$

$$F_{\beta 2} = a_2 + \frac{1}{8}\cos(\beta)$$

$$F_{\beta 3} = a_3 - \frac{1}{2}\cos(\beta) + \frac{1}{4}\cos^2(\beta)$$

Optimal value of the six empirical constants (a_1–a_6) for solution of the undrained stability of unsupported conical excavations.

a_1	a_2	a_3	a_4	a_5	a_6
2.8711	2.4209	−0.1373	0.7709	−2.2195	1.8365

Figure 4.18: The closed-form solution (Keawsawasvong, 2017)

4.5.2 Converting Sn to FOS according to Michalowski (2002) and Huang & Ji (2022)

Sn and FOS are two separate indexes to quantify the safety level of a geotechnical problem/study. Michalowski (2002) and Huang & Ji (2022) have both conducted study relating to slope stability. Both scholars touched on the topic of how the Sn is related to FOS when they were studying slope stability.

Michalowski (2002) firstly referred to Taylor (1937) to create a conversion from slope angle (β) to Sn with incorporation of FOS. The use of this conversion requires iteration to finalize the conversion. He further studied to modify the conversion together with consideration of pore pressure (r_u) and created another set of graphs of conversion between FOS (by F/tan ϕ) and Sn (by C/ γ H tan ϕ) as shown on Figure 4.19. The set of graphs with r_u equal to zero (meaning zero pore pressure, i.e. dry soil) was selected by the author to convert the Sn to FOS because this tallies with the configuration of the FE model set-up by the author.

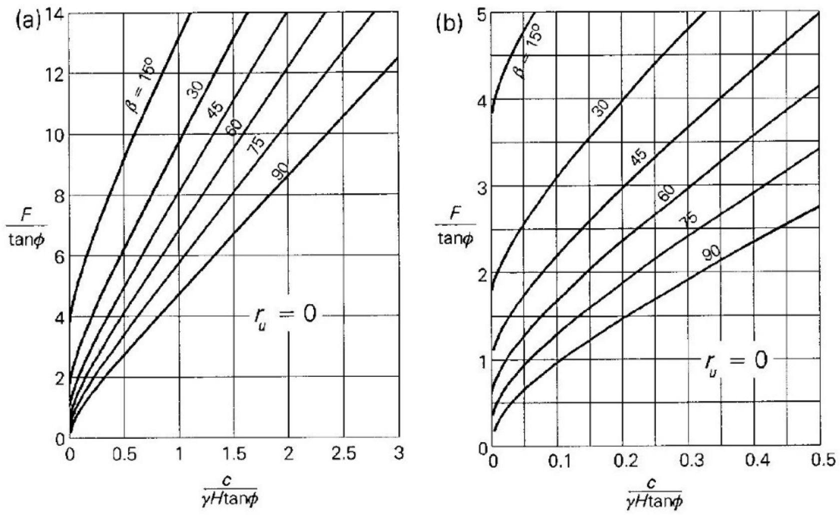


Figure 4.19: Graphical Relationship between Sn & FOS (Michalowski, 2002)

Huang & Ji (2022) studied slope stability issue with respect to regional earthquake-induced landslide prediction under rotational failure mechanism. The researchers referred to numbers of previous scholars including Chen (1975), Baker & Garber (1978) and Louidis et al. (2003) to establish the following mathematical relationship between Sn and FOS;

$$\frac{F}{\tan\phi'} = A\left(\frac{c'}{\gamma H \tan\phi'}\right)^{B} + \frac{1}{\tan\beta}$$

$$\textit{Where} \quad A = 10.50\ \exp(-0.009\beta)$$

$$B = \begin{cases} 0.72 - 3.5\times 10^{-5}\beta^2 + 0.0031\beta if 0 \le \frac{c'}{\gamma H\tan\phi'} \le 1 \\ 0.83 - 2.2\times 10^{-5}\beta^2 + 0.0026\beta if 1 < \frac{c'}{\gamma H\tan\phi'} \le 3 \end{cases}$$

The author thereafter reviewed these two conversions to visualize/examine any difference between them as well their applicability before deciding which conversion is to be adopted. The Table 4.6 elaborated the values of comparison.

Table 4.6: Comparison between Michalowski (2002) and Huang & Ji (2022)

Sn	Michalowski (2002)	Huang & Ji (2022)	Difference
c / γ H*tan φ	FOS / tan φ	FOS / tan φ	
0.100	0.957	0.899	-6.4%
0.150	1.223	1.202	-1.7%
0.200	1.469	1.477	0.5%
0.300	1.917	1.974	2.9%
0.400	2.359	2.425	2.7%
0.500	2.762	2.845	2.9%
		Average =	0.2%

As shown on Table 4.6, both researchers have concluded a conversion with good agreement from one and other. The author would therefore reckon that FOS for forthcoming comparison proposed by the author by using conversion from both methods may be unnecessary. The selection of either method falls into the applicability. The author finally decided to select Huang & Ji (2022) because the conversion method by equation is slightly more accurate and easier for use.

4.5.3 Discussion between the calculated FOS from Regression Equations and Prediction from Previous Researchers

The author thereafter created a comprehensive summary aiming to reflect the phenomena, reliability as well as performance of the developed equations by comparing to the prediction of FOSs in accordance with the outcome from previous researchers. The summary is formed by a series of FOSs (i) firstly calculated from the developed regression equations, and (ii) estimated with reference to table/chart or closed-form equations from previous researches. The range of FOSs is with respect to H/b ratio from 1 to 10 so as to tally with the scope of study of those previous researches by Khatri & Kumar (2010) and Keawsawasvong (2017). Whilst, the series of calculated FOSs from the regression equations is with respect to the optimum excavation interval (which is from 2.0m to 3.0m) proposed in Chapter 4.3.1. Figures 4.20 is then created as a graphical illustration demonstrating the comparison.

Figures 4.20 clearly shows that the method by Khatri & Kumar (2010) and Keawaswsavong (2017) are both possibly insufficient to accurately predict the FOSs for segmental excavation for a circular shaft with diameter from 1.5m to 3.0m. Since both researchers created the prediction based on H/b ratio meaning that FOS is estimated to be the same under a same H/b ratio as of the following example;

Table 4.7: Example of FOSs among Khatri & Kumar (2010), Keawsawasvong (2017) and Regression Equation (for H/b=4 and ϕ =35°)

H (m)	B (m)	Dia. (m)	H/b	FOS based on		FOS from Regression Equation	% Difference (-ve: under-estimated) (+ve: over-estimated)
				Khatri & Kumar (2010)	Keawaswsavong (2017)		
4.0	1.0	2.0	4	1.063	1.032	1.380 (Ep = 2.0m)	-29.8% (Khatri & Kumar) -33.7% (Keawaswsavong)
6.0	1.5	3.0	4	1.063	1.032	1.300 (Ep = 2.0m)	-22.3% (Khatri & Kumar) -26.0% (Keawaswsavong)

Table 4.7 is one of the author's observations showing the deficiency from the previous researches about the accuracy/reliability of predicting FOS because the author has demonstrated the diameter of the circular shaft excavation is one of the factors influencing the variation of FOS as presented in Chapter 4.3. As shown, the FOSs from Khatri & Kumar (2010) and Keswaswsavong (2017) (although the values from both researchers are close to each other) has both been under-estimated comparing to the values from regression equations. The author critically reviewed that this under-estimation is still tolerable in view of the nature of design,

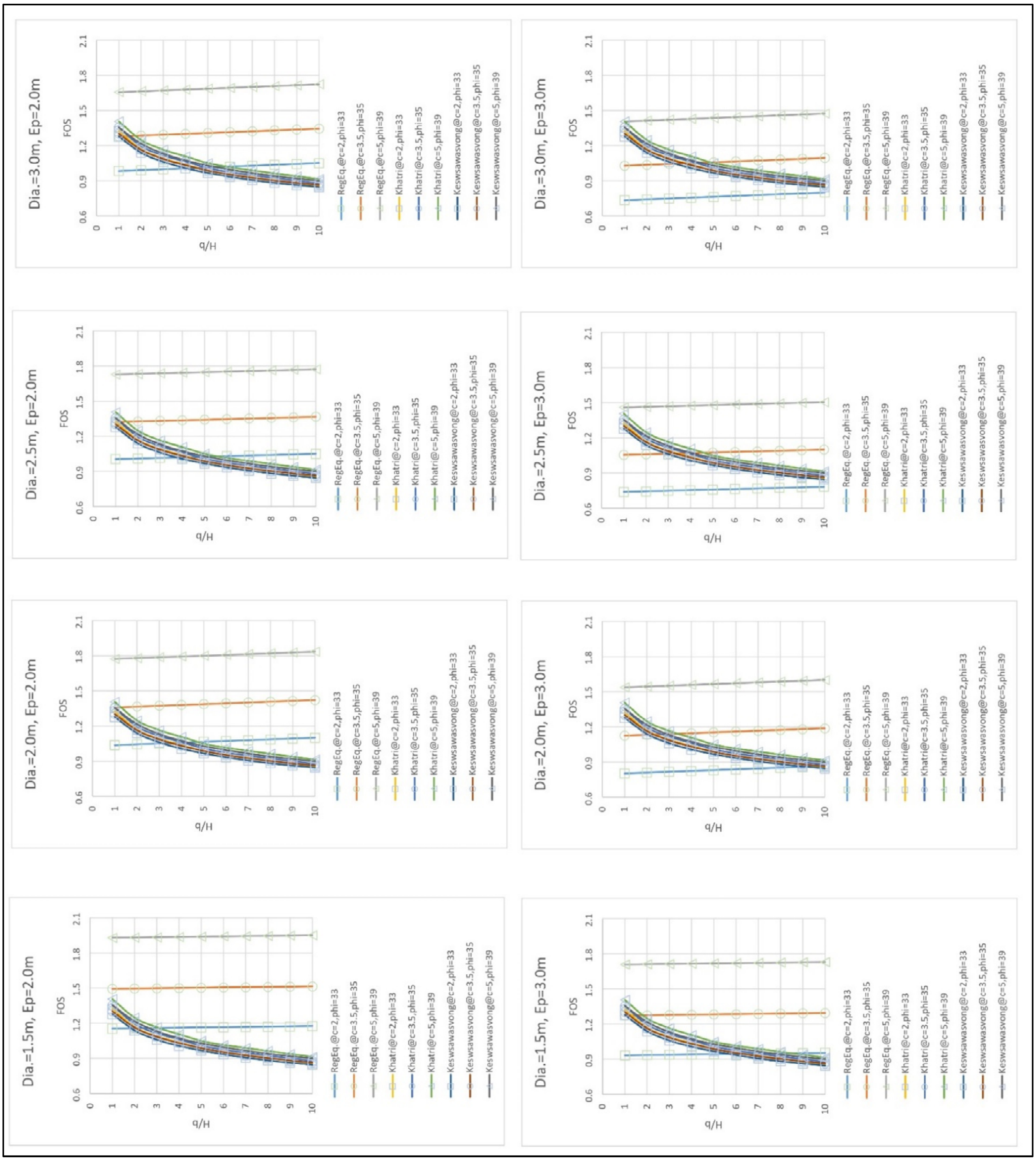


Figure 4.20: Graphical Presentation of Comprehensive Comparison about FOS from H/b Ratio

i.e. too conservative. The percentage of under-estimation of the example ranges from -22.3% to -33.7%. However, the author also observed the case of over-estimation as shown in Table 4.8.

Table 4.8: Example of FOSs among Khatri & Kumar (2010), Keawsawasvong (2017) and Regression Equation (for H/b=4 and ϕ =33^{o})

H (m)	B (m)	Dia. (m)	H/b	FOS based on		FOS from Regression Equation	% Difference (-ve: under-estimated) (+ve over-estimated)
				Khatri & Kumar (2010)	Keawaswsavong (2017)		
4.0	1.0	2.0	4	1.038	1.007	0.824 (Ep = 3.0m)	+20.6% (Khatri & Kumar) +18.2% (Keawaswsavong)
6.0	1.5	3.0	4	1.038	1.007	0.755 (Ep = 3.0m)	+27.3% (Khatri & Kumar) +25.0% (Keawaswsavong)

As shown on the above table, both previous researchers have over-estimated the FOS by percentages ranging from +18.2% to +27.3%. This over-estimation could cause irreversible disaster for a real-lift project if the situation is overlooked.

Since under-estimated or over-estimated scenarios were both observed, the author thereafter summarized the percentage difference between FOS from regression equations and from previous researches so as to visualize the distribution of FOS values in Table 4.9 below.

Table 4.9: Distribution of FOSs among Khatri & Kumar (2010), Keawsawasvong (2017) and Regression Equations

Ep (m)	H/b	Maximum Percentage Difference (%) -ve: under-estimated / +ve: over-estimated								
		φ= 33			φ= 35			φ= 39		
		K&K[1]	Kea.[2]	Reg.Eq.[3]	K&K[1]	Kea.[2]	Reg.Eq.[3]	K&K[1]	Kea.[2]	Reg.Eq.[3]
2.0	1	+12.8 (Dia.=1.5m)	+9.6 (Dia.=1.5m)	0 (Dia.=1.5m)	-10.4 (Dia.=1.5m)	-14.7 (Dia.=1.5m)	0 (Dia.=1.5m)	-37.2 (Dia.=1.5m)	-42.7 (Dia.=1.5m)	0 (Dia.=1.5m)
	5	-18.0 (Dia.=1.5m)	-20.3 (Dia.=1.5m)	0 (Dia.=1.5m)	-49.1 (Dia.=1.5m)	-52.2 (Dia.=1.5m)	0 (Dia.=1.5m)	-84.7 (Dia.=1.5m)	-88.4 (Dia.=1.5m)	0 (Dia.=1.5m)
	10	-37.0 (Dia.=1.5m)	-39.1 (Dia.=1.5m)	0 (Dia.=1.5m)	-72.6 (Dia.=1.5m)	-75.2 (Dia.=1.5m)	0 (Dia.=1.5m)	**-113.5** (Dia.=1.5m)	**-116.9** (Dia.=1.5m)	0 (Dia.=1.5m)
3.0	1	**+44.7** (Dia.=3.0m)	**+42.6** (Dia.=3.0m)	0 (Dia.=3.0m)	+24.1 (Dia.=3.0m)	+21.1 (Dia.=3.0m)	0 (Dia.=3.0m)	+0.1 (Dia.=3.0m)	-3.7 (Dia.=3.0m)	0 (Dia.=3.0m)
	5	+22.7 (Dia.=3.0m)	+21.2 (Dia.=3.0m)	0 (Dia.=3.0m)	-4.8 (Dia.=3.0m)	-7.0 (Dia.=3.0m)	0 (Dia.=3.0m)	-36.7 (Dia.=3.0m)	-39.5 (Dia.=3.0m)	0 (Dia.=3.0m)
	10	+6.9 (Dia.=3.0m)	+5.4 (Dia.=3.0m)	0 (Dia.=3.0m)	-24.6 (Dia.=3.0m)	-26.5 (Dia.=3.0m)	0 (Dia.=3.0m)	-61.1 (Dia.=3.0m)	-63.7 (Dia.=3.0m)	0 (Dia.=3.0m)

Note ~ 1: Khatri & Kumar (2010), 2: Keawsawasvong (2027), 3: Regression Equation developed by the author.

Remark ~ The bold values are the absolute maximum and minimum.

The table shows that the most extreme situation is under-estimated by -113.5% / -116.9% or over-estimated by +44.7% / +42.6%. The author reckons that the range of under-estimation and over-estimation are both intolerable when adopting the previous researches outcome to predict the FOS of segmental excavation of a circular caisson shaft. In contrast, the developed regression equations would therefore be more appropriate to be used for FOS prediction for the case of segmental excavation of a circular shaft with diameter from 1.5m to 3.0m because of the following observations;

- The FOS decreases when the H/b ratio increases for Khatri & Kumar and Keawsawasvong. Whilst, the FOS from regression equation is in opposite.
- The distribution of the curves of Khatri and Kumar and Keswsawasvong are relatively concentrated comparing to those distributions of the regression equations. Hence, the level of influence from shear strength parameter of soil of regression equations is observed owning a much more significant effect than those of Khatri & Kumar and Keawsawasvong. The percentage of over-estimation or under-estimation is thus more obvious.
- The previous literatures have not taken segmental excavation depth (Ep) into account during their formulation of FOS prediction. Figures 4.20 has then shown the level of influence of Ep to be so critical that the variation of percentage difference in FOS could be reversed from -10.4% / -14.7% (under-estimated scenario) to +6.0% / +2.3% (over-estimated scenarios) under the case of ϕ angle equal to 35^o and caisson diameter at 1.5m with Ep changed from 2.0m to 3.0m.
- The most extreme under-estimation occurs at larger excavation diameter (i.e. Dia.=3.0m) and larger excavation interval Ep (i.e. Ep=3.0m) as shown on Figure 4.20. The portion of the under-estimation reduces when both of the diameter and Ep decrease.
- The sensitivity of “Diameter” affecting the FOS is found less influencing under the same Ep. On the contrary, the influencing level of Ep is observed to be more significant under the same excavation diameter.

In conclusion from the above comprehensive comparison, the use of previous research outcome by Khatri & Kumar and Keswsawasvong is probably insufficient to obtain an accurate prediction of FOS with respect to proposed optimum segmental excavation interval (Ep) for a caisson shaft excavation with diameter from 1.5m to 3.0m. Alternatively, the above observations shall have clearly shown the differences between the previous research outcomes and this study, when these differences lead to an inapplicable and incorrect prediction of FOS for a partially supported segmental circular excavation if following the previous research outcome. In contrast, the use of developed regression equations is able to provide a more accurate prediction of FOS because the effect from Ep, caisson diameter as well as shear strength parameters of soil have all been properly considered by the developed equations.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATION

This chapter covers the summary of major findings of this study, the associated research implications, limitations and recommendation for future research.

5.1 Summary of Major Findings

The most important research objective of this study is recalled as to theoretically investigate the optimum depth or interval of each segmental excavation along the depth of caisson so as to predict the FOS of a vertically excavated and partially unsupported shaft. This objective was satisfactorily achieved after the author has performed a series of FE analysis. The author based on the analyzed results to conclude a suggestion of the optimum segmental excavation interval to be in a range from 2.0m to 3.0m for various diameters (including 1.5, 2.0m, 2.5m and 3.0m) of a caisson. The author also developed 4 regression equations (with respect to caisson diameter of 1.5m, 2.0m, 2.5m and 3.0m) enabling the prediction of FOS according to the geometric parameter of the caisson shaft and geotechnical parameters of the subjected site. One of the regression equations was selected to be validated by a real shaft excavation with on-site monitoring or measurement of any stress-change at the location of the potential failure surface. Since the validation is found to be only partially reflected, the author thereafter produced another comprehensive comparison so as to reflect the phenomena of the developed regression equations against the previous researches' outcome. The most important finding from this comparison is regarding to the limitation of FOS prediction from previous research outcome resulting in under-estimation by about -116% and over-estimation by about +44.7% in extreme. In contrast, the developed equations are able to provide a more accurate prediction of FOS because all influence factors (e.g. segmental excavation depth ~ Ep, arching effect related to caisson diameter and shear strength parameters of soil) have been properly been considered during the establishment of the equations.

In addition, the following research findings are also concluded:

1. The FOS of segmental vertical excavations which are partially unsupported was found to be approximately direct-proportional to SF along the depth of caisson (maximum 15m deep) being applicable for caisson diameter from 1.5m to 3.0m.

2. The smaller caisson diameter (Dia), the higher FOS of segmental vertical excavations along the depth of caisson (maximum 15 deep) under the scenario of same excavation depth (Ep).
3. The FOS of segmental vertical excavations was more fluctuated for a smaller excavation interval (Ep) along the depth of a caisson.
4. The smaller excavation depth (Ep), the higher FOS of segmental vertical excavations along the depth of caisson (maximum 15m deep) under the scenario of same caisson diameter (Dia).
5. The FOS decreases when the H/b ratio increases for Khatri & Kumar and Keawsawasvong. However, the trend is found opposite for the developed regression equation.
6. The distribution of FOS predicted by regression equations is found to be substantially varied with respect to the effect from shear strength parameter of soil when comparing to those distributions estimated according to Khatri & Kumar and Keawsawasvong. This is one of the observations in relation to the cause of obvious over-estimation or under-estimation among the author's regression equations, Khatri & Kumar and Keawsawasvong.
7. Segmental excavation interval (Ep) has not been considered by Khatri & Kumar and Keawsawasvong resulting in that the FOS predicted by the author's regression equations may change from over-estimation to under-estimation for some cases with the same caisson diameter and shear strength parameters of soil but under different Ep. This is one of the important deficiency observed from the previous research outcome in relation to this study.

5.2 Expected contributions

Both of the theoretical/academic and practical contribution are expected to have been achieved from this study by the author.

The first academic contribution is about the formulation of empirical equations with adopting finite element approach and modelling so as to enable a prediction of FOSs (as an alternative expression to describe the level of stability of a geotechnical condition similar to Stability Numbers according to Khatri & Kumar 2010 and Keawsawasyong 2017) of the segmental progressive excavation, in a form of being vertical and circular, according to various input including diameter of the excavation as well as geotechnical parameters. These equations enable the prediction of the optimum/maximum segmental excavation interval by eliminating hazard from shaft collapse.

The second academic contribution falls into the observation from the comprehensive comparison among the developed regression equations by the author and research outcome by Khatri & Kumar and Keawsawasvong. The most important finding from the comparison is about the deficiency of FOS prediction for a circular shaft excavation by previous researchers, because they have not covered the consideration from segmental excavation interval (Ep). Whilst, the importance of shear strength parameter as well as the arching effect related to the caisson diameter may have not been fully reflected from the previous researches. As a result from all these deficiencies, the FOS prediction according to the previous researches is not only found with insufficient accuracy, but also possibly be under-estimated or over-estimated by -116% or +44.7% respectively.

Further to the above academic contribution, the actual practical contribution of this study is possibly about the elimination the potential hazard of shaft collapse. The old practice in the past to check the sign of distress or collapse from the segmental excavation was only by visual inspection by workers. The reliability of the method was rather low since the scientific basis of the method was considerably insufficient and weak. The enabling of predicting FOS therefore allows the site supervisor to scientifically check the safety level of the subjected excavation in advance, so as to ensure that the depth of segmental excavation would not cause hazards to workers or harm to surrounding ground or structures and eventually guaranteeing construction safety and quality throughout the entire construction.

5.3 Limitation and Recommendation for Future Research

This study is framed by specific research approaches, conditions, and assumptions, which are outlined as follows. First, the analysis is limited to homogeneous cohesive soil aligning with the typical geological conditions found in Hong Kong. Second, the increase in soil strength with depth, specifically regarding the friction angle and cohesion, has not been considered in this study. Additionally, the effects of groundwater and lateral earth pressure induced by surcharge loads at the ground level have been excluded from the finite element (FE) modeling and analysis. Lastly, the geometrical parameters for the caisson, including diameters ranging from 1.5 meters to 3.0 meters and a maximum excavation depth of 15 meters, are confined to those specified in previous chapters due to the scope of this research.

In light of these limitations, several recommendations for future research are proposed. First, it is advisable to explore a broader range of soil shear strengths, particularly for cohesionless soils, to enhance the coverage and generalizability of the developed empirical equations. Second, the introduction of a dimensionless factor, denoted as “m” (Kumar et al., 2014), which defines the rate of increase of shear strength parameters with depth, should be considered in the configuration of the finite element model and subsequent analyses. Furthermore, incorporating groundwater conditions and surcharge loads into the FE software would allow for a more comprehensive modeling approach, necessitating adjustments in the regression analysis used to formulate empirical equations. These incorporations are anticipated to significantly enhance the generality of the regression equations since the real-world situations probably encountered during the shaft excavation have all been considered, although the complexity when formulating the regression equations is unavoidable. Finally, the introduction of a ratio representing "overall depth to caisson diameter" as a modified variable may also be implemented to improve the generalization of the equations derived from this study.

Another recommendation in addition to the above is to study and/or assess the sensitivity analysis of the change of Ep (Excavation Depth/Interval) in progress of shaft excavation of one caisson. The Ep along the entire excavation depth is a constant under one single caisson in this current study, but this could possibly be changed or adjusted along the shaft excavation in a real-world situation. The FE models are also able to be configured to suit the change of Ep along the depth of the caisson excavation. Nevertheless, this recommendation is probably a time-consuming activity because this sensitivity analysis involves substantially large amount of models and work-load. The outcome, however, from this sensitivity analysis could be further enhance the generality and applicability of the regression equations, which is therefore recommended.

The author would also recommend to explore the possible use of robotic system to replace dangerous or harmful construction activities in view of the current advancement of robotic technology. The subject research is one of the examples introducing a robotic excavator to replace the original human excavation activities. The author truly believes that this introduction can definitely improve the safety and health level originally suffered by human, which eventually benefit the construction industry of Hong Kong.

Chapter 4.4.1 to 4.4.3 has presented the prototype by the research team showing the possibility of introducing robotic system into caisson shaft excavation. Shaft excavation in trial using the prototype was also presented. The excavation trial could not only be used for feasibility testing to the developed machine, but also create opportunities for on-site measurement about the stability level of a partially supported shaft in relation to the discussion in Chapter 4.4.4. Therefore, on-site measurements with respect to various combinations of caisson diameter, overall excavation depth, excavation interval and different geological condition are so valuable and should be further conducted when the prototype is being modified, configured and tested. In the progress of the development of the prototype complete with site trials, a comprehensive database of measured values with respect to various combinations of variables (including caisson diameter, overall excavation depth, segmental excavation interval, different geological condition) could be established. This establishment of the database is extremely beneficial and crucial for validating or conducting back-analysis to the regression equations, resulting that a more robust research outcome can be finally achieved.

APPENDICES

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
2	33	66	1.5	1	1	1.310	1.5	1.5	1.179									
2	33	66	1.5	2	1	1.264				2	2	1.088	2.5	2.5	Unstable			
2	33	66	1.5	3	1	1.272	3	1.5	1.112							3	3	Unstable
2	33	66	1.5	4	1	1.337	4.5	1.5	1.123	4	2	1.070						
2	33	66	1.5	5	1	1.334							5	2.5	Unstable			
2	33	66	1.5	6	1	1.408	6	1.5	1.229	6	2	1.120				6	3	Unstable
2	33	66	1.5	7	1	1.375	7.5	1.5	1.236				7.5	2.5	Unstable			
2	33	66	1.5	8	1	1.320				8	2	1.08						
2	33	66	1.5	9	1	1.302	9	1.5	1.143							9	3	Unstable
2	33	66	1.5	10	1	1.411	10.5	1.5	1.150	10	2	1.111	10	2.5	Unstable			
2	33	66	1.5	11	1	1.365												
2	33	66	1.5	12	1	1.365	12	1.5	1.177	12	2	1.100	12.5	2.5	Unstable	12	3	Unstable
2	33	66	1.5	13	1	1.351	13.5	1.5	1.244									
2	33	66	1.5	14	1	1.352				14	2	1.105						
2	33	66	1.5	15	1	1.356	15	1.5	1.191				15	2.5	Unstable	15	3	Unstable
2	33	66	2	1	1	1.214	1.5	1.5	1.103									
2	33	66	2	2	1	1.135				2	2	Unstable	2.5	2.5	Unstable			
2	33	66	2	3	1	1.131	3	1.5	1.118							3	3	Unstable
2	33	66	2	4	1	1.247	4.5	1.5	1.078	4	2	Unstable						
2	33	66	2	5	1	1.261							5	2.5	Unstable			
2	33	66	2	6	1	1.266	6	1.5	1.054	6	2	Unstable				6	3	Unstable
2	33	66	2	7	1	1.310	7.5	1.5	1.149				7.5	2.5	Unstable			
2	33	66	2	8	1	1.327				8	2	Unstable						
2	33	66	2	9	1	1.316	9	1.5	1.163							9	3	Unstable
2	33	66	2	10	1	1.339	10.5	1.5	1.091	10	2	Unstable	10	2.5	Unstable			
2	33	66	2	11	1	1.290												
2	33	66	2	12	1	1.231	12	1.5	1.138	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	33	66	2	13	1	1.340	13.5	1.5	1.108									
2	33	66	2	14	1	1.354				14	2	Unstable						
2	33	66	2	15	1	1.243	15	1.5	1.206				15	2.5	Unstable	15	3	Unstable
2	33	66	2.5	1	1	1.255	1.5	1.5	Unstable									
2	33	66	2.5	2	1	1.160				2	2	Unstable	2.5	2.5	Unstable			
2	33	66	2.5	3	1	1.155	3	1.5	Unstable							3	3	Unstable
2	33	66	2.5	4	1	1.156	4.5	1.5	Unstable	4	2	Unstable						
2	33	66	2.5	5	1	1.244							5	2.5	Unstable			
2	33	66	2.5	6	1	1.235	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	33	66	2.5	7	1	1.219	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	33	66	2.5	8	1	1.264				8	2	Unstable						
2	33	66	2.5	9	1	1.240	9	1.5	Unstable							9	3	Unstable
2	33	66	2.5	10	1	1.281	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	33	66	2.5	11	1	1.206												
2	33	66	2.5	12	1	1.226	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	33	66	2.5	13	1	1.297	13.5	1.5	Unstable									
2	33	66	2.5	14	1	1.271				14	2	Unstable						
2	33	66	2.5	15	1	1.252	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable
2	33	66	3	1	1	1.122	1.5	1.5	Unstable									
2	33	66	3	2	1	1.139				2	2	Unstable	2.5	2.5	Unstable			
2	33	66	3	3	1	1.201	3	1.5	Unstable							3	3	Unstable
2	33	66	3	4	1	1.139	4.5	1.5	Unstable	4	2	Unstable						
2	33	66	3	5	1	1.216							5	2.5	Unstable			
2	33	66	3	6	1	1.111	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	33	66	3	7	1	1.293	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	33	66	3	8	1	1.265				8	2	Unstable						
2	33	66	3	9	1	1.247	9	1.5	Unstable							9	3	Unstable
2	33	66	3	10	1	1.260	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	33	66	3	11	1	1.244												
2	33	66	3	12	1	1.142	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	33	66	3	13	1	1.169	13.5	1.5	Unstable									
2	33	66	3	14	1	1.145				14	2	Unstable						
2	33	66	3	15	1	1.158	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
2	35	70	1.5	1	1	1.341	1.5	1.5	1.224									
2	35	70	1.5	2	1	1.327				2	2	1.131	2.5	2.5	1.028			
2	35	70	1.5	3	1	1.332	3	1.5	1.168							3	3	1.026
2	35	70	1.5	4	1	1.408	4.5	1.5	1.164	4	2	1.128						
2	35	70	1.5	5	1	1.397							5	2.5	1.062			
2	35	70	1.5	6	1	1.468	6	1.5	1.281	6	2	1.156				6	3	1.022
2	35	70	1.5	7	1	1.436	7.5	1.5	1.286				7.5	2.5	1.083			
2	35	70	1.5	8	1	1.372				8	2	1.127						
2	35	70	1.5	9	1	1.335	9	1.5	1.177							9	3	1.036
2	35	70	1.5	10	1	1.466	10.5	1.5	1.192	10	2	1.157	10	2.5	1.095			
2	35	70	1.5	11	1	1.421												
2	35	70	1.5	12	1	1.426	12	1.5	1.227	12	2	1.160	12.5	2.5	1.108	12	3	1.036
2	35	70	1.5	13	1	1.396	13.5	1.5	1.299									
2	35	70	1.5	14	1	1.404				14	2	1.15						
2	35	70	1.5	15	1	1.402	15	1.5	1.219				15	2.5	1.069	15	3	1.005
2	35	70	2	1	1	1.250	1.5	1.5	1.128									
2	35	70	2	2	1	1.181				2	2	1.029	2.5	2.5	Unstable			
2	35	70	2	3	1	1.203	3	1.5	1.018							3	3	Unstable
2	35	70	2	4	1	1.310	4.5	1.5	1.133	4	2	1.017						
2	35	70	2	5	1	1.275							5	2.5	Unstable			
2	35	70	2	6	1	1.307	6	1.5	1.117	6	2	1.030				6	3	Unstable
2	35	70	2	7	1	1.367	7.5	1.5	1.116				7.5	2.5	Unstable			
2	35	70	2	8	1	1.392				8	2	1.058						
2	35	70	2	9	1	1.365	9	1.5	1.068							9	3	Unstable
2	35	70	2	10	1	1.397	10.5	1.5	1.125	10	2	1.062	10	2.5	Unstable			
2	35	70	2	11	1	1.332												
2	35	70	2	12	1	1.362	12	1.5	1.109	12	2	1.060	12.5	2.5	Unstable	12	3	Unstable
2	35	70	2	13	1	1.381	13.5	1.5	1.142									
2	35	70	2	14	1	1.419				14	2	1.132						
2	35	70	2	15	1	1.319	15	1.5	1.130				15	2.5	Unstable	15	3	Unstable
2	35	70	2.5	1	1	1.298	1.5	1.5	Unstable									
2	35	70	2.5	2	1	1.210				2	2	Unstable	2.5	2.5	Unstable			
2	35	70	2.5	3	1	1.208	3	1.5	Unstable							3	3	Unstable
2	35	70	2.5	4	1	1.204	4.5	1.5	Unstable	4	2	Unstable						
2	35	70	2.5	5	1	1.295							5	2.5	Unstable			
2	35	70	2.5	6	1	1.278	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	35	70	2.5	7	1	1.276	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	35	70	2.5	8	1	1.294				8	2	Unstable						
2	35	70	2.5	9	1	1.282	9	1.5	Unstable							9	3	Unstable
2	35	70	2.5	10	1	1.327	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	35	70	2.5	11	1	1.270												
2	35	70	2.5	12	1	1.192	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	35	70	2.5	13	1	1.353	13.5	1.5	Unstable									
2	35	70	2.5	14	1	1.320				14	2	Unstable						
2	35	70	2.5	15	1	1.286	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable
2	35	70	3	1	1	1.160	1.5	1.5	Unstable									
2	35	70	3	2	1	1.193				2	2	Unstable	2.5	2.5	Unstable			
2	35	70	3	3	1	1.259	3	1.5	Unstable							3	3	Unstable
2	35	70	3	4	1	1.205	4.5	1.5	Unstable	4	2	Unstable						
2	35	70	3	5	1	1.266							5	2.5	Unstable			
2	35	70	3	6	1	1.149	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	35	70	3	7	1	1.355	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	35	70	3	8	1	1.318				8	2	Unstable						
2	35	70	3	9	1	1.288	9	1.5	Unstable							9	3	Unstable
2	35	70	3	10	1	1.306	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	35	70	3	11	1	1.273												
2	35	70	3	12	1	1.174	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	35	70	3	13	1	1.204	13.5	1.5	Unstable									
2	35	70	3	14	1	1.203				14	2	Unstable						
2	35	70	3	15	1	1.193	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
2	37	74	1.5	1	1	1.405	1.5	1.5	1.264									
2	37	74	1.5	2	1	1.380				2	2	1.128	2.5	2.5	1.080			
2	37	74	1.5	3	1	1.394	3	1.5	1.215							3	3	1.054
2	37	74	1.5	4	1	1.462	4.5	1.5	1.210	4	2	1.140						
2	37	74	1.5	5	1	1.456							5	2.5	1.101			
2	37	74	1.5	6	1	1.533	6	1.5	1.328	6	2	1.146				6	3	1.081
2	37	74	1.5	7	1	1.494	7.5	1.5	1.326				7.5	2.5	1.139			
2	37	74	1.5	8	1	1.415				8	2	1.162						
2	37	74	1.5	9	1	1.366	9	1.5	1.226							9	3	1.062
2	37	74	1.5	10	1	1.530	10.5	1.5	1.227	10	2	1.161	10	2.5	1.142			
2	37	74	1.5	11	1	1.492												
2	37	74	1.5	12	1	1.453	12	1.5	1.262	12	2	1.141	12.5	2.5	1.161	12	3	1.043
2	37	74	1.5	13	1	1.459	13.5	1.5	1.335									
2	37	74	1.5	14	1	1.447				14	2	1.141						
2	37	74	1.5	15	1	1.443	15	1.5	1.281				15	2.5	1.108	15	3	1.066
2	37	74	2	1	1	1.288	1.5	1.5	1.163									
2	37	74	2	2	1	1.239				2	2	1.070	2.5	2.5	Unstable			
2	37	74	2	3	1	1.242	3	1.5	1.063							3	3	Unstable
2	37	74	2	4	1	1.363	4.5	1.5	1.162	4	2	1.070						
2	37	74	2	5	1	1.343							5	2.5	Unstable			
2	37	74	2	6	1	1.365	6	1.5	1.157	6	2	1.060				6	3	Unstable
2	37	74	2	7	1	1.414	7.5	1.5	1.145				7.5	2.5	Unstable			
2	37	74	2	8	1	1.447				8	2	1.092						
2	37	74	2	9	1	1.397	9	1.5	1.106							9	3	Unstable
2	37	74	2	10	1	1.438	10.5	1.5	1.157	10	2	1.109	10	2.5	Unstable			
2	37	74	2	11	1	1.387												
2	37	74	2	12	1	1.340	12	1.5	1.158	12	2	1.118	12.5	2.5	Unstable	12	3	Unstable
2	37	74	2	13	1	1.431	13.5	1.5	1.181									
2	37	74	2	14	1	1.464				14	2	1.170						
2	37	74	2	15	1	1.363	15	1.5	1.164				15	2.5	Unstable	15	3	Unstable
2	37	74	2.5	1	1	1.319	1.5	1.5	Unstable									
2	37	74	2.5	2	1	1.258				2	2	Unstable	2.5	2.5	Unstable			
2	37	74	2.5	3	1	1.255	3	1.5	Unstable							3	3	Unstable
2	37	74	2.5	4	1	1.227	4.5	1.5	Unstable	4	2	Unstable						
2	37	74	2.5	5	1	1.342							5	2.5	Unstable			
2	37	74	2.5	6	1	1.323	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	37	74	2.5	7	1	1.298	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	37	74	2.5	8	1	1.350				8	2	Unstable						
2	37	74	2.5	9	1	1.308	9	1.5	Unstable							9	3	Unstable
2	37	74	2.5	10	1	1.382	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	37	74	2.5	11	1	1.324												
2	37	74	2.5	12	1	1.218	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	37	74	2.5	13	1	1.404	13.5	1.5	Unstable									
2	37	74	2.5	14	1	1.358				14	2	Unstable						
2	37	74	2.5	15	1	1.334	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable
2	37	74	3	1	1	1.193	1.5	1.5	Unstable									
2	37	74	3	2	1	1.251				2	2	Unstable	2.5	2.5	Unstable			
2	37	74	3	3	1	1.321	3	1.5	Unstable							3	3	Unstable
2	37	74	3	4	1	1.226	4.5	1.5	Unstable	4	2	Unstable						
2	37	74	3	5	1	1.317							5	2.5	Unstable			
2	37	74	3	6	1	1.186	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	37	74	3	7	1	1.416	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	37	74	3	8	1	1.370				8	2	Unstable						
2	37	74	3	9	1	1.316	9	1.5	Unstable							9	3	Unstable
2	37	74	3	10	1	1.380	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	37	74	3	11	1	1.310												
2	37	74	3	12	1	1.202	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	37	74	3	13	1	1.271	13.5	1.5	Unstable									
2	37	74	3	14	1	1.218				14	2	Unstable						
2	37	74	3	15	1	1.240	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
2	39	78	1.5	1	1	1.440	1.5	1.5	1.324									
2	39	78	1.5	2	1	1.451				2	2	1.219	2.5	2.5	1.127			
2	39	78	1.5	3	1	1.452	3	1.5	1.271							3	3	1.089
2	39	78	1.5	4	1	1.519	4.5	1.5	1.249	4	2	1.215						
2	39	78	1.5	5	1	1.532							5	2.5	1.142			
2	39	78	1.5	6	1	1.600	6	1.5	1.378	6	2	1.253				6	3	1.127
2	39	78	1.5	7	1	1.527	7.5	1.5	1.385				7.5	2.5	1.190			
2	39	78	1.5	8	1	1.465				8	2	1.212						
2	39	78	1.5	9	1	1.439	9	1.5	1.254							9	3	1.106
2	39	78	1.5	10	1	1.584	10.5	1.5	1.280	10	2	1.245	10	2.5	1.203			
2	39	78	1.5	11	1	1.524												
2	39	78	1.5	12	1	1.510	12	1.5	1.327	12	2	1.251	12.5	2.5	1.205	12	3	1.104
2	39	78	1.5	13	1	1.516	13.5	1.5	1.387									
2	39	78	1.5	14	1	1.504				14	2	1.225						
2	39	78	1.5	15	1	1.491	15	1.5	1.305				15	2.5	1.158	15	3	1.109
2	39	78	2	1	1	1.330	1.5	1.5	1.210									
2	39	78	2	2	1	1.278				2	2	1.102	2.5	2.5	1.052			
2	39	78	2	3	1	1.318	3	1.5	1.083							3	3	Unstable
2	39	78	2	4	1	1.428	4.5	1.5	1.192	4	2	1.115						
2	39	78	2	5	1	1.418							5	2.5	1.032			
2	39	78	2	6	1	1.392	6	1.5	1.195	6	2	1.121				6	3	Unstable
2	39	78	2	7	1	1.464	7.5	1.5	1.181				7.5	2.5	1.060			
2	39	78	2	8	1	1.523				8	2	1.130						
2	39	78	2	9	1	1.456	9	1.5	1.144							9	3	Unstable
2	39	78	2	10	1	1.497	10.5	1.5	1.183	10	2	1.151	10	2.5	1.072			
2	39	78	2	11	1	1.428												
2	39	78	2	12	1	1.383	12	1.5	1.196	12	2	1.139	12.5	2.5	1.078	12	3	Unstable
2	39	78	2	13	1	1.494	13.5	1.5	1.219									
2	39	78	2	14	1	1.474				14	2	1.214						
2	39	78	2	15	1	1.414	15	1.5	1.209				15	2.5	1.039	15	3	Unstable
2	39	78	2.5	1	1	1.392	1.5	1.5	1.069									
2	39	78	2.5	2	1	1.307				2	2	1.031	2.5	2.5	Unstable			
2	39	78	2.5	3	1	1.320	3	1.5	1.044							3	3	Unstable
2	39	78	2.5	4	1	1.291	4.5	1.5	1.101	4	2	0.991						
2	39	78	2.5	5	1	1.391							5	2.5	Unstable			
2	39	78	2.5	6	1	1.365	6	1.5	1.119	6	2	1.040				6	3	Unstable
2	39	78	2.5	7	1	1.347	7.5	1.5	1.112				7.5	2.5	Unstable			
2	39	78	2.5	8	1	1.396				8	2	1.041						
2	39	78	2.5	9	1	1.365	9	1.5	1.106							9	3	Unstable
2	39	78	2.5	10	1	1.441	10.5	1.5	1.129	10	2	1.080	10	2.5	Unstable			
2	39	78	2.5	11	1	1.347												
2	39	78	2.5	12	1	1.237	12	1.5	1.141	12	2	1.068	12.5	2.5	Unstable	12	3	Unstable
2	39	78	2.5	13	1	1.460	13.5	1.5	1.111									
2	39	78	2.5	14	1	1.402				14	2	1.037						
2	39	78	2.5	15	1	1.384	15	1.5	1.156				15	2.5	Unstable	15	3	Unstable
2	39	78	3	1	1	1.225	1.5	1.5	Unstable									
2	39	78	3	2	1	1.318				2	2	Unstable	2.5	2.5	Unstable			
2	39	78	3	3	1	1.386	3	1.5	Unstable							3	3	Unstable
2	39	78	3	4	1	1.252	4.5	1.5	Unstable	4	2	Unstable						
2	39	78	3	5	1	1.361							5	2.5	Unstable			
2	39	78	3	6	1	1.222	6	1.5	Unstable	6	2	Unstable				6	3	Unstable
2	39	78	3	7	1	1.474	7.5	1.5	Unstable				7.5	2.5	Unstable			
2	39	78	3	8	1	1.427				8	2	Unstable						
2	39	78	3	9	1	1.351	9	1.5	Unstable							9	3	Unstable
2	39	78	3	10	1	1.420	10.5	1.5	Unstable	10	2	Unstable	10	2.5	Unstable			
2	39	78	3	11	1	1.336												
2	39	78	3	12	1	1.240	12	1.5	Unstable	12	2	Unstable	12.5	2.5	Unstable	12	3	Unstable
2	39	78	3	13	1	1.292	13.5	1.5	Unstable									
2	39	78	3	14	1	1.264				14	2	Unstable						
2	39	78	3	15	1	1.276	15	1.5	Unstable				15	2.5	Unstable	15	3	Unstable

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3	33	99	1.5	1	1	1.665	1.5	1.5	1.450									
3	33	99	1.5	2	1	1.506				2	2	1.341	2.5	2.5	1.217			
3	33	99	1.5	3	1	1.499	3	1.5	1.317							3	3	1.185
3	33	99	1.5	4	1	1.571	4.5	1.5	1.347	4	2	1.279						
3	33	99	1.5	5	1	1.587							5	2.5	1.214			
3	33	99	1.5	6	1	1.651	6	1.5	1.455	6	2	1.328				6	3	1.187
3	33	99	1.5	7	1	1.641	7.5	1.5	1.488				7.5	2.5	1.268			
3	33	99	1.5	8	1	1.612				8	2	1.309						
3	33	99	1.5	9	1	1.613	9	1.5	1.421							9	3	1.191
3	33	99	1.5	10	1	1.664	10.5	1.5	1.408	10	2	1.356	10	2.5	1.286			
3	33	99	1.5	11	1	1.661												
3	33	99	1.5	12	1	1.595	12	1.5	1.459	12	2	1.348	12.5	2.5	1.298	12	3	1.210
3	33	99	1.5	13	1	1.657	13.5	1.5	1.507									
3	33	99	1.5	14	1	1.607				14	2	1.366						
3	33	99	1.5	15	1	1.639	15	1.5	1.440				15	2.5	1.262	15	3	1.210
3	33	99	2	1	1	1.542	1.5	1.5	1.336									
3	33	99	2	2	1	1.376				2	2	1.224	2.5	2.5	1.151			
3	33	99	2	3	1	1.397	3	1.5	1.216							3	3	1.065
3	33	99	2	4	1	1.471	4.5	1.5	1.286	4	2	1.180						
3	33	99	2	5	1	1.488							5	2.5	1.106			
3	33	99	2	6	1	1.530	6	1.5	1.333	6	2	1.213				6	3	1.065
3	33	99	2	7	1	1.560	7.5	1.5	1.367				7.5	2.5	1.152			
3	33	99	2	8	1	1.594				8	2	1.250						
3	33	99	2	9	1	1.578	9	1.5	1.366							9	3	1.102
3	33	99	2	10	1	1.606	10.5	1.5	1.370	10	2	1.271	10	2.5	1.184			
3	33	99	2	11	1	1.591												
3	33	99	2	12	1	1.516	12	1.5	1.349	12	2	1.255	12.5	2.5	1.185	12	3	1.096
3	33	99	2	13	1	1.609	13.5	1.5	1.321									
3	33	99	2	14	1	1.618				14	2	1.293						
3	33	99	2	15	1	1.596	15	1.5	1.370				15	2.5	1.161	15	3	1.108
3	33	99	2.5	1	1	1.605	1.5	1.5	1.276									
3	33	99	2.5	2	1	1.388				2	2	1.153	2.5	2.5	1.033			
3	33	99	2.5	3	1	1.377	3	1.5	1.320							3	3	Unstable
3	33	99	2.5	4	1	1.412	4.5	1.5	1.280	4	2	1.064						
3	33	99	2.5	5	1	1.470							5	2.5	1.044			
3	33	99	2.5	6	1	1.488	6	1.5	1.245	6	2	1.141				6	3	Unstable
3	33	99	2.5	7	1	1.493	7.5	1.5	1.362				7.5	2.5	1.083			
3	33	99	2.5	8	1	1.521				8	2	1.186						
3	33	99	2.5	9	1	1.520	9	1.5	1.344							9	3	Unstable
3	33	99	2.5	10	1	1.553	10.5	1.5	1.281	10	2	1.206	10	2.5	1.113			
3	33	99	2.5	11	1	1.515												
3	33	99	2.5	12	1	1.530	12	1.5	1.281	12	2	1.193	12.5	2.5	1.077	12	3	Unstable
3	33	99	2.5	13	1	1.566	13.5	1.5	1.343									
3	33	99	2.5	14	1	1.546				14	2	1.150						
3	33	99	2.5	15	1	1.519	15	1.5	1.291				15	2.5	1.101	15	3	Unstable
3	33	99	3	1	1	1.412	1.5	1.5	1.311									
3	33	99	3	2	1	1.360				2	2	1.122	2.5	2.5	1.029			
3	33	99	3	3	1	1.403	3	1.5	1.185							3	3	Unstable
3	33	99	3	4	1	1.353	4.5	1.5	1.158	4	2	1.056						
3	33	99	3	5	1	1.433							5	2.5	1.040			
3	33	99	3	6	1	1.448	6	1.5	1.225	6	2	1.058				6	3	Unstable
3	33	99	3	7	1	1.517	7.5	1.5	1.327				7.5	2.5	1.057			
3	33	99	3	8	1	1.522				8	2	1.158						
3	33	99	3	9	1	1.499	9	1.5	1.306							9	3	Unstable
3	33	99	3	10	1	1.523	10.5	1.5	1.259	10	2	1.176	10	2.5	1.081			
3	33	99	3	11	1	1.505												
3	33	99	3	12	1	1.451	12	1.5	1.301	12	2	1.132	12.5	2.5	1.083	12	3	Unstable
3	33	99	3	13	1	1.496	13.5	1.5	1.224									
3	33	99	3	14	1	1.478				14	2	1.137						
3	33	99	3	15	1	1.433	15	1.5	1.334				15	2.5	1.074	15	3	Unstable

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3	35	105	1.5	1	1	1.725	1.5	1.5	1.497									
3	35	105	1.5	2	1	1.570				2	2	1.394	2.5	2.5	1.256			
3	35	105	1.5	3	1	1.574	3	1.5	1.374							3	3	1.227
3	35	105	1.5	4	1	1.644	4.5	1.5	1.401	4	2	1.334						
3	35	105	1.5	5	1	1.655							5	2.5	1.269			
3	35	105	1.5	6	1	1.725	6	1.5	1.523	6	2	1.392				6	3	1.243
3	35	105	1.5	7	1	1.703	7.5	1.5	1.556				7.5	2.5	1.319			
3	35	105	1.5	8	1	1.672				8	2	1.349						
3	35	105	1.5	9	1	1.667	9	1.5	1.482							9	3	1.244
3	35	105	1.5	10	1	1.748	10.5	1.5	1.471	10	2	1.409	10	2.5	1.340			
3	35	105	1.5	11	1	1.722												
3	35	105	1.5	12	1	1.697	12	1.5	1.511	12	2	1.397	12.5	2.5	1.352	12	3	1.260
3	35	105	1.5	13	1	1.704	13.5	1.5	1.567									
3	35	105	1.5	14	1	1.699				14	2	1.400						
3	35	105	1.5	15	1	1.713	15	1.5	1.498				15	2.5	1.315	15	3	1.262
3	35	105	2	1	1	1.588	1.5	1.5	1.376									
3	35	105	2	2	1	1.431				2	2	1.265	2.5	2.5	1.188			
3	35	105	2	3	1	1.427	3	1.5	1.260							3	3	1.104
3	35	105	2	4	1	1.556	4.5	1.5	1.342	4	2	1.223						
3	35	105	2	5	1	1.555							5	2.5	1.158			
3	35	105	2	6	1	1.599	6	1.5	1.387	6	2	1.268				6	3	1.109
3	35	105	2	7	1	1.630	7.5	1.5	1.423				7.5	2.5	1.203			
3	35	105	2	8	1	1.668				8	2	1.299						
3	35	105	2	9	1	1.648	9	1.5	1.421							9	3	1.159
3	35	105	2	10	1	1.677	10.5	1.5	1.413	10	2	1.318	10	2.5	1.232			
3	35	105	2	11	1	1.648												
3	35	105	2	12	1	1.557	12	1.5	1.398	12	2	1.310	12.5	2.5	1.223	12	3	1.147
3	35	105	2	13	1	1.679	13.5	1.5	1.351									
3	35	105	2	14	1	1.691				14	2	1.360						
3	35	105	2	15	1	1.653	15	1.5	1.407				15	2.5	1.207	15	3	1.146
3	35	105	2.5	1	1	1.651	1.5	1.5	1.308									
3	35	105	2.5	2	1	1.445				2	2	1.193	2.5	2.5	1.072			
3	35	105	2.5	3	1	1.439	3	1.5	1.381							3	3	1.048
3	35	105	2.5	4	1	1.480	4.5	1.5	1.339	4	2	1.104						
3	35	105	2.5	5	1	1.538							5	2.5	1.095			
3	35	105	2.5	6	1	1.547	6	1.5	1.305	6	2	1.196				6	3	1.053
3	35	105	2.5	7	1	1.575	7.5	1.5	1.428				7.5	2.5	1.109			
3	35	105	2.5	8	1	1.591				8	2	1.232						
3	35	105	2.5	9	1	1.586	9	1.5	1.404							9	3	1.080
3	35	105	2.5	10	1	1.623	10.5	1.5	1.335	10	2	1.250	10	2.5	1.163			
3	35	105	2.5	11	1	1.568												
3	35	105	2.5	12	1	1.599	12	1.5	1.310	12	2	1.237	12.5	2.5	1.110	12	3	1.077
3	35	105	2.5	13	1	1.634	13.5	1.5	1.407									
3	35	105	2.5	14	1	1.606				14	2	1.189						
3	35	105	2.5	15	1	1.586	15	1.5	1.353				15	2.5	1.143	15	3	1.079
3	35	105	3	1	1	1.460	1.5	1.5	1.264									
3	35	105	3	2	1	1.411				2	2	1.167	2.5	2.5	1.062			
3	35	105	3	3	1	1.469	3	1.5	1.252							3	3	1.033
3	35	105	3	4	1	1.407	4.5	1.5	1.252	4	2	1.093						
3	35	105	3	5	1	1.502							5	2.5	1.089			
3	35	105	3	6	1	1.493	6	1.5	1.238	6	2	1.112				6	3	1.035
3	35	105	3	7	1	1.592	7.5	1.5	1.280				7.5	2.5	1.100			
3	35	105	3	8	1	1.589				8	2	1.193						
3	35	105	3	9	1	1.560	9	1.5	1.326							9	3	1.028
3	35	105	3	10	1	1.589	10.5	1.5	1.248	10	2	1.217	10	2.5	1.114			
3	35	105	3	11	1	1.564												
3	35	105	3	12	1	1.505	12	1.5	1.228	12	2	1.165	12.5	2.5	1.120	12	3	1.044
3	35	105	3	13	1	1.538	13.5	1.5	1.363									
3	35	105	3	14	1	1.492				14	2	1.170						
3	35	105	3	15	1	1.489	15	1.5	1.233				15	2.5	1.113	15	3	1.042

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3	37	111	1.5	1	1	1.780	1.5	1.5	1.558									
3	37	111	1.5	2	1	1.626				2	2	1.433	2.5	2.5	1.306			
3	37	111	1.5	3	1	1.629	3	1.5	1.436							3	3	1.274
3	37	111	1.5	4	1	1.721	4.5	1.5	1.460	4	2	1.385						
3	37	111	1.5	5	1	1.716							5	2.5	1.326			
3	37	111	1.5	6	1	1.805	6	1.5	1.589	6	2	1.443				6	3	1.294
3	37	111	1.5	7	1	1.793	7.5	1.5	1.621				7.5	2.5	1.372			
3	37	111	1.5	8	1	1.721				8	2	1.405						
3	37	111	1.5	9	1	1.718	9	1.5	1.530							9	3	1.290
3	37	111	1.5	10	1	1.830	10.5	1.5	1.515	10	2	1.476	10	2.5	1.393			
3	37	111	1.5	11	1	1.798												
3	37	111	1.5	12	1	1.760	12	1.5	1.567	12	2	1.456	12.5	2.5	1.400	12	3	1.315
3	37	111	1.5	13	1	1.754	13.5	1.5	1.619									
3	37	111	1.5	14	1	1.773				14	2	1.449						
3	37	111	1.5	15	1	1.769	15	1.5	1.559				15	2.5	1.367	15	3	1.309
3	37	111	2	1	1	1.639	1.5	1.5	1.414									
3	37	111	2	2	1	1.478				2	2	1.307	2.5	2.5	1.232			
3	37	111	2	3	1	1.504	3	1.5	1.312							3	3	1.150
3	37	111	2	4	1	1.614	4.5	1.5	1.384	4	2	1.268						
3	37	111	2	5	1	1.626							5	2.5	1.207			
3	37	111	2	6	1	1.646	6	1.5	1.448	6	2	1.317				6	3	1.136
3	37	111	2	7	1	1.705	7.5	1.5	1.465				7.5	2.5	1.252			
3	37	111	2	8	1	1.736				8	2	1.364						
3	37	111	2	9	1	1.697	9	1.5	1.471							9	3	1.203
3	37	111	2	10	1	1.741	10.5	1.5	1.458	10	2	1.376	10	2.5	1.271			
3	37	111	2	11	1	1.723												
3	37	111	2	12	1	1.572	12	1.5	1.460	12	2	1.348	12.5	2.5	1.265	12	3	1.190
3	37	111	2	13	1	1.745	13.5	1.5	1.387									
3	37	111	2	14	1	1.770				14	2	1.392						
3	37	111	2	15	1	1.717	15	1.5	1.446				15	2.5	1.239	15	3	1.180
3	37	111	2.5	1	1	1.668	1.5	1.5	1.350									
3	37	111	2.5	2	1	1.504				2	2	1.233	2.5	2.5	1.112			
3	37	111	2.5	3	1	1.494	3	1.5	1.441							3	3	1.084
3	37	111	2.5	4	1	1.502	4.5	1.5	1.396	4	2	1.147						
3	37	111	2.5	5	1	1.597							5	2.5	1.147			
3	37	111	2.5	6	1	1.621	6	1.5	1.351	6	2	1.251				6	3	1.099
3	37	111	2.5	7	1	1.608	7.5	1.5	1.492				7.5	2.5	1.158			
3	37	111	2.5	8	1	1.656				8	2	1.269						
3	37	111	2.5	9	1	1.632	9	1.5	1.445							9	3	1.116
3	37	111	2.5	10	1	1.690	10.5	1.5	1.367	10	2	1.301	10	2.5	1.194			
3	37	111	2.5	11	1	1.645												
3	37	111	2.5	12	1	1.644	12	1.5	1.366	12	2	1.276	12.5	2.5	1.137	12	3	1.124
3	37	111	2.5	13	1	1.694	13.5	1.5	1.452									
3	37	111	2.5	14	1	1.673				14	2	1.219						
3	37	111	2.5	15	1	1.617	15	1.5	1.416				15	2.5	1.169	15	3	1.120
3	37	111	3	1	1	1.505	1.5	1.5	1.263									
3	37	111	3	2	1	1.468				2	2	1.207	2.5	2.5	1.098			
3	37	111	3	3	1	1.537	3	1.5	1.242							3	3	1.086
3	37	111	3	4	1	1.462	4.5	1.5	1.321	4	2	1.134						
3	37	111	3	5	1	1.571							5	2.5	1.133			
3	37	111	3	6	1	1.546	6	1.5	1.310	6	2	1.151				6	3	1.078
3	37	111	3	7	1	1.659	7.5	1.5	1.281				7.5	2.5	1.133			
3	37	111	3	8	1	1.661				8	2	1.237						
3	37	111	3	9	1	1.621	9	1.5	1.332							9	3	1.056
3	37	111	3	10	1	1.659	10.5	1.5	1.345	10	2	1.260	10	2.5	1.159			
3	37	111	3	11	1	1.632												
3	37	111	3	12	1	1.548	12	1.5	1.277	12	2	1.212	12.5	2.5	1.155	12	3	1.086
3	37	111	3	13	1	1.577	13.5	1.5	1.315									
3	37	111	3	14	1	1.546				14	2	1.215						
3	37	111	3	15	1	1.538	15	1.5	1.326				15	2.5	1.141	15	3	1.087

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3	39	117	1.5	1	1	1.830	1.5	1.5	1.606									
3	39	117	1.5	2	1	1.704				2	2	1.486	2.5	2.5	1.354			
3	39	117	1.5	3	1	1.710	3	1.5	1.495							3	3	1.318
3	39	117	1.5	4	1	1.800	4.5	1.5	1.523	4	2	1.444						
3	39	117	1.5	5	1	1.781							5	2.5	1.377			
3	39	117	1.5	6	1	1.863	6	1.5	1.663	6	2	1.513				6	3	1.347
3	39	117	1.5	7	1	1.864	7.5	1.5	1.696				7.5	2.5	1.426			
3	39	117	1.5	8	1	1.787				8	2	1.469						
3	39	117	1.5	9	1	1.706	9	1.5	1.539							9	3	1.347
3	39	117	1.5	10	1	1.885	10.5	1.5	1.567	10	2	1.517	10	2.5	1.437			
3	39	117	1.5	11	1	1.845												
3	39	117	1.5	12	1	1.818	12	1.5	1.607	12	2	1.529	12.5	2.5	1.462	12	3	1.367
3	39	117	1.5	13	1	1.844	13.5	1.5	1.688									
3	39	117	1.5	14	1	1.802				14	2	1.516						
3	39	117	1.5	15	1	1.807	15	1.5	1.613				15	2.5	1.408	15	3	1.361
3	39	117	2	1	1	1.675	1.5	1.5	1.466									
3	39	117	2	2	1	1.543				2	2	1.355	2.5	2.5	1.281			
3	39	117	2	3	1	1.564	3	1.5	1.365							3	3	1.186
3	39	117	2	4	1	1.678	4.5	1.5	1.455	4	2	1.332						
3	39	117	2	5	1	1.679							5	2.5	1.261			
3	39	117	2	6	1	1.728	6	1.5	1.501	6	2	1.357				6	3	1.191
3	39	117	2	7	1	1.778	7.5	1.5	1.527				7.5	2.5	1.300			
3	39	117	2	8	1	1.813				8	2	1.409						
3	39	117	2	9	1	1.765	9	1.5	1.523							9	3	1.250
3	39	117	2	10	1	1.803	10.5	1.5	1.509	10	2	1.416	10	2.5	1.318			
3	39	117	2	11	1	1.773												
3	39	117	2	12	1	1.696	12	1.5	1.511	12	2	1.394	12.5	2.5	1.313	12	3	1.214
3	39	117	2	13	1	1.799	13.5	1.5	1.443									
3	39	117	2	14	1	1.824				14	2	1.454						
3	39	117	2	15	1	1.755	15	1.5	1.501				15	2.5	1.290	15	3	1.251
3	39	117	2.5	1	1	1.721	1.5	1.5	1.383									
3	39	117	2.5	2	1	1.568				2	2	1.418	2.5	2.5	1.152			
3	39	117	2.5	3	1	1.559	3	1.5	1.509							3	3	1.129
3	39	117	2.5	4	1	1.561	4.5	1.5	1.451	4	2	1.291						
3	39	117	2.5	5	1	1.681							5	2.5	1.197			
3	39	117	2.5	6	1	1.678	6	1.5	1.360	6	2	1.320				6	3	1.143
3	39	117	2.5	7	1	1.676	7.5	1.5	1.555				7.5	2.5	1.205			
3	39	117	2.5	8	1	1.724				8	2	1.311						
3	39	117	2.5	9	1	1.695	9	1.5	1.487							9	3	1.168
3	39	117	2.5	10	1	1.756	10.5	1.5	1.433	10	2	1.359	10	2.5	1.234			
3	39	117	2.5	11	1	1.716												
3	39	117	2.5	12	1	1.724	12	1.5	1.415	12	2	1.273	12.5	2.5	1.167	12	3	1.166
3	39	117	2.5	13	1	1.765	13.5	1.5	1.484									
3	39	117	2.5	14	1	1.713				14	2	1.272						
3	39	117	2.5	15	1	1.717	15	1.5	1.454				15	2.5	1.240	15	3	1.165
3	39	117	3	1	1	1.551	1.5	1.5	1.305									
3	39	117	3	2	1	1.527				2	2	1.259	2.5	2.5	1.129			
3	39	117	3	3	1	1.604	3	1.5	1.302							3	3	1.106
3	39	117	3	4	1	1.564	4.5	1.5	1.376	4	2	1.181						
3	39	117	3	5	1	1.645							5	2.5	1.171			
3	39	117	3	6	1	1.572	6	1.5	1.369	6	2	1.178				6	3	1.121
3	39	117	3	7	1	1.732	7.5	1.5	1.314				7.5	2.5	1.178			
3	39	117	3	8	1	1.721				8	2	1.277						
3	39	117	3	9	1	1.685	9	1.5	1.375							9	3	1.088
3	39	117	3	10	1	1.727	10.5	1.5	1.391	10	2	1.296	10	2.5	1.210			
3	39	117	3	11	1	1.695												
3	39	117	3	12	1	1.604	12	1.5	1.318	12	2	1.245	12.5	2.5	1.189	12	3	1.127
3	39	117	3	13	1	1.639	13.5	1.5	1.356									
3	39	117	3	14	1	1.594				14	2	1.257						
3	39	117	3	15	1	1.588	15	1.5	1.370				15	2.5	1.190	15	3	1.131

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3.5	33	115.5	1.5	1	1	1.837	1.5	1.5	1.593									
3.5	33	115.5	1.5	2	1	1.630				2	2	1.462	2.5	2.5	1.320			
3.5	33	115.5	1.5	3	1	1.623	3	1.5	1.420							3	3	1.282
3.5	33	115.5	1.5	4	1	1.677	4.5	1.5	1.440	4	2	1.367						
3.5	33	115.5	1.5	5	1	1.696							5	2.5	1.296			
3.5	33	115.5	1.5	6	1	1.750	6	1.5	1.548	6	2	1.423				6	3	1.269
3.5	33	115.5	1.5	7	1	1.751	7.5	1.5	1.587				7.5	2.5	1.367			
3.5	33	115.5	1.5	8	1	1.737				8	2	1.415						
3.5	33	115.5	1.5	9	1	1.758	9	1.5	1.535							9	3	1.276
3.5	33	115.5	1.5	10	1	1.781	10.5	1.5	1.526	10	2	1.453	10	2.5	1.372			
3.5	33	115.5	1.5	11	1	1.762												
3.5	33	115.5	1.5	12	1	1.705	12	1.5	1.572	12	2	1.461	12.5	2.5	1.396	12	3	1.296
3.5	33	115.5	1.5	13	1	1.740	13.5	1.5	1.612									
3.5	33	115.5	1.5	14	1	1.781				14	2	1.457						
3.5	33	115.5	1.5	15	1	1.754	15	1.5	1.564				15	2.5	1.361	15	3	1.305
3.5	33	115.5	2	1	1	1.704	1.5	1.5	1.466									
3.5	33	115.5	2	2	1	1.493				2	2	1.324	2.5	2.5	1.249			
3.5	33	115.5	2	3	1	1.444	3	1.5	1.310							3	3	1.150
3.5	33	115.5	2	4	1	1.578	4.5	1.5	1.369	4	2	1.265						
3.5	33	115.5	2	5	1	1.598							5	2.5	1.193			
3.5	33	115.5	2	6	1	1.631	6	1.5	1.423	6	2	1.295				6	3	1.146
3.5	33	115.5	2	7	1	1.666	7.5	1.5	1.472				7.5	2.5	1.243			
3.5	33	115.5	2	8	1	1.694				8	2	1.355						
3.5	33	115.5	2	9	1	1.704	9	1.5	1.475							9	3	1.195
3.5	33	115.5	2	10	1	1.702	10.5	1.5	1.474	10	2	1.367	10	2.5	1.283			
3.5	33	115.5	2	11	1	1.674												
3.5	33	115.5	2	12	1	1.642	12	1.5	1.460	12	2	1.360	12.5	2.5	1.274	12	3	1.188
3.5	33	115.5	2	13	1	1.731	13.5	1.5	1.449									
3.5	33	115.5	2	14	1	1.726				14	2	1.391						
3.5	33	115.5	2	15	1	1.706	15	1.5	1.470				15	2.5	1.251	15	3	1.204
3.5	33	115.5	2.5	1	1	1.731	1.5	1.5	1.400									
3.5	33	115.5	2.5	2	1	1.491				2	2	1.256	2.5	2.5	1.129			
3.5	33	115.5	2.5	3	1	1.477	3	1.5	1.411							3	3	1.095
3.5	33	115.5	2.5	4	1	1.490	4.5	1.5	1.366	4	2	1.165						
3.5	33	115.5	2.5	5	1	1.544							5	2.5	1.116			
3.5	33	115.5	2.5	6	1	1.586	6	1.5	1.355	6	2	1.215				6	3	1.071
3.5	33	115.5	2.5	7	1	1.586	7.5	1.5	1.449				7.5	2.5	1.165			
3.5	33	115.5	2.5	8	1	1.624				8	2	1.271						
3.5	33	115.5	2.5	9	1	1.622	9	1.5	1.436							9	3	1.110
3.5	33	115.5	2.5	10	1	1.651	10.5	1.5	1.399	10	2	1.300	10	2.5	1.209			
3.5	33	115.5	2.5	11	1	1.633												
3.5	33	115.5	2.5	12	1	1.671	12	1.5	1.391	12	2	1.297	12.5	2.5	1.174	12	3	1.130
3.5	33	115.5	2.5	13	1	1.671	13.5	1.5	1.456									
3.5	33	115.5	2.5	14	1	1.658				14	2	1.253						
3.5	33	115.5	2.5	15	1	1.642	15	1.5	1.405				15	2.5	1.199	15	3	1.136
3.5	33	115.5	3	1	1	1.030	1.5	1.5	1.425									
3.5	33	115.5	3	2	1	1.468				2	2	1.206	2.5	2.5	1.098			
3.5	33	115.5	3	3	1	1.492	3	1.5	1.281							3	3	1.046
3.5	33	115.5	3	4	1	1.456	4.5	1.5	1.242	4	2	1.144						
3.5	33	115.5	3	5	1	1.526							5	2.5	1.093			
3.5	33	115.5	3	6	1	1.577	6	1.5	1.317	6	2	1.188				6	3	1.051
3.5	33	115.5	3	7	1	1.604	7.5	1.5	1.418				7.5	2.5	1.115			
3.5	33	115.5	3	8	1	1.615				8	2	1.255						
3.5	33	115.5	3	9	1	1.601	9	1.5	1.396							9	3	1.075
3.5	33	115.5	3	10	1	1.627	10.5	1.5	1.362	10	2	1.266	10	2.5	1.167			
3.5	33	115.5	3	11	1	1.608												
3.5	33	115.5	3	12	1	1.580	12	1.5	1.408	12	2	1.224	12.5	2.5	1.168	12	3	1.091
3.5	33	115.5	3	13	1	1.610	13.5	1.5	1.355									
3.5	33	115.5	3	14	1	1.560				14	2	1.245						
3.5	33	115.5	3	15	1	1.584	15	1.5	1.437				15	2.5	1.112	15	3	1.098

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3.5	35	122.5	1.5	1	1	1.889	1.5	1.5	1.639									
3.5	35	122.5	1.5	2	1	1.697				2	2	1.516	2.5	2.5	1.367			
3.5	35	122.5	1.5	3	1	1.672	3	1.5	1.474							3	3	1.330
3.5	35	122.5	1.5	4	1	1.736	4.5	1.5	1.499	4	2	1.418						
3.5	35	122.5	1.5	5	1	1.769							5	2.5	1.349			
3.5	35	122.5	1.5	6	1	1.832	6	1.5	1.619	6	2	1.493				6	3	1.332
3.5	35	122.5	1.5	7	1	1.824	7.5	1.5	1.659				7.5	2.5	1.420			
3.5	35	122.5	1.5	8	1	1.802				8	2	1.468						
3.5	35	122.5	1.5	9	1	1.837	9	1.5	1.584							9	3	1.332
3.5	35	122.5	1.5	10	1	1.871	10.5	1.5	1.561	10	2	1.517	10	2.5	1.437			
3.5	35	122.5	1.5	11	1	1.834												
3.5	35	122.5	1.5	12	1	1.833	12	1.5	1.645	12	2	1.510	12.5	2.5	1.441	12	3	1.353
3.5	35	122.5	1.5	13	1	1.843	13.5	1.5	1.675									
3.5	35	122.5	1.5	14	1	1.852				14	2	1.513						
3.5	35	122.5	1.5	15	1	1.839	15	1.5	1.617				15	2.5	1.419	15	3	1.363
3.5	35	122.5	2	1	1	1.741	1.5	1.5	1.509									
3.5	35	122.5	2	2	1	1.539				2	2	1.377	2.5	2.5	1.285			
3.5	35	122.5	2	3	1	1.502	3	1.5	1.358							3	3	1.196
3.5	35	122.5	2	4	1	1.633	4.5	1.5	1.425	4	2	1.320						
3.5	35	122.5	2	5	1	1.659							5	2.5	1.248			
3.5	35	122.5	2	6	1	1.705	6	1.5	1.481	6	2	1.348				6	3	1.189
3.5	35	122.5	2	7	1	1.743	7.5	1.5	1.533				7.5	2.5	1.284			
3.5	35	122.5	2	8	1	1.776				8	2	1.409						
3.5	35	122.5	2	9	1	1.753	9	1.5	1.535							9	3	1.249
3.5	35	122.5	2	10	1	1.777	10.5	1.5	1.525	10	2	1.421	10	2.5	1.335			
3.5	35	122.5	2	11	1	1.746												
3.5	35	122.5	2	12	1	1.663	12	1.5	1.520	12	2	1.413	12.5	2.5	1.322	12	3	1.239
3.5	35	122.5	2	13	1	1.777	13.5	1.5	1.503									
3.5	35	122.5	2	14	1	1.804				14	2	1.452						
3.5	35	122.5	2	15	1	1.769	15	1.5	1.528				15	2.5	1.295	15	3	1.242
3.5	35	122.5	2.5	1	1	1.771	1.5	1.5	1.446									
3.5	35	122.5	2.5	2	1	1.561				2	2	1.300	2.5	2.5	1.165			
3.5	35	122.5	2.5	3	1	1.539	3	1.5	1.470							3	3	1.141
3.5	35	122.5	2.5	4	1	1.538	4.5	1.5	1.424	4	2	1.186						
3.5	35	122.5	2.5	5	1	1.646							5	2.5	1.166			
3.5	35	122.5	2.5	6	1	1.644	6	1.5	1.380	6	2	1.275				6	3	1.116
3.5	35	122.5	2.5	7	1	1.658	7.5	1.5	1.502				7.5	2.5	1.196			
3.5	35	122.5	2.5	8	1	1.705				8	2	1.333						
3.5	35	122.5	2.5	9	1	1.687	9	1.5	1.498							9	3	1.174
3.5	35	122.5	2.5	10	1	1.724	10.5	1.5	1.462	10	2	1.355	10	2.5	1.243			
3.5	35	122.5	2.5	11	1	1.681												
3.5	35	122.5	2.5	12	1	1.708	12	1.5	1.433	12	2	1.348	12.5	2.5	1.207	12	3	1.173
3.5	35	122.5	2.5	13	1	1.741	13.5	1.5	1.511									
3.5	35	122.5	2.5	14	1	1.730				14	2	1.310						
3.5	35	122.5	2.5	15	1	1.703	15	1.5	1.470				15	2.5	1.239	15	3	1.168
3.5	35	122.5	3	1	1	1.608	1.5	1.5	1.492									
3.5	35	122.5	3	2	1	1.523				2	2	1.253	2.5	2.5	1.162			
3.5	35	122.5	3	3	1	1.559	3	1.5	1.334							3	3	1.118
3.5	35	122.5	3	4	1	1.522	4.5	1.5	1.297	4	2	1.188						
3.5	35	122.5	3	5	1	1.597							5	2.5	1.164			
3.5	35	122.5	3	6	1	1.634	6	1.5	1.371	6	2	1.200				6	3	1.101
3.5	35	122.5	3	7	1	1.679	7.5	1.5	1.497				7.5	2.5	1.180			
3.5	35	122.5	3	8	1	1.685				8	2	1.308						
3.5	35	122.5	3	9	1	1.669	9	1.5	1.452							9	3	1.112
3.5	35	122.5	3	10	1	1.694	10.5	1.5	1.410	10	2	1.319	10	2.5	1.218			
3.5	35	122.5	3	11	1	1.673												
3.5	35	122.5	3	12	1	1.637	12	1.5	1.470	12	2	1.280	12.5	2.5	1.220	12	3	1.124
3.5	35	122.5	3	13	1	1.679	13.5	1.5	1.383									
3.5	35	122.5	3	14	1	1.648				14	2	1.281						
3.5	35	122.5	3	15	1	1.609	15	1.5	1.488				15	2.5	1.221	15	3	1.128

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3.5	37	129.5	1.5	1	1	1.959	1.5	1.5	1.688									
3.5	37	129.5	1.5	2	1	1.746				2	2	1.565	2.5	2.5	1.413			
3.5	37	129.5	1.5	3	1	1.737	3	1.5	1.536							3	3	1.375
3.5	37	129.5	1.5	4	1	1.812	4.5	1.5	1.568	4	2	1.489						
3.5	37	129.5	1.5	5	1	1.823							5	2.5	1.413			
3.5	37	129.5	1.5	6	1	1.909	6	1.5	1.692	6	2	1.559				6	3	1.390
3.5	37	129.5	1.5	7	1	1.905	7.5	1.5	1.732				7.5	2.5	1.466			
3.5	37	129.5	1.5	8	1	1.846				8	2	1.527						
3.5	37	129.5	1.5	9	1	1.839	9	1.5	1.655							9	3	1.388
3.5	37	129.5	1.5	10	1	1.926	10.5	1.5	1.660	10	2	1.579	10	2.5	1.496			
3.5	37	129.5	1.5	11	1	1.880												
3.5	37	129.5	1.5	12	1	1.888	12	1.5	1.685	12	2	1.566	12.5	2.5	1.499	12	3	1.401
3.5	37	129.5	1.5	13	1	1.930	13.5	1.5	1.725									
3.5	37	129.5	1.5	14	1	1.922				14	2	1.577						
3.5	37	129.5	1.5	15	1	1.893	15	1.5	1.660				15	2.5	1.469	15	3	1.453
3.5	37	129.5	2	1	1	1.793	1.5	1.5	1.548									
3.5	37	129.5	2	2	1	1.576				2	2	1.422	2.5	2.5	1.335			
3.5	37	129.5	2	3	1	1.616	3	1.5	1.410							3	3	1.234
3.5	37	129.5	2	4	1	1.678	4.5	1.5	1.484	4	2	1.374						
3.5	37	129.5	2	5	1	1.731							5	2.5	1.284			
3.5	37	129.5	2	6	1	1.768	6	1.5	1.548	6	2	1.411				6	3	1.233
3.5	37	129.5	2	7	1	1.821	7.5	1.5	1.588				7.5	2.5	1.349			
3.5	37	129.5	2	8	1	1.850				8	2	1.475						
3.5	37	129.5	2	9	1	1.795	9	1.5	1.590							9	3	1.290
3.5	37	129.5	2	10	1	1.843	10.5	1.5	1.583	10	2	1.476	10	2.5	1.382			
3.5	37	129.5	2	11	1	1.778												
3.5	37	129.5	2	12	1	1.784	12	1.5	1.555	12	2	1.475	12.5	2.5	1.376	12	3	1.290
3.5	37	129.5	2	13	1	1.871	13.5	1.5	1.520									
3.5	37	129.5	2	14	1	1.878				14	2	1.509						
3.5	37	129.5	2	15	1	1.832	15	1.5	1.582				15	2.5	1.350	15	3	1.294
3.5	37	129.5	2.5	1	1	1.825	1.5	1.5	1.494									
3.5	37	129.5	2.5	2	1	1.614				2	2	1.331	2.5	2.5	1.198			
3.5	37	129.5	2.5	3	1	1.603	3	1.5	1.532							3	3	1.180
3.5	37	129.5	2.5	4	1	1.598	4.5	1.5	1.487	4	2	1.237						
3.5	37	129.5	2.5	5	1	1.699							5	2.5	1.221			
3.5	37	129.5	2.5	6	1	1.722	6	1.5	1.467	6	2	1.322				6	3	1.167
3.5	37	129.5	2.5	7	1	1.751	7.5	1.5	1.563				7.5	2.5	1.246			
3.5	37	129.5	2.5	8	1	1.774				8	2	1.391						
3.5	37	129.5	2.5	9	1	1.765	9	1.5	1.561							9	3	1.205
3.5	37	129.5	2.5	10	1	1.804	10.5	1.5	1.510	10	2	1.405	10	2.5	1.294			
3.5	37	129.5	2.5	11	1	1.754												
3.5	37	129.5	2.5	12	1	1.790	12	1.5	1.478	12	2	1.382	12.5	2.5	1.255	12	3	1.213
3.5	37	129.5	2.5	13	1	1.820	13.5	1.5	1.576									
3.5	37	129.5	2.5	14	1	1.803				14	2	1.344						
3.5	37	129.5	2.5	15	1	1.735	15	1.5	1.507				15	2.5	1.284	15	3	1.212
3.5	37	129.5	3	1	1	1.235	1.5	1.5	1.498									
3.5	37	129.5	3	2	1	1.577				2	2	1.307	2.5	2.5	1.205			
3.5	37	129.5	3	3	1	1.630	3	1.5	1.384							3	3	1.154
3.5	37	129.5	3	4	1	1.584	4.5	1.5	1.351	4	2	1.228						
3.5	37	129.5	3	5	1	1.675							5	2.5	1.214			
3.5	37	129.5	3	6	1	1.692	6	1.5	1.424	6	2	1.245				6	3	1.151
3.5	37	129.5	3	7	1	1.758	7.5	1.5	1.546				7.5	2.5	1.230			
3.5	37	129.5	3	8	1	1.763				8	2	1.355						
3.5	37	129.5	3	9	1	1.740	9	1.5	1.520							9	3	1.153
3.5	37	129.5	3	10	1	1.774	10.5	1.5	1.462	10	2	1.368	10	2.5	1.260			
3.5	37	129.5	3	11	1	1.742												
3.5	37	129.5	3	12	1	1.685	12	1.5	1.521	12	2	1.323	12.5	2.5	1.256	12	3	1.174
3.5	37	129.5	3	13	1	1.725	13.5	1.5	1.424									
3.5	37	129.5	3	14	1	1.678				14	2	1.327						
3.5	37	129.5	3	15	1	1.674	15	1.5	1.544				15	2.5	1.247	15	3	1.171

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
3.5	39	136.5	1.5	1	1	2.000	1.5	1.5	1.713									
3.5	39	136.5	1.5	2	1	1.825				2	2	1.620	2.5	2.5	1.464			
3.5	39	136.5	1.5	3	1	1.820	3	1.5	1.603							3	3	1.426
3.5	39	136.5	1.5	4	1	1.863	4.5	1.5	1.632	4	2	1.545						
3.5	39	136.5	1.5	5	1	1.884							5	2.5	1.475			
3.5	39	136.5	1.5	6	1	1.929	6	1.5	1.757	6	2	1.635				6	3	1.450
3.5	39	136.5	1.5	7	1	1.966	7.5	1.5	1.815				7.5	2.5	1.532			
3.5	39	136.5	1.5	8	1	1.909				8	2	1.569						
3.5	39	136.5	1.5	9	1	1.949	9	1.5	1.685							9	3	1.447
3.5	39	136.5	1.5	10	1	2.015	10.5	1.5	1.694	10	2	1.646	10	2.5	1.556			
3.5	39	136.5	1.5	11	1	1.931												
3.5	39	136.5	1.5	12	1	1.892	12	1.5	1.750	12	2	1.635	12.5	2.5	1.560	12	3	1.466
3.5	39	136.5	1.5	13	1	1.974	13.5	1.5	1.814									
3.5	39	136.5	1.5	14	1	1.966				14	2	1.637						
3.5	39	136.5	1.5	15	1	1.999	15	1.5	1.741				15	2.5	1.523	15	3	1.465
3.5	39	136.5	2	1	1	1.823	1.5	1.5	1.594									
3.5	39	136.5	2	2	1	1.647				2	2	1.471	2.5	2.5	1.386			
3.5	39	136.5	2	3	1	1.640	3	1.5	1.465							3	3	1.274
3.5	39	136.5	2	4	1	1.806	4.5	1.5	1.556	4	2	1.428						
3.5	39	136.5	2	5	1	1.815							5	2.5	1.350			
3.5	39	136.5	2	6	1	1.836	6	1.5	1.611	6	2	1.467				6	3	1.268
3.5	39	136.5	2	7	1	1.901	7.5	1.5	1.630				7.5	2.5	1.397			
3.5	39	136.5	2	8	1	1.904				8	2	1.525						
3.5	39	136.5	2	9	1	1.853	9	1.5	1.657							9	3	1.339
3.5	39	136.5	2	10	1	1.943	10.5	1.5	1.644	10	2	1.536	10	2.5	1.427			
3.5	39	136.5	2	11	1	1.887												
3.5	39	136.5	2	12	1	1.711	12	1.5	1.631	12	2	1.520	12.5	2.5	1.424	12	3	1.328
3.5	39	136.5	2	13	1	1.927	13.5	1.5	1.579									
3.5	39	136.5	2	14	1	1.948				14	2	1.559						
3.5	39	136.5	2	15	1	1.913	15	1.5	1.630				15	2.5	1.394	15	3	1.353
3.5	39	136.5	2.5	1	1	1.889	1.5	1.5	1.528									
3.5	39	136.5	2.5	2	1	1.682				2	2	1.355	2.5	2.5	1.245			
3.5	39	136.5	2.5	3	1	1.665	3	1.5	1.600							3	3	1.229
3.5	39	136.5	2.5	4	1	1.696	4.5	1.5	1.553	4	2	1.280						
3.5	39	136.5	2.5	5	1	1.780							5	2.5	1.275			
3.5	39	136.5	2.5	6	1	1.796	6	1.5	1.508	6	2	1.388				6	3	1.219
3.5	39	136.5	2.5	7	1	1.825	7.5	1.5	1.652				7.5	2.5	1.294			
3.5	39	136.5	2.5	8	1	1.839				8	2	1.435						
3.5	39	136.5	2.5	9	1	1.834	9	1.5	1.588							9	3	1.241
3.5	39	136.5	2.5	10	1	1.866	10.5	1.5	1.543	10	2	1.463	10	2.5	1.350			
3.5	39	136.5	2.5	11	1	1.833												
3.5	39	136.5	2.5	12	1	1.871	12	1.5	1.535	12	2	1.436	12.5	2.5	1.273	12	3	1.258
3.5	39	136.5	2.5	13	1	1.886	13.5	1.5	1.634									
3.5	39	136.5	2.5	14	1	1.842				14	2	1.382						
3.5	39	136.5	2.5	15	1	1.818	15	1.5	1.559				15	2.5	1.328	15	3	1.262
3.5	39	136.5	3	1	1	1.696	1.5	1.5	1.575									
3.5	39	136.5	3	2	1	1.629				2	2	1.349	2.5	2.5	1.240			
3.5	39	136.5	3	3	1	1.699	3	1.5	1.437							3	3	1.200
3.5	39	136.5	3	4	1	1.664	4.5	1.5	1.402	4	2	1.273						
3.5	39	136.5	3	5	1	1.755							5	2.5	1.262			
3.5	39	136.5	3	6	1	1.723	6	1.5	1.476	6	2	1.286				6	3	1.203
3.5	39	136.5	3	7	1	1.846	7.5	1.5	1.616				7.5	2.5	1.278			
3.5	39	136.5	3	8	1	1.838				8	2	1.403						
3.5	39	136.5	3	9	1	1.805	9	1.5	1.583							9	3	1.179
3.5	39	136.5	3	10	1	1.838	10.5	1.5	1.509	10	2	1.414	10	2.5	1.294			
3.5	39	136.5	3	11	1	1.819												
3.5	39	136.5	3	12	1	1.737	12	1.5	1.575	12	2	1.364	12.5	2.5	1.296	12	3	1.213
3.5	39	136.5	3	13	1	1.779	13.5	1.5	1.469									
3.5	39	136.5	3	14	1	1.723				14	2	1.372						
3.5	39	136.5	3	15	1	1.703	15	1.5	1.623				15	2.5	1.278	15	3	1.212

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
4	33	132	1.5	1	1	2.027	1.5	1.5	1.726									
4	33	132	1.5	2	1	1.755				2	2	1.579	2.5	2.5	1.427			
4	33	132	1.5	3	1	1.721	3	1.5	1.516							3	3	1.377
4	33	132	1.5	4	1	1.773	4.5	1.5	1.528	4	2	1.448						
4	33	132	1.5	5	1	1.782							5	2.5	1.377			
4	33	132	1.5	6	1	1.838	6	1.5	1.626	6	2	1.500				6	3	1.350
4	33	132	1.5	7	1	1.858	7.5	1.5	1.674				7.5	2.5	1.445			
4	33	132	1.5	8	1	1.838				8	2	1.508						
4	33	132	1.5	9	1	1.843	9	1.5	1.643							9	3	1.365
4	33	132	1.5	10	1	1.873	10.5	1.5	1.638	10	2	1.541	10	2.5	1.455			
4	33	132	1.5	11	1	1.874												
4	33	132	1.5	12	1	1.829	12	1.5	1.660	12	2	1.550	12.5	2.5	1.478	12	3	1.390
4	33	132	1.5	13	1	1.889	13.5	1.5	1.706									
4	33	132	1.5	14	1	1.896				14	2	1.548						
4	33	132	1.5	15	1	1.864	15	1.5	1.656				15	2.5	1.446	15	3	1.386
4	33	132	2	1	1	1.857	1.5	1.5	1.576									
4	33	132	2	2	1	1.639				2	2	1.429	2.5	2.5	1.344			
4	33	132	2	3	1	1.602	3	1.5	1.397							3	3	1.236
4	33	132	2	4	1	1.660	4.5	1.5	1.451	4	2	1.330						
4	33	132	2	5	1	1.675							5	2.5	1.257			
4	33	132	2	6	1	1.721	6	1.5	1.498	6	2	1.371				6	3	1.214
4	33	132	2	7	1	1.758	7.5	1.5	1.564				7.5	2.5	1.321			
4	33	132	2	8	1	1.789				8	2	1.432						
4	33	132	2	9	1	1.777	9	1.5	1.551							9	3	1.277
4	33	132	2	10	1	1.794	10.5	1.5	1.570	10	2	1.453	10	2.5	1.359			
4	33	132	2	11	1	1.799												
4	33	132	2	12	1	1.764	12	1.5	1.552	12	2	1.443	12.5	2.5	1.357	12	3	1.272
4	33	132	2	13	1	1.796	13.5	1.5	1.580									
4	33	132	2	14	1	1.809				14	2	1.482						
4	33	132	2	15	1	1.807	15	1.5	1.565				15	2.5	1.344	15	3	1.276
4	33	132	2.5	1	1	1.872	1.5	1.5	1.521									
4	33	132	2.5	2	1	1.602				2	2	1.352	2.5	2.5	1.218			
4	33	132	2.5	3	1	1.577	3	1.5	1.494							3	3	1.186
4	33	132	2.5	4	1	1.605	4.5	1.5	1.450	4	2	1.260						
4	33	132	2.5	5	1	1.664							5	2.5	1.185			
4	33	132	2.5	6	1	1.669	6	1.5	1.416	6	2	1.304				6	3	1.137
4	33	132	2.5	7	1	1.690	7.5	1.5	1.530				7.5	2.5	1.253			
4	33	132	2.5	8	1	1.712				8	2	1.368						
4	33	132	2.5	9	1	1.704	9	1.5	1.536							9	3	1.192
4	33	132	2.5	10	1	1.740	10.5	1.5	1.496	10	2	1.387	10	2.5	1.276			
4	33	132	2.5	11	1	1.734												
4	33	132	2.5	12	1	1.736	12	1.5	1.481	12	2	1.387	12.5	2.5	1.254	12	3	1.219
4	33	132	2.5	13	1	1.762	13.5	1.5	1.545									
4	33	132	2.5	14	1	1.760				14	2	1.345						
4	33	132	2.5	15	1	1.746	15	1.5	1.511				15	2.5	1.284	15	3	1.218
4	33	132	3	1	1	1.702	1.5	1.5	1.551									
4	33	132	3	2	1	1.575				2	2	1.317	2.5	2.5	1.213			
4	33	132	3	3	1	1.578	3	1.5	1.370							3	3	1.152
4	33	132	3	4	1	1.558	4.5	1.5	1.318	4	2	1.217						
4	33	132	3	5	1	1.611							5	2.5	1.178			
4	33	132	3	6	1	1.662	6	1.5	1.400	6	2	1.264				6	3	1.110
4	33	132	3	7	1	1.692	7.5	1.5	1.493				7.5	2.5	1.210			
4	33	132	3	8	1	1.698				8	2	1.328						
4	33	132	3	9	1	1.691	9	1.5	1.482							9	3	1.158
4	33	132	3	10	1	1.719	10.5	1.5	1.443	10	2	1.334	10	2.5	1.249			
4	33	132	3	11	1	1.702												
4	33	132	3	12	1	1.691	12	1.5	1.498	12	2	1.307	12.5	2.5	1.261	12	3	1.165
4	33	132	3	13	1	1.692	13.5	1.5	1.473									
4	33	132	3	14	1	1.693				14	2	1.334						
4	33	132	3	15	1	1.679	15	1.5	1.522				15	2.5	1.253	15	3	1.166

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
4	35	140	1.5	1	1	2.076	1.5	1.5	1.787									
4	35	140	1.5	2	1	1.802				2	2	1.631	2.5	2.5	1.472			
4	35	140	1.5	3	1	1.793	3	1.5	1.572							3	3	1.421
4	35	140	1.5	4	1	1.853	4.5	1.5	1.594	4	2	1.513						
4	35	140	1.5	5	1	1.860							5	2.5	1.437			
4	35	140	1.5	6	1	1.902	6	1.5	1.700	6	2	1.571				6	3	1.407
4	35	140	1.5	7	1	1.938	7.5	1.5	1.745				7.5	2.5	1.504			
4	35	140	1.5	8	1	1.903				8	2	1.571						
4	35	140	1.5	9	1	1.941	9	1.5	1.709							9	3	1.412
4	35	140	1.5	10	1	1.951	10.5	1.5	1.702	10	2	1.610	10	2.5	1.519			
4	35	140	1.5	11	1	1.857												
4	35	140	1.5	12	1	1.912	12	1.5	1.735	12	2	1.620	12.5	2.5	1.548	12	3	1.442
4	35	140	1.5	13	1	1.949	13.5	1.5	1.781									
4	35	140	1.5	14	1	1.916				14	2	1.615						
4	35	140	1.5	15	1	1.953	15	1.5	1.730				15	2.5	1.513	15	3	1.447
4	35	140	2	1	1	1.907	1.5	1.5	1.635									
4	35	140	2	2	1	1.635				2	2	1.477	2.5	2.5	1.386			
4	35	140	2	3	1	1.630	3	1.5	1.446							3	3	1.268
4	35	140	2	4	1	1.737	4.5	1.5	1.513	4	2	1.378						
4	35	140	2	5	1	1.753							5	2.5	1.315			
4	35	140	2	6	1	1.771	6	1.5	1.570	6	2	1.434				6	3	1.262
4	35	140	2	7	1	1.845	7.5	1.5	1.616				7.5	2.5	1.375			
4	35	140	2	8	1	1.874				8	2	1.501						
4	35	140	2	9	1	1.857	9	1.5	1.622							9	3	1.331
4	35	140	2	10	1	1.876	10.5	1.5	1.643	10	2	1.513	10	2.5	1.413			
4	35	140	2	11	1	1.859												
4	35	140	2	12	1	1.840	12	1.5	1.617	12	2	1.499	12.5	2.5	1.413	12	3	1.324
4	35	140	2	13	1	1.879	13.5	1.5	1.616									
4	35	140	2	14	1	1.863				14	2	1.543						
4	35	140	2	15	1	1.879	15	1.5	1.625				15	2.5	1.388	15	3	1.335
4	35	140	2.5	1	1	1.953	1.5	1.5	1.568									
4	35	140	2.5	2	1	1.661				2	2	1.400	2.5	2.5	1.256			
4	35	140	2.5	3	1	1.637	3	1.5	1.559							3	3	1.226
4	35	140	2.5	4	1	1.667	4.5	1.5	1.509	4	2	1.311						
4	35	140	2.5	5	1	1.738							5	2.5	1.241			
4	35	140	2.5	6	1	1.731	6	1.5	1.474	6	2	1.349				6	3	1.188
4	35	140	2.5	7	1	1.763	7.5	1.5	1.599				7.5	2.5	1.306			
4	35	140	2.5	8	1	1.795				8	2	1.418						
4	35	140	2.5	9	1	1.801	9	1.5	1.595							9	3	1.252
4	35	140	2.5	10	1	1.826	10.5	1.5	1.559	10	2	1.432	10	2.5	1.337			
4	35	140	2.5	11	1	1.815												
4	35	140	2.5	12	1	1.796	12	1.5	1.541	12	2	1.436	12.5	2.5	1.295	12	3	1.254
4	35	140	2.5	13	1	1.837	13.5	1.5	1.609									
4	35	140	2.5	14	1	1.828				14	2	1.405						
4	35	140	2.5	15	1	1.772	15	1.5	1.565				15	2.5	1.337	15	3	1.254
4	35	140	3	1	1	1.743	1.5	1.5	1.493									
4	35	140	3	2	1	1.624				2	2	1.359	2.5	2.5	1.233			
4	35	140	3	3	1	1.647	3	1.5	1.427							3	3	1.183
4	35	140	3	4	1	1.606	4.5	1.5	1.432	4	2	1.264						
4	35	140	3	5	1	1.684							5	2.5	1.231			
4	35	140	3	6	1	1.711	6	1.5	1.462	6	2	1.318				6	3	1.159
4	35	140	3	7	1	1.774	7.5	1.5	1.480				7.5	2.5	1.258			
4	35	140	3	8	1	1.776				8	2	1.380						
4	35	140	3	9	1	1.767	9	1.5	1.528							9	3	1.179
4	35	140	3	10	1	1.790	10.5	1.5	1.493	10	2	1.397	10	2.5	1.294			
4	35	140	3	11	1	1.776												
4	35	140	3	12	1	1.758	12	1.5	1.503	12	2	1.369	12.5	2.5	1.304	12	3	1.208
4	35	140	3	13	1	1.764	13.5	1.5	1.563									
4	35	140	3	14	1	1.749				14	2	1.377						
4	35	140	3	15	1	1.726	15	1.5	1.494				15	2.5	1.307	15	3	1.219

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
4	37	148	1.5	1	1	2.102	1.5	1.5	1.832									
4	37	148	1.5	2	1	1.882				2	2	1.685	2.5	2.5	1.542			
4	37	148	1.5	3	1	1.864	3	1.5	1.630							3	3	1.467
4	37	148	1.5	4	1	1.896	4.5	1.5	1.666	4	2	1.572						
4	37	148	1.5	5	1	1.913							5	2.5	1.494			
4	37	148	1.5	6	1	1.883	6	1.5	1.776	6	2	1.643				6	3	1.469
4	37	148	1.5	7	1	1.993	7.5	1.5	1.832				7.5	2.5	1.543			
4	37	148	1.5	8	1	1.984				8	2	1.627						
4	37	148	1.5	9	1	1.947	9	1.5	1.750							9	3	1.476
4	37	148	1.5	10	1	2.025	10.5	1.5	1.796	10	2	1.679	10	2.5	1.587			
4	37	148	1.5	11	1	1.992												
4	37	148	1.5	12	1	1.959	12	1.5	1.820	12	2	1.680	12.5	2.5	1.609	12	3	1.492
4	37	148	1.5	13	1	2.015	13.5	1.5	1.859									
4	37	148	1.5	14	1	2.033				14	2	1.677						
4	37	148	1.5	15	1	2.005	15	1.5	1.788				15	2.5	1.573	15	3	1.501
4	37	148	2	1	1	1.949	1.5	1.5	1.685									
4	37	148	2	2	1	1.696				2	2	1.523	2.5	2.5	1.431			
4	37	148	2	3	1	1.709	3	1.5	1.504							3	3	1.321
4	37	148	2	4	1	1.786	4.5	1.5	1.587	4	2	1.459						
4	37	148	2	5	1	1.840							5	2.5	1.380			
4	37	148	2	6	1	1.861	6	1.5	1.633	6	2	1.498				6	3	1.313
4	37	148	2	7	1	1.913	7.5	1.5	1.675				7.5	2.5	1.437			
4	37	148	2	8	1	1.951				8	2	1.564						
4	37	148	2	9	1	1.872	9	1.5	1.696							9	3	1.387
4	37	148	2	10	1	1.957	10.5	1.5	1.670	10	2	1.571	10	2.5	1.468			
4	37	148	2	11	1	1.989												
4	37	148	2	12	1	1.896	12	1.5	1.672	12	2	1.558	12.5	2.5	1.475	12	3	1.378
4	37	148	2	13	1	1.940	13.5	1.5	1.668									
4	37	148	2	14	1	1.959				14	2	1.606						
4	37	148	2	15	1	1.875	15	1.5	1.697				15	2.5	1.438	15	3	1.384
4	37	148	2.5	1	1	1.982	1.5	1.5	1.614									
4	37	148	2.5	2	1	1.725				2	2	1.438	2.5	2.5	1.299			
4	37	148	2.5	3	1	1.705	3	1.5	1.616							3	3	1.263
4	37	148	2.5	4	1	1.738	4.5	1.5	1.567	4	2	1.362						
4	37	148	2.5	5	1	1.817							5	2.5	1.294			
4	37	148	2.5	6	1	1.825	6	1.5	1.531	6	2	1.429				6	3	1.237
4	37	148	2.5	7	1	1.836	7.5	1.5	1.671				7.5	2.5	1.337			
4	37	148	2.5	8	1	1.885				8	2	1.469						
4	37	148	2.5	9	1	1.843	9	1.5	1.656							9	3	1.299
4	37	148	2.5	10	1	1.890	10.5	1.5	1.622	10	2	1.489	10	2.5	1.382			
4	37	148	2.5	11	1	1.865												
4	37	148	2.5	12	1	1.872	12	1.5	1.600	12	2	1.501	12.5	2.5	1.353	12	3	1.310
4	37	148	2.5	13	1	1.887	13.5	1.5	1.666									
4	37	148	2.5	14	1	1.923				14	2	1.447						
4	37	148	2.5	15	1	1.903	15	1.5	1.623				15	2.5	1.384	15	3	1.299
4	37	148	3	1	1	1.795	1.5	1.5	1.543									
4	37	148	3	2	1	1.684				2	2	1.38	2.5	2.5	1.282			
4	37	148	3	3	1	1.719	3	1.5	1.483							3	3	1.239
4	37	148	3	4	1	1.682	4.5	1.5	1.484	4	2	1.320						
4	37	148	3	5	1	1.761							5	2.5	1.285			
4	37	148	3	6	1	1.805	6	1.5	1.498	6	2	1.367				6	3	1.214
4	37	148	3	7	1	1.854	7.5	1.5	1.541				7.5	2.5	1.309			
4	37	148	3	8	1	1.865				8	2	1.434						
4	37	148	3	9	1	1.835	9	1.5	1.587							9	3	1.240
4	37	148	3	10	1	1.881	10.5	1.5	1.533	10	2	1.454	10	2.5	1.329			
4	37	148	3	11	1	1.847												
4	37	148	3	12	1	1.797	12	1.5	1.535	12	2	1.417	12.5	2.5	1.350	12	3	1.248
4	37	148	3	13	1	1.839	13.5	1.5	1.618									
4	37	148	3	14	1	1.768				14	2	1.422						
4	37	148	3	15	1	1.782	15	1.5	1.533				15	2.5	1.347	15	3	1.258

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
4	39	156	1.5	1	1	2.168	1.5	1.5	1.892									
4	39	156	1.5	2	1	1.953				2	2	1.722	2.5	2.5	1.576			
4	39	156	1.5	3	1	1.936	3	1.5	1.704							3	3	1.526
4	39	156	1.5	4	1	2.004	4.5	1.5	1.719	4	2	1.640						
4	39	156	1.5	5	1	1.899							5	2.5	1.556			
4	39	156	1.5	6	1	1.970	6	1.5	1.845	6	2	1.715				6	3	1.524
4	39	156	1.5	7	1	2.084	7.5	1.5	1.901				7.5	2.5	1.611			
4	39	156	1.5	8	1	2.041				8	2	1.687						
4	39	156	1.5	9	1	1.979	9	1.5	1.809							9	3	1.534
4	39	156	1.5	10	1	2.101	10.5	1.5	1.812	10	2	1.741	10	2.5	1.651			
4	39	156	1.5	11	1	2.112												
4	39	156	1.5	12	1	1.992	12	1.5	1.879	12	2	1.734	12.5	2.5	1.657	12	3	1.555
4	39	156	1.5	13	1	2.077	13.5	1.5	1.938									
4	39	156	1.5	14	1	2.069				14	2	1.742						
4	39	156	1.5	15	1	1.939	15	1.5	1.833				15	2.5	1.629	15	3	1.551
4	39	156	2	1	1	1.991	1.5	1.5	1.732									
4	39	156	2	2	1	1.753				2	2	1.574	2.5	2.5	1.485			
4	39	156	2	3	1	1.789	3	1.5	1.560							3	3	1.369
4	39	156	2	4	1	1.897	4.5	1.5	1.639	4	2	1.516						
4	39	156	2	5	1	1.840							5	2.5	1.431			
4	39	156	2	6	1	1.900	6	1.5	1.709	6	2	1.556				6	3	1.368
4	39	156	2	7	1	1.891	7.5	1.5	1.755				7.5	2.5	1.482			
4	39	156	2	8	1	2.005				8	2	1.626						
4	39	156	2	9	1	1.939	9	1.5	1.768							9	3	1.430
4	39	156	2	10	1	2.056	10.5	1.5	1.768	10	2	1.636	10	2.5	1.520			
4	39	156	2	11	1	1.889												
4	39	156	2	12	1	1.938	12	1.5	1.744	12	2	1.628	12.5	2.5	1.524	12	3	1.426
4	39	156	2	13	1	2.042	13.5	1.5	1.721									
4	39	156	2	14	1	2.068				14	2	1.670						
4	39	156	2	15	1	2.038	15	1.5	1.740				15	2.5	1.497	15	3	1.476
4	39	156	2.5	1	1	2.072	1.5	1.5	1.659									
4	39	156	2.5	2	1	1.788				2	2	1.485	2.5	2.5	1.340			
4	39	156	2.5	3	1	1.771	3	1.5	1.682							3	3	1.307
4	39	156	2.5	4	1	1.787	4.5	1.5	1.639	4	2	1.416						
4	39	156	2.5	5	1	1.859							5	2.5	1.349			
4	39	156	2.5	6	1	1.894	6	1.5	1.620	6	2	1.499				6	3	1.288
4	39	156	2.5	7	1	1.905	7.5	1.5	1.743				7.5	2.5	1.397			
4	39	156	2.5	8	1	1.925				8	2	1.527						
4	39	156	2.5	9	1	1.932	9	1.5	1.723							9	3	1.340
4	39	156	2.5	10	1	1.975	10.5	1.5	1.676	10	2	1.552	10	2.5	1.437			
4	39	156	2.5	11	1	1.945												
4	39	156	2.5	12	1	1.956	12	1.5	1.633	12	2	1.551	12.5	2.5	1.385	12	3	1.348
4	39	156	2.5	13	1	1.956	13.5	1.5	1.738									
4	39	156	2.5	14	1	1.978				14	2	1.495						
4	39	156	2.5	15	1	1.974	15	1.5	1.680				15	2.5	1.427	15	3	1.345
4	39	156	3	1	1	1.853	1.5	1.5	1.584									
4	39	156	3	2	1	1.745				2	2	1.454	2.5	2.5	1.323			
4	39	156	3	3	1	1.797	3	1.5	1.546							3	3	1.284
4	39	156	3	4	1	1.754	4.5	1.5	1.546	4	2	1.370						
4	39	156	3	5	1	1.837							5	2.5	1.339			
4	39	156	3	6	1	1.836	6	1.5	1.552	6	2	1.413				6	3	1.269
4	39	156	3	7	1	1.937	7.5	1.5	1.584				7.5	2.5	1.360			
4	39	156	3	8	1	1.851				8	2	1.499						
4	39	156	3	9	1	1.920	9	1.5	1.641							9	3	1.283
4	39	156	3	10	1	1.953	10.5	1.5	1.571	10	2	1.513	10	2.5	1.399			
4	39	156	3	11	1	1.911												
4	39	156	3	12	1	1.864	12	1.5	1.562	12	2	1.467	12.5	2.5	1.398	12	3	1.296
4	39	156	3	13	1	1.899	13.5	1.5	1.671									
4	39	156	3	14	1	1.834				14	2	1.470						
4	39	156	3	15	1	1.849	15	1.5	1.532				15	2.5	1.407	15	3	1.290

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
5	33	165	1.5	1	1	2.341	1.5	1.5	1.995									
5	33	165	1.5	2	1	1.993				2	2	1.794	2.5	2.5	1.616			
5	33	165	1.5	3	1	1.914	3	1.5	1.700							3	3	1.551
5	33	165	1.5	4	1	1.947	4.5	1.5	1.692	4	2	1.617						
5	33	165	1.5	5	1	1.931							5	2.5	1.526			
5	33	165	1.5	6	1	1.943	6	1.5	1.775	6	2	1.639				6	3	1.487
5	33	165	1.5	7	1	2.034	7.5	1.5	1.830				7.5	2.5	1.584			
5	33	165	1.5	8	1	2.012				8	2	1.659						
5	33	165	1.5	9	1	1.980	9	1.5	1.804							9	3	1.492
5	33	165	1.5	10	1	2.047	10.5	1.5	1.816	10	2	1.701	10	2.5	1.603			
5	33	165	1.5	11	1	2.062												
5	33	165	1.5	12	1	2.022	12	1.5	1.829	12	2	1.701	12.5	2.5	1.621	12	3	1.525
5	33	165	1.5	13	1	2.069	13.5	1.5	1.894									
5	33	165	1.5	14	1	2.083				14	2	1.713						
5	33	165	1.5	15	1	2.043	15	1.5	1.838				15	2.5	1.599	15	3	1.542
5	33	165	2	1	1	2.160	1.5	1.5	1.821									
5	33	165	2	2	1	1.856				2	2	1.636	2.5	2.5	1.512			
5	33	165	2	3	1	1.745	3	1.5	1.589							3	3	1.400
5	33	165	2	4	1	1.797	4.5	1.5	1.604	4	2	1.490						
5	33	165	2	5	1	1.834							5	2.5	1.407			
5	33	165	2	6	1	1.884	6	1.5	1.644	6	2	1.507				6	3	1.346
5	33	165	2	7	1	1.923	7.5	1.5	1.705				7.5	2.5	1.455			
5	33	165	2	8	1	1.949				8	2	1.569						
5	33	165	2	9	1	1.890	9	1.5	1.717							9	3	1.408
5	33	165	2	10	1	1.970	10.5	1.5	1.736	10	2	1.602	10	2.5	1.499			
5	33	165	2	11	1	1.959												
5	33	165	2	12	1	1.949	12	1.5	1.731	12	2	1.605	12.5	2.5	1.508	12	3	1.415
5	33	165	2	13	1	1.970	13.5	1.5	1.747									
5	33	165	2	14	1	1.987				14	2	1.636						
5	33	165	2	15	1	1.972	15	1.5	1.749				15	2.5	1.496	15	3	1.432
5	33	165	2.5	1	1	2.186	1.5	1.5	1.734									
5	33	165	2.5	2	1	1.805				2	2	1.552	2.5	2.5	1.390			
5	33	165	2.5	3	1	1.756	3	1.5	1.661							3	3	1.340
5	33	165	2.5	4	1	1.718	4.5	1.5	1.594	4	2	1.385						
5	33	165	2.5	5	1	1.805							5	2.5	1.337			
5	33	165	2.5	6	1	1.818	6	1.5	1.560	6	2	1.445				6	3	1.291
5	33	165	2.5	7	1	1.848	7.5	1.5	1.671				7.5	2.5	1.388			
5	33	165	2.5	8	1	1.878				8	2	1.497						
5	33	165	2.5	9	1	1.871	9	1.5	1.691							9	3	1.324
5	33	165	2.5	10	1	1.901	10.5	1.5	1.664	10	2	1.536	10	2.5	1.433			
5	33	165	2.5	11	1	1.894												
5	33	165	2.5	12	1	1.910	12	1.5	1.670	12	2	1.533	12.5	2.5	1.410	12	3	1.357
5	33	165	2.5	13	1	1.918	13.5	1.5	1.695									
5	33	165	2.5	14	1	1.915				14	2	1.517						
5	33	165	2.5	15	1	1.886	15	1.5	1.693				15	2.5	1.442	15	3	1.363
5	33	165	3	1	1	1.985	1.5	1.5	1.666									
5	33	165	3	2	1	1.779				2	2	1.497	2.5	2.5	1.338			
5	33	165	3	3	1	1.742	3	1.5	1.519							3	3	1.308
5	33	165	3	4	1	1.703	4.5	1.5	1.508	4	2	1.352						
5	33	165	3	5	1	1.763							5	2.5	1.301			
5	33	165	3	6	1	1.804	6	1.5	1.547	6	2	1.389				6	3	1.226
5	33	165	3	7	1	1.842	7.5	1.5	1.576				7.5	2.5	1.326			
5	33	165	3	8	1	1.853				8	2	1.464						
5	33	165	3	9	1	1.840	9	1.5	1.606							9	3	1.279
5	33	165	3	10	1	1.865	10.5	1.5	1.627	10	2	1.494	10	2.5	1.390			
5	33	165	3	11	1	1.867												
5	33	165	3	12	1	1.864	12	1.5	1.622	12	2	1.460	12.5	2.5	1.396	12	3	1.305
5	33	165	3	13	1	1.865	13.5	1.5	1.658									
5	33	165	3	14	1	1.841				14	2	1.493						
5	33	165	3	15	1	1.845	15	1.5	1.647				15	2.5	1.411	15	3	1.308

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
5	35	175	1.5	1	1	2.394	1.5	1.5	2.049									
5	35	175	1.5	2	1	2.041				2	2	1.852	2.5	2.5	1.673			
5	35	175	1.5	3	1	1.965	3	1.5	1.764							3	3	1.614
5	35	175	1.5	4	1	2.022	4.5	1.5	1.769	4	2	1.681						
5	35	175	1.5	5	1	1.972							5	2.5	1.583			
5	35	175	1.5	6	1	1.983	6	1.5	1.856	6	2	1.716				6	3	1.543
5	35	175	1.5	7	1	2.030	7.5	1.5	1.897				7.5	2.5	1.654			
5	35	175	1.5	8	1	2.096				8	2	1.732						
5	35	175	1.5	9	1	2.092	9	1.5	1.869							9	3	1.564
5	35	175	1.5	10	1	2.095	10.5	1.5	1.892	10	2	1.772	10	2.5	1.675			
5	35	175	1.5	11	1	2.056												
5	35	175	1.5	12	1	2.109	12	1.5	1.902	12	2	1.773	12.5	2.5	1.705	12	3	1.587
5	35	175	1.5	13	1	2.121	13.5	1.5	1.965									
5	35	175	1.5	14	1	2.128				14	2	1.793						
5	35	175	1.5	15	1	2.118	15	1.5	1.906				15	2.5	1.669	15	3	1.612
5	35	175	2	1	1	1.556	1.5	1.5	1.868									
5	35	175	2	2	1	1.918				2	2	1.682	2.5	2.5	1.568			
5	35	175	2	3	1	1.789	3	1.5	1.645							3	3	1.444
5	35	175	2	4	1	1.905	4.5	1.5	1.664	4	2	1.551						
5	35	175	2	5	1	1.854							5	2.5	1.460			
5	35	175	2	6	1	1.951	6	1.5	1.715	6	2	1.578				6	3	1.405
5	35	175	2	7	1	1.921	7.5	1.5	1.786				7.5	2.5	1.521			
5	35	175	2	8	1	2.007				8	2	1.645						
5	35	175	2	9	1	2.011	9	1.5	1.791							9	3	1.454
5	35	175	2	10	1	2.043	10.5	1.5	1.805	10	2	1.668	10	2.5	1.565			
5	35	175	2	11	1	2.045												
5	35	175	2	12	1	1.952	12	1.5	1.800	12	2	1.670	12.5	2.5	1.571	12	3	1.460
5	35	175	2	13	1	2.012	13.5	1.5	1.823									
5	35	175	2	14	1	2.067				14	2	1.698						
5	35	175	2	15	1	2.061	15	1.5	1.824				15	2.5	1.556	15	3	1.492
5	35	175	2.5	1	1	2.445	1.5	1.5	1.780									
5	35	175	2.5	2	1	1.868				2	2	1.602	2.5	2.5	1.431			
5	35	175	2.5	3	1	1.782	3	1.5	1.731							3	3	1.386
5	35	175	2.5	4	1	1.822	4.5	1.5	1.666	4	2	1.451						
5	35	175	2.5	5	1	1.824							5	2.5	1.368			
5	35	175	2.5	6	1	1.901	6	1.5	1.637	6	2	1.508				6	3	1.337
5	35	175	2.5	7	1	1.911	7.5	1.5	1.758				7.5	2.5	1.441			
5	35	175	2.5	8	1	1.970				8	2	1.550						
5	35	175	2.5	9	1	1.929	9	1.5	1.764							9	3	1.367
5	35	175	2.5	10	1	1.984	10.5	1.5	1.733	10	2	1.595	10	2.5	1.468			
5	35	175	2.5	11	1	1.892												
5	35	175	2.5	12	1	2.003	12	1.5	1.721	12	2	1.594	12.5	2.5	1.464	12	3	1.410
5	35	175	2.5	13	1	1.987	13.5	1.5	1.768									
5	35	175	2.5	14	1	2.018				14	2	1.576						
5	35	175	2.5	15	1	1.998	15	1.5	1.743				15	2.5	1.496	15	3	1.414
5	35	175	3	1	1	2.029	1.5	1.5	1.705									
5	35	175	3	2	1	1.833				2	2	1.550	2.5	2.5	1.410			
5	35	175	3	3	1	1.815	3	1.5	1.580							3	3	1.346
5	35	175	3	4	1	1.756	4.5	1.5	1.574	4	2	1.408						
5	35	175	3	5	1	1.797							5	2.5	1.357			
5	35	175	3	6	1	1.866	6	1.5	1.618	6	2	1.458				6	3	1.277
5	35	175	3	7	1	1.925	7.5	1.5	1.652				7.5	2.5	1.386			
5	35	175	3	8	1	1.912				8	2	1.532						
5	35	175	3	9	1	1.909	9	1.5	1.684							9	3	1.332
5	35	175	3	10	1	1.939	10.5	1.5	1.687	10	2	1.550	10	2.5	1.447			
5	35	175	3	11	1	1.876												
5	35	175	3	12	1	1.890	12	1.5	1.701	12	2	1.477	12.5	2.5	1.452	12	3	1.366
5	35	175	3	13	1	1.927	13.5	1.5	1.731									
5	35	175	3	14	1	1.932				14	2	1.554						
5	35	175	3	15	1	1.929	15	1.5	1.720				15	2.5	1.465	15	3	1.357

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
5	37	185	1.5	1	1	2.457	1.5	1.5	2.110									
5	37	185	1.5	2	1	2.121				2	2	1.910	2.5	2.5	1.725			
5	37	185	1.5	3	1	2.079	3	1.5	2.830							3	3	1.665
5	37	185	1.5	4	1	2.097	4.5	1.5	1.824	4	2	1.738						
5	37	185	1.5	5	1	2.018							5	2.5	1.649			
5	37	185	1.5	6	1	2.174	6	1.5	1.951	6	2	1.790				6	3	1.608
5	37	185	1.5	7	1	2.119	7.5	1.5	1.953				7.5	2.5	1.725			
5	37	185	1.5	8	1	2.019				8	2	1.809						
5	37	185	1.5	9	1	2.074	9	1.5	1.953							9	3	1.631
5	37	185	1.5	10	1	2.176	10.5	1.5	1.957	10	2	1.843	10	2.5	1.734			
5	37	185	1.5	11	1	2.197												
5	37	185	1.5	12	1	2.165	12	1.5	1.994	12	2	1.852	12.5	2.5	1.759	12	3	1.670
5	37	185	1.5	13	1	2.144	13.5	1.5	1.997									
5	37	185	1.5	14	1	2.189				14	2	1.860						
5	37	185	1.5	15	1	2.228	15	1.5	1.993				15	2.5	1.740	15	3	1.677
5	37	185	2	1	1	1.672	1.5	1.5	1.922									
5	37	185	2	2	1	1.978				2	2	1.735	2.5	2.5	1.619			
5	37	185	2	3	1	1.850	3	1.5	1.678							3	3	1.490
5	37	185	2	4	1	1.952	4.5	1.5	1.735	4	2	1.606						
5	37	185	2	5	1	1.986							5	2.5	1.509			
5	37	185	2	6	1	2.030	6	1.5	1.783	6	2	1.648				6	3	1.448
5	37	185	2	7	1	2.036	7.5	1.5	1.871				7.5	2.5	1.593			
5	37	185	2	8	1	2.107				8	2	1.715						
5	37	185	2	9	1	2.076	9	1.5	1.833							9	3	1.529
5	37	185	2	10	1	2.107	10.5	1.5	1.884	10	2	1.742	10	2.5	1.632			
5	37	185	2	11	1	2.131												
5	37	185	2	12	1	2.015	12	1.5	1.859	12	2	1.736	12.5	2.5	1.632	12	3	1.534
5	37	185	2	13	1	2.088	13.5	1.5	1.892									
5	37	185	2	14	1	2.118				14	2	1.779						
5	37	185	2	15	1	2.175	15	1.5	1.889				15	2.5	1.613	15	3	1.535
5	37	185	2.5	1	1	2.303	1.5	1.5	1.837									
5	37	185	2.5	2	1	1.937				2	2	1.650	2.5	2.5	1.475			
5	37	185	2.5	3	1	1.901	3	1.5	1.771							3	3	1.438
5	37	185	2.5	4	1	1.888	4.5	1.5	1.743	4	2	1.508						
5	37	185	2.5	5	1	1.969							5	2.5	1.436			
5	37	185	2.5	6	1	1.864	6	1.5	1.680	6	2	1.579				6	3	1.392
5	37	185	2.5	7	1	1.962	7.5	1.5	1.828				7.5	2.5	1.503			
5	37	185	2.5	8	1	1.954				8	2	1.626						
5	37	185	2.5	9	1	2.011	9	1.5	1.840							9	3	1.438
5	37	185	2.5	10	1	2.091	10.5	1.5	1.803	10	2	1.669	10	2.5	1.551			
5	37	185	2.5	11	1	2.055												
5	37	185	2.5	12	1	2.071	12	1.5	1.783	12	2	1.664	12.5	2.5	1.507	12	3	1.467
5	37	185	2.5	13	1	2.041	13.5	1.5	1.858									
5	37	185	2.5	14	1	2.109				14	2	1.629						
5	37	185	2.5	15	1	2.061	15	1.5	1.801				15	2.5	1.550	15	3	1.462
5	37	185	3	1	1	1.261	1.5	1.5	1.757									
5	37	185	3	2	1	1.888				2	2	1.590	2.5	2.5	1.443			
5	37	185	3	3	1	1.885	3	1.5	1.642							3	3	1.395
5	37	185	3	4	1	1.722	4.5	1.5	1.641	4	2	1.465						
5	37	185	3	5	1	1.923							5	2.5	1.411			
5	37	185	3	6	1	1.917	6	1.5	1.681	6	2	1.519				6	3	1.334
5	37	185	3	7	1	1.975	7.5	1.5	1.703				7.5	2.5	1.448			
5	37	185	3	8	1	1.997				8	2	1.593						
5	37	185	3	9	1	1.973	9	1.5	1.753							9	3	1.375
5	37	185	3	10	1	2.038	10.5	1.5	1.741	10	2	1.611	10	2.5	1.510			
5	37	185	3	11	1	1.980												
5	37	185	3	12	1	1.947	12	1.5	1.761	12	2	1.567	12.5	2.5	1.508	12	3	1.414
5	37	185	3	13	1	2.024	13.5	1.5	1.802									
5	37	185	3	14	1	2.011				14	2	1.614						
5	37	185	3	15	1	2.005	15	1.5	1.787				15	2.5	1.511	15	3	1.417

Appendix A

Raw Dataset of FOS Values

SF = c * phi

c	phi	SF	Dia	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS	Depth	Ed	FOS
5	39	195	1.5	1	1	2.498	1.5	1.5	2.164									
5	39	195	1.5	2	1	2.176				2	2	1.972	2.5	2.5	1.777			
5	39	195	1.5	3	1	2.150	3	1.5	1.888							3	3	1.717
5	39	195	1.5	4	1	2.183	4.5	1.5	1.797	4	2	1.815						
5	39	195	1.5	5	1	2.001							5	2.5	1.714			
5	39	195	1.5	6	1	2.239	6	1.5	2.047	6	2	1.854				6	3	1.676
5	39	195	1.5	7	1	2.309	7.5	1.5	2.068				7.5	2.5	1.800			
5	39	195	1.5	8	1	2.127				8	2	1.877						
5	39	195	1.5	9	1	2.198	9	1.5	2.025							9	3	1.680
5	39	195	1.5	10	1	2.235	10.5	1.5	2.060	10	2	1.927	10	2.5	1.823			
5	39	195	1.5	11	1	2.218												
5	39	195	1.5	12	1	2.246	12	1.5	2.052	12	2	1.927	12.5	2.5	1.831	12	3	1.731
5	39	195	1.5	13	1	2.202	13.5	1.5	1.918									
5	39	195	1.5	14	1	2.268				14	2	1.932						
5	39	195	1.5	15	1	2.189	15	1.5	2.056				15	2.5	1.806	15	3	1.734
5	39	195	2	1	1	1.663	1.5	1.5	1.979									
5	39	195	2	2	1	2.049				2	2	1.794	2.5	2.5	1.670			
5	39	195	2	3	1	1.927	3	1.5	1.762							3	3	1.537
5	39	195	2	4	1	2.099	4.5	1.5	1.812	4	2	1.659						
5	39	195	2	5	1	2.135							5	2.5	1.579			
5	39	195	2	6	1	1.999	6	1.5	1.807	6	2	1.712				6	3	1.520
5	39	195	2	7	1	2.084	7.5	1.5	1.948				7.5	2.5	1.655			
5	39	195	2	8	1	2.175				8	2	1.781						
5	39	195	2	9	1	2.175	9	1.5	1.896							9	3	1.598
5	39	195	2	10	1	2.224	10.5	1.5	1.952	10	2	1.809	10	2.5	1.695			
5	39	195	2	11	1	1.929												
5	39	195	2	12	1	2.234	12	1.5	1.927	12	2	1.810	12.5	2.5	1.701	12	3	1.590
5	39	195	2	13	1	2.184	13.5	1.5	1.960									
5	39	195	2	14	1	2.228				14	2	1.85						
5	39	195	2	15	1	1.960	15	1.5	1.958				15	2.5	1.672	15	3	1.591
5	39	195	2.5	1	1	2.367	1.5	1.5	1.894									
5	39	195	2.5	2	1	2.002				2	2	1.695	2.5	2.5	1.519			
5	39	195	2.5	3	1	1.874	3	1.5	2.831							3	3	1.477
5	39	195	2.5	4	1	1.971	4.5	1.5	1.753	4	2	1.569						
5	39	195	2.5	5	1	1.902							5	2.5	1.498			
5	39	195	2.5	6	1	1.839	6	1.5	1.756	6	2	1.616				6	3	1.450
5	39	195	2.5	7	1	1.960	7.5	1.5	1.929				7.5	2.5	1.556			
5	39	195	2.5	8	1	2.119				8	2	1.699						
5	39	195	2.5	9	1	2.065	9	1.5	1.817							9	3	1.472
5	39	195	2.5	10	1	2.107	10.5	1.5	1.869	10	2	1.735	10	2.5	1.611			
5	39	195	2.5	11	1	2.151												
5	39	195	2.5	12	1	2.144	12	1.5	1.827	12	2	1.723	12.5	2.5	1.572	12	3	1.520
5	39	195	2.5	13	1	2.205	13.5	1.5	1.923									
5	39	195	2.5	14	1	2.209				14	2	1.692						
5	39	195	2.5	15	1	2.136	15	1.5	1.883				15	2.5	1.612	15	3	1.522
5	39	195	3	1	1	2.137	1.5	1.5	1.804									
5	39	195	3	2	1	1.950				2	2	1.643	2.5	2.5	1.496			
5	39	195	3	3	1	1.969	3	1.5	1.709							3	3	1.438
5	39	195	3	4	1	1.823	4.5	1.5	1.708	4	2	1.516						
5	39	195	3	5	1	1.988							5	2.5	1.470			
5	39	195	3	6	1	1.984	6	1.5	1.757	6	2	1.569				6	3	1.389
5	39	195	3	7	1	2.061	7.5	1.5	1.780				7.5	2.5	1.500			
5	39	195	3	8	1	2.038				8	2	1.652						
5	39	195	3	9	1	2.090	9	1.5	1.830							9	3	1.426
5	39	195	3	10	1	2.076	10.5	1.5	1.799	10	2	1.677	10	2.5	1.565			
5	39	195	3	11	1	2.067												
5	39	195	3	12	1	2.081	12	1.5	1.826	12	2	1.641	12.5	2.5	1.571	12	3	1.474
5	39	195	3	13	1	2.109	13.5	1.5	1.873									
5	39	195	3	14	1	2.085				14	2	1.674						
5	39	195	3	15	1	2.099	15	1.5	1.809				15	2.5	1.575	15	3	1.460

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
0	0.677	0.545	0.132	0.132	21.2	<-- Station No. 1 ~ 1.5m
5	0.593	0.531	0.062	0.062	21.1	<-- Station No. 1 ~ 1.5m
10	0.593	0.593	0.000	0.000	21.5	<-- Station No. 1 ~ 1.5m
15	0.593	0.572	0.021	0.021	21.4	<-- Station No. 1 ~ 1.5m
20	0.556	0.522	0.034	0.034	21.9	<-- Station No. 1 ~ 1.5m
25	0.556	0.566	0.009	-0.009	21.9	<-- Station No. 1 ~ 1.5m
30	0.588	0.550	0.039	0.039	22.2	<-- Station No. 1 ~ 1.5m
35	0.588	0.525	0.064	0.064	21.8	<-- Station No. 1 ~ 1.5m
40	0.588	0.504	0.084	0.084	21.7	<-- Station No. 1 ~ 1.5m
45	0.588	0.497	0.091	0.091	21.6	<-- Station No. 1 ~ 1.5m
50	0.588	0.634	0.046	-0.046	21.5	<-- Station No. 1 ~ 1.5m
55	0.588	0.593	0.005	-0.005	21.5	<-- Station No. 1 ~ 1.5m
60	0.588	0.511	0.078	0.078	21.6	<-- Station No. 1 ~ 1.5m
65	0.588	0.547	0.041	0.041	21.5	<-- Station No. 1 ~ 1.5m
70	0.588	0.525	0.064	0.064	21.5	<-- Station No. 1 ~ 1.5m
75	0.588	0.602	0.014	-0.014	21.6	<-- Station No. 1 ~ 1.5m
80	0.588	0.547	0.041	0.041	21.8	<-- Station No. 1 ~ 1.5m
85	0.588	0.497	0.091	0.091	21.7	<-- Station No. 1 ~ 1.5m
90	0.588	0.499	0.089	0.089	22	<-- Station No. 1 ~ 1.5m
95	0.588	0.490	0.098	0.098	22.4	<-- Station No. 1 ~ 1.5m
100	0.588	0.456	0.132	0.132	23	<-- Station No. 1 ~ 1.5m
105	0.588	0.481	0.107	0.107	23.5	<-- Station No. 1 ~ 1.5m
110	0.588	0.369	0.219	0.219	23.8	<-- Station No. 1 ~ 1.5m
115	0.588	0.381	0.208	0.208	23.4	<-- Station No. 1 ~ 1.5m
120	0.588	0.399	0.189	0.189	24	<-- Station No. 1 ~ 1.5m
125	0.588	0.342	0.246	0.246	24.3	<-- Station No. 1 ~ 1.5m
130	0.588	0.328	0.260	0.260	24.6	<-- Station No. 1 ~ 1.5m
135	0.588	0.383	0.205	0.205	24.7	<-- Station No. 1 ~ 1.5m
140	0.588	0.335	0.253	0.253	25.1	<-- Station No. 1 ~ 1.5m
145	0.588	0.283	0.306	0.306	25.2	<-- Station No. 1 ~ 1.5m
150	0.588	0.274	0.315	0.315	24.9	<-- Station No. 1 ~ 1.5m
155	0.588	0.265	0.324	0.324	25.4	<-- Station No. 1 ~ 1.5m
160	0.588	0.276	0.312	0.312	25.4	<-- Station No. 1 ~ 1.5m
165	0.588	0.290	0.299	0.299	25.3	<-- Station No. 1 ~ 1.5m
170	0.588	0.287	0.301	0.301	25.2	<-- Station No. 1 ~ 1.5m
175	0.588	0.260	0.328	0.328	25.2	<-- Station No. 1 ~ 1.5m
180	0.588	0.294	0.294	0.294	24.8	<-- Station No. 1 ~ 1.5m
185	0.588	0.369	0.219	0.219	24.7	<-- Station No. 1 ~ 1.5m
190	0.588	0.303	0.285	0.285	24.8	<-- Station No. 1 ~ 1.5m
195	0.588	0.356	0.233	0.233	24.3	<-- Station No. 1 ~ 1.5m
200	0.588	0.328	0.260	0.260	24.1	<-- Station No. 1 ~ 1.5m
205	0.588	0.333	0.255	0.255	23.9	<-- Station No. 1 ~ 1.5m
210	0.588	0.340	0.249	0.249	23.6	<-- Station No. 1 ~ 1.5m
215	0.588	0.360	0.228	0.228	23.5	<-- Station No. 1 ~ 1.5m
220	0.588	0.406	0.182	0.182	23.3	<-- Station No. 1 ~ 1.5m
225	0.588	0.381	0.208	0.208	23.2	<-- Station No. 1 ~ 1.5m
230	0.588	0.392	0.196	0.196	23.1	<-- Station No. 1 ~ 1.5m
235	0.588	0.392	0.196	0.196	23.2	<-- Station No. 1 ~ 1.5m
240	0.588	0.481	0.107	0.107	22.9	<-- Station No. 1 ~ 1.5m
245	0.588	0.406	0.182	0.182	22.8	<-- Station No. 1 ~ 1.5m
250	0.588	0.431	0.157	0.157	22.7	<-- Station No. 1 ~ 1.5m
255	0.588	0.431	0.157	0.157	22.7	<-- Station No. 1 ~ 1.5m
260	0.588	0.401	0.187	0.187	22.6	<-- Station No. 1 ~ 1.5m
265	0.588	0.401	0.187	0.187	22.4	<-- Station No. 1 ~ 1.5m
270	0.588	0.422	0.166	0.166	22.4	<-- Station No. 1 ~ 1.5m
275	0.588	0.488	0.100	0.100	22.3	<-- Station No. 1 ~ 1.5m
280	0.588	0.525	0.064	0.064	22.2	<-- Station No. 1 ~ 1.5m
285	0.588	0.447	0.141	0.141	22.1	<-- Station No. 1 ~ 1.5m
290	0.588	0.447	0.141	0.141	22.1	<-- Station No. 1 ~ 1.5m
295	0.588	0.468	0.121	0.121	22	<-- Station No. 1 ~ 1.5m
300	0.588	0.495	0.094	0.094	21.9	<-- Station No. 1 ~ 1.5m
305	0.588	0.493	0.096	0.096	21.8	<-- Station No. 1 ~ 1.5m
310	0.588	0.486	0.103	0.103	21.7	<-- Station No. 1 ~ 1.5m
315	0.588	0.488	0.100	0.100	21.7	<-- Station No. 1 ~ 1.5m
320	0.588	0.456	0.132	0.132	21.7	<-- Station No. 1 ~ 1.5m
325	0.588	0.481	0.107	0.107	21.6	<-- Station No. 1 ~ 1.5m
330	0.588	0.497	0.091	0.091	21.6	<-- Station No. 1 ~ 1.5m
335	0.588	0.540	0.048	0.048	21.6	<-- Station No. 1 ~ 1.5m
340	0.588	0.536	0.052	0.052	21.5	<-- Station No. 1 ~ 1.5m
345	0.588	0.468	0.121	0.121	21.4	<-- Station No. 1 ~ 1.5m
350	0.588	0.543	0.046	0.046	21.4	<-- Station No. 1 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
355	0.588	0.572	0.016	0.016	21.3	<-- Station No. 1 ~ 1.5m
360	0.588	0.513	0.075	0.075	21.3	<-- Station No. 1 ~ 1.5m
365	0.588	0.486	0.103	0.103	21.3	<-- Station No. 1 ~ 1.5m
370	0.588	0.474	0.114	0.114	21.2	<-- Station No. 1 ~ 1.5m
375	0.588	0.486	0.103	0.103	21.1	<-- Station No. 1 ~ 1.5m
380	0.588	0.568	0.021	0.021	21.2	<-- Station No. 1 ~ 1.5m
385	0.588	0.497	0.091	0.091	21.1	<-- Station No. 1 ~ 1.5m
390	0.588	0.499	0.089	0.089	21	<-- Station No. 1 ~ 1.5m
395	0.588	0.563	0.025	0.025	21	<-- Station No. 1 ~ 1.5m
400	0.588	0.591	0.002	-0.002	20.9	<-- Station No. 1 ~ 1.5m
405	0.588	0.486	0.103	0.103	21	<-- Station No. 1 ~ 1.5m
410	0.588	0.552	0.036	0.036	21	<-- Station No. 1 ~ 1.5m
415	0.588	0.563	0.025	0.025	21	<-- Station No. 1 ~ 1.5m
420	0.588	0.595	0.007	-0.007	20.8	<-- Station No. 1 ~ 1.5m
425	0.588	0.556	0.032	0.032	20.7	<-- Station No. 1 ~ 1.5m
430	0.588	0.540	0.048	0.048	20.8	<-- Station No. 1 ~ 1.5m
435	0.588	0.566	0.023	0.023	20.7	<-- Station No. 1 ~ 1.5m
440	0.588	0.518	0.071	0.071	20.6	<-- Station No. 1 ~ 1.5m
445	0.588	0.636	0.048	-0.048	20.6	<-- Station No. 1 ~ 1.5m
450	0.588	0.570	0.018	0.018	20.5	<-- Station No. 1 ~ 1.5m
455	0.588	0.561	0.027	0.027	20.5	<-- Station No. 1 ~ 1.5m
460	0.588	0.556	0.032	0.032	20.4	<-- Station No. 1 ~ 1.5m
465	0.588	0.520	0.068	0.068	20.5	<-- Station No. 1 ~ 1.5m
470	0.588	0.582	0.007	0.007	20.5	<-- Station No. 1 ~ 1.5m
475	0.588	0.547	0.041	0.041	20.3	<-- Station No. 1 ~ 1.5m
480	0.588	0.611	0.023	-0.023	20.3	<-- Station No. 1 ~ 1.5m
485	0.588	0.604	0.016	-0.016	20.3	<-- Station No. 1 ~ 1.5m
490	0.588	0.572	0.016	0.016	20.2	<-- Station No. 1 ~ 1.5m
495	0.588	0.572	0.016	0.016	20.2	<-- Station No. 1 ~ 1.5m
500	0.588	0.586	0.002	0.002	20.3	<-- Station No. 1 ~ 1.5m
505	0.588	0.625	0.036	-0.036	20.3	<-- Station No. 1 ~ 1.5m
510	0.588	0.572	0.016	0.016	20.2	<-- Station No. 1 ~ 1.5m
515	0.588	0.563	0.025	0.025	20.1	<-- Station No. 1 ~ 1.5m
520	0.588	0.536	0.052	0.052	20.1	<-- Station No. 1 ~ 1.5m
525	0.588	0.572	0.016	0.016	20.1	<-- Station No. 1 ~ 1.5m
530	0.588	0.584	0.005	0.005	20.1	<-- Station No. 1 ~ 1.5m
535	0.588	0.609	0.021	-0.021	20.2	<-- Station No. 1 ~ 1.5m
540	0.588	0.552	0.036	0.036	20.1	<-- Station No. 1 ~ 1.5m
545	0.588	0.604	0.016	-0.016	20.2	<-- Station No. 1 ~ 1.5m
550	0.588	0.563	0.025	0.025	20	<-- Station No. 1 ~ 1.5m
555	0.588	0.563	0.025	0.025	20	<-- Station No. 1 ~ 1.5m
560	0.588	0.629	0.041	-0.041	20	<-- Station No. 1 ~ 1.5m
565	0.588	0.625	0.036	-0.036	19.9	<-- Station No. 1 ~ 1.5m
570	0.588	0.568	0.021	0.021	19.9	<-- Station No. 1 ~ 1.5m
575	0.588	0.634	0.046	-0.046	20.1	<-- Station No. 1 ~ 1.5m
580	0.588	0.620	0.032	-0.032	20	<-- Station No. 1 ~ 1.5m
585	0.588	0.641	0.052	-0.052	20	<-- Station No. 1 ~ 1.5m
590	0.588	0.643	0.055	-0.055	19.9	<-- Station No. 1 ~ 1.5m
595	0.588	0.584	0.005	0.005	20	<-- Station No. 1 ~ 1.5m
600	0.588	0.568	0.021	0.021	19.9	<-- Station No. 1 ~ 1.5m
605	0.588	0.650	0.062	-0.062	19.8	<-- Station No. 1 ~ 1.5m
610	0.588	0.572	0.016	0.016	19.8	<-- Station No. 1 ~ 1.5m
615	0.588	0.591	0.002	-0.002	19.8	<-- Station No. 1 ~ 1.5m
620	0.588	0.620	0.032	-0.032	19.8	<-- Station No. 1 ~ 1.5m
625	0.588	0.629	0.041	-0.041	19.8	<-- Station No. 1 ~ 1.5m
630	0.588	0.572	0.016	0.016	19.8	<-- Station No. 1 ~ 1.5m
635	0.588	0.684	0.096	-0.096	19.9	<-- Station No. 1 ~ 1.5m
640	0.588	0.613	0.025	-0.025	19.8	<-- Station No. 1 ~ 1.5m
645	0.588	0.607	0.018	-0.018	19.8	<-- Station No. 1 ~ 1.5m
650	0.588	0.664	0.075	-0.075	19.7	<-- Station No. 1 ~ 1.5m
655	0.588	0.629	0.041	-0.041	19.7	<-- Station No. 1 ~ 1.5m
660	0.588	0.618	0.030	-0.030	19.8	<-- Station No. 1 ~ 1.5m
665	0.588	0.643	0.055	-0.055	19.8	<-- Station No. 1 ~ 1.5m
670	0.588	0.609	0.021	-0.021	19.7	<-- Station No. 1 ~ 1.5m
675	0.588	0.659	0.071	-0.071	19.8	<-- Station No. 1 ~ 1.5m
680	0.588	0.595	0.007	-0.007	19.7	<-- Station No. 1 ~ 1.5m
685	0.588	0.664	0.075	-0.075	19.8	<-- Station No. 1 ~ 1.5m
690	0.588	0.584	0.005	0.005	19.7	<-- Station No. 1 ~ 1.5m
695	0.588	0.657	0.068	-0.068	19.7	<-- Station No. 1 ~ 1.5m
700	0.588	0.682	0.094	-0.094	19.8	<-- Station No. 1 ~ 1.5m
705	0.588	0.584	0.005	0.005	19.6	<-- Station No. 1 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
710	0.588	0.613	0.025	-0.025	19.7	<-- Station No. 1 ~ 1.5m
715	0.588	0.597	0.009	-0.009	19.8	<-- Station No. 1 ~ 1.5m
720	0.588	0.668	0.080	-0.080	19.7	<-- Station No. 1 ~ 1.5m
725	0.588	0.595	0.007	-0.007	19.6	<-- Station No. 1 ~ 1.5m
730	0.588	0.579	0.009	0.009	19.7	<-- Station No. 1 ~ 1.5m
735	0.588	0.579	0.009	0.009	19.7	<-- Station No. 1 ~ 1.5m
740	0.588	0.620	0.032	-0.032	19.7	<-- Station No. 1 ~ 1.5m
745	0.588	0.595	0.007	-0.007	19.7	<-- Station No. 1 ~ 1.5m
750	0.588	0.625	0.036	-0.036	19.8	<-- Station No. 1 ~ 1.5m
755	0.588	0.659	0.071	-0.071	19.7	<-- Station No. 1 ~ 1.5m
760	0.588	0.611	0.023	-0.023	19.7	<-- Station No. 1 ~ 1.5m
765	0.588	0.611	0.023	-0.023	19.9	<-- Station No. 1 ~ 1.5m
770	0.588	0.591	0.002	-0.002	19.8	<-- Station No. 1 ~ 1.5m
775	0.588	0.666	0.078	-0.078	19.6	<-- Station No. 1 ~ 1.5m
780	0.588	0.600	0.011	-0.011	19.5	<-- Station No. 1 ~ 1.5m
785	0.588	0.593	0.005	-0.005	19.7	<-- Station No. 1 ~ 1.5m
790	0.588	0.677	0.089	-0.089	19.3	<-- Station No. 1 ~ 1.5m
795	0.588	0.600	0.011	-0.011	19.8	<-- Station No. 1 ~ 1.5m
800	0.588	0.643	0.055	-0.055	19.6	<-- Station No. 1 ~ 1.5m
805	0.588	0.625	0.036	-0.036	19.6	<-- Station No. 1 ~ 1.5m
810	0.588	0.655	0.066	-0.066	19.6	<-- Station No. 1 ~ 1.5m
815	0.588	0.632	0.043	-0.043	19.5	<-- Station No. 1 ~ 1.5m
820	0.588	0.636	0.048	-0.048	19.4	<-- Station No. 1 ~ 1.5m
825	0.588	0.675	0.087	-0.087	19.5	<-- Station No. 1 ~ 1.5m
830	0.588	0.680	0.091	-0.091	19.5	<-- Station No. 1 ~ 1.5m
835	0.588	0.593	0.005	-0.005	19.6	<-- Station No. 1 ~ 1.5m
840	0.588	0.682	0.094	-0.094	19.5	<-- Station No. 1 ~ 1.5m
845	0.588	0.764	0.176	-0.176	19.5	<-- Station No. 1 ~ 1.5m
850	0.588	0.632	0.043	-0.043	19.8	<-- Station No. 1 ~ 1.5m
855	0.588	0.604	0.016	-0.016	19.4	<-- Station No. 1 ~ 1.5m
860	0.588	0.680	0.091	-0.091	19.5	<-- Station No. 1 ~ 1.5m
865	0.588	0.714	0.125	-0.125	19.7	<-- Station No. 1 ~ 1.5m
870	0.588	0.623	0.034	-0.034	19.5	<-- Station No. 1 ~ 1.5m
875	0.588	0.632	0.043	-0.043	19.5	<-- Station No. 1 ~ 1.5m
880	0.588	0.702	0.114	-0.114	19.5	<-- Station No. 1 ~ 1.5m
885	0.588	0.657	0.068	-0.068	19.5	<-- Station No. 1 ~ 1.5m
890	0.588	0.677	0.089	-0.089	19.5	<-- Station No. 1 ~ 1.5m
895	0.588	0.604	0.016	-0.016	19.6	<-- Station No. 1 ~ 1.5m
900	0.588	0.632	0.043	-0.043	19.5	<-- Station No. 1 ~ 1.5m
905	0.588	0.677	0.089	-0.089	19.6	<-- Station No. 1 ~ 1.5m
910	0.588	0.604	0.016	-0.016	19.4	<-- Station No. 1 ~ 1.5m
915	0.588	0.627	0.039	-0.039	19.6	<-- Station No. 1 ~ 1.5m
920	0.588	0.655	0.066	-0.066	19.5	<-- Station No. 1 ~ 1.5m
925	0.588	0.629	0.041	-0.041	19.5	<-- Station No. 1 ~ 1.5m
930	0.588	0.634	0.046	-0.046	19.5	<-- Station No. 1 ~ 1.5m
935	0.588	0.691	0.103	-0.103	19.5	<-- Station No. 1 ~ 1.5m
940	0.588	0.632	0.043	-0.043	19.2	<-- Station No. 1 ~ 1.5m
945	0.588	0.657	0.068	-0.068	19.5	<-- Station No. 1 ~ 1.5m
950	0.588	0.616	0.027	-0.027	19.4	<-- Station No. 1 ~ 1.5m
955	0.588	0.609	0.021	-0.021	19.5	<-- Station No. 1 ~ 1.5m
960	0.588	0.627	0.039	-0.039	19.5	<-- Station No. 1 ~ 1.5m
965	0.588	0.643	0.055	-0.055	19.6	<-- Station No. 1 ~ 1.5m
970	0.588	0.609	0.021	-0.021	19.5	<-- Station No. 1 ~ 1.5m
975	0.588	0.609	0.021	-0.021	19.5	<-- Station No. 1 ~ 1.5m
980	0.588	0.641	0.052	-0.052	19.5	<-- Station No. 1 ~ 1.5m
985	0.588	0.634	0.046	-0.046	19.5	<-- Station No. 1 ~ 1.5m
990	0.588	0.602	0.014	-0.014	19.4	<-- Station No. 1 ~ 1.5m
995	0.588	0.657	0.068	-0.068	19.5	<-- Station No. 1 ~ 1.5m
1000	0.588	0.652	0.064	-0.064	19.5	<-- Station No. 1 ~ 1.5m
1005	0.588	0.609	0.021	-0.021	19.4	<-- Station No. 1 ~ 1.5m
1010	0.588	0.595	0.007	-0.007	19.5	<-- Station No. 1 ~ 1.5m
1015	0.588	0.611	0.023	-0.023	19.5	<-- Station No. 1 ~ 1.5m
1020	0.588	0.641	0.052	-0.052	19.7	<-- Station No. 1 ~ 1.5m
1025	0.588	0.629	0.041	-0.041	19.3	<-- Station No. 1 ~ 1.5m
1030	0.588	0.600	0.011	-0.011	19.6	<-- Station No. 1 ~ 1.5m
1035	0.588	0.645	0.057	-0.057	19.6	<-- Station No. 1 ~ 1.5m
1040	0.588	0.666	0.078	-0.078	19.8	<-- Station No. 1 ~ 1.5m
1045	0.588	0.609	0.021	-0.021	19.6	<-- Station No. 1 ~ 1.5m
1050	0.588	0.629	0.041	-0.041	19.5	<-- Station No. 1 ~ 1.5m
1055	0.588	0.705	0.116	-0.116	19.5	<-- Station No. 1 ~ 1.5m
1060	0.588	0.652	0.064	-0.064	19.7	<-- Station No. 1 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1065	0.588	0.705	0.116	-0.116	19.6	<-- Station No. 1 ~ 1.5m
1070	0.588	0.609	0.021	-0.021	19.6	<-- Station No. 1 ~ 1.5m
1075	0.588	0.597	0.009	-0.009	19.7	<-- Station No. 1 ~ 1.5m
1080	0.588	0.607	0.018	-0.018	19.7	<-- Station No. 1 ~ 1.5m
1085	0.588	0.639	0.050	-0.050	19.7	<-- Station No. 1 ~ 1.5m
1090	0.588	0.595	0.007	-0.007	19.9	<-- Station No. 1 ~ 1.5m
1095	0.588	0.613	0.025	-0.025	19.8	<-- Station No. 1 ~ 1.5m
1100	0.588	0.739	0.151	-0.151	19.7	<-- Station No. 1 ~ 1.5m
1105	0.588	0.670	0.082	-0.082	19.9	<-- Station No. 1 ~ 1.5m
1110	0.588	0.632	0.043	-0.043	19.7	<-- Station No. 1 ~ 1.5m
1115	0.588	0.670	0.082	-0.082	19.7	<-- Station No. 1 ~ 1.5m
1120	0.588	0.675	0.087	-0.087	19.8	<-- Station No. 1 ~ 1.5m
1125	0.588	0.652	0.064	-0.064	19.8	<-- Station No. 1 ~ 1.5m
1130	0.588	0.666	0.078	-0.078	19.9	<-- Station No. 1 ~ 1.5m
1135	0.588	0.702	0.114	-0.114	19.9	<-- Station No. 1 ~ 1.5m
1140	0.588	0.639	0.050	-0.050	19.8	<-- Station No. 1 ~ 1.5m
1145	0.588	0.616	0.027	-0.027	19.8	<-- Station No. 1 ~ 1.5m
1150	0.588	0.588	0.000	0.000	19.8	<-- Station No. 1 ~ 1.5m
1155	0.588	0.632	0.043	-0.043	19.8	<-- Station No. 1 ~ 1.5m
1160	0.588	0.655	0.066	-0.066	19.9	<-- Station No. 1 ~ 1.5m
1165	0.588	0.668	0.080	-0.080	19.9	<-- Station No. 1 ~ 1.5m
1170	0.588	0.636	0.048	-0.048	19.9	<-- Station No. 1 ~ 1.5m
1175	0.588	0.657	0.068	-0.068	19.9	<-- Station No. 1 ~ 1.5m
1180	0.588	0.659	0.071	-0.071	19.9	<-- Station No. 1 ~ 1.5m
1185	0.588	0.680	0.091	-0.091	20	<-- Station No. 1 ~ 1.5m
1190	0.588	0.741	0.153	-0.153	20	<-- Station No. 1 ~ 1.5m
1195	0.588	0.597	0.009	-0.009	19.9	<-- Station No. 1 ~ 1.5m
1200	0.588	0.593	0.005	-0.005	20	<-- Station No. 1 ~ 1.5m
1205	0.588	0.689	0.100	-0.100	20	<-- Station No. 1 ~ 1.5m
1210	0.588	0.586	0.002	0.002	20	<-- Station No. 1 ~ 1.5m
1215	0.588	0.712	0.123	-0.123	20.3	<-- Station No. 1 ~ 1.5m
1220	0.588	0.586	0.002	0.002	20.2	<-- Station No. 1 ~ 1.5m
1225	0.588	0.584	0.005	0.005	20.1	<-- Station No. 1 ~ 1.5m
1230	0.588	0.611	0.023	-0.023	20.1	<-- Station No. 1 ~ 1.5m
1235	0.588	0.575	0.014	0.014	20.2	<-- Station No. 1 ~ 1.5m
1240	0.588	0.753	0.164	-0.164	20.2	<-- Station No. 1 ~ 1.5m
1245	0.588	0.597	0.009	-0.009	20.1	<-- Station No. 1 ~ 1.5m
1250	0.588	0.579	0.009	0.009	20.3	<-- Station No. 1 ~ 1.5m
1255	0.588	0.741	0.153	-0.153	20.4	<-- Station No. 1 ~ 1.5m
1260	0.588	0.563	0.025	0.025	20.3	<-- Station No. 1 ~ 1.5m
1265	0.588	0.629	0.041	-0.041	20.3	<-- Station No. 1 ~ 1.5m
1270	0.588	0.755	0.166	-0.166	20.4	<-- Station No. 1 ~ 1.5m
1275	0.588	0.563	0.025	0.025	20.4	<-- Station No. 1 ~ 1.5m
1280	0.588	0.559	0.030	0.030	20.5	<-- Station No. 1 ~ 1.5m
1285	0.588	0.568	0.021	0.021	20.5	<-- Station No. 1 ~ 1.5m
1290	0.588	0.559	0.030	0.030	20.6	<-- Station No. 1 ~ 1.5m
1295	0.588	0.554	0.034	0.034	20.6	<-- Station No. 1 ~ 1.5m
1300	0.588	0.643	0.055	-0.055	20.5	<-- Station No. 1 ~ 1.5m
1305	0.588	0.561	0.027	0.027	20.5	<-- Station No. 1 ~ 1.5m
1310	0.588	0.559	0.030	0.030	20.6	<-- Station No. 1 ~ 1.5m
1315	0.588	0.550	0.039	0.039	20.7	<-- Station No. 1 ~ 1.5m
1320	0.588	0.556	0.032	0.032	20.7	<-- Station No. 1 ~ 1.5m
1325	0.588	0.577	0.011	0.011	20.4	<-- Station No. 1 ~ 1.5m
1330	0.588	0.552	0.036	0.036	20.6	<-- Station No. 1 ~ 1.5m
1335	0.588	0.554	0.034	0.034	20.7	<-- Station No. 1 ~ 1.5m
1340	0.588	0.556	0.032	0.032	20.8	<-- Station No. 1 ~ 1.5m
1345	0.588	0.613	0.025	-0.025	20.8	<-- Station No. 1 ~ 1.5m
1350	0.588	0.575	0.014	0.014	20.9	<-- Station No. 1 ~ 1.5m
1355	0.588	0.545	0.043	0.043	20.9	<-- Station No. 1 ~ 1.5m
1360	0.588	0.536	0.052	0.052	20.9	<-- Station No. 1 ~ 1.5m
1365	0.588	0.643	0.055	-0.055	21	<-- Station No. 1 ~ 1.5m
1370	0.588	0.572	0.016	0.016	20.9	<-- Station No. 1 ~ 1.5m
1375	0.588	0.609	0.021	-0.021	20.9	<-- Station No. 1 ~ 1.5m
1380	0.588	0.545	0.043	0.043	20.9	<-- Station No. 1 ~ 1.5m
1385	0.588	0.563	0.025	0.025	20.9	<-- Station No. 1 ~ 1.5m
1390	0.588	0.559	0.030	0.030	20.9	<-- Station No. 1 ~ 1.5m
1395	0.588	0.520	0.068	0.068	20.9	<-- Station No. 1 ~ 1.5m
1400	0.588	0.520	0.068	0.068	20.9	<-- Station No. 1 ~ 1.5m
1405	0.588	0.554	0.034	0.034	20.9	<-- Station No. 1 ~ 1.5m
1410	0.588	0.563	0.025	0.025	20.9	<-- Station No. 1 ~ 1.5m
1415	0.588	0.634	0.046	-0.046	21	<-- Station No. 1 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1420	0.588	0.586	0.002	0.002	21	<-- Station No. 1 ~ 1.5m
1425	0.588	0.529	0.059	0.059	21.1	<-- Station No. 1 ~ 1.5m
1430	0.588	0.511	0.078	0.078	21.1	<-- Station No. 1 ~ 1.5m
1435	0.588	0.515	0.073	0.073	21.3	<-- Station No. 1 ~ 1.5m
1440	0.588	0.575	0.014	0.014	21.2	<-- Station No. 1 ~ 1.5m
0	0.588	0.417	0.171	0.171	22.5	<-- Station No. 2 ~ 1.5m
5	0.588	0.415	0.173	0.173	22.6	<-- Station No. 2 ~ 1.5m
10	0.588	0.426	0.162	0.162	22.7	<-- Station No. 2 ~ 1.5m
15	0.588	0.426	0.162	0.162	23.2	<-- Station No. 2 ~ 1.5m
20	0.588	0.392	0.196	0.196	23.6	<-- Station No. 2 ~ 1.5m
25	0.588	0.381	0.208	0.208	23.7	<-- Station No. 2 ~ 1.5m
30	0.588	0.385	0.203	0.203	23.3	<-- Station No. 2 ~ 1.5m
35	0.588	0.369	0.219	0.219	23.1	<-- Station No. 2 ~ 1.5m
40	0.588	0.383	0.205	0.205	23	<-- Station No. 2 ~ 1.5m
45	0.588	0.399	0.189	0.189	22.9	<-- Station No. 2 ~ 1.5m
50	0.588	0.408	0.180	0.180	23	<-- Station No. 2 ~ 1.5m
55	0.588	0.477	0.112	0.112	23	<-- Station No. 2 ~ 1.5m
60	0.588	0.456	0.132	0.132	22.9	<-- Station No. 2 ~ 1.5m
65	0.588	0.504	0.084	0.084	22.8	<-- Station No. 2 ~ 1.5m
70	0.588	0.385	0.203	0.203	23	<-- Station No. 2 ~ 1.5m
75	0.588	0.401	0.187	0.187	23	<-- Station No. 2 ~ 1.5m
80	0.588	0.395	0.194	0.194	23	<-- Station No. 2 ~ 1.5m
85	0.588	0.404	0.185	0.185	23.2	<-- Station No. 2 ~ 1.5m
90	0.588	0.493	0.096	0.096	23.5	<-- Station No. 2 ~ 1.5m
95	0.588	0.369	0.219	0.219	23.6	<-- Station No. 2 ~ 1.5m
100	0.588	0.322	0.267	0.267	24.3	<-- Station No. 2 ~ 1.5m
105	0.588	0.278	0.310	0.310	24.8	<-- Station No. 2 ~ 1.5m
110	0.588	0.269	0.319	0.319	25.3	<-- Station No. 2 ~ 1.5m
115	0.588	0.230	0.358	0.358	25.8	<-- Station No. 2 ~ 1.5m
120	0.588	0.249	0.340	0.340	26.2	<-- Station No. 2 ~ 1.5m
125	0.588	0.228	0.360	0.360	26.7	<-- Station No. 2 ~ 1.5m
130	0.588	0.153	0.436	0.436	26.8	<-- Station No. 2 ~ 1.5m
135	0.588	0.141	0.447	0.447	27	<-- Station No. 2 ~ 1.5m
140	0.588	0.135	0.454	0.454	27.1	<-- Station No. 2 ~ 1.5m
145	0.588	0.246	0.342	0.342	27.3	<-- Station No. 2 ~ 1.5m
150	0.588	0.103	0.486	0.486	27.3	<-- Station No. 2 ~ 1.5m
155	0.588	0.091	0.497	0.497	27.6	<-- Station No. 2 ~ 1.5m
160	0.588	0.121	0.468	0.468	27.8	<-- Station No. 2 ~ 1.5m
165	0.588	0.087	0.502	0.502	27.9	<-- Station No. 2 ~ 1.5m
170	0.588	0.208	0.381	0.381	27.9	<-- Station No. 2 ~ 1.5m
175	0.588	0.139	0.449	0.449	28	<-- Station No. 2 ~ 1.5m
180	0.588	0.137	0.452	0.452	28	<-- Station No. 2 ~ 1.5m
185	0.588	0.109	0.479	0.479	28.1	<-- Station No. 2 ~ 1.5m
190	0.588	0.132	0.456	0.456	28	<-- Station No. 2 ~ 1.5m
195	0.588	0.096	0.493	0.493	27.2	<-- Station No. 2 ~ 1.5m
200	0.588	0.139	0.449	0.449	26.8	<-- Station No. 2 ~ 1.5m
205	0.588	0.155	0.433	0.433	26.4	<-- Station No. 2 ~ 1.5m
210	0.588	0.242	0.347	0.347	25.9	<-- Station No. 2 ~ 1.5m
215	0.588	0.182	0.406	0.406	25.7	<-- Station No. 2 ~ 1.5m
220	0.588	0.208	0.381	0.381	25.7	<-- Station No. 2 ~ 1.5m
225	0.588	0.217	0.372	0.372	25.3	<-- Station No. 2 ~ 1.5m
230	0.588	0.294	0.294	0.294	25.2	<-- Station No. 2 ~ 1.5m
235	0.588	0.228	0.360	0.360	25.2	<-- Station No. 2 ~ 1.5m
240	0.588	0.253	0.335	0.335	25	<-- Station No. 2 ~ 1.5m
245	0.588	0.342	0.246	0.246	24.9	<-- Station No. 2 ~ 1.5m
250	0.588	0.230	0.358	0.358	24.6	<-- Station No. 2 ~ 1.5m
255	0.588	0.310	0.278	0.278	24.9	<-- Station No. 2 ~ 1.5m
260	0.588	0.260	0.328	0.328	25.1	<-- Station No. 2 ~ 1.5m
265	0.588	0.287	0.301	0.301	24.8	<-- Station No. 2 ~ 1.5m
270	0.588	0.278	0.310	0.310	24.4	<-- Station No. 2 ~ 1.5m
275	0.588	0.269	0.319	0.319	24.3	<-- Station No. 2 ~ 1.5m
280	0.588	0.303	0.285	0.285	24.2	<-- Station No. 2 ~ 1.5m
285	0.588	0.312	0.276	0.276	24	<-- Station No. 2 ~ 1.5m
290	0.588	0.290	0.299	0.299	23.9	<-- Station No. 2 ~ 1.5m
295	0.588	0.287	0.301	0.301	23.9	<-- Station No. 2 ~ 1.5m
300	0.588	0.296	0.292	0.292	23.7	<-- Station No. 2 ~ 1.5m
305	0.588	0.406	0.182	0.182	23.6	<-- Station No. 2 ~ 1.5m
310	0.588	0.344	0.244	0.244	23.5	<-- Station No. 2 ~ 1.5m
315	0.588	0.317	0.271	0.271	23.4	<-- Station No. 2 ~ 1.5m
320	0.588	0.344	0.244	0.244	23.4	<-- Station No. 2 ~ 1.5m
325	0.588	0.335	0.253	0.253	23.5	<-- Station No. 2 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
330	0.588	0.326	0.262	0.262	23.4	<-- Station No. 2 ~ 1.5m
335	0.588	0.347	0.242	0.242	23.2	<-- Station No. 2 ~ 1.5m
340	0.588	0.342	0.246	0.246	23.2	<-- Station No. 2 ~ 1.5m
345	0.588	0.401	0.187	0.187	23	<-- Station No. 2 ~ 1.5m
350	0.588	0.358	0.230	0.230	23	<-- Station No. 2 ~ 1.5m
355	0.588	0.397	0.192	0.192	23.1	<-- Station No. 2 ~ 1.5m
360	0.588	0.447	0.141	0.141	22.9	<-- Station No. 2 ~ 1.5m
365	0.588	0.360	0.228	0.228	22.8	<-- Station No. 2 ~ 1.5m
370	0.588	0.353	0.235	0.235	22.7	<-- Station No. 2 ~ 1.5m
375	0.588	0.381	0.208	0.208	22.6	<-- Station No. 2 ~ 1.5m
380	0.588	0.381	0.208	0.208	22.6	<-- Station No. 2 ~ 1.5m
385	0.588	0.429	0.160	0.160	22.6	<-- Station No. 2 ~ 1.5m
390	0.588	0.385	0.203	0.203	22.5	<-- Station No. 2 ~ 1.5m
395	0.588	0.369	0.219	0.219	22.5	<-- Station No. 2 ~ 1.5m
400	0.588	0.426	0.162	0.162	22.4	<-- Station No. 2 ~ 1.5m
405	0.588	0.390	0.198	0.198	22.4	<-- Station No. 2 ~ 1.5m
410	0.588	0.424	0.164	0.164	22.3	<-- Station No. 2 ~ 1.5m
415	0.588	0.397	0.192	0.192	22.2	<-- Station No. 2 ~ 1.5m
420	0.588	0.392	0.196	0.196	22.3	<-- Station No. 2 ~ 1.5m
425	0.588	0.408	0.180	0.180	22.1	<-- Station No. 2 ~ 1.5m
430	0.588	0.392	0.196	0.196	22.2	<-- Station No. 2 ~ 1.5m
435	0.588	0.454	0.135	0.135	22.2	<-- Station No. 2 ~ 1.5m
440	0.588	0.401	0.187	0.187	22	<-- Station No. 2 ~ 1.5m
445	0.588	0.406	0.182	0.182	21.9	<-- Station No. 2 ~ 1.5m
450	0.588	0.401	0.187	0.187	22	<-- Station No. 2 ~ 1.5m
455	0.588	0.445	0.144	0.144	21.9	<-- Station No. 2 ~ 1.5m
460	0.588	0.422	0.166	0.166	21.9	<-- Station No. 2 ~ 1.5m
465	0.588	0.438	0.151	0.151	21.9	<-- Station No. 2 ~ 1.5m
470	0.588	0.438	0.151	0.151	21.8	<-- Station No. 2 ~ 1.5m
475	0.588	0.449	0.139	0.139	21.8	<-- Station No. 2 ~ 1.5m
480	0.588	0.461	0.128	0.128	21.8	<-- Station No. 2 ~ 1.5m
485	0.588	0.452	0.137	0.137	21.8	<-- Station No. 2 ~ 1.5m
490	0.588	0.536	0.052	0.052	21.8	<-- Station No. 2 ~ 1.5m
495	0.588	0.536	0.052	0.052	21.8	<-- Station No. 2 ~ 1.5m
500	0.588	0.424	0.164	0.164	21.7	<-- Station No. 2 ~ 1.5m
505	0.588	0.547	0.041	0.041	21.6	<-- Station No. 2 ~ 1.5m
510	0.588	0.529	0.059	0.059	21.8	<-- Station No. 2 ~ 1.5m
515	0.588	0.477	0.112	0.112	21.6	<-- Station No. 2 ~ 1.5m
520	0.588	0.461	0.128	0.128	21.7	<-- Station No. 2 ~ 1.5m
525	0.588	0.440	0.148	0.148	21.6	<-- Station No. 2 ~ 1.5m
530	0.588	0.436	0.153	0.153	21.5	<-- Station No. 2 ~ 1.5m
535	0.588	0.488	0.100	0.100	21.5	<-- Station No. 2 ~ 1.5m
540	0.588	0.431	0.157	0.157	21.5	<-- Station No. 2 ~ 1.5m
545	0.588	0.433	0.155	0.155	21.5	<-- Station No. 2 ~ 1.5m
550	0.588	0.461	0.128	0.128	21.5	<-- Station No. 2 ~ 1.5m
555	0.588	0.445	0.144	0.144	21.5	<-- Station No. 2 ~ 1.5m
560	0.588	0.470	0.119	0.119	21.5	<-- Station No. 2 ~ 1.5m
565	0.588	0.452	0.137	0.137	21.5	<-- Station No. 2 ~ 1.5m
570	0.588	0.509	0.080	0.080	21.4	<-- Station No. 2 ~ 1.5m
575	0.588	0.449	0.139	0.139	21.4	<-- Station No. 2 ~ 1.5m
580	0.588	0.483	0.105	0.105	21.4	<-- Station No. 2 ~ 1.5m
585	0.588	0.447	0.141	0.141	21.4	<-- Station No. 2 ~ 1.5m
590	0.588	0.442	0.146	0.146	21.3	<-- Station No. 2 ~ 1.5m
595	0.588	0.497	0.091	0.091	21.4	<-- Station No. 2 ~ 1.5m
600	0.588	0.458	0.130	0.130	21.4	<-- Station No. 2 ~ 1.5m
605	0.588	0.468	0.121	0.121	21.3	<-- Station No. 2 ~ 1.5m
610	0.588	0.452	0.137	0.137	21.3	<-- Station No. 2 ~ 1.5m
615	0.588	0.454	0.135	0.135	21.2	<-- Station No. 2 ~ 1.5m
620	0.588	0.472	0.116	0.116	21.3	<-- Station No. 2 ~ 1.5m
625	0.588	0.468	0.121	0.121	21.2	<-- Station No. 2 ~ 1.5m
630	0.588	0.495	0.094	0.094	21.2	<-- Station No. 2 ~ 1.5m
635	0.588	0.472	0.116	0.116	21.1	<-- Station No. 2 ~ 1.5m
640	0.588	0.472	0.116	0.116	21.2	<-- Station No. 2 ~ 1.5m
645	0.588	0.499	0.089	0.089	21.2	<-- Station No. 2 ~ 1.5m
650	0.588	0.534	0.055	0.055	21.1	<-- Station No. 2 ~ 1.5m
655	0.588	0.520	0.068	0.068	21.1	<-- Station No. 2 ~ 1.5m
660	0.588	0.527	0.062	0.062	21.1	<-- Station No. 2 ~ 1.5m
665	0.588	0.470	0.119	0.119	21.1	<-- Station No. 2 ~ 1.5m
670	0.588	0.465	0.123	0.123	21.1	<-- Station No. 2 ~ 1.5m
675	0.588	0.547	0.041	0.041	21.1	<-- Station No. 2 ~ 1.5m
680	0.588	0.561	0.027	0.027	21.1	<-- Station No. 2 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
685	0.588	0.538	0.050	0.050	21.3	<-- Station No. 2 ~ 1.5m
690	0.588	0.509	0.080	0.080	21.1	<-- Station No. 2 ~ 1.5m
695	0.588	0.538	0.050	0.050	21.1	<-- Station No. 2 ~ 1.5m
700	0.588	0.474	0.114	0.114	21.1	<-- Station No. 2 ~ 1.5m
705	0.588	0.477	0.112	0.112	21.1	<-- Station No. 2 ~ 1.5m
710	0.588	0.540	0.048	0.048	21.1	<-- Station No. 2 ~ 1.5m
715	0.588	0.540	0.048	0.048	21	<-- Station No. 2 ~ 1.5m
720	0.588	0.502	0.087	0.087	21	<-- Station No. 2 ~ 1.5m
725	0.588	0.479	0.109	0.109	21	<-- Station No. 2 ~ 1.5m
730	0.588	0.552	0.036	0.036	21	<-- Station No. 2 ~ 1.5m
735	0.588	0.536	0.052	0.052	21.2	<-- Station No. 2 ~ 1.5m
740	0.588	0.525	0.064	0.064	20.9	<-- Station No. 2 ~ 1.5m
745	0.588	0.570	0.018	0.018	21.1	<-- Station No. 2 ~ 1.5m
750	0.588	0.481	0.107	0.107	20.9	<-- Station No. 2 ~ 1.5m
755	0.588	0.504	0.084	0.084	21	<-- Station No. 2 ~ 1.5m
760	0.588	0.568	0.021	0.021	20.9	<-- Station No. 2 ~ 1.5m
765	0.588	0.488	0.100	0.100	20.9	<-- Station No. 2 ~ 1.5m
770	0.588	0.502	0.087	0.087	21	<-- Station No. 2 ~ 1.5m
775	0.588	0.518	0.071	0.071	21	<-- Station No. 2 ~ 1.5m
780	0.588	0.534	0.055	0.055	20.9	<-- Station No. 2 ~ 1.5m
785	0.588	0.483	0.105	0.105	21	<-- Station No. 2 ~ 1.5m
790	0.588	0.495	0.094	0.094	21	<-- Station No. 2 ~ 1.5m
795	0.588	0.550	0.039	0.039	21	<-- Station No. 2 ~ 1.5m
800	0.588	0.550	0.039	0.039	20.9	<-- Station No. 2 ~ 1.5m
805	0.588	0.566	0.023	0.023	20.9	<-- Station No. 2 ~ 1.5m
810	0.588	0.522	0.066	0.066	21	<-- Station No. 2 ~ 1.5m
815	0.588	0.490	0.098	0.098	20.9	<-- Station No. 2 ~ 1.5m
820	0.588	0.595	0.007	-0.007	21.1	<-- Station No. 2 ~ 1.5m
825	0.588	0.497	0.091	0.091	20.9	<-- Station No. 2 ~ 1.5m
830	0.588	0.575	0.014	0.014	20.9	<-- Station No. 2 ~ 1.5m
835	0.588	0.488	0.100	0.100	20.9	<-- Station No. 2 ~ 1.5m
840	0.588	0.566	0.023	0.023	20.9	<-- Station No. 2 ~ 1.5m
845	0.588	0.493	0.096	0.096	21	<-- Station No. 2 ~ 1.5m
850	0.588	0.486	0.103	0.103	20.8	<-- Station No. 2 ~ 1.5m
855	0.588	0.586	0.002	0.002	20.8	<-- Station No. 2 ~ 1.5m
860	0.588	0.499	0.089	0.089	20.8	<-- Station No. 2 ~ 1.5m
865	0.588	0.486	0.103	0.103	20.8	<-- Station No. 2 ~ 1.5m
870	0.588	0.520	0.068	0.068	20.8	<-- Station No. 2 ~ 1.5m
875	0.588	0.570	0.018	0.018	20.7	<-- Station No. 2 ~ 1.5m
880	0.588	0.595	0.007	-0.007	20.8	<-- Station No. 2 ~ 1.5m
885	0.588	0.509	0.080	0.080	20.7	<-- Station No. 2 ~ 1.5m
890	0.588	0.618	0.030	-0.030	20.7	<-- Station No. 2 ~ 1.5m
895	0.588	0.499	0.089	0.089	20.7	<-- Station No. 2 ~ 1.5m
900	0.588	0.540	0.048	0.048	20.9	<-- Station No. 2 ~ 1.5m
905	0.588	0.502	0.087	0.087	20.7	<-- Station No. 2 ~ 1.5m
910	0.588	0.561	0.027	0.027	20.6	<-- Station No. 2 ~ 1.5m
915	0.588	0.506	0.082	0.082	20.6	<-- Station No. 2 ~ 1.5m
920	0.588	0.522	0.066	0.066	20.7	<-- Station No. 2 ~ 1.5m
925	0.588	0.525	0.064	0.064	20.7	<-- Station No. 2 ~ 1.5m
930	0.588	0.522	0.066	0.066	20.6	<-- Station No. 2 ~ 1.5m
935	0.588	0.504	0.084	0.084	20.6	<-- Station No. 2 ~ 1.5m
940	0.588	0.543	0.046	0.046	20.6	<-- Station No. 2 ~ 1.5m
945	0.588	0.547	0.041	0.041	20.6	<-- Station No. 2 ~ 1.5m
950	0.588	0.540	0.048	0.048	20.6	<-- Station No. 2 ~ 1.5m
955	0.588	0.550	0.039	0.039	20.6	<-- Station No. 2 ~ 1.5m
960	0.588	0.504	0.084	0.084	20.6	<-- Station No. 2 ~ 1.5m
965	0.588	0.559	0.030	0.030	20.6	<-- Station No. 2 ~ 1.5m
970	0.588	0.513	0.075	0.075	20.6	<-- Station No. 2 ~ 1.5m
975	0.588	0.513	0.075	0.075	20.6	<-- Station No. 2 ~ 1.5m
980	0.588	0.518	0.071	0.071	20.5	<-- Station No. 2 ~ 1.5m
985	0.588	0.518	0.071	0.071	20.6	<-- Station No. 2 ~ 1.5m
990	0.588	0.525	0.064	0.064	20.5	<-- Station No. 2 ~ 1.5m
995	0.588	0.552	0.036	0.036	20.6	<-- Station No. 2 ~ 1.5m
1000	0.588	0.531	0.057	0.057	20.5	<-- Station No. 2 ~ 1.5m
1005	0.588	0.568	0.021	0.021	20.4	<-- Station No. 2 ~ 1.5m
1010	0.588	0.534	0.055	0.055	20.5	<-- Station No. 2 ~ 1.5m
1015	0.588	0.591	0.002	-0.002	20.5	<-- Station No. 2 ~ 1.5m
1020	0.588	0.595	0.007	-0.007	20.5	<-- Station No. 2 ~ 1.5m
1025	0.588	0.547	0.041	0.041	20.5	<-- Station No. 2 ~ 1.5m
1030	0.588	0.566	0.023	0.023	20.5	<-- Station No. 2 ~ 1.5m
1035	0.588	0.534	0.055	0.055	20.4	<-- Station No. 2 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1040	0.588	0.520	0.068	0.068	20.5	<-- Station No. 2 ~ 1.5m
1045	0.588	0.550	0.039	0.039	20.5	<-- Station No. 2 ~ 1.5m
1050	0.588	0.515	0.073	0.073	20.5	<-- Station No. 2 ~ 1.5m
1055	0.588	0.572	0.016	0.016	20.4	<-- Station No. 2 ~ 1.5m
1060	0.588	0.547	0.041	0.041	20.5	<-- Station No. 2 ~ 1.5m
1065	0.588	0.554	0.034	0.034	20.4	<-- Station No. 2 ~ 1.5m
1070	0.588	0.591	0.002	-0.002	20.4	<-- Station No. 2 ~ 1.5m
1075	0.588	0.597	0.009	-0.009	20.5	<-- Station No. 2 ~ 1.5m
1080	0.588	0.552	0.036	0.036	20.4	<-- Station No. 2 ~ 1.5m
1085	0.588	0.550	0.039	0.039	20.4	<-- Station No. 2 ~ 1.5m
1090	0.588	0.520	0.068	0.068	20.4	<-- Station No. 2 ~ 1.5m
1095	0.588	0.552	0.036	0.036	20.4	<-- Station No. 2 ~ 1.5m
1100	0.588	0.563	0.025	0.025	20.5	<-- Station No. 2 ~ 1.5m
1105	0.588	0.525	0.064	0.064	20.5	<-- Station No. 2 ~ 1.5m
1110	0.588	0.550	0.039	0.039	20.5	<-- Station No. 2 ~ 1.5m
1115	0.588	0.529	0.059	0.059	20.4	<-- Station No. 2 ~ 1.5m
1120	0.588	0.586	0.002	0.002	20.5	<-- Station No. 2 ~ 1.5m
1125	0.588	0.588	0.000	0.000	20.5	<-- Station No. 2 ~ 1.5m
1130	0.588	0.572	0.016	0.016	20.5	<-- Station No. 2 ~ 1.5m
1135	0.588	0.600	0.011	-0.011	20.4	<-- Station No. 2 ~ 1.5m
1140	0.588	0.556	0.032	0.032	20.4	<-- Station No. 2 ~ 1.5m
1145	0.588	0.597	0.009	-0.009	20.5	<-- Station No. 2 ~ 1.5m
1150	0.588	0.563	0.025	0.025	20.5	<-- Station No. 2 ~ 1.5m
1155	0.588	0.522	0.066	0.066	20.4	<-- Station No. 2 ~ 1.5m
1160	0.588	0.522	0.066	0.066	20.5	<-- Station No. 2 ~ 1.5m
1165	0.588	0.527	0.062	0.062	20.5	<-- Station No. 2 ~ 1.5m
1170	0.588	0.547	0.041	0.041	20.5	<-- Station No. 2 ~ 1.5m
1175	0.588	0.563	0.025	0.025	20.5	<-- Station No. 2 ~ 1.5m
1180	0.588	0.525	0.064	0.064	20.5	<-- Station No. 2 ~ 1.5m
1185	0.588	0.600	0.011	-0.011	20.7	<-- Station No. 2 ~ 1.5m
1190	0.588	0.531	0.057	0.057	20.6	<-- Station No. 2 ~ 1.5m
1195	0.588	0.515	0.073	0.073	20.6	<-- Station No. 2 ~ 1.5m
1200	0.588	0.536	0.052	0.052	20.7	<-- Station No. 2 ~ 1.5m
1205	0.588	0.522	0.066	0.066	20.8	<-- Station No. 2 ~ 1.5m
1210	0.588	0.538	0.050	0.050	20.8	<-- Station No. 2 ~ 1.5m
1215	0.588	0.597	0.009	-0.009	20.9	<-- Station No. 2 ~ 1.5m
1220	0.588	0.525	0.064	0.064	20.8	<-- Station No. 2 ~ 1.5m
1225	0.588	0.563	0.025	0.025	20.9	<-- Station No. 2 ~ 1.5m
1230	0.588	0.502	0.087	0.087	21	<-- Station No. 2 ~ 1.5m
1235	0.588	0.522	0.066	0.066	21.1	<-- Station No. 2 ~ 1.5m
1240	0.588	0.561	0.027	0.027	21.1	<-- Station No. 2 ~ 1.5m
1245	0.588	0.527	0.062	0.062	21.2	<-- Station No. 2 ~ 1.5m
1250	0.588	0.511	0.078	0.078	21.2	<-- Station No. 2 ~ 1.5m
1255	0.588	0.499	0.089	0.089	21.3	<-- Station No. 2 ~ 1.5m
1260	0.588	0.479	0.109	0.109	21.3	<-- Station No. 2 ~ 1.5m
1265	0.588	0.566	0.023	0.023	21.4	<-- Station No. 2 ~ 1.5m
1270	0.588	0.659	0.071	-0.071	21.5	<-- Station No. 2 ~ 1.5m
1275	0.588	0.486	0.103	0.103	21.5	<-- Station No. 2 ~ 1.5m
1280	0.588	0.522	0.066	0.066	21.3	<-- Station No. 2 ~ 1.5m
1285	0.588	0.474	0.114	0.114	21.6	<-- Station No. 2 ~ 1.5m
1290	0.588	0.477	0.112	0.112	21.6	<-- Station No. 2 ~ 1.5m
1295	0.588	0.543	0.046	0.046	21.7	<-- Station No. 2 ~ 1.5m
1300	0.588	0.527	0.062	0.062	21.7	<-- Station No. 2 ~ 1.5m
1305	0.588	0.540	0.048	0.048	21.7	<-- Station No. 2 ~ 1.5m
1310	0.588	0.504	0.084	0.084	21.6	<-- Station No. 2 ~ 1.5m
1315	0.588	0.543	0.046	0.046	21.7	<-- Station No. 2 ~ 1.5m
1320	0.588	0.463	0.125	0.125	21.9	<-- Station No. 2 ~ 1.5m
1325	0.588	0.470	0.119	0.119	21.8	<-- Station No. 2 ~ 1.5m
1330	0.588	0.483	0.105	0.105	21.8	<-- Station No. 2 ~ 1.5m
1335	0.588	0.483	0.105	0.105	22	<-- Station No. 2 ~ 1.5m
1340	0.588	0.513	0.075	0.075	21.9	<-- Station No. 2 ~ 1.5m
1345	0.588	0.477	0.112	0.112	21.9	<-- Station No. 2 ~ 1.5m
1350	0.588	0.479	0.109	0.109	22.1	<-- Station No. 2 ~ 1.5m
1355	0.588	0.511	0.078	0.078	22.3	<-- Station No. 2 ~ 1.5m
1360	0.588	0.513	0.075	0.075	22.1	<-- Station No. 2 ~ 1.5m
1365	0.588	0.520	0.068	0.068	22.1	<-- Station No. 2 ~ 1.5m
1370	0.588	0.504	0.084	0.084	22.1	<-- Station No. 2 ~ 1.5m
1375	0.588	0.442	0.146	0.146	22.2	<-- Station No. 2 ~ 1.5m
1380	0.588	0.433	0.155	0.155	22.2	<-- Station No. 2 ~ 1.5m
1385	0.588	0.454	0.135	0.135	22.2	<-- Station No. 2 ~ 1.5m
1390	0.588	0.452	0.137	0.137	22.2	<-- Station No. 2 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1395	0.588	0.481	0.107	0.107	22.2	<-- Station No. 2 ~ 1.5m
1400	0.588	0.429	0.160	0.160	22.3	<-- Station No. 2 ~ 1.5m
1405	0.588	0.433	0.155	0.155	22.3	<-- Station No. 2 ~ 1.5m
1410	0.588	0.502	0.087	0.087	22.4	<-- Station No. 2 ~ 1.5m
1415	0.588	0.527	0.062	0.062	22.4	<-- Station No. 2 ~ 1.5m
1420	0.588	0.417	0.171	0.171	22.5	<-- Station No. 2 ~ 1.5m
1425	0.588	0.497	0.091	0.091	22.4	<-- Station No. 2 ~ 1.5m
1430	0.588	0.431	0.157	0.157	22.4	<-- Station No. 2 ~ 1.5m
1435	0.588	0.417	0.171	0.171	22.4	<-- Station No. 2 ~ 1.5m
1440	0.588	0.431	0.157	0.157	22.4	<-- Station No. 2 ~ 1.5m
0	0.588	0.504	0.084	0.084	22.4	<-- Station No. 3 ~ 1.5m
5	0.588	0.438	0.151	0.151	22.5	<-- Station No. 3 ~ 1.5m
10	0.588	0.522	0.066	0.066	22.5	<-- Station No. 3 ~ 1.5m
15	0.588	0.433	0.155	0.155	22.6	<-- Station No. 3 ~ 1.5m
20	0.588	0.438	0.151	0.151	22.6	<-- Station No. 3 ~ 1.5m
25	0.588	0.178	0.410	0.410	25.5	<-- Station No. 3 ~ 1.5m
30	0.128	0.276	0.148	-0.148	25.6	<-- Station No. 3 ~ 1.5m
35	0.128	0.276	0.148	-0.148	25.4	<-- Station No. 3 ~ 1.5m
40	0.128	0.189	0.062	-0.062	25.2	<-- Station No. 3 ~ 1.5m
45	0.235	0.226	0.009	0.009	25.5	<-- Station No. 3 ~ 1.5m
50	0.235	0.189	0.046	0.046	25.5	<-- Station No. 3 ~ 1.5m
55	0.235	0.187	0.048	0.048	25.4	<-- Station No. 3 ~ 1.5m
60	0.235	0.189	0.046	0.046	25.6	<-- Station No. 3 ~ 1.5m
65	0.235	0.194	0.041	0.041	25.8	<-- Station No. 3 ~ 1.5m
70	0.235	0.178	0.057	0.057	26.1	<-- Station No. 3 ~ 1.5m
75	0.235	0.139	0.096	0.096	26.3	<-- Station No. 3 ~ 1.5m
80	0.235	0.125	0.109	0.109	26.5	<-- Station No. 3 ~ 1.5m
85	0.235	0.180	0.055	0.055	26.6	<-- Station No. 3 ~ 1.5m
90	0.235	0.121	0.114	0.114	27	<-- Station No. 3 ~ 1.5m
95	0.235	0.105	0.130	0.130	27.2	<-- Station No. 3 ~ 1.5m
100	0.235	0.089	0.146	0.146	27.3	<-- Station No. 3 ~ 1.5m
105	0.235	0.087	0.148	0.148	27.1	<-- Station No. 3 ~ 1.5m
110	0.235	0.107	0.128	0.128	27.2	<-- Station No. 3 ~ 1.5m
115	0.235	0.100	0.135	0.135	27.3	<-- Station No. 3 ~ 1.5m
120	0.235	0.096	0.139	0.139	27.1	<-- Station No. 3 ~ 1.5m
125	0.235	0.112	0.123	0.123	27	<-- Station No. 3 ~ 1.5m
130	0.235	0.144	0.091	0.091	26.7	<-- Station No. 3 ~ 1.5m
135	0.235	0.176	0.059	0.059	26.6	<-- Station No. 3 ~ 1.5m
140	0.235	0.160	0.075	0.075	26.4	<-- Station No. 3 ~ 1.5m
145	0.235	0.201	0.034	0.034	26.1	<-- Station No. 3 ~ 1.5m
150	0.235	0.226	0.009	0.009	26	<-- Station No. 3 ~ 1.5m
155	0.235	0.233	0.002	0.002	25.6	<-- Station No. 3 ~ 1.5m
160	0.235	0.201	0.034	0.034	25.4	<-- Station No. 3 ~ 1.5m
165	0.235	0.187	0.048	0.048	25.3	<-- Station No. 3 ~ 1.5m
170	0.235	0.201	0.034	0.034	25.3	<-- Station No. 3 ~ 1.5m
175	0.235	0.201	0.034	0.034	25.2	<-- Station No. 3 ~ 1.5m
180	0.235	0.228	0.007	0.007	25.2	<-- Station No. 3 ~ 1.5m
185	0.235	0.214	0.021	0.021	25.1	<-- Station No. 3 ~ 1.5m
190	0.235	0.281	0.046	-0.046	25	<-- Station No. 3 ~ 1.5m
195	0.235	0.228	0.007	0.007	25	<-- Station No. 3 ~ 1.5m
200	0.235	0.285	0.050	-0.050	25.1	<-- Station No. 3 ~ 1.5m
205	0.235	0.233	0.002	0.002	24.8	<-- Station No. 3 ~ 1.5m
210	0.235	0.258	0.023	-0.023	24.8	<-- Station No. 3 ~ 1.5m
215	0.235	0.276	0.041	-0.041	24.8	<-- Station No. 3 ~ 1.5m
220	0.235	0.230	0.005	0.005	24.7	<-- Station No. 3 ~ 1.5m
225	0.235	0.308	0.073	-0.073	24.7	<-- Station No. 3 ~ 1.5m
230	0.235	0.249	0.014	-0.014	24.6	<-- Station No. 3 ~ 1.5m
235	0.235	0.233	0.002	0.002	24.5	<-- Station No. 3 ~ 1.5m
240	0.235	0.296	0.062	-0.062	24.5	<-- Station No. 3 ~ 1.5m
245	0.235	0.335	0.100	-0.100	24.5	<-- Station No. 3 ~ 1.5m
250	0.235	0.290	0.055	-0.055	24.4	<-- Station No. 3 ~ 1.5m
255	0.235	0.292	0.057	-0.057	24.4	<-- Station No. 3 ~ 1.5m
260	0.235	0.326	0.091	-0.091	24.3	<-- Station No. 3 ~ 1.5m
265	0.235	0.283	0.048	-0.048	24.2	<-- Station No. 3 ~ 1.5m
270	0.235	0.281	0.046	-0.046	24.1	<-- Station No. 3 ~ 1.5m
275	0.235	0.319	0.084	-0.084	24.2	<-- Station No. 3 ~ 1.5m
280	0.235	0.342	0.107	-0.107	24	<-- Station No. 3 ~ 1.5m
285	0.235	0.335	0.100	-0.100	24	<-- Station No. 3 ~ 1.5m
290	0.235	0.322	0.087	-0.087	23.9	<-- Station No. 3 ~ 1.5m
295	0.235	0.310	0.075	-0.075	23.9	<-- Station No. 3 ~ 1.5m
300	0.235	0.294	0.059	-0.059	23.8	<-- Station No. 3 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
305	0.235	0.306	0.071	-0.071	23.7	<-- Station No. 3 ~ 1.5m
310	0.235	0.344	0.109	-0.109	23.7	<-- Station No. 3 ~ 1.5m
315	0.235	0.351	0.116	-0.116	23.7	<-- Station No. 3 ~ 1.5m
320	0.235	0.287	0.052	-0.052	23.7	<-- Station No. 3 ~ 1.5m
325	0.235	0.358	0.123	-0.123	23.7	<-- Station No. 3 ~ 1.5m
330	0.235	0.349	0.114	-0.114	23.7	<-- Station No. 3 ~ 1.5m
335	0.235	0.353	0.119	-0.119	23.8	<-- Station No. 3 ~ 1.5m
340	0.235	0.365	0.130	-0.130	23.8	<-- Station No. 3 ~ 1.5m
345	0.235	0.358	0.123	-0.123	23.6	<-- Station No. 3 ~ 1.5m
350	0.235	0.319	0.084	-0.084	23.5	<-- Station No. 3 ~ 1.5m
355	0.235	0.381	0.146	-0.146	23.5	<-- Station No. 3 ~ 1.5m
360	0.235	0.312	0.078	-0.078	23.4	<-- Station No. 3 ~ 1.5m
365	0.235	0.308	0.073	-0.073	23.5	<-- Station No. 3 ~ 1.5m
370	0.235	0.306	0.071	-0.071	23.4	<-- Station No. 3 ~ 1.5m
375	0.235	0.317	0.082	-0.082	23.3	<-- Station No. 3 ~ 1.5m
380	0.235	0.408	0.173	-0.173	23.2	<-- Station No. 3 ~ 1.5m
385	0.235	0.395	0.160	-0.160	23.2	<-- Station No. 3 ~ 1.5m
390	0.235	0.319	0.084	-0.084	23.2	<-- Station No. 3 ~ 1.5m
395	0.235	0.331	0.096	-0.096	23.1	<-- Station No. 3 ~ 1.5m
400	0.235	0.408	0.173	-0.173	23.2	<-- Station No. 3 ~ 1.5m
405	0.235	0.358	0.123	-0.123	23.1	<-- Station No. 3 ~ 1.5m
410	0.235	0.349	0.114	-0.114	23.1	<-- Station No. 3 ~ 1.5m
415	0.235	0.385	0.151	-0.151	23	<-- Station No. 3 ~ 1.5m
420	0.235	0.347	0.112	-0.112	22.9	<-- Station No. 3 ~ 1.5m
425	0.235	0.404	0.169	-0.169	22.9	<-- Station No. 3 ~ 1.5m
430	0.235	0.449	0.214	-0.214	22.8	<-- Station No. 3 ~ 1.5m
435	0.235	0.342	0.107	-0.107	22.9	<-- Station No. 3 ~ 1.5m
440	0.235	0.385	0.151	-0.151	22.9	<-- Station No. 3 ~ 1.5m
445	0.235	0.344	0.109	-0.109	22.7	<-- Station No. 3 ~ 1.5m
450	0.235	0.417	0.182	-0.182	22.8	<-- Station No. 3 ~ 1.5m
455	0.235	0.360	0.125	-0.125	22.7	<-- Station No. 3 ~ 1.5m
460	0.235	0.379	0.144	-0.144	22.6	<-- Station No. 3 ~ 1.5m
465	0.235	0.388	0.153	-0.153	22.6	<-- Station No. 3 ~ 1.5m
470	0.235	0.388	0.153	-0.153	22.7	<-- Station No. 3 ~ 1.5m
475	0.235	0.376	0.141	-0.141	22.5	<-- Station No. 3 ~ 1.5m
480	0.235	0.372	0.137	-0.137	22.4	<-- Station No. 3 ~ 1.5m
485	0.235	0.456	0.221	-0.221	22.4	<-- Station No. 3 ~ 1.5m
490	0.235	0.390	0.155	-0.155	22.4	<-- Station No. 3 ~ 1.5m
495	0.235	0.383	0.148	-0.148	22.4	<-- Station No. 3 ~ 1.5m
500	0.235	0.429	0.194	-0.194	22.3	<-- Station No. 3 ~ 1.5m
505	0.235	0.458	0.223	-0.223	22.3	<-- Station No. 3 ~ 1.5m
510	0.235	0.408	0.173	-0.173	22.3	<-- Station No. 3 ~ 1.5m
515	0.235	0.408	0.173	-0.173	22.3	<-- Station No. 3 ~ 1.5m
520	0.235	0.506	0.271	-0.271	22.2	<-- Station No. 3 ~ 1.5m
525	0.235	0.417	0.182	-0.182	22.2	<-- Station No. 3 ~ 1.5m
530	0.235	0.390	0.155	-0.155	22.2	<-- Station No. 3 ~ 1.5m
535	0.235	0.379	0.144	-0.144	22.2	<-- Station No. 3 ~ 1.5m
540	0.235	0.410	0.176	-0.176	22.1	<-- Station No. 3 ~ 1.5m
545	0.235	0.413	0.178	-0.178	22.1	<-- Station No. 3 ~ 1.5m
550	0.235	0.463	0.228	-0.228	22.1	<-- Station No. 3 ~ 1.5m
555	0.235	0.479	0.244	-0.244	22	<-- Station No. 3 ~ 1.5m
560	0.235	0.493	0.258	-0.258	22	<-- Station No. 3 ~ 1.5m
565	0.235	0.445	0.210	-0.210	22	<-- Station No. 3 ~ 1.5m
570	0.235	0.413	0.178	-0.178	21.9	<-- Station No. 3 ~ 1.5m
575	0.235	0.397	0.162	-0.162	21.9	<-- Station No. 3 ~ 1.5m
580	0.235	0.399	0.164	-0.164	21.9	<-- Station No. 3 ~ 1.5m
585	0.235	0.401	0.166	-0.166	21.9	<-- Station No. 3 ~ 1.5m
590	0.235	0.438	0.203	-0.203	21.9	<-- Station No. 3 ~ 1.5m
595	0.235	0.406	0.171	-0.171	21.9	<-- Station No. 3 ~ 1.5m
600	0.235	0.426	0.192	-0.192	21.8	<-- Station No. 3 ~ 1.5m
605	0.235	0.410	0.176	-0.176	21.8	<-- Station No. 3 ~ 1.5m
610	0.235	0.452	0.217	-0.217	21.8	<-- Station No. 3 ~ 1.5m
615	0.235	0.410	0.176	-0.176	21.8	<-- Station No. 3 ~ 1.5m
620	0.235	0.436	0.201	-0.201	21.8	<-- Station No. 3 ~ 1.5m
625	0.235	0.436	0.201	-0.201	21.8	<-- Station No. 3 ~ 1.5m
630	0.235	0.417	0.182	-0.182	21.7	<-- Station No. 3 ~ 1.5m
635	0.235	0.472	0.237	-0.237	21.6	<-- Station No. 3 ~ 1.5m
640	0.235	0.433	0.198	-0.198	21.6	<-- Station No. 3 ~ 1.5m
645	0.235	0.415	0.180	-0.180	21.6	<-- Station No. 3 ~ 1.5m
650	0.235	0.426	0.192	-0.192	21.6	<-- Station No. 3 ~ 1.5m
655	0.235	0.486	0.251	-0.251	21.6	<-- Station No. 3 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
660	0.235	0.495	0.260	-0.260	21.7	<-- Station No. 3 ~ 1.5m
665	0.235	0.433	0.198	-0.198	21.5	<-- Station No. 3 ~ 1.5m
670	0.235	0.463	0.228	-0.228	21.8	<-- Station No. 3 ~ 1.5m
675	0.235	0.442	0.208	-0.208	21.5	<-- Station No. 3 ~ 1.5m
680	0.235	0.436	0.201	-0.201	21.5	<-- Station No. 3 ~ 1.5m
685	0.235	0.438	0.203	-0.203	21.4	<-- Station No. 3 ~ 1.5m
690	0.235	0.456	0.221	-0.221	21.4	<-- Station No. 3 ~ 1.5m
695	0.235	0.440	0.205	-0.205	21.4	<-- Station No. 3 ~ 1.5m
700	0.235	0.511	0.276	-0.276	21.5	<-- Station No. 3 ~ 1.5m
705	0.235	0.525	0.290	-0.290	21.4	<-- Station No. 3 ~ 1.5m
710	0.235	0.538	0.303	-0.303	21.4	<-- Station No. 3 ~ 1.5m
715	0.235	0.454	0.219	-0.219	21.5	<-- Station No. 3 ~ 1.5m
720	0.235	0.506	0.271	-0.271	21.3	<-- Station No. 3 ~ 1.5m
725	0.235	0.449	0.214	-0.214	21.4	<-- Station No. 3 ~ 1.5m
730	0.235	0.483	0.249	-0.249	21.4	<-- Station No. 3 ~ 1.5m
735	0.235	0.442	0.208	-0.208	21.4	<-- Station No. 3 ~ 1.5m
740	0.235	0.479	0.244	-0.244	21.4	<-- Station No. 3 ~ 1.5m
745	0.235	0.438	0.203	-0.203	21.4	<-- Station No. 3 ~ 1.5m
750	0.235	0.463	0.228	-0.228	21.3	<-- Station No. 3 ~ 1.5m
755	0.235	0.531	0.296	-0.296	21.4	<-- Station No. 3 ~ 1.5m
760	0.235	0.456	0.221	-0.221	21.2	<-- Station No. 3 ~ 1.5m
765	0.235	0.474	0.239	-0.239	21.3	<-- Station No. 3 ~ 1.5m
770	0.235	0.506	0.271	-0.271	21.2	<-- Station No. 3 ~ 1.5m
775	0.235	0.483	0.249	-0.249	21.3	<-- Station No. 3 ~ 1.5m
780	0.235	0.556	0.322	-0.322	21.2	<-- Station No. 3 ~ 1.5m
785	0.235	0.545	0.310	-0.310	21.2	<-- Station No. 3 ~ 1.5m
790	0.235	0.470	0.235	-0.235	21.2	<-- Station No. 3 ~ 1.5m
795	0.235	0.490	0.255	-0.255	21.1	<-- Station No. 3 ~ 1.5m
800	0.235	0.454	0.219	-0.219	21.2	<-- Station No. 3 ~ 1.5m
805	0.235	0.490	0.255	-0.255	21.1	<-- Station No. 3 ~ 1.5m
810	0.235	0.472	0.237	-0.237	21	<-- Station No. 3 ~ 1.5m
815	0.235	0.499	0.265	-0.265	21.1	<-- Station No. 3 ~ 1.5m
820	0.235	0.486	0.251	-0.251	21.4	<-- Station No. 3 ~ 1.5m
825	0.235	0.518	0.283	-0.283	21.2	<-- Station No. 3 ~ 1.5m
830	0.235	0.449	0.214	-0.214	21.2	<-- Station No. 3 ~ 1.5m
835	0.235	0.593	0.358	-0.358	21.2	<-- Station No. 3 ~ 1.5m
840	0.235	0.540	0.306	-0.306	21	<-- Station No. 3 ~ 1.5m
845	0.235	0.522	0.287	-0.287	21.3	<-- Station No. 3 ~ 1.5m
850	0.235	0.483	0.249	-0.249	21.3	<-- Station No. 3 ~ 1.5m
855	0.235	0.458	0.223	-0.223	21.3	<-- Station No. 3 ~ 1.5m
860	0.235	0.525	0.290	-0.290	21.2	<-- Station No. 3 ~ 1.5m
865	0.235	0.493	0.258	-0.258	21.2	<-- Station No. 3 ~ 1.5m
870	0.235	0.465	0.230	-0.230	21.2	<-- Station No. 3 ~ 1.5m
875	0.235	0.483	0.249	-0.249	21.4	<-- Station No. 3 ~ 1.5m
880	0.235	0.447	0.212	-0.212	21.2	<-- Station No. 3 ~ 1.5m
885	0.235	0.497	0.262	-0.262	21.3	<-- Station No. 3 ~ 1.5m
890	0.235	0.461	0.226	-0.226	21.2	<-- Station No. 3 ~ 1.5m
895	0.235	0.456	0.221	-0.221	21.2	<-- Station No. 3 ~ 1.5m
900	0.235	0.477	0.242	-0.242	21.2	<-- Station No. 3 ~ 1.5m
905	0.235	0.463	0.228	-0.228	21.2	<-- Station No. 3 ~ 1.5m
910	0.235	0.554	0.319	-0.319	21.2	<-- Station No. 3 ~ 1.5m
915	0.235	0.543	0.308	-0.308	21.2	<-- Station No. 3 ~ 1.5m
920	0.235	0.545	0.310	-0.310	21.2	<-- Station No. 3 ~ 1.5m
925	0.235	0.458	0.223	-0.223	21.2	<-- Station No. 3 ~ 1.5m
930	0.235	0.520	0.285	-0.285	21.2	<-- Station No. 3 ~ 1.5m
935	0.235	0.525	0.290	-0.290	21.1	<-- Station No. 3 ~ 1.5m
940	0.235	0.566	0.331	-0.331	21.1	<-- Station No. 3 ~ 1.5m
945	0.235	0.468	0.233	-0.233	21.3	<-- Station No. 3 ~ 1.5m
950	0.235	0.474	0.239	-0.239	21.1	<-- Station No. 3 ~ 1.5m
955	0.235	0.568	0.333	-0.333	21.2	<-- Station No. 3 ~ 1.5m
960	0.235	0.536	0.301	-0.301	21.2	<-- Station No. 3 ~ 1.5m
965	0.235	0.575	0.340	-0.340	21.1	<-- Station No. 3 ~ 1.5m
970	0.235	0.504	0.269	-0.269	21.1	<-- Station No. 3 ~ 1.5m
975	0.235	0.497	0.262	-0.262	21.2	<-- Station No. 3 ~ 1.5m
980	0.235	0.527	0.292	-0.292	21.1	<-- Station No. 3 ~ 1.5m
985	0.235	0.483	0.249	-0.249	21	<-- Station No. 3 ~ 1.5m
990	0.235	0.509	0.274	-0.274	21.2	<-- Station No. 3 ~ 1.5m
995	0.235	0.509	0.274	-0.274	21	<-- Station No. 3 ~ 1.5m
1000	0.235	0.531	0.296	-0.296	21	<-- Station No. 3 ~ 1.5m
1005	0.235	0.513	0.278	-0.278	21.1	<-- Station No. 3 ~ 1.5m
1010	0.235	0.474	0.239	-0.239	21	<-- Station No. 3 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1015	0.235	0.509	0.274	-0.274	21	<-- Station No. 3 ~ 1.5m
1020	0.235	0.536	0.301	-0.301	20.9	<-- Station No. 3 ~ 1.5m
1025	0.235	0.552	0.317	-0.317	20.9	<-- Station No. 3 ~ 1.5m
1030	0.235	0.520	0.285	-0.285	20.9	<-- Station No. 3 ~ 1.5m
1035	0.235	0.586	0.351	-0.351	20.9	<-- Station No. 3 ~ 1.5m
1040	0.235	0.522	0.287	-0.287	20.9	<-- Station No. 3 ~ 1.5m
1045	0.235	0.497	0.262	-0.262	20.9	<-- Station No. 3 ~ 1.5m
1050	0.235	0.515	0.281	-0.281	20.9	<-- Station No. 3 ~ 1.5m
1055	0.235	0.522	0.287	-0.287	20.9	<-- Station No. 3 ~ 1.5m
1060	0.235	0.547	0.312	-0.312	20.9	<-- Station No. 3 ~ 1.5m
1065	0.235	0.497	0.262	-0.262	20.9	<-- Station No. 3 ~ 1.5m
1070	0.235	0.499	0.265	-0.265	20.8	<-- Station No. 3 ~ 1.5m
1075	0.235	0.511	0.276	-0.276	20.8	<-- Station No. 3 ~ 1.5m
1080	0.235	0.506	0.271	-0.271	21	<-- Station No. 3 ~ 1.5m
1085	0.235	0.490	0.255	-0.255	20.7	<-- Station No. 3 ~ 1.5m
1090	0.235	0.490	0.255	-0.255	20.7	<-- Station No. 3 ~ 1.5m
1095	0.235	0.497	0.262	-0.262	20.8	<-- Station No. 3 ~ 1.5m
1100	0.235	0.502	0.267	-0.267	20.8	<-- Station No. 3 ~ 1.5m
1105	0.235	0.497	0.262	-0.262	20.8	<-- Station No. 3 ~ 1.5m
1110	0.235	0.490	0.255	-0.255	20.8	<-- Station No. 3 ~ 1.5m
1115	0.235	0.483	0.249	-0.249	20.8	<-- Station No. 3 ~ 1.5m
1120	0.235	0.495	0.260	-0.260	20.8	<-- Station No. 3 ~ 1.5m
1125	0.235	0.577	0.342	-0.342	20.8	<-- Station No. 3 ~ 1.5m
1130	0.235	0.518	0.283	-0.283	20.8	<-- Station No. 3 ~ 1.5m
1135	0.235	0.490	0.255	-0.255	20.7	<-- Station No. 3 ~ 1.5m
1140	0.235	0.495	0.260	-0.260	20.8	<-- Station No. 3 ~ 1.5m
1145	0.235	0.497	0.262	-0.262	20.7	<-- Station No. 3 ~ 1.5m
1150	0.235	0.547	0.312	-0.312	20.7	<-- Station No. 3 ~ 1.5m
1155	0.235	0.527	0.292	-0.292	20.7	<-- Station No. 3 ~ 1.5m
1160	0.235	0.554	0.319	-0.319	20.8	<-- Station No. 3 ~ 1.5m
1165	0.235	0.611	0.376	-0.376	20.8	<-- Station No. 3 ~ 1.5m
1170	0.235	0.556	0.322	-0.322	20.7	<-- Station No. 3 ~ 1.5m
1175	0.235	0.499	0.265	-0.265	20.8	<-- Station No. 3 ~ 1.5m
1180	0.235	0.502	0.267	-0.267	20.8	<-- Station No. 3 ~ 1.5m
1185	0.235	0.525	0.290	-0.290	20.8	<-- Station No. 3 ~ 1.5m
1190	0.235	0.582	0.347	-0.347	20.8	<-- Station No. 3 ~ 1.5m
1195	0.235	0.540	0.306	-0.306	20.8	<-- Station No. 3 ~ 1.5m
1200	0.235	0.531	0.296	-0.296	20.9	<-- Station No. 3 ~ 1.5m
1205	0.235	0.538	0.303	-0.303	20.9	<-- Station No. 3 ~ 1.5m
1210	0.235	0.504	0.269	-0.269	20.8	<-- Station No. 3 ~ 1.5m
1215	0.235	0.490	0.255	-0.255	20.8	<-- Station No. 3 ~ 1.5m
1220	0.235	0.493	0.258	-0.258	20.9	<-- Station No. 3 ~ 1.5m
1225	0.235	0.568	0.333	-0.333	20.9	<-- Station No. 3 ~ 1.5m
1230	0.235	0.490	0.255	-0.255	21	<-- Station No. 3 ~ 1.5m
1235	0.235	0.579	0.344	-0.344	20.9	<-- Station No. 3 ~ 1.5m
1240	0.235	0.499	0.265	-0.265	21.1	<-- Station No. 3 ~ 1.5m
1245	0.235	0.493	0.258	-0.258	21.1	<-- Station No. 3 ~ 1.5m
1250	0.235	0.483	0.249	-0.249	21.1	<-- Station No. 3 ~ 1.5m
1255	0.235	0.490	0.255	-0.255	21.2	<-- Station No. 3 ~ 1.5m
1260	0.235	0.506	0.271	-0.271	21.2	<-- Station No. 3 ~ 1.5m
1265	0.235	0.522	0.287	-0.287	21.4	<-- Station No. 3 ~ 1.5m
1270	0.235	0.518	0.283	-0.283	21.5	<-- Station No. 3 ~ 1.5m
1275	0.235	0.456	0.221	-0.221	21.4	<-- Station No. 3 ~ 1.5m
1280	0.235	0.499	0.265	-0.265	21.5	<-- Station No. 3 ~ 1.5m
1285	0.235	0.481	0.246	-0.246	21.5	<-- Station No. 3 ~ 1.5m
1290	0.235	0.527	0.292	-0.292	21.7	<-- Station No. 3 ~ 1.5m
1295	0.235	0.461	0.226	-0.226	21.5	<-- Station No. 3 ~ 1.5m
1300	0.235	0.483	0.249	-0.249	21.6	<-- Station No. 3 ~ 1.5m
1305	0.235	0.483	0.249	-0.249	21.5	<-- Station No. 3 ~ 1.5m
1310	0.235	0.518	0.283	-0.283	21.4	<-- Station No. 3 ~ 1.5m
1315	0.235	0.518	0.283	-0.283	21.5	<-- Station No. 3 ~ 1.5m
1320	0.235	0.445	0.210	-0.210	21.6	<-- Station No. 3 ~ 1.5m
1325	0.235	0.527	0.292	-0.292	21.6	<-- Station No. 3 ~ 1.5m
1330	0.235	0.525	0.290	-0.290	21.6	<-- Station No. 3 ~ 1.5m
1335	0.235	0.447	0.212	-0.212	21.5	<-- Station No. 3 ~ 1.5m
1340	0.235	0.497	0.262	-0.262	21.5	<-- Station No. 3 ~ 1.5m
1345	0.235	0.481	0.246	-0.246	21.6	<-- Station No. 3 ~ 1.5m
1350	0.235	0.461	0.226	-0.226	21.8	<-- Station No. 3 ~ 1.5m
1355	0.235	0.456	0.221	-0.221	22	<-- Station No. 3 ~ 1.5m
1360	0.235	0.468	0.233	-0.233	22	<-- Station No. 3 ~ 1.5m
1365	0.235	0.495	0.260	-0.260	21.8	<-- Station No. 3 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1370	0.235	0.442	0.208	-0.208	21.9	<-- Station No. 3 ~ 1.5m
1375	0.235	0.433	0.198	-0.198	21.8	<-- Station No. 3 ~ 1.5m
1380	0.235	0.436	0.201	-0.201	21.8	<-- Station No. 3 ~ 1.5m
1385	0.235	0.454	0.219	-0.219	21.7	<-- Station No. 3 ~ 1.5m
1390	0.235	0.513	0.278	-0.278	21.7	<-- Station No. 3 ~ 1.5m
1395	0.235	0.497	0.262	-0.262	21.7	<-- Station No. 3 ~ 1.5m
1400	0.235	0.431	0.196	-0.196	21.8	<-- Station No. 3 ~ 1.5m
1405	0.235	0.424	0.189	-0.189	21.8	<-- Station No. 3 ~ 1.5m
1410	0.235	0.433	0.198	-0.198	21.9	<-- Station No. 3 ~ 1.5m
1415	0.235	0.458	0.223	-0.223	21.8	<-- Station No. 3 ~ 1.5m
1420	0.235	0.502	0.267	-0.267	21.8	<-- Station No. 3 ~ 1.5m
1425	0.235	0.502	0.267	-0.267	21.9	<-- Station No. 3 ~ 1.5m
1430	0.235	0.456	0.221	-0.221	21.9	<-- Station No. 3 ~ 1.5m
1435	0.235	0.438	0.203	-0.203	21.8	<-- Station No. 3 ~ 1.5m
1440	0.235	0.470	0.235	-0.235	21.8	<-- Station No. 3 ~ 1.5m
0	0.235	0.347	0.112	-0.112	23.6	<-- Station No. 4 ~ 1.5m
5	0.235	0.381	0.146	-0.146	23.4	<-- Station No. 4 ~ 1.5m
10	0.235	0.360	0.125	-0.125	23.3	<-- Station No. 4 ~ 1.5m
15	0.235	0.360	0.125	-0.125	23.2	<-- Station No. 4 ~ 1.5m
20	0.235	0.353	0.119	-0.119	23.1	<-- Station No. 4 ~ 1.5m
25	0.235	0.349	0.114	-0.114	23.1	<-- Station No. 4 ~ 1.5m
30	0.235	0.353	0.119	-0.119	23.1	<-- Station No. 4 ~ 1.5m
35	0.235	0.360	0.125	-0.125	23.1	<-- Station No. 4 ~ 1.5m
40	0.235	0.408	0.173	-0.173	23	<-- Station No. 4 ~ 1.5m
45	0.235	0.401	0.166	-0.166	22.9	<-- Station No. 4 ~ 1.5m
50	0.235	0.410	0.176	-0.176	22.9	<-- Station No. 4 ~ 1.5m
55	0.235	0.408	0.173	-0.173	23.1	<-- Station No. 4 ~ 1.5m
60	0.235	0.358	0.123	-0.123	23.2	<-- Station No. 4 ~ 1.5m
65	0.235	0.351	0.116	-0.116	23.2	<-- Station No. 4 ~ 1.5m
70	0.235	0.349	0.114	-0.114	23.5	<-- Station No. 4 ~ 1.5m
75	0.235	0.353	0.119	-0.119	23.4	<-- Station No. 4 ~ 1.5m
80	0.235	0.340	0.105	-0.105	23.5	<-- Station No. 4 ~ 1.5m
85	0.235	0.404	0.169	-0.169	23.4	<-- Station No. 4 ~ 1.5m
90	0.235	0.351	0.116	-0.116	23.2	<-- Station No. 4 ~ 1.5m
95	0.235	0.356	0.121	-0.121	23.1	<-- Station No. 4 ~ 1.5m
100	0.235	0.356	0.121	-0.121	23.1	<-- Station No. 4 ~ 1.5m
105	0.235	0.363	0.128	-0.128	23	<-- Station No. 4 ~ 1.5m
110	0.235	0.379	0.144	-0.144	22.9	<-- Station No. 4 ~ 1.5m
115	0.235	0.442	0.208	-0.208	22.9	<-- Station No. 4 ~ 1.5m
120	0.235	0.424	0.189	-0.189	22.9	<-- Station No. 4 ~ 1.5m
125	0.235	0.390	0.155	-0.155	22.9	<-- Station No. 4 ~ 1.5m
130	0.235	0.369	0.135	-0.135	22.9	<-- Station No. 4 ~ 1.5m
135	0.235	0.392	0.157	-0.157	22.9	<-- Station No. 4 ~ 1.5m
140	0.235	0.454	0.219	-0.219	22.9	<-- Station No. 4 ~ 1.5m
145	0.235	0.477	0.242	-0.242	22.9	<-- Station No. 4 ~ 1.5m
150	0.235	0.385	0.151	-0.151	22.8	<-- Station No. 4 ~ 1.5m
155	0.235	0.431	0.196	-0.196	23	<-- Station No. 4 ~ 1.5m
160	0.235	0.458	0.223	-0.223	23	<-- Station No. 4 ~ 1.5m
165	0.235	0.452	0.217	-0.217	22.9	<-- Station No. 4 ~ 1.5m
170	0.235	0.367	0.132	-0.132	22.9	<-- Station No. 4 ~ 1.5m
175	0.235	0.358	0.123	-0.123	23	<-- Station No. 4 ~ 1.5m
180	0.235	0.369	0.135	-0.135	23	<-- Station No. 4 ~ 1.5m
185	0.235	0.385	0.151	-0.151	23	<-- Station No. 4 ~ 1.5m
190	0.235	0.372	0.137	-0.137	23	<-- Station No. 4 ~ 1.5m
195	0.235	0.385	0.151	-0.151	23.1	<-- Station No. 4 ~ 1.5m
200	0.235	0.390	0.155	-0.155	23	<-- Station No. 4 ~ 1.5m
205	0.235	0.381	0.146	-0.146	23	<-- Station No. 4 ~ 1.5m
210	0.235	0.344	0.109	-0.109	23.2	<-- Station No. 4 ~ 1.5m
215	0.235	0.349	0.114	-0.114	23.1	<-- Station No. 4 ~ 1.5m
220	0.235	0.397	0.162	-0.162	22.9	<-- Station No. 4 ~ 1.5m
225	0.235	0.438	0.203	-0.203	22.9	<-- Station No. 4 ~ 1.5m
230	0.235	0.406	0.171	-0.171	22.9	<-- Station No. 4 ~ 1.5m
235	0.235	0.433	0.198	-0.198	22.9	<-- Station No. 4 ~ 1.5m
240	0.235	0.395	0.160	-0.160	22.8	<-- Station No. 4 ~ 1.5m
245	0.235	0.436	0.201	-0.201	22.9	<-- Station No. 4 ~ 1.5m
250	0.235	0.417	0.182	-0.182	22.9	<-- Station No. 4 ~ 1.5m
255	0.235	0.392	0.157	-0.157	23	<-- Station No. 4 ~ 1.5m
260	0.235	0.440	0.205	-0.205	23.1	<-- Station No. 4 ~ 1.5m
265	0.235	0.447	0.212	-0.212	22.8	<-- Station No. 4 ~ 1.5m
270	0.235	0.461	0.226	-0.226	22.7	<-- Station No. 4 ~ 1.5m
275	0.235	0.372	0.137	-0.137	22.7	<-- Station No. 4 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
280	0.235	0.415	0.180	-0.180	22.7	<-- Station No. 4 ~ 1.5m
285	0.235	0.452	0.217	-0.217	22.7	<-- Station No. 4 ~ 1.5m
290	0.235	0.417	0.182	-0.182	22.7	<-- Station No. 4 ~ 1.5m
295	0.235	0.383	0.148	-0.148	22.7	<-- Station No. 4 ~ 1.5m
300	0.235	0.401	0.166	-0.166	22.6	<-- Station No. 4 ~ 1.5m
305	0.235	0.385	0.151	-0.151	22.6	<-- Station No. 4 ~ 1.5m
310	0.235	0.431	0.196	-0.196	22.6	<-- Station No. 4 ~ 1.5m
315	0.235	0.392	0.157	-0.157	22.6	<-- Station No. 4 ~ 1.5m
320	0.235	0.390	0.155	-0.155	22.5	<-- Station No. 4 ~ 1.5m
325	0.235	0.392	0.157	-0.157	22.5	<-- Station No. 4 ~ 1.5m
330	0.235	0.388	0.153	-0.153	22.5	<-- Station No. 4 ~ 1.5m
335	0.235	0.392	0.157	-0.157	22.4	<-- Station No. 4 ~ 1.5m
340	0.235	0.424	0.189	-0.189	22.4	<-- Station No. 4 ~ 1.5m
345	0.235	0.392	0.157	-0.157	22.4	<-- Station No. 4 ~ 1.5m
350	0.235	0.470	0.235	-0.235	22.3	<-- Station No. 4 ~ 1.5m
355	0.235	0.404	0.169	-0.169	22.3	<-- Station No. 4 ~ 1.5m
360	0.235	0.447	0.212	-0.212	22.3	<-- Station No. 4 ~ 1.5m
365	0.235	0.463	0.228	-0.228	22.3	<-- Station No. 4 ~ 1.5m
370	0.235	0.410	0.176	-0.176	22.4	<-- Station No. 4 ~ 1.5m
375	0.235	0.504	0.269	-0.269	22.2	<-- Station No. 4 ~ 1.5m
380	0.235	0.415	0.180	-0.180	22.2	<-- Station No. 4 ~ 1.5m
385	0.235	0.426	0.192	-0.192	22.2	<-- Station No. 4 ~ 1.5m
390	0.235	0.449	0.214	-0.214	22.1	<-- Station No. 4 ~ 1.5m
395	0.235	0.413	0.178	-0.178	22	<-- Station No. 4 ~ 1.5m
400	0.235	0.438	0.203	-0.203	22	<-- Station No. 4 ~ 1.5m
405	0.235	0.410	0.176	-0.176	22	<-- Station No. 4 ~ 1.5m
410	0.235	0.456	0.221	-0.221	21.9	<-- Station No. 4 ~ 1.5m
415	0.235	0.470	0.235	-0.235	21.9	<-- Station No. 4 ~ 1.5m
420	0.235	0.422	0.187	-0.187	21.9	<-- Station No. 4 ~ 1.5m
425	0.235	0.454	0.219	-0.219	21.8	<-- Station No. 4 ~ 1.5m
430	0.235	0.479	0.244	-0.244	21.9	<-- Station No. 4 ~ 1.5m
435	0.235	0.463	0.228	-0.228	21.8	<-- Station No. 4 ~ 1.5m
440	0.235	0.436	0.201	-0.201	21.8	<-- Station No. 4 ~ 1.5m
445	0.235	0.474	0.239	-0.239	21.7	<-- Station No. 4 ~ 1.5m
450	0.235	0.463	0.228	-0.228	21.7	<-- Station No. 4 ~ 1.5m
455	0.235	0.440	0.205	-0.205	21.7	<-- Station No. 4 ~ 1.5m
460	0.235	0.433	0.198	-0.198	21.6	<-- Station No. 4 ~ 1.5m
465	0.235	0.438	0.203	-0.203	21.6	<-- Station No. 4 ~ 1.5m
470	0.235	0.449	0.214	-0.214	21.6	<-- Station No. 4 ~ 1.5m
475	0.235	0.436	0.201	-0.201	21.6	<-- Station No. 4 ~ 1.5m
480	0.235	0.477	0.242	-0.242	21.5	<-- Station No. 4 ~ 1.5m
485	0.235	0.509	0.274	-0.274	21.5	<-- Station No. 4 ~ 1.5m
490	0.235	0.438	0.203	-0.203	21.5	<-- Station No. 4 ~ 1.5m
495	0.235	0.438	0.203	-0.203	21.5	<-- Station No. 4 ~ 1.5m
500	0.235	0.522	0.287	-0.287	21.5	<-- Station No. 4 ~ 1.5m
505	0.235	0.442	0.208	-0.208	21.5	<-- Station No. 4 ~ 1.5m
510	0.235	0.511	0.276	-0.276	21.5	<-- Station No. 4 ~ 1.5m
515	0.235	0.463	0.228	-0.228	21.4	<-- Station No. 4 ~ 1.5m
520	0.235	0.440	0.205	-0.205	21.4	<-- Station No. 4 ~ 1.5m
525	0.235	0.479	0.244	-0.244	21.4	<-- Station No. 4 ~ 1.5m
530	0.235	0.438	0.203	-0.203	21.4	<-- Station No. 4 ~ 1.5m
535	0.235	0.474	0.239	-0.239	21.4	<-- Station No. 4 ~ 1.5m
540	0.235	0.511	0.276	-0.276	21.4	<-- Station No. 4 ~ 1.5m
545	0.235	0.438	0.203	-0.203	21.4	<-- Station No. 4 ~ 1.5m
550	0.235	0.477	0.242	-0.242	21.5	<-- Station No. 4 ~ 1.5m
555	0.235	0.452	0.217	-0.217	21.4	<-- Station No. 4 ~ 1.5m
560	0.235	0.458	0.223	-0.223	21.4	<-- Station No. 4 ~ 1.5m
565	0.235	0.525	0.290	-0.290	21.3	<-- Station No. 4 ~ 1.5m
570	0.235	0.458	0.223	-0.223	21.3	<-- Station No. 4 ~ 1.5m
575	0.235	0.463	0.228	-0.228	21.3	<-- Station No. 4 ~ 1.5m
580	0.235	0.499	0.265	-0.265	21.4	<-- Station No. 4 ~ 1.5m
585	0.235	0.470	0.235	-0.235	21.4	<-- Station No. 4 ~ 1.5m
590	0.235	0.483	0.249	-0.249	21.3	<-- Station No. 4 ~ 1.5m
595	0.235	0.461	0.226	-0.226	21.3	<-- Station No. 4 ~ 1.5m
600	0.235	0.499	0.265	-0.265	21.3	<-- Station No. 4 ~ 1.5m
605	0.235	0.461	0.226	-0.226	21.3	<-- Station No. 4 ~ 1.5m
610	0.235	0.461	0.226	-0.226	21.4	<-- Station No. 4 ~ 1.5m
615	0.235	0.463	0.228	-0.228	21.3	<-- Station No. 4 ~ 1.5m
620	0.235	0.470	0.235	-0.235	21.2	<-- Station No. 4 ~ 1.5m
625	0.235	0.499	0.265	-0.265	21.3	<-- Station No. 4 ~ 1.5m
630	0.235	0.540	0.306	-0.306	21.3	<-- Station No. 4 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
635	0.235	0.497	0.262	-0.262	21.2	<-- Station No. 4 ~ 1.5m
640	0.235	0.479	0.244	-0.244	21.2	<-- Station No. 4 ~ 1.5m
645	0.235	0.547	0.312	-0.312	21.2	<-- Station No. 4 ~ 1.5m
650	0.235	0.461	0.226	-0.226	21.2	<-- Station No. 4 ~ 1.5m
655	0.235	0.520	0.285	-0.285	21	<-- Station No. 4 ~ 1.5m
660	0.235	0.497	0.262	-0.262	21.2	<-- Station No. 4 ~ 1.5m
665	0.235	0.550	0.315	-0.315	21.2	<-- Station No. 4 ~ 1.5m
670	0.235	0.529	0.294	-0.294	21.2	<-- Station No. 4 ~ 1.5m
675	0.235	0.538	0.303	-0.303	21.2	<-- Station No. 4 ~ 1.5m
680	0.235	0.543	0.308	-0.308	21.3	<-- Station No. 4 ~ 1.5m
685	0.235	0.468	0.233	-0.233	21.2	<-- Station No. 4 ~ 1.5m
690	0.235	0.499	0.265	-0.265	21.3	<-- Station No. 4 ~ 1.5m
695	0.235	0.545	0.310	-0.310	21.2	<-- Station No. 4 ~ 1.5m
700	0.235	0.543	0.308	-0.308	21.1	<-- Station No. 4 ~ 1.5m
705	0.235	0.552	0.317	-0.317	21.2	<-- Station No. 4 ~ 1.5m
710	0.235	0.525	0.290	-0.290	21.2	<-- Station No. 4 ~ 1.5m
715	0.235	0.504	0.269	-0.269	21.2	<-- Station No. 4 ~ 1.5m
720	0.235	0.470	0.235	-0.235	21.2	<-- Station No. 4 ~ 1.5m
725	0.235	0.497	0.262	-0.262	21.1	<-- Station No. 4 ~ 1.5m
730	0.235	0.582	0.347	-0.347	21.1	<-- Station No. 4 ~ 1.5m
735	0.235	0.563	0.328	-0.328	21.2	<-- Station No. 4 ~ 1.5m
740	0.235	0.479	0.244	-0.244	21.1	<-- Station No. 4 ~ 1.5m
745	0.235	0.479	0.244	-0.244	21.4	<-- Station No. 4 ~ 1.5m
750	0.235	0.550	0.315	-0.315	21.1	<-- Station No. 4 ~ 1.5m
755	0.235	0.534	0.299	-0.299	21.1	<-- Station No. 4 ~ 1.5m
760	0.235	0.472	0.237	-0.237	21.3	<-- Station No. 4 ~ 1.5m
765	0.235	0.525	0.290	-0.290	21	<-- Station No. 4 ~ 1.5m
770	0.235	0.538	0.303	-0.303	21.1	<-- Station No. 4 ~ 1.5m
775	0.235	0.499	0.265	-0.265	20.9	<-- Station No. 4 ~ 1.5m
780	0.235	0.525	0.290	-0.290	21	<-- Station No. 4 ~ 1.5m
785	0.235	0.509	0.274	-0.274	21	<-- Station No. 4 ~ 1.5m
790	0.235	0.486	0.251	-0.251	21.1	<-- Station No. 4 ~ 1.5m
795	0.235	0.513	0.278	-0.278	21	<-- Station No. 4 ~ 1.5m
800	0.235	0.483	0.249	-0.249	21	<-- Station No. 4 ~ 1.5m
805	0.235	0.472	0.237	-0.237	21	<-- Station No. 4 ~ 1.5m
810	0.235	0.552	0.317	-0.317	21	<-- Station No. 4 ~ 1.5m
815	0.235	0.474	0.239	-0.239	21	<-- Station No. 4 ~ 1.5m
820	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 4 ~ 1.5m
825	0.235	0.572	0.338	-0.338	20.9	<-- Station No. 4 ~ 1.5m
830	0.235	0.474	0.239	-0.239	21	<-- Station No. 4 ~ 1.5m
835	0.235	0.520	0.285	-0.285	21	<-- Station No. 4 ~ 1.5m
840	0.235	0.543	0.308	-0.308	20.9	<-- Station No. 4 ~ 1.5m
845	0.235	0.518	0.283	-0.283	20.9	<-- Station No. 4 ~ 1.5m
850	0.235	0.488	0.253	-0.253	20.9	<-- Station No. 4 ~ 1.5m
855	0.235	0.525	0.290	-0.290	20.9	<-- Station No. 4 ~ 1.5m
860	0.235	0.518	0.283	-0.283	20.9	<-- Station No. 4 ~ 1.5m
865	0.235	0.497	0.262	-0.262	21	<-- Station No. 4 ~ 1.5m
870	0.235	0.486	0.251	-0.251	21.1	<-- Station No. 4 ~ 1.5m
875	0.235	0.511	0.276	-0.276	20.9	<-- Station No. 4 ~ 1.5m
880	0.235	0.479	0.244	-0.244	20.9	<-- Station No. 4 ~ 1.5m
885	0.235	0.518	0.283	-0.283	20.9	<-- Station No. 4 ~ 1.5m
890	0.235	0.483	0.249	-0.249	20.9	<-- Station No. 4 ~ 1.5m
895	0.235	0.481	0.246	-0.246	20.9	<-- Station No. 4 ~ 1.5m
900	0.235	0.511	0.276	-0.276	20.9	<-- Station No. 4 ~ 1.5m
905	0.235	0.520	0.285	-0.285	21	<-- Station No. 4 ~ 1.5m
910	0.235	0.547	0.312	-0.312	20.9	<-- Station No. 4 ~ 1.5m
915	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 4 ~ 1.5m
920	0.235	0.486	0.251	-0.251	20.9	<-- Station No. 4 ~ 1.5m
925	0.235	0.502	0.267	-0.267	20.9	<-- Station No. 4 ~ 1.5m
930	0.235	0.495	0.260	-0.260	20.9	<-- Station No. 4 ~ 1.5m
935	0.235	0.504	0.269	-0.269	21	<-- Station No. 4 ~ 1.5m
940	0.235	0.525	0.290	-0.290	20.9	<-- Station No. 4 ~ 1.5m
945	0.235	0.490	0.255	-0.255	20.8	<-- Station No. 4 ~ 1.5m
950	0.235	0.572	0.338	-0.338	20.8	<-- Station No. 4 ~ 1.5m
955	0.235	0.525	0.290	-0.290	20.8	<-- Station No. 4 ~ 1.5m
960	0.235	0.497	0.262	-0.262	20.9	<-- Station No. 4 ~ 1.5m
965	0.235	0.545	0.310	-0.310	20.8	<-- Station No. 4 ~ 1.5m
970	0.235	0.543	0.308	-0.308	21	<-- Station No. 4 ~ 1.5m
975	0.235	0.543	0.308	-0.308	21	<-- Station No. 4 ~ 1.5m
980	0.235	0.550	0.315	-0.315	20.8	<-- Station No. 4 ~ 1.5m
985	0.235	0.497	0.262	-0.262	20.8	<-- Station No. 4 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
990	0.235	0.520	0.285	-0.285	20.8	<-- Station No. 4 ~ 1.5m
995	0.235	0.531	0.296	-0.296	20.8	<-- Station No. 4 ~ 1.5m
1000	0.235	0.525	0.290	-0.290	20.8	<-- Station No. 4 ~ 1.5m
1005	0.235	0.499	0.265	-0.265	20.7	<-- Station No. 4 ~ 1.5m
1010	0.235	0.513	0.278	-0.278	20.9	<-- Station No. 4 ~ 1.5m
1015	0.235	0.568	0.333	-0.333	20.8	<-- Station No. 4 ~ 1.5m
1020	0.235	0.575	0.340	-0.340	20.8	<-- Station No. 4 ~ 1.5m
1025	0.235	0.488	0.253	-0.253	21	<-- Station No. 4 ~ 1.5m
1030	0.235	0.543	0.308	-0.308	20.8	<-- Station No. 4 ~ 1.5m
1035	0.235	0.506	0.271	-0.271	20.8	<-- Station No. 4 ~ 1.5m
1040	0.235	0.556	0.322	-0.322	20.8	<-- Station No. 4 ~ 1.5m
1045	0.235	0.550	0.315	-0.315	20.8	<-- Station No. 4 ~ 1.5m
1050	0.235	0.502	0.267	-0.267	20.7	<-- Station No. 4 ~ 1.5m
1055	0.235	0.515	0.281	-0.281	20.7	<-- Station No. 4 ~ 1.5m
1060	0.235	0.511	0.276	-0.276	20.8	<-- Station No. 4 ~ 1.5m
1065	0.235	0.499	0.265	-0.265	20.8	<-- Station No. 4 ~ 1.5m
1070	0.235	0.529	0.294	-0.294	20.8	<-- Station No. 4 ~ 1.5m
1075	0.235	0.522	0.287	-0.287	20.9	<-- Station No. 4 ~ 1.5m
1080	0.235	0.493	0.258	-0.258	20.8	<-- Station No. 4 ~ 1.5m
1085	0.235	0.511	0.276	-0.276	20.7	<-- Station No. 4 ~ 1.5m
1090	0.235	0.506	0.271	-0.271	20.9	<-- Station No. 4 ~ 1.5m
1095	0.235	0.547	0.312	-0.312	20.8	<-- Station No. 4 ~ 1.5m
1100	0.235	0.520	0.285	-0.285	20.8	<-- Station No. 4 ~ 1.5m
1105	0.235	0.486	0.251	-0.251	20.8	<-- Station No. 4 ~ 1.5m
1110	0.235	0.577	0.342	-0.342	20.8	<-- Station No. 4 ~ 1.5m
1115	0.235	0.495	0.260	-0.260	20.8	<-- Station No. 4 ~ 1.5m
1120	0.235	0.502	0.267	-0.267	20.8	<-- Station No. 4 ~ 1.5m
1125	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 4 ~ 1.5m
1130	0.235	0.506	0.271	-0.271	20.9	<-- Station No. 4 ~ 1.5m
1135	0.235	0.506	0.271	-0.271	20.9	<-- Station No. 4 ~ 1.5m
1140	0.235	0.488	0.253	-0.253	20.9	<-- Station No. 4 ~ 1.5m
1145	0.235	0.543	0.308	-0.308	20.8	<-- Station No. 4 ~ 1.5m
1150	0.235	0.529	0.294	-0.294	20.9	<-- Station No. 4 ~ 1.5m
1155	0.235	0.497	0.262	-0.262	21	<-- Station No. 4 ~ 1.5m
1160	0.235	0.522	0.287	-0.287	20.9	<-- Station No. 4 ~ 1.5m
1165	0.235	0.509	0.274	-0.274	20.9	<-- Station No. 4 ~ 1.5m
1170	0.235	0.499	0.265	-0.265	21	<-- Station No. 4 ~ 1.5m
1175	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 4 ~ 1.5m
1180	0.235	0.513	0.278	-0.278	21	<-- Station No. 4 ~ 1.5m
1185	0.235	0.481	0.246	-0.246	21.1	<-- Station No. 4 ~ 1.5m
1190	0.235	0.506	0.271	-0.271	21	<-- Station No. 4 ~ 1.5m
1195	0.235	0.504	0.269	-0.269	21.1	<-- Station No. 4 ~ 1.5m
1200	0.235	0.570	0.335	-0.335	21.2	<-- Station No. 4 ~ 1.5m
1205	0.235	0.502	0.267	-0.267	21.1	<-- Station No. 4 ~ 1.5m
1210	0.235	0.479	0.244	-0.244	21.1	<-- Station No. 4 ~ 1.5m
1215	0.235	0.570	0.335	-0.335	21.3	<-- Station No. 4 ~ 1.5m
1220	0.235	0.490	0.255	-0.255	21.2	<-- Station No. 4 ~ 1.5m
1225	0.235	0.529	0.294	-0.294	21.2	<-- Station No. 4 ~ 1.5m
1230	0.235	0.502	0.267	-0.267	21.3	<-- Station No. 4 ~ 1.5m
1235	0.235	0.465	0.230	-0.230	21.3	<-- Station No. 4 ~ 1.5m
1240	0.235	0.556	0.322	-0.322	21.4	<-- Station No. 4 ~ 1.5m
1245	0.235	0.456	0.221	-0.221	21.5	<-- Station No. 4 ~ 1.5m
1250	0.235	0.454	0.219	-0.219	21.6	<-- Station No. 4 ~ 1.5m
1255	0.235	0.449	0.214	-0.214	21.6	<-- Station No. 4 ~ 1.5m
1260	0.235	0.504	0.269	-0.269	21.7	<-- Station No. 4 ~ 1.5m
1265	0.235	0.463	0.228	-0.228	21.7	<-- Station No. 4 ~ 1.5m
1270	0.235	0.449	0.214	-0.214	21.8	<-- Station No. 4 ~ 1.5m
1275	0.235	0.502	0.267	-0.267	21.9	<-- Station No. 4 ~ 1.5m
1280	0.235	0.477	0.242	-0.242	22	<-- Station No. 4 ~ 1.5m
1285	0.235	0.456	0.221	-0.221	22	<-- Station No. 4 ~ 1.5m
1290	0.235	0.433	0.198	-0.198	22.1	<-- Station No. 4 ~ 1.5m
1295	0.235	0.426	0.192	-0.192	22.2	<-- Station No. 4 ~ 1.5m
1300	0.235	0.477	0.242	-0.242	22.3	<-- Station No. 4 ~ 1.5m
1305	0.235	0.417	0.182	-0.182	22.4	<-- Station No. 4 ~ 1.5m
1310	0.235	0.413	0.178	-0.178	22.6	<-- Station No. 4 ~ 1.5m
1315	0.235	0.445	0.210	-0.210	22.7	<-- Station No. 4 ~ 1.5m
1320	0.235	0.463	0.228	-0.228	22.7	<-- Station No. 4 ~ 1.5m
1325	0.235	0.442	0.208	-0.208	22.9	<-- Station No. 4 ~ 1.5m
1330	0.235	0.431	0.196	-0.196	23	<-- Station No. 4 ~ 1.5m
1335	0.235	0.381	0.146	-0.146	23	<-- Station No. 4 ~ 1.5m
1340	0.235	0.392	0.157	-0.157	23.1	<-- Station No. 4 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1345	0.235	0.356	0.121	-0.121	23.3	<-- Station No. 4 ~ 1.5m
1350	0.235	0.404	0.169	-0.169	23.3	<-- Station No. 4 ~ 1.5m
1355	0.235	0.383	0.148	-0.148	23.4	<-- Station No. 4 ~ 1.5m
1360	0.235	0.404	0.169	-0.169	23.3	<-- Station No. 4 ~ 1.5m
1365	0.235	0.356	0.121	-0.121	23.2	<-- Station No. 4 ~ 1.5m
1370	0.235	0.358	0.123	-0.123	23.4	<-- Station No. 4 ~ 1.5m
1375	0.235	0.324	0.089	-0.089	23.7	<-- Station No. 4 ~ 1.5m
1380	0.235	0.324	0.089	-0.089	24	<-- Station No. 4 ~ 1.5m
1385	0.235	0.356	0.121	-0.121	24.3	<-- Station No. 4 ~ 1.5m
1390	0.235	0.276	0.041	-0.041	24.6	<-- Station No. 4 ~ 1.5m
1395	0.235	0.285	0.050	-0.050	24.7	<-- Station No. 4 ~ 1.5m
1400	0.235	0.260	0.025	-0.025	24.5	<-- Station No. 4 ~ 1.5m
1405	0.235	0.294	0.059	-0.059	24.3	<-- Station No. 4 ~ 1.5m
1410	0.235	0.278	0.043	-0.043	24.3	<-- Station No. 4 ~ 1.5m
1415	0.235	0.276	0.041	-0.041	24.3	<-- Station No. 4 ~ 1.5m
1420	0.235	0.276	0.041	-0.041	24.4	<-- Station No. 4 ~ 1.5m
1425	0.235	0.290	0.055	-0.055	24.1	<-- Station No. 4 ~ 1.5m
1430	0.235	0.283	0.048	-0.048	24	<-- Station No. 4 ~ 1.5m
1435	0.235	0.287	0.052	-0.052	23.9	<-- Station No. 4 ~ 1.5m
1440	0.235	0.326	0.091	-0.091	23.8	<-- Station No. 4 ~ 1.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
0	0.588	0.554	0.034	0.034	20.6	<-- Station No. 1 ~ 2.5m
5	0.588	0.643	0.055	-0.055	20.5	<-- Station No. 1 ~ 2.5m
10	0.588	0.561	0.027	0.027	20.5	<-- Station No. 1 ~ 2.5m
15	0.588	0.559	0.030	0.030	20.6	<-- Station No. 1 ~ 2.5m
20	0.588	0.550	0.039	0.039	20.7	<-- Station No. 1 ~ 2.5m
25	0.588	0.556	0.032	0.032	20.7	<-- Station No. 1 ~ 2.5m
30	0.588	0.577	0.011	0.011	20.4	<-- Station No. 1 ~ 2.5m
35	0.588	0.552	0.036	0.036	20.6	<-- Station No. 1 ~ 2.5m
40	0.588	0.554	0.034	0.034	20.7	<-- Station No. 1 ~ 2.5m
45	0.588	0.556	0.032	0.032	20.8	<-- Station No. 1 ~ 2.5m
50	0.588	0.613	0.025	-0.025	20.8	<-- Station No. 1 ~ 2.5m
55	0.588	0.575	0.014	0.014	20.9	<-- Station No. 1 ~ 2.5m
60	0.588	0.545	0.043	0.043	20.9	<-- Station No. 1 ~ 2.5m
65	0.588	0.536	0.052	0.052	20.9	<-- Station No. 1 ~ 2.5m
70	0.588	0.643	0.055	-0.055	21	<-- Station No. 1 ~ 2.5m
75	0.588	0.572	0.016	0.016	20.9	<-- Station No. 1 ~ 2.5m
80	0.588	0.609	0.021	-0.021	20.9	<-- Station No. 1 ~ 2.5m
85	0.588	0.545	0.043	0.043	20.9	<-- Station No. 1 ~ 2.5m
90	0.588	0.563	0.025	0.025	20.9	<-- Station No. 1 ~ 2.5m
95	0.588	0.559	0.030	0.030	20.9	<-- Station No. 1 ~ 2.5m
100	0.588	0.520	0.068	0.068	20.9	<-- Station No. 1 ~ 2.5m
105	0.588	0.520	0.068	0.068	20.9	<-- Station No. 1 ~ 2.5m
110	0.588	0.554	0.034	0.034	20.9	<-- Station No. 1 ~ 2.5m
115	0.588	0.563	0.025	0.025	20.9	<-- Station No. 1 ~ 2.5m
120	0.588	0.634	0.046	-0.046	21	<-- Station No. 1 ~ 2.5m
125	0.588	0.586	0.002	0.002	21	<-- Station No. 1 ~ 2.5m
130	0.588	0.529	0.059	0.059	21.1	<-- Station No. 1 ~ 2.5m
135	0.588	0.511	0.078	0.078	21.1	<-- Station No. 1 ~ 2.5m
140	0.588	0.515	0.073	0.073	21.3	<-- Station No. 1 ~ 2.5m
145	0.588	0.575	0.014	0.014	21.2	<-- Station No. 1 ~ 2.5m
150	0.588	0.538	0.050	0.050	21.3	<-- Station No. 1 ~ 2.5m
155	0.588	0.566	0.023	0.023	21.3	<-- Station No. 1 ~ 2.5m
160	0.588	0.566	0.023	0.023	21.3	<-- Station No. 1 ~ 2.5m
165	0.588	0.497	0.091	0.091	21.3	<-- Station No. 1 ~ 2.5m
170	0.588	0.502	0.087	0.087	21.5	<-- Station No. 1 ~ 2.5m
175	0.588	0.540	0.048	0.048	21.5	<-- Station No. 1 ~ 2.5m
180	0.588	0.588	0.000	0.000	21.5	<-- Station No. 1 ~ 2.5m
185	0.588	0.506	0.082	0.082	21.5	<-- Station No. 1 ~ 2.5m
190	0.588	0.575	0.014	0.014	21.6	<-- Station No. 1 ~ 2.5m
195	0.588	0.515	0.073	0.073	21.7	<-- Station No. 1 ~ 2.5m
200	0.588	0.525	0.064	0.064	21.7	<-- Station No. 1 ~ 2.5m
205	0.588	0.488	0.100	0.100	21.8	<-- Station No. 1 ~ 2.5m
210	0.588	0.495	0.094	0.094	22	<-- Station No. 1 ~ 2.5m
215	0.588	0.538	0.050	0.050	22	<-- Station No. 1 ~ 2.5m
220	0.588	0.458	0.130	0.130	22.1	<-- Station No. 1 ~ 2.5m
225	0.588	0.547	0.041	0.041	22.2	<-- Station No. 1 ~ 2.5m
230	0.588	0.515	0.073	0.073	22.2	<-- Station No. 1 ~ 2.5m
235	0.588	0.518	0.071	0.071	22.4	<-- Station No. 1 ~ 2.5m
240	0.588	0.440	0.148	0.148	22.5	<-- Station No. 1 ~ 2.5m
245	0.588	0.442	0.146	0.146	22.6	<-- Station No. 1 ~ 2.5m
250	0.588	0.509	0.080	0.080	22.4	<-- Station No. 1 ~ 2.5m
255	0.588	0.506	0.082	0.082	22.2	<-- Station No. 1 ~ 2.5m
260	0.588	0.547	0.041	0.041	22.4	<-- Station No. 1 ~ 2.5m
265	0.588	0.497	0.091	0.091	22.1	<-- Station No. 1 ~ 2.5m
270	0.588	0.463	0.125	0.125	22	<-- Station No. 1 ~ 2.5m
275	0.588	0.499	0.089	0.089	22	<-- Station No. 1 ~ 2.5m
280	0.588	0.465	0.123	0.123	21.9	<-- Station No. 1 ~ 2.5m
285	0.588	0.433	0.155	0.155	22.2	<-- Station No. 1 ~ 2.5m
290	0.588	0.527	0.062	0.062	22.1	<-- Station No. 1 ~ 2.5m
295	0.588	0.452	0.137	0.137	22.4	<-- Station No. 1 ~ 2.5m
300	0.588	0.431	0.157	0.157	23	<-- Station No. 1 ~ 2.5m
305	0.588	0.454	0.135	0.135	22.9	<-- Station No. 1 ~ 2.5m
310	0.588	0.481	0.107	0.107	23	<-- Station No. 1 ~ 2.5m
315	0.588	0.488	0.100	0.100	22.8	<-- Station No. 1 ~ 2.5m
320	0.588	0.399	0.189	0.189	22.8	<-- Station No. 1 ~ 2.5m
325	0.588	0.449	0.139	0.139	23	<-- Station No. 1 ~ 2.5m
330	0.588	0.404	0.185	0.185	23.2	<-- Station No. 1 ~ 2.5m
335	0.588	0.381	0.208	0.208	23.2	<-- Station No. 1 ~ 2.5m
340	0.588	0.452	0.137	0.137	23.1	<-- Station No. 1 ~ 2.5m
345	0.588	0.395	0.194	0.194	23	<-- Station No. 1 ~ 2.5m
350	0.588	0.468	0.121	0.121	22.9	<-- Station No. 1 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
355	0.588	0.493	0.096	0.096	22.7	<-- Station No. 1 ~ 2.5m
360	0.588	0.408	0.180	0.180	22.6	<-- Station No. 1 ~ 2.5m
365	0.588	0.410	0.178	0.178	22.6	<-- Station No. 1 ~ 2.5m
370	0.588	0.442	0.146	0.146	22.4	<-- Station No. 1 ~ 2.5m
375	0.588	0.431	0.157	0.157	22.5	<-- Station No. 1 ~ 2.5m
380	0.588	0.408	0.180	0.180	22.5	<-- Station No. 1 ~ 2.5m
385	0.588	0.436	0.153	0.153	22.6	<-- Station No. 1 ~ 2.5m
390	0.588	0.442	0.146	0.146	22.6	<-- Station No. 1 ~ 2.5m
395	0.588	0.449	0.139	0.139	22.5	<-- Station No. 1 ~ 2.5m
400	0.588	0.506	0.082	0.082	22.7	<-- Station No. 1 ~ 2.5m
405	0.588	0.420	0.169	0.169	22.4	<-- Station No. 1 ~ 2.5m
410	0.588	0.468	0.121	0.121	22.4	<-- Station No. 1 ~ 2.5m
415	0.588	0.420	0.169	0.169	22.5	<-- Station No. 1 ~ 2.5m
420	0.588	0.408	0.180	0.180	22.4	<-- Station No. 1 ~ 2.5m
425	0.588	0.490	0.098	0.098	22.3	<-- Station No. 1 ~ 2.5m
430	0.588	0.458	0.130	0.130	22.3	<-- Station No. 1 ~ 2.5m
435	0.588	0.497	0.091	0.091	22.2	<-- Station No. 1 ~ 2.5m
440	0.588	0.452	0.137	0.137	22.4	<-- Station No. 1 ~ 2.5m
445	0.588	0.458	0.130	0.130	22.2	<-- Station No. 1 ~ 2.5m
450	0.588	0.447	0.141	0.141	22.1	<-- Station No. 1 ~ 2.5m
455	0.588	0.472	0.116	0.116	22.1	<-- Station No. 1 ~ 2.5m
460	0.588	0.426	0.162	0.162	22.1	<-- Station No. 1 ~ 2.5m
465	0.588	0.447	0.141	0.141	22.2	<-- Station No. 1 ~ 2.5m
470	0.588	0.474	0.114	0.114	22.1	<-- Station No. 1 ~ 2.5m
475	0.588	0.527	0.062	0.062	22	<-- Station No. 1 ~ 2.5m
480	0.588	0.438	0.151	0.151	22	<-- Station No. 1 ~ 2.5m
485	0.588	0.440	0.148	0.148	21.9	<-- Station No. 1 ~ 2.5m
490	0.588	0.520	0.068	0.068	21.8	<-- Station No. 1 ~ 2.5m
495	0.588	0.458	0.130	0.130	21.8	<-- Station No. 1 ~ 2.5m
500	0.588	0.502	0.087	0.087	21.9	<-- Station No. 1 ~ 2.5m
505	0.588	0.481	0.107	0.107	21.8	<-- Station No. 1 ~ 2.5m
510	0.588	0.479	0.109	0.109	21.8	<-- Station No. 1 ~ 2.5m
515	0.588	0.477	0.112	0.112	21.8	<-- Station No. 1 ~ 2.5m
520	0.588	0.458	0.130	0.130	21.9	<-- Station No. 1 ~ 2.5m
525	0.588	0.518	0.071	0.071	21.6	<-- Station No. 1 ~ 2.5m
530	0.588	0.456	0.132	0.132	21.6	<-- Station No. 1 ~ 2.5m
535	0.588	0.449	0.139	0.139	21.6	<-- Station No. 1 ~ 2.5m
540	0.588	0.481	0.107	0.107	21.7	<-- Station No. 1 ~ 2.5m
545	0.588	0.463	0.125	0.125	21.7	<-- Station No. 1 ~ 2.5m
550	0.588	0.495	0.094	0.094	21.6	<-- Station No. 1 ~ 2.5m
555	0.588	0.458	0.130	0.130	21.6	<-- Station No. 1 ~ 2.5m
560	0.588	0.566	0.023	0.023	21.5	<-- Station No. 1 ~ 2.5m
565	0.588	0.534	0.055	0.055	21.5	<-- Station No. 1 ~ 2.5m
570	0.588	0.502	0.087	0.087	21.4	<-- Station No. 1 ~ 2.5m
575	0.588	0.468	0.121	0.121	21.4	<-- Station No. 1 ~ 2.5m
580	0.588	0.468	0.121	0.121	21.5	<-- Station No. 1 ~ 2.5m
585	0.588	0.525	0.064	0.064	21.4	<-- Station No. 1 ~ 2.5m
590	0.588	0.474	0.114	0.114	21.3	<-- Station No. 1 ~ 2.5m
595	0.588	0.493	0.096	0.096	21.4	<-- Station No. 1 ~ 2.5m
600	0.588	0.479	0.109	0.109	21.3	<-- Station No. 1 ~ 2.5m
605	0.588	0.470	0.119	0.119	21.4	<-- Station No. 1 ~ 2.5m
610	0.588	0.499	0.089	0.089	21.3	<-- Station No. 1 ~ 2.5m
615	0.588	0.481	0.107	0.107	21.3	<-- Station No. 1 ~ 2.5m
620	0.588	0.474	0.114	0.114	21.3	<-- Station No. 1 ~ 2.5m
625	0.588	0.520	0.068	0.068	21.3	<-- Station No. 1 ~ 2.5m
630	0.588	0.495	0.094	0.094	21.3	<-- Station No. 1 ~ 2.5m
635	0.588	0.504	0.084	0.084	21.3	<-- Station No. 1 ~ 2.5m
640	0.588	0.504	0.084	0.084	21.3	<-- Station No. 1 ~ 2.5m
645	0.588	0.483	0.105	0.105	21.3	<-- Station No. 1 ~ 2.5m
650	0.588	0.520	0.068	0.068	21.2	<-- Station No. 1 ~ 2.5m
655	0.588	0.547	0.041	0.041	21.2	<-- Station No. 1 ~ 2.5m
660	0.588	0.483	0.105	0.105	21.1	<-- Station No. 1 ~ 2.5m
665	0.588	0.502	0.087	0.087	21.2	<-- Station No. 1 ~ 2.5m
670	0.588	0.502	0.087	0.087	21.2	<-- Station No. 1 ~ 2.5m
675	0.588	0.504	0.084	0.084	21.1	<-- Station No. 1 ~ 2.5m
680	0.588	0.502	0.087	0.087	21.1	<-- Station No. 1 ~ 2.5m
685	0.588	0.497	0.091	0.091	21.1	<-- Station No. 1 ~ 2.5m
690	0.588	0.563	0.025	0.025	21.1	<-- Station No. 1 ~ 2.5m
695	0.588	0.513	0.075	0.075	21.1	<-- Station No. 1 ~ 2.5m
700	0.588	0.529	0.059	0.059	21.1	<-- Station No. 1 ~ 2.5m
705	0.588	0.504	0.084	0.084	21.1	<-- Station No. 1 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
710	0.588	0.522	0.066	0.066	21	<-- Station No. 1 ~ 2.5m
715	0.588	0.586	0.002	0.002	21.1	<-- Station No. 1 ~ 2.5m
720	0.588	0.499	0.089	0.089	21.1	<-- Station No. 1 ~ 2.5m
725	0.588	0.527	0.062	0.062	21.1	<-- Station No. 1 ~ 2.5m
730	0.588	0.584	0.005	0.005	21.1	<-- Station No. 1 ~ 2.5m
735	0.588	0.495	0.094	0.094	21	<-- Station No. 1 ~ 2.5m
740	0.588	0.499	0.089	0.089	21	<-- Station No. 1 ~ 2.5m
745	0.588	0.563	0.025	0.025	21	<-- Station No. 1 ~ 2.5m
750	0.588	0.486	0.103	0.103	21	<-- Station No. 1 ~ 2.5m
755	0.588	0.488	0.100	0.100	20.9	<-- Station No. 1 ~ 2.5m
760	0.588	0.545	0.043	0.043	21	<-- Station No. 1 ~ 2.5m
765	0.588	0.499	0.089	0.089	21	<-- Station No. 1 ~ 2.5m
770	0.588	0.520	0.068	0.068	20.9	<-- Station No. 1 ~ 2.5m
775	0.588	0.538	0.050	0.050	21	<-- Station No. 1 ~ 2.5m
780	0.588	0.493	0.096	0.096	21	<-- Station No. 1 ~ 2.5m
785	0.588	0.559	0.030	0.030	21	<-- Station No. 1 ~ 2.5m
790	0.588	0.527	0.062	0.062	21.1	<-- Station No. 1 ~ 2.5m
795	0.588	0.506	0.082	0.082	20.9	<-- Station No. 1 ~ 2.5m
800	0.588	0.543	0.046	0.046	20.9	<-- Station No. 1 ~ 2.5m
805	0.588	0.525	0.064	0.064	20.9	<-- Station No. 1 ~ 2.5m
810	0.588	0.497	0.091	0.091	20.9	<-- Station No. 1 ~ 2.5m
815	0.588	0.490	0.098	0.098	20.9	<-- Station No. 1 ~ 2.5m
820	0.588	0.563	0.025	0.025	20.9	<-- Station No. 1 ~ 2.5m
825	0.588	0.490	0.098	0.098	20.9	<-- Station No. 1 ~ 2.5m
830	0.588	0.522	0.066	0.066	21.1	<-- Station No. 1 ~ 2.5m
835	0.588	0.536	0.052	0.052	20.9	<-- Station No. 1 ~ 2.5m
840	0.588	0.611	0.023	-0.023	20.9	<-- Station No. 1 ~ 2.5m
845	0.588	0.502	0.087	0.087	20.9	<-- Station No. 1 ~ 2.5m
850	0.588	0.527	0.062	0.062	20.8	<-- Station No. 1 ~ 2.5m
855	0.588	0.527	0.062	0.062	20.8	<-- Station No. 1 ~ 2.5m
860	0.588	0.552	0.036	0.036	20.8	<-- Station No. 1 ~ 2.5m
865	0.588	0.506	0.082	0.082	20.8	<-- Station No. 1 ~ 2.5m
870	0.588	0.520	0.068	0.068	20.8	<-- Station No. 1 ~ 2.5m
875	0.588	0.527	0.062	0.062	20.8	<-- Station No. 1 ~ 2.5m
880	0.588	0.680	0.091	-0.091	20.9	<-- Station No. 1 ~ 2.5m
885	0.588	0.540	0.048	0.048	20.7	<-- Station No. 1 ~ 2.5m
890	0.588	0.502	0.087	0.087	21	<-- Station No. 1 ~ 2.5m
895	0.588	0.566	0.023	0.023	20.8	<-- Station No. 1 ~ 2.5m
900	0.588	0.579	0.009	0.009	20.8	<-- Station No. 1 ~ 2.5m
905	0.588	0.625	0.036	-0.036	20.8	<-- Station No. 1 ~ 2.5m
910	0.588	0.511	0.078	0.078	20.8	<-- Station No. 1 ~ 2.5m
915	0.588	0.518	0.071	0.071	20.8	<-- Station No. 1 ~ 2.5m
920	0.588	0.513	0.075	0.075	20.8	<-- Station No. 1 ~ 2.5m
925	0.588	0.561	0.027	0.027	20.8	<-- Station No. 1 ~ 2.5m
930	0.588	0.527	0.062	0.062	20.6	<-- Station No. 1 ~ 2.5m
935	0.588	0.529	0.059	0.059	20.8	<-- Station No. 1 ~ 2.5m
940	0.588	0.584	0.005	0.005	20.8	<-- Station No. 1 ~ 2.5m
945	0.588	0.595	0.007	-0.007	20.8	<-- Station No. 1 ~ 2.5m
950	0.588	0.518	0.071	0.071	20.8	<-- Station No. 1 ~ 2.5m
955	0.588	0.527	0.062	0.062	20.8	<-- Station No. 1 ~ 2.5m
960	0.588	0.593	0.005	-0.005	20.8	<-- Station No. 1 ~ 2.5m
965	0.588	0.515	0.073	0.073	20.9	<-- Station No. 1 ~ 2.5m
970	0.588	0.511	0.078	0.078	20.8	<-- Station No. 1 ~ 2.5m
975	0.588	0.577	0.011	0.011	20.8	<-- Station No. 1 ~ 2.5m
980	0.588	0.588	0.000	0.000	20.8	<-- Station No. 1 ~ 2.5m
985	0.588	0.579	0.009	0.009	20.8	<-- Station No. 1 ~ 2.5m
990	0.588	0.522	0.066	0.066	20.8	<-- Station No. 1 ~ 2.5m
995	0.588	0.550	0.039	0.039	20.7	<-- Station No. 1 ~ 2.5m
1000	0.588	0.540	0.048	0.048	20.8	<-- Station No. 1 ~ 2.5m
1005	0.588	0.540	0.048	0.048	20.7	<-- Station No. 1 ~ 2.5m
1010	0.588	0.554	0.034	0.034	20.7	<-- Station No. 1 ~ 2.5m
1015	0.588	0.529	0.059	0.059	20.7	<-- Station No. 1 ~ 2.5m
1020	0.588	0.609	0.021	-0.021	20.6	<-- Station No. 1 ~ 2.5m
1025	0.588	0.572	0.016	0.016	20.6	<-- Station No. 1 ~ 2.5m
1030	0.588	0.513	0.075	0.075	20.8	<-- Station No. 1 ~ 2.5m
1035	0.588	0.545	0.043	0.043	20.7	<-- Station No. 1 ~ 2.5m
1040	0.588	0.529	0.059	0.059	20.7	<-- Station No. 1 ~ 2.5m
1045	0.588	0.536	0.052	0.052	20.6	<-- Station No. 1 ~ 2.5m
1050	0.588	0.515	0.073	0.073	20.7	<-- Station No. 1 ~ 2.5m
1055	0.588	0.531	0.057	0.057	20.6	<-- Station No. 1 ~ 2.5m
1060	0.588	0.584	0.005	0.005	20.6	<-- Station No. 1 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1065	0.588	0.597	0.009	-0.009	20.6	<-- Station No. 1 ~ 2.5m
1070	0.588	0.579	0.009	0.009	20.6	<-- Station No. 1 ~ 2.5m
1075	0.588	0.597	0.009	-0.009	20.6	<-- Station No. 1 ~ 2.5m
1080	0.588	0.525	0.064	0.064	20.7	<-- Station No. 1 ~ 2.5m
1085	0.588	0.570	0.018	0.018	20.7	<-- Station No. 1 ~ 2.5m
1090	0.588	0.595	0.007	-0.007	20.6	<-- Station No. 1 ~ 2.5m
1095	0.588	0.586	0.002	0.002	20.6	<-- Station No. 1 ~ 2.5m
1100	0.588	0.515	0.073	0.073	20.6	<-- Station No. 1 ~ 2.5m
1105	0.588	0.641	0.052	-0.052	20.7	<-- Station No. 1 ~ 2.5m
1110	0.588	0.579	0.009	0.009	20.6	<-- Station No. 1 ~ 2.5m
1115	0.588	0.518	0.071	0.071	20.5	<-- Station No. 1 ~ 2.5m
1120	0.588	0.518	0.071	0.071	20.6	<-- Station No. 1 ~ 2.5m
1125	0.588	0.655	0.066	-0.066	20.6	<-- Station No. 1 ~ 2.5m
1130	0.588	0.525	0.064	0.064	20.6	<-- Station No. 1 ~ 2.5m
1135	0.588	0.511	0.078	0.078	20.6	<-- Station No. 1 ~ 2.5m
1140	0.588	0.593	0.005	-0.005	20.6	<-- Station No. 1 ~ 2.5m
1145	0.588	0.547	0.041	0.041	20.7	<-- Station No. 1 ~ 2.5m
1150	0.588	0.609	0.021	-0.021	20.6	<-- Station No. 1 ~ 2.5m
1155	0.588	0.563	0.025	0.025	20.6	<-- Station No. 1 ~ 2.5m
1160	0.588	0.556	0.032	0.032	20.6	<-- Station No. 1 ~ 2.5m
1165	0.588	0.650	0.062	-0.062	20.5	<-- Station No. 1 ~ 2.5m
1170	0.588	0.618	0.030	-0.030	20.5	<-- Station No. 1 ~ 2.5m
1175	0.588	0.552	0.036	0.036	20.6	<-- Station No. 1 ~ 2.5m
1180	0.588	0.527	0.062	0.062	20.5	<-- Station No. 1 ~ 2.5m
1185	0.588	0.680	0.091	-0.091	20.5	<-- Station No. 1 ~ 2.5m
1190	0.588	0.566	0.023	0.023	20.6	<-- Station No. 1 ~ 2.5m
1195	0.588	0.600	0.011	-0.011	20.5	<-- Station No. 1 ~ 2.5m
1200	0.588	0.620	0.032	-0.032	20.5	<-- Station No. 1 ~ 2.5m
1205	0.588	0.527	0.062	0.062	20.5	<-- Station No. 1 ~ 2.5m
1210	0.588	0.529	0.059	0.059	20.3	<-- Station No. 1 ~ 2.5m
1215	0.588	0.525	0.064	0.064	20.5	<-- Station No. 1 ~ 2.5m
1220	0.588	0.586	0.002	0.002	20.5	<-- Station No. 1 ~ 2.5m
1225	0.588	0.559	0.030	0.030	20.5	<-- Station No. 1 ~ 2.5m
1230	0.588	0.534	0.055	0.055	20.6	<-- Station No. 1 ~ 2.5m
1235	0.588	0.595	0.007	-0.007	20.5	<-- Station No. 1 ~ 2.5m
1240	0.588	0.527	0.062	0.062	20.5	<-- Station No. 1 ~ 2.5m
1245	0.588	0.575	0.014	0.014	20.5	<-- Station No. 1 ~ 2.5m
1250	0.588	0.566	0.023	0.023	20.5	<-- Station No. 1 ~ 2.5m
1255	0.588	0.534	0.055	0.055	20.4	<-- Station No. 1 ~ 2.5m
1260	0.588	0.527	0.062	0.062	20.5	<-- Station No. 1 ~ 2.5m
1265	0.588	0.552	0.036	0.036	20.5	<-- Station No. 1 ~ 2.5m
1270	0.588	0.543	0.046	0.046	20.4	<-- Station No. 1 ~ 2.5m
1275	0.588	0.593	0.005	-0.005	20.5	<-- Station No. 1 ~ 2.5m
1280	0.588	0.545	0.043	0.043	20.5	<-- Station No. 1 ~ 2.5m
1285	0.588	0.543	0.046	0.046	20.4	<-- Station No. 1 ~ 2.5m
1290	0.588	0.625	0.036	-0.036	20.5	<-- Station No. 1 ~ 2.5m
1295	0.588	0.572	0.016	0.016	20.5	<-- Station No. 1 ~ 2.5m
1300	0.588	0.552	0.036	0.036	20.4	<-- Station No. 1 ~ 2.5m
1305	0.588	0.657	0.068	-0.068	20.5	<-- Station No. 1 ~ 2.5m
1310	0.588	0.538	0.050	0.050	20.5	<-- Station No. 1 ~ 2.5m
1315	0.588	0.572	0.016	0.016	20.5	<-- Station No. 1 ~ 2.5m
1320	0.588	0.550	0.039	0.039	20.5	<-- Station No. 1 ~ 2.5m
1325	0.588	0.559	0.030	0.030	20.6	<-- Station No. 1 ~ 2.5m
1330	0.588	0.550	0.039	0.039	20.7	<-- Station No. 1 ~ 2.5m
1335	0.588	0.556	0.032	0.032	20.6	<-- Station No. 1 ~ 2.5m
1340	0.588	0.525	0.064	0.064	20.8	<-- Station No. 1 ~ 2.5m
1345	0.588	0.561	0.027	0.027	20.7	<-- Station No. 1 ~ 2.5m
1350	0.588	0.600	0.011	-0.011	20.8	<-- Station No. 1 ~ 2.5m
1355	0.588	0.588	0.000	0.000	20.8	<-- Station No. 1 ~ 2.5m
1360	0.588	0.600	0.011	-0.011	21	<-- Station No. 1 ~ 2.5m
1365	0.588	0.566	0.023	0.023	20.8	<-- Station No. 1 ~ 2.5m
1370	0.588	0.527	0.062	0.062	20.9	<-- Station No. 1 ~ 2.5m
1375	0.588	0.600	0.011	-0.011	20.9	<-- Station No. 1 ~ 2.5m
1380	0.588	0.577	0.011	0.011	20.9	<-- Station No. 1 ~ 2.5m
1385	0.588	0.506	0.082	0.082	20.9	<-- Station No. 1 ~ 2.5m
1390	0.588	0.536	0.052	0.052	21.1	<-- Station No. 1 ~ 2.5m
1395	0.588	0.504	0.084	0.084	21	<-- Station No. 1 ~ 2.5m
1400	0.588	0.513	0.075	0.075	21	<-- Station No. 1 ~ 2.5m
1405	0.588	0.527	0.062	0.062	21	<-- Station No. 1 ~ 2.5m
1410	0.588	0.572	0.016	0.016	21.1	<-- Station No. 1 ~ 2.5m
1415	0.588	0.525	0.064	0.064	21.4	<-- Station No. 1 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1420	0.588	0.509	0.080	0.080	21.2	<-- Station No. 1 ~ 2.5m
1425	0.588	0.504	0.084	0.084	21.2	<-- Station No. 1 ~ 2.5m
1430	0.588	0.497	0.091	0.091	21.2	<-- Station No. 1 ~ 2.5m
1435	0.588	0.504	0.084	0.084	21.2	<-- Station No. 1 ~ 2.5m
1440	0.588	0.497	0.091	0.091	21.3	<-- Station No. 1 ~ 2.5m
0	0.588	0.543	0.046	0.046	21.7	<-- Station No. 2 ~ 2.5m
5	0.588	0.527	0.062	0.062	21.7	<-- Station No. 2 ~ 2.5m
10	0.588	0.540	0.048	0.048	21.7	<-- Station No. 2 ~ 2.5m
15	0.588	0.504	0.084	0.084	21.6	<-- Station No. 2 ~ 2.5m
20	0.588	0.543	0.046	0.046	21.7	<-- Station No. 2 ~ 2.5m
25	0.588	0.463	0.125	0.125	21.9	<-- Station No. 2 ~ 2.5m
30	0.588	0.470	0.119	0.119	21.8	<-- Station No. 2 ~ 2.5m
35	0.588	0.483	0.105	0.105	21.8	<-- Station No. 2 ~ 2.5m
40	0.588	0.483	0.105	0.105	22	<-- Station No. 2 ~ 2.5m
45	0.588	0.513	0.075	0.075	21.9	<-- Station No. 2 ~ 2.5m
50	0.588	0.477	0.112	0.112	21.9	<-- Station No. 2 ~ 2.5m
55	0.588	0.479	0.109	0.109	22.1	<-- Station No. 2 ~ 2.5m
60	0.588	0.511	0.078	0.078	22.3	<-- Station No. 2 ~ 2.5m
65	0.588	0.513	0.075	0.075	22.1	<-- Station No. 2 ~ 2.5m
70	0.588	0.520	0.068	0.068	22.1	<-- Station No. 2 ~ 2.5m
75	0.588	0.504	0.084	0.084	22.1	<-- Station No. 2 ~ 2.5m
80	0.588	0.442	0.146	0.146	22.2	<-- Station No. 2 ~ 2.5m
85	0.588	0.433	0.155	0.155	22.2	<-- Station No. 2 ~ 2.5m
90	0.588	0.454	0.135	0.135	22.2	<-- Station No. 2 ~ 2.5m
95	0.588	0.452	0.137	0.137	22.2	<-- Station No. 2 ~ 2.5m
100	0.588	0.481	0.107	0.107	22.2	<-- Station No. 2 ~ 2.5m
105	0.588	0.429	0.160	0.160	22.3	<-- Station No. 2 ~ 2.5m
110	0.588	0.433	0.155	0.155	22.3	<-- Station No. 2 ~ 2.5m
115	0.588	0.502	0.087	0.087	22.4	<-- Station No. 2 ~ 2.5m
120	0.588	0.527	0.062	0.062	22.4	<-- Station No. 2 ~ 2.5m
125	0.588	0.417	0.171	0.171	22.5	<-- Station No. 2 ~ 2.5m
130	0.588	0.497	0.091	0.091	22.4	<-- Station No. 2 ~ 2.5m
135	0.588	0.431	0.157	0.157	22.4	<-- Station No. 2 ~ 2.5m
140	0.588	0.417	0.171	0.171	22.4	<-- Station No. 2 ~ 2.5m
145	0.588	0.431	0.157	0.157	22.4	<-- Station No. 2 ~ 2.5m
150	0.588	0.424	0.164	0.164	22.4	<-- Station No. 2 ~ 2.5m
155	0.588	0.474	0.114	0.114	22.4	<-- Station No. 2 ~ 2.5m
160	0.588	0.367	0.221	0.221	22.4	<-- Station No. 2 ~ 2.5m
165	0.588	0.424	0.164	0.164	22.4	<-- Station No. 2 ~ 2.5m
170	0.588	0.474	0.114	0.114	22.4	<-- Station No. 2 ~ 2.5m
175	0.588	0.413	0.176	0.176	22.5	<-- Station No. 2 ~ 2.5m
180	0.588	0.449	0.139	0.139	22.5	<-- Station No. 2 ~ 2.5m
185	0.588	0.452	0.137	0.137	22.6	<-- Station No. 2 ~ 2.5m
190	0.588	0.456	0.132	0.132	22.7	<-- Station No. 2 ~ 2.5m
195	0.588	0.422	0.166	0.166	22.8	<-- Station No. 2 ~ 2.5m
200	0.588	0.399	0.189	0.189	22.9	<-- Station No. 2 ~ 2.5m
205	0.588	0.385	0.203	0.203	23	<-- Station No. 2 ~ 2.5m
210	0.588	0.429	0.160	0.160	23	<-- Station No. 2 ~ 2.5m
215	0.588	0.388	0.201	0.201	22.9	<-- Station No. 2 ~ 2.5m
220	0.588	0.385	0.203	0.203	22.8	<-- Station No. 2 ~ 2.5m
225	0.588	0.454	0.135	0.135	22.9	<-- Station No. 2 ~ 2.5m
230	0.588	0.456	0.132	0.132	23	<-- Station No. 2 ~ 2.5m
235	0.588	0.392	0.196	0.196	23.1	<-- Station No. 2 ~ 2.5m
240	0.588	0.429	0.160	0.160	23	<-- Station No. 2 ~ 2.5m
245	0.588	0.390	0.198	0.198	22.9	<-- Station No. 2 ~ 2.5m
250	0.588	0.404	0.185	0.185	23	<-- Station No. 2 ~ 2.5m
255	0.588	0.424	0.164	0.164	23	<-- Station No. 2 ~ 2.5m
260	0.588	0.422	0.166	0.166	23	<-- Station No. 2 ~ 2.5m
265	0.588	0.367	0.221	0.221	23.1	<-- Station No. 2 ~ 2.5m
270	0.588	0.365	0.223	0.223	23.4	<-- Station No. 2 ~ 2.5m
275	0.588	0.365	0.223	0.223	24	<-- Station No. 2 ~ 2.5m
280	0.588	0.326	0.262	0.262	24	<-- Station No. 2 ~ 2.5m
285	0.588	0.326	0.262	0.262	23.9	<-- Station No. 2 ~ 2.5m
290	0.588	0.347	0.242	0.242	23.9	<-- Station No. 2 ~ 2.5m
295	0.588	0.353	0.235	0.235	24.3	<-- Station No. 2 ~ 2.5m
300	0.588	0.385	0.203	0.203	24.4	<-- Station No. 2 ~ 2.5m
305	0.588	0.338	0.251	0.251	24.5	<-- Station No. 2 ~ 2.5m
310	0.588	0.292	0.296	0.296	25.1	<-- Station No. 2 ~ 2.5m
315	0.588	0.239	0.349	0.349	25.1	<-- Station No. 2 ~ 2.5m
320	0.588	0.249	0.340	0.340	25.3	<-- Station No. 2 ~ 2.5m
325	0.588	0.258	0.331	0.331	24.7	<-- Station No. 2 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
330	0.588	0.319	0.269	0.269	24.6	<-- Station No. 2 ~ 2.5m
335	0.588	0.274	0.315	0.315	24.7	<-- Station No. 2 ~ 2.5m
340	0.588	0.340	0.249	0.249	24.5	<-- Station No. 2 ~ 2.5m
345	0.588	0.360	0.228	0.228	24.4	<-- Station No. 2 ~ 2.5m
350	0.588	0.301	0.287	0.287	24.3	<-- Station No. 2 ~ 2.5m
355	0.588	0.292	0.296	0.296	24.2	<-- Station No. 2 ~ 2.5m
360	0.588	0.303	0.285	0.285	24.1	<-- Station No. 2 ~ 2.5m
365	0.588	0.353	0.235	0.235	24.1	<-- Station No. 2 ~ 2.5m
370	0.588	0.303	0.285	0.285	24	<-- Station No. 2 ~ 2.5m
375	0.588	0.333	0.255	0.255	24	<-- Station No. 2 ~ 2.5m
380	0.588	0.333	0.255	0.255	23.9	<-- Station No. 2 ~ 2.5m
385	0.588	0.410	0.178	0.178	24	<-- Station No. 2 ~ 2.5m
390	0.588	0.392	0.196	0.196	24	<-- Station No. 2 ~ 2.5m
395	0.588	0.376	0.212	0.212	23.9	<-- Station No. 2 ~ 2.5m
400	0.588	0.360	0.228	0.228	24.2	<-- Station No. 2 ~ 2.5m
405	0.588	0.358	0.230	0.230	24.2	<-- Station No. 2 ~ 2.5m
410	0.588	0.301	0.287	0.287	24	<-- Station No. 2 ~ 2.5m
415	0.588	0.360	0.228	0.228	23.7	<-- Station No. 2 ~ 2.5m
420	0.588	0.324	0.265	0.265	23.6	<-- Station No. 2 ~ 2.5m
425	0.588	0.347	0.242	0.242	23.5	<-- Station No. 2 ~ 2.5m
430	0.588	0.417	0.171	0.171	23.5	<-- Station No. 2 ~ 2.5m
435	0.588	0.422	0.166	0.166	23.4	<-- Station No. 2 ~ 2.5m
440	0.588	0.353	0.235	0.235	23.3	<-- Station No. 2 ~ 2.5m
445	0.588	0.344	0.244	0.244	23.2	<-- Station No. 2 ~ 2.5m
450	0.588	0.415	0.173	0.173	23.2	<-- Station No. 2 ~ 2.5m
455	0.588	0.347	0.242	0.242	23.1	<-- Station No. 2 ~ 2.5m
460	0.588	0.369	0.219	0.219	23.2	<-- Station No. 2 ~ 2.5m
465	0.588	0.360	0.228	0.228	23	<-- Station No. 2 ~ 2.5m
470	0.588	0.388	0.201	0.201	22.9	<-- Station No. 2 ~ 2.5m
475	0.588	0.363	0.226	0.226	22.9	<-- Station No. 2 ~ 2.5m
480	0.588	0.369	0.219	0.219	22.8	<-- Station No. 2 ~ 2.5m
485	0.588	0.388	0.201	0.201	22.8	<-- Station No. 2 ~ 2.5m
490	0.588	0.383	0.205	0.205	22.7	<-- Station No. 2 ~ 2.5m
495	0.588	0.363	0.226	0.226	22.7	<-- Station No. 2 ~ 2.5m
500	0.588	0.383	0.205	0.205	22.7	<-- Station No. 2 ~ 2.5m
505	0.588	0.372	0.217	0.217	22.6	<-- Station No. 2 ~ 2.5m
510	0.588	0.477	0.112	0.112	22.6	<-- Station No. 2 ~ 2.5m
515	0.588	0.426	0.162	0.162	22.5	<-- Station No. 2 ~ 2.5m
520	0.588	0.381	0.208	0.208	22.5	<-- Station No. 2 ~ 2.5m
525	0.588	0.404	0.185	0.185	22.4	<-- Station No. 2 ~ 2.5m
530	0.588	0.410	0.178	0.178	22.4	<-- Station No. 2 ~ 2.5m
535	0.588	0.385	0.203	0.203	22.3	<-- Station No. 2 ~ 2.5m
540	0.588	0.410	0.178	0.178	22.3	<-- Station No. 2 ~ 2.5m
545	0.588	0.429	0.160	0.160	22.3	<-- Station No. 2 ~ 2.5m
550	0.588	0.426	0.162	0.162	22.2	<-- Station No. 2 ~ 2.5m
555	0.588	0.470	0.119	0.119	22.2	<-- Station No. 2 ~ 2.5m
560	0.588	0.447	0.141	0.141	22.2	<-- Station No. 2 ~ 2.5m
565	0.588	0.431	0.157	0.157	22.2	<-- Station No. 2 ~ 2.5m
570	0.588	0.431	0.157	0.157	22.1	<-- Station No. 2 ~ 2.5m
575	0.588	0.445	0.144	0.144	22	<-- Station No. 2 ~ 2.5m
580	0.588	0.468	0.121	0.121	21.9	<-- Station No. 2 ~ 2.5m
585	0.588	0.417	0.171	0.171	21.9	<-- Station No. 2 ~ 2.5m
590	0.588	0.426	0.162	0.162	22	<-- Station No. 2 ~ 2.5m
595	0.588	0.408	0.180	0.180	21.9	<-- Station No. 2 ~ 2.5m
600	0.588	0.456	0.132	0.132	21.8	<-- Station No. 2 ~ 2.5m
605	0.588	0.426	0.162	0.162	21.8	<-- Station No. 2 ~ 2.5m
610	0.588	0.468	0.121	0.121	21.8	<-- Station No. 2 ~ 2.5m
615	0.588	0.417	0.171	0.171	21.7	<-- Station No. 2 ~ 2.5m
620	0.588	0.506	0.082	0.082	21.8	<-- Station No. 2 ~ 2.5m
625	0.588	0.495	0.094	0.094	21.7	<-- Station No. 2 ~ 2.5m
630	0.588	0.513	0.075	0.075	21.8	<-- Station No. 2 ~ 2.5m
635	0.588	0.431	0.157	0.157	21.7	<-- Station No. 2 ~ 2.5m
640	0.588	0.431	0.157	0.157	20.2	<-- Station No. 2 ~ 2.5m
645	0.588	0.477	0.112	0.112	21.6	<-- Station No. 2 ~ 2.5m
650	0.588	0.481	0.107	0.107	21.6	<-- Station No. 2 ~ 2.5m
655	0.588	0.436	0.153	0.153	21.6	<-- Station No. 2 ~ 2.5m
660	0.588	0.513	0.075	0.075	21.5	<-- Station No. 2 ~ 2.5m
665	0.588	0.433	0.155	0.155	21.6	<-- Station No. 2 ~ 2.5m
670	0.588	0.438	0.151	0.151	21.5	<-- Station No. 2 ~ 2.5m
675	0.588	0.493	0.096	0.096	21.5	<-- Station No. 2 ~ 2.5m
680	0.588	0.486	0.103	0.103	21.5	<-- Station No. 2 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
685	0.588	0.502	0.087	0.087	21.5	<-- Station No. 2 ~ 2.5m
690	0.588	0.445	0.144	0.144	21.5	<-- Station No. 2 ~ 2.5m
695	0.588	0.518	0.071	0.071	21.4	<-- Station No. 2 ~ 2.5m
700	0.588	0.481	0.107	0.107	21.4	<-- Station No. 2 ~ 2.5m
705	0.588	0.468	0.121	0.121	21.4	<-- Station No. 2 ~ 2.5m
710	0.588	0.449	0.139	0.139	21.4	<-- Station No. 2 ~ 2.5m
715	0.588	0.449	0.139	0.139	21.4	<-- Station No. 2 ~ 2.5m
720	0.588	0.515	0.073	0.073	21.4	<-- Station No. 2 ~ 2.5m
725	0.588	0.474	0.114	0.114	21.4	<-- Station No. 2 ~ 2.5m
730	0.588	0.440	0.148	0.148	21.3	<-- Station No. 2 ~ 2.5m
735	0.588	0.474	0.114	0.114	21.3	<-- Station No. 2 ~ 2.5m
740	0.588	0.474	0.114	0.114	21.3	<-- Station No. 2 ~ 2.5m
745	0.588	0.454	0.135	0.135	21.4	<-- Station No. 2 ~ 2.5m
750	0.588	0.463	0.125	0.125	21.3	<-- Station No. 2 ~ 2.5m
755	0.588	0.479	0.109	0.109	21.2	<-- Station No. 2 ~ 2.5m
760	0.588	0.463	0.125	0.125	21.3	<-- Station No. 2 ~ 2.5m
765	0.588	0.461	0.128	0.128	21.2	<-- Station No. 2 ~ 2.5m
770	0.588	0.458	0.130	0.130	21.1	<-- Station No. 2 ~ 2.5m
775	0.588	0.502	0.087	0.087	21.2	<-- Station No. 2 ~ 2.5m
780	0.588	0.497	0.091	0.091	21.2	<-- Station No. 2 ~ 2.5m
785	0.588	0.493	0.096	0.096	21.2	<-- Station No. 2 ~ 2.5m
790	0.588	0.486	0.103	0.103	21.1	<-- Station No. 2 ~ 2.5m
795	0.588	0.509	0.080	0.080	21.2	<-- Station No. 2 ~ 2.5m
800	0.588	0.468	0.121	0.121	21.1	<-- Station No. 2 ~ 2.5m
805	0.588	0.547	0.041	0.041	21.1	<-- Station No. 2 ~ 2.5m
810	0.588	0.522	0.066	0.066	21.1	<-- Station No. 2 ~ 2.5m
815	0.588	0.506	0.082	0.082	21	<-- Station No. 2 ~ 2.5m
820	0.588	0.497	0.091	0.091	21	<-- Station No. 2 ~ 2.5m
825	0.588	0.486	0.103	0.103	21.1	<-- Station No. 2 ~ 2.5m
830	0.588	0.527	0.062	0.062	21	<-- Station No. 2 ~ 2.5m
835	0.588	0.509	0.080	0.080	21	<-- Station No. 2 ~ 2.5m
840	0.588	0.572	0.016	0.016	21	<-- Station No. 2 ~ 2.5m
845	0.588	0.481	0.107	0.107	21	<-- Station No. 2 ~ 2.5m
850	0.588	0.572	0.016	0.016	21	<-- Station No. 2 ~ 2.5m
855	0.588	0.495	0.094	0.094	21	<-- Station No. 2 ~ 2.5m
860	0.588	0.502	0.087	0.087	21	<-- Station No. 2 ~ 2.5m
865	0.588	0.525	0.064	0.064	20.9	<-- Station No. 2 ~ 2.5m
870	0.588	0.509	0.080	0.080	20.9	<-- Station No. 2 ~ 2.5m
875	0.588	0.513	0.075	0.075	21	<-- Station No. 2 ~ 2.5m
880	0.588	0.513	0.075	0.075	21	<-- Station No. 2 ~ 2.5m
885	0.588	0.490	0.098	0.098	20.8	<-- Station No. 2 ~ 2.5m
890	0.588	0.575	0.014	0.014	21.1	<-- Station No. 2 ~ 2.5m
895	0.588	0.497	0.091	0.091	20.9	<-- Station No. 2 ~ 2.5m
900	0.588	0.518	0.071	0.071	20.9	<-- Station No. 2 ~ 2.5m
905	0.588	0.527	0.062	0.062	21	<-- Station No. 2 ~ 2.5m
910	0.588	0.509	0.080	0.080	20.9	<-- Station No. 2 ~ 2.5m
915	0.588	0.520	0.068	0.068	20.9	<-- Station No. 2 ~ 2.5m
920	0.588	0.495	0.094	0.094	20.9	<-- Station No. 2 ~ 2.5m
925	0.588	0.499	0.089	0.089	20.9	<-- Station No. 2 ~ 2.5m
930	0.588	0.488	0.100	0.100	20.8	<-- Station No. 2 ~ 2.5m
935	0.588	0.509	0.080	0.080	20.9	<-- Station No. 2 ~ 2.5m
940	0.588	0.566	0.023	0.023	20.9	<-- Station No. 2 ~ 2.5m
945	0.588	0.488	0.100	0.100	20.8	<-- Station No. 2 ~ 2.5m
950	0.588	0.513	0.075	0.075	20.8	<-- Station No. 2 ~ 2.5m
955	0.588	0.522	0.066	0.066	20.9	<-- Station No. 2 ~ 2.5m
960	0.588	0.543	0.046	0.046	20.9	<-- Station No. 2 ~ 2.5m
965	0.588	0.531	0.057	0.057	20.8	<-- Station No. 2 ~ 2.5m
970	0.588	0.502	0.087	0.087	20.8	<-- Station No. 2 ~ 2.5m
975	0.588	0.577	0.011	0.011	20.9	<-- Station No. 2 ~ 2.5m
980	0.588	0.604	0.016	-0.016	20.7	<-- Station No. 2 ~ 2.5m
985	0.588	0.575	0.014	0.014	20.7	<-- Station No. 2 ~ 2.5m
990	0.588	0.543	0.046	0.046	20.8	<-- Station No. 2 ~ 2.5m
995	0.588	0.582	0.007	0.007	20.7	<-- Station No. 2 ~ 2.5m
1000	0.588	0.497	0.091	0.091	20.7	<-- Station No. 2 ~ 2.5m
1005	0.588	0.559	0.030	0.030	20.8	<-- Station No. 2 ~ 2.5m
1010	0.588	0.525	0.064	0.064	20.7	<-- Station No. 2 ~ 2.5m
1015	0.588	0.504	0.084	0.084	20.8	<-- Station No. 2 ~ 2.5m
1020	0.588	0.499	0.089	0.089	20.8	<-- Station No. 2 ~ 2.5m
1025	0.588	0.543	0.046	0.046	20.7	<-- Station No. 2 ~ 2.5m
1030	0.588	0.504	0.084	0.084	20.7	<-- Station No. 2 ~ 2.5m
1035	0.588	0.499	0.089	0.089	20.7	<-- Station No. 2 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1040	0.588	0.529	0.059	0.059	20.7	<-- Station No. 2 ~ 2.5m
1045	0.588	0.497	0.091	0.091	20.7	<-- Station No. 2 ~ 2.5m
1050	0.588	0.511	0.078	0.078	20.7	<-- Station No. 2 ~ 2.5m
1055	0.588	0.511	0.078	0.078	20.7	<-- Station No. 2 ~ 2.5m
1060	0.588	0.518	0.071	0.071	20.6	<-- Station No. 2 ~ 2.5m
1065	0.588	0.502	0.087	0.087	20.6	<-- Station No. 2 ~ 2.5m
1070	0.588	0.543	0.046	0.046	20.6	<-- Station No. 2 ~ 2.5m
1075	0.588	0.602	0.014	-0.014	20.7	<-- Station No. 2 ~ 2.5m
1080	0.588	0.566	0.023	0.023	20.7	<-- Station No. 2 ~ 2.5m
1085	0.588	0.527	0.062	0.062	20.7	<-- Station No. 2 ~ 2.5m
1090	0.588	0.584	0.005	0.005	20.7	<-- Station No. 2 ~ 2.5m
1095	0.588	0.543	0.046	0.046	20.6	<-- Station No. 2 ~ 2.5m
1100	0.588	0.586	0.002	0.002	20.6	<-- Station No. 2 ~ 2.5m
1105	0.588	0.529	0.059	0.059	20.6	<-- Station No. 2 ~ 2.5m
1110	0.588	0.511	0.078	0.078	20.6	<-- Station No. 2 ~ 2.5m
1115	0.588	0.531	0.057	0.057	20.6	<-- Station No. 2 ~ 2.5m
1120	0.588	0.531	0.057	0.057	20.6	<-- Station No. 2 ~ 2.5m
1125	0.588	0.597	0.009	-0.009	20.6	<-- Station No. 2 ~ 2.5m
1130	0.588	0.511	0.078	0.078	20.6	<-- Station No. 2 ~ 2.5m
1135	0.588	0.540	0.048	0.048	20.6	<-- Station No. 2 ~ 2.5m
1140	0.588	0.531	0.057	0.057	20.7	<-- Station No. 2 ~ 2.5m
1145	0.588	0.506	0.082	0.082	20.5	<-- Station No. 2 ~ 2.5m
1150	0.588	0.597	0.009	-0.009	20.6	<-- Station No. 2 ~ 2.5m
1155	0.588	0.525	0.064	0.064	20.6	<-- Station No. 2 ~ 2.5m
1160	0.588	0.509	0.080	0.080	20.5	<-- Station No. 2 ~ 2.5m
1165	0.588	0.588	0.000	0.000	20.6	<-- Station No. 2 ~ 2.5m
1170	0.588	0.534	0.055	0.055	20.6	<-- Station No. 2 ~ 2.5m
1175	0.588	0.552	0.036	0.036	20.7	<-- Station No. 2 ~ 2.5m
1180	0.588	0.522	0.066	0.066	20.6	<-- Station No. 2 ~ 2.5m
1185	0.588	0.620	0.032	-0.032	20.5	<-- Station No. 2 ~ 2.5m
1190	0.588	0.543	0.046	0.046	20.6	<-- Station No. 2 ~ 2.5m
1195	0.588	0.520	0.068	0.068	20.6	<-- Station No. 2 ~ 2.5m
1200	0.588	0.522	0.066	0.066	20.6	<-- Station No. 2 ~ 2.5m
1205	0.588	0.522	0.066	0.066	20.5	<-- Station No. 2 ~ 2.5m
1210	0.588	0.518	0.071	0.071	20.6	<-- Station No. 2 ~ 2.5m
1215	0.588	0.525	0.064	0.064	20.7	<-- Station No. 2 ~ 2.5m
1220	0.588	0.522	0.066	0.066	20.6	<-- Station No. 2 ~ 2.5m
1225	0.588	0.538	0.050	0.050	20.7	<-- Station No. 2 ~ 2.5m
1230	0.588	0.511	0.078	0.078	20.6	<-- Station No. 2 ~ 2.5m
1235	0.588	0.575	0.014	0.014	20.7	<-- Station No. 2 ~ 2.5m
1240	0.588	0.570	0.018	0.018	20.6	<-- Station No. 2 ~ 2.5m
1245	0.588	0.515	0.073	0.073	20.6	<-- Station No. 2 ~ 2.5m
1250	0.588	0.511	0.078	0.078	20.7	<-- Station No. 2 ~ 2.5m
1255	0.588	0.520	0.068	0.068	20.7	<-- Station No. 2 ~ 2.5m
1260	0.588	0.531	0.057	0.057	20.7	<-- Station No. 2 ~ 2.5m
1265	0.588	0.563	0.025	0.025	20.7	<-- Station No. 2 ~ 2.5m
1270	0.588	0.504	0.084	0.084	20.7	<-- Station No. 2 ~ 2.5m
1275	0.588	0.547	0.041	0.041	20.7	<-- Station No. 2 ~ 2.5m
1280	0.588	0.525	0.064	0.064	20.7	<-- Station No. 2 ~ 2.5m
1285	0.588	0.518	0.071	0.071	20.9	<-- Station No. 2 ~ 2.5m
1290	0.588	0.577	0.011	0.011	20.7	<-- Station No. 2 ~ 2.5m
1295	0.588	0.550	0.039	0.039	20.8	<-- Station No. 2 ~ 2.5m
1300	0.588	0.595	0.007	-0.007	20.8	<-- Station No. 2 ~ 2.5m
1305	0.588	0.513	0.075	0.075	20.7	<-- Station No. 2 ~ 2.5m
1310	0.588	0.520	0.068	0.068	20.7	<-- Station No. 2 ~ 2.5m
1315	0.588	0.627	0.039	-0.039	20.9	<-- Station No. 2 ~ 2.5m
1320	0.588	0.520	0.068	0.068	20.8	<-- Station No. 2 ~ 2.5m
1325	0.588	0.515	0.073	0.073	20.8	<-- Station No. 2 ~ 2.5m
1330	0.588	0.613	0.025	-0.025	20.9	<-- Station No. 2 ~ 2.5m
1335	0.588	0.511	0.078	0.078	20.9	<-- Station No. 2 ~ 2.5m
1340	0.588	0.593	0.005	-0.005	20.9	<-- Station No. 2 ~ 2.5m
1345	0.588	0.531	0.057	0.057	21.1	<-- Station No. 2 ~ 2.5m
1350	0.588	0.506	0.082	0.082	20.9	<-- Station No. 2 ~ 2.5m
1355	0.588	0.511	0.078	0.078	21	<-- Station No. 2 ~ 2.5m
1360	0.588	0.511	0.078	0.078	21.1	<-- Station No. 2 ~ 2.5m
1365	0.588	0.538	0.050	0.050	21.2	<-- Station No. 2 ~ 2.5m
1370	0.588	0.529	0.059	0.059	21.2	<-- Station No. 2 ~ 2.5m
1375	0.588	0.495	0.094	0.094	21.4	<-- Station No. 2 ~ 2.5m
1380	0.588	0.566	0.023	0.023	21.1	<-- Station No. 2 ~ 2.5m
1385	0.588	0.556	0.032	0.032	20.9	<-- Station No. 2 ~ 2.5m
1390	0.588	0.531	0.057	0.057	21.2	<-- Station No. 2 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1395	0.588	0.613	0.025	-0.025	21.2	<-- Station No. 2 ~ 2.5m
1400	0.588	0.520	0.068	0.068	21.2	<-- Station No. 2 ~ 2.5m
1405	0.588	0.520	0.068	0.068	21.2	<-- Station No. 2 ~ 2.5m
1410	0.588	0.488	0.100	0.100	21.3	<-- Station No. 2 ~ 2.5m
1415	0.588	0.502	0.087	0.087	21.3	<-- Station No. 2 ~ 2.5m
1420	0.588	0.545	0.043	0.043	21.3	<-- Station No. 2 ~ 2.5m
1425	0.588	0.477	0.112	0.112	21.4	<-- Station No. 2 ~ 2.5m
1430	0.588	0.504	0.084	0.084	21.4	<-- Station No. 2 ~ 2.5m
1435	0.588	0.518	0.071	0.071	21.5	<-- Station No. 2 ~ 2.5m
1440	0.588	0.499	0.089	0.089	21.7	<-- Station No. 2 ~ 2.5m
0	0.235	0.461	0.226	-0.226	21.5	<-- Station No. 3 ~ 2.5m
5	0.235	0.483	0.249	-0.249	21.6	<-- Station No. 3 ~ 2.5m
10	0.235	0.483	0.249	-0.249	21.5	<-- Station No. 3 ~ 2.5m
15	0.235	0.518	0.283	-0.283	21.4	<-- Station No. 3 ~ 2.5m
20	0.235	0.518	0.283	-0.283	21.5	<-- Station No. 3 ~ 2.5m
25	0.235	0.445	0.210	-0.210	21.6	<-- Station No. 3 ~ 2.5m
30	0.235	0.527	0.292	-0.292	21.6	<-- Station No. 3 ~ 2.5m
35	0.235	0.525	0.290	-0.290	21.6	<-- Station No. 3 ~ 2.5m
40	0.235	0.447	0.212	-0.212	21.5	<-- Station No. 3 ~ 2.5m
45	0.235	0.497	0.262	-0.262	21.5	<-- Station No. 3 ~ 2.5m
50	0.235	0.481	0.246	-0.246	21.6	<-- Station No. 3 ~ 2.5m
55	0.235	0.461	0.226	-0.226	21.8	<-- Station No. 3 ~ 2.5m
60	0.235	0.456	0.221	-0.221	22	<-- Station No. 3 ~ 2.5m
65	0.235	0.468	0.233	-0.233	22	<-- Station No. 3 ~ 2.5m
70	0.235	0.495	0.260	-0.260	21.8	<-- Station No. 3 ~ 2.5m
75	0.235	0.442	0.208	-0.208	21.9	<-- Station No. 3 ~ 2.5m
80	0.235	0.433	0.198	-0.198	21.8	<-- Station No. 3 ~ 2.5m
85	0.235	0.436	0.201	-0.201	21.8	<-- Station No. 3 ~ 2.5m
90	0.235	0.454	0.219	-0.219	21.7	<-- Station No. 3 ~ 2.5m
95	0.235	0.513	0.278	-0.278	21.7	<-- Station No. 3 ~ 2.5m
100	0.235	0.497	0.262	-0.262	21.7	<-- Station No. 3 ~ 2.5m
105	0.235	0.431	0.196	-0.196	21.8	<-- Station No. 3 ~ 2.5m
110	0.235	0.424	0.189	-0.189	21.8	<-- Station No. 3 ~ 2.5m
115	0.235	0.433	0.198	-0.198	21.9	<-- Station No. 3 ~ 2.5m
120	0.235	0.458	0.223	-0.223	21.8	<-- Station No. 3 ~ 2.5m
125	0.235	0.502	0.267	-0.267	21.8	<-- Station No. 3 ~ 2.5m
130	0.235	0.502	0.267	-0.267	21.9	<-- Station No. 3 ~ 2.5m
135	0.235	0.456	0.221	-0.221	21.9	<-- Station No. 3 ~ 2.5m
140	0.235	0.438	0.203	-0.203	21.8	<-- Station No. 3 ~ 2.5m
145	0.235	0.470	0.235	-0.235	21.8	<-- Station No. 3 ~ 2.5m
150	0.235	0.442	0.208	-0.208	21.7	<-- Station No. 3 ~ 2.5m
155	0.235	0.433	0.198	-0.198	21.8	<-- Station No. 3 ~ 2.5m
160	0.235	0.438	0.203	-0.203	21.9	<-- Station No. 3 ~ 2.5m
165	0.235	0.495	0.260	-0.260	22.3	<-- Station No. 3 ~ 2.5m
170	0.235	0.465	0.230	-0.230	22.2	<-- Station No. 3 ~ 2.5m
175	0.235	0.440	0.205	-0.205	22.4	<-- Station No. 3 ~ 2.5m
180	0.235	0.440	0.205	-0.205	22.4	<-- Station No. 3 ~ 2.5m
185	0.235	0.422	0.187	-0.187	22.5	<-- Station No. 3 ~ 2.5m
190	0.235	0.388	0.153	-0.153	22.8	<-- Station No. 3 ~ 2.5m
195	0.235	0.413	0.178	-0.178	22.8	<-- Station No. 3 ~ 2.5m
200	0.235	0.385	0.151	-0.151	22.7	<-- Station No. 3 ~ 2.5m
205	0.235	0.436	0.201	-0.201	22.9	<-- Station No. 3 ~ 2.5m
210	0.235	0.415	0.180	-0.180	23.4	<-- Station No. 3 ~ 2.5m
215	0.235	0.399	0.164	-0.164	23.3	<-- Station No. 3 ~ 2.5m
220	0.235	0.358	0.123	-0.123	23.2	<-- Station No. 3 ~ 2.5m
225	0.235	0.385	0.151	-0.151	23.6	<-- Station No. 3 ~ 2.5m
230	0.235	0.322	0.087	-0.087	23.7	<-- Station No. 3 ~ 2.5m
235	0.235	0.347	0.112	-0.112	23.7	<-- Station No. 3 ~ 2.5m
240	0.235	0.340	0.105	-0.105	23.4	<-- Station No. 3 ~ 2.5m
245	0.235	0.433	0.198	-0.198	23.4	<-- Station No. 3 ~ 2.5m
250	0.235	0.363	0.128	-0.128	23.3	<-- Station No. 3 ~ 2.5m
255	0.235	0.360	0.125	-0.125	23.3	<-- Station No. 3 ~ 2.5m
260	0.235	0.381	0.146	-0.146	23.3	<-- Station No. 3 ~ 2.5m
265	0.235	0.363	0.128	-0.128	23.3	<-- Station No. 3 ~ 2.5m
270	0.235	0.452	0.217	-0.217	23.2	<-- Station No. 3 ~ 2.5m
275	0.235	0.369	0.135	-0.135	23.2	<-- Station No. 3 ~ 2.5m
280	0.235	0.347	0.112	-0.112	23	<-- Station No. 3 ~ 2.5m
285	0.235	0.401	0.166	-0.166	23	<-- Station No. 3 ~ 2.5m
290	0.235	0.369	0.135	-0.135	23	<-- Station No. 3 ~ 2.5m
295	0.235	0.367	0.132	-0.132	22.9	<-- Station No. 3 ~ 2.5m
300	0.235	0.442	0.208	-0.208	22.8	<-- Station No. 3 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
305	0.235	0.406	0.171	-0.171	22.7	<-- Station No. 3 ~ 2.5m
310	0.235	0.395	0.160	-0.160	22.7	<-- Station No. 3 ~ 2.5m
315	0.235	0.429	0.194	-0.194	22.7	<-- Station No. 3 ~ 2.5m
320	0.235	0.383	0.148	-0.148	22.5	<-- Station No. 3 ~ 2.5m
325	0.235	0.395	0.160	-0.160	22.5	<-- Station No. 3 ~ 2.5m
330	0.235	0.399	0.164	-0.164	22.4	<-- Station No. 3 ~ 2.5m
335	0.235	0.413	0.178	-0.178	22.5	<-- Station No. 3 ~ 2.5m
340	0.235	0.422	0.187	-0.187	22.5	<-- Station No. 3 ~ 2.5m
345	0.235	0.388	0.153	-0.153	22.5	<-- Station No. 3 ~ 2.5m
350	0.235	0.483	0.249	-0.249	22.4	<-- Station No. 3 ~ 2.5m
355	0.235	0.433	0.198	-0.198	22.4	<-- Station No. 3 ~ 2.5m
360	0.235	0.490	0.255	-0.255	22.4	<-- Station No. 3 ~ 2.5m
365	0.235	0.461	0.226	-0.226	22.4	<-- Station No. 3 ~ 2.5m
370	0.235	0.440	0.205	-0.205	22.4	<-- Station No. 3 ~ 2.5m
375	0.235	0.465	0.230	-0.230	22.3	<-- Station No. 3 ~ 2.5m
380	0.235	0.385	0.151	-0.151	22.6	<-- Station No. 3 ~ 2.5m
385	0.235	0.456	0.221	-0.221	22.4	<-- Station No. 3 ~ 2.5m
390	0.235	0.397	0.162	-0.162	22.3	<-- Station No. 3 ~ 2.5m
395	0.235	0.410	0.176	-0.176	22.3	<-- Station No. 3 ~ 2.5m
400	0.235	0.408	0.173	-0.173	22.4	<-- Station No. 3 ~ 2.5m
405	0.235	0.397	0.162	-0.162	22.2	<-- Station No. 3 ~ 2.5m
410	0.235	0.438	0.203	-0.203	22.2	<-- Station No. 3 ~ 2.5m
415	0.235	0.429	0.194	-0.194	22.3	<-- Station No. 3 ~ 2.5m
420	0.235	0.470	0.235	-0.235	22.3	<-- Station No. 3 ~ 2.5m
425	0.235	0.420	0.185	-0.185	22.3	<-- Station No. 3 ~ 2.5m
430	0.235	0.474	0.239	-0.239	22.4	<-- Station No. 3 ~ 2.5m
435	0.235	0.470	0.235	-0.235	22.4	<-- Station No. 3 ~ 2.5m
440	0.235	0.479	0.244	-0.244	22.4	<-- Station No. 3 ~ 2.5m
445	0.235	0.404	0.169	-0.169	22.2	<-- Station No. 3 ~ 2.5m
450	0.235	0.438	0.203	-0.203	22.3	<-- Station No. 3 ~ 2.5m
455	0.235	0.406	0.171	-0.171	22.2	<-- Station No. 3 ~ 2.5m
460	0.235	0.458	0.223	-0.223	22.1	<-- Station No. 3 ~ 2.5m
465	0.235	0.456	0.221	-0.221	22.1	<-- Station No. 3 ~ 2.5m
470	0.235	0.420	0.185	-0.185	22	<-- Station No. 3 ~ 2.5m
475	0.235	0.456	0.221	-0.221	22.1	<-- Station No. 3 ~ 2.5m
480	0.235	0.433	0.198	-0.198	22	<-- Station No. 3 ~ 2.5m
485	0.235	0.454	0.219	-0.219	22.1	<-- Station No. 3 ~ 2.5m
490	0.235	0.481	0.246	-0.246	22	<-- Station No. 3 ~ 2.5m
495	0.235	0.458	0.223	-0.223	22.1	<-- Station No. 3 ~ 2.5m
500	0.235	0.456	0.221	-0.221	22.1	<-- Station No. 3 ~ 2.5m
505	0.235	0.468	0.233	-0.233	22	<-- Station No. 3 ~ 2.5m
510	0.235	0.415	0.180	-0.180	21.9	<-- Station No. 3 ~ 2.5m
515	0.235	0.461	0.226	-0.226	21.9	<-- Station No. 3 ~ 2.5m
520	0.235	0.420	0.185	-0.185	21.9	<-- Station No. 3 ~ 2.5m
525	0.235	0.465	0.230	-0.230	21.9	<-- Station No. 3 ~ 2.5m
530	0.235	0.465	0.230	-0.230	21.8	<-- Station No. 3 ~ 2.5m
535	0.235	0.452	0.217	-0.217	21.8	<-- Station No. 3 ~ 2.5m
540	0.235	0.452	0.217	-0.217	21.8	<-- Station No. 3 ~ 2.5m
545	0.235	0.495	0.260	-0.260	21.8	<-- Station No. 3 ~ 2.5m
550	0.235	0.438	0.203	-0.203	21.8	<-- Station No. 3 ~ 2.5m
555	0.235	0.445	0.210	-0.210	21.7	<-- Station No. 3 ~ 2.5m
560	0.235	0.547	0.312	-0.312	21.6	<-- Station No. 3 ~ 2.5m
565	0.235	0.534	0.299	-0.299	21.6	<-- Station No. 3 ~ 2.5m
570	0.235	0.454	0.219	-0.219	21.6	<-- Station No. 3 ~ 2.5m
575	0.235	0.470	0.235	-0.235	21.5	<-- Station No. 3 ~ 2.5m
580	0.235	0.502	0.267	-0.267	21.5	<-- Station No. 3 ~ 2.5m
585	0.235	0.552	0.317	-0.317	21.5	<-- Station No. 3 ~ 2.5m
590	0.235	0.438	0.203	-0.203	21.4	<-- Station No. 3 ~ 2.5m
595	0.235	0.483	0.249	-0.249	21.4	<-- Station No. 3 ~ 2.5m
600	0.235	0.502	0.267	-0.267	21.4	<-- Station No. 3 ~ 2.5m
605	0.235	0.527	0.292	-0.292	21.4	<-- Station No. 3 ~ 2.5m
610	0.235	0.465	0.230	-0.230	21.4	<-- Station No. 3 ~ 2.5m
615	0.235	0.502	0.267	-0.267	21.3	<-- Station No. 3 ~ 2.5m
620	0.235	0.474	0.239	-0.239	21.2	<-- Station No. 3 ~ 2.5m
625	0.235	0.456	0.221	-0.221	21.3	<-- Station No. 3 ~ 2.5m
630	0.235	0.456	0.221	-0.221	21.2	<-- Station No. 3 ~ 2.5m
635	0.235	0.458	0.223	-0.223	21.2	<-- Station No. 3 ~ 2.5m
640	0.235	0.483	0.249	-0.249	21.2	<-- Station No. 3 ~ 2.5m
645	0.235	0.509	0.274	-0.274	21.3	<-- Station No. 3 ~ 2.5m
650	0.235	0.461	0.226	-0.226	21.2	<-- Station No. 3 ~ 2.5m
655	0.235	0.486	0.251	-0.251	21.3	<-- Station No. 3 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
660	0.235	0.899	0.664	-0.664	21.7	<-- Station No. 3 ~ 2.5m
665	0.235	0.506	0.271	-0.271	21	<-- Station No. 3 ~ 2.5m
670	0.235	0.502	0.267	-0.267	21.1	<-- Station No. 3 ~ 2.5m
675	0.235	0.479	0.244	-0.244	21.1	<-- Station No. 3 ~ 2.5m
680	0.235	0.506	0.271	-0.271	21	<-- Station No. 3 ~ 2.5m
685	0.235	0.474	0.239	-0.239	21	<-- Station No. 3 ~ 2.5m
690	0.235	0.493	0.258	-0.258	21	<-- Station No. 3 ~ 2.5m
695	0.235	0.506	0.271	-0.271	21	<-- Station No. 3 ~ 2.5m
700	0.235	0.566	0.331	-0.331	21	<-- Station No. 3 ~ 2.5m
705	0.235	0.465	0.230	-0.230	21	<-- Station No. 3 ~ 2.5m
710	0.235	0.490	0.255	-0.255	21	<-- Station No. 3 ~ 2.5m
715	0.235	0.547	0.312	-0.312	21	<-- Station No. 3 ~ 2.5m
720	0.235	0.474	0.239	-0.239	21	<-- Station No. 3 ~ 2.5m
725	0.235	0.545	0.310	-0.310	20.9	<-- Station No. 3 ~ 2.5m
730	0.235	0.495	0.260	-0.260	21	<-- Station No. 3 ~ 2.5m
735	0.235	0.540	0.306	-0.306	20.9	<-- Station No. 3 ~ 2.5m
740	0.235	0.502	0.267	-0.267	20.9	<-- Station No. 3 ~ 2.5m
745	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 3 ~ 2.5m
750	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 3 ~ 2.5m
755	0.235	0.509	0.274	-0.274	20.9	<-- Station No. 3 ~ 2.5m
760	0.235	0.486	0.251	-0.251	20.8	<-- Station No. 3 ~ 2.5m
765	0.235	0.536	0.301	-0.301	20.9	<-- Station No. 3 ~ 2.5m
770	0.235	0.572	0.338	-0.338	21	<-- Station No. 3 ~ 2.5m
775	0.235	0.575	0.340	-0.340	20.9	<-- Station No. 3 ~ 2.5m
780	0.235	0.493	0.258	-0.258	20.9	<-- Station No. 3 ~ 2.5m
785	0.235	0.504	0.269	-0.269	20.9	<-- Station No. 3 ~ 2.5m
790	0.235	0.552	0.317	-0.317	20.9	<-- Station No. 3 ~ 2.5m
795	0.235	0.502	0.267	-0.267	20.9	<-- Station No. 3 ~ 2.5m
800	0.235	0.495	0.260	-0.260	20.9	<-- Station No. 3 ~ 2.5m
805	0.235	0.529	0.294	-0.294	20.8	<-- Station No. 3 ~ 2.5m
810	0.235	0.497	0.262	-0.262	20.9	<-- Station No. 3 ~ 2.5m
815	0.235	0.554	0.319	-0.319	20.8	<-- Station No. 3 ~ 2.5m
820	0.235	0.493	0.258	-0.258	20.8	<-- Station No. 3 ~ 2.5m
825	0.235	0.611	0.376	-0.376	20.8	<-- Station No. 3 ~ 2.5m
830	0.235	0.543	0.308	-0.308	20.9	<-- Station No. 3 ~ 2.5m
835	0.235	0.506	0.271	-0.271	20.8	<-- Station No. 3 ~ 2.5m
840	0.235	0.552	0.317	-0.317	20.8	<-- Station No. 3 ~ 2.5m
845	0.235	0.527	0.292	-0.292	20.9	<-- Station No. 3 ~ 2.5m
850	0.235	0.561	0.326	-0.326	20.8	<-- Station No. 3 ~ 2.5m
855	0.235	0.525	0.290	-0.290	20.7	<-- Station No. 3 ~ 2.5m
860	0.235	0.520	0.285	-0.285	20.8	<-- Station No. 3 ~ 2.5m
865	0.235	0.504	0.269	-0.269	20.7	<-- Station No. 3 ~ 2.5m
870	0.235	0.529	0.294	-0.294	20.7	<-- Station No. 3 ~ 2.5m
875	0.235	0.536	0.301	-0.301	20.8	<-- Station No. 3 ~ 2.5m
880	0.235	0.593	0.358	-0.358	20.7	<-- Station No. 3 ~ 2.5m
885	0.235	0.497	0.262	-0.262	20.7	<-- Station No. 3 ~ 2.5m
890	0.235	0.527	0.292	-0.292	20.7	<-- Station No. 3 ~ 2.5m
895	0.235	0.529	0.294	-0.294	20.7	<-- Station No. 3 ~ 2.5m
900	0.235	0.588	0.353	-0.353	20.9	<-- Station No. 3 ~ 2.5m
905	0.235	0.499	0.265	-0.265	20.7	<-- Station No. 3 ~ 2.5m
910	0.235	0.518	0.283	-0.283	20.8	<-- Station No. 3 ~ 2.5m
915	0.235	0.540	0.306	-0.306	20.8	<-- Station No. 3 ~ 2.5m
920	0.235	0.522	0.287	-0.287	20.7	<-- Station No. 3 ~ 2.5m
925	0.235	0.504	0.269	-0.269	20.7	<-- Station No. 3 ~ 2.5m
930	0.235	0.509	0.274	-0.274	20.7	<-- Station No. 3 ~ 2.5m
935	0.235	0.515	0.281	-0.281	20.7	<-- Station No. 3 ~ 2.5m
940	0.235	0.572	0.338	-0.338	20.8	<-- Station No. 3 ~ 2.5m
945	0.235	0.504	0.269	-0.269	20.8	<-- Station No. 3 ~ 2.5m
950	0.235	0.547	0.312	-0.312	20.7	<-- Station No. 3 ~ 2.5m
955	0.235	0.529	0.294	-0.294	20.7	<-- Station No. 3 ~ 2.5m
960	0.235	0.515	0.281	-0.281	20.7	<-- Station No. 3 ~ 2.5m
965	0.235	0.538	0.303	-0.303	20.7	<-- Station No. 3 ~ 2.5m
970	0.235	0.568	0.333	-0.333	20.8	<-- Station No. 3 ~ 2.5m
975	0.235	0.495	0.260	-0.260	20.7	<-- Station No. 3 ~ 2.5m
980	0.235	0.561	0.326	-0.326	20.7	<-- Station No. 3 ~ 2.5m
985	0.235	0.497	0.262	-0.262	20.7	<-- Station No. 3 ~ 2.5m
990	0.235	0.616	0.381	-0.381	20.7	<-- Station No. 3 ~ 2.5m
995	0.235	0.520	0.285	-0.285	20.8	<-- Station No. 3 ~ 2.5m
1000	0.235	0.502	0.267	-0.267	20.7	<-- Station No. 3 ~ 2.5m
1005	0.235	0.511	0.276	-0.276	20.8	<-- Station No. 3 ~ 2.5m
1010	0.235	0.559	0.324	-0.324	20.7	<-- Station No. 3 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1015	0.235	0.561	0.326	-0.326	20.8	<-- Station No. 3 ~ 2.5m
1020	0.235	0.536	0.301	-0.301	20.7	<-- Station No. 3 ~ 2.5m
1025	0.235	0.502	0.267	-0.267	20.7	<-- Station No. 3 ~ 2.5m
1030	0.235	0.502	0.267	-0.267	20.6	<-- Station No. 3 ~ 2.5m
1035	0.235	0.552	0.317	-0.317	20.8	<-- Station No. 3 ~ 2.5m
1040	0.235	0.529	0.294	-0.294	20.7	<-- Station No. 3 ~ 2.5m
1045	0.235	0.547	0.312	-0.312	20.8	<-- Station No. 3 ~ 2.5m
1050	0.235	0.597	0.363	-0.363	20.8	<-- Station No. 3 ~ 2.5m
1055	0.235	0.554	0.319	-0.319	20.9	<-- Station No. 3 ~ 2.5m
1060	0.235	0.499	0.265	-0.265	20.8	<-- Station No. 3 ~ 2.5m
1065	0.235	0.527	0.292	-0.292	20.8	<-- Station No. 3 ~ 2.5m
1070	0.235	0.547	0.312	-0.312	20.7	<-- Station No. 3 ~ 2.5m
1075	0.235	0.495	0.260	-0.260	20.7	<-- Station No. 3 ~ 2.5m
1080	0.235	0.545	0.310	-0.310	20.7	<-- Station No. 3 ~ 2.5m
1085	0.235	0.543	0.308	-0.308	20.7	<-- Station No. 3 ~ 2.5m
1090	0.235	0.550	0.315	-0.315	20.6	<-- Station No. 3 ~ 2.5m
1095	0.235	0.550	0.315	-0.315	20.6	<-- Station No. 3 ~ 2.5m
1100	0.235	0.509	0.274	-0.274	20.6	<-- Station No. 3 ~ 2.5m
1105	0.235	0.534	0.299	-0.299	20.7	<-- Station No. 3 ~ 2.5m
1110	0.235	0.513	0.278	-0.278	20.6	<-- Station No. 3 ~ 2.5m
1115	0.235	0.550	0.315	-0.315	20.6	<-- Station No. 3 ~ 2.5m
1120	0.235	0.520	0.285	-0.285	20.6	<-- Station No. 3 ~ 2.5m
1125	0.235	0.502	0.267	-0.267	20.7	<-- Station No. 3 ~ 2.5m
1130	0.235	0.518	0.283	-0.283	20.7	<-- Station No. 3 ~ 2.5m
1135	0.235	0.538	0.303	-0.303	20.7	<-- Station No. 3 ~ 2.5m
1140	0.235	0.538	0.303	-0.303	20.7	<-- Station No. 3 ~ 2.5m
1145	0.235	0.509	0.274	-0.274	20.6	<-- Station No. 3 ~ 2.5m
1150	0.235	0.509	0.274	-0.274	20.6	<-- Station No. 3 ~ 2.5m
1155	0.235	0.554	0.319	-0.319	20.7	<-- Station No. 3 ~ 2.5m
1160	0.235	0.536	0.301	-0.301	20.6	<-- Station No. 3 ~ 2.5m
1165	0.235	0.602	0.367	-0.367	20.7	<-- Station No. 3 ~ 2.5m
1170	0.235	0.540	0.306	-0.306	20.6	<-- Station No. 3 ~ 2.5m
1175	0.235	0.572	0.338	-0.338	20.6	<-- Station No. 3 ~ 2.5m
1180	0.235	0.568	0.333	-0.333	20.6	<-- Station No. 3 ~ 2.5m
1185	0.235	0.511	0.276	-0.276	20.7	<-- Station No. 3 ~ 2.5m
1190	0.235	0.545	0.310	-0.310	20.6	<-- Station No. 3 ~ 2.5m
1195	0.235	0.600	0.365	-0.365	20.5	<-- Station No. 3 ~ 2.5m
1200	0.235	0.522	0.287	-0.287	20.5	<-- Station No. 3 ~ 2.5m
1205	0.235	0.529	0.294	-0.294	20.5	<-- Station No. 3 ~ 2.5m
1210	0.235	0.591	0.356	-0.356	20.5	<-- Station No. 3 ~ 2.5m
1215	0.235	0.600	0.365	-0.365	20.5	<-- Station No. 3 ~ 2.5m
1220	0.235	0.566	0.331	-0.331	20.5	<-- Station No. 3 ~ 2.5m
1225	0.235	0.593	0.358	-0.358	20.5	<-- Station No. 3 ~ 2.5m
1230	0.235	0.582	0.347	-0.347	20.5	<-- Station No. 3 ~ 2.5m
1235	0.235	0.563	0.328	-0.328	20.5	<-- Station No. 3 ~ 2.5m
1240	0.235	0.529	0.294	-0.294	20.4	<-- Station No. 3 ~ 2.5m
1245	0.235	0.554	0.319	-0.319	20.4	<-- Station No. 3 ~ 2.5m
1250	0.235	0.543	0.308	-0.308	20.6	<-- Station No. 3 ~ 2.5m
1255	0.235	0.536	0.301	-0.301	20.4	<-- Station No. 3 ~ 2.5m
1260	0.235	0.579	0.344	-0.344	20.5	<-- Station No. 3 ~ 2.5m
1265	0.235	0.527	0.292	-0.292	20.4	<-- Station No. 3 ~ 2.5m
1270	0.235	0.582	0.347	-0.347	20.5	<-- Station No. 3 ~ 2.5m
1275	0.235	0.582	0.347	-0.347	20.5	<-- Station No. 3 ~ 2.5m
1280	0.235	0.550	0.315	-0.315	20.5	<-- Station No. 3 ~ 2.5m
1285	0.235	0.547	0.312	-0.312	20.6	<-- Station No. 3 ~ 2.5m
1290	0.235	0.531	0.296	-0.296	20.8	<-- Station No. 3 ~ 2.5m
1295	0.235	0.522	0.287	-0.287	20.9	<-- Station No. 3 ~ 2.5m
1300	0.235	0.588	0.353	-0.353	20.6	<-- Station No. 3 ~ 2.5m
1305	0.235	0.525	0.290	-0.290	20.6	<-- Station No. 3 ~ 2.5m
1310	0.235	0.506	0.271	-0.271	20.7	<-- Station No. 3 ~ 2.5m
1315	0.235	0.529	0.294	-0.294	20.6	<-- Station No. 3 ~ 2.5m
1320	0.235	0.531	0.296	-0.296	20.6	<-- Station No. 3 ~ 2.5m
1325	0.235	0.563	0.328	-0.328	20.6	<-- Station No. 3 ~ 2.5m
1330	0.235	0.513	0.278	-0.278	20.8	<-- Station No. 3 ~ 2.5m
1335	0.235	0.497	0.262	-0.262	20.8	<-- Station No. 3 ~ 2.5m
1340	0.235	0.511	0.276	-0.276	20.8	<-- Station No. 3 ~ 2.5m
1345	0.235	0.595	0.360	-0.360	20.8	<-- Station No. 3 ~ 2.5m
1350	0.235	0.547	0.312	-0.312	20.8	<-- Station No. 3 ~ 2.5m
1355	0.235	0.525	0.290	-0.290	20.9	<-- Station No. 3 ~ 2.5m
1360	0.235	0.570	0.335	-0.335	20.8	<-- Station No. 3 ~ 2.5m
1365	0.235	0.490	0.255	-0.255	20.9	<-- Station No. 3 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1370	0.235	0.495	0.260	-0.260	20.9	<-- Station No. 3 ~ 2.5m
1375	0.235	0.540	0.306	-0.306	20.9	<-- Station No. 3 ~ 2.5m
1380	0.235	0.566	0.331	-0.331	21	<-- Station No. 3 ~ 2.5m
1385	0.235	0.584	0.349	-0.349	20.9	<-- Station No. 3 ~ 2.5m
1390	0.235	0.547	0.312	-0.312	21	<-- Station No. 3 ~ 2.5m
1395	0.235	0.577	0.342	-0.342	20.8	<-- Station No. 3 ~ 2.5m
1400	0.235	0.556	0.322	-0.322	21	<-- Station No. 3 ~ 2.5m
1405	0.235	0.568	0.333	-0.333	20.9	<-- Station No. 3 ~ 2.5m
1410	0.235	0.499	0.265	-0.265	21	<-- Station No. 3 ~ 2.5m
1415	0.235	0.522	0.287	-0.287	21	<-- Station No. 3 ~ 2.5m
1420	0.235	0.545	0.310	-0.310	21	<-- Station No. 3 ~ 2.5m
1425	0.235	0.497	0.262	-0.262	21	<-- Station No. 3 ~ 2.5m
1430	0.235	0.493	0.258	-0.258	21.1	<-- Station No. 3 ~ 2.5m
1435	0.235	0.518	0.283	-0.283	21.2	<-- Station No. 3 ~ 2.5m
1440	0.235	0.483	0.249	-0.249	21.3	<-- Station No. 3 ~ 2.5m
0	0.235	0.426	0.192	-0.192	22.2	<-- Station No. 4 ~ 2.5m
5	0.235	0.477	0.242	-0.242	22.3	<-- Station No. 4 ~ 2.5m
10	0.235	0.417	0.182	-0.182	22.4	<-- Station No. 4 ~ 2.5m
15	0.235	0.413	0.178	-0.178	22.6	<-- Station No. 4 ~ 2.5m
20	0.235	0.445	0.210	-0.210	22.7	<-- Station No. 4 ~ 2.5m
25	0.235	0.463	0.228	-0.228	22.7	<-- Station No. 4 ~ 2.5m
30	0.235	0.442	0.208	-0.208	22.9	<-- Station No. 4 ~ 2.5m
35	0.235	0.431	0.196	-0.196	23	<-- Station No. 4 ~ 2.5m
40	0.235	0.381	0.146	-0.146	23	<-- Station No. 4 ~ 2.5m
45	0.235	0.392	0.157	-0.157	23.1	<-- Station No. 4 ~ 2.5m
50	0.235	0.356	0.121	-0.121	23.3	<-- Station No. 4 ~ 2.5m
55	0.235	0.404	0.169	-0.169	23.3	<-- Station No. 4 ~ 2.5m
60	0.235	0.383	0.148	-0.148	23.4	<-- Station No. 4 ~ 2.5m
65	0.235	0.404	0.169	-0.169	23.3	<-- Station No. 4 ~ 2.5m
70	0.235	0.356	0.121	-0.121	23.2	<-- Station No. 4 ~ 2.5m
75	0.235	0.358	0.123	-0.123	23.4	<-- Station No. 4 ~ 2.5m
80	0.235	0.324	0.089	-0.089	23.7	<-- Station No. 4 ~ 2.5m
85	0.235	0.324	0.089	-0.089	24	<-- Station No. 4 ~ 2.5m
90	0.235	0.356	0.121	-0.121	24.3	<-- Station No. 4 ~ 2.5m
95	0.235	0.276	0.041	-0.041	24.6	<-- Station No. 4 ~ 2.5m
100	0.235	0.285	0.050	-0.050	24.7	<-- Station No. 4 ~ 2.5m
105	0.235	0.260	0.025	-0.025	24.5	<-- Station No. 4 ~ 2.5m
110	0.235	0.294	0.059	-0.059	24.3	<-- Station No. 4 ~ 2.5m
115	0.235	0.278	0.043	-0.043	24.3	<-- Station No. 4 ~ 2.5m
120	0.235	0.276	0.041	-0.041	24.3	<-- Station No. 4 ~ 2.5m
125	0.235	0.276	0.041	-0.041	24.4	<-- Station No. 4 ~ 2.5m
130	0.235	0.290	0.055	-0.055	24.1	<-- Station No. 4 ~ 2.5m
135	0.235	0.283	0.048	-0.048	24	<-- Station No. 4 ~ 2.5m
140	0.235	0.287	0.052	-0.052	23.9	<-- Station No. 4 ~ 2.5m
145	0.235	0.326	0.091	-0.091	23.8	<-- Station No. 4 ~ 2.5m
150	0.235	0.365	0.130	-0.130	23.7	<-- Station No. 4 ~ 2.5m
155	0.235	0.349	0.114	-0.114	23.7	<-- Station No. 4 ~ 2.5m
160	0.235	0.349	0.114	-0.114	23.7	<-- Station No. 4 ~ 2.5m
165	0.235	0.301	0.066	-0.066	23.7	<-- Station No. 4 ~ 2.5m
170	0.235	0.338	0.103	-0.103	23.8	<-- Station No. 4 ~ 2.5m
175	0.235	0.301	0.066	-0.066	23.8	<-- Station No. 4 ~ 2.5m
180	0.235	0.294	0.059	-0.059	23.8	<-- Station No. 4 ~ 2.5m
185	0.235	0.296	0.062	-0.062	24	<-- Station No. 4 ~ 2.5m
190	0.235	0.283	0.048	-0.048	24.2	<-- Station No. 4 ~ 2.5m
195	0.235	0.324	0.089	-0.089	24.1	<-- Station No. 4 ~ 2.5m
200	0.235	0.331	0.096	-0.096	24.3	<-- Station No. 4 ~ 2.5m
205	0.235	0.335	0.100	-0.100	24.2	<-- Station No. 4 ~ 2.5m
210	0.235	0.271	0.036	-0.036	24.1	<-- Station No. 4 ~ 2.5m
215	0.235	0.283	0.048	-0.048	24.1	<-- Station No. 4 ~ 2.5m
220	0.235	0.360	0.125	-0.125	24	<-- Station No. 4 ~ 2.5m
225	0.235	0.340	0.105	-0.105	23.9	<-- Station No. 4 ~ 2.5m
230	0.235	0.301	0.066	-0.066	24.2	<-- Station No. 4 ~ 2.5m
235	0.235	0.274	0.039	-0.039	24.7	<-- Station No. 4 ~ 2.5m
240	0.235	0.285	0.050	-0.050	24.8	<-- Station No. 4 ~ 2.5m
245	0.235	0.274	0.039	-0.039	24.8	<-- Station No. 4 ~ 2.5m
250	0.235	0.285	0.050	-0.050	24.8	<-- Station No. 4 ~ 2.5m
255	0.235	0.260	0.025	-0.025	24.9	<-- Station No. 4 ~ 2.5m
260	0.235	0.258	0.023	-0.023	24.8	<-- Station No. 4 ~ 2.5m
265	0.235	0.287	0.052	-0.052	24.6	<-- Station No. 4 ~ 2.5m
270	0.235	0.299	0.064	-0.064	24.7	<-- Station No. 4 ~ 2.5m
275	0.235	0.312	0.078	-0.078	24.5	<-- Station No. 4 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
280	0.235	0.294	0.059	-0.059	24.5	<-- Station No. 4 ~ 2.5m
285	0.235	0.276	0.041	-0.041	24.4	<-- Station No. 4 ~ 2.5m
290	0.235	0.292	0.057	-0.057	24.2	<-- Station No. 4 ~ 2.5m
295	0.235	0.276	0.041	-0.041	24.2	<-- Station No. 4 ~ 2.5m
300	0.235	0.287	0.052	-0.052	24.1	<-- Station No. 4 ~ 2.5m
305	0.235	0.294	0.059	-0.059	24.1	<-- Station No. 4 ~ 2.5m
310	0.235	0.299	0.064	-0.064	24.1	<-- Station No. 4 ~ 2.5m
315	0.235	0.296	0.062	-0.062	24	<-- Station No. 4 ~ 2.5m
320	0.235	0.308	0.073	-0.073	23.9	<-- Station No. 4 ~ 2.5m
325	0.235	0.353	0.119	-0.119	23.9	<-- Station No. 4 ~ 2.5m
330	0.235	0.358	0.123	-0.123	23.8	<-- Station No. 4 ~ 2.5m
335	0.235	0.315	0.080	-0.080	23.8	<-- Station No. 4 ~ 2.5m
340	0.235	0.344	0.109	-0.109	23.7	<-- Station No. 4 ~ 2.5m
345	0.235	0.365	0.130	-0.130	23.7	<-- Station No. 4 ~ 2.5m
350	0.235	0.340	0.105	-0.105	23.6	<-- Station No. 4 ~ 2.5m
355	0.235	0.374	0.139	-0.139	23.5	<-- Station No. 4 ~ 2.5m
360	0.235	0.324	0.089	-0.089	23.5	<-- Station No. 4 ~ 2.5m
365	0.235	0.383	0.148	-0.148	23.5	<-- Station No. 4 ~ 2.5m
370	0.235	0.383	0.148	-0.148	23.5	<-- Station No. 4 ~ 2.5m
375	0.235	0.381	0.146	-0.146	23.4	<-- Station No. 4 ~ 2.5m
380	0.235	0.351	0.116	-0.116	23.3	<-- Station No. 4 ~ 2.5m
385	0.235	0.410	0.176	-0.176	23.2	<-- Station No. 4 ~ 2.5m
390	0.235	0.365	0.130	-0.130	23.2	<-- Station No. 4 ~ 2.5m
395	0.235	0.413	0.178	-0.178	23.4	<-- Station No. 4 ~ 2.5m
400	0.235	0.417	0.182	-0.182	23.3	<-- Station No. 4 ~ 2.5m
405	0.235	0.385	0.151	-0.151	23.2	<-- Station No. 4 ~ 2.5m
410	0.235	0.356	0.121	-0.121	23.3	<-- Station No. 4 ~ 2.5m
415	0.235	0.395	0.160	-0.160	23.2	<-- Station No. 4 ~ 2.5m
420	0.235	0.397	0.162	-0.162	23.3	<-- Station No. 4 ~ 2.5m
425	0.235	0.351	0.116	-0.116	23.2	<-- Station No. 4 ~ 2.5m
430	0.235	0.360	0.125	-0.125	23.1	<-- Station No. 4 ~ 2.5m
435	0.235	0.385	0.151	-0.151	23.1	<-- Station No. 4 ~ 2.5m
440	0.235	0.385	0.151	-0.151	23.1	<-- Station No. 4 ~ 2.5m
445	0.235	0.353	0.119	-0.119	23.1	<-- Station No. 4 ~ 2.5m
450	0.235	0.367	0.132	-0.132	23.1	<-- Station No. 4 ~ 2.5m
455	0.235	0.385	0.151	-0.151	23	<-- Station No. 4 ~ 2.5m
460	0.235	0.358	0.123	-0.123	22.9	<-- Station No. 4 ~ 2.5m
465	0.235	0.404	0.169	-0.169	22.8	<-- Station No. 4 ~ 2.5m
470	0.235	0.363	0.128	-0.128	22.9	<-- Station No. 4 ~ 2.5m
475	0.235	0.358	0.123	-0.123	22.9	<-- Station No. 4 ~ 2.5m
480	0.235	0.456	0.221	-0.221	22.9	<-- Station No. 4 ~ 2.5m
485	0.235	0.429	0.194	-0.194	22.8	<-- Station No. 4 ~ 2.5m
490	0.235	0.410	0.176	-0.176	22.7	<-- Station No. 4 ~ 2.5m
495	0.235	0.383	0.148	-0.148	22.7	<-- Station No. 4 ~ 2.5m
500	0.235	0.456	0.221	-0.221	22.8	<-- Station No. 4 ~ 2.5m
505	0.235	0.365	0.130	-0.130	22.6	<-- Station No. 4 ~ 2.5m
510	0.235	0.415	0.180	-0.180	22.6	<-- Station No. 4 ~ 2.5m
515	0.235	0.424	0.189	-0.189	22.7	<-- Station No. 4 ~ 2.5m
520	0.235	0.424	0.189	-0.189	22.6	<-- Station No. 4 ~ 2.5m
525	0.235	0.381	0.146	-0.146	22.6	<-- Station No. 4 ~ 2.5m
530	0.235	0.406	0.171	-0.171	22.5	<-- Station No. 4 ~ 2.5m
535	0.235	0.417	0.182	-0.182	22.5	<-- Station No. 4 ~ 2.5m
540	0.235	0.390	0.155	-0.155	22.5	<-- Station No. 4 ~ 2.5m
545	0.235	0.447	0.212	-0.212	22.5	<-- Station No. 4 ~ 2.5m
550	0.235	0.372	0.137	-0.137	22.5	<-- Station No. 4 ~ 2.5m
555	0.235	0.385	0.151	-0.151	22.4	<-- Station No. 4 ~ 2.5m
560	0.235	0.413	0.178	-0.178	22.4	<-- Station No. 4 ~ 2.5m
565	0.235	0.401	0.166	-0.166	22.4	<-- Station No. 4 ~ 2.5m
570	0.235	0.397	0.162	-0.162	22.4	<-- Station No. 4 ~ 2.5m
575	0.235	0.397	0.162	-0.162	22.3	<-- Station No. 4 ~ 2.5m
580	0.235	0.433	0.198	-0.198	22.3	<-- Station No. 4 ~ 2.5m
585	0.235	0.433	0.198	-0.198	22.3	<-- Station No. 4 ~ 2.5m
590	0.235	0.440	0.205	-0.205	22.3	<-- Station No. 4 ~ 2.5m
595	0.235	0.395	0.160	-0.160	22.2	<-- Station No. 4 ~ 2.5m
600	0.235	0.390	0.155	-0.155	22.3	<-- Station No. 4 ~ 2.5m
605	0.235	0.392	0.157	-0.157	22.2	<-- Station No. 4 ~ 2.5m
610	0.235	0.390	0.155	-0.155	22.2	<-- Station No. 4 ~ 2.5m
615	0.235	0.454	0.219	-0.219	22.3	<-- Station No. 4 ~ 2.5m
620	0.235	0.413	0.178	-0.178	22.2	<-- Station No. 4 ~ 2.5m
625	0.235	0.463	0.228	-0.228	22.2	<-- Station No. 4 ~ 2.5m
630	0.235	0.438	0.203	-0.203	22.2	<-- Station No. 4 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
635	0.235	0.420	0.185	-0.185	22.2	<-- Station No. 4 ~ 2.5m
640	0.235	0.429	0.194	-0.194	22.2	<-- Station No. 4 ~ 2.5m
645	0.235	0.463	0.228	-0.228	22.1	<-- Station No. 4 ~ 2.5m
650	0.235	0.431	0.196	-0.196	22.1	<-- Station No. 4 ~ 2.5m
655	0.235	0.399	0.164	-0.164	22.1	<-- Station No. 4 ~ 2.5m
660	0.235	0.433	0.198	-0.198	22	<-- Station No. 4 ~ 2.5m
665	0.235	0.465	0.230	-0.230	22	<-- Station No. 4 ~ 2.5m
670	0.235	0.429	0.194	-0.194	22.1	<-- Station No. 4 ~ 2.5m
675	0.235	0.483	0.249	-0.249	22.1	<-- Station No. 4 ~ 2.5m
680	0.235	0.401	0.166	-0.166	22	<-- Station No. 4 ~ 2.5m
685	0.235	0.449	0.214	-0.214	21.9	<-- Station No. 4 ~ 2.5m
690	0.235	0.404	0.169	-0.169	22.1	<-- Station No. 4 ~ 2.5m
695	0.235	0.454	0.219	-0.219	22	<-- Station No. 4 ~ 2.5m
700	0.235	0.449	0.214	-0.214	22	<-- Station No. 4 ~ 2.5m
705	0.235	0.426	0.192	-0.192	22	<-- Station No. 4 ~ 2.5m
710	0.235	0.438	0.203	-0.203	21.9	<-- Station No. 4 ~ 2.5m
715	0.235	0.461	0.226	-0.226	22	<-- Station No. 4 ~ 2.5m
720	0.235	0.422	0.187	-0.187	21.9	<-- Station No. 4 ~ 2.5m
725	0.235	0.415	0.180	-0.180	22	<-- Station No. 4 ~ 2.5m
730	0.235	0.454	0.219	-0.219	21.9	<-- Station No. 4 ~ 2.5m
735	0.235	0.458	0.223	-0.223	21.9	<-- Station No. 4 ~ 2.5m
740	0.235	0.499	0.265	-0.265	22	<-- Station No. 4 ~ 2.5m
745	0.235	0.440	0.205	-0.205	21.9	<-- Station No. 4 ~ 2.5m
750	0.235	0.490	0.255	-0.255	21.9	<-- Station No. 4 ~ 2.5m
755	0.235	0.431	0.196	-0.196	21.8	<-- Station No. 4 ~ 2.5m
760	0.235	0.493	0.258	-0.258	21.9	<-- Station No. 4 ~ 2.5m
765	0.235	0.415	0.180	-0.180	21.9	<-- Station No. 4 ~ 2.5m
770	0.235	0.527	0.292	-0.292	21.9	<-- Station No. 4 ~ 2.5m
775	0.235	0.461	0.226	-0.226	21.8	<-- Station No. 4 ~ 2.5m
780	0.235	0.417	0.182	-0.182	21.9	<-- Station No. 4 ~ 2.5m
785	0.235	0.488	0.253	-0.253	21.8	<-- Station No. 4 ~ 2.5m
790	0.235	0.502	0.267	-0.267	21.9	<-- Station No. 4 ~ 2.5m
795	0.235	0.534	0.299	-0.299	21.8	<-- Station No. 4 ~ 2.5m
800	0.235	0.504	0.269	-0.269	21.9	<-- Station No. 4 ~ 2.5m
805	0.235	0.413	0.178	-0.178	21.8	<-- Station No. 4 ~ 2.5m
810	0.235	0.438	0.203	-0.203	22	<-- Station No. 4 ~ 2.5m
815	0.235	0.456	0.221	-0.221	21.8	<-- Station No. 4 ~ 2.5m
820	0.235	0.440	0.205	-0.205	21.8	<-- Station No. 4 ~ 2.5m
825	0.235	0.420	0.185	-0.185	21.8	<-- Station No. 4 ~ 2.5m
830	0.235	0.493	0.258	-0.258	21.8	<-- Station No. 4 ~ 2.5m
835	0.235	0.440	0.205	-0.205	21.9	<-- Station No. 4 ~ 2.5m
840	0.235	0.452	0.217	-0.217	21.8	<-- Station No. 4 ~ 2.5m
845	0.235	0.472	0.237	-0.237	21.8	<-- Station No. 4 ~ 2.5m
850	0.235	0.415	0.180	-0.180	21.9	<-- Station No. 4 ~ 2.5m
855	0.235	0.525	0.290	-0.290	21.7	<-- Station No. 4 ~ 2.5m
860	0.235	0.479	0.244	-0.244	21.7	<-- Station No. 4 ~ 2.5m
865	0.235	0.465	0.230	-0.230	21.8	<-- Station No. 4 ~ 2.5m
870	0.235	0.495	0.260	-0.260	21.7	<-- Station No. 4 ~ 2.5m
875	0.235	0.420	0.185	-0.185	21.6	<-- Station No. 4 ~ 2.5m
880	0.235	0.479	0.244	-0.244	21.8	<-- Station No. 4 ~ 2.5m
885	0.235	0.522	0.287	-0.287	21.8	<-- Station No. 4 ~ 2.5m
890	0.235	0.420	0.185	-0.185	21.7	<-- Station No. 4 ~ 2.5m
895	0.235	0.436	0.201	-0.201	21.7	<-- Station No. 4 ~ 2.5m
900	0.235	0.495	0.260	-0.260	21.7	<-- Station No. 4 ~ 2.5m
905	0.235	0.490	0.255	-0.255	21.7	<-- Station No. 4 ~ 2.5m
910	0.235	0.470	0.235	-0.235	21.7	<-- Station No. 4 ~ 2.5m
915	0.235	0.420	0.185	-0.185	21.6	<-- Station No. 4 ~ 2.5m
920	0.235	0.461	0.226	-0.226	21.7	<-- Station No. 4 ~ 2.5m
925	0.235	0.490	0.255	-0.255	21.7	<-- Station No. 4 ~ 2.5m
930	0.235	0.454	0.219	-0.219	21.8	<-- Station No. 4 ~ 2.5m
935	0.235	0.461	0.226	-0.226	21.7	<-- Station No. 4 ~ 2.5m
940	0.235	0.540	0.306	-0.306	21.7	<-- Station No. 4 ~ 2.5m
945	0.235	0.481	0.246	-0.246	21.7	<-- Station No. 4 ~ 2.5m
950	0.235	0.474	0.239	-0.239	21.7	<-- Station No. 4 ~ 2.5m
955	0.235	0.477	0.242	-0.242	21.7	<-- Station No. 4 ~ 2.5m
960	0.235	0.527	0.292	-0.292	21.8	<-- Station No. 4 ~ 2.5m
965	0.235	0.506	0.271	-0.271	21.7	<-- Station No. 4 ~ 2.5m
970	0.235	0.502	0.267	-0.267	21.7	<-- Station No. 4 ~ 2.5m
975	0.235	0.431	0.196	-0.196	21.8	<-- Station No. 4 ~ 2.5m
980	0.235	0.504	0.269	-0.269	21.8	<-- Station No. 4 ~ 2.5m
985	0.235	0.479	0.244	-0.244	21.7	<-- Station No. 4 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
990	0.235	0.461	0.226	-0.226	21.7	<-- Station No. 4 ~ 2.5m
995	0.235	0.483	0.249	-0.249	21.6	<-- Station No. 4 ~ 2.5m
1000	0.235	0.442	0.208	-0.208	21.6	<-- Station No. 4 ~ 2.5m
1005	0.235	0.518	0.283	-0.283	21.6	<-- Station No. 4 ~ 2.5m
1010	0.235	0.440	0.205	-0.205	21.6	<-- Station No. 4 ~ 2.5m
1015	0.235	0.522	0.287	-0.287	21.6	<-- Station No. 4 ~ 2.5m
1020	0.235	0.470	0.235	-0.235	21.6	<-- Station No. 4 ~ 2.5m
1025	0.235	0.479	0.244	-0.244	21.6	<-- Station No. 4 ~ 2.5m
1030	0.235	0.499	0.265	-0.265	21.6	<-- Station No. 4 ~ 2.5m
1035	0.235	0.445	0.210	-0.210	21.6	<-- Station No. 4 ~ 2.5m
1040	0.235	0.481	0.246	-0.246	21.5	<-- Station No. 4 ~ 2.5m
1045	0.235	0.454	0.219	-0.219	21.5	<-- Station No. 4 ~ 2.5m
1050	0.235	0.458	0.223	-0.223	21.5	<-- Station No. 4 ~ 2.5m
1055	0.235	0.488	0.253	-0.253	21.5	<-- Station No. 4 ~ 2.5m
1060	0.235	0.545	0.310	-0.310	21.5	<-- Station No. 4 ~ 2.5m
1065	0.235	0.513	0.278	-0.278	21.5	<-- Station No. 4 ~ 2.5m
1070	0.235	0.458	0.223	-0.223	21.5	<-- Station No. 4 ~ 2.5m
1075	0.235	0.506	0.271	-0.271	21.5	<-- Station No. 4 ~ 2.5m
1080	0.235	0.499	0.265	-0.265	21.5	<-- Station No. 4 ~ 2.5m
1085	0.235	0.497	0.262	-0.262	21.5	<-- Station No. 4 ~ 2.5m
1090	0.235	0.456	0.221	-0.221	21.5	<-- Station No. 4 ~ 2.5m
1095	0.235	0.474	0.239	-0.239	21.4	<-- Station No. 4 ~ 2.5m
1100	0.235	0.438	0.203	-0.203	21.4	<-- Station No. 4 ~ 2.5m
1105	0.235	0.458	0.223	-0.223	21.4	<-- Station No. 4 ~ 2.5m
1110	0.235	0.440	0.205	-0.205	21.4	<-- Station No. 4 ~ 2.5m
1115	0.235	0.497	0.262	-0.262	21.4	<-- Station No. 4 ~ 2.5m
1120	0.235	0.497	0.262	-0.262	21.4	<-- Station No. 4 ~ 2.5m
1125	0.235	0.527	0.292	-0.292	21.4	<-- Station No. 4 ~ 2.5m
1130	0.235	0.513	0.278	-0.278	21.5	<-- Station No. 4 ~ 2.5m
1135	0.235	0.522	0.287	-0.287	21.5	<-- Station No. 4 ~ 2.5m
1140	0.235	0.515	0.281	-0.281	21.4	<-- Station No. 4 ~ 2.5m
1145	0.235	0.527	0.292	-0.292	21.4	<-- Station No. 4 ~ 2.5m
1150	0.235	0.499	0.265	-0.265	21.4	<-- Station No. 4 ~ 2.5m
1155	0.235	0.468	0.233	-0.233	21.4	<-- Station No. 4 ~ 2.5m
1160	0.235	0.458	0.223	-0.223	21.4	<-- Station No. 4 ~ 2.5m
1165	0.235	0.440	0.205	-0.205	21.4	<-- Station No. 4 ~ 2.5m
1170	0.235	0.483	0.249	-0.249	21.4	<-- Station No. 4 ~ 2.5m
1175	0.235	0.481	0.246	-0.246	21.4	<-- Station No. 4 ~ 2.5m
1180	0.235	0.527	0.292	-0.292	21.4	<-- Station No. 4 ~ 2.5m
1185	0.235	0.479	0.244	-0.244	21.4	<-- Station No. 4 ~ 2.5m
1190	0.235	0.442	0.208	-0.208	21.4	<-- Station No. 4 ~ 2.5m
1195	0.235	0.481	0.246	-0.246	21.4	<-- Station No. 4 ~ 2.5m
1200	0.235	0.504	0.269	-0.269	21.5	<-- Station No. 4 ~ 2.5m
1205	0.235	0.472	0.237	-0.237	21.5	<-- Station No. 4 ~ 2.5m
1210	0.235	0.527	0.292	-0.292	21.6	<-- Station No. 4 ~ 2.5m
1215	0.235	0.525	0.290	-0.290	21.4	<-- Station No. 4 ~ 2.5m
1220	0.235	0.445	0.210	-0.210	21.5	<-- Station No. 4 ~ 2.5m
1225	0.235	0.472	0.237	-0.237	21.5	<-- Station No. 4 ~ 2.5m
1230	0.235	0.483	0.249	-0.249	21.4	<-- Station No. 4 ~ 2.5m
1235	0.235	0.525	0.290	-0.290	21.4	<-- Station No. 4 ~ 2.5m
1240	0.235	0.468	0.233	-0.233	21.5	<-- Station No. 4 ~ 2.5m
1245	0.235	0.465	0.230	-0.230	21.4	<-- Station No. 4 ~ 2.5m
1250	0.235	0.483	0.249	-0.249	21.6	<-- Station No. 4 ~ 2.5m
1255	0.235	0.470	0.235	-0.235	21.4	<-- Station No. 4 ~ 2.5m
1260	0.235	0.509	0.274	-0.274	21.4	<-- Station No. 4 ~ 2.5m
1265	0.235	0.481	0.246	-0.246	21.5	<-- Station No. 4 ~ 2.5m
1270	0.235	0.497	0.262	-0.262	21.4	<-- Station No. 4 ~ 2.5m
1275	0.235	0.483	0.249	-0.249	21.5	<-- Station No. 4 ~ 2.5m
1280	0.235	0.502	0.267	-0.267	21.5	<-- Station No. 4 ~ 2.5m
1285	0.235	0.486	0.251	-0.251	21.5	<-- Station No. 4 ~ 2.5m
1290	0.235	0.488	0.253	-0.253	21.5	<-- Station No. 4 ~ 2.5m
1295	0.235	0.511	0.276	-0.276	21.6	<-- Station No. 4 ~ 2.5m
1300	0.235	0.454	0.219	-0.219	21.5	<-- Station No. 4 ~ 2.5m
1305	0.235	0.488	0.253	-0.253	21.6	<-- Station No. 4 ~ 2.5m
1310	0.235	0.470	0.235	-0.235	21.5	<-- Station No. 4 ~ 2.5m
1315	0.235	0.529	0.294	-0.294	21.5	<-- Station No. 4 ~ 2.5m
1320	0.235	0.486	0.251	-0.251	21.5	<-- Station No. 4 ~ 2.5m
1325	0.235	0.509	0.274	-0.274	21.5	<-- Station No. 4 ~ 2.5m
1330	0.235	0.449	0.214	-0.214	21.5	<-- Station No. 4 ~ 2.5m
1335	0.235	0.461	0.226	-0.226	21.5	<-- Station No. 4 ~ 2.5m
1340	0.235	0.515	0.281	-0.281	21.6	<-- Station No. 4 ~ 2.5m

Minutes Elapsed	Pressure Base_3	Pressure Inst_3	Pressure Diff	Pressure Diff	DegC_3	
1345	0.235	0.502	0.267	-0.267	21.5	<-- Station No. 4 ~ 2.5m
1350	0.235	0.445	0.210	-0.210	21.7	<-- Station No. 4 ~ 2.5m
1355	0.235	0.445	0.210	-0.210	21.6	<-- Station No. 4 ~ 2.5m
1360	0.235	0.538	0.303	-0.303	21.6	<-- Station No. 4 ~ 2.5m
1365	0.235	0.445	0.210	-0.210	21.6	<-- Station No. 4 ~ 2.5m
1370	0.235	0.452	0.217	-0.217	21.6	<-- Station No. 4 ~ 2.5m
1375	0.235	0.433	0.198	-0.198	21.7	<-- Station No. 4 ~ 2.5m
1380	0.235	0.456	0.221	-0.221	21.7	<-- Station No. 4 ~ 2.5m
1385	0.235	0.458	0.223	-0.223	21.7	<-- Station No. 4 ~ 2.5m
1390	0.235	0.502	0.267	-0.267	21.8	<-- Station No. 4 ~ 2.5m
1395	0.235	0.456	0.221	-0.221	21.9	<-- Station No. 4 ~ 2.5m
1400	0.235	0.424	0.189	-0.189	21.9	<-- Station No. 4 ~ 2.5m
1405	0.235	0.458	0.223	-0.223	22	<-- Station No. 4 ~ 2.5m
1410	0.235	0.493	0.258	-0.258	22	<-- Station No. 4 ~ 2.5m
1415	0.235	0.442	0.208	-0.208	22	<-- Station No. 4 ~ 2.5m
1420	0.235	0.413	0.178	-0.178	22.1	<-- Station No. 4 ~ 2.5m
1425	0.235	0.456	0.221	-0.221	22.1	<-- Station No. 4 ~ 2.5m
1430	0.235	0.495	0.260	-0.260	22.1	<-- Station No. 4 ~ 2.5m
1435	0.235	0.406	0.171	-0.171	22.2	<-- Station No. 4 ~ 2.5m
1440	0.235	0.406	0.171	-0.171	22.5	<-- Station No. 4 ~ 2.5m

Author's Regression Equation

	Dia = 1.5m										
1.5	FOS =	1.1987	+	0.0060065	SF	+	0.0031731	Depth	-	0.22138	Ep
	Dia = 2.0m										
2	FOS =	1.1243	+	0.0056998	SF	+	0.0069021	Depth	-	0.23482	Ep
	Dia = 2.5m										
2.5	FOS =	1.1646	+	0.0055929	SF	+	0.0039906	Depth	-	0.26674	Ep
	Dia = 3.0m										
3	FOS =	1.1332	+	0.005212	SF	+	0.0049319	Depth	-	0.25045	Ep

Kahtri & Kumar (2010) **H/b**

1	2	3	4	5	6	7	8	9	10	<-- H/b
4.893	5.801	6.397	6.856	7.386	7.748	8.047	8.348	8.642	8.958	<-- γH/c

Michalowski (2002)

c / γ H*tan(phi)	F / tan(phi)				
0.100	0.957	0.05	0.266	5.3141	0.1882
0.150	1.223	0.05	0.246	4.9288	0.2029
0.200	1.469	0.10	0.448	4.4758	0.2234
0.300	1.917	0.10	0.442	4.4193	0.2263
0.400	2.359	0.10	0.403	4.0296	0.2482
0.500	2.762				

Huang & Ji (2022)

c / γ H*tan(phi)	F / tan(phi)				
0.100	0.899	0.05	0.303	6.0537	0.1652
0.150	1.202	0.05	0.275	5.4944	0.1820
0.200	1.477	0.10	0.497	4.9703	0.2012
0.300	1.974	0.10	0.451	4.5110	0.2217
0.400	2.425	0.10	0.420	4.1977	0.2382
0.500	2.845				

Keawsawasvong (2017)

where $N_c = F_{\beta 1} + F_{\beta 2}\sqrt{\frac{H}{b}} + F_{\beta 3}\frac{H}{b}$

where $F_{\beta 1} = a_1 + \frac{10}{3}\cos(\beta) - \frac{1}{2}\cos^2(\beta)$

$F_{\beta 2} = a_2 + \frac{1}{8}\cos(\beta)$

$F_{\beta 3} = a_3 - \frac{1}{2}\cos(\beta) + \frac{1}{4}\cos^2(\beta)$

$Nc = \frac{\gamma H}{c}$

a1 = 2.8711
a2 = 2.4209
a3 = -0.1373
a4 = 0.7709
a5 = -2.2195
a6 = 1.8365

β = 90
cos(β) = 0.000

Khatri & Kumar (2010): Maximum % of "Under-estimation" = -113.5%; Maximum % of "Over-estimation" = 44.7%

Keawsawasvong (2017): Maximum % of "Under-estimation" = -116.9%; Maximum % of "Over-estimation" = 42.6%

Author's Regression Equation for Caisson Diameter of 1.5m									Khatri & Kumar (2010)			Huang & Ji (2022)			Keawsawasvong (2017)						Huang & Ji (2022)		
Caisson Dia. (m)	Cohesion c	Friction Angle phi	Str. Factor SF	H/b	b (Dia/2)	H (H/b*b)	Ep	FOS	H/b	γ H / c	c / γ H*tan(phi)	FOS/tan(phi)	FOS	% Diff.	H/b	$F_{\beta 1}$	$F_{\beta 2}$	$F_{\beta 3}$	γ H / c	c / γ H*tan(phi)	FOS/tan(phi)	FOS	% Diff
1.5	2	33	66	1	0.75	0.75	2	1.155	1	4.893	0.315	2.040	1.325	12.8%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	9.6%
1.5	2	33	66	2	0.75	1.5	2	1.157	2	5.801	0.265	1.802	1.170	1.1%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	-1.6%
1.5	2	33	66	3	0.75	2.25	2	1.160	3	6.397	0.241	1.679	1.090	-6.3%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	-9.3%
1.5	2	33	66	4	0.75	3	2	1.162	4	6.856	0.225	1.599	1.038	-11.9%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	-15.4%
1.5	2	33	66	5	0.75	3.75	2	1.164	5	7.386	0.208	1.519	0.986	-18.0%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	-20.3%
1.5	2	33	66	6	0.75	4.5	2	1.167	6	7.748	0.199	1.470	0.955	-22.2%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	-24.9%
1.5	2	33	66	7	0.75	5.25	2	1.169	7	8.047	0.191	1.429	0.928	-26.0%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	-29.0%
1.5	2	33	66	8	0.75	6	2	1.171	8	8.348	0.184	1.391	0.904	-29.6%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	-32.7%
1.5	2	33	66	9	0.75	6.75	2	1.174	9	8.642	0.178	1.357	0.881	-33.2%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	-36.0%
1.5	2	33	66	10	0.75	7.5	2	1.176	10	8.958	0.172	1.322	0.859	-37.0%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	-39.1%
1.5	3.5	35	122.5	1	0.75	0.75	2	1.494	1	4.893	0.292	1.933	1.354	-10.4%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	-14.7%
1.5	3.5	35	122.5	2	0.75	1.5	2	1.496	2	5.801	0.246	1.706	1.195	-25.2%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	-28.6%
1.5	3.5	35	122.5	3	0.75	2.25	2	1.499	3	6.397	0.223	1.592	1.115	-34.4%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	-38.1%
1.5	3.5	35	122.5	4	0.75	3	2	1.501	4	6.856	0.208	1.518	1.063	-41.2%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-45.5%
1.5	3.5	35	122.5	5	0.75	3.75	2	1.504	5	7.386	0.193	1.440	1.008	-49.1%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-52.2%
1.5	3.5	35	122.5	6	0.75	4.5	2	1.506	6	7.748	0.184	1.391	0.974	-54.7%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-58.0%
1.5	3.5	35	122.5	7	0.75	5.25	2	1.508	7	8.047	0.177	1.353	0.947	-59.2%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-63.0%
1.5	3.5	35	122.5	8	0.75	6	2	1.511	8	8.348	0.171	1.318	0.923	-63.7%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-67.5%
1.5	3.5	35	122.5	9	0.75	6.75	2	1.513	9	8.642	0.165	1.286	0.900	-68.1%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-71.6%
1.5	3.5	35	122.5	10	0.75	7.5	2	1.516	10	8.958	0.159	1.254	0.878	-72.6%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-75.2%
1.5	5	39	195	1	0.75	0.75	2	1.930	1	4.893	0.252	1.737	1.407	-37.2%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-42.4%
1.5	5	39	195	2	0.75	1.5	2	1.932	2	5.801	0.213	1.541	1.248	-54.8%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-58.8%
1.5	5	39	195	3	0.75	2.25	2	1.934	3	6.397	0.193	1.438	1.165	-66.1%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-70.9%
1.5	5	39	195	4	0.75	3	2	1.937	4	6.856	0.180	1.367	1.107	-74.9%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-80.5%
1.5	5	39	195	5	0.75	3.75	2	1.939	5	7.386	0.167	1.296	1.050	-84.7%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-88.4%
1.5	5	39	195	6	0.75	4.5	2	1.941	6	7.748	0.159	1.254	1.015	-91.3%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-95.2%
1.5	5	39	195	7	0.75	5.25	2	1.944	7	8.047	0.153	1.221	0.989	-96.6%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-101.2%
1.5	5	39	195	8	0.75	6	2	1.946	8	8.348	0.148	1.189	0.963	-102.1%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-107.0%
1.5	5	39	195	9	0.75	6.75	2	1.949	9	8.642	0.143	1.159	0.938	-107.6%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-112.2%
1.5	5	39	195	10	0.75	7.5	2	1.951	10	8.958	0.138	1.128	0.914	-113.5%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-116.9%
1.5					0.75																		
1.5	2	33	66	1	0.75	0.75	3	0.933	1	4.893	0.315	2.040	1.325	29.6%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	26.9%
1.5	2	33	66	2	0.75	1.5	3	0.936	2	5.801	0.265	1.802	1.170	20.0%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	17.8%
1.5	2	33	66	3	0.75	2.25	3	0.938	3	6.397	0.241	1.679	1.090	14.0%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	11.5%
1.5	2	33	66	4	0.75	3	3	0.941	4	6.856	0.225	1.599	1.038	9.4%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	6.6%
1.5	2	33	66	5	0.75	3.75	3	0.943	5	7.386	0.208	1.519	0.986	4.4%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	2.6%
1.5	2	33	66	6	0.75	4.5	3	0.945	6	7.748	0.199	1.470	0.955	1.0%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	-1.2%
1.5	2	33	66	7	0.75	5.25	3	0.948	7	8.047	0.191	1.429	0.928	-2.1%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	-4.6%
1.5	2	33	66	8	0.75	6	3	0.950	8	8.348	0.184	1.391	0.904	-5.1%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	-7.6%
1.5	2	33	66	9	0.75	6.75	3	0.952	9	8.642	0.178	1.357	0.881	-8.1%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	-10.4%
1.5	2	33	66	10	0.75	7.5	3	0.955	10	8.958	0.172	1.322	0.859	-11.2%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	-12.9%
1.5	3.5	35	122.5	1	0.75	0.75	3	1.273	1	4.893	0.292	1.933	1.354	6.0%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	2.3%
1.5	3.5	35	122.5	2	0.75	1.5	3	1.275	2	5.801	0.246	1.706	1.195	-6.7%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	-9.6%
1.5	3.5	35	122.5	3	0.75	2.25	3	1.277	3	6.397	0.223	1.592	1.115	-14.6%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	-17.7%
1.5	3.5	35	122.5	4	0.75	3	3	1.280	4	6.856	0.208	1.518	1.063	-20.4%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-24.1%
1.5	3.5	35	122.5	5	0.75	3.75	3	1.282	5	7.386	0.193	1.440	1.008	-27.2%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-29.8%
1.5	3.5	35	122.5	6	0.75	4.5	3	1.285	6	7.748	0.184	1.391	0.974	-31.9%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-34.8%
1.5	3.5	35	122.5	7	0.75	5.25	3	1.287	7	8.047	0.177	1.353	0.947	-35.9%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-39.1%
1.5	3.5	35	122.5	8	0.75	6	3	1.289	8	8.348	0.171	1.318	0.923	-39.7%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-43.0%
1.5	3.5	35	122.5	9	0.75	6.75	3	1.292	9	8.642	0.165	1.286	0.900	-43.5%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-46.5%
1.5	3.5	35	122.5	10	0.75	7.5	3	1.294	10	8.958	0.159	1.254	0.878	-47.4%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-49.6%
1.5	5	39	195	1	0.75	0.75	3	1.708	1	4.893	0.252	1.737	1.407	-21.4%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-26.1%
1.5	5	39	195	2	0.75	1.5	3	1.711	2	5.801	0.213	1.541	1.248	-37.1%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-40.6%
1.5	5	39	195	3	0.75	2.25	3	1.713	3	6.397	0.193	1.438	1.165	-47.1%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-51.3%
1.5	5	39	195	4	0.75	3	3	1.715	4	6.856	0.180	1.367	1.107	-54.9%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-59.9%
1.5	5	39	195	5	0.75	3.75	3	1.718	5	7.386	0.167	1.296	1.050	-63.6%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-66.9%
1.5	5	39	195	6	0.75	4.5	3	1.720	6	7.748	0.159	1.254	1.015	-69.4%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-72.9%
1.5	5	39	195	7	0.75	5.25	3	1.722	7	8.047	0.153	1.221	0.989	-74.2%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-78.3%
1.5	5	39	195	8	0.75	6	3	1.725	8	8.348	0.148	1.189	0.963	-79.1%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-83.4%
1.5	5	39	195	9	0.75	6.75	3	1.727	9	8.642	0.143	1.159	0.938	-84.0%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-88.1%
1.5	5	39	195	10	0.75	7.5	3	1.730	10	8.958	0.138	1.128	0.914	-89.3%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-92.3%
1.5					0.75																		

Author's Regression Equation

	Dia = 1.5m								
1.5	FOS =	1.1987	+	0.0060065	SF +	0.0031731	Depth -	0.22138	Ep
	Dia = 2.0m								
2	FOS =	1.1243	+	0.0056998	SF +	0.0069021	Depth -	0.23482	Ep
	Dia = 2.5m								
2.5	FOS =	1.1646	+	0.0055929	SF +	0.0039906	Depth -	0.26674	Ep
	Dia = 3.0m								
3	FOS =	1.1332	+	0.005212	SF +	0.0049319	Depth -	0.25045	Ep

Kahtri & Kumar (2010) **H/b**

1	2	3	4	5	6	7	8	9	10	<-- H/b
4.893	5.801	6.397	6.856	7.386	7.748	8.047	8.348	8.642	8.958	<-- γH/c

Michalowski (2002)

c / (γ H*tan(phi))	F / tan(phi)				
0.100	0.957	0.05	0.266	5.3141	0.1882
0.150	1.223	0.05	0.246	4.9288	0.2029
0.200	1.469	0.10	0.448	4.4758	0.2234
0.300	1.917	0.10	0.442	4.4193	0.2263
0.400	2.359	0.10	0.403	4.0296	0.2482
0.500	2.762				

Huang & Ji (2022)

c / (γ H*tan(phi))	F / tan(phi)				
0.100	0.899	0.05	0.303	6.0537	0.1652
0.150	1.202	0.05	0.275	5.4944	0.1820
0.200	1.477	0.10	0.497	4.9703	0.2012
0.300	1.974	0.10	0.451	4.5110	0.2217
0.400	2.425	0.10	0.420	4.1977	0.2382
0.500	2.845				

Keawsawasvong (2017)

$$\text{where } N_c = F_{\beta 1} + F_{\beta 2}\sqrt{\frac{H}{b}} + F_{\beta 3}\frac{H}{b}$$

$$\text{where } F_{\beta 1} = a_1 + \frac{10}{3}\cos(\beta) - \frac{1}{2}\cos^2(\beta)$$

$$F_{\beta 2} = a_2 + \frac{1}{8}\cos(\beta)$$

$$F_{\beta 3} = a_3 - \frac{1}{2}\cos(\beta) + \frac{1}{4}\cos^2(\beta)$$

$$Nc = \frac{\gamma H}{c}$$

a1 = 2.8711
a2 = 2.4209
a3 = -0.1373
a4 = 0.7709
a5 = -2.2195
a6 = 1.8365

β = 90
cos(β) = 0.000

Khatri & Kumar (2010): Maximum % of "Under-estimation" = -113.5%; Maximum % of "Over-estimation" = 44.7%

Keawsawasvong (2017): Maximum % of "Under-estimation" = -116.9%; Maximum % of "Over-estimation" = 42.6%

Author's Regression Equation for Caisson Diameter of 1.5m: Caisson Dia. (m)	Cohesion c	Friction Angle phi	Str. Factor SF	H/b	b (Dia/2)	H (H/b*b)	Ep	FOS	Khatri & Kumar (2010): H/b	γ H / c	c / (γ H*tan(phi))	Huang & Ji (2022): FOS/tan(phi)	FOS	% Diff.	Keawsawasvong (2017): H/b	$F_{\beta 1}$	$F_{\beta 2}$	$F_{\beta 3}$	γ H / c	c / (γ H*tan(phi))	Huang & Ji (2022): FOS/tan(phi)	FOS	% Diff
2	2	33	66	1	1	1	2	1.038	1	4.893	0.315	2.040	1.325	21.7%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	18.8%
2	2	33	66	2	1	2	2	1.045	2	5.801	0.265	1.802	1.170	10.7%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	8.3%
2	2	33	66	3	1	3	2	1.052	3	6.397	0.241	1.679	1.090	3.6%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	0.9%
2	2	33	66	4	1	4	2	1.058	4	6.856	0.225	1.599	1.038	-1.9%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	-5.1%
2	2	33	66	5	1	5	2	1.065	5	7.386	0.208	1.519	0.986	-8.0%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	-10.1%
2	2	33	66	6	1	6	2	1.072	6	7.748	0.199	1.470	0.955	-12.3%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	-14.8%
2	2	33	66	7	1	7	2	1.079	7	8.047	0.191	1.429	0.928	-16.3%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	-19.1%
2	2	33	66	8	1	8	2	1.086	8	8.348	0.184	1.391	0.904	-20.2%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	-23.0%
2	2	33	66	9	1	9	2	1.093	9	8.642	0.178	1.357	0.881	-24.0%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	-26.7%
2	2	33	66	10	1	10	2	1.100	10	8.958	0.172	1.322	0.859	-28.1%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	-30.1%
2	3.5	35	122.5	1	1	1	2	1.360	1	4.893	0.292	1.933	1.354	-0.4%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	-4.4%
2	3.5	35	122.5	2	1	2	2	1.367	2	5.801	0.246	1.706	1.195	-14.4%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	-17.5%
2	3.5	35	122.5	3	1	3	2	1.374	3	6.397	0.223	1.592	1.115	-23.2%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	-26.6%
2	3.5	35	122.5	4	1	4	2	1.380	4	6.856	0.208	1.518	1.063	-29.9%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-33.8%
2	3.5	35	122.5	5	1	5	2	1.387	5	7.386	0.193	1.440	1.008	-37.6%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-40.5%
2	3.5	35	122.5	6	1	6	2	1.394	6	7.748	0.184	1.391	0.974	-43.2%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-46.3%
2	3.5	35	122.5	7	1	7	2	1.401	7	8.047	0.177	1.353	0.947	-47.9%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-51.4%
2	3.5	35	122.5	8	1	8	2	1.408	8	8.348	0.171	1.318	0.923	-52.6%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-56.1%
2	3.5	35	122.5	9	1	9	2	1.415	9	8.642	0.165	1.286	0.900	-57.2%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-60.4%
2	3.5	35	122.5	10	1	10	2	1.422	10	8.958	0.159	1.254	0.878	-62.0%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-64.4%
2	5	39	195	1	1	1	2	1.773	1	4.893	0.252	1.737	1.407	-26.0%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-30.8%
2	5	39	195	2	1	2	2	1.780	2	5.801	0.213	1.541	1.248	-42.7%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-46.3%
2	5	39	195	3	1	3	2	1.787	3	6.397	0.193	1.438	1.165	-53.4%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-57.9%
2	5	39	195	4	1	4	2	1.794	4	6.856	0.180	1.367	1.107	-62.0%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-67.2%
2	5	39	195	5	1	5	2	1.801	5	7.386	0.167	1.296	1.050	-71.5%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-75.0%
2	5	39	195	6	1	6	2	1.808	6	7.748	0.159	1.254	1.015	-78.1%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-81.7%
2	5	39	195	7	1	7	2	1.814	7	8.047	0.153	1.221	0.989	-83.5%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-87.8%
2	5	39	195	8	1	8	2	1.821	8	8.348	0.148	1.189	0.963	-89.1%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-93.7%
2	5	39	195	9	1	9	2	1.828	9	8.642	0.143	1.159	0.938	-94.8%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-99.1%
2	5	39	195	10	1	10	2	1.835	10	8.958	0.138	1.128	0.914	-100.8%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-104.0%
2					1																		
2	2	33	66	1	1	1	3	0.803	1	4.893	0.315	2.040	1.325	39.4%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	37.2%
2	2	33	66	2	1	2	3	0.810	2	5.801	0.265	1.802	1.170	30.8%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	28.9%
2	2	33	66	3	1	3	3	0.817	3	6.397	0.241	1.679	1.090	25.1%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	23.0%
2	2	33	66	4	1	4	3	0.824	4	6.856	0.225	1.599	1.038	20.7%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	18.2%
2	2	33	66	5	1	5	3	0.831	5	7.386	0.208	1.519	0.986	15.8%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	14.2%
2	2	33	66	6	1	6	3	0.837	6	7.748	0.199	1.470	0.955	12.3%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	10.4%
2	2	33	66	7	1	7	3	0.844	7	8.047	0.191	1.429	0.928	9.0%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	6.8%
2	2	33	66	8	1	8	3	0.851	8	8.348	0.184	1.391	0.904	5.8%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	3.6%
2	2	33	66	9	1	9	3	0.858	9	8.642	0.178	1.357	0.881	2.6%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	0.5%
2	2	33	66	10	1	10	3	0.865	10	8.958	0.172	1.322	0.859	-0.7%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	-2.3%
2	3.5	35	122.5	1	1	1	3	1.125	1	4.893	0.292	1.933	1.354	16.9%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	13.6%
2	3.5	35	122.5	2	1	2	3	1.132	2	5.801	0.246	1.706	1.195	5.3%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	2.7%
2	3.5	35	122.5	3	1	3	3	1.139	3	6.397	0.223	1.592	1.115	-2.1%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	-4.9%
2	3.5	35	122.5	4	1	4	3	1.146	4	6.856	0.208	1.518	1.063	-7.8%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-11.1%
2	3.5	35	122.5	5	1	5	3	1.153	5	7.386	0.193	1.440	1.008	-14.3%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-16.7%
2	3.5	35	122.5	6	1	6	3	1.159	6	7.748	0.184	1.391	0.974	-19.1%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-21.6%
2	3.5	35	122.5	7	1	7	3	1.166	7	8.047	0.177	1.353	0.947	-23.1%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-26.0%
2	3.5	35	122.5	8	1	8	3	1.173	8	8.348	0.171	1.318	0.923	-27.2%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-30.1%
2	3.5	35	122.5	9	1	9	3	1.180	9	8.642	0.165	1.286	0.900	-31.1%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-33.8%
2	3.5	35	122.5	10	1	10	3	1.187	10	8.958	0.159	1.254	0.878	-35.2%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-37.3%
2	5	39	195	1	1	1	3	1.538	1	4.893	0.252	1.737	1.407	-9.4%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-13.5%
2	5	39	195	2	1	2	3	1.545	2	5.801	0.213	1.541	1.248	-23.8%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-27.0%
2	5	39	195	3	1	3	3	1.552	3	6.397	0.193	1.438	1.165	-33.2%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-37.1%
2	5	39	195	4	1	4	3	1.559	4	6.856	0.180	1.367	1.107	-40.8%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-45.3%
2	5	39	195	5	1	5	3	1.566	5	7.386	0.167	1.296	1.050	-49.1%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-52.2%
2	5	39	195	6	1	6	3	1.573	6	7.748	0.159	1.254	1.015	-54.9%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-58.1%
2	5	39	195	7	1	7	3	1.580	7	8.047	0.153	1.221	0.989	-59.8%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-63.5%
2	5	39	195	8	1	8	3	1.587	8	8.348	0.148	1.189	0.963	-64.7%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-68.7%
2	5	39	195	9	1	9	3	1.593	9	8.642	0.143	1.159	0.938	-69.8%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-73.5%
2	5	39	195	10	1	10	3	1.600	10	8.958	0.138	1.128	0.914	-75.1%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-77.9%
2					1																		

Author's Regression Equation

Dia = 1.5m

1.5	FOS =	1.1987	+	0.0060065	SF	+	0.0031731	Depth	-	0.22138 Ep

Dia = 2.0m

2	FOS =	1.1243	+	0.0056998	SF	+	0.0069021	Depth	-	0.23482 Ep

Dia = 2.5m

2.5	FOS =	1.1646	+	0.0055929	SF	+	0.0039906	Depth	-	0.26674 Ep

Dia = 3.0m

3	FOS =	1.1332	+	0.005212	SF	+	0.0049319	Depth	-	0.25045 Ep

Kahtri & Kumar (2010) **H/b**

1	2	3	4	5	6	7	8	9	10	<-- H/b
4.893	5.801	6.397	6.856	7.386	7.748	8.047	8.348	8.642	8.958	<-- γH/c

Michalowski (2002)

c / γ H*tan(phi)	F / tan(phi)				
0.100	0.957	0.05	0.266	5.3141	0.1882
0.150	1.223	0.05	0.246	4.9288	0.2029
0.200	1.469	0.10	0.448	4.4758	0.2234
0.300	1.917	0.10	0.442	4.4193	0.2263
0.400	2.359	0.10	0.403	4.0296	0.2482
0.500	2.762				

Keawsawasvong (2017)

where $N_c = F_{\beta 1} + F_{\beta 2}\sqrt{\frac{H}{b}} + F_{\beta 3}\frac{H}{b}$

where $F_{\beta 1} = a_1 + \frac{10}{3}\cos(\beta) - \frac{1}{2}\cos^2(\beta)$

$F_{\beta 2} = a_2 + \frac{1}{8}\cos(\beta)$

$F_{\beta 3} = a_3 - \frac{1}{2}\cos(\beta) + \frac{1}{4}\cos^2(\beta)$

$Nc = \frac{\gamma H}{c}$

a1 = 2.8711
a2 = 2.4209
a3 = -0.1373
a4 = 0.7709
a5 = -2.2195
a6 = 1.8365

β = 90
cos(β) = 0.000

Huang & Ji (2022)

c / γ H*tan(phi)	F / tan(phi)				
0.100	0.899	0.05	0.303	6.0537	0.1652
0.150	1.202	0.05	0.275	5.4944	0.1820
0.200	1.477	0.10	0.497	4.9703	0.2012
0.300	1.974	0.10	0.451	4.5110	0.2217
0.400	2.425	0.10	0.420	4.1977	0.2382
0.500	2.845				

Maximum % of "Under-estimation" = -113.5%
Maximum % of "Over-estimation" = 44.7%

Maximum % of "Under-estimation" = -116.9%
Maximum % of "Over-estimation" = 42.6%

Author's Regression Equation for Caisson Diameter of 1.5m									Khatri & Kumar (2010)						Keawsawasvong (2017)								
Caisson Dia. (m)	Cohesion c	Friction Angle phi	Str. Factor SF	H/b	b (Dia/2)	H (H/b*b)	Ep	FOS	H/b	γ H / c	c / γ H*tan(phi)	Huang & Ji (2022) FOS/tan(phi)	FOS	% Diff.	H/b	$F_{\beta 1}$	$F_{\beta 2}$	$F_{\beta 3}$	γ H / c	c / γ H*tan(phi)	Huang & Ji (2022) FOS/tan(phi)	FOS	% Diff
2.5	2	33	66	1	1.25	1.25	2	1.005	1	4.893	0.315	2.040	1.325	24.1%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	21.3%
2.5	2	33	66	2	1.25	2.5	2	1.010	2	5.801	0.265	1.802	1.170	13.7%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	11.3%
2.5	2	33	66	3	1.25	3.75	2	1.015	3	6.397	0.241	1.679	1.090	6.9%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	4.3%
2.5	2	33	66	4	1.25	5	2	1.020	4	6.856	0.225	1.599	1.038	1.8%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	-1.3%
2.5	2	33	66	5	1.25	6.25	2	1.025	5	7.386	0.208	1.519	0.986	-3.9%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	-6.0%
2.5	2	33	66	6	1.25	7.5	2	1.030	6	7.748	0.199	1.470	0.955	-7.9%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	-10.3%
2.5	2	33	66	7	1.25	8.75	2	1.035	7	8.047	0.191	1.429	0.928	-11.5%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	-14.2%
2.5	2	33	66	8	1.25	10	2	1.040	8	8.348	0.184	1.391	0.904	-15.1%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	-17.8%
2.5	2	33	66	9	1.25	11.25	2	1.045	9	8.642	0.178	1.357	0.881	-18.6%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	-21.1%
2.5	2	33	66	10	1.25	12.5	2	1.050	10	8.958	0.172	1.322	0.859	-22.3%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	-24.2%
2.5	3.5	35	122.5	1	1.25	1.25	2	1.321	1	4.893	0.292	1.933	1.354	2.4%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	-1.5%
2.5	3.5	35	122.5	2	1.25	2.5	2	1.326	2	5.801	0.246	1.706	1.195	-11.0%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	-14.0%
2.5	3.5	35	122.5	3	1.25	3.75	2	1.331	3	6.397	0.223	1.592	1.115	-19.4%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	-22.7%
2.5	3.5	35	122.5	4	1.25	5	2	1.336	4	6.856	0.208	1.518	1.063	-25.7%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-29.5%
2.5	3.5	35	122.5	5	1.25	6.25	2	1.341	5	7.386	0.193	1.440	1.008	-33.0%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-35.8%
2.5	3.5	35	122.5	6	1.25	7.5	2	1.346	6	7.748	0.184	1.391	0.974	-38.3%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-41.2%
2.5	3.5	35	122.5	7	1.25	8.75	2	1.351	7	8.047	0.177	1.353	0.947	-42.6%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-46.0%
2.5	3.5	35	122.5	8	1.25	10	2	1.356	8	8.348	0.171	1.318	0.923	-47.0%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-50.4%
2.5	3.5	35	122.5	9	1.25	11.25	2	1.361	9	8.642	0.165	1.286	0.900	-51.2%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-54.3%
2.5	3.5	35	122.5	10	1.25	12.5	2	1.366	10	8.958	0.159	1.254	0.878	-55.6%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-58.0%
2.5	5	39	195	1	1.25	1.25	2	1.727	1	4.893	0.252	1.737	1.407	-22.8%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-27.4%
2.5	5	39	195	2	1.25	2.5	2	1.732	2	5.801	0.213	1.541	1.248	-38.8%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-42.4%
2.5	5	39	195	3	1.25	3.75	2	1.737	3	6.397	0.193	1.438	1.165	-49.1%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-53.4%
2.5	5	39	195	4	1.25	5	2	1.742	4	6.856	0.180	1.367	1.107	-57.3%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-62.3%
2.5	5	39	195	5	1.25	6.25	2	1.747	5	7.386	0.167	1.296	1.050	-66.4%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-69.7%
2.5	5	39	195	6	1.25	7.5	2	1.752	6	7.748	0.159	1.254	1.015	-72.6%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-76.1%
2.5	5	39	195	7	1.25	8.75	2	1.757	7	8.047	0.153	1.221	0.989	-77.7%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-81.8%
2.5	5	39	195	8	1.25	10	2	1.762	8	8.348	0.148	1.189	0.963	-82.9%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-87.3%
2.5	5	39	195	9	1.25	11.25	2	1.767	9	8.642	0.143	1.159	0.938	-88.2%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-92.4%
2.5	5	39	195	10	1.25	12.5	2	1.772	10	8.958	0.138	1.128	0.914	-93.9%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-97.0%
2.5					1.25																		
2.5	2	33	66	1	1.25	1.25	3	0.738	1	4.893	0.315	2.040	1.325	44.3%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	42.2%
2.5	2	33	66	2	1.25	2.5	3	0.743	2	5.801	0.265	1.802	1.170	36.5%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	34.7%
2.5	2	33	66	3	1.25	3.75	3	0.748	3	6.397	0.241	1.679	1.090	31.4%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	29.4%
2.5	2	33	66	4	1.25	5	3	0.753	4	6.856	0.225	1.599	1.038	27.4%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	25.2%
2.5	2	33	66	5	1.25	6.25	3	0.758	5	7.386	0.208	1.519	0.986	23.1%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	21.6%
2.5	2	33	66	6	1.25	7.5	3	0.763	6	7.748	0.199	1.470	0.955	20.0%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	18.3%
2.5	2	33	66	7	1.25	8.75	3	0.768	7	8.047	0.191	1.429	0.928	17.2%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	15.2%
2.5	2	33	66	8	1.25	10	3	0.773	8	8.348	0.184	1.391	0.904	14.4%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	12.4%
2.5	2	33	66	9	1.25	11.25	3	0.778	9	8.642	0.178	1.357	0.881	11.7%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	9.8%
2.5	2	33	66	10	1.25	12.5	3	0.783	10	8.958	0.172	1.322	0.859	8.8%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	7.4%
2.5	3.5	35	122.5	1	1.25	1.25	3	1.054	1	4.893	0.292	1.933	1.354	22.1%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	19.0%
2.5	3.5	35	122.5	2	1.25	2.5	3	1.059	2	5.801	0.246	1.706	1.195	11.3%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	8.9%
2.5	3.5	35	122.5	3	1.25	3.75	3	1.064	3	6.397	0.223	1.592	1.115	4.5%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	1.9%
2.5	3.5	35	122.5	4	1.25	5	3	1.069	4	6.856	0.208	1.518	1.063	-0.6%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-3.7%
2.5	3.5	35	122.5	5	1.25	6.25	3	1.074	5	7.386	0.193	1.440	1.008	-6.5%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-8.8%
2.5	3.5	35	122.5	6	1.25	7.5	3	1.079	6	7.748	0.184	1.391	0.974	-10.9%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-13.2%
2.5	3.5	35	122.5	7	1.25	8.75	3	1.084	7	8.047	0.177	1.353	0.947	-14.5%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-17.2%
2.5	3.5	35	122.5	8	1.25	10	3	1.089	8	8.348	0.171	1.318	0.923	-18.1%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-20.8%
2.5	3.5	35	122.5	9	1.25	11.25	3	1.094	9	8.642	0.165	1.286	0.900	-21.6%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-24.1%
2.5	3.5	35	122.5	10	1.25	12.5	3	1.099	10	8.958	0.159	1.254	0.878	-25.2%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-27.1%
2.5	5	39	195	1	1.25	1.25	3	1.460	1	4.893	0.252	1.737	1.407	-3.8%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-7.7%
2.5	5	39	195	2	1.25	2.5	3	1.465	2	5.801	0.213	1.541	1.248	-17.4%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-20.4%
2.5	5	39	195	3	1.25	3.75	3	1.470	3	6.397	0.193	1.438	1.165	-26.2%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-29.9%
2.5	5	39	195	4	1.25	5	3	1.475	4	6.856	0.180	1.367	1.107	-33.2%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-37.5%
2.5	5	39	195	5	1.25	6.25	3	1.480	5	7.386	0.167	1.296	1.050	-41.0%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-43.8%
2.5	5	39	195	6	1.25	7.5	3	1.485	6	7.748	0.159	1.254	1.015	-46.3%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-49.3%
2.5	5	39	195	7	1.25	8.75	3	1.490	7	8.047	0.153	1.221	0.989	-50.7%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-54.2%
2.5	5	39	195	8	1.25	10	3	1.495	8	8.348	0.148	1.189	0.963	-55.2%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-59.0%
2.5	5	39	195	9	1.25	11.25	3	1.500	9	8.642	0.143	1.159	0.938	-59.8%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-63.3%
2.5	5	39	195	10	1.25	12.5	3	1.505	10	8.958	0.138	1.128	0.914	-64.7%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-67.3%
2.5					1.25																		

Author's Regression Equation

Dia = 1.5m

1.5	FOS =	1.1987	+	0.0060065	SF	+	0.0031731	Depth	-	0.22138	Ep

Dia = 2.0m

2	FOS =	1.1243	+	0.0056998	SF	+	0.0069021	Depth	-	0.23482	Ep

Dia = 2.5m

2.5	FOS =	1.1646	+	0.0055929	SF	+	0.0039906	Depth	-	0.26674	Ep

Dia = 3.0m

3	FOS =	1.1332	+	0.005212	SF	+	0.0049319	Depth	-	0.25045	Ep

Kahtri & Kumar (2010) **H/b**

1	2	3	4	5	6	7	8	9	10	<-- H/b
4.893	5.801	6.397	6.856	7.386	7.748	8.047	8.348	8.642	8.958	<-- γH/c

Michalowski (2002)

c / γ H*tan(phi)	F / tan(phi)				
0.100	0.957	0.05	0.266	5.3141	0.1882
0.150	1.223	0.05	0.246	4.9288	0.2029
0.200	1.469	0.10	0.448	4.4758	0.2234
0.300	1.917	0.10	0.442	4.4193	0.2263
0.400	2.359	0.10	0.403	4.0296	0.2482
0.500	2.762				

Huang & Ji (2022)

c / γ H*tan(phi)	F / tan(phi)				
0.100	0.899	0.05	0.303	6.0537	0.1652
0.150	1.202	0.05	0.275	5.4944	0.1820
0.200	1.477	0.10	0.497	4.9703	0.2012
0.300	1.974	0.10	0.451	4.5110	0.2217
0.400	2.425	0.10	0.420	4.1977	0.2382
0.500	2.845				

Keawsawasvong (2017)

where $N_c = F_{\beta 1} + F_{\beta 2}\sqrt{\frac{H}{b}} + F_{\beta 3}\frac{H}{b}$

where $F_{\beta 1} = a_1 + \frac{10}{3}\cos(\beta) - \frac{1}{2}\cos^2(\beta)$

$F_{\beta 2} = a_2 + \frac{1}{8}\cos(\beta)$

$F_{\beta 3} = a_3 - \frac{1}{2}\cos(\beta) + \frac{1}{4}\cos^2(\beta)$

$Nc = \frac{\gamma H}{c}$

a1 = 2.8711
a2 = 2.4209
a3 = -0.1373
a4 = 0.7709
a5 = -2.2195
a6 = 1.8365

β = 90
cos(β) = 0.000

Maximum % of "Under-estimation" = -113.5%
Maximum % of "Over-estimation" = 44.7%

Maximum % of "Under-estimation" = -116.9%
Maximum % of "Over-estimation" = 42.6%

Author's Regression Equation for Caisson Diameter of 1.5m									Khatri & Kumar (2010)						Keawsawasvong (2017)								
Caisson Dia. (m)	Cohesion c	Friction Angle phi	Str. Factor SF	H/b	b (Dia/2)	H (H/b*b)	Ep	FOS	H/b	γ H / c	c / γ H*tan(phi)	Huang & Ji (2022) FOS/tan(phi)	FOS	% Diff.	H/b	$F_{\beta 1}$	$F_{\beta 2}$	$F_{\beta 3}$	γ H / c	c / γ H*tan(phi)	Huang & Ji (2022) FOS/tan(phi)	FOS	% Diff
3	2	33	66	1	1.5	1.5	2	0.984	1	4.893	0.315	2.040	1.325	25.8%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	23.0%
3	2	33	66	2	1.5	3	2	0.991	2	5.801	0.265	1.802	1.170	15.3%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	13.0%
3	2	33	66	3	1.5	4.5	2	0.998	3	6.397	0.241	1.679	1.090	8.4%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	5.9%
3	2	33	66	4	1.5	6	2	1.006	4	6.856	0.225	1.599	1.038	3.1%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	0.1%
3	2	33	66	5	1.5	7.5	2	1.013	5	7.386	0.208	1.519	0.986	-2.7%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	-4.7%
3	2	33	66	6	1.5	9	2	1.021	6	7.748	0.199	1.470	0.955	-6.9%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	-9.3%
3	2	33	66	7	1.5	10.5	2	1.028	7	8.047	0.191	1.429	0.928	-10.8%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	-13.5%
3	2	33	66	8	1.5	12	2	1.035	8	8.348	0.184	1.391	0.904	-14.6%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	-17.3%
3	2	33	66	9	1.5	13.5	2	1.043	9	8.642	0.178	1.357	0.881	-18.4%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	-20.9%
3	2	33	66	10	1.5	15	2	1.050	10	8.958	0.172	1.322	0.859	-22.3%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	-24.2%
3	3.5	35	122.5	1	1.5	1.5	2	1.278	1	4.893	0.292	1.933	1.354	5.6%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	1.8%
3	3.5	35	122.5	2	1.5	3	2	1.286	2	5.801	0.246	1.706	1.195	-7.6%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	-10.5%
3	3.5	35	122.5	3	1.5	4.5	2	1.293	3	6.397	0.223	1.592	1.115	-16.0%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	-19.2%
3	3.5	35	122.5	4	1.5	6	2	1.300	4	6.856	0.208	1.518	1.063	-22.3%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-26.1%
3	3.5	35	122.5	5	1.5	7.5	2	1.308	5	7.386	0.193	1.440	1.008	-29.7%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-32.4%
3	3.5	35	122.5	6	1.5	9	2	1.315	6	7.748	0.184	1.391	0.974	-35.1%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-38.0%
3	3.5	35	122.5	7	1.5	10.5	2	1.323	7	8.047	0.177	1.353	0.947	-39.6%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-42.9%
3	3.5	35	122.5	8	1.5	12	2	1.330	8	8.348	0.171	1.318	0.923	-44.1%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-47.5%
3	3.5	35	122.5	9	1.5	13.5	2	1.337	9	8.642	0.165	1.286	0.900	-48.5%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-51.6%
3	3.5	35	122.5	10	1.5	15	2	1.345	10	8.958	0.159	1.254	0.878	-53.2%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-55.5%
3	5	39	195	1	1.5	1.5	2	1.656	1	4.893	0.252	1.737	1.407	-17.7%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-22.2%
3	5	39	195	2	1.5	3	2	1.663	2	5.801	0.213	1.541	1.248	-33.3%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-36.7%
3	5	39	195	3	1.5	4.5	2	1.671	3	6.397	0.193	1.438	1.165	-43.4%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-47.6%
3	5	39	195	4	1.5	6	2	1.678	4	6.856	0.180	1.367	1.107	-51.6%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-56.4%
3	5	39	195	5	1.5	7.5	2	1.686	5	7.386	0.167	1.296	1.050	-60.6%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-63.8%
3	5	39	195	6	1.5	9	2	1.693	6	7.748	0.159	1.254	1.015	-66.8%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-70.2%
3	5	39	195	7	1.5	10.5	2	1.700	7	8.047	0.153	1.221	0.989	-72.0%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-76.0%
3	5	39	195	8	1.5	12	2	1.708	8	8.348	0.148	1.189	0.963	-77.3%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-81.6%
3	5	39	195	9	1.5	13.5	2	1.715	9	8.642	0.143	1.159	0.938	-82.8%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-86.8%
3	5	39	195	10	1.5	15	2	1.723	10	8.958	0.138	1.128	0.914	-88.5%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-91.5%
3					1.5																		
3	2	33	66	1	1.5	1.5	3	0.733	1	4.893	0.315	2.040	1.325	44.7%	1	2.8711	2.4209	-0.1373	5.155	0.299	1.967	1.278	42.6%
3	2	33	66	2	1.5	3	3	0.741	2	5.801	0.265	1.802	1.170	36.7%	2	2.8711	2.4209	-0.1373	6.020	0.256	1.754	1.139	35.0%
3	2	33	66	3	1.5	4.5	3	0.748	3	6.397	0.241	1.679	1.090	31.4%	3	2.8711	2.4209	-0.1373	6.652	0.231	1.633	1.061	29.5%
3	2	33	66	4	1.5	6	3	0.755	4	6.856	0.225	1.599	1.038	27.3%	4	2.8711	2.4209	-0.1373	7.164	0.215	1.551	1.007	25.0%
3	2	33	66	5	1.5	7.5	3	0.763	5	7.386	0.208	1.519	0.986	22.7%	5	2.8711	2.4209	-0.1373	7.598	0.203	1.490	0.968	21.2%
3	2	33	66	6	1.5	9	3	0.770	6	7.748	0.199	1.470	0.955	19.3%	6	2.8711	2.4209	-0.1373	7.977	0.193	1.438	0.934	17.5%
3	2	33	66	7	1.5	10.5	3	0.778	7	8.047	0.191	1.429	0.928	16.2%	7	2.8711	2.4209	-0.1373	8.315	0.185	1.395	0.906	14.2%
3	2	33	66	8	1.5	12	3	0.785	8	8.348	0.184	1.391	0.904	13.1%	8	2.8711	2.4209	-0.1373	8.620	0.179	1.359	0.883	11.1%
3	2	33	66	9	1.5	13.5	3	0.792	9	8.642	0.178	1.357	0.881	10.1%	9	2.8711	2.4209	-0.1373	8.898	0.173	1.329	0.863	8.2%
3	2	33	66	10	1.5	15	3	0.800	10	8.958	0.172	1.322	0.859	6.9%	10	2.8711	2.4209	-0.1373	9.154	0.168	1.302	0.846	5.4%
3	3.5	35	122.5	1	1.5	1.5	3	1.028	1	4.893	0.292	1.933	1.354	24.1%	1	2.8711	2.4209	-0.1373	5.155	0.277	1.860	1.302	21.1%
3	3.5	35	122.5	2	1.5	3	3	1.035	2	5.801	0.246	1.706	1.195	13.4%	2	2.8711	2.4209	-0.1373	6.020	0.237	1.662	1.164	11.0%
3	3.5	35	122.5	3	1.5	4.5	3	1.043	3	6.397	0.223	1.592	1.115	6.5%	3	2.8711	2.4209	-0.1373	6.652	0.215	1.550	1.085	3.9%
3	3.5	35	122.5	4	1.5	6	3	1.050	4	6.856	0.208	1.518	1.063	1.2%	4	2.8711	2.4209	-0.1373	7.164	0.199	1.473	1.032	-1.8%
3	3.5	35	122.5	5	1.5	7.5	3	1.057	5	7.386	0.193	1.440	1.008	-4.8%	5	2.8711	2.4209	-0.1373	7.598	0.188	1.411	0.988	-7.0%
3	3.5	35	122.5	6	1.5	9	3	1.065	6	7.748	0.184	1.391	0.974	-9.3%	6	2.8711	2.4209	-0.1373	7.977	0.179	1.361	0.953	-11.7%
3	3.5	35	122.5	7	1.5	10.5	3	1.072	7	8.047	0.177	1.353	0.947	-13.2%	7	2.8711	2.4209	-0.1373	8.315	0.172	1.322	0.925	-15.9%
3	3.5	35	122.5	8	1.5	12	3	1.080	8	8.348	0.171	1.318	0.923	-17.0%	8	2.8711	2.4209	-0.1373	8.620	0.166	1.288	0.902	-19.7%
3	3.5	35	122.5	9	1.5	13.5	3	1.087	9	8.642	0.165	1.286	0.900	-20.7%	9	2.8711	2.4209	-0.1373	8.898	0.161	1.260	0.882	-23.2%
3	3.5	35	122.5	10	1.5	15	3	1.094	10	8.958	0.159	1.254	0.878	-24.6%	10	2.8711	2.4209	-0.1373	9.154	0.156	1.235	0.865	-26.5%
3	5	39	195	1	1.5	1.5	3	1.406	1	4.893	0.252	1.737	1.407	0.1%	1	2.8711	2.4209	-0.1373	5.155	0.240	1.673	1.355	-3.7%
3	5	39	195	2	1.5	3	3	1.413	2	5.801	0.213	1.541	1.248	-13.2%	2	2.8711	2.4209	-0.1373	6.020	0.205	1.502	1.216	-16.2%
3	5	39	195	3	1.5	4.5	3	1.420	3	6.397	0.193	1.438	1.165	-21.9%	3	2.8711	2.4209	-0.1373	6.652	0.186	1.398	1.132	-25.5%
3	5	39	195	4	1.5	6	3	1.428	4	6.856	0.180	1.367	1.107	-28.9%	4	2.8711	2.4209	-0.1373	7.164	0.172	1.325	1.073	-33.1%
3	5	39	195	5	1.5	7.5	3	1.435	5	7.386	0.167	1.296	1.050	-36.7%	5	2.8711	2.4209	-0.1373	7.598	0.163	1.271	1.029	-39.5%
3	5	39	195	6	1.5	9	3	1.443	6	7.748	0.159	1.254	1.015	-42.1%	6	2.8711	2.4209	-0.1373	7.977	0.155	1.228	0.995	-45.0%
3	5	39	195	7	1.5	10.5	3	1.450	7	8.047	0.153	1.221	0.989	-46.6%	7	2.8711	2.4209	-0.1373	8.315	0.149	1.193	0.966	-50.1%
3	5	39	195	8	1.5	12	3	1.457	8	8.348	0.148	1.189	0.963	-51.3%	8	2.8711	2.4209	-0.1373	8.620	0.143	1.161	0.940	-55.0%
3	5	39	195	9	1.5	13.5	3	1.465	9	8.642	0.143	1.159	0.938	-56.1%	9	2.8711	2.4209	-0.1373	8.898	0.139	1.134	0.918	-59.5%
3	5	39	195	10	1.5	15	3	1.472	10	8.958	0.138	1.128	0.914	-61.1%	10	2.8711	2.4209	-0.1373	9.154	0.135	1.111	0.899	-63.7%

INDUSTRY COLLABORATIVE RESEARCH
The Hong Kong Polytechnic University and **Fong On Construction Limited**

HAND-DUG CAISSON WORKER INTERVIEW REPORT

Submitted by PolyU-BRE
Feb 2019

Team leaders:
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Ir. Jerry Lai

PREAMBLE

The interview was conducted to understand the …

This report is divided into 4 sections. Section 1 is …

The date of the interview is Jan. 15, 2019. The time of the interview was scheduled from 10:00 am to 13:00 pm. The venue of the interview is Fong On Construction Limited (address: …)

The interviewers are Ir. Jerry Lai and Ms. Dandan Li. The interviewee is Mr. Chen. Mr. Chen is a hand-dug caisson worker with … years of experience…

1. WORK PROCESS

1.1. Site preparation

1.1.1. Any expected difficulties in robotic-dug caisson?

Chen: Robot can be used in normal soil condition. When the soil conditions are complex, it may be difficult for the robot to perform soil excavation. For instance, the robot can be easily get damaged in a seaside site due to gushing water.

1.1.2. Any reasons of using hand-dug caisson? Economic, working area is limited or other reasons.

Chen: There are four main reasons:
(i) **Method**: The technology of hand-dug caisson is easier than other construction methods;
(ii) **Cost**: The cost of hand-dug caisson is lower than other construction methods. To illustrate, on the flat ground, the cost of the hand-dug caisson is **one-third** of the bored pile. On the steep slope, the cost of the hand-dug caisson may be even up to **one-seventh** of the bored pile. The reason is that the construction of bored pile requires the use of the heavy-duty machines and temporary working platform for placing the machines;
(iii) **Mobilisation**: It is easier to build hand-dug caisson on sloping site with limited working space. If bored piles require to be constructed on a slope, heavy-duty machines must be dismantled at the bottom of the hill and transported to the site which is not a problem of hand-dug caisson (Figure 1);
(iv) **Time**: When constructing a single pile, the time constructing a hand-dug caisson is longer than a bored pile. However, since hand-dug caissons can be constructed concurrently, the total duration of hand-dug caissons can be less than that of bored piles.

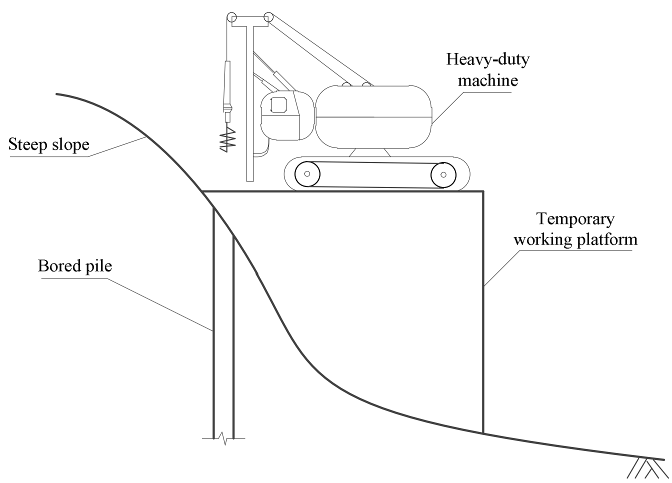

Figure 1: Construction of bored pile on steep slope

1.1.3. Any features of the construction sites suitable for using hand-dug caisson? Seaside?

Chen: The hand-dug caissons are more suitable for constructing the piles on the slopes and in the soils with low groundwater level. It is extremely difficult to construct hand-dug caisson at the seaside owing to the gushing water. If the soil is in "slurry" form particularly in reclaimed land, bored piles are more preferred.

1.1.4. Is soil investigation carrying out before starting of work?

Chen: Yes, the engineer must carry out the site and soil investigation before digging.

1.2. Excavation

Chen: The depth of daily excavation depends on the weather, soil condition, and other factors. Maximum depth is about 900mm/day. In general, there is no minimum depth requirement. However, site agents/foreman usually requires the workers to dig at least 550 mm/day in order to control the work progress and calculate labour rate. In any case, the workers must complete a ring of caisson one day. The last construction process of a day is pouring of a concrete lining such that the formwork should be left on site overnight.

1.3. Setting up formwork

1.3.1. Does the formwork need lateral bracing?

Chen: Usually not. The height of formwork with wedge-shape is 900mm, as shown in Figure 2. A formwork ring is assembled by four pieces of steel moulds and screws. One of the joints is inlaid with timber to control the installation and removal of the formwork on site. The gap for placing timber is 50-70mm. The formwork is usually installed at the end of the excavation and removed before starting the excavation on the following day.

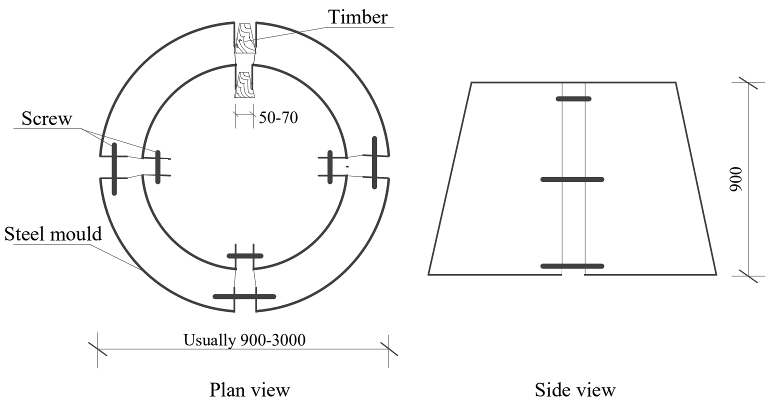

Figure 2: A sketch of formwork used in hand-dug caisson

1.3.2. What is the formwork made from? Metal, wooden, or other materials?

Chen: All formworks are made from steel.

1.3.3. Are there different heights of formwork?

Chen: The common height of formwork is 900mm. If the height of excavation is less than 900mm, the workers still use this formwork with 900mm and pour concrete lining with lower height. If the site condition is beneficial for caisson excavation, the height of formwork may be increased, e.g., to 1000mm.

1.4. Pouring concrete lining

1.4.1. Is there any reinforcement in concrete lining?

Chen: Maybe, whether reinforcement is needed in concrete lining depends on the diameter of caisson and the soil condition. This is determined by the engineer. When the draft diameter is less than 1.5m, usually, there is no reinforcement. Note that the thickest concrete lining is 120mm.

1.4.2. What type of concrete is used for casting lining? Ready-mix, mix in-situ by gauge box, mix in-situ by weighted batch or others?

Chen: The concrete for pouring lining is premixed and transported to the site by concrete truckmixers. The process of pouring lining requires two workers, one of them stands at the top of caisson to pour concrete into a funnel, the other worker stands at the bottom of caisson to control the pouring rate of concrete into the formwork and hammering the steel mould (the stiffener but not the plate) to vibrating the concrete. The construction of pouring concrete lining is shown in Figure 3.

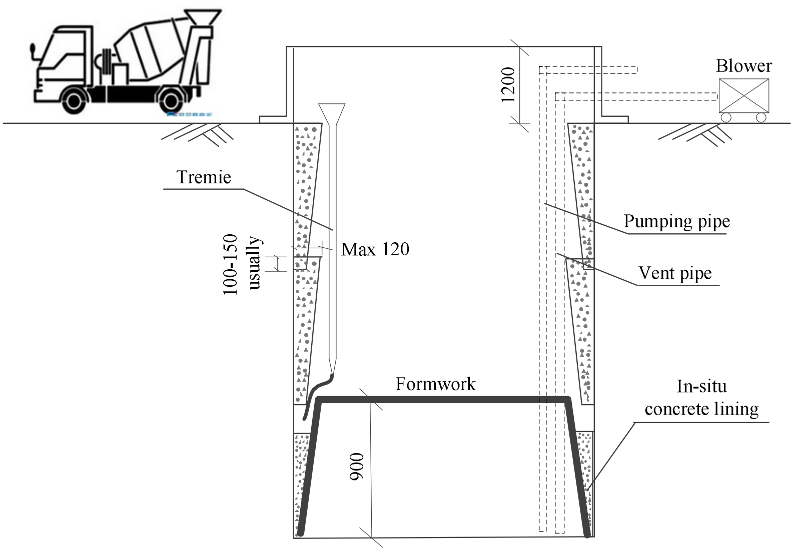

Figure 3: The construction of pouring concrete lining

1.5. Excavation of following cycle

1.5.1. How long is the setting time of concrete lining?

Chen: The formwork can be removed in the next day under the normal construction condition. Since the height of the formwork is certain, the overlapping height of concrete lining depends on the construction progress of the day, usually 100-150mm (Figure 3). If the progress is slow, such as due to rainy days, poor geological conditions, the overlapping height of concrete lining will be increased. This is decided by the site agent or the foreman.

1.6. Bottom bell-out (Construction method, steel bar)

1.6.1. What is the construction method of the bell-out at the bottom of the pile?

Chen: The bottom belling for caisson piles is very rare to be constructed. Caissons are usually straight without the bell-out.

1.6.2. What is the construction method in rock socket?

Chen: The construction in rock socket is the most difficult process. It takes 7-8 days to drill the rock with 800mm depth. The cost of construction in rock socket is at least **three times** than that of in soil. There is no need for pouring concrete lining in rock socket. During rock excavation: (i) first, the digging worker drill a lot of holes with 25 mm diameter on the rock starting from the middle, and divided it into several pieces similar to a cake (Figure 4); (ii) then, he drills two large holes on each piece of rock and ties them using steel wires; (iii) finally, these pieces of rocks are mechanically hooked and lifted one by one. Meanwhile, the worker keeps drilling the rock (between previously drilled holes) to separate (a piece of) the rock separate from the large piece of rock (i.e., indicated as "repeated hole" in Figure 4).

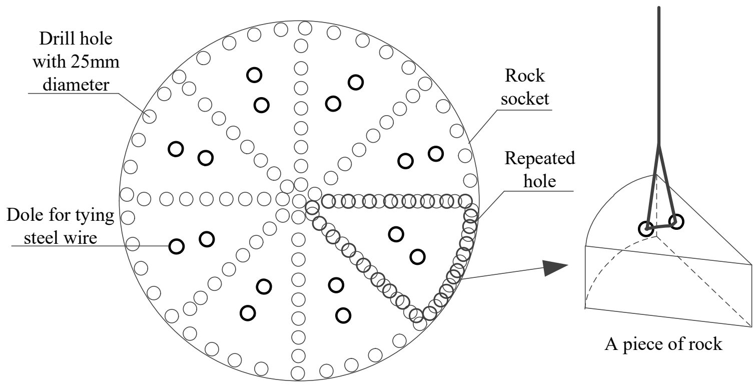

Figure 4: Digging the rock socket

1.6.3. <u>How to check the quality of excavation, concrete lining and rock?</u>

Chen: The engineer enters the caisson draft to check the quality of excavation and concrete lining. He will be lifted (up and down) by a steel cage to carry out visual inspection (Figure 5). In term of rock quality, the worker drills a hole with 5m depth at the caisson bottom and take out the rock core sample for lab testing. The drilling time is about 0.5 day.

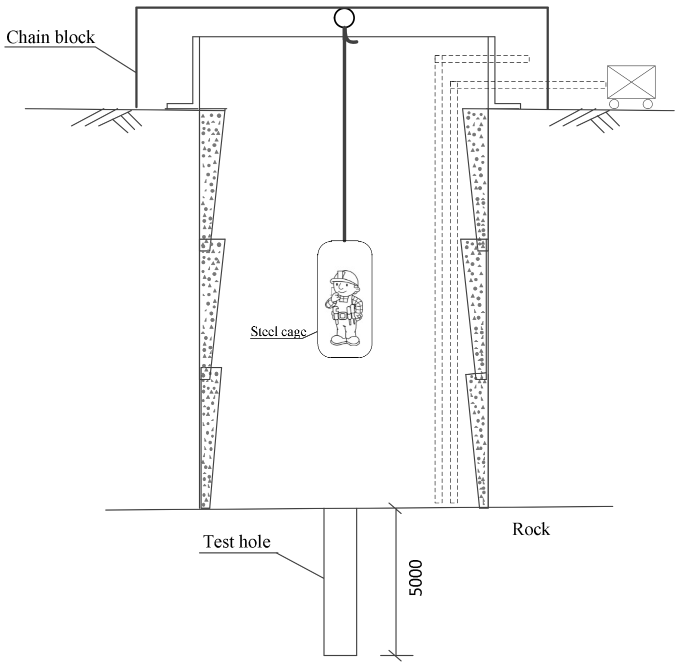

Figure 5: The sketch of checking quality

1.7. Placing reinforcement cage (Binding method in shaft, hoisting method, reinforcement cage installation)

1.7.1. <u>What is the construction method of placing reinforcement cage?</u>

Chen: A separate construction team, which is not the excavation team, is responsible for binding steel bars into reinforcement cages. A worker stays at the top of the caisson. He is responsible for transferring steel bars to the bottom of the shaft using a hoisting system. Another worker stays at the bottom of the caisson. He is responsible for fixing and binding a reinforcement cage. At the top of the caisson, there is a winch machine with ~7 m high for transferring steel bars (Figure 6). The length of a steel bar is ~12 m. The lifting point of the steel bar is slightly ahead of the middle point of it (i.e., indicated as “Lifting point” in Figure 6). At the bottom of the caisson, the worker fixes the dropped steel bars and ties them using steel wires into a reinforcement cage. The binding process is delivered from the bottom to top of the caisson.

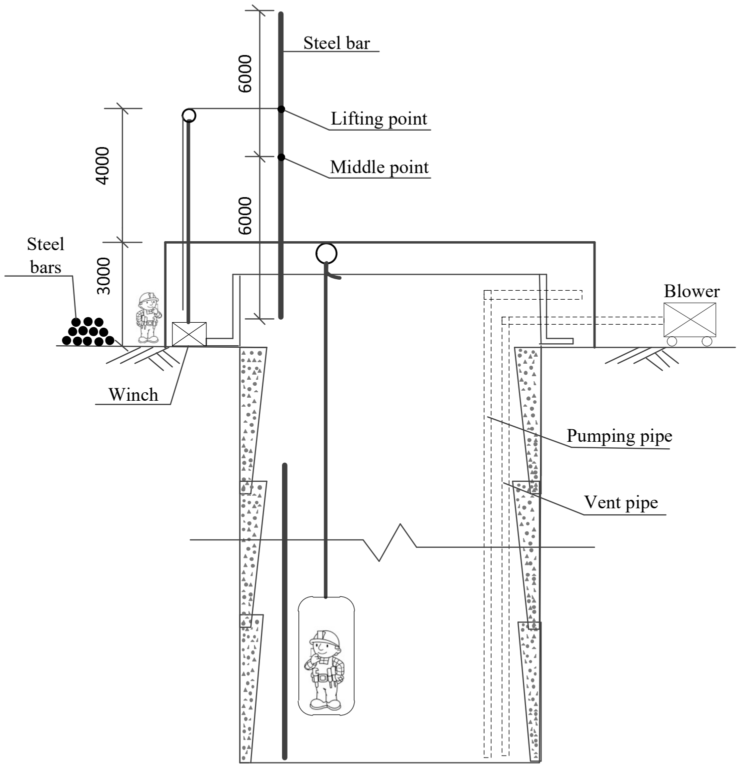

Figure 6: Reinforcement cage construction in hand-dug caisson

1.7.2. <u>Are there any safety concerns when placing the reinforcement cage?</u>

Chen: The construction of the reinforcement cage is the most dangerous process. There are two factors: (i) when transferring steel bars, it may fall suddenly and hit the workers; (ii) when fixing and tying the reinforcement cage, it could topple over *en masse*.

1.7.3. Are there any differences between hand-dug caisson and bored pile when constructing the reinforcement cage?

Jerry: The main difference of these two methods is the direction of cage construction. For hand-dug caisson construction, the reinforcement cages are connected from the bottom to the top. In contrast, for bored pile construction, the reinforcement cages are connected from top to bottom. The reinforcement cages are pre-fabricated and lifted by heavy-duty equipment and placed into the shaft in segments. As shown in Figure 7, a rebar cage fixing device is set up to suspend reinforcement cages at the upper part of the shaft, then, the bar benders and fixers will bind the connections between reinforcement cages.

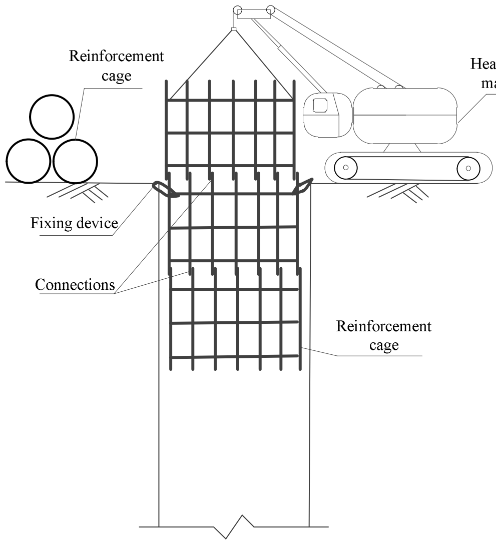

Figure 7: Connecting reinforcement cages in bored pile construction

1.8. Pouring concrete (Concrete casting, vibration method)

1.8.1. What is the construction method of pouring concrete?

Chen: Pouring concrete is the easiest process in hand-dug caisson. Workers use tremie pipes to pour concrete, and there is no need for vibration.

2. DESIGN AND EQUIPMENT

2.1. Design

2.1.1. Caisson diameter

Chen: The diameter of caisson is between 900mm and 3m. The common diameters of caisson are 1.5m, 2m, 2.2m and 2.5m. The diameter of caisson controls the concrete volume. The concrete volume is limited by the maximum concreting volume per day from practical point of view. There are very limited caissons with a diameter of 7m. The total volume of concrete for caisson of 7m diameter is over 1000 m^3. A caisson with larger diameter will collapse easily. Thus, it is better to construct a caisson with a small diameter. Notably, the depth of each ring is small if the shaft diameter is large. Mini-excavators are needed for constructing the caissons with large diameter.

2.1.2. Caisson depth

Chen: The maximum depth of caisson is 50m. There are limited caissons with 70m deep. For large diameter caissons, they are limited to 10m depth.

2.1.3. Concrete grade

Chen: 30D/20 (That means the concrete compressive strength at 28-day is 30 MPa, and the maximum diameter of the aggregate in the concrete is 20 mm.)

3. EQUIPMENT

Chen: The workers use shovels to dig the soil. The workers use pneumatic hammers to dig the rocks. Air compressor is used to power the pneumatic hammer. One single air compressor can provide the power for digging the rock in 7 caissons concurrently.

4. CONSTRUCTION MANAGEMENT

4.1. Project time management

4.1.1. What is the average time for constructing a "one ring" cycle?

Chen: The workers must complete one ring in a caisson each day, no matter how late it is. One digger can be responsible for constructing one ring of two caissons with 1-1.5m diameter per day. A caisson of 1.5m diameter can be constructed with 800 mm depth by the workers per day.

4.1.2. What is the average time before lining formwork is removed in a ring cycle?

Chen: Only one night.

4.1.3. How deep can the caisson being constructed by the workers in a day?

Chen: It depends on excavation depth, soil layer, and caisson diameter. The workers must construct a ring of caisson for each day. The workers usually excavate the shaft for at least 550mm per day.

4.2. Project cost management

4.2.1. How the workers' wages are distributed among different types of workers?

Chen: Wages are calculated according to the volume of excavated soil and rock. The salary of diggers is **2 times** as much as of other types of worker. If the soil and rock being excavated with same volume, the salary of digging the rock is **3 times** as much as of that digging the soil. As a result, the salary of the diggers can be **6 times** as much as of other types of workers.

4.2.2. What is the construction cost of a caisson?

Chen: It depends on the soil, rock, and location. If caisson construction is carried out at the top of a hill or at the seaside, the construction cost can hardly be estimated.

4.2.3. Which are the most critical factors affecting the cost?

Chen: Site geology and weather condition (rainy days).

4.3. Project quality management

4.3.1. How to control the groundwater level?

Chen: A dry condition of soil is required for caisson construction, and the specific water pumping schemes should be designed by the engineers. In order to reduce any adverse impact of pumping groundwater on surrounding buildings, grouting can be carried out to reinforce the soil around the caisson. Each construction site has more than 10 water-level monitoring equipment to detect the groundwater level near the caissons. If the diameter of caisson is 1.2m or 1.5m, soil grouting will be done in the area of within a diameter of 1.8m or 2m, respectively. The diameter of a grouting hole should not more than 300 mm.

4.3.2. How to ensure the quality of concrete lining?

Chen: By hammering the steel formwork (to the stiffener, but not steel plate) when concreting the lining.

4.4. Health and safety management

4.4.1. Is there any damage to the machines?

Chen: Machines can be damaged. The main cause is the drop of chain block.

4.4.2. Is there any safety measure for ensuring the worker's health and safety with respect to site condition? For example, is there any preventive measure for monitoring noxious gas, vapor, mist, smoke and dust?

Chen: To reduce the risk of having the lung disease, the caisson workers are required to wear special respiratory protective masks. The workers may be exposed to the noxious gases, especially during the rainy season. When the caissons are idled for few days, methane will be produced. In practice, to test if any methane gas accumulated in the caisson, the caisson worker will throw the lighted paper into the caisson to see if it burns more intensely. If so, it proves that methane gas exists. It should be ventilated before worker's entry.

4.4.3. Is there any measures ensuring worker's health and safety with respect to weather condition? For example, is there any responsive measure in dealing with the loss of worker productivity under site conditions of hot temperature or heavy rain?

Chen: Not the case. The temperature in the caisson is lower than that on the ground. The workers are preferred to be in the caissons.

4.5. Policies

4.5.1. What motivated worker to become a hand-dug caisson worker in the old days?

Chen: There are three reasons: (i) High salary; (ii) Technical nature of the job, the workers will paid more compared to other general workers; (ii) Flexible working hours, the skilled worker can leave early once his job is done.

4.5.2. What is the age profile of a hand-dug caisson worker?

Chen: The caisson workers usually begin their career when they are 30 years old. The career will be ended when they are 50 years old. Hence, the average age of the caisson workers is around 40 years old.

4.5.3. How their lives change when the practice was banned in Hong Kong?

Chen: When the practice of hand-dug caissons were banned, the Hong Kong government implemented slope maintenance policy. Most of the unemployed hand-dug caisson workers changed their career paths to soil nail workers.

- END -

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